



# ICT for people

**40 YEARS OF ACADEMIC DEVELOPMENT IN STOCKHOLM**





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*dsv*

*40 år*



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**ICT for People**

Department for Computer and Systems Sciences (DSV)  
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# Preface

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This book is the fruit of a collection of experiences from 40 years of academic research and education at the Department for Computer and Systems Sciences (DSV) at Stockholm University and Royal Institute of Technology. It is being presented at the occasion of the Department's 40th Anniversary.

The Department started its activities in the middle of 1966. During these 40 years that have passed, many organizational changes, research advancements, and educational modernizations have taken place.

In this book we have collected contributions that show the development of these activities at the Department from a number of different angles. We have tried to make this collection of impressions as broad as possible. Therefore we have approached numerous early teachers and researchers, and asked them to contribute personally to the book. Here, we have stressed the word "personally". We wanted the reader to receive an impression of academic activities in a wide and expanding environment.

Responsibility for the different chapter contributions where author names are given, rests with each author. For the rest of the book, an editorial group consisting of professors Janis Bubenko, Carl Gustav Jansson, Tomas Ohlin and Louise Yngström, and Head of Department Anita Kollerbaaur, is responsible. The editing and graphical presentations are made by Hardy Hedman.

This book should rather be viewed as a "documentary" than an exact recollection of "what happened". Our memories might be inadequate, and contributions may overlap. The Book is also complemented by information on the Web.

We wish the reader good and inspiring reading about a 40 year development that in our opinion has had the touch of pioneering academic activities. We welcome any attempt to do it again, starting from now.

Stockholm in October 2006

*For the Editorial group*



*Anita Kollerbaaur*

# Acknowledgements

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This 40 year Anniversary book is the fruit of dedicated work by many persons who at different times have been connected to, and employed by, the DSV Department at Stockholm University and the Royal Institute of Technology in Stockholm, Sweden.

Where not names of individual authors are shown below, responsibility for the work rests with a group of researchers consisting of professors *Janis Bubenko*, *Carl Gustaf Jansson*, *Tomas Ohlin*, *Louise Yngström*, and *Anita Kollerbaur* who is present Head of Department at DSV.

As seen below, three internationally recognized professors have been kind enough to accept special invitations to participate. These are *Arne Sølvyberg*, *Adele Goldberg*, and *Zary Segall*.

Furthermore, a large number of contributors have been present in the discussions, creative moments and writing hours, whose outcome is this volume. Among these, we would like to mention (in alphabetical order):

*Matts Alsén, Peter Bagge, Stig Berild, Gunnar Björkman, Henrik Boström, Elin Carlsson, Rudolfo Candia, Tord Dahl, Mats Danielsson, Love Ekenberg, Rune Engman, Göran Goldkuhl, Lars Gunnarsson, Mattias Hällström, Rolf Høyer, Kristina Höök, Kristo Ivanov, Paul Johanesson, Jussi Karlgren, Ken Larsson, Mats Lundeberg, Anders G Nilsson, Birgitta Olsson, Jacob Palme, Eduardo Pérez, Emily Rosenqvist, Robert Ramberg, Péter Révay, Eric Roupé, Anne-Marie Philipsson, Åsa Rudström, Kjell Samuelsson, Jozef Swiatycki, Lars Söderlund, Bengt Wangler, Mats Wiklund and Tobias Wrigstad.*

For language control *Karin Tidholm* has been a great help.

An important piece of work has been carried out by *Hardy Hedman*. He has defined text forms and created graphical layout for the book, in order to achieve its present reader comfort.

*A sincere thank you to all contributors!*

*The editorial group*

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# *DSV 40 years*

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**The Birth of an academic discipline in the information age.**



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# DSV 40 YEARS

## The birth of an academic discipline in the information age

### The delivery

In the beginning of the 1960s, it became clear on a political level that the expansive development related to computing would motivate increasing measures on several educational levels.

On April 3, 1963, the Swedish University Chancellor therefore appointed a committee, chaired by G. Hävermark, with a mission to investigate the need for activities in a new academic discipline, “Administrative Data Processing”, and to suggest a process for introducing it at Swedish universities. The committee ► produced a report “Akademisk utbildning i administrativ databehandling” on November 25, 1964 (UHÄ 1964). It recommended three chairs to be created, starting 1965 at the universities in Stockholm, Göteborg, and Lund. The report also presented course outlines for the first three semesters of academic studies, corresponding to 60 academic credit points. It was understood that studies in Administrative Data Processing should be combined with academic studies in other disciplines, such as Business Administration, Statistics or Mathematics, in order to achieve a Bachelor of Science degree (120 credit points in total).

The Ministry of Education decided to give the new discipline the following name: “Informationsbehandling, särskilt den administrativa databehandlingens metodik” (Information processing specialising in methods for administrative data processing). This corresponded at that time reasonably well to the discipline named “Information Systems” in certain other countries, including USA.

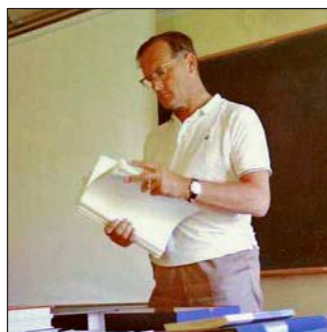
From July 1, 1965, the new discipline was established at the Royal Institute of Technology, Stockholm. The topic was to be taught not only to students of technology, but also to students at Stockholm University. The Department was formed in 1966. Börje Langefors was appointed acting professor in 1965 and full professor in 1967.

Twenty years later, in 1987, the name was changed to “Computer and Systems Sciences”, or in Swedish “Data- och Systemvetenskap”, or for short DSV. In this book, “DSV” will be used from now on also for the initial period.

From the 1990s and onwards, the abbreviation “IT” (for “information technology”), or internationally “ICT” (for “information and communications technology”) has come in wide use. In this text, IT and ICT are used as synonyms.

Looking back, it is difficult to keep a meta perspective, as so much has happened. This book tries to describe some of the most important events and developments within this tremendous evolution in education as well as in research, an evolution which have had a substantial impact on the Swedish society.

► Other members of the committee were O. Dopping (secretary), Carl-Erik Fröberg, Curt Kihlstedt, Björn Tell, and Christina Österberg.



**Börje Langefors,**  
the first professor

From the Swedish “Nationalencyklopedin” we note that the word “**DATOR**” in the middle of the 1960s was suggested by Börje Langefors. In short time the word reached wide recognition.

During the last thirty years we have seen systematic shifts in the use of computers. Originally used only in professional settings by comparatively few, computers were considered as peculiar unique artifacts, powerful but still primarily passive tools. Today the focus is on large groups of humans communicating and collaborating, assisted by large networks of fine-grained computational elements. These computational elements penetrate into all human activities and are used by virtually everybody. They are rapidly more embedded in and not distinguishable from other artifacts, and typically more active in the collaborative processes – in contrast to being the passive tools of yesterday.

In the academic discipline Computer and Systems Sciences, has been included knowledge and skills necessary to analyse, design, develop, and maintain information systems in organisations, small as well as large. According to Langefors, problems and methods related to information systems can be said to belong to the *infological* or to the *datalogical* realm. In the infological realm, focus is placed on analysis of organisations including aspects such as objectives, processes, and information requirements. Here, the aim is to study the information system from an organizational viewpoint. This includes analysis of information modelling and supply, as well as usability issues and human-computer interaction. In the datalogical realm, focus is placed on efficient storage, processing and communication of data. Particular topics here focus on data modelling, data base management, data manipulation languages, and query languages. The datalogical realm in Langefors view, also includes CASE-technology, method engineering, and software engineering.

Langefors also observed that Information Systems is a discipline with few fixed borders – conceptions and views are continuously changing. This means that new types of problems, infological as well as datalogical, constantly emerge, while other kinds of problems become less relevant as time passes. Many of these changes are triggered by advances in computer programming as well as computer and communication technology or by changing information demands.

Evidently, Computer and Systems Sciences encompass a large set of different scientific problems. They can be of technical, economical, organizational, social, legal, or political nature. It is not possible for one university department alone to develop expertise in solving more than a subset of all these problems.

Many of the more specific areas of competence, where DSV has contributed with pioneering thoughts, like systems development, information modelling, object-oriented programming, human-computer interaction, artificial intelligence, Internet technology, decision support systems, and information security were evidently not at all envisioned at early times. This also valid for applications

like computer-based education and computer conferencing systems.

### The growth of the organization

All activities at DSV organizationally belong to either KTH (The Royal Institute of Technology) or SU (Stockholm University). Today, in the beginning of the new century, the KTH activities are organized within the School of Information and Communication Technology, and the SU activities still within the faculty of Social Sciences. Research, graduate education, undergraduate education and all external society contacts are performed at both universities. Every course or program, every research project, every single employment and position are formally established at either SU or KTH. However, almost all employees are engaged in activities at both universities.

Administratively, this double organizational status demands a greater effort, but DSV considers it as an advantageous arrangement.

An academic discipline matures through developments in research and education carried out by its scholars. Since the start, DSV has developed from being a Department with a few enthusiastic optimists, to (in 2006) a large number of full time employments, some 135 persons. In total the number of individuals employed at DSV shorter or longer periods has been no less than 536. A total listing of all employed at DSV during 1966-2006 is given on DSV's web. All of these have contributed to DSV's development, in different roles, as teachers and researchers, as administrators and as teaching assistants. Because of the format of this book, it is not possible to give details of who developed and taught individual courses, who led and participated in the many research projects or who contributed to the internal development and administration. However, those who are not mentioned explicitly in this book by name should know that they are all remembered, and that plans are to make as much historical material as possible available on the DSV Jubilee web.

Aside of Börje Langefors, a few names could be specially mentioned. The initial group of teachers and researchers who took a special role in the creation of DSV were: Janis Bubenko jr, Peter Bagge, Rune Engman, Olle Källhammar, Nils Lindecrantz, Mats Lundeborg, Tomas Ohlin, and Kjell Samuelsson. DSV's Head of Department, who led the Department successfully during the long period 1979 - 2002, Tord Dahl, should be specially mentioned. From the second half of 2002, the Head of Department is Anita Kollerbaaur. At the Department, Anita has been the initializer of this book (supported by a working group consisting of Janis Bubenko, Carl Gustaf Jansson, Tomas Ohlin (secretary), and Louise Yngström).



**Janis Bubenko jr.**  
Professor at DSV 1981 - 2000.



**Tord Dahl**  
DSV's Head of Department  
1979 - 2002.



**Anita Kollerbaaur**  
DSV's Head of Department  
from 2002.

**Empirical summary**

A numerical overview of the DSV development is presented in the table below.

| Year                          | 1990 | 1995 | 2000 | 2005  |
|-------------------------------|------|------|------|-------|
| No of students                | 750  | 875  | 1150 | 1600  |
| No of graduated licentiates   | 8    | 6    | 7    | 8     |
| No of graduated doctors       | 1    | 2    | 2    | 12    |
| No of professors              | 2    | 4    | 4    | 8 ►   |
| Total income (in million sek) | 25   | 57   | 103  | 127►► |

The table illustrates development during from 1990 to 2005, showing totals for KTH and SU. The figure for students refers to those registered for 40 credit points. Guest professors are included, one in 1990 and two in 1999 and 2000.

► In 2006, the professors at SU are Love Ekenberg, Kia Höök, Harald Kjellin (2006), Jacob Palme, Robert Ramberg and Louise Yngström, at KTH Carl Gustaf Jansson, Paul Johannesson, Magnus Boman and Sead Muftic (2006). Professors emeritus are Börje Langefors and Janis Bubenko jr. Terttu Orci and Bengt Lundeberg both deceased in 2001.

►► 2005 the total income for research and graduate education was 34 million SEK, 60% from external funds The main financiers are Vinnova, EU, Swedish Knowledge Foundation Development, Swedish Foundation for Strategic Research and Swedish Research Council.

**DSV from the KTH campus to the Forum building in Kista**

**1966**

DSV started in the KTH campus



**1971**

The department moved to the new SU campus in Frescati



This quantitative development has been possible to achieve with preserved quality, which was certified by the National Swedish Agency for Higher Education. In their national evaluation of all University departments in the area 2003-2004, DSV's undergraduate education was judged as "First class" and one of the best in Sweden ►.

DSV was also awarded SU's price for best undergraduate education Department in 1997.

A number of political reforms regarding higher education have influenced DSV, as all other university departments. For development of research and graduate education we want to particularly mention the importance of the tenure track reform for professors, that considerably increased the numbers of professors. The growing Department has moved physically four times. The first premises were on core part of the KTH campus, to be followed by premises within the new SU campus in Frescati 1971, that hosted DSV until 1990. Since then, DSV has been located in Kista, first in the Electrum building, and then from 2001 in the Forum building, both at Isafjordsgatan.

The administrative tools at the Department have naturally also changed substantially, following the technical development. DSV has been a pioneer in the use of timesharing systems, personal computers, use of computer conferencing systems and web technology. This relates also to adoption of general tools, such as word processors. In one area DSV was late – the rationalization of its own internal administration. Critique from students led to the

► Evaluation of the discipline Computer and Systems Sciences/ Informatics in Swedish Universities, report 2004:10 R, National Agency for Higher Education (in Swedish).



Chancellor Gustaf Lindencrona and Head of Department Tord Dahl standing in front of the token for the award as SUs best undergraduate education department 1997.

1990

DSV in the Electrum building ...



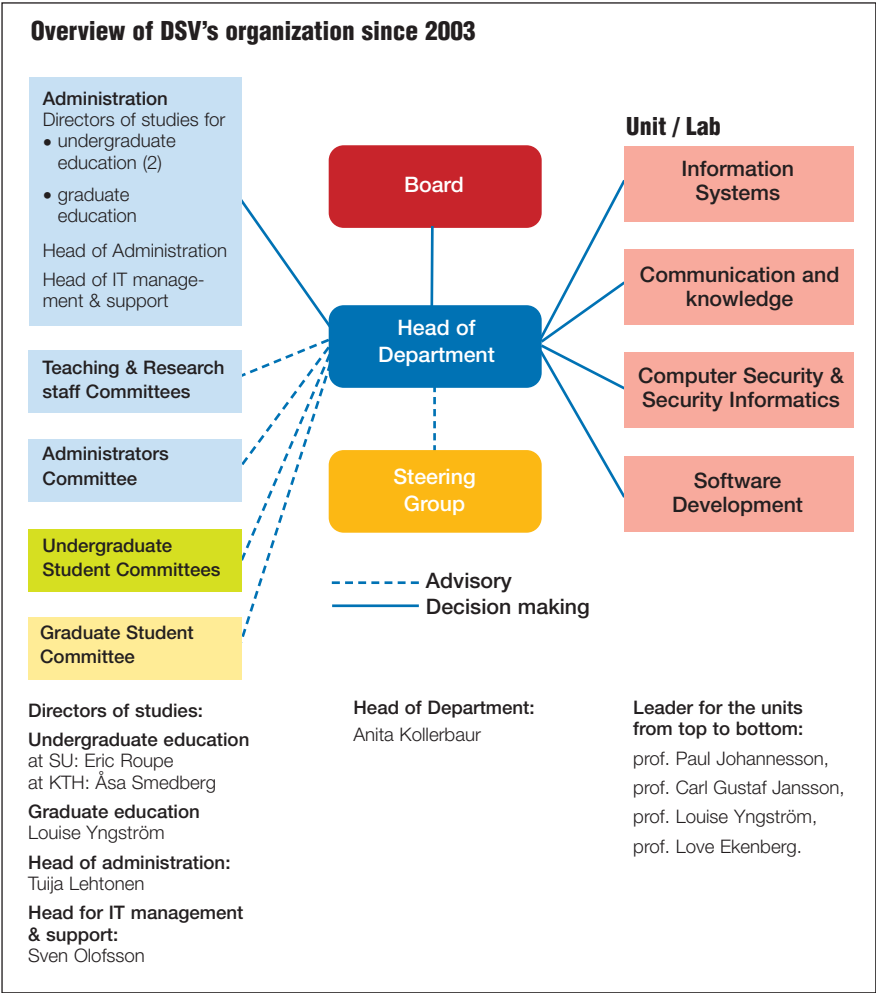
2001

and from 2001 in the Forum Building in Kista.



development of Daisy, now supporting most of the main work processes and parts of internal information both for students and employees. For group communication, FirstClass has been used since 1998.

A change in the organisation was made in 2003, illustrated in the figure below. Until 1995 the same main organization was kept, until the point when research was reorganized into three research laboratories.



**Undergraduate Education**

Undergraduate education has historically been the dominant activity for DSV caused by the need of educated people both within industry, academy and society in general. DSV's goal however is to achieve a balance between research and graduate education on one hand and undergraduate education on the other. DSV offers undergraduate courses and programs to students either

at Stockholm University or at KTH. Single-subject courses are often offered to joined groups. The SU education has always had a larger size compared to KTH

The first course block was offered in 1966, with approximately 70 students enrolled at SU. In 2005 the undergraduate education had grown to approximately 1600 student places per year. As a whole and contrary to most other departments in the same area, DSV's undergraduate education has not only been stable the last few years, but in effect also grown since 2000. This is interesting, since so many activities in the ICT sector at the change of century decreased in both quantity and impact.

The contents of DSV education should mirror both latest findings in research and the current needs in trade and industry, particularly within areas where DSV has special competence. Courses designed specifically for the KTH education programmes have another focus than those designed for SU programmes. However, the contents of many courses and educational elements are relevant for both target groups.

Single subject courses have been offered at both universities since the beginning, many with joint student groups and often as sets of courses in the same academic area, such as Security Informatics or Artificial Intelligence.

At SU, DSV has developed and offered the following main programmes:

- the three-year Applied Systems Science programme, (Systemvetenskapliga Linjen – short ASY) from 1977-1992
- the four-year Computer and Systems Sciences programme, 1993-2006
- the two-year Information Processing and Computer Science Programme (Datalinjen), 1983-1989
- the four-year ICT and Communication Science programme, from 2002
- the three-year Multimedia Education and Technology programme (a collaboration with the Pedagogic department), from 2004
- the Market Communication and ICT programme was established together with the institution for GI/IHR, from 2006
- the two-year ICT for Development Masters programme with international recruitment, from 2006

DSV's involvement in programmes at KTH consists of three masters programmes (60 credits – to be extended to 80 credits in 2007):

- engineering and management of information systems
- information and communication security
- interactive systems engineering.

To this should be added courses included in the KTH MSc programmes mainly the Information Technology, Technical Computer Science and Electrical Engineering programmes.

Experience showed that students increasingly prefer longer education.

The programmes and courses at SU have been successful in recruiting female students. The percentage of women varies. DSV has had figures between 31% and 48%, with a peak in 1999. Compared to the figures for female recruitment to the KTH programmes even the lowest of the above figures is high.

Evidently, the good relations and cooperation between the Department and students have to be mentioned. As required from the faculty at SU, students are organized in a Departmental student committee (Ämnesrådet – ÄR). In addition, students at DSV formed D.I.S.K. in February 1990, meaning the Students Union of the Department for Computer and Systems Sciences (“Data- och Systemvetenskapliga Institutionens Studerandes Kårörening”).

Regulations prescribe students to be represented in the board, and also to participate in preparation of educational changes. At DSV, students are consulted early in all planning processes which is of great value for the Department. The Student Counseling Committee includes representatives from ÄR and DISK. From DSV these discussions include the Head of Department, study rector, student counselors and responsible administrators.

### Graduate Education

The study programmes for DSV’s graduate program were initially specified solely for a Doctorate and a Licentiate in Computer and Systems Sciences, either at KTH or SU. In the year 2000, a study plan for the research area Man-Machine Interaction at Stockholm University was added, facilitating also for candidates with backgrounds in humanities, cognitive sciences, medicine or communication sciences to enter the PhD program at DSV.

All three programs include the mandatory courses Theory of Science, Research Methodology and Scientific Communication, while further courses are chosen within a wide range of higher level or PhD specific courses, to support the specific area of research the candidates are pursuing. Courses are offered by the Department, by arrangements between various Research Schools and consortia including also other national and international research collaborations. ►

There have been a number of organizational reforms influencing graduate education, 1969, 1973, 1990 and 1998. A new reform is expected in 2007.

At DSV, graduate education started in the late 1960s. It has passed a number of stages and has been coupled with changes particularly during the 1970s and the 1980s. Then there were too few advisors and too many students. The funding was limited, graduate students had to work a lot on their free time.

At the end of the 1970s, 67 students were enrolled as PhD or Licentiate candidates. 18 of them were registered at KTH, and 49

► Thorough analyses and descriptions of the graduate education (including also the undergraduate education) can be found in the DSV report “Självvärdering för Institutionen för data- och systemvetenskap, 2003-03-28, Underlag för Högskoleverkets utvärdering” (in Swedish).

at Stockholm University. At the end of the 1980s, the financial side was improved in connection to increased external funding. The increased number of professors and associate professors in the beginning of the new century has mainly solved the problem of supervising, but instead the funding has become a larger problem again. In 1998 the new PhD Educational Act was enforced, stating in principle that each PhD candidate should be fully funded from the beginning, in order to enter a PhD education, that would last between four and five years.

During a period, a Research Education Committee consisting of all supervisors was established, in order to stimulate and improve the whole graduate programme, and to link the PhD students' research closer to research at the laboratories.

A PhD programme study director was initiated 1995, to be further formalized 1997. This PhD programme is in 2006 coordinated by a steering group and a group of senior researchers.

In 2006, each of the 70-90 active PhD students has a main personal supervisor and belongs to one of the laboratories. There are local graduate programme coordinators to aid the supervisors – in this way the study director and the research secretary can support and supervise the program processes from a more general point of view than before ►.

In addition to “regular PhD students” being admitted to the programme, DSV has commitments with other universities in Sweden, whose teachers through grants for PhD studies pursue their education with DSV support.

Related to SIDA, concerning higher education in developing countries, selected university teachers to do the same ►►. In addition, DSV has industrial PhD candidates whose companies fund the studies.

Women now constitute a growing share of the PhD awardees. During the six years, 2000-2005, 25% of all DSV PhD degrees and 22% of all DSV Licentiate degrees were achieved by women. Over time, 65% of all women being awarded PhD degrees and 68% of all women being awarded Licentiate degrees at the Department were noted during the last six years.

## Research

Being a young department in a new scientific area, there were no research traditions to fall back upon in the 1960s and 1970s. Early research contributions were made in the research groups:

- CADIS (Computer-Aided Design of Information Systems) in the datalogical realm was initiated 1969 and led by Janis Bubenko.
- ISAC (Information Systems and Analysis of Change) performed research in the infological realm during the period 1970-1980, initiated and led by Mats Lundeberg.
- PRINCESS (PRoject for Interactive Computer-based Education SystemS) performing research on computers and education, was initiated 1973, led by Anita Kollerbaur.

► Organisation described was part of the re-organisation at the Department effectuated in 2003.

►► SIDA PhD candidates pursue their PhD program on a sandwich basis, meaning they spend half the time in DSV and the other half in their respective universities.

- Research on videoconferencing was started by Kjell Samuelsson in the middle of the 1970s, leading to the experimental system InformatiCom.
- Research in the area of Programming Methodology started 1976, initiated by Sten-Åke Tärnlund.

The main financing for these activities was external via STU (the Swedish National Board for Technical Development), with which the Department had an exceptionally productive cooperation during the 1970s, and SÖ (the Swedish National Board of Education).

Two research centres were established between 1980 and 1988, within the framework programme for research in Software and Information Systems funded by STU. CADIS became SYSLAB, with one location in Stockholm and one in Gothenburg, and the PRINCESS work was included in the centre CLEA (Computer-based LEarning environments). DSV also funded several large projects from the STU programme 1987-92.

In 1995, the number of projects and researchers had grown, and to improve coordination and to further stimulate the research, three laboratories were created: SECLab (Laboratory for Security Informatics), led by Sead Muftic, K2 Lab (Laboratory for Knowledge and Communication), led by Carl Gustaf Jansson, and SYSLab, Laboratory for Information Systems and Software Development, led by Janis Bubenko.

In 2003, DSV was reorganized into units with responsibility for research, graduate and undergraduate education in their respective areas:

- Security Informatics, which performs research from mainly three points of departure: from a Use/Paradigmatic perspective, from a Managing perspective, and from an Architecture perspective.
- Knowledge and Communication, in which studies are performed on how information technology, i.e. communication and computation systems, can support communication and augmentation of knowledge in groups of individuals and in organizations.
- Information Systems, which includes research within the areas of Business Intelligence, Database Technology, Enterprise Modelling, Interoperability, ICT in Organizations, Knowledge Management, Project Management, Software Maintenance, and Systems and Software Development Methods.
- Systems development, covering various aspects of software modelling, development and verification. The unit also hosts a large programme for ICT in developing countries and research on various aspects of games.

Research at DSV is often interdisciplinary, for instance in information systems relating to Economics and Law, within human-machine interaction relating to Psychology, Pedagogy, Linguistics

and Ethnography. In Software Development there are a close connections to Logics, Statistics and Applied Mathematics. During the last ten years, from 1995, the focus on design has triggered contacts also with disciplines in the areas of communication, industrial design and arts.

### **Influences and external impact**

Academic education in the Computer and Systems Sciences area is today (2006) taught at more than 20 universities and university colleges in Sweden, originating from the DSV. It is represented by departments having many different names such as Computer and Systems Sciences, Informatics, Economic Information Systems, and Business Information Systems.

DSV has in fact developed and hosted a fundamental source of academic knowledge, measured in the number of professors in the Nordic countries that have had their origin at the DSV Department (more than 30 in 2006). Furthermore, as is reported later in this book, the number of visiting international scholars and researchers at DSV is impressive.

A large number of scientific publications have been produced, including the PhD dissertations. Early prototypes of new applications have often shown to be useful for much longer periods than expected. Most important of all, it may be allowed to note that the knowledge that students with DSV exams have carried into practice in Swedish industry and public sector, has been substantial.

In subsequent parts of the book, the reader will find reports about DSV initiatives in arranging or leading national as well as international scientific conferences, and active participation in professional organizations such as IFIP, ACM and IEEE. There are also reports on cooperation with private and public companies, contacts with national organizations and public authorities, with international scientific networks and expert groups.

DSV is also proud to report an intense participation in EU-supported collaborative research and development projects. DSV has also stimulated several Swedish companies to increase their participation in EU-projects, and has also been instrumental in SIDA-supported projects aiming at supporting and promoting ICT in developing countries.

A number of spin-off companies have had DSV origin. Persons from DSV have initiated research institutes such as SISU and Institut V, and many private companies in the ICT area, including ENEA, Infocon, NeoTech, CNet, Projektplatsen, Compumine, MAD Preference, and more. These are later described in the book.

Many of the activities at DSV have naturally reach long outside the Department. The DSV impact on education in Swedish schools has been fruitful. This includes impacts from many educational research projects and useful cooperation with school administrations.

DSV has also responded to many requests to take part in public policy connected types of analysis of proposals and effects from education and research in “information society”. This concept was only vaguely defined in the 1970s and 80s. DSV rooted participation in public committees and commissions on industrial, social and legal information society matters have been strong, especially considering that reforms for expansion of higher education and research often have been born here. Many analytic reports with roots at the Department have been created, where expansion of education and research in information society have been described. In fact, it can be stated that analysts with close connection to the Department took active part in the very creation of the concept “information society”. Many concerns were analyzed, of organizational, structural, economic, social, and legal types. As a consequence, important social applications have been noted. These applications have shown to be of considerable value for expansion of later university educational development.

Taken together, this forms an impressive body of effects and influences from DSV education and research.

From THAIS, page 33,  
we choose:  
“The fundamental principle  
of systems work”

*This principle stresses the importance of determining requirements before designing a system and the importance of analysing whether the designed system actually meets the requirements. This principle is often overlooked even today.*

#### 10. The Fundamental Principle of Systems Work.

The argument presented above, as well as experience from different kinds of systems analysis and design, support the use of a fundamental principle for all systems analysis, design, or management. We give a precise statement of this fundamental working principle here and we then take it as a guiding rule for our further discussions.

##### 1 Fundamental Principle of Systems Work:

Partition the systems work into separate tasks, a through d,

##### a. Definition of the System as a set of parts.

List all parts from which the system is regarded as built-up.

##### b. Definition of System Structure.

Define all interconnections which make up the system by joining its parts together.

##### c. Definition of Systems Parts.

For each single part (or group of similar parts) separately define its properties as required by the system work at hand and do this in a format as specified by the way the systems structure is defined (in task b).

##### d. Determination of the properties of the system.

Using the definitions as produced by the tasks a, b, and all separate tasks c, all taken together. Compare with specifications wanted for the system and repeat a, b, c, and d until satisfied.

*This quotation points to the need for distinguishing between application knowledge and knowledge about the information system. Langefors also foresees the establishment of standards of information needs for different applications.*

From THAIS, page 149,  
we choose  
"The function of an  
information system"

#### 1. The function of an information system.

- 1 When an information system is needed it is as an auxiliary for another system. The information system has to provide the information needed at any point at any time, in a system.
- 2 It is usual to find that some information is needed often, but instead only in a limited part of the system while other information calls for data from many points in the system, but instead can be sampled at more distant points in time.
- 3 It is of course important in information system design to be able to pin-point situations of this kind because by neglecting such special properties of the system one may either be doing too much data transport and processing, or less than necessary. Both extremes will cause a loss.
- 4 In order to be able to determine the right amount of information to provide we need to be able to find out why information is needed in a system. We shall find it practical to turn around the question and ask instead how we could make use of information.
- 5 It is when a system changes its state with time that we need a continuously working information system and, as a consequence, meet the problem of designing the information system for efficient information flows and information collection.
- 6 If the system served (or controlled) by the information system is static the information system becomes merely a computation, for instance in the form of setting up a system of equations, finding its solution, and evaluating the solution.
- 7 A consequence of 5 is that information system design will most often be concerned with information for the control of a dynamic system. The information needs, timewise, will have to be determined by the rate with which it must be made available, and processed, in order to provide for a control of the (controlled) system so that it performs in a stable way.
- 8 The problems of how to control belong to control theory (or decision theory). The theory of information systems has to study the information needs, and processing needs, as established by control theory, and to find economic means for providing this information and processing.

It follows from what has been said that one basic problem for the information system design is to find different kinds of information which are of potential utility for the control to be effected by means of the information system. We thus have, as any problem solving situation, a need for a search activity. Information system science can do a lot to aid in this search by establishing check-lists of the information needs for the production of different kinds of information. For the development of such check-lists both survey of information relations in existing systems and study of theoretically established decision rules are useful.

From THAIS, page 150,  
we choose  
“Two tasks of an  
information system”

*This quotation introduces the distinction between operative and directive information. It points to the importance of analysing the utility of directive information and of evaluating it against the cost of producing it. This principle is equally important today. It is, however, often neglected in practical systems work.*

## 2. Two tasks of an information system.

- 1 The different functions of an information system can be classified into two kinds of tasks (or “task-categories”). In one of these tasks information is necessary, in the other task information has a smaller or greater utility, while not being absolutely necessary. Information for the second task is optional and in order to determine whether to bring it in and use it in the system or not, one has to estimate both the utility and the information processing cost that would follow its introduction.
- 2 The kind of task for which information is necessary has to do with the operative functioning of the managed system. For this operative functioning any “administrative system” is dependent on information even if all questions of systems economy are disregarded. (For many technical (non-administrative) systems this is not the case.) Thus operative information is a necessity.
- 3 When we also add to the requirement of operative functioning a requirement of total system economy, then new kinds of information are called for. We shall call this directive information. The reason why we regard this second kind of tasks for information as not necessary but only useful is that it appears that many, perhaps most, business systems to-day must (on closer analysis) be said to disregard total system economy and concentrate upon operative functioning, probably because before reasonably operative functioning has been achieved then everything else is of secondary importance.
- 4 As we shall see the information needed for operative functioning at one system point can be delimited to a small, neighbouring part of the system. Consequently this kind of information tasks puts limited requirements on the capacity for communication and information processing and also reduces the sophistication required. This may explain how manual systems have managed to handle these tasks fairly well and how practical experience has been a reasonably satisfactory background.
- 5 When interest is focussed on total system economy a completely different situation comes up before the information system designer (and its manager). Now the need arises of using information from all over the system and even from its environment and this enters both big communication problems and a need for sophisticated analysis. And now need arises to have clearly defined the goals of the total system management. Typically, the operative-functioning-concentrated management can do without goals defined – and has done so forever.

*It is easy to see that when Langefors talks about "points in a system" and information about them, he actually means the same as when we today talk about "objects" and information about objects in a system. An additional quality of Langefors' thinking about information is the added temporal dimension - every elementary message about a system point also has an indication about the time of the validity of the information.*

From THAIS, page 181-2,  
we choose  
"The meaning of information within a system"

#### 4. The meaning of Information within a system

The meaning of a certain kind of information as defined above is well defined with respect to the system. It is knowledge of the status or behaviour of one specified point within the system.

We find that when we talk about getting information from a system point we will normally mean a new state description from that point, to be added to the total, stored, information about that point. Obviously we need to distinguish between "information" in the sense of kind of information and "information" as obtained from some system point. To this end we introduce the term "message" and use it to mean an addition to our stored information. We also define "point message" to mean a new description of state or of change of state from one point in the system. Thus a point message will occur each time any one of the state variables at a system point has changed enough to pass some pre-determined significance threshold.

We have described how the meaning of a certain kind of information with respect to a system – and now also the meaning of a point message – is determined by identification of the point (in away that has meaning to the system) and by the elementary state or elementary behaviour or a property at the point. We have to say a few more words about what is meant by state and behaviour.

When we talk about controlling a system then one or more characteristics of the system are changing with time – thereby constituting a behaviour of the system. The "characteristics" will typically consist of physical entities that exist in the system, flow through the system, or are handled by the system or, maybe, movements of the system and its parts. For each such physical entity we assume that a set of measures are defined. 1) Such a measure may be a magnitude such as length, weight, temperature, velocity, or it may be one characteristic out of a specified set such as a persons name or number or the indication of sex. The state of the system at a certain point will be described by the set of physical entities (or state variables) that exist in that system point, together With the values of these variables in that point at that point-in-time (whereby, of course, also the value of the variable time is to be given). By elementary state we mean the measure of one of the state variables at a point in a time interval. An elementary message will consist of the identification of the system point, the moment of time, and measure of one of the state variables of the system in the point as well as identification of the kind of this state variable.

Notice that while an elementary message has a certain information content, or semantic content, nothing smaller than an elementary message has. For instance, the value of a state variable alone does not bring any information at all, and neither does it when accompanied by an identification of its kind alone, or of the system point alone. An identification as to locality and kind without any accompanying measure is void of information, and a measure without an identification is without meaning. It is interesting to see how this fact has its counterpart in the broader question of semantic content in a linguistic message.

From THAIS, page 184,  
we choose  
"The value of information  
in a system"

*This text stresses the importance of designing flexible information systems that easily can be modified to manage changed information requirements in the application domain.*

### 5. The Value of Information in a system.

The value of the information about a system point with respect to the system can be measured by the value it has for controlling the system. Specifically the value of the information carried by an elementary message is determined by the amount of value it adds to the information in total e, g. by the increase in value for the whole system that corresponds to the economic gains that can be obtained by using (the information of) the message. It is seen that when we define value of information in this way, using the concept of message and referring to a specific system and specific objectives for that system then there is, fundamentally, no difficulty in obtaining precision. If we ask instead about the value of a message in an absolute sense, without relation to a specified system, then we do not find an answer. This is just the way this kind of question is usually posed. It is only to be expected that precision is not obtained.

We shall see that the value of a certain message does not only depend on the system itself, it also depends on how much information has already been obtained (and stored). Our solution of the problem of meaning was obtained at the price of restricting to points and state variables well defined. This means that we are not able to give information about changes of the system design and that even if we would be able to do that then the information system would not know the meaning. This is a case where we might instead well give the message in ordinary language and have a man understand it. The restriction here that the automatic information system (contrary to man) would not understand such a new kind of message is not very severe for we must in such situations provide the system with new algorithms for using the new kinds of information and therefore it would not be much trouble to give at the same time enough form specification for the new message to make it readable by the system. This is true provided we have designed the information system, from the beginning, in such a flexible way that it can be extended when need arises.

One requirement must be stated at this point. A system which is not completely formalized – and therefore will have to expect that new kinds of messages, with unforeseen kind of content, may become necessary once in a while – must, if it is to work in a fully integrated way, be able to accept such messages, although not understanding them, and without being able to use or process them, and have means for asking man for advice or asking man to take over control.

We see that the value (within the system) of a certain message is determined by the theory of control for that system and not by the theory of information systems. The value of the message is determined by the economic gains that can be achieved by using the message in all efficient operating doctrines for the controlled system which the theory for that system has been able to establish. That theory would also have to evaluate the gains. What information systems theory will have to do in this connection is to explore the operating doctrines that are available and the accompanying gains and to establish the needs for messages and their processing that are associated with each such doctrine and then to work out the most efficient way of handling and processing this information. The most efficient handling will lead to the lowest information cost and this has to be compared to the information value, that is the economic gains it produces, in order to enable a decision as to whether to include that information in the information system or not.

*This quotation clarifies the distinction between data and information. It also points out that an elementary message is the smallest unit that can carry information. Furthermore, it is important that the elementary message is associated with a point in time of its validity. Getting a message with no time on it is like getting a postcard with no date.*

Finally, from THAIS, page 193, we choose "Data representation of information in a system. Volume of data"

## 6. Data Representation of Information in a System. Volume of Data.

1. "Data" is often used in everyday language as a synonym of "information". We have already pointed out that in a formal analysis we must be clear about the different meanings of different occurrences of "information" and we therefore need to use different words for different (even if closely related) concepts. We use "data" here to stand for "means for representing information" <sup>1)</sup>. More specifically we shall define data to be plural of datum and "datum" to mean "a set of symbols to represent a part of a message". Thus data will often mean a digital or alphabetical representation of one or more parts of one or more messages. This definition is still very much conformal to every-day usage, although more restricted. Our definition does not clearly include representation of information in so-called analogue form. If we should need to use the word data at all in such connection we must, in our terminology, apply the prefix analogue and say "analogue data". We prefer to avoid this however and not use "data" in connection with analogue representation. We shall call a data representation of a message a record. An elementary record then will represent an elementary message. The singular form "datum" would correspond to the representation of one value such as the measure of a state variable or a name. Notice that whereas the data representing a message carry information a single datum will not carry any information whatsoever.
2. We will need to have a word for such part of a message as is represented by a datum and we shall call it a term. We have mentioned that an elementary message will typically consist of four terms identifying respectively a system point, a point in time, a kind of state variable and, finally, the measure of a state variable. When all terms in a message are represented by data we have a data representation of the message.
3. For the case of distinction we shall call a "physical record" a block. A block may thus represent one or more records. We can (within a specified system) regard each term as an operator which selects one element from a set. Thus the first term in a message may select one point out of predefined set of system points. Likewise one term may be regarded as selecting one point in time. It may be objected here that as time is normally regarded as a continuous variable we do not have a well defined set of time points. That is not so, however, for as soon as we have decided to represent time by a datum (a finite string of symbols) we have defined a smallest time interval in our information system. We then have actually defined time by a finite set of well specified intervals.

In a similar way we can see any data representation of information is a selection of individual elements out of a certain set of sets.

<sup>1)</sup> We have seen that determining the value of a certain information we did not come to define "amount of information". We now come to see that "amount" or "volume" of the data representing information can be defined. We also shall see that data volume has no natural connection with the value of information but, of course, it has relevance for the cost of handling and processing.

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# The Pioneer

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## — early texts by professor Börje Langefors

In this book, numerous references are given to the pioneer at the department for Information Processing ADP at the Royal Institute of technology and Stockholm University, professor Börje Langefors. Many comments are given about his creativity and amazing foresight concerning the theory of computerized systems, created long before comparable thinking and formulae turned out to be suggested by colleagues as well as by competitors.

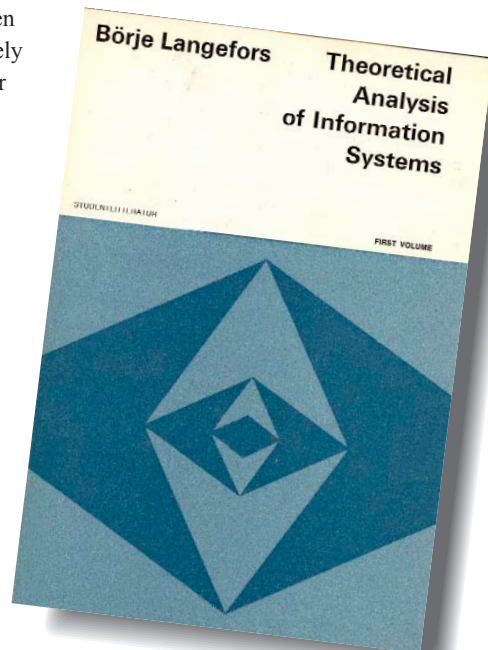
Evidently, it is a very difficult task to make a correct summary even of his most important scientific contributions in a limited space. However, to give a feeling for his way of writing, indicating his way of thinking, we choose to duplicate a few short text pieces in this chapter. They do not pretend to cover any specific field of scientific concern, nor do they claim to cover his major personal interests. But they aim to show his way of thinking and writing.

They are shown here for exemplifying and scientifically emotional reasons. It is thoughtful to rest one's mind on some sentences that, when they were written, were challenging and likely to create discussion, but which, in the mirror of over 40 years, haveshown to be mindful and wise.

Thus, below we exhibit six examples of early scientific texts by Börje Langefors. They are all chosen from his monumental book "Theoretical analysis of Information Systems" (THAIS), edition 1966, published by Studentlitteratur, Lund, Sweden.



Börje Langefors  
in Trondheim 2003.





# *Invited contributions*

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In order to make this 40-year Anniversary especially qualified, a request has been sent to three distinguished and established researchers to give specific contributions. The researchers chosen have in different and complementary ways contributed to activities that are close to the scientific development at the Department. The desire was to cover innovative and essential aspects of our past, but also to include some important example on what the future will look like.

The three persons have responded with enthusiasm, and it is a great honour to include their contributions here.

The scientists are *Arne Sølberg*, an internationally well established researcher who has been active very close to the department for a long time. Since 1974, he is professor at Trondheim University, and has contributed scientifically widely on topics that in many respects are central to interests of numerous scientists at the department.

In addition to this, the book creators are happy to be able to include a special contribution by Dr. *Adele Goldberg*. She is a pioneer of advanced use of computers for learning, has worked substantially at Xerox Palo Alto Research Center, and has been president of the ACM. She has been an inspirer to scientific activities and projects in this scientific field at DSV.

Computing is rapidly penetrating the realm of our everyday things and clothes, with the ambition on one hand to support normal day-to-day activities and on the other to support people with special needs in critical situations. The third contributor, professor *Zary Segall*, currently at University of Maryland, is a prominent researcher with this orientation, who also has a strong track record of cooperation with DSV.

Naturally all these contributions are self-contained while simultaneously complement important scientific developments within the Department. We are honoured to be able to include these aspects in our book.

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# REFLECTING ON FORTY YEARS OF COMPUTER-BASED EDUCATION

## ABSTRACT

While the research community has done interesting intellectual work around the uses of computers in education, the largest impact on personal learning has been access to informal knowledge, while the largest impact on organized learning (public education) and corporate training remains programmed instruction. Programmed instruction is really a form of telling students what they need to know. Computer technology, in contrast, was expected to introduce a learner-initiated inquiry or constructivist approach to education based on the use of simulations and programming. Unfortunately, these goals have not been broadly realized due (1) to the cost and effort to develop sufficient and challenging content, and (2) to the lack of teacher training on effective use of technology. In particular, the educational goals of the Xerox Smalltalk project have yet to be realized, despite the widespread use of the project's hardware and communications vision, and the impact of the Smalltalk system on modern software engineering practices. We still need to develop lower cost and more accessible solutions to building and exploring computer-based models, and we need to integrate use of these models in teacher training programs.

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## The Paradigm is Still Programmed Instruction

The first time I used computers for delivering instruction, I was a student, working at the Center for Research on Learning and Teaching at the University of Michigan. We were using IBM 1500 workstations, programming using Coursewriter II. I worked on German courses whose style was not unlike an online textbook, typically called “programmed instruction” books. That was 1967. Less than a year earlier I had a job with IBM, between semesters in college. My workgroup had shelves full of these programmed instruction books, which filled my otherwise unassigned hours at work much like a crossword puzzle book might. From these books, I learned how to wire IBM unit record machines – 407, 409, and 514 accounting machines. Wiring plug boards was a very physical way to write programs, and visually very satisfying to puzzle solvers like me. Programmed instruction books taught me well, well enough to be taken seriously as a systems engineer even though I was not hired in that role and never attended an official IBM course.

So the programmed instruction books worked very well for me. Interestingly, the mainstream use of computers in education today is the same programmed instruction format.

This observation is not an indictment. While the research community has done interesting intellectual work around the uses of computers in education – intelligent computer tutors, multi-media presentations of hard to visualize ideas, animation systems, collaboration environments – the largest impact on personal learning has been access to informal knowledge (including through Internet search), while the largest impact on organized learning (public



**Adele Goldberg**

Consultant focused on the use of virtual communities to support more effective teamwork. Dr Adele Goldberg is currently involved in projects on drug development, and training in neuroscience and mental health. From 2002 to 2006, Adele served as the CTO and new development manager of AgileMind, Inc., an educational technology company formed to enhance both equity and high achievement in secondary school math and science. Dr. Goldberg was the founding Chairman and CEO of ParcPlace Systems, Inc. ParcPlace was formed in 1988 from technology Adele helped develop while at the Xerox Palo Alto Research Center as researcher and laboratory manager of the Smalltalk-80 research team. Dr. Goldberg received a Ph.D. in Information Science from the University of Chicago. From 1984-1986, she served as president of the ACM, the U.S. computer professional society.

education) and corporate training remains programmed instruction-telling students what they need to know.

The teaching profession has not adopted technology that is already in widespread home use. Classrooms pretty much look the way they did fifty years ago. School libraries now have computers in them, and history, literature, and social sciences courses assign searches on the Internet rather than using the card catalog and indexes. But computer use is generally constrained for fear that a student might glimpse a naked human body or learn something which is deemed by some to be evil. There are some exceptions, of course. Becker and Ravitz (2001) have been documenting evidence that, although consistent with Larry Cuban's claim (Cuban, 2001) that technology will not have much impact in education, indicates that teachers with adequate technical expertise, adequate classroom access to computers, and a teaching philosophy that supports learning around group projects, will proactively involve students in computer use.

The current classroom situation is in stark contrast to what's going on in the informal culture. Out on the streets the kids have invented a new way to talk shorthand, spurred on by strong thumbs and affordable cell phones; changes in Internet communications has rewritten grassroots politics for communities and nations; online newspapers and bloggers spread news and opinion globally; and expert video game players are treated as "rock stars". Kids believe that information ought to be free and utilize peer-to-peer networking programs of considerable sophistication in order to share music and videos.

Nonetheless, digital programmed instruction books continue to dominate the formally approved and commercially viable educational uses of computers today.

### **The Problem is Content Creation**

In 1969, one of my graduate school professors scowled at my proposal to do my PhD research around computer uses in education, as he believed everything was already known about the information science foundations underlying this field. It is possible that he was right. From an engineering standpoint, while the infrastructure for creating and delivering content has improved enormously, the fundamentals remain the same. Instructional design either forces a (computed) pathway through the content or allows the learner to move freely about the content. Creating content of sufficient quality and pedagogical value remains the costly and challenging part of any new curriculum effort. If programmed instruction represents best practices today, then it is worth asking whether in fact my professor was right.

"Computer-assisted learning" and "intelligent computer-assisted learning" research of the seventies focused on three areas:

- testing, including adaptive techniques and simple drill-and-practice, as a way to collect data to construct mathematical

models of learning;

- teaching computer programming as a way to teach general problem solving skills; and
- providing simulations and data visualization as a way to stimulate exploration of underlying scientific models.

No matter which pedagogical paradigm was chosen, doing anything significant historically has required large teams and long development cycles. Content was never thought to be exciting; the real research interest and the opportunities for publications were in new programming languages and immersive simulations.

One approach to managing the costs of content development is to delegate it to the teachers who have to prepare for their classes anyways. Today some schools leverage available office productivity tools – word processing, slide presentations, and spreadsheets – and utilize college campus frameworks for distributing teacher-created material to students. Such teacher-sourced material does not have the formal editorial scrutiny applied to the content created by educational publishing houses, but that is apparently not a problem at the university level. Colleges and universities delegate curriculum content control to faculty in any case.

In contrast, public school teachers for primary and secondary education have neither the training nor the time nor the computer access to create online materials. Although U.S. public schools can all claim existence of computers and Internet connectivity, the reality is that the limited numbers of computers restricts access to less than an hour a week per student. And remember, none of the Internet collaboration frameworks are acceptable today in K-12 public schools in the United States where schools are charged with protecting kids from predators and protect themselves from recorded messages containing improper vocabulary. These schools do avail themselves of several commercial systems that provide kids and their parents with Internet delivery of course plans, test scores, and course grades. But these are highly structured and controlled information systems, not the open communications toolsets common at colleges and universities.

***“Content was never thought to be exciting; the real research interest and the opportunities for publications were in new programming languages and immersive simulations.”***

***“In contrast, public school teachers for primary and secondary education have neither the training nor the time nor the computer access to create online materials.”***

### **The Problem is Teacher Training**

The excitement of simulation and programming seems to have stagnated inside the world of formal schooling even though it is the bread-and-butter of video and console games. One reason this option is ignored seems to be the burden of training teachers to use such tools, coupled with the lack of access most students have to computers with adequate communications bandwidth. My observations of computer impact are drawn from four years’ as technical lead (from 2002 to 2006) on a project to develop online mathematics courses for grades 6-12. This work originated in Texas and has been adopted by major urban school districts in other U.S. states.

The goal of the work was and remains professional development for classroom teachers of mathematics and science. However, the features and benefits of the resulting educational system were molded as much by the increased emphasis on accountability and the resulting national and state testing procedures, as by interest in improving teacher efficacy. Specifically, this project tackled issues of:

1. lowering the cost of content development, especially for engaging learning interactions, through effective use of formal curriculum specification (using XML as the notation) and dynamically configured interactions (using Flash) that communicate response data to the backend server;
2. managing content usage and question response data from both informal and formal online tests, for immediate and long term analysis and reporting;
3. delivering content to a scalable environment that can easily provide adequate service as enrollment numbers climb to well over 150,000 served students;
4. modeling how schools operate and therefore how to consistently and securely identify users as they transfer among schools, and be able to track student performance year-to-year;
5. supporting teachers and administrators around the use of technology primarily for classroom presentation/interaction, instructional planning and review, student review, and assessment.

Teaching teachers is a challenging problem. It would be doubly challenging if the goal were to enable and develop teaching skills around technology, rather than having the technology support the traditional classroom lecture model of teaching, which is the case in this particular project. There was and is no attempt to change either curriculum content or style. In fact, there was and is a major effort in this project to align the online programmed instruction material to popular textbooks and to state standards and objectives in order to improve administrative reporting around teacher results as measured by the performance of their students.

Training teachers to incorporate the computer-based content into their classroom activities, and maintaining constant contact with the teachers to encourage use and share experiences, requires major one-on-one mentoring efforts, both in advance and throughout the school year. Unfortunately, in this project, these teacher mentoring interactions are done without the use of the collaboration tools (although these are available in the computer-based delivery system), probably because teachers have neither the computer access nor the time to spend on their own professional development outside scheduled school activities.

Initially, we envisioned the technology as supporting community-building, and so we provided online discussion forums and a closed community messaging system to encourage communica-

tions with and among students and their teachers. This failed due primarily to the U.S. legal obligations of the schools to protect all of their students and teachers from illicit contacts on the open Internet, as well as the politics of sharing information across otherwise independent school districts. The qualities that we as computer scientists admire most about the use of our technology, those qualities that we generally believe provide the greatest leverage for learning, are not viewed as strengths in the context of modern U.S. education.

Content in this system is traditional programmed instruction with well thought-out examples in the form of multi-media visualization aids embedded in textbook-like presentations, all aligned to standard textbooks. A significant and unanticipated commercial success arose when it was realized that the course visualization materials were primarily useful to the teachers as a part of their classroom lectures, rather than to the students for review. A teacher, armed with a low-cost video projector and a computer, could step through the computer screens and engage their students in answering questions posed on each page or in observing the animated explanations. Typically the teacher could then click on a “reveal” button to see what the computer suggests is the answer. This focus on the use of the online content as a driver for classroom lectures solved the real problem that schools have insufficient computers and mathematics students have inadequate computer laboratory time to explore online content on their own. It also has the advantage of moving the organizational consistency of the programmed instruction course into the live classroom with its traditional setting. The production values and the immediacy of the presentation and the social setting differentiate material delivered in this fashion from traditional written-word textbooks.

Used in this way, computer-based content is only effective when augmented by instructional planning tools, suggested questions to use to challenge the students thinking, essays and possibly videos around other teachers’ experiences – all materials that the teacher has to have the time to explore and consider. Few public schools in the U.S. can afford to give their teachers the time for such preparation, and most schools today have to take their teachers away from instruction to participate in preparing and administering the increasing number of obligatory state accountability exams.

When I first got involved in this schools project, I was hopeful that we could bring more simulation capability to the classroom, especially given the focus on Advanced Placement courses (initially for Calculus and Statistics) in which such techniques had been researched in the past. But the reality of the teacher professional development challenges and the costs associated with authoring such material quickly squashed such thinking. Probably the textbook publishing background of the company management also contributed to the programmed instruction format of the courses.

***“The qualities that we as computer scientists admire most about the use of our technology, those qualities that we generally believe provide the greatest leverage for learning, are not viewed as strengths in the context of modern U.S. education.”***

Opportunity to increase enrollment in Advanced Placement courses comes from moving into the larger enrollment feeder courses – Algebra, Geometry, Precalculus, and Middle School Math. As accountability issues dominate schools, these feeder courses take the majority of the school administration attention and therefore represent a larger market and social-impact potential in both primary and secondary schools. More to the point, all U.S. students must now pass an Algebra exam in order to receive their secondary school certificates.

The technical challenges were also there, but could be managed despite few resources to do so (just two of us initially, adding one engineer after the first year!) Anything done for the mainstream school delivery needs to be delivered over the Internet to a browser, with an assumption of low bandwidth and minimal request to schools to download anything other than standard media players. We also had to deal with old desktop machines and their Windows 98 operating systems. All of the technology was developed in Python using MySQL for the database and Zope as the application development and delivery server.

### **Which Comes First, Technology or Pedagogy?**

The cost of developing course content has been the driver in computer-assisted education since the field began. At Stanford University, I worked at the Institute for Mathematical Studies in the Social Sciences. I recall assisting in course content development with members of the Slavic Department, from whom I learned that the beneficiaries of online curriculum development are the authors of the courses, in this case the professors themselves. Authors are forced to better organize their instructional design by the need to fully prepare content in advance, to explicitly set expectations for educational outcomes for the online students, and then to prepare online lessons to produce those outcomes. In contrast, professors often prepare lectures one at a time and sometimes without an obvious plan, so that students are not clear as to what to expect. Experience with the very early NSF TICCIT project reinforced this point (Bunderson, 1973). Adult learners, who were pursuing college degrees evenings while working in the day, preferred the online approach because the course map was well defined, in advance, and the “teacher” always showed up (which is to say, the computer terminal presenting the course software was working). This notion of prepared course content, vetted for consistency, repeatability, and effectiveness, appears offline as well. The University of Phoenix has made quite a success of being able to consistently repeat its courses anywhere in the U.S. in the same timetable, so that students who are working and traveling can keep up with their educational pursuits by attending class in any of the University’s locations.

This theme of consistent and well-defined course content is

***“Adult learners, who were pursuing college degrees evenings while working in the day, preferred the online approach because the course map was well defined, in advance, and the ‘teacher’ always showed up...”***

certainly one reason for the popularity of corporate online training courses. One of my colleagues calls this the IKEA model of education – mass marketed, inexpensive, sometimes stylish, but nonetheless created from pre-prepared parts and not oriented to creative “out-of-the-box” thinking. Moreover, registration and usage tracking that are typically a part of online courses give organizations proof that material was covered and the user successfully completed an assessment of understanding. Such proof is important to organization’s that must demonstrate employee compliance (for example, Stanford recently had all its employees take an online course on sexual harassment). Programmed instruction formats do this sort of thing well (or at least “good enough”) and continue to have a significant role for educational technology.

The cost of developing course content is not mitigated by the remarkable growth of information made available on the Internet. Information is the raw material for education but, without some measure of wisdom and direction, students flounder in a sea of data. Some suggest that learners should be left to decide for themselves what to learn, to explore libraries whether physical or virtual, to seek specific answers and to bump against information that they did not know in advance was of interest. For these purposes, the current state of the Internet, with such efforts as Wikipedia, WikiBooks, and Google Scholar, present exciting opportunities.

Instead of telling kids what they should know, the kids figure out how to ask questions of search engines and of people that they find in community sites, and we let them discover what there is to know. Even advertisements present learning opportunities; so do blogs and discussion forums, including those designed for educational purposes. One of my favorites is the NY Times Learning Network (<http://www.nytimes.com/learning>). Basing education on search-whether online or off-presumes that we are teaching critical thinking, that the learners learn how to sift fact from opinion, and

***“The cost of developing course content is not mitigated by the remarkable growth of information made available on the Internet. Information is the raw material for education but, without some measure of wisdom and direction, students flounder in a sea of data.”***

A page from NY Times Learning Network. The site has information for students, teachers and parents.

The screenshot displays the NY Times Learning Network website. At the top, it reads "The New York Times ON THE WEB LearningNetwork GRADES 3-12" and "CONNECTIONS FOR STUDENTS, TEACHERS AND PARENTS." A sidebar on the left is divided into "Student CONNECTIONS" (including News Summaries, Daily News Quiz, Word of the Day, Test Prep Question of the Day, Science Q & A, Letters to the Editor, Ask a Reporter, and Web Navigator) and "Teacher CONNECTIONS" (including Daily Lesson Plan, Lesson Plan Archive, and a Teacher icon). The main content area features a date "SATURDAY, SEPTEMBER 9, 2006" and a headline "ISSUES IN DEPTH: LOOKING BACK: SEPTEMBER 11" with a sub-headline "NEW: 5 TEACHERS REPORT ON THE FIRST MONTH OF SCHOOL." Below this is an article titled "9/11 Leaves Its Mark on History Classes" by JANNY SCOTT, with a sub-headline "Five years after the attacks on New York and Washington, many historians say 9/11 and its aftermath are leaving their mark on how American history is written and taught." To the right of the article is a "Justice Learning" sidebar with the text "civic education in the real world" and an image of a book. Further right is a sidebar from "TEACHERS COLLEGE COLUMBIA UNIVERSITY" titled "COMMUNICATION, COMPUTING, & TECHNOLOGY IN EDUCATION" with a list of programs: "Programs Include: COMMUNICATION & EDUCATION, COMPUTING IN EDUCATION, INSTRUCTIONAL TECHNOLOGY & MEDIA." The bottom of the page shows a "RELATED LESSONS" section.

opinion from nonsense. At least one of the search engine companies is experimenting with providing a trust index with search results so naïve users will not place the same degree of trust in all responses. Of course, this begs the question of how we teach learners healthy doubt (including of the search engine companies).

In the context of public education and the litigious way in which parents in the U.S. interact with public educators, active search-based learning can hardly succeed without some core agreement on what is indeed fact. Take the latest recount on the number of planets in our universe. Did we mislead those students who counted to nine with a “planet” Pluto, or have we now shown the power that scientific definition and modeling really has in how we converse in a literate world? And have we opened an opportunity to discuss what distinguishes a “planet” from an “orbiting body” and why such a distinction is important.

### **The Xerox Smalltalk Project – Teaching Modeling as a Learning Tool**

The Smalltalk or “Dynabook” project that I was a part of at Xerox PARC introduced a different use-model for computers in education. At the outset of this project, the accepted approach used large, time-shared computers and privately configured networks with software aimed at drill-and-practice, programmed instruction, and, in the case of my own work at Stanford-providing construction-based interactions such as online proof construction in symbolic logic.

At Xerox PARC, the Smalltalk project was disruptive technology. The researchers on the Smalltalk project believed that, at some time in the future, every child (really everyone) would own their own personal, powerful, and portable computer that combined the functionality of a notebook, pen, accessible file storage, network connectivity, musical instrument, paint, and telephone. The hardware of this vision is indeed a reality today (Kay and Goldberg, 1977; Goldberg and Robson, 1989).

The Smalltalk researchers set out to invent software worthy of such a tool:

- A programming language in which users would model the world as they understood that world was or could be
- An information system in which data could be gathered and applied to the programmed model
- A multimedia system in which the forms of data – graphical, musical, numerical – could all be integrated
- A communications system in which both model and data could be shared with others, who in turn could challenge the model through new data
- A programming environment whose interface to the user was based on the idea of storing, retrieving, and testing the use of information, where programs themselves are malleable information

***“The researchers on the Smalltalk project believed that, at some time in the future, every child (really everyone) would own their own personal, powerful, and portable computer that combined the functionality of a notebook, pen, accessible file storage, network connectivity, musical instrument, paint, and telephone. The hardware of this vision is indeed a reality today...”***

Stating the research objectives of the Smalltalk project in this way indicates that the research is still incomplete, although this project was then and remains a major influence on how software is developed today. The Smalltalk system introduced the ideas of purely object-oriented languages (built on a virtual machine model), program development environments in which rapid development and code understandability were goals, and graphical user interfaces to allow programmers to exploit visual and audial as well as textual representations of information.

But the educational goals of the project were not met and remain unmet today.

Smalltalk's roots are in simulation – specifically Simula 67 (Dahl, O.-J., Myhrhaug, B and Nygaard, K., 1968). The power of object-oriented technology is in its approach to creating objects whose interface specification together forms a language for talking about a specific domain in which the objects exist and interact. The collection of objects and how these objects relate both structurally and dynamically form a model of that domain. The educational aspiration was to enable young programmers to describe a model, to invoke that model in the context of data, and to create a rendering of the model in a visual and audial manner that assists both the programmer and the program users to understand the model.

Learning about something in this rubric is to learn to make a model of the thing and compare the model with observed reality. This is the essence of science. If the model is good enough to explain all observations, then the model and the phenomenon are thought to represent the same thing, even if the model uses mechanisms hidden from observation and different than the reality.

Teaching in this manner works best when others can challenge the model with data or, even better, can create derivatives that refine the applicability of the model. The ability of the teacher to recognize opportunities for challenging the model – through data not considered or refinements not attempted – offers the kind of educational context in which students participate with their teachers in a truly intellectual endeavor. Moreover, the specification of the model is in itself a form of questioning, of searching for patterns rather than of facts.

Such an approach to teaching is hard, especially in large classes and where student behavior poses challenging social situations. Not only are the students expected to learn (individually and in groups) through inquiry and construction, in contrast to memorization and repetition, but the teachers are as well. There are no testable function points that can be defined a priori. In the past, the teacher's role was to tell the students what they should know, and this could be done in lecture mode to large classes. The Smalltalk idea was to allow the students to tell the teachers what is understood, in the form of an executable computer model, and to engage the teachers and other students in a dialogue as to whether that

***“ Learning about something in this rubric is to learn to make a model of the thing and compare the model with observed reality. This is the essence of science.”***

***“ The Smalltalk idea was to allow the students to tell the teachers what is understood, in the form of an executable computer model, and to engage the teachers and other students in a dialogue as to whether that understanding was sufficiently robust. This approach is consistent with the notion of teacher as coach.”***

understanding was sufficiently robust. This approach is consistent with the notion of teacher as coach.

As early as 1978, one of our research challenge problems came from considering how to learn about world history. Suppose you wish to know something about the hidden relationships among the British and French at some time in history. You hypothesize that much of the exchange of information that allowed some form of collaboration came about from the relationship among the servants of the royal houses who met when their households visited one another. You build a model of how such interactions could have transmitted rationales for detente among the nobility. You then wander a library-physical libraries were initially assumed, with the ability to collect data directly into the computer model you built and could thereby test. This challenge problem led us to name the first truly portable personal computer we built in 1978: “The NoteTaker” (see the picture and entry at

[http://en.wikipedia.org/wiki/Xerox\\_NoteTaker](http://en.wikipedia.org/wiki/Xerox_NoteTaker)).

It was a dual processor Intel 8086 with a bitmap display, sufficient battery power to run for several hours, and it fit nicely under one’s seat in the coach cabin of commercial airplanes.

### **The Next Step: Use Technology to Change the Role of Teachers?**

Today’s world is very different from the world of forty years ago. Modern technology, low cost computing, low cost displays, low cost mass storage, and-most significantly-low cost communications have changed the way things get done. The transition to a wired society has been nearly instantaneous. The change in public primary and secondary education however appears virtually unchanged. While workers are online, collaborating with colleagues worldwide, with instant messaging, voice-over-the-internet free calls, application sharing and whiteboards, school kids in much of the U.S. sit in their seats, open their textbooks, and follow the direction of their classroom teachers. Moreover, most recent reports from data collected as part of the 2005 U.S. National Assessment of Educational Progress in Science shows that location, not demographics, is the primary determinant of learning quality. Where you live determines whether teachers are afforded supportive professional development. We should understand this outcome as saying that the best way to prepare learners to be literate in a wired society is to prepare their teachers. Students model their teachers and mirror their skills.

Researchers and practitioners in the use of computers in education need to address the next grand challenges for both learners and their teachers:

- How do we teach the use of modeling and model validation as a primary paradigm for computer usage? What is the programming system needed to create and probe models that is accessible to teachers and their students? What is the

***“...the best way to prepare learners to be literate in a wired society is to prepare their teachers. Students model their teachers and mirror their skills.”***

hierarchy or set of such systems that moves through the learners' years and educational interests?

- How do we teach critical thinking and critical evaluation of data and information? What are the complimentary data visualization and data-model pairing technologies?
- How do we prepare teachers to teach the new basics of technology use in an environment where significant changes occur over months, not years? What support is needed to engage teachers, who are otherwise preoccupied with their classroom needs, in their own professional development? The solutions here may or may not differ depending on whether we are dealing with a teacher in training or a teacher with his or her own classroom demands.
- How do we teach students and teachers how to effectively leverage technology as a tool for independent inquiry and community learning? And, of course, what does this mean in terms of providing every student with sufficient computing and network access? Just as paper, pencils, and textbooks are standard classroom supplies that can be taken home, will the push for even more inexpensive computers solve the access problem?

Our role as harbingers of technology is to rethink the learning paradigm, go outside the institutions, and to do so by imagining a wired global world – overcrowded as it might be – even one without school buildings. We need to recognize that the technology changes we are experiencing require that we change the definition of literacy, place even greater demands on the ability to think critically and reason incisively, and form a new foundation for the role of our teachers.

***“ We need to recognize that the technology changes we are experiencing require that we change the definition of literacy, place even greater demands on the ability to think critically and reason incisively, and form a new foundation for the role of our teachers.*”**

## References

- Becker, Henry Jay, and Ravitz, Jason L., Computer Use by Teachers: Are Cuban's Predications Correct? presented at the 2001 Annual Meeting of the American Educational Research Association, Seattle, March, 2001.
- Bunderson, C. V. The TICCIT project: Design strategy for educational innovation. In S. A. Harrison & L. M. Stolurow (Eds.) Productivity in Higher Education, National Institutes of Education, September, 1973.
- Dahl, O. J., Myhrhaug, B., and Nygaard, K., 1968, 1970, 1984: “SIMULA 67 Common Base Language”, Norwegian Computing Center 1968 and later editions
- Goldberg, Adele and Robson, David, Smalltalk-80: The Language and Its Implementation, Addison-Wesley, 1989, ISBN 0201136880.
- Kay, Alan and Goldberg, Adele, “Personal Dynamic Media”, IEEE Computer, 10.3, March 1977.



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## LOOKING BACK TO LOOKING TO THE FUTURE: EARLY ENCOUNTERS WITH DSV

### INTRODUCTION

Forty years is a long time in the lifespan of a human being. And the last 50-60 years also cover most of the history of information technology. So forty years is a long time also in that perspective. My own personal, professional history is intertwined with the history of computing and information system sciences. And my early personal professional experiences are closely related to the ways of DSV in the late 1960's and in the 1970's, in Börje Langefors' tenure as The Professor of Information Systems.



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Looking back, it is astonishing how “modern” are also today some of the research problems that confronted us back then. It may be that we did not manage to solve the research questions that we challenged ourselves with, because we were not clever enough to find solutions. Or it may be that the research questions were too complex to enable us to formulate them in such a way that practical solutions could be found. Nevertheless, many of the unsolved problems that bothered us then, still pop up in the research agendas of new funding schemes, in most cases disguised in new terminology.

What follows cover several issues. First, I will describe parts of my own personal professional history of my early years, how I go into computing, and how Börje Langefors in particular, but also Janis Bubenko, influenced my professional outlook, my carrier path and my life. I will write about the influence that DSV had on the Nordic scene, about the way that computers were adapted in society, and how this influenced some of the developments of the Nordic IT research scene, and also in Europe. And I will reflect a little on some of the research problems that we approached, and that are still unsolved. And at last, reflect on how the future use of computers relates to early activities at DSV. I have called my contribution “Looking back to looking to the future: Early encounters with DSV”. Of course we were intensely occupied with the future in those days, of all of the fantastic things that we were going to do with the computers of the day. We were

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► Sølvberg has been active in many international organizations for research cooperation. Co-founder of the CAiSE conference series. Visiting Scientist with IBM San Jose Research Labs, The University of Florida, The Naval Postgraduate School, The University of California at Santa Barbara, and most recently with the University of California at Los Angeles.

***“Of course we were intensely occupied with the future in those days... We were talking about the ‘intelligent data terminal’, which 15-20 years later became the Personal Computer. We operated remote computers over the phone lines already during the 1960’s.”***

talking about the “intelligent data terminal”, which 15-20 years later became the Personal Computer. We operated remote computers over the phone lines already during the 1960’s. We made our own little spreadsheet types of I/O software long before the term had been coined. And we discussed when the day would come when software was canned in suitable storage media and sold to the public in shops.

So we were certainly looking to the future, as much as today’s young folks look forward, maybe even more. So for me the writing of this short account is also an exercise in looking back to looking towards the future. My contact with Börje Langefors and the other people at DSV formed many of my views of the future at that time. So my “encounters with DSV” should also have a place in the title.

### **How I was introduced to DSV-thinking**

I studied physics in Trondheim, Norway, at NTH – the Norwegian Institute of Technology – which was comparable to KTH and to Chalmers in Sweden. The study was called Technical Physics, in order to distinguish it from “ordinary” physics at “ordinary” universities, but also in order to underline an emphasis on engineering applications in the study. In addition to a fairly normal physics curriculum we had the introductory courses taken by the students of civil engineering, electrical engineering and chemical engineering. I left Trondheim and NTH for military service in the summer of 1962. NTH got its first computer in November the same year. So when I left NTH in 1962 I had hardly heard about digital computers.

I landed a job as a programmer at the newly formed Computing Centre at NTH in the summer of 1964. In the meantime I had tried to make sense out of my knowledge of physics, applying it to practical engineering problems. This had left me disappointed. It seemed that whenever I tried to find solutions by using two-dimensional models of nature, I needed three-dimensional models that had no analytical solution, and were too complicated to easily render numerical solutions. I felt betrayed by my professors. I had worked so hard to acquire a knowledge that now seemed to be useless for most practical problems. So two years after leaving my physics studies at NTH, I was mentally prepared to make a career shift.

The programming job came at the right time for me. I thrived. It was immensely fun to program the GIER computer from Regnecentralen in Copenhagen, which was equipped with that wonderful Algol 60 compiler of Peter Naur and his co-workers. I started out as a programmer of technical applications, but drifted gradually over to administrative data processing, as it was called at the time.

Technical applications were fairly simple. Most of them rested on applying numerical mathematics to models of nature of a kind

that I knew well from my physics studies. The administrative programming problems were different. They were very simple from a formal, mathematical point of view, but were difficult to make work properly. As seen from the perspective of a programmer of technical application programming this was due to dumb users. We all know today that the explanation is different.

I became increasingly dissatisfied with being a programmer. Programming occurred to me to be the writing of letters of instructions to dumb computing devices. There was no aspect of phrasing a “letter” as one would specify a model of nature, so that it could be analysed and reasoned about. And there was no analytical way to find out whether the “letter” was an appropriate “letter”, or a not so appropriate “letter” with not so sensible instructions to the computer. In short: I missed the world of models that I had learnt to appreciate during my physics studies.

Along came Börje Langefors. He gave a seminar at NTH during late spring 1967, shortly after DSV had been established. He lectured from his book “Theoretical Analysis of Information Systems”, which was quickly known under the acronym “Thais”. I was completely fascinated. Here was the answer to my desire of viewing application programming as any other problem of a mature technological field.

I read “Thais” in a matter of a few days, and followed up by reading the (Swedish) book “Databehandlingsteknik” by Börje’s co-worker Janis A. Bubenko jr., then lecturer at DSV’s forerunner as a university department. Janis’ book was of an entirely different nature than Börje’s book. But the books complemented each other in a superb way, as seen from my perspective. Both books introduced formal approaches to the application of computers to practical problems.

Börje’s book concentrated on the information aspect of “application programming”. Janis concentrated on how to calculate the operational effects on the computer, on the effects of arranging data and programs of the “applications” in one or the other way. Together the two books opened a new world to me, of how to approach the technology of application programming. Remember, those were the days when programming was seen as an art by many of the central scientific spirits in the field of computer programming. Most of those came from mathematics, and had little respect for “engineers”, and for technology as such.

### **Professional interaction was encouraged among the Nordic countries**

As seen in retrospect many important future trends in information technology were already quite explicit in Scandinavia in the late 1950’s and the 1960’s. Peter Naur and his group at Regnecentralen in Copenhagen were in the forefront of programming languages and compiler technology. Ole Johan Dahl and Kristen Nygaard of Norsk Regnesentral in Oslo developed Simula. And in Sweden,



“Thais” by Börje Langefors and “Databehandlingsteknik” by Janis Bubenko jr were two books introducing formal approaches to the application of computers to practical problems.

***“The computer societies of the Nordic countries arranged annual professional conferences, first called NorSAM and later reorganised to become NordDATA. The conferences were well attended by practitioners and by the emerging academic community.”***

► IFIP – International Federation of Information Processing

Börje Langefors proposed bold, new ideas on the relationship among computers, organisations and people.

And there was much more going on. Around the young Erik Sandewall an artificial intelligence community emerged, first in Uppsala and later in Linköping when Erik Sandewall got a professorship there. The computer societies of the Nordic countries arranged annual professional conferences, first called NorSAM and later reorganised to become NordDATA. The conferences were well attended by practitioners and by the emerging academic community. IFIP ► emerged as a pivot for organising worldwide meeting places for IT-research, although IFIP never really stepped out of its European origins, and remained mostly a meeting place for European IT-researchers.

This was fairly short after the war. There was a very strong political movement in Scandinavia to come together. There was talk of a Nordic Union paralleling the ideas of the European Union. The cost of travelling was still high, and it seemed to be the right thing to do to seek contacts in the “brother countries”. There was money available for research cooperation in NordForsk. Mostly, this money was for covering marginal costs of meetings with Nordic participation, but the signal effect was there.

The Nordic dimension was particularly important for the emerging computing field. The computer was a fairly recent arrival on the scene. New research communities were in formative stages. Whereas the “old” sciences already had their arenas for cooperation and interaction, the “new” ones did not. So the “Nordic” movement came at a crucial time for the emerging academic fields of Information Technology. The opportunities were readily taken by the young people who gathered around Langefors, and a Nordic Information Systems research community formed.

### **Many competing views of computers and computation**

Scandinavia was at a crossroads in the emerging era of information technology. Several different views on the role of computers and the nature of computing competed for public attention, and for space in the expanding academic sector.

The major contenders may be distinguished by their differing views on the

- Computer as a calculator
- Computer as a hardware device
- Computer as a software device
- Computer as a component in technical systems
- Computer as a “thinking” machine
- Computer as enabler of effective organisations

Each of these views had their proponents, and each was rooted in different, existing academic environments. These different “schools” were to some extent fighting for dominance. The “winning” view

would quite naturally get access to larger chunks of the publicly funded academic research “cake” than those that “lost”. It is quite interesting to note that this fight among the competing views of the role of computers is not yet over.

The calculator view dominated during the first years of the “new age”, together with the device view. The calculator view and the software device view often went together, as did the hardware device and technical component views.

Numerical calculation was the first major application area of computers, and the calculations were supported by impressive improvements in the field of “computing machinery”. In the universities the calculator view was rooted in the departments of mathematics, while the device view was rooted in the hardware skills of electrical engineering. The new “software” field of programming languages and the associated compilers grew from both communities.

Electronics was the “mother” of computer hardware, and electronic components were widely used in all sorts of technical instruments. In particular, the new programmable devices made their way into control engineering, paving the way for robotics. A new, powerful way of building “intelligent” technical systems of high complexity had been found. The view of the computer as a technical component device was in particular firmly rooted in the electrical engineering departments of the technical universities.

The “thinking machine” was high up on the research agenda. Even if it was generally viewed as belonging to the more esoteric branches of the research tree, it nourished the fantasy of both the young and the old, and of the science fiction writers. Even if progress was painfully slow, “artificial intelligence” early established itself in the academic curricula.

The field of “computers in organisations” was mostly taken up at business schools. It was usually treated as a minor subject, and mostly as a subject without academic value on its own.

### **Could “Information Systems” become an academic discipline?**

With the UNIVAC 1 computer launched in 1953, and IBM’s hugely successful 1400-series of computers, administrative data processing was all of a sudden on the scene. It soon took over as the dominant application field. But “administrative data processing” was not seen as a field worthy of serious academic consideration. The technologists had little respect for managers, and this view carried over to the administrative work of managers. The apparent lack of respect by mathematicians and technologists was not restricted to administrative data processing, but was a plight shared by the computer programmer profession at large.

Programming was viewed as a craft, and programmers as craftsmen with little need of formal education. Software was seen as belonging less to engineering than was hardware, and very low in the pecking order was the poor programmer of administrative

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*“...administrative data processing was not seen as a field worthy of serious academic consideration.”*

***“The low academic status of administrative data processing improved to the better in Scandinavia when Börje Langefors entered the academic scene.”***



Janis Bubenko jr and Tomas Ohlin both at DSV, wrote this book 1971.

***“So, excellence in building applications in combination with technical excellence, were in this view the core knowledge areas of computation!”***

applications.

The low academic status of administrative data processing improved to the better in Scandinavia when Börje Langefors entered the academic scene. He had a successful background in SAAB as a computer designer, and was the chief responsible for the programming language ALGOL-GENIUS. He had a rock-solid engineering background, and was widely respected. Among his most important achievements was his early contribution to finite element methods in structural engineering. In short, his achievements were impressive. He could not be easily overlooked by more traditional souls in the academic gardens.

In his “Thais” book Börje Langefors provided a solid philosophical foundation for “administrative data processing” as an engineering discipline. Problems of constructing data processing systems built from component systems were laid out and explained in engineering terms. And the data processing aspects were integrated with the problems of organisational management, with the problems of organisational change, with the problems of providing decision support in organisations, and with the problems of evaluating and selecting existing hardware and software solutions.

The strong emphasis on computer applications, which was evident at DSV of the late 1960’s and the 1970’s, was very appealing to me. Equally appealing was the fact that computer technology proper was treated with respect as the major enabler and renewer of the “applications”. The 1971 book on operating systems authored by Janis Bubenko and Tomas Ohlin, both at DSV in this period, bears evidence of the strong emphasis put on computer technology as core knowledge at the department. For me this was a natural way of perceiving the world of computers, having been raised at a university computing centre. The core business of a computing centre in those days was in the combination of providing operational stability of its computers, and in finding profitable ways of putting the computers to work. So, excellence in building applications in combination with technical excellence, were in this view the core knowledge areas of computation!

This view turned upside down the conventional wisdom of the times. Programming was generally viewed as a skill that could be acquired quite easily. So, computational skills were regarded as add-ons to the “real” knowledge of the “application” fields. The conventional wisdom was that a programmer could never be expected to acquire enough knowledge about an “application” field without long and thorough education, while the opposite was quite possible.

## Computers and their applications: Is there a common framework?

The combination of application and technology was not an easy sell in the academic environment. Universities are discipline- and profession-oriented. Each professional education tends to strive for self-sufficiency. All of the important knowledge areas in a professional education should be delivered by the profession. That was the conventional thinking. So every application area should be self-sufficient, comprising its own type of computation. The idea of having the technology itself being the pivot and provider of knowledge for the various application areas was from the beginning a matter that created much controversy, and still does.

This view of differing cultures and different disciplines has been very long lived. It is therefore encouraging to see a new view of integration finally being advocated also for the relationship between computing and the sciences. A quote from the Summary of a recent report titled “Towards 2020 Science” published by Microsoft Research early 2006, underscores this change:

“An important development in science is occurring at the intersection of computer science and the sciences that has the potential to have a profound effect on science. It is a leap from the application of computing to support scientists to ‘do’ science (i.e. ‘computational science’) to the integration of computer science concepts, tools and theorems into the very fabric of science. While on the face of it, this change may seem subtle, we believe it to be fundamental to science and the way science is practiced. Indeed, we believe this development represents the foundations of a new revolution in science.”

The above is very encouraging, indeed, and may pave the way for much needed changes in contemporary science education. This bold statement may have effects in the scientific community, also because the Microsoft report is basis for a special theme of the March, 2006 volume of the influential scientific journal *Nature*.

The Microsoft report's summary goes on to say that

“Conceptual and technological tools developed within computer science are, for the first time, starting to have wide-ranging applications outside the subject in which they originated, especially in sciences investigating complex systems, most notably in biology and chemistry.”

The last statement seems odd for those who have been living in the world of the “computer as enabler of effective organisations”. What happened in the field of information systems was that the conceptual and technological tools developed within computer science became widely applied in the complex world of organisations

of people who interact with a wide variety of artefacts. It was very clear from the start on, that computers did not merely permit managers to ‘do’ management, but that the integration of computers and human actors was the system. Börje Langefors managed to express this insight in simple ways, and hence made it easier for others to carry the integration idea out into the academic world, and to translate the idea into curricula and education of the new generations.

### **The Nordic “subculture” of information systems research**

In the mid-1960’s, Sweden decided to split the emerging academic field in numerical mathematics and in administrative data processing (ADB). This had consequences for the other Nordic countries. Sweden paved the way for universities in the other Nordic countries to establish professorial chairs in Information Systems.

My own NTH was a latecomer to computing compared to the universities in our Scandinavian neighbour countries. The first academic department of Computer Science was not formally established at NTH until in 1972, which is considerably later than when DSV was established. In the early 70’s it was beyond discussion that the information systems field as defined by Langefors should be treated on equal footing with core computer science subjects like operating systems and compiler technique.

The issues that were opened up for research during Börje Langefors’ tenure were many. Most of them were concerned in some way or another with the broad themes of

- Complexity of engineering design
- The nature of information
- The information systems development process
- Management of change in organisations

***“The emphasis on distinguishing between data and information had a strong effect on contemporary thinking in the Nordic countries about education and research in information technology.”***

The emphasis on distinguishing between data and information had a strong effect on contemporary thinking in the Nordic countries about education and research in information technology. The explicit expression of the idea that information systems should be designed for satisfying the needs of users, and to be developed in a co-operation between users and computer specialists, had likewise a strong effect on the education of the next generation of data engineers.

In the various Nordic universities there were only a few “langeforsians” in the beginning. For most of us it was a fairly lonely life, each of us living in environments populated mostly by compiler constructors and operating systems specialists. The idea of seeking together on a Nordic basis was floated around 1969, and we decided to form SCIP – SCandinavian Information Project. We went to NordForsk to find money. Young colleagues from the Nordic countries joined. Janis Bubenko took a leading role together with several others. We arranged several informal workshops in

the different Nordic countries. A rather close-knit group of young researchers formed. Nordic summer schools were organised, and we arranged our first working conference at Hotel Scanticon outside of Aarhus in Denmark 14th-17th of April, 1971.

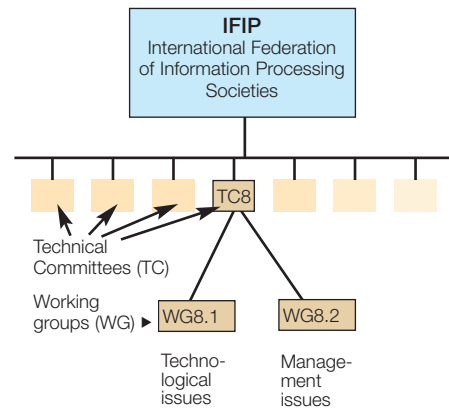
To the SCIP conference had been invited several like-minded young researchers from different countries in Europe. They were encouraged in finding soul mates, and soon dubbed our approach to information systems design to be “The Scandinavian School of Information Systems Research”. So over a few years a Nordic nucleus group of young persons had been formed. The members of the SCIP group developed commonly agreed ideas to bring out into teaching at their respective universities. They kept in contact and influenced each other in the years to come. The bonds that were forged in those early days resulted in lifelong scientific exchange among many, and in personal friendship.

### The emergence of an international IS research community

The SCIP conference in 1971 encouraged the emerging Nordic community of information systems researchers to seek wider contacts to Europe and to the rest of the world. IFIP – International Federation of Information Processing Societies – provided a convenient organisational tool. IFIP is organised in Technical Committees (TC), each with several Working Groups (WG). In 1974-75 Börje Langefors was asked to help organise a new TC for Information Systems. He was instrumental in having the new TC approved by IFIP, but left it to Janis Bubenko, Mats Lundeborg, myself and other “youngsters” from SCIP to “blow life” into the organisational construction.

The IFIP Technical Committee number 8, for Information Systems, TC8, was accepted by IFIP in 1976, and started with two working groups, WG8.1 and WG8.2. The two groups had different profiles. WG8.1 was seen to be mostly concerned with technological issues, while WG8.2 was more concerned with management issues related to the increasing use of computers in organisations.

Referring back to the four broad research themes listed in the previous section, it seems fair to say that WG8.1 was mostly concerned with complexity of IS design, while WG8.2 was mostly concerned with management of change in organisations. The two groups had common interests in the IS development process, and on issues related to the nature of information. Those two themes of common interest were seen rather differently by the two groups. While WG8.1 was mostly interested in data modelling and in the semantics of information, WG8.2 was more interested in the value of information as enabler of improved management decisions. Likewise for the IS development process. The members of WG8.1 had an interest in IS specification languages that would enable the automatic translation of requirements specifications to operational application programs, while WG8.2 was more interested in how to



organise users' participation for developing IS specifications.

The initial memberships of both groups were heavily influenced by SCIP members, and were consequently influenced by the thinking of "The Scandinavian School". In SCIP there were a variety of views on what were the research issues of most "importance", but there was also a civil attitude of mutual respect for colleagues with other research views and research agendas than one's own. This attitude of mutual respect carried over to TC8 and its working groups, and was reflected in many co-arrangements of working conferences that were attended by members of both groups.

Parallel to participating in the working groups of TC8, scientific contacts with USA were established. Both Janis Bubenko and I were on sabbaticals in USA in 1976/77. Janis was on the east coast, and I was on the west coast, but both of us were with data base research groups in IBM Research. This was the period of data base modelling languages, of DBTG's network model, the relational model, and the entity-relationship model.

The "Scandinavian" thinking on information systems design was received with open minds by our US colleagues. Janis and I were welcomed into the research community. Both of us became members of the VLDB Endowment ▶ for many years, and Janis was President of VLDB during the 1990's. I like to believe that our American venture had positive effects for the SCIP group as well as for the TC8.

▶ **VLDB Endowment Inc**

– Very Large Data Base  
Endowment Inc.:

a non-profit organisation for  
promoting and exchanging  
scholarly work in databases  
and related fields.

### **IS research: the past, and the future**

The Nordic IS research community emerged during a time of profound technological change, which influenced on many work processes in our societies. The old ways did not suffice any more, and could not compete with new work processes that were heavily supported by computers. This was very tough on the older members of the workforce, who had difficulties in adapting to the new ways. The new technology was by many to be seen to be an enemy of the workers, of the proletariat.

Many countries have had their workforce adapted to the new information technology in more heavy-handed ways than in the Nordic countries, and with less success. This reflects to a large extent on the culture, on the way that we organise our societies. But I also choose to believe that the approach to information systems design that grew out of DSV of the 1960's and 70's should be given due credit. The strong emphasis on wide participation by the future users in the requirements specification process has been imprinted into the future generations of information systems designers during their education. I believe that this has been a very strong factor in bridging the gap between those who are computer literates and those that are not, and thereby has contributed to a mostly successful transition into the IT society that we now live in.

In 2006 we live in at time of unprecedented change. We live in a world were everybody can interact with everybody else. The technical advancements have been astonishing. The Internet has changed profoundly how we interact, how we do business, how we organise ourselves, how we can influence others. Data storage, processing and transmission are becoming nearly free commodities. The individual computers will disappear and become integrated into a complex technical background. The computers will be nowhere, and everywhere, like electricity. Computers are already imbedded in biological material. The convergence between IT and biology will increase, and this will happen fast. And so on.

I believe that four of the major research themes of DSV from the mid-60's and onwards are as central today as they were then, namely,

- (1) complexity of engineering design,
- (2) the nature of information,
- (3) the information systems development process, and
- (4) the management of change in organisations.

The concrete research projects of course have to be formulated in a contemporary setting. But it is clear that we have not found sufficient answers for many of the research problems that we were aware of in the early days. How to master complexity is a particular challenging problem, which appears more and more often in almost every field of engineering, management and science.

There are also today many forces that encourage scientific "fragmentation". In information technology this translates into developing IT specialities that isolate themselves from each other, and may result in intense wheel reinvention. It is to hope that future IS research in the Nordic countries can contribute to the strengthening of IT as a scientific discipline in itself, and thus counteract the fragmentary forces.

Congratulations, DSV, with the first 40 years! And keep up the good work!

***"The concrete research projects of course have to be formulated in a contemporary setting. But it is clear that we have not found sufficient answers for many of the research problems that we were aware of in the early days."***

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# CONVERGENT DESIGN IN COMPUTER SCIENCE AND ENGINEERING

## ABSTRACT

From their inception and through their history, Computer Science, Engineering and IT have been fertile grounds for innovation and timely renewal. Unassumingly exploring the difficult task of innovation and renewal, this short contribution will briefly document the emergent trend of combining science and engineering with fields of studies that are considered non-science and non-engineering such as design, fashion and visual arts.



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## Convergent Design in Action

After a few definitions that will set up the scene for Convergent Design and co-emergent technologies, the body of this presentation will highlight “Convergent Design in Action”. Nine scholarly convergent design projects will be illustrated. Each of the projects has been executed by graduate and undergraduate students from multiple disciplines during a four month course in *Human Aware Convergent Design*. All the credit for the success of those projects goes entirely to my very talented and highly motivated students and faculty collaborators.

Conceptually Convergent Design is the broadest understanding of the process of innovation. In particular, Convergent Design refers to scientific and non-scientific skills and processes that are integrated to generate highly effective results that have form, utility, significance and business model. The fusion of form, utility, significance and business, foster a unique co-design process that naturally bridges between disciplines, is highly motivational and often leads to innovation.

Further, we are interested in Convergent Design processes that lead to products or services that have substantial significance in improving people life or helping individuals in a meaningful way. The business model component is reflective of the ultimate goal of having the results of the process reaching people and positively influencing their life.

One of the key components of Convergent Design is fast prototyping. With remarkable consistency, typically using only 10 to 12 weeks from design to full prototype the Convergent Design teaching and research methods have been able to repeatedly and predictably demonstrate innovative ideas and products.

## Zary Segall

Distinguished Professor and Founding Director, Center for Convergent Design, University of Maryland, Baltimore (UMBC), Guest Chair Professor, KTH and Stockholm University.

***“...we are interested in Convergent Design processes that lead to products or services that have substantial significance in improving people life or helping individuals in a meaningful way.”***

**Computer Science, Engineering, Design, Fashion and Business**

The teaching and research methodology is based on the notion of co-emerging technologies. In other words we are applying Convergent Design in areas of inquiries that are considered up-and-coming technologies. In this case, Convergent Design was applied to Wearable Computer Systems and Human Aware Computing. Wearable Computers are naturally a subject of convergence between Computer Science, Engineering, Design, Fashion and Business. Wearable systems hold the promise of augmenting the individual, increasing social interactions and promoting new computation models. For this promise to become a reality, we need to modify our perception of computing and information systems. We call this new way of thinking “Human Aware Computing”. Human aware computing is promoting active sensing of the body physiology, human emotion and situations and is using this information as input for new types of applications in the communication, health care and cognitive computing.

As outlined, this is a just an invitation for you the reader to explore the Convergent Design in Action. Hence, the emphasis of this presentation is in the outcome of the process: The Convergent Design Projects.

There are 9 projects further presented in separate captions: ePark, magicHat, aWare, BabyWear, WIT, eBag, Chimera, Xpog and Jpod.

# ePark

## Utility

People at theme parks are forced to spend substantial time waiting in long lines for rides, food, etc. The theme park business model is, in part, based on minimizing the time the customer is waiting in line.

The ePark system introduces the notion of a virtual line to address this issue. By using RFID-enabled bracelets and SMS messages, guests are able to schedule their day for minimal waiting in line and maximum enjoyment.

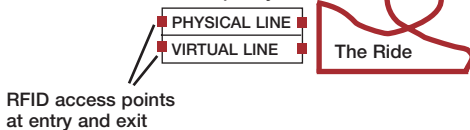


## Design

### Features:

- New algorithms for theme park virtual queue
- Wearable RFID-enabled bracelets implementing a virtual queue and providing new marketing opportunities
- Central Server supporting RFID reader stations throughout the park
- SMS managing system for real-time notification of scheduled events
- Terminal stations with menus to schedule rides, register and create groups

Each ride would have a waiting area for both physical and virtual lines, to ensure capacity.



## Significance

The park visitors will no longer associate amusement parks with long waits in line. The park operators will gain new marketing and earning opportunities. It's a win-win proposition!



HUMAN AWARE WEARABLE COMPUTING COURSE

Instructor: **ZARY SEGALL**

**EPARK:** Cathy Chen, Chad Eby, Bryan Hurley, Anil Kavalipurapu, Clint Moulds Brandon Wilson, Karthikeyan Ravichandran, Shantanu Shukla, Al Stone, Jesse Stump, Derek Lynch

**PARAMOUNT PARKS INC.:** Mark Kupferman, VP Research and Marketing



# thinkWearable;magicHat

## Utility

The magicHat is based on the concept of deconstructing the mobile phone and enhancing it with a minimum of components with the goal of exploring the mobile interaction/annotation of physical and social spaces. Our wearable computer is built around the notion of providing useful just-in-time information as well as a mechanism for recording social events. The magicHat system organization is based on the components of a high-end mobile phone with additional components that include a GPS, a digital compass and miniature vibrators (for non-obtrusive directions). Most of the components are mounted in a headgear form factor. The functionality provided by the system can vary depending on the application, but can include just-in-time information retrieval and guidance, dynamical annotations, social ad-hoc networks and group coordination and awareness.

## Design

### Tiara.

- The continuous shape of the object allows for easy change of size.
- Integrated earpiece and bone microphone.
- Small internal vibrators to indicate direction in a non-obtrusive way.
- Side-mounted digital camera at the temple.
- Compartment for central components and battery power at the back.





#### Headband.

- Primarily to be used by skiers and snow boarders for real time nonintrusive directions and communication.
- Manufactured in fleece or wool, embedding the different technology parts and components inside.
- The technology parts are easily placed in the “textile tube” of the headband, to allow a high degree of customization and graphic identity applications.



#### All-in-one earpiece.

- Design is located around the ear of the user. The small speaker and its position allows for surrounding sounds to get free access to the ear while discreetly whispering information to the user.

### Significance

The goal is to apply human awareness and emotion-centered reasoning to help people communicate in new and richer ways. The novel artifacts are promising the user new abilities to simultaneously interact with people and the physical environment.

**Faculty:** Magnus Boman, Carl-Gustaf Jansson, Bertil Thorngren and Zary Segall (lead)

**Conceptual and product design, 3D-illustrations:** Nikolaus Frank

**Graphic design, interface design:** Cecilia Frank

**Graduate students and researchers:** Johan Mattsson, Catharina Melian, Ola Hamfors, Li Wei, Markus Bylund, Alex Jonsson, Ester Appelgren, Tobias Törnqvist and Fredrik Espinoza.

**Collaborators and sponsors:** Telia, Ericsson, IBM Svenska AB, Brainheart Capital, Royal Institute of Technology, Stockholm School of Economics, Fulbright Commission, Vinnova, Intel Corp., Swedish Institute of Computer Science, Frank etc, University of Oregon, University of Maryland (UMBC), Tekniska Museet and Telemuseum in Stockholm.

# thinkWearable;aWare

## Utility

The idea is to use “wearable thinking” in solving some of the challenges of people being physically apart. It is well-known that people can sustain higher quality collaboration and relationships while being in close proximity, thus being “situation-aware.” This situation-awareness rapidly drops as distance increases. The “aWare messenger,” achieves these desired goal by providing situation-aware communication through generating a sense of presence and emotional status (mood), and by employing location and context-awareness capabilities.

## Design

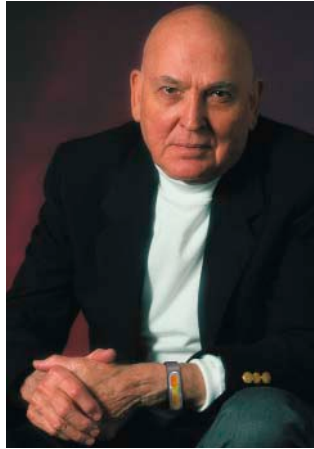
### The aWare card.

- Credit card-sized object, which fits in wallets, business card holders, security card clips etc.
- Bluetooth connectivity to a Wearable server or 3G phone.
- Touch sensitive and combinable with other aWare cards.
- A transparent soft plastic sleeve is applied to the personal server, allowing for an aWare card screen to be included. A stylus is also included and can be used as an input device through the soft protective plastic.
- The modular aWare card can be mounted on a wrist-holder that is enhanced with vital signs sensors. By sliding the card in the holder, it is securely attached to the wrist-piece.



### Wearable server/Communicator





#### The aWare clip.

- Wearable accessory for mobile users of all ages, allowing the user to integrate the artifact with clothing, a necklace, a belt or on the wrist.
- Bluetooth connectivity with a Wearable server or a 3G phone.
- The frame incorporates a microphone and a speaker, so the user can talk directly to the object.
- The consumer can slide the aWare user interface sideways and pan on a larger "strip" of information.
- Touch sensitive surface, allowing for text input and interaction with graphics.



#### Significance

The aWare objects capture contextual and physiological information such as stress level, pulse, posture, and translates it into a mood and user activity indication. The aWare devices have the potential to help people mitigate the anxiety generated by distance as well as playing a central role in wellness and new forms of health care.

**Faculty:** Magnus Boman, Carl-Gustaf Jansson, Bertil Thorngren and Zary Segall (lead)

**Conceptual and product design, 3D-illustrations:** Nikolaus Frank

**Graphic design, interface design:** Cecilia Frank

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# BabyWear

**BabyWear** is an integrated system designed both to shorten the time a premature infant spends in neonatal intensive care, and also to improve the quality of life for the infant while being cared for in a NICU.

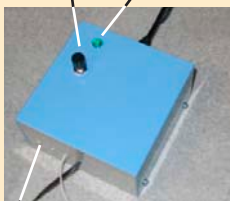
## The BabyWear System

The **Pacifier-Activated Listening** system uses an instrumented pacifier to sense when an infant is actively sucking and infrared sensors to detect general activity level. When used in conjunction with the Sound Therapy Hat, the system can be used to reward sucking behavior with audio. Medical studies indicate this type of system may reinforce nursing, and actually accelerate weight gain in premature infants, getting them home from the hospital sooner.

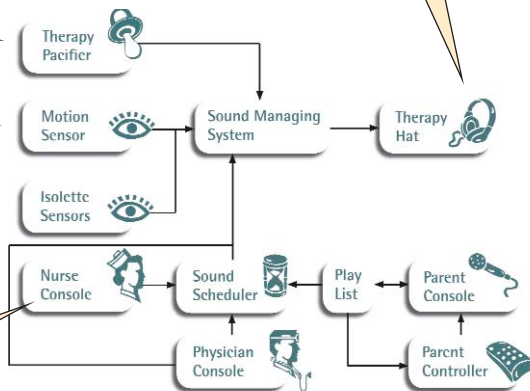
The **Sound Therapy Hat** helps reduce ambient noise infants are constantly exposed to in a busy NICUs while also delivering soothing or stimulating sounds chosen by time of day as well as feed-back from a P.A.L. unit or its own integrated sensors.

### Nurse's Console

Audio Switch Pilot Light



Sensor Expansion



Default pane displays the list of songs that are common to all infants.

Playlist pane displays the current list and order of songs that the baby is listening to.

Custom pane displays the list of songs that have been uploaded specifically for this particular infant.

Songs can be added from either list.

Songs can be removed from the playlist.





## Sound Therapy Hat

- **Provides** active and passive noise abatement
- **Delivers** therapeutic audio stimulus to the premature baby
- **Includes** an integrated sensor package for measuring temperature, galvanic skin resistance, etc.

### Problem

Premature infants are exposed to constant noise in the neonatal intensive care unit (NICU). It is not uncommon for noise levels within the NICU to be greater than that of street noise level. This produces negative long-term effects.

### Goal

Design a device that neutralizes sound within each neonatal isolette.

### Additional Specifications

The device must withstand chemical cleansers for sterilization, must be small in size and must be determined by clinical engineering not to interfere with existing equipment.

Galvanic Skin Resistance Sensor      Stereo Headphones



Sound Insulation

## Sound Therapy Pacifier

- **Senses** sucking of pacifier, both interval and intensity
- **Triggers** lullabies and fades audio levels in and out based on user-definable sucking time-out
- **Plays Back** recorded heartbeat and gut sounds, independent of, or in concert with, lullabies
- **Includes** tunable low-pass filters to simulate in utero sound quality
- **Hosts** infra-red sensors for motion detection and receives analog data from existing medical sensors

Force sensor



WEARABLE COMPUTERS COURSE Instructor: **ZARY SEGALL**

In collaboration with **John Hopkins Hospital**: Chris Lehmann M.D., Pamela Donohue M.D.

**Imaging Research Center**: Chad Eby, Dan Bailey **Visual Arts program**: Margaret Re, David Yager

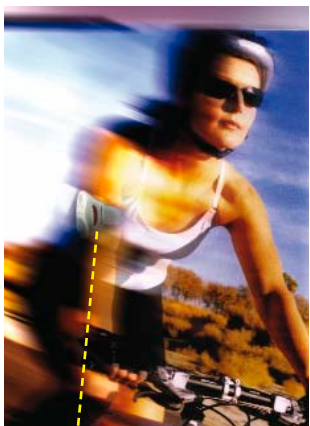
**BabyWear**: Sheetal Agarwal, Sedric Boddie, Jackie Bryson, Bryan Hurley, Zhkin Meng, Adams O'Sullivan, Nimish Vartak

# WIT

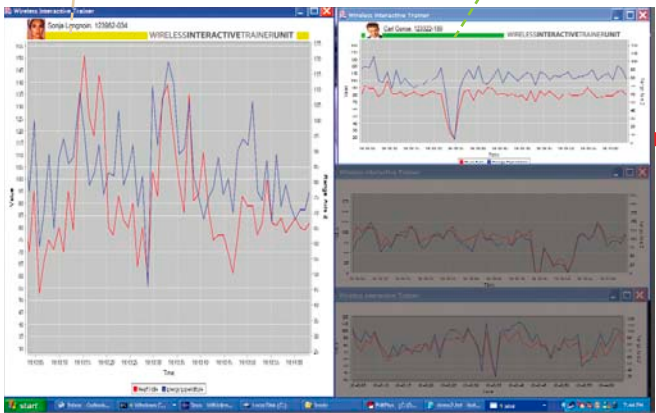


## WIT – Wearable Interactive Trainer

- Continuous monitoring in and out of the gym
- Wearable design
- Real time communications
- Integrated heart rate monitor
- UPC scanner to record exact calories intake
- Records climatic parameters such as humidity
- Multiple trainee tracking
- Bluetooth and Wifi compatible
- Trainer and trainee can geographically be in different locations.



Monitoring System



The trainer monitoring remote athletes using WIT

WEARABLE COMPUTING COURSE Instructor: **ZARY SEGALL** in collaboration with the UMBC track coach.  
**WIT:** Lance Byrd, Keith Dvorsky, Angelique Johnson, Petikul Lerkram, Pavan Reddivari.

# eBag

## Utility

Natural and man-made disasters are clear and present dangers and a matter of increasing concern to individuals. This project targets the design of a collection of objects and mobile services that will help an individual in a particular type of disaster emergency. We call this collection the eBag, while the specific services provided within are referred to as ELIS (Emergency Location and Identification Services).

## Design

### Current Hardware:

- Location identification based on GPS.
- Wearable computer running ELIS software.
- Specially designed backpack that delivers and produces electrical power.
- The backpack integrates the electronics and houses a set of survival objects.

### ELIS Features:

- Creates groups amongst the users.
- Provides multi mode communication including an ad-hoc network.
- Facilitates GPS tracking for all connected users.
- Contains a live chat feature.
- Senses and reports physiological data (NA).
- Provides survival gear and electrical power.



- ◀ One of the features of the ELIS system is a live chat feature and a map panel designed to display the individual GPS location.

## Significance

The purpose of this project is to study and provide a solution to many problems encountered by those individuals experiencing natural and man made disasters, such as hurricane, tsunami, floods and terrorist attacks.

HUMAN AWARE WEARABLE COMPUTING COURSE Instructor: **ZARY SEGALL**

**EBAG:** Payal Aggarwal, Chad Eby, Pat Gillespie, Bryan Hurley, Brian Sauk, Stephen Uithoven, Qufei Wu.

# Chimera

## Utility

The Chimera serves to connect people with their own experiences, as well as to other peoples experiences. It allows people to bond over common interests and increases social openness and a sense of community.

## Design

### Chimera Features:

- GPS-based camera.
- Physiological data collection.
- Continuously searches using Google.
- Autonomous blogging based on location and physiology.
- Directly generates KML code for Google Earth.
- Integrates Google Earth's virtual or prerecorded travel (flyby) with pictures.



## Significance

The Chimera serves to connect people with their own experiences, as well as to other peoples' experiences. It allows people to bond over common interests and increases social openness and a sense of community.

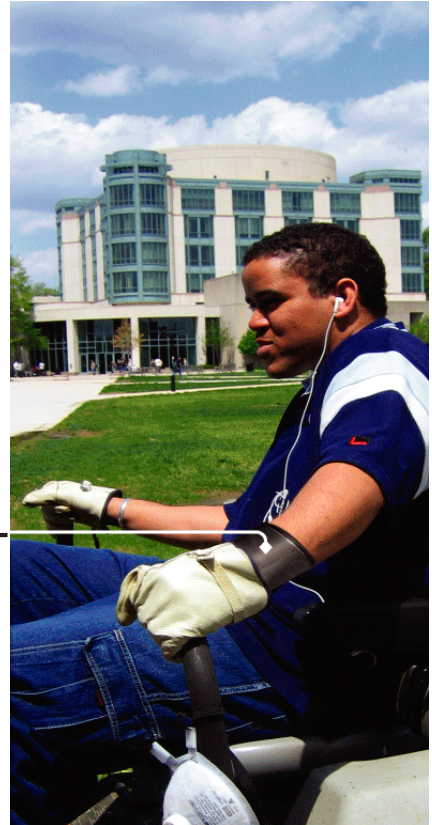
HUMAN AWARE WEARABLE COMPUTING COURSE Instructor: **ZARY SEGALL**

**CHIMERA:** Chad Eby, Jesse English, Bryan Hurley, Palanivel Kodeswaran, Nnadozie Onunkwo, Ashwini Ujjinamatada, Sean Wilson, Thomas Yoon, Yi Zhao.

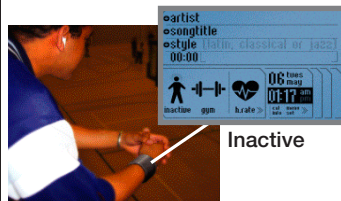
# Xpog

## Xpog – a contextualized human aware music player

Xpog is a wearable, personalized music player that utilizes data collected from various sensors and attempts to make music selection an automated activity. The use of physiological information, along with context, provides the Xpog system an awareness of the music choices of a user without requiring user intervention. Using decision tree induction techniques, Xpog generates rules that provide the user with physiology-based song selection from a personal MP3 player or a download from a subscription-based service such as satellite radio.



### At the GYM



Inactive



Active

WEARABLE COMPUTING COURSE Instructor: **ZARY SEGALL** in collaboration with Peggy Re  
XPOG: Ruchita Bhargava, John Foster, Abhishek Gujar, Deen King-Smith, Mariano Ramos.

# Jpod

## Utility

The goal of Jpod is to determine, in real time, the safest and most efficient jogging exercise envelope for a specific individual. To this extent, Jpod is a collection of integrated algorithms that are based on a set of models, such as body-mechanics, environment, physiology and safe exercise training. Similar to the Jpod predecessor, Xpod, the preferred manifestation is through manipulation of sound files existing in an mp3 player.

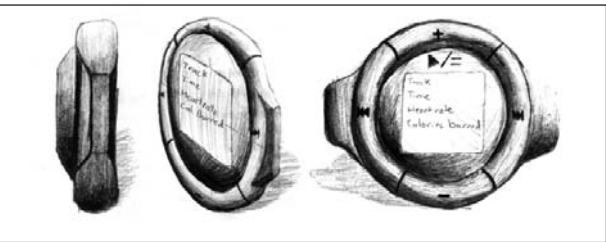
## Design

### Jpod Features:

- Intelligent playlists that are dynamic to adjust to a user's workout.
- New algorithms that help a user exercise efficiently while reducing the risk of injury.
- Ability to read current weather/environmental conditions while exercising, from Web Services.
- Elegant design that incorporates style and functionality.
- Algorithmic real time adjustment of exercise parameters such as a warmup/cooldown for a specific individual.

## Significance

Jogging is one of the more dangerous sports. Six out of ten joggers are injured in an average year. One of the biggest obstacles to exercising and training is determining ever-changing, real time exercise regimes that are personalized, intelligent, safe and effective. Jpod is taking relevant steps in making jogging safe and meaningful for an individual. Existing research has shown the potential of reducing the injury rate by up to 25% by using similar considerations as in Jpod.



◀ Sketches for Jpod rendering

HUMAN AWARE WEARABLE COMPUTING COURSE Instructor: **ZARY SEGALL**

**JPOD:** Oluwaseun Aduroja, Jonathan Bronson, Sandeep Balijepalli, Chad Eby, Alexander Feldman, Bryan Hurley, Michael Michniewski, John Nosek, Erick Pember, Zachary Radtka, Candice Scarborough  
**UMBC DEPT. OF ATHLETICS:** J. Murray Davis, Head Coach, Cross Country/Distance.

# *Memories and reflections*

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In this chapter, the reader will find contributions from a large number of early teachers and researchers, who have given personal contributions to the development at the Department. All these persons have taken the invitation to participate positively, and their contributions can be found below.

Almost all of the contributors have reached the academic position of professor, most of them at the Department.

We have asked the contributors to be personal rather than formal, and we have given them free scope to choose what memories to describe. This means that they could treat any part of the development over the years that have passed. Because of this, the contributions below are quite different both in content and in form.

The contributions below are placed in alphabetical order.

We hope that the reader in a meaningful way can enjoy impressions given from these texts, that together – as we see it – treat important parts of the development at the Department.

Naturally all these contributions are self-contained while simultaneously complement important scientific developments within the Department. We are honored to be able to include these aspects in our book.



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## FROM CADIS TO SISU - MEMORIES FROM TWO DECADES

### ABSTRACT

The author's research and research management activities during the period 1965 - 1985 are reported. It includes participation in forming the department of Information processing – administrative data processing (now DSV – Computer and Systems Science) in 1966 and starting up one of its first research groups, CADIS. The main output from CADIS was the associative data base management system CS4 including a data management and programming language. CADIS was followed in 1980 by SYSLAB, the Systems Development Laboratory, with researchers both in Gothenburg and in Stockholm. The main output from SYSLAB was information modelling knowledge, an object oriented tool for development of distributed, interactive systems (OPAL), and a CASE shell for implementation of method-specific support tools (RAMATIC). SISU, the Swedish Institute for Systems Development, was established in 1985, thanks to the initiative of SYSLAB's personnel and its industrial advisory group.

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**Janis A. Bubenko Jr**

Bubenko (TeknD, Docent, Dr.ing.h.c, ACM Fellow) was appointed professor at Chalmers University of Technology and University of Gothenburg in 1977 and at the Royal Institute of Technology and Stockholm University in 1981.

He was head of the research groups CADIS and SYSLAB. In 1984 he initiated the establishment of the Swedish Institute for Systems Development – SISU and was its managing director 1985 - 92.

When Börje Langefors employed me in his research group for information systems in 1965, I had already been active in the computing field for about 8 years. During 1961 – 1965 I was employed by Univac and in charge of its systems and programming department in Scandinavia. Working for a computer vendor was, however, quite far from doing research. I was, therefore, quite happy to be offered to join Langefors' group in 1965, and to participate in forming the department in 1966.

Initially, my interest areas within the field of computing were computing system performance analysis and operating systems. This was probably due to my background in engineering, in particular in structural mechanics, as well as my job at Univac. Inspired by Langefors' book THAIS (Langefors 1967) my interest turned towards representation of an analysis of information systems, including data base systems. My "scientific view" of the field of information systems was, and to a large extent still is, very much that of an engineer. I prefer doing things that will (or can) eventually be of some practical value in society. I consider mathematics an important component in the education of systems analysts and designers. This does not mean that I believe that everything related to information systems can be, or should be, formally defined. Neither does it mean that systems should be designed by engineers only. Many disciplines, such as economists, psychologists, and production engineers can be required in the systems development process depending on the application area of the information system to be designed. Information systems are considered to be among the most complex systems designed by man. I am, therefore, convinced that the discipline of mathematics, including logic, does help us to arrive at more complete, less fuzzy and less "sloppy" definitions of conceptual frameworks and

***"Information systems are considered to be among the most complex systems designed by man."***

theories. Furthermore, many activities in the systems development process are concerned with modelling. First we model organisations, their intentions and goals, their “ontologies” (conceptual structures), business rules, as well as actors and business processes. Later in the development process we model data bases, computing processes and man-machine interaction. All these modelling activities require, in the end, clarity and precision. A minimum of schooling in mathematics and logic is required in order to understand modelling methods and in order to perform modelling in a qualitatively acceptable way, I feel.

This paper deals with memories of my research and research management activities from 1965 until about 1985. Memories of other, early research groups at the department at that time, ISAC and PRINCESS, will be reported by others.

### CADIS

CADIS stands for Computer Aided Design of Information Systems. The research group was formed in 1969, thanks to financial support from STU ► (Styrelsen för Teknisk Utveckling, later NUTEK). During CADIS lifetime, 1969 - 1979 the STU support for the project totalled about 2 million SEK. The group consisted initially of three researchers: Olle Källhammar, Stig Berild, and I. Later, several more persons joined the group for longer or shorter periods. Eva Lindencrona, “Jompa” Jan-Erik Johansson, Lars Kahn, Sam Nachmens, Anna Stina Eskilsson, Marianne Janning, Clary Sundblad, Jan Flodén, Lennart Schoug, Eric Roupé, and Péter Reévy are some of the people who did part-time research for CADIS.

As the name of the group says, our basic intention was to use the computer itself in designing computer based information systems. We worked along two directions. The first was aimed at developing a CASE ►► type of system and tool long before the word CASE was introduced (Bubenko and Källhammar 1971). The second was to use computer simulation in analysing the performance, primarily transaction response times, of “interactive” information systems (Bubenko 1970).

► The National Swedish Board for Technical Development

►► Computer Aided Software Engineering – CASE, introduced in the eighties.

The CADIS-group, around 1970.  
From left:  
Janis Bubenko,  
Olle Källhammar,  
"Jompa" Johansson  
and Stig Berild.



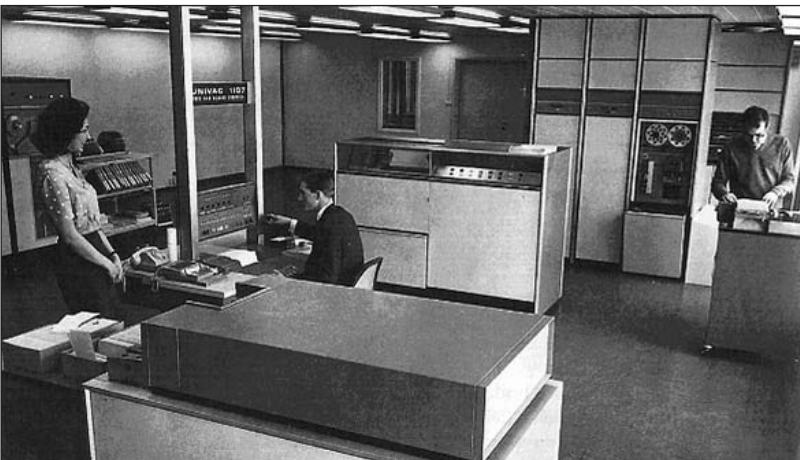
## CADIS System 1 to 4

How should we go about designing a computer-based tool for information system design? It would be unwise to build a tool for a particular, existing information systems development method. The tool would become obsolete long before it was ready for use, as many kinds of information system development methods existed at that time and they all were evolving rapidly. Consequently, we developed a tool that could handle arbitrary “system descriptions”. The elementary component of a structured system description was an associative triplet, e.g.  $\langle A, R, B \rangle$ , where A is an object, B is an object or a value, and R is a relation (also an object). This idea of a triplet was taken from the LEAP language (Feldman and Rowner 1969) and it matched nicely the idea of an “elementary record” and the definition of systems as illustrated by Langefors in THAIS. Complex associative networks could be described by triplets. A network could be the description of a database schema, an entity-relationship structure, or a process structure. In a way we were three years ahead of Mike Senko’s DIAM (Senko, Altman et al. 1973) approach and six years ahead of Chen’s Entity-Relationship approach of 1976 (Chen 1976). Looking back, I can only regret that we were not particularly aware of the importance of publishing our results more widely in internationally recognised conferences and journals at that time. Instead, we produced probably more than about 100 CADIS reports and working papers, whose quality was only irregularly checked in peer-review processes.

Our first computer program that could manipulate associative structures was called CS1 – CADIS System 1. It was implemented in the language BASIC on an interactive Hewlett Packard computer. The program was eventually further developed and implemented on both IBM 360/50, Univac 1107 and, in the end of 1970s, also on a DEC 20/20 (Digital Equipment ►). A data manipulation language CSL (CADIS System Language) was added to the

***” In a way we were three years ahead of Mike Senko’s DIAM (Senko, Altman et al. 1973) approach and six years ahead of Chen’s Entity-Relationship approach of 1976 (Chen 1976).”***

► DEC (Digital Equipment Company), a famous computer manufacturer, was bought by Compac in the nineties.



A large computer at the end of 1960-ies. (Univac 1107)

system. The system's name became CS4 and a user guide was published (Janning, Nachmens et al. 1979). A surprising additional use of CS4 was its suitability for rapid development of operative information systems (“rapid prototyping”). We called it “experimental systems development”. It turned out that using an associative application data base, systems of processes using that data base could be incrementally built with a minimum of programming effort and errors. At the end of 1970s Berild, Nachmens and, during a few years, also I formed a company, Databaskonsult DBK AB. Our plan was to develop a product based on CS4. The product that was developed was called Dream/CS5. It was marketed as a “Fifth generation Language” – a popular concept at that time. As far as I can recall, about 100 installations of CS5 were sold, primarily to the Swedish Defence. CS5 could, however, not match the marketing force of the relational data model and relational database systems (at that time advocated by IBM). Understanding tables was at that time simpler than understanding object-based and associative data structures. It should, however, be noted that we, at the end of 1970s, had a reasonably efficient operative system that could, popularly speaking, define and work with entity-relationship structures.

► Very Large Data Bases, an annual, international conference since 1975.

►► ACM Transactions On Database Systems

An odd thing occurred in 1977. Stig Berild's and Sam Nachmens' paper on CS4 accepted by VLDB'77 ► (Berild and Nachmens 1977) was selected as one of the three best submitted papers of that conference. The paper was therefore extracted from the conference proceedings, to be reserved for special publication in TODS ►►. The paper was submitted to three extra reviewers in order to improve its content and style. What happened, however, was that one of the extra reviewers, probably an “important database scientist”, vetoed the publication of this paper for reasons that had to do with whether you “like” associative structures or not. Unfortunately, this led to that this excellent paper was never published as it had been deleted from the conference proceedings awaiting journal publication. I still do not know who this important scientist is, I can only guess.

Concluding the CS4 part of this paper, I still feel we developed a good concept and a potentially very powerful product. We could, however, not match the marketing efforts of proponents, i.e. IBM, of the relational data model and associated products. The existing CS5 installations, implemented on SUN Microsystems by Infocon AB, survived until about 1995. Several Dream/CS5 installations are, however, still active and maintained today (see Stig Berild's article about Databaskonsult at the end of this book).

### **Simulation of Real-Time Systems**

The name of this simulation package is ARTS – Analysis of Real-Time Systems (initially it had another name: SRTS (Bubenko 1970). It is based on discrete time, event-controlled simulation

implemented first in Simula 1 ► and later converted to Simula 67. The intended use of ARTS is to simulate interactive, transaction-oriented systems. Each type of transaction is described as a process (that can include parallel sub-processes) of requests for computing resources such as processor time, access to disk file X or tape file Y, channel time to secondary storage or to a terminal, need for computer memory, need for a program, etc. A process can require the execution of another process, which in turn will require basic resources such as processor time, channel time, and storage. An important part of preparing input data for an ARTS simulation run was to analyse the particular vendor's computing system, including its operating system and data base management system, and to describe the system in terms of resource requirements for different system processes. For instance, the request for a data base record is described as a process that requires computer memory, programs, processor time, channel-time, disk access, etc. Thousands of transaction executions are simulated this way and statistics are gathered regarding queuing times and in general the response time for various transactions.

Computing power was quite expensive during the end of the 1960s and the beginning of the 1970s. Consequently, ARTS was used when an organisation was in the process of acquiring and evaluating an expensive, interactive system from one or more vendors. I can remember some 5-6 "sharp" practical uses of ARTS. It happened more than once that a vendor had overestimated the performance of his computer and operating system for a particular application. Of course, this led to long discussions with computer vendors about the reliability of our results. As far as I can remember, after an open explanation of the underlying assumptions of the simulation, our results were accepted, also by the vendors.

### Impact of CADIS research

Practical uses of ARTS included performance analysis of interactive computer systems at e.g. Dagens Nyheter, Trygg Hansa, and at Danderyd's Hospital. In the first two cases, ARTS was used to check if the offered computer systems would match response-time requirements set by the procuring company. I remember the computer manufacturers were initially a bit sceptical about the accuracy of the results of our simulation runs. It turned out, however, the results were surprisingly accurate, compared to subsequent real life measurements.

CS4 was developed further in a spin-off company from Databaskonsult AB ►►. The main actors in this company were Stig Berild and Sam Nachmens. The product was further developed (CS5/DREAM) and used primarily in the defence sector (about 100 installations), but also in the education of our department (Experimental Systems Development) and in developing an

► Simula 67 is the world's first object-oriented language, designed by the Norwegian computer scientists Ole-Johan Dahl and Kristen Nygaard.

***"It happened more than once that a vendor had overestimated the performance of his computer and operating system for a particular application."***

►► This company was later named Infocon AB

administrative system at Stockholm University. CS4 ran also on DSV's Digital Equipment Dec 20/20 system.

Another area of our research was developing a method for design of database schemata according to the Codasyl DBTG format. The method developed was applied to a real case for the Swedish Road Authority (Vägverket) and it also resulted in a number of publications e.g. (Bubenko, Berild et al. 1976).

CADIS played an active role in Nordic co-operation as well. A significant number of contacts were established with Nordic researchers within the SCIP - project, sponsored by NORD-FORSK (results of the project are described in (Bubenko, Langefors et al. 1971)). Another significant Nordic activity co-organised by CADIS and Arne Sölvbergs group at NTH ► was a workshop on Data Base Schema Design and Evaluation (Bubenko and Sölvberg 1975) in Röros, Norway, 1975.

During the seventies, CADIS contributed significantly to courses given by the department. CADIS personnel developed and held courses in a number of areas such as data processing techniques, database systems, database design, fifth generation languages, experimental systems development, conceptual modelling, systems development methods and techniques, performance analysis techniques, and operating systems.

CADIS results were presented at Swedish and Nordic conferences (NordSAM, NordDATA) as well as at international conferences organised by IFIP, VLDB and ACM. CADIS researchers were quite active in writing research reports and working papers. They were published in the TRITA-IB-ADB series ►►. At the end of the seventies we had, as far as I can remember, produced more than 150 such "local" reports and working papers. In general, however, our rate of producing international journal and conference papers was fairly low, compared to the productivity of researchers in the US. It seemed at that time that having a long list of publications when applying for an academic position was not that important. As we know, the situation is quite different today.

PhD dissertations were accomplished during the seventies by Janis Bubenko, Eva Lindencrona, Lars Kahn, Christer Hultén, and Lars Söderlund. Bubenko was appointed "oavlönad docent" in 1974.

### **The period 1976 – 1982**

Thanks to a scholarship from IBM Sweden, I spent the year 1976 as a visiting researcher at Thomas J Watson Research Centre, Yorktown Heights, NY, USA. Here I had the opportunity to work together with other data base researchers, primarily, Michael Senko. My own research at IBM was oriented towards temporally oriented conceptual modelling. At that time, one of my reports written at IBM (Bubenko 1977) was considered pioneering work on temporal data models. I returned to the department in February 1977. Similar scholarships were later awarded also to Stig Berild

► NTH – Norges Tekniska  
Högskola, now NTNU

►► TRITA-IB-ADB stands for  
Transactions of the Royal Institute  
of Technology,  
InformationsBehandling, ADB.

***“It seemed at that time that  
having a long list of publications  
when applying for an academic  
position was not that important.  
As we know, the situation is  
quite different today”.***

and to Lars Kahn. They spent a year each at IBM Research in San José, California during the late seventies.

In August 1977 I was appointed professor of “Information Processing, specialising in administrative data processing” at the Gothenburg university and Chalmers University of Technology. One quarter of this chair was to be used for graduate teaching and supervising at the Lund University. Later I applied for the professor’s chair after Börje Langefors, and was appointed professor at Stockholm University and Royal Institute of Technology from the autumn of 1981. So, in the interval September 1977 to December 1981, I lived in Stockholm, but I was commuting 3 - 4 days every week to Gothenburg and about once a month also to Lund.

The CADIS research activity remained in Stockholm, and I tried to visit it once every second week. In Gothenburg I had the opportunity to meet new colleagues and research interests. Several of the researchers at the department of information processing – ADB in Gothenburg were already active in a project called VIA in a comparative analysis of practical information system development methods. This project was sponsored by the Volvo Car company. Rolf Høyer had been the acting professor in Gothenburg prior to my appointment. My initial contribution to the department in Gothenburg was conceptual modelling methods, data base design methods, and theoretical aspects of information system development methods. We also started a few smaller STU-financed research projects (FRIDA and RAGU) which developed a prototype for automatic design of a DBTG-type data structure starting from defined information requirements, and also made some empirical research regarding current practices in using development methods and in specifying system requirements.

## **SYSLAB**

A fairly large “Framework program for research in software and information systems” was developed by STU during the end of the seventies. Instrumental persons here were Lennart Lindeborg and Lars Kahn (then working at STU), a reference group of practitioners from Riksdataböndet, and an executive control group headed by Lennart Nordström. The overall aim of the program was to develop knowledge, methods, and tools in order to improve the quality of software and information systems. The program was to be supervised by a number of international experts who would visit and peer-review each laboratory once every year. Financial support should be given to research laboratories with a strong scientific leadership and good international reputation. As far as I remember, the program totalled more than 100 million Swedish crowns during a five-year period. At this time it was a large sum of money.

The framework program matched the profile of our researchers in Stockholm as well as in Gothenburg quite well. We decided to

***“In order to strengthen our ties with practitioners and to better understand their needs, we established an industrial advisory group consisting of knowledgeable persons from business, industry, and the official sector”.***

set up two laboratories SYSLAB-S in Stockholm and SYSLAB-G in Gothenburg. I was the scientific leader for both laboratories. Tord Dahl, the head of the department DSV, was to be the administrative manager. We applied for grants from within this framework program and received during five years about 2,5 MSEK for Stockholm and 1,2 MSEK for Gothenburg annually.

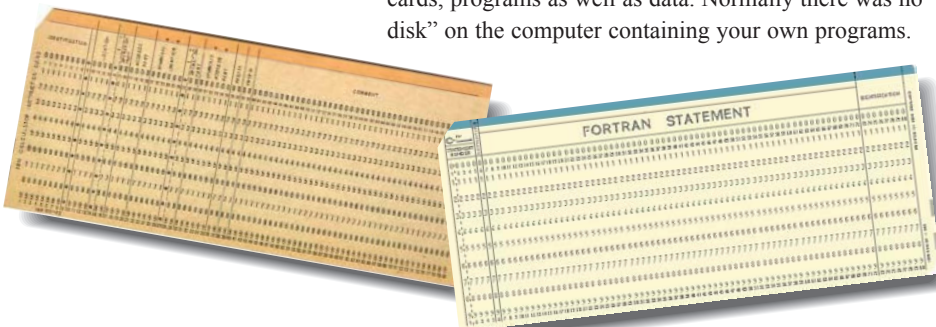
SYSLAB-S and SYSLAB-G worked in reality as one, decentralised organisation. We had frequent joint workshops. During the first half of the framework program I was almost weekly in Gothenburg and during the second half most often in Stockholm. In order to strengthen our ties with practitioners and to better understand their needs, we established an industrial advisory group consisting of knowledgeable persons from business, industry, and the official sector. The group was headed by Rune Brandinger, then CEO of Valand Insurance Co. Members of the group were Krister Gustavsson, Statskontoret, Gunnar Holmdahl, ASEA Information Systems, Göran Kling, Volvo-Data, Sten Martin, Swedish Defence, Per-Olov Persson, Riksdataböndet, Sven-Erik Wallin, Esselte Datacenter, and Kurt Wedin, Vattenfall. We had frequent meetings and discussions with the group.

STU's international experts with a particular responsibility for SYSLAB were, Professor Erich Neuhold, then at University of Vienna, Professor Hans-Jochen Schneider, Technical University of Berlin, Professor Arne Sölvberg, NTH, Trondheim, and S. Bing Yao, University of Maryland, USA. In addition, SYSLAB had its own expert advisors Professor Dennis Tsichritzis, then at Toronto University, and Professor Raymond T. Yeh, University of Maryland, USA

### **The technical and political environment**

In order to appreciate our choice of research topics during the seventies and eighties it is necessary to understand the technical environment and also the political attitudes during that period. In spite of the 1968 “student revolution” (which most of us hardly noticed) the sixties, and early seventies were quite “technology friendly”. All computing was done in large computing centres. “Batch processing” was the rule. Jobs to be executed on the computer were prepared on punched cards. A job could consist of thousands of cards, programs as well as data. Normally there was no “hard disk” on the computer containing your own programs.

Two punched cards from the 1960s, one for data input and another for writing program statements in FORTRAN.



The cards were delivered to a computing centre and processed in batches. If you were lucky and had made no mistakes in the leading control cards (e.g. JCL - Job Control Language, by some called "gissel") or in your program, you could expect the result after a few hours. Even if programs were developed in this inefficient way, interactive (real-time) special purpose application systems, such as airline reservation systems, had existed for a decade. The bulk of systems, however, were large, centralised, and batch-processing oriented. Consequently, the dominating paradigm in systems development during the sixties and seventies was a "waterfall" process with many stages and a heavy emphasis on documentation of each phase. To acquire a new computer system and develop an application system, e.g. for an insurance application, was an affair that could cost several tens of millions of crowns and take a couple of years to complete. Heavy emphasis was put on developing system descriptions during all development phases, and on analysis of such descriptions with respect to their correctness and validity as well as to the performance of the application system. Many, several hundreds of "system development methods" were competing on the market at this time. No commercially available computer base tool for system description and analysis (compared to CASE-tools of the late eighties) was at hand. All documentation had to be done by hand. There was also a "theoretical fight" between believers of different methods as well as between supporters of three different approaches for structuring of data in a data base: the hierarchical model (IMS) of IBM, the Codasyl DBTG Network structure, and the Relational Data Model (table oriented).

During the end of the seventies and the beginning of the eighties, new "smaller" computers (minicomputers) such as the Digital Equipments PDP, VAX and DEC 10 and 20 systems were introduced in university environments and also in companies. They were time-sharing computers each serving a relatively large number of (30 – 50) user terminals. Most employees of our department could now enjoy their own terminal in their room. Programs could now be developed and tested "on-line". We could send "mail" to each other, but initially only to a user of the same computer ►. This was also the start of us typing our own documents instead of using secretaries. But the initial terminals were extremely primitive compared even to the simplest PC of today. They were text terminals ►►. Each screen could display about 20 lines of text, 80 characters (green on black, or yellow on black) long. There were no graphic representation possibilities. There was no mouse and "clicking on the screen" was not possible.

Politically, the picture changed a bit in 1976 when the right wing, the liberal and the Center party formed a governing coalition. One of the changes was, I feel, that the government played a more compliant role with respect to the labour unions. The unions and their workers had made some bad experiences in some

***"Consequently, the dominating paradigm in systems development during the sixties and seventies was a 'waterfall' process with many stages and a heavy emphasis on documentation of each phase".***

***"This was also the start of us typing our own documents instead of using secretaries".***

► A primitive form of "internet" started in the early eighties. If your computer was connected to the telephone network, then you could send a mail to another computer on the network by specifying an address as a path from the source computer to the destination computer, through a number of intermediary computers.

►► More advanced terminals and work-stations existed at this time, permitting graphics, but we could not afford them. "Affordable" workstations with better graphic facilities were introduced around 1985.

information system development projects. The workers felt “run over” by the system development teams. Systems development resulted, they felt, often that information systems degraded the skills of workers. The users/workers did not appreciate this. Consequently, the labour unions asked for more power and co-determination in systems development projects. This was in a way given to them, when needed, in terms of a particular “employee consultant” (löntagarkonsult) who at the employer's expense assisted the workers in taking part in the requirements determination and system development process.

### **The research of SYSLAB**

The previous section describes the technological environment and some political attitudes of the early eighties. They gave us the following impulses and ideas regarding our own research:

- There was a great need for computer support in system description and analysis but it was not fruitful to develop a tool for a particular method, we felt. There were too many methods on the market and the methods constantly changed their characteristics. Could we instead develop a tool that was easily “adaptable” to different methods and description techniques?
- The technological advances were rapidly coming: better terminals and work-stations (with graphics), and computers working and communicating in networks. How should we exploit these advances in order to develop architectures of user friendly and efficient information systems for our business and industry environments ▶?
- How could we help organisations which dealt with the maintenance of large and complex (many parts, many components and versions) software systems to manage the work more efficiently?
- The methods used in practice (by consultants and by companies) were simple to use but they lacked precision and rigour to be supported by a computer-based tool. Consequently, SYSLAB performed a number of theoretical as well as empirical investigations regarding methodological fundamentals (e.g. temporal databases, axiomatic information models), use of information models and languages, use of enterprise modelling, and practice of requirements determination and analysis. A consequence of moving the workers and users towards a more participatory position was also our ambition to involve workers and users more explicitly, particularly in the requirements acquisition and modelling phase of systems development.

Some of the above ideas are further described below.

In SYSLAB-S a significant effort was assigned to developing a *prototype* OPAL (Ahlsen, Björnerstedt et al. 1984) for software development in the area of distributed, interactive *office information systems*. The prototype was designed to make use of recent

***“There were too many methods on the market and the methods constantly changed their characteristics.”***

► This area was at that time called “Office Information Systems”.

advances in hardware, software and communications technologies. Ideas implemented in this prototype were novel. It was an object-oriented system architecture that could define, create, and manage active objects in a distributed environment. It demonstrated system properties that can be seen in full operation today, e.g. workflow systems, CSCW-systems, and objects with properties similar to cookies, viruses, and “spyware”. This kind of objects were discussed by the originators of the object-oriented OPAL system years before we even had heard of PCs, Windows, internet and all its peculiarities.

In Gothenburg a major research effort was directed towards developing a “meta-CASE” tool (or a “CASE shell”), i.e. a tool that could be used to develop graphics-oriented documentation tools for different methods on the market. This was about at the time when the concept CASE (Computer Aided Software Engineering) was coined. The name of our effort was RAMATIC (simply meaning the tool of the RAM (Requirements Analysis Methodology) project). Unfortunately, not much about RAMATIC is published internationally (Dahl, Ericsson et al. 1985). One explanation is that we were so busy in trying to implement this extremely complex system that writing papers was given a low priority. Furthermore, we did not wish to publish papers of a system that was not reasonably complete ▶ .

Later the RAMATIC effort was transferred to SISU (see the following section) where we tried to make it a product, or at least something closer to a product. We never made it a real product, but the tool became practically used in several Swedish enterprises, e.g. Televerket (now Telia) and Volvo Personvagnar for implementing computer support for methods used in Televerket and Volvo respectively. RAMATIC was also used in some

***“It was an object-oriented system architecture that could define, create, and manage active objects in a distributed environment.”***

***“...we were so busy in trying to implement this extremely complex system that writing papers was given a low priority.”***

▶ This seems to be contrary to what many researchers are doing today.

#### **A major part of SYSLAB Stockholm personnel at end of 1984.**

From left: Kim Waldén, Bo Steinholtz, Åsa Rudström, Anders Björnerstedt, Marianne Sindler, Janis Bubenko, Carl-Gustaf Jansson, Eva Lindencrona, Terttu Orci, Stefan Britts, Alfs Berztiss, Matts Ahlsén, Benkt Wangler, Lars Asker, Tord Dahl, Lars Söderlund, Christer Hultén.



EU-financed projects during the SISU period, e.g. in F3 and in TEMPORA. The basic idea of RAMATIC was

- 1) to define a conceptual model of the descriptive structures of a method (e.g. data models, process models, event models, etc. and their properties),
- 2) to define how the objects should be graphically represented (e.g. rectangles with text, ovals, arrows, etc.),
- 3) to define what particular constraints should hold in composing a graph (e.g. an entity should include at least one attribute), and
- 4) where (on what screen or page) an object symbol should be represented.

It is worth remembering that we attempted to build this tool when no “windowing” systems existed, no track-ball (mouse) existed and the screens of a terminal were character screens (an oval, for instance, had to be represented by dashes, slashes, dots, etc). In order to be able to “work in several windows”, we simply put several physical screens next to each other (controlled by a “multiplexer” of our own design). This particular problem disappeared later in the mid-eighties when we could acquire windows and graphics oriented workstations, such as SUN. A notable characteristic was that RAMATIC used the CS4 system’s associative data base management system to store and manage the descriptions above. It turned out the associative data structure was more efficient for manipulating and navigating in networks of “descriptive objects” than relational tables.

#### **A major part of SYSLAB Gothenburg personnel at end of 1984**

First row: Thanos Magoulas, Ulf Sundin, Mats-Roger Gustavsson, Roland Dahl, Håkan Torbjär.

Second row: Kalevi Pessi, Janis Bubenko, Ed Lief, Peder Brandt, Lars-Åke Johansson, Dick Eriksson.





Two persons instrumental at the start of SISU in the autumn of 1984: Lars Kahn, then at Ericsson, helped to arrange a substantial financial grant from Ericsson. Rune Brandinger became the first chairman of SISU's board of directors. Rune was then CEO at the insurance company VALAND.

Due to space limitations, several other activities of SYSLAB must wait for other publications to appear. It should however be mentioned that we also did action-oriented research regarding requirements, information, and conceptual modelling. Courses were offered to practitioners and also to university students. A conceptual modelling textbook was published (Bubenko and Lindencrona 1984).

## SISU

I think it is fair to say that one important impact of SYSLAB was the formation of SISU (the Swedish Institute for Systems Development). Instrumental in this process was the SYSLAB's industrial advisory group headed by Rune Brandinger. SISU was initially financed by STU and 24 organisations and companies. The Swedish government decided in the autumn of 1984 to establish the operation of the industry research institute SISU starting January 1st, 1985. The 1985 budget of SISU was about 6 MSEK. Thirteen researchers were transferred from SYSLAB to SISU in January 1985. I was appointed the first managing director of SISU.

The main goal of the SISU institute was to act as a bridge between practice and academia. Consequently, SISU took some results of SYSLAB and tried to develop them into "products" which could be used in practice. Two of these were OPAL and RAMATIC. In particular RAMATIC was later used in several projects financed by the European Union's Framework programmes. Another heritage from SYSLAB was the conceptual information modelling knowledge and tradition. It later contributed to developing strongly participatory business and enterprise modelling approaches as well as modelling tools within SISU. These will, however, be described elsewhere.

## Concluding remarks

Looking back at two decades of ones working life, a question naturally arises: did we do the right things? Had we known how computing and communications technologies would develop,

***"One important impact of SYSLAB was the formation of SISU."***

***“The main ingredient of the output of research is ‘new knowledge’ and not (necessarily) ‘new products’.”***

would we have focussed on other research topics?

The answer to this is dependent on how one looks at academic research and at evaluation of research. The main ingredient of the output of research is “new knowledge” and not (necessarily) “new products”. New knowledge manifests itself in scientific publications (after having passed a peer reviewing process), in functioning prototypes, and in academic degrees and positions of different kinds. Also forming a new company, or an institute, is based on new knowledge. In this respect, I think, CADIS and SYSLAB can be reasonably satisfied. A majority of the persons on the two pictures above have achieved a PhD degree. Six of former SYSLAB staff became full professors. Some have responsible positions in government controlled, research planning and funding organisations. A number of consulting companies have been established. We are also particularly proud of having organised the 1985 international Very Large Data Bases (VLDB) conference in Stockholm, attracting a record attendance of more than 800 delegates.

On the other hand, having a retrospective look at these twenty years, I must admit we had some controversial aspirations, attitudes and activities as well. On the whole, we made, perhaps, the same kind of mistakes many academic researchers in information systems are doing today:

***“We were tackling too many problems that were ‘wicked’ and ill-defined.”***

- We were much too optimistic about what we could achieve with our limited knowledge, experience, time, and resources
- We were tackling too many problems that were “wicked” and ill-defined. In the beginning we were not experienced and mature enough to handle such problems in a scientifically adequate way. Expressed in another way: we were eager in publishing hypotheses and less concerned about whether these hypotheses were reasonable or correct.
- We were fairly ignorant about how fast technology was developing. For instance, in the late seventies none of us could imagine that only ten years later very powerful personal microcomputers, PCs and Macs, with advanced graphics facilities would be flooding the market, and only a few years later internet would have developed into such a powerful and useful communications concept and tool.

We spent considerable resources in developing tools and methods based on quickly developing and aging technology. We were also unrealistically optimistic about how quickly and to what degree practitioners could understand, appreciate and use the kind of results we were developing. On the other hand, such optimistic attitude is perhaps necessary in order to make progress at all?

## References

- Ahlsen, M., A. Björnerstedt, S. Britts and C. Hulten (1984). "An Architecture for Object Management." ACM TOIS 2(3).
- Berild, S. and S. Nachmens (1977). CS4 a Tool for Database Design by Infological Simulation. 3rd International Conference on Very Large Data Bases, Tokyo.
- Bubenko, J. A., Jr (1970). SRTS -1 (Special Real-Time Simulator) – an Introductory Description. Systemering 70. J. A. Bubenko, Jr, O. Källhammar, B. Langefors, M. Lundeberg and A. Sölvberg. Lund, Studentlitteratur.
- Bubenko, J. A., jr (1977). The Temporal Dimension in Information Modelling. IFIP WG 2.6 Working Conference on Architecture and Models in Data Base Management Systems, Nice, France, North Holland.
- Bubenko, J. A., Jr, S. Berild, E. Lindencrona-Ohlin and S. Nachmens (1976). From Information Requirements to DBTG Data Structures. ACM Sigplan/SIGMOD Conference on Data Abstraction, March 22-24, Salt Lake City, Utah, ACM.
- Bubenko, J. A., Jr and O. Källhammar (1971). CADIS: Computer-Aided Design of Information Systems. Computer-Aided Information Systems Analysis and Design. J. A. Bubenko, Jr, B. Langefors and A. Sölvberg, Studentlitteratur, Lund, Sweden.
- Bubenko, J. A., jr, B. Langefors and A. Solvberg, Eds. (1971). Computer-Aided Information System Analysis and Design. Lund, Studentlitteratur.
- Bubenko, J. A., Jr and A. Sölvberg, Eds. (1975). Data Base Schema Design and Evaluation. Röros, Norway, Nordic Workshop sponsored by NORDFORSK.
- Bubenko, J. A., Jr. and E. Lindencrona (1984). Konceptuell modellering – Informationsanalys. Lund, Studentlitteratur.
- Chen, P. P. (1976). "The Entity-Relationship Model – Toward a Unified View of Data." ACM Transactions on Database Systems 1(1): 9-36.
- Dahl, R., D. Ericsson, L.-Å. Johansson, U. Sundin and H. Torbjär (1985). RAMATIC – a Modelling Support System, SYSLAB, Department of Computer and Systems Science, The Univ. of Stockholm.
- Feldman, J. A. and P. D. Rowner (1969). "An ALGOL-based Associative Language." Communications of ACM 12(8): 439 - 449.
- Janning, M., S. Nachmens and S. Berild (1979). Introduktion till Associativa Databaser och CS4-Systemet. Lund, Sweden, Studentlitteratur.
- Langefors, B. (1967). Theoretical Analysis of Information Systems. Lund, Sweden, Studentlitteratur.
- Senko, M. E., E. B. Altman, M. M. Astrahan and P. L. Fehder (1973). "Data Structures and Accessing in Database Systems." IBM Systems Journal 12(1).

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## COLLABORATIVE RESEARCHING – FROM ISAC TO VITS THROUGH HUMOR

### ABSTRACT

The paper addresses questions like: How do we organize research environments? How do we succeed in creating good collaboration in research? These questions are viewed through the personal experiences from participating in three collective research environments (the research groups of ISAC, HUMOR and VITS). The importance of a collective research capital is stressed. Such an intellectual capital consists of knowledge capital, social capital and process capital.

Knowledge capital can be formed by joint research products, like theories, models and methods. Such knowledge products transcend beyond individual contributions. They are formed by the endeavours of several researchers working together and building on each others' works and adhering to some common core foundations.

When working together, social bonds between the researchers emerge as a social capital.

Process capital describes the ways research and research education are conducted, like for example seminar culture. The evolution and relations between the three research environments are described. The systems-theoretical and infological foundation from Langefors in ISAC, via the human-infological theories and methods in HUMOR, to the concert of different theories and methods all founded in socio-instrumental pragmatism in VITS.

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### Introduction

How do we organize research environments? How do we succeed in creating good collaboration in research? How can we exploit individual research talents when trying to work together? Are individual research careers possible in collective research environments? These are pending questions when discussing ways to perform research. However, I do not find such questions often addressed in writings on research strategy.

In this short essay I will give my personal reflections on these matters. These reflections are personal since they will present and elaborate on my own experiences during more than 30 years of active research in collective research environments. It is thus a very personal document dealing with my ways and my convictions of how to organize and perform research. The thoughts that I present are however not some passing fancies. They have evolved through a long time with continual reflections on these matters. So I claim that I have something important to say to other members of the research community.

I will below briefly go through experiences from working in three research organisations; first the ISAC research group, then the HUMOR research group and lastly the VITS research network.

### ISAC Research Group

I started my research career as a young research candidate 1973 in the ISAC ► research group at the DSV ►► department, Stockholm university/Royal Institute of technology. The ISAC group was



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► In 1973 ISAC was an acronym for Information Systems for Administrative Control. Later it was changed to Information Systems work and Analysis of Changes.

►► At that time the official name of the department was not DSV. It was known as ADB department (from the Swedish name of the discipline at that time, Administrativ databehandling [Administrative data processing]). I will however use the name DSV in this article.

headed by Mats Lundeberg and our work was to a large extent inspired by the pioneering works of our first professor Börje Langefors (1966) on information systems (IS). ISAC worked in the area of what we at that time called problem oriented systems development (or with typical langeforsian terms ‘infologically oriented systemeering’). We created methods for early stages of information systems development (ISD). These early stages were labelled change analysis, activity studies, information analysis. Many papers were written and also some books (Lundeberg, Goldkuhl, Nilsson, 1978; 1981). We created the ISAC method, which at that time became a rather famous method for ISD and which inspired other methods as well. There were several people in the ISAC group participating in the work around the ISAC methodology. As a result of our book writings (ibid) the main contributors became Mats Lundeberg, Anders G Nilsson and myself.

***“ISAC talked about user orientation early in the history of information systems, when the research was mainly more technically oriented.”***

ISAC talked about user orientation early in the history of information systems, when the research was mainly more technically oriented. Our research was questioned by many technically oriented researchers. I think that this was one reason why ISAC was a rather closed group. There was an external pressure, which made the group work more tightly together.

I was a member of the ISAC group 1973-1980. During this time I wrote my Ph D dissertation (Goldkuhl, 1980) with Börje Langefors as the main supervisor and Mats Lundeberg as secondary supervisor. In this dissertation I presented results from method development concerning information analysis (the ISAC method) and empirical studies concerning methods use. The dissertation can be seen as an important contribution to the ISAC approach. It also contained, however, seeds for alternative ways of thinking. As said above, we were to a high degree inspired by Börje Langefors (1966) works on infological systemeering. This was one main theoretical source for my work. However, during my dissertation writing, I became hesitant towards the systems-theoretical base of Langefors' works. I missed something. The human aspects seemed to be under-developed. With inspiration from humanistic and actor-oriented views in reference disciplines such as philosophy, psychology, sociology and linguistics I added such views to the infological theory. Instead of talking about infology I started, in my dissertation, to talk about human-infology. This was a seed for an altered theoretical orientation and also for another research organisation (more is to be said about this below).

I started my research career working in a research group – the ISAC group – and this has had a tremendous impact on my later work as I can see it now. We, members of the ISAC group, worked together in creating something larger (the ISAC methodology), which was much greater than a single person could have done on his own.

## HUMOR Research Group

1980/81 the research at the DSV department was re-organised. The SYSLAB research organisation was created and consisted of researchers from DSV and our sister department in Göteborg. Janis Bubenko had been professor in Göteborg and when moving back to Stockholm as the new professor after Börje Langefors, this trans-departmental research organisation (SYSLAB) was created. SYSLAB consisted of several small research groups. At that time some researchers in Göteborg and Stockholm created a new research group within the SYSLAB frame. The Human-Infological research group (abbreviated HUMOR) was created and I was appointed leader of this new group. The name of the group was taken from the emergent theoretical orientation of *human-infology*, which I started to develop during my dissertation work some years ago. This theoretical orientation was a common basis for our research endeavours in the HUMOR group.

I was the leader of the HUMOR group 1981-1985. During 1982 I got a position at the department in Göteborg and as a result of this the HUMOR group continuously became a Göteborg group. After some while we also left the SYSLAB organisation.

The research in HUMOR was partially built on earlier work in ISAC, but was also a reaction towards that work. We continued to address early stages of ISD, now called change analysis and information requirements analysis. We were inspired by the ISAC methodology and used parts of it when creating new methods called the SIM ► methodology. Some steps in the alternative direction were already taken in the transition from ISAC to HUMOR/SIM. I wrote a book 1981 on ISD methods together with the ISAC member Anders G Nilsson and the HUMOR member Annie Röstlinger (Goldkuhl, Nilsson, Röstlinger, 1981). This book consisted of some parts of the ISAC method but took steps towards what later became the SIM method. Later, I made a clear distance to the ISAC method and wrote a critical paper about the ISAC method (Goldkuhl, 1984), which got a lot of attention among Swedish research colleagues.

The human-infological perspective was further developed within the HUMOR group. There was a great influence from so-called speech act theory (e.g. Searle, 1969). I made important theoretical and methodological development together with my research colleague from Finland, Kalle Lyytinen, who was a guest researcher in HUMOR at DSV 1981/82. We wrote several papers together. The most important was probably our ICIS-82 contribution (Goldkuhl & Lyytinen, 1982) where we coined a new emergent IS perspective based on speech act theory: The language-action view. This view influenced to a great extent the work on the SIM method for information requirements analysis. While language-action influenced information requirements analysis, there were other human-infological influences on Change analysis/SIMM,

► SIM was originally an acronym for Speech act based Information systems Modelling. Later the method was changed to SIMM and several other meanings have been used for this acronym, e.g. Situation adaptable Information systems Modelling Method.

which became the main research contribution from the HUMOR group. Several researchers participated in development and practical tests of the method. Different theories on problem solving, creativity, critical thinking and organizational change influenced the development of the change analysis method.

In the end of 1985 I moved to Linköping and started to work at the Linköping University. The work in the HUMOR group came to an end as a consequence of this. My research around the SIMM methodology continued but it took other shapes. Together with two research colleagues from the HUMOR group (Annie Röstlinger and Jan Selldén) I created a small consultancy firm (Intention AB) devoted to work around the SIMM methodology. During the years 1986-1990 we worked, besides university teaching, with dissemination of the SIMM method to trade and industry. Annie Röstlinger and I wrote a book on change analysis (Goldkuhl & Röstlinger, 1988). I wrote also a manuscript on information requirements analysis, which was published as a book later (Goldkuhl, 1993).

What was the difference between the work in the ISAC group and in the HUMOR group? Obviously there were some similarities. We partially addressed the same issues (methods for earlier ISD), and this work was a collective research endeavour. We also had much cooperation with companies (often in action research projects) in the two groups. In the HUMOR group, we had more of a common theoretical ground for our work. Although, the langeforsian theories played an important role in the ISAC group, there were many other theoretical influences on the research. There were different influences on the different researchers' works. There was not such a strong theoretical cohesion in the ISAC group compared with the HUMOR group. The research methodological awareness was much higher in the HUMOR group. Our research emerged along anti-positivistic and hermeneutic threads. This led us to an even greater opposition to prevailing trends in IS research. I think you can say that we were "young and angry" researchers acting in great opposition towards established research. This also made the HUMOR group a tightly connected group. We had to defend ourselves towards a "hostile environment".

### **VITS research network**

After some successful years as consultants, it was time for more dedicated research again. I started 1990/91, together with Annie Röstlinger, the VITS ► research group at the Department of Computer & Information Science, Linköping University (LiU). This research started on the basis of our successful work with the SIMM methodology. This was a natural input to our work. But we also wanted to proceed in new directions. We started research projects on CASE tools and meta-modelling, information systems architecture and IS evaluation.

► VITS is an acronym for the Swedish "Verksamhetsutveckling, IT-användning, Styrning och samverkan"; in English "Workpractice development, IT usage, coordination and cooperation".

The starting of VITS was done together with establishment of Ph D education in information systems development at LiU. I became an entrepreneur for this Ph D education, which was performed well integrated with the research in the VITS group.

When starting the VITS group I tried to build on the positive experiences from ISAC and HUMOR. Based on these experiences I had a strong belief in collective research. However, I also wanted to learn from some more negative issues. Both ISAC and HUMOR had been fairly closed groups. Of course we had a lot of exchange with other researchers and practitioners, but anyway, collaborations with others could have been more intense. I wanted VITS to be a more open group with not so distinct borders to its environment. I wanted the group to be more cooperative in its relations to other researchers.

Based on these intentions, I cultivated contacts with other universities in Sweden. Several teachers at smaller universities were enrolled as Ph D candidates in our new Ph D education in Linköping. These teachers/Ph D candidates were also engaged in the VITS research. Win-win situations were created. We (in Linköping) afforded research tasks and a Ph D programme and the external Ph D candidates contributed with time and efforts. After some years (around 1995) the VITS group had grown to more than 15 members. We discovered that that were more members from outside Linköping University than were employed at the university. This led us to change organisation idea and form of VITS. Earlier VITS was defined as a Linköping-based research groups with some members from outside. This was changed to the following: VITS is a net-worked and multi-sited research organisation. VITS has several academic host organisations. VITS has continued to expand and today (2006) we are more than 40 members from eight Swedish universities (Linköping, Borås, Dalarna, Gotland, Jönköping, Kalmar, Karlstad, Örebro). VITS is not described as a research group. It is a virtual research organisation. It is a network in two dimensions; one geographical network, consisting of different university groups (as mentioned above) and a subject matter network, actually eight collaborating research groups (E-government, Business Processes & Information Systems, Business Interaction & Electronic Business, Qualitative Research Methodology, IT & mobility, Information Systems Actability, Methodology & Meta development, Soft infrastructure). The research scope of VITS is much broader compared with ISAC and HUMOR.

The research environment of VITS has shown to be very attractive for many researchers. I will try to give some hints why so many persons have found VITS to be an interesting research environment to join and to contribute to ►.

A research network like VITS is much more than the sum of its members. Such a research network holds a network capital. This is

► Parts of this have been described more thoroughly elsewhere; e.g. Goldkuhl (2002). Confer also assessments of the Ph D programme in information systems development in Linköping (Linköpings universitet, 2003; Högskoleverket, 2004). Confer also our website ([www.vits.org](http://www.vits.org)) with extensive descriptions of the research and numerous publications to be downloaded.

an intellectual capital that I want to divide into three parts:

- Knowledge capital
- Social capital
- Process capital

► There is a clear theoretical continuation from HUMOR to VITS, confer Goldkuhl (1992). I have also related the work in VITS back to the theories of Börje Langefors (Goldkuhl, 1995).

VITS has developed several knowledge products as parts of its knowledge capital. These knowledge products are theories, models and methods. Also ISAC and HUMOR developed joint methods. In HUMOR, we also worked with a joint development of the human-infological conceptual foundation. However, in VITS, this has been taken to a higher level ►. During the years, a coherent group of theories, theoretical models and methods have been developed. The different theories and theoretical models build on a common theoretical ground. This common ground is now called socio-instrumental pragmatism (Goldkuhl & Röstlinger, 2003a; Goldkuhl, 2005). It is an action-theoretic synthesis of different action-theories from different reference disciplines. As an action-theoretic synthesis it has been especially adapted to information systems studies. Socio-instrumental pragmatism functions as a common and progenitive ground for other VITS theories. The most prominent theories in the VITS family are Workpractice Theory (e.g. Goldkuhl & Röstlinger, 2003b), Business Action Theory (e.g. Goldkuhl & Lind, 2004) and Information Systems Actability Theory (e.g. Goldkuhl & Ågerfalk, 2002). It is far beyond the purpose of this paper to describe the contents of these different theories.

These different theories function as theoretical bases and are used together with methods in the SIMM method family. There is a heritage of methods from HUMOR (change analysis, information requirements analysis), but these methods have been substantially further developed (Goldkuhl & Röstlinger, 2005; Cronholm & Goldkuhl, 2005). Several other methods have also been developed, for example methods for inter-organisational analysis, knowledge analysis, IS architectural design, IS evaluation, method integration, method configuration. The qualitative and interpretive research tradition (from HUMOR) has been included but it has also nuanced and brought further to research approaches more built on pragmatic foundations than plain interpretive (Goldkuhl, 2004a). Much effort has been put on research methodology. One very important contribution is the development of a combined inductive and theory-driven approach called Multi-Grounded Theory (Goldkuhl & Cronholm, 2003). This approach builds partially on the established social science method for qualitative analysis, Grounded Theory (Glaser & Strauss, 1967).

VITS is a result-oriented organisation. Since 1994, we have produced 13 Ph D dissertations and 35 licentiate thesis. Many of these publications have utilized methods and theories from the VITS knowledge arsenal and also contributed to their development.

The different methods and theories rely, as said above, on a common socio-pragmatic foundation. This is a common value ground, which also involves a knowledge interest to contribute to the improvement of the practice of information systems. We develop theories, but they aim to be useful as practical theories (Cronen, 2001; Goldkuhl, 2004b).

To strive for joint knowledge products has been a very important aspect of the VITS research. A coherent body of knowledge is created. It enables cumulative research with continuous development, application and testing. It also enables collective research with different researchers contributing to a joint knowledge at different points in time. Fragmentation and isolation are avoided among research members and a common research focus is chosen instead. To work together on common knowledge products strengthens the social capital in the network. It stimulates interest, motivation and commitment for co-work. The knowledge capital and the social capital hold the network together. The geographical dispersion of the network has of course negative influences on it. Such a dispersed network can fall apart. This has not happened. VITS researchers, coming from different universities, like to work together on joint projects, theories and methods.

Over time, we have worked hard to create synergy effects between the VITS research and the Ph D education in information systems development. A *process capital* has been developed. We have a very active seminar culture in VITS. Besides normal research seminars in the network we have also arranged other important meetings for knowledge exchange and development. Several times, we have arranged our own VITS doctoral consortia (with invited international experts) for review of thesis proposals. Every year we arrange the VITS pre-international workshop in order to stimulate the production of publications to be submitted to international conferences and journals. These different seminars and meetings are not closed for only VITS members. Other research colleagues are also invited to keep the group open to the environment.

VITS researchers are taking part in different international networks; for example LAP (Language-Action Perspective), OS (Organisational Semiotics) and ALOIS (Action in Language, Organisations and Information Systems). We have arranged several workshops and conferences. Several VITS researchers are also participating in a new international scientific journal (Systems, Signs & Actions; [www.sysiac.org](http://www.sysiac.org)) related to the scientific communities mentioned above.

The work in these three research organisations has strengthened my conviction of the importance of collaborative research. The results should never have been achieved if there were researchers working in isolation.

I worked in these three research organisations; in ISAC during

***“To work together on common knowledge products strengthens the social capital in the network. It stimulates interest, motivation and commitment for co-work.”***

***“The results should never have been achieved if there were researchers working in isolation.”***

the 70s, in HUMOR during the first part of the 80s and in VITS since beginning of the 90s. The first two were DSV groups, but not the third one (VITS). However, VITS owes a methodical heritage to Langefors and ISAC and a humanistic and action-theoretic heritage to HUMOR. I have learnt a lot in working in these three research environments. Since the inception of my research career, as young research assistant in ISAC 1973, I have appreciated to work closely together with other research colleagues and to create theories and methods together with them. As a research director (in HUMOR and VITS) I like to be an inspirer for other researchers and stimulate them to work together on common knowledge products. Much of my own research during the last years has been dedicated to foundational (socio-pragmatic) theories that I consider to be appropriate theoretical tools for other researchers to apply on diverse research endeavours. These theories are, of course, aimed for both VITS researchers and external researchers.

***“ Collaborative researching means a co-creation of knowledge. Collaborative researching is meaningful and it is fun.”***

Collaborative researching means a co-creation of knowledge. Collaborative researching is meaningful and it is fun. There is a thread from ISAC, through HUMOR to VITS in knowledge creation. There has, in these three research organisations, been a foundational belief and knowledge interest for a more constructive utilisation of information technology by people, organisations and in society. Practical theories and methods can contribute to make IT-supported work better work.

## References

- Cronen V (2001) Practical theory, practical art, and the pragmatic-systemic account of inquiry, Communication theory, Vol 11, No 1
- Cronholm S, Goldkuhl G (2005) Handlingsbara IT-system – design och utvärdering, VITS, Institutionen för datavetenskap, Linköpings universitet
- Glaser B, Strauss A (1967) The discovery of grounded theory, Aldine, New York
- Goldkuhl G (1980) Framställning och användning av informationsmodeller, Dr.avh, TRITA-IBADB-4099, Institutionen för ADB, Stockholms universitet
- Goldkuhl G (1984) ISAC omvärderad, ingår i Nissen H-E (Red, 1984) Systemutveckling – av vem, för vem och hur? Arbetarskyddsfonden, Stockholm
- Goldkuhl G (1992) Från HUMOR till VITS – Humaninfologi anno 1992, VITS Höstseminarium, IDA, Linköpings Universitet
- Goldkuhl G (1993) Verksamhetsutveckla datasystem, Intention, Linköping
- Goldkuhl G (1995) Information as action and communication, in Dahlbom B (Ed, 1995) The infological equation. Essays in honor of Börje Langefors, Gothenburg Studies of information systems 6, Göteborg university

- Goldkuhl G (2002) Forskningsgruppen VITS – en nätverksbaserad och flerakademisk forskningsorganisation, IDA, Linköpings universitet
- Goldkuhl G (2004a) Meanings of pragmatism: Ways to conduct information systems research, in Proc of the 2nd Intl Conf on Action in Language, Organisations and Information Systems (ALOIS), Linköping University
- Goldkuhl G (2004b) Design theories in information systems – a need for multi-grounding, Journal of Information Technology Theory and Application (JITTA), 6(2) p 59-72
- Goldkuhl G, Cronholm S (2003) Multi-grounded theory – Adding theoretical grounding to grounded theory, in Proc of the 2nd European Conference on Research Methods in Business and Management (ECRM 2003), Reading
- Goldkuhl G, Lind M (2004) Developing e-interactions – a framework for business capabilities and exchanges, in Proc of the 12th European Conference on information systems (ECIS2004), Turku
- Goldkuhl G, Lyytinen K (1982) A language action view of information systems, In Ginzberg & Ross (Eds, 1982) Proceedings of 3rd International Conference on Information Systems, Ann Arbor
- Goldkuhl G, Nilsson A, Röstlinger A (1981) Att specificera informationssystem, Liber, Malmö
- Goldkuhl G, Röstlinger A (1988) Förändringsanalys – Arbetsmetodik och förhållningssätt för goda förändringsbeslut, Studentlitteratur, Lund
- Goldkuhl G, Röstlinger A (2003a) Towards an integral understanding of organisations and information systems: Convergence of three theories, in Gazendam H WM, Jorna R J, Cijssouw R S (Eds, 2003) Dynamics and Change in Organizations. Studies in Organizational Semiotics, Kluwer, Boston
- Goldkuhl G, Röstlinger A (2003b) The significance of workpractice diagnosis: Socio-pragmatic ontology and epistemology of change analysis, in Proc of the International workshop on Action in Language, Organisations and Information Systems (ALOIS-2003), Linköping University
- Goldkuhl G, Röstlinger A (2005) Change Analysis – Innovation and Evolution, invited paper to the 14th Intl Conf on Information Systems Development, Karlstad University
- Goldkuhl G, Ågerfalk P J (2002) Actability: A way to understand information systems pragmatics. In Liu K et al (eds. 2002) Coordination and Communication Using Signs: Studies in Organisational Semiotics - 2, Kluwer Academic Publishers, Boston
- Högskoleverket (2004) Utvärdering av ämnet data- och systemvetenskap/informatik vid svenska universitet och högskolor, Högskoleverket, Stockholm
- Langefors B (1966) Theoretical analysis of information systems, Studentlitteratur, Lund
- Linköpings universitet (2003) Självvärdering av forskarutbildningsämnet informationssystemutveckling, Institutionen för datavetenskap, Linköpings universitet
- Lundeberg M, Goldkuhl G, Nilsson A (1978) Systemering, Studentlitteratur, Lund

Lundeberg M, Goldkuhl G, Nilsson A (1981) Information systems development – A systematic approach, Prentice-Hall, Englewood Cliffs

Searle JR (1969) Speech acts. An essay in the philosophy of language, Cambridge University Press, London

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# A NOTE ON DECISION ANALYSIS AND OTHER STUFF

## ABSTRACT

The first part of this section is devoted to a DSV-related biographical history of myself; the second part is about our inabilities in decision making that we all have in common. I will also briefly discuss why systems for decision support in general are insufficient and what appealing alternatives might look like.



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## Biography

Was it really in 1988 that I started at DSV? Yes, it is coming back to me now. I seem to remember this tacit figure, Magnus Boman, approaching me with desperation in his posture and a glimmer of hope that perhaps I, a PhD student in mathematics, might save his day by helping to teach some conceptual modelling in one of his courses. This was basically my first contact with computer science at all, so Magnus must have been really desperate or must have been deceived by my irresistible charm.

Or perhaps it was me that was charmed by the irresistible enthusiasm and devotion of the students and staff at DSV who encouraged me to stay on while keeping one foot in the consultancy circuit.

So at some point, I decided to change topics from mathematics to computer and systems sciences and earned a PhD at DSV in 1994. The department was kind enough to let me do whatever I liked to in decision analysis and I also found an inspired supervisor in Per-Erik Malmnäs from the Department of Philosophy. Per-Erik was kind to accept me despite his strong conviction that a PhD candidate in logic that was not able to read a decent amount of ancient Greek was not much to count on. I also started my work with the talented Mats Danielson at that time.

After the PhD I was allowed to combine some lecturing and research at DSV with consultancy work in industrial logic verification. That was surprisingly much fun and I remember that I was grateful that I could combine standard academic work and other more obscure stuff. In particular, the head of department at that time, Tord Dahl, was extremely open-minded in this respect. I also started to do some work in conflict modelling and detection with Paul Johannesson as well. Paul is a nice guy and I found that area quite fascinating for a while.

## Love Ekenberg

PhD 1994 and professor at DSV, Stockholm University, 2002.

Research interests:

Decision systems analysis, logic modelling and verification, IT for development in several forms".

After some time, I left for a post-doc position at IIASA in Laxenburg outside Vienna. Down there, I continued with decision analytical research combined with heavy wine consumption. I must have found this combination very inspiring, because I made some, what I perceive as, important discoveries and become docent at DSV in 1997.

Then I went north to Mid Sweden University in Sundsvall for some years, attracted by a stimulating research collaboration with Johan Thorbiörnson. I became professor in computer science there in 2001.

In parallel, I still maintained a lecturer position at DSV. To be entirely stuck in a small city is very dangerous, something I had the opportunity to perform some empirical studies about.

Johan fell in love and moved to Stockholm. Me too. And I became professor at Stockholm University in 2002.

To impress my wife, I had to make a quick switch back to mathematics at Stockholm University and earned a PhD there too. That might seem both unnecessary and quite dumb, but what could I do?

I have, for as long as I can remember, been quite disturbed by the unequal distribution of wealth in this world. So I have, during the latest nine years or so, been working with ICT4D (ICT for development) in various organizations, authorities, and developing countries. These activities led to the establishment of a unit for development cooperation at DSV and later to the establishment of the SPIDER centre for ICT4D. Some of the details are described elsewhere in this book. However, I am not entirely convinced that this is the most efficient way of bringing about change, but so far I have not yet found any feasible alternatives. Mail me if you have any other viable suggestions.

In any case, my main activities at DSV and elsewhere have consisted of producing what I like to think about as quite nice and far reaching research in decision theory and I should mention something about that as well.

## Decision Theory

I will try to save the reader from boring mathematical details of my work and instead try to explain what the point of it all is. I will also limit the text to my decision analytical approaches. As I mentioned, I have done some other things as well, but this is what I am working on at the moment.

## Human Decision Making

A main problem in decision support contexts is that unguided decision making is far too difficult and far too often leads to inefficient decision processes and undesired outcomes. Since most managers and similar professionals believe that they are excellent decision makers, they normally become quite angry when I say so.

***“I have, for as long as I can remember, been quite disturbed by the unequal distribution of wealth in this world. So I have, during the latest nine years or so, been working with ICT4D (ICT for development) in various organizations, authorities, and developing countries.”***

***“...unguided decision making ... far too often leads to inefficient decision processes and undesired outcomes. Since most managers and similar professionals believe that they are excellent decision makers, they normally become quite angry when I say so.”***

Nevertheless, that observation is not particularly original and the human tendency to simplify complex problems is well known. Already in 1955, Herbert Simon argued that people do attempt to be rational, but since they have limited information processing capacity they cannot be completely rational.

People frequently try to decompose problems into sub-problems. When doing so, more complex phenomena are in many cases represented barely by a numeric value. This is very amusing (or tragic), since even my cat realizes that this cannot be reasonable.

For most intelligent people, it is obvious that we cannot consider numbers as equitable representations of a significantly more complex reality and I will not enter into further discussions about that here. Let us just agree on the fact that the capability of human thinking in itself is severely limited. And why shouldn't it be? As a species, we are still young and underdeveloped.

### Decision Support Systems

Many people have tried to invent solutions to this situation and various types of decision support systems have become of interest for a multitude of reasons. Thus, there have been numerous approaches to delivering decision support from, e.g., computational, mathematical, financial, philosophical, psychological, and sociological angles.

Looking at the concept of decision support systems, it spans a wide area, but in general tends to be oriented towards representation of different views of the information available while putting emphasis more on the presentational side than on the analytical side. On the other hand, in order to make well-informed decisions, there seems to be a strong need for an analytic component as well, guiding the decision-maker in formulating the actual decision problem and evaluating the available options using some kind of reliable method. So while reasoning and clarifications lead to the establishment of facts and figures, decision analysis aids in making the actual decisions based on these facts.

Obviously and unfortunately, the world is a complex place and pure mathematical models of decision analysis are generally oversimplified and disregard important factors. In particular, normative science, typified by statistical decision theory, tries to characterize ideal inference or decision processes. Likewise unfortunate, descriptive models try to explain how real decisions are made, why people make decisions the way they do, and why people do not always follow normative rules for decision making. This is often very nice, but these models give no indication of how to actually make an informed choice.

***“Obviously and unfortunately, the world is a complex place and pure mathematical models of decision analysis are generally oversimplified and disregard important factors.”***

### Classical Decision Analysis

To make this a little more precise, I will very briefly discuss some features of classical decision theory. In this theory, probabilistic

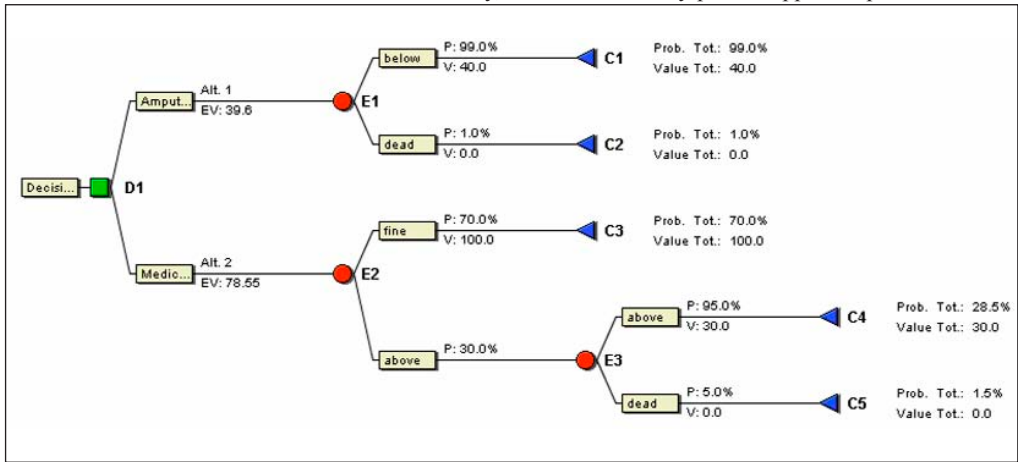
decision models are often given a tree representation. A decision tree consists of a root (green square in the figure below), representing a decision, a set of event nodes (red dots), representing some kind of uncertainty and consequence nodes (blue triangles), representing possible final outcomes.

In such trees, probability distributions are assigned in the form of weights in the probability nodes as measures of the uncertainties involved. The informal semantics are simply that given an alternative being chosen, there is a probability that an event subsequently occurs. This event can either be a consequence with a value assigned to it or another event. Thereafter, one or more decision rules, such as for example maximizing the expected value, can be applied to the model.

In the figure below, we can see that there are two alternatives. Each of them may lead to a number of direct or indirect consequences. The consequences do not occur with necessity, but they might occur with a known probability which is stated above the edges in the tree. The values at the blue consequence nodes denote the values obtained if the corresponding consequence occurs.

- root
- event node
- ▶ consequence node (possible final outcome)

Obviously, such a numerically precise approach puts extreme



demands on the input capability of the decision-maker. With the exception for very simple decision situations, how could you (or anyone) in a meaningful sense tell the exact probability of a future event or the exact value of a future consequence. In real life, most people cannot even distinguish between probabilities ranging roughly from 30% to 70%. So the hope of getting useful decision guidance from numerically precise approaches seems to be far from realistic.

***“In real life, most people cannot even distinguish between probabilities ranging roughly from 30% to 70%.”***

## Intervals

Consequently, other options for imprecise reasoning have emerged. During the last 45 years, numerous methods based on interval estimates of probabilities and values of any sort (not only numerical values) have been suggested as improvements. Some of them are based on, e.g., capacities, evidence theory and belief functions, various kinds of logic, upper and lower probabilities, or sets of probability measures. If you don't know what they are, never mind. I will explain the most important properties below.

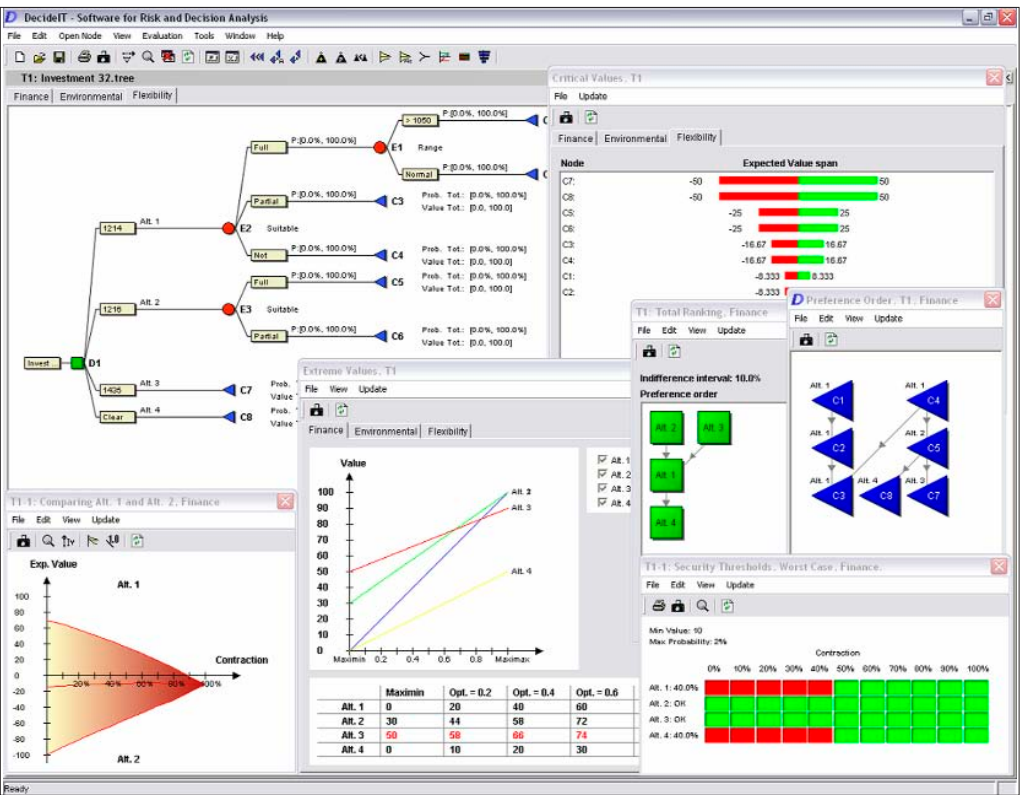
Formally, a common characteristic of the imprecise approaches above is that typically they do not include some of the very strong axioms of probability theory and thus they do not require a decision-maker to model and evaluate a decision situation using precise probability (and, in some cases, value) estimates.

This means that within such a framework, you can, among other things, say that a probability is within a confidence interval instead of stating it as a precise number. Suddenly, rational decision making becomes much more within reach.

The flip side of this is that the computational efforts required for evaluation are dramatically increased and for general problems using general algorithms, you have to be a god (or a goddess) to obtain a result. This is because the time consumed for the calculations will sometimes be several billions of years. So this option is applicable to very few of us, even if we are quite liberal with respect to our theology.

Consequently, one of the things I have been doing for around 15 years, together with Mats Danielson, is developing new algorithms for solving these kinds of decision problems. At present, we have a response time of at most a few seconds, also for very large problems involving thousands of consequences in deep trees. Thus, the interval approach has turned out to actually be feasible from a computational viewpoint as well. Further, we have, together with two of our PhD students, Jim Idefeldt and Aron Larsson, developed a nice computer tool and established the company Preference AB for industrial applications of computational decision analysis.

Our methods have been applied to numerous real-world problems in various industries and governmental authorities, on problems ranging from 6 to 1,800 consequences in projects lasting from 1 day to 40 man-months and with project budgets from SEK 100,000 to 8 billion.



**An advanced decision support system**

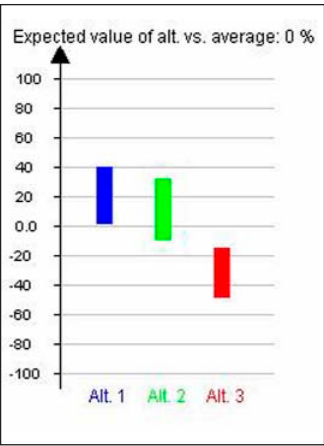
The screen dump is from a decision support system, developed by Mats Danielsson, Love Ekenberg, Jim Idefeldt and Aron Larsson.

**The Problem of Overlaps**

In a complex world, nothing important is really easy and interval decision making is no exception. As I have argued above, an advantage of approaches using upper and lower probabilities is that they do not require taking exact probability distributions into consideration.

On the other hand, it is then often difficult to find a reasonable decision rule that selects an alternative out of a set of alternatives and at the same time fully reflects the intensions of a decision-maker. Since the probabilities and values are represented by intervals, the expected value range of an alternative will also be an interval. In effect, the procedure retains all alternatives with overlapping expected utility intervals, even if the overlap is very small. Such a situation is illustrated in the figure to the left, where the ranges of the expected values of the two leftmost alternatives (1 and 2) are strongly overlapping, while both are clearly better than the rightmost one (3).

Alternative 3 is probably so bad that it would have been detected by unguided inspection of the decision problem. However, it is often not possible to discriminate enough between stronger alternatives and pure interval analysis cannot provide any sharper advice in the situation in the figure.



## Distributions

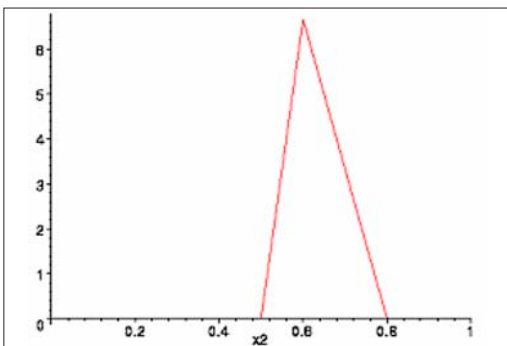
In the example above, one might feel that this is not really an issue, since the alternatives are actually quite similar and that the non-discrimination just reflects things as they are.

Wrong!!! It actually depends on the decision structure. The more information the structure in itself provides, the narrower the "real" range of possible values will be. Thus, structure provides information that can be meaningfully quantified. This is a result of utmost importance and I have dedicated the latest three years to establishing various properties of this discovery. Moreover, the results are geometrically beautiful (and therefore true).

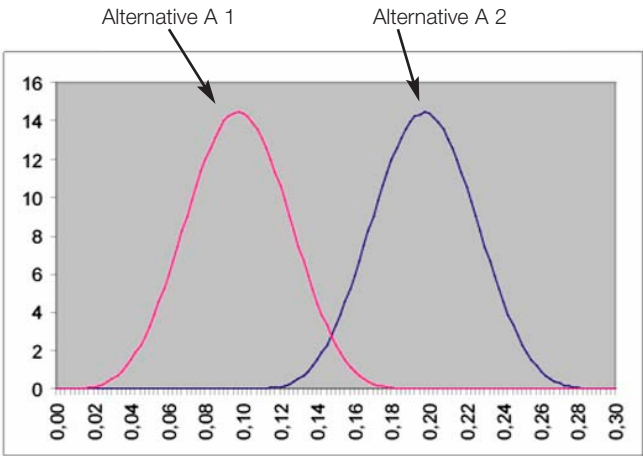
The idea is based on the decision-maker's belief in different parts of the intervals, expressed or implied, being taken into consideration. It can be said to represent the beliefs in various sub-parts of the feasible intervals. As a result, no total lack of overlap is required for successful discrimination between alternatives. Rather, an overlap by interval parts carrying little belief mass, i.e. representing a very small part of the decision-maker's belief, is allowed. Then, the non-overlapping parts can be thought of as being the core of the decision-maker's appreciation of the decision situation, thus allowing discrimination.

This sounds a bit intricate, but the basic idea is very simple. Assume that you, for instance, estimate the probability that it will rain tomorrow to be around 60%. However, you, as an intelligent person, do not for a moment believe that this probability is exactly 60% and you want to state some kind of confidence interval around this estimate. Say that you, after some contemplation, conclude that the probability is definitely not less than 50% and not greater than 80%, and furthermore you believe just little bit more in lower probabilities than in higher. Moreover, since you originally assumed that the probability is around 60%, you tend to believe more in numbers just around 60% rather than around 80%.

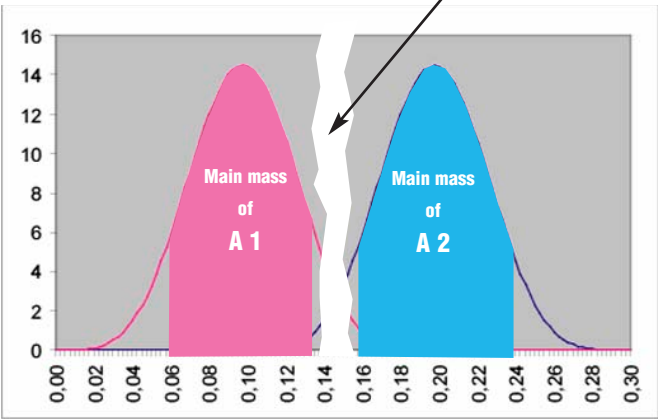
This belief could, for example, be quantified and represented as in the figure below. The higher the function value is, the higher the belief in the respective probabilities is. Let us call the graph a belief distribution. Such distributions can have whatever shape depending on the various beliefs of a decision-maker.



When a decision tree is evaluated, the final result, such as the expected value of an alternative, also receives such a belief distribution from its components. The interesting and important observation now is that this resulting distribution is very concentrated around a small sub-interval, fairly independent of the shapes of its component distributions. In the figure below, this phenomenon can be observed for overlapping ranges of expected values. The two alternatives contain statements that render the alternatives impossible to discriminate by traditional interval analysis.



Let's say that the purple distribution is over the range of an alternative A1 and the blue over another alternative A2. The range for A1 is 0 to 0.30 and the range for A2 is 0.02 to 0.28. Obviously, these intervals are heavily overlapping. Traditional interval analysis cannot discriminate between them. But now we also consider the resulting blue and purple belief distributions. As can be seen, the main mass (area under the graph) of A1 is between, say, 0.06 and 0.13 and the main mass of A2 is roughly between 0.16 and 0.24. Thus the aggregated beliefs significantly separate the alternatives and alternative A2 should be selected.



## Concluding Remarks

During the latest 15 years or so, I have, together with some other researchers and PhD students, been working on various aspects of decision analysis and quite recently I have made some particularly beautiful observations that can be considered as the third paradigm in decision theory.

The first paradigm can be said to have begun with von Neumann and Morgenstern as they introduced a structured and formal approach to decision making. The second one emerged as different researchers expanded the classic theory by introducing other types of uncertainties as well. The motivation behind the second paradigm was that the classical theories were perceived as being too demanding for practical decision making. This relaxation is necessary since the classical theories can be misleading when forcing decision-makers to assert precise values even when they are not available. However, by relaxing the strong requirements, the price paid is that often the alternatives become more difficult to discriminate between.

This was why I started to develop a theory around the idea that the decision structure itself is of highest importance for an adequate understanding of decision situations and can (as well as must) be used for enhancing the decision analysis. Without such considerations, the results can be seriously misleading.

So, in short, you need me.

## References

- L. Ekenberg, J. Thorbiörnson and T. Baidya, "Value Differences using Second Order Distributions", *International Journal of Approximate Reasoning* 38/1 pp. 81-97, 2005.
- A. Larsson, J. Johansson, L. Ekenberg, and M. Danielson, "Decision Analysis with Multiple Objectives in a Framework for Evaluating Imprecision", *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, Vol. 13, No. 5, pp. 495-509, 2005.
- M. Danielson, L. Ekenberg, Å. Grönlund and A. Larsson, "Public Decision Support – Using a DSS to Increase Democratic Transparency", *International Journal of Public Information Systems* 1, pp. 3-25, 2005.
- L. Ekenberg, M. Danielson and J. Thorbiörnson, "Multiplicative Properties in Evaluation of Decision Trees", *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, Vol. 14, No. 3, 2006.
- M. Danielson, L. Ekenberg and A. Larsson, "Distribution of Belief in Decision Trees", to appear in *International Journal of Approximate Reasoning*.
- M. Danielson and L. Ekenberg, "Computing Upper and Lower Bounds in Interval Decision Trees", to appear in *European Journal of Operational Research*.

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# DSV AS A NORDIC SCIENTIFIC POWERHOUSE

and source of inspiration in the pioneering period – An external Perspective

## ABSTRACT

This paper, written as a homage to the early stages of DSV, emphasizes the fruitful role of Börje Langefors and his early research environment regarding the development of information systems research also outside Sweden, using particularly Norway as an illustrative example. This development, which created a network of Nordic researchers, was strongly enhanced not only by the strength of the theoretical foundation laid by Langefors, but also by his exceptional helpfulness and constructive openness to new ideas, a truly eclectic attitude. This gradually led to a broader and original research paradigm - the internationally acknowledged Scandinavian Approach to systems analysis and design. ►



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## The Foundation for a Scandinavian Tradition

Of course, it is a truism to state that the early history of DSV to a large extent is a history of *Börje Langefors*' pioneering and successful work of establishing systems work and administrative information processing as a new *scientific area*, not only in Sweden, but also in the entire Scandinavian area. Before he was appointed as the first professor of *Information Processing*, especially *Administrative Data Processing* (1966), as was the formal title of his joint chair at the Royal Institute of Technology and the University of Stockholm, the academic approach to the area was little more than what we today call computer science. The latter area was confined to methods for using computers as an artifact, paying very little attention to the real life problems which computers were meant to solve.

At this time it was becoming increasingly clear that the growing usage of computers in industry and public service was hampered by lack of sound theory and scientific methods. This was especially true for the areas of problem analysis and formulation, and the subsequent planning of the information systems in the organization where computers were to be implemented. However, until Langefors established the *Department of Administrative Information Processing* at University of Stockholm, there were no academic environments in the entire Scandinavian region, which were assigned to deal explicitly with those problems.

The Stockholm initiative meant a great stimulus for young academics in other Scandinavian countries having recognized the importance of this emerging problem area. Furthermore, the pioneering works of Langefors, *Theoretical Analysis of Information Systems* (1966) and *System för företagsstyrning* (1970) provided an extremely fruitful theoretical foundation for initiation and

## Rolf Høyer

Rolf Høyer was one of the earliest candidates earning the degree *teknologie doktor* from the predecessor of DSV in 1974. In 1975 recruited to act as professor of information systems at the universities of Gothenburg and Bergen. 1985 appointed tenured professor at Norwegian School of Management. Retired 2005, but still active as researcher in media economics.

► Albeit the open attitude to expansion of the initial paradigm elicited much original and fruitful research, it also inevitably led to rivalry between the different paradigmatic conceptions of what was relevant research, thereby creating tensions. Using concepts suggested by Thomas Kuhn, the paper identifies the main directions of this family of new research areas, which during the 1970's and 80's sprang out under the wide, liberal Langeforsian academic umbrella.

development of research activities elsewhere. Above all, the general paradigm suggested by Langefors that information processing implied two different problem areas; the problems related to *what* information the systems should contain, as opposed to those related to *how* the information systems should be constructed to provide the information. This extremely salient dichotomy immediately had great importance, as it opened up and legitimized research in the area of organizational and business systems analysis, assuming that mainly the information user environment was the competent source for defining information needs and systems requirements. One may also assert that the new theoretical framework defined and legitimized a new field of study being very different from the then well established area of pure computer science.

Indeed, these insights and propositions represented an enormous inspiration to embryonic research environments far outside the Stockholm institution. Small study groups were formed, not only elsewhere in Sweden, but also in the other Scandinavian countries. However, progress was hampered by lack of assigned resources, which is frequently the case for new, emerging research areas. Furthermore, there were no academic chairs and no senior researchers readily available to lead the development outside the Stockholm kernel.

Without doubt, one may safely assert that Langefors and his first colleagues represented a most important source of inspiration and guidance for the following development of research and education of administrative information systems analysis and development in all Scandinavia, and also had impact on other environments in Europe.

It is outside the scope of this article to survey the impact of the Stockholm initiative generally in the Scandinavian countries. However, the development on one location in Norway will be described below as a significant example of scientific transfer, mainly because this author had the privilege to participate acquiring first hand knowledge, but also because members of this environment came to develop a very comprehensive and rewarding cooperation with members and subgroups of the Stockholm institution.

### **The Development of a Norwegian Environment in Trondheim**

Without doubt, *Arne Sølberg* was the first Norwegian academic who realized the potential of the new Stockholm school of systems thinking. During a short period of time starting 1968, he managed to establish and build up a group of young researchers with the aim of developing the new ideas further. His group was organized at a research foundation (*Sintef*), which was associated with the former *Norges Tekniske Høgskole, Norwegian Institute of Technology (NTH)*. The foundation was to a large extent financed

***“...Langefors and his first colleagues represented a most important source of inspiration and guidance for the following development of research and education of administrative information systems analysis and development in all Scandinavia...”***

by industrial, contracting projects, but also by scarce research grants. This was partly an advantage because it implied far more freedom to take new initiatives, avoiding the traditional university bureaucracy. But it also represented a heavy disadvantage, because projects had to be fully financed by industry and limited public grants.

In contrast to the Stockholm environment, which in the beginning had a basic university funding, the NTH research group had to base much of the activities on external financial sources. As a consequence, the research had to be directed towards experiments on applications of the fundamental theories and methods developed by Langefors and associates. In itself, this was a highly relevant and valuable scope of research. Without implying any criticism to Langefors' works whatsoever, one may however, assert that the theories and frameworks first presented were somewhat crude, absolutely not readily available as practical tools for implementation of new and effective ways of systems analysis and design in industrial environments. Obviously, methods had to be tested and improved, gradually making them easy to use and generally workable, which the NTH group just had in mind and enthusiastically set off to do.

This practically oriented approach obviously needed to be guided and supported by a stronger theoretical environment. Hence Arne Sølvyberg approached Langefors asking for cooperation, and was very positively received. Shortly afterwards, Sølvyberg and Rolf Høyer, who had joined the group, enrolled as doctoral students under Langefors' supervision. Later on, students from other parts of Sweden and Scandinavia also started to follow this track.

It is important to emphasize and appreciate the openness and hospitality characterizing the Stockholm institution in those pioneering years, where Langefors personally set the tone. Although he had absolutely no formal obligations to undertake any supervision and cooperation with outside persons and groups of researchers, he vigorously engaged into these external activities. He was always available during visits to Stockholm by the external doctoral students, and he actually read in advance most of the more or less immature and crude papers presented to him. We, the Norwegian doctoral students, remember well some extensive, but improvised consulting meetings taking place in his private garden, where he otherwise would be busy working on his own scientific work which he generously and unconditionally set aside. We also remember well the cordial hospitality and support shown by his now deceased wife Eva, during our intrusion of their private sphere.

In this way, he became a continuous source of inspiration and scientific training. Without any doubt, the cooperation made available through Langefors' personal efforts paved the way for further

***“It is important to emphasize and appreciate the openness and hospitality characterizing the Stockholm institution in those pioneering years, where Langefors personally set the tone.”***

progress of the NTH research group, leading to a good production of research papers and teaching programs during the following years. Three members of the original NTH group were later appointed professors of information systems at a relatively young age, not at least due to their merits of working in the Langeforsian tradition, developing further the basic ideas and theories which they first met in the late 1960s.

### **International informal Cooperation and the later Development of formalized Networks**

It is also important to note that Langefors' attitude of exceptional openness and helpfulness to a large extent made him a role model. The open attitude spread to his closest colleagues, forming a regular practice at the institution. The NTH group, especially Sølvsberg and Høyer, engaged into a following fruitful cooperation with *Mats Lundeborg* and *Janis Bubenko*, from which they as externals benefited grossly. This cooperation, initiated in the first years of the 1970s, turned out to last for the rest of their professional careers, being mutually rewarding, both professionally and socially.

Following this example, similar cooperation and diffusion of scientific knowledge with a Stockholm origin, also appeared on other locations. The very early appointed chair of information science at *The Faculty of Social Sciences and Humanities at University of Bergen* was clearly inspired and influenced by Langeforsian thinking, and relations were also established to persons at *Copenhagen Business School* and several Finnish universities (Oulu and Jyväskylä), just to mention a few in the Scandinavian area.

The role model formed by Langefors as a leader of a truly open academic system, being established during his first years in the chair at the Stockholm institution, was also, however to various degrees, adopted by his students in later mature positions, as a natural and efficient way of operating a university system for research and education. Probably, the most notable example of such a practice today is flourishing at University of Linköping. *Göran Goldkuhl*, a graduate from the Stockholm institution and a former research assistant in that environment, has established a very comprehensive nationwide network for research and doctoral student teaching. This network named VITS, appears very attractive and useful to students from all over Sweden wanting to work in a research environment not available at their home base. It seems that the VITS network is a very viable and more systematized continuation of the initial organizational virtues of the Stockholm institution in the 1970s. Also some other networks of similar character are operative in Sweden, however on a smaller scale than VITS.

Obviously, running such an open system puts a heavy burden and strain upon the leader of the network. But in the same way as

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Langefors accepted this situation as a challenge and the obviously right thing to do, it appears that Goldkuhl is carrying this outstanding heritage further on. Elaborate organizations like VITS do not, to the author's knowledge, exist to such an extent at similar institutions in the other Scandinavian countries, although the model apparently has a potential to be a very efficient one.

However, it must be emphasized that the development of such networks to some extent seems to evolve due to a somewhat inadequate public funding of academic institutions in Sweden. The policy of putting priority on having many small institutions, many of sub-critical staffing, instead of concentrating the resources to fewer but stronger environments, clearly has some severe dysfunctional consequences. These may to some extent be overcome by networks like VITS when being run by a highly qualified and devoted kernel group.

Anyway, this development evolving in the recent years was probably neither intended nor foreseen by Langefors and his colleagues when they more or less intuitively developed the open system model at the Stockholm institution, in the early 1970s.

***“The policy of putting priority on having many small institutions, many of sub-critical staffing, instead of concentrating the resources to fewer but stronger environments, clearly has some severe dysfunctional consequences. These may to some extent be overcome by networks like VITS...”***

### **The Eclectic Research Perspective – Virtues and Problems**

A striking characteristic of Langefors' constant development of theory and models for information systems analysis and design is the continuous broadening of the underlying scientific paradigms. The main concern of the methods suggested in his first major scientific work, published already in 1966, *Theoretical Analysis of Information Systems (THAIS)*, was to optimize information structures with regard to implementation on computer systems. In his next major publication, *System för företagsstyrning*, he broadened his perspective dramatically by linking information systems analysis to managerial and business problems. While THAIS was clearly embedded in an engineering tradition, mainly treating system analysis and design as engineering problems, the latter publication may clearly be conceived also as a contribution to the management and business administration literature.

More was to come: In the last chapters of *System för företagsstyrning*, he introduced a totally new perspective; a sincere concern for the role of information systems users. Here he emphasized the importance of understanding the real need for information in the user community, and that these needs had to be formulated by the users themselves through participation in the systems work. The role of the system specialist would then be to construct information systems that would convey the information requested by the users.

This indeed represented a new conception of the character of the systems development process. As a consequence, it raised a challenge to develop a new breed of methods for systems analysis and design which were user friendly for other groups of people

than the systems specialists. Above all, the methods ought to be designed to analyse information needs and to design *theoretical models* for the information structures and processes which, at a later stage, would be realized by data processing systems. Langefors named this entire new area *infology*, in contrast to the already reasonably well explored area of *datalogy*. Mats Lundeborg, then one of Langefors' closest apprentices, immediately engaged creatively into this new research area, gradually building up a large, specialized research group which soon gained international recognition, especially in all Nordic countries.

This perspective was later developed even further by the introduction of methods for analyzing the surrounding business organization and processes which the information systems were designed to serve. In this development several other candidates from the Langeforsian school contributed significantly; *Hans Erik Nissen*, *Göran Goldkuhl* and *Anders Nilsson* to mention just a few. The open character of the Stockholm tradition was maintained, as researchers from other countries were invited to contribute to this innovative laboratory for development of new methodologies, e.g. Erling S. Andersen, a Norwegian economist who came to publish extensively with Lundeborg.

A broadening of the research paradigms continued rapidly in other areas. In succeeding papers, Langefors explored various aspects of the character of information usage in the work organization further. He was particularly interested in the value of information in the decision making process, an interest which gradually led him into the area of *cognitive psychology*. His famous *information equation*, emphasizing that the subjective value of new information is relative to the individual's present knowledge and knowledge structure as well as the time dimension, appeared as a salient linkage between informatics and cognitive psychology.

A further broadening of this perspective appeared in research performed by another of Langefors' external doctoral students, *Rolf Høyer*, who introduced an exploration of the social and organizational *implications* of information systems, thereby linking infology to work sociology and organization theory. These were areas which had previously been considered absolutely alien to informatics. It is typical for Langefors' eclectic attitude to such research endeavors and explorations, which were breaking existing borders of current paradigms, that he encouraged the work in progress, finally accepting the work as a relevant doctoral thesis at his institution.

### **Towards the end of the Eclectic Paradigm**

The work of Høyer and others, led directly to an interest in the role of information system development as a vehicle for contributing to *industrial democracy*. Høyer asserted that such efforts in most cases were feasible as part of a mutually confident process,

***“Langefors ... famous information equation, emphasizing that the subjective value of new information is relative to the individual's present knowledge and knowledge structure as well as the time dimension, appeared as a salient linkage between informatics and cognitive psychology.”***

where the enterprise on one side, and the individual and group of individuals on the other, were pursuing objectives which in the end might be reconciled. He suggested that information systems development should actually be regarded as a process of *organization development (OD)*. He thereby came to link informatics to the well-established knowledge area *Organizational Behavior*. Thereby he introduced another expansion of the research paradigm, which many at that time felt had been stretched uncomfortably far. Organizational strain started to build up in the institution, however not clearly outspoken.

While the OD perspective might be described as being based upon a *harmony model of organizational processes*, other researchers in- and outside the institution aggressively opposed and challenged such an approach as being a valid one for contributing to industrial democracy. Rather, they insisted that one ought to realize that the objectives of employees were very different from those of the enterprise as such. Actually, they were believed to be so inconsistent that it would be impossible to arrive at a reasonable reconciliation. Furthermore, the power and knowledge bases of the enterprise were assumed to be so superior as compared to that of the employees and their unions, that meaningful cooperation would be meaningless. Hence, the only way to support development of industrial democracy was to introduce and maintain a state of conflict, and at the same time improve the power base of the employees, however on their own premises. The conflict perspective was born, thereby unfortunately allowing a deliberate political bias to creep into the research.

These ideas were pursued enthusiastically, among others, by *Pelle Ehn*, another of the younger doctoral students at the institution, joining forces in a network with similar research interests at universities in Oslo and Aarhus. The dominant method of research within those groups was labeled *action research*, a term borrowed from therapeutic oriented subcultures of the social sciences. A characteristic was strong interrelationships with the trade unions, which were regarded as the "owner" of the research. Another characteristic was that a legitimate result of the research primarily would be the outcome and the process of the action. This caused inevitably traditional reports and scientific publications to be less important and play a minor role, thereby reducing severely the esteem and acceptance of this type of research in the traditional scientific community in general. This made it evident that any attempt to reconcile the different conceptions of what was relevant research would be meaningless. No institutional umbrella would be wide enough to encompass such a diversity of controversial world views.

At this point of paradigmatic development at the institution, the eclectic period inevitably had to come to an end. To understand the inherent strains now gradually having risen, one must also take

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into consideration that the research scope not only widened towards the social sciences. At the same time, talented young researchers conducted research in quite different directions, applying formal methodologies in the vicinity of the borderline to the area of the established computer science. Beside very successful projects oriented towards advanced technical problems of data base design (*Bubenko*), some researchers chose formal logic (calculus) as a possible vehicle for administrative systems analysis and design. *Sten Åke Tärnlund* appeared as the main proponent of such research endeavors.

During more than a decade since the institution was formed in 1966, Langefors as the unchallenged scientific leader, advocated an eclectic perspective for the growing research at the institute. New ideas were welcomed and supported, but also creatively incorporated into his research. He constantly, and in innovative ways, broadened his perspectives, walking a very long way from the systems engineering tradition all the way into alien areas as cognitive psychology. What a flexible mind! By being a brilliant scientist and the unchallenged intellectual leader, he actually legitimized such broad perspectives and made the eclectic paradigm the normal intellectual framework for managing a research institution.

However, in the hindsight's clear light, it is easy to understand that this paradigm inevitably would create severe internal tensions as more and more "allowable" ways of doing research appeared. In a way, the institution as a joint intellectual system started to fall apart. At the end, there were no possibilities available for reconciliation of the different views, spanning from extreme formal methodologies to action research and cognitive psychology. Inevitably, the proponents of the various subgroups were drawn into an escalating state of intellectual competition about which research orientation ought to be focused upon, and which orientations should be regarded as peripheral and alien to the interests of the institute, some even considered unacceptable or unscientific.

Such a situation is well analyzed and modeled by *Thomas S. Kuhn* in his work "*The Structure of Scientific Revolutions*" (1962). In this work, Kuhn describes the transformation of an established scientific tradition through a turbulent change process, into a new and stable situation. The development at the institution towards the end of the period with Langefors at the helmet, until his successor finally was appointed, may be explained very instructively by applying Kuhn's model.

### **The Transformation from an Eclectic to a Focused Paradigm**

In the pre-Langeforsian era, the academic conception of informatics was more or less dominated by what today is computer science. When Langefors was appointed professor of *Information Processing, especially Administrative Data Processing*, and the

***"Langefors ...actually legitimized such broad perspectives and made the eclectic paradigm the normal intellectual framework for managing a research institution."***

simultaneous publishing of THAIS, this was in itself a *scientific revolution* in the micro-cosmos of informatics. Then a period of “*normal science*” prevailed, however with marginally different research approaches living peacefully together under one umbrella, the dominant eclectic paradigm.

However, after some time, several new and steadily more different approaches were launched, gradually starting to compete with each other. Each approach being advocated by groups with different conceptions of what should be the dominant paradigm, that is: Which type of research should be the dominant one, and what types ought to be considered peripheral or even irrelevant?

As seen from outside, this was just what happened towards the 1980's before the old paradigm simply fell apart. Those concerned will remember the never ending disputes of what ought to be the content of the university discipline of information processing. This debate always occurred every time a new chair was to be appointed at most other universities in Sweden. The author possesses first hand knowledge about those fierce debates, as he served as expert to the appointment committees at many of the universities establishing new chairs for the first time (Gothenburg, Lund, Copenhagen, Stockholm School of Economics, et al.).

In Kuhn's model, competition will prevail until one of the competing views conquers the arena, defining what shall be the dominant way of doing research and what shall be the official content of the academic area in question. Then a period of “*normal science*” occurs, until the current paradigm after some period of time again is attacked by newcomers suggesting a change of the current paradigm.

Kuhn's model describes nicely what happened. Among the many competing conceptions of relevant research, the mainstream research tradition meticulously built up by *Janis Bubenko* conquered the Stockholm chair of Administrative Information Processing. The following change of research paradigm towards data systems and formal methods was clearly signaled when the key word information was removed from the formal name of the institution, being replaced by the term data science. The present DSV was born.

The competing conceptions of what were the most relevant areas of research and education, were gradually spread to other institutions where the various research views were successfully implanted: Sølvyberg at Norges Teknisk-Naturvitenskapelige Universitet in Trondheim, Lundeberg and Høyer at the Business schools in Stockholm and Oslo, Nissen and Ehn at universities of Lund and Aarhus, Goldkuhl and Nilsson at the universities of Linköping and Karlstad.

In this way, one may comfortably conclude that the open, eclectic tradition practiced by Börje Langefors proved to be a very constructive one. He succeeded in breeding a very broad tradition

***“The following change of research paradigm towards data systems and formal methods was clearly signaled when the key word information was removed from the formal name of the institution, being replaced by the term data science. The present DSV was born.”***

of information systems research, a tradition consisting of a variety of fruitful research approaches, being very beneficial to the entire Scandinavian area, and giving name to the internationally accepted term “The Scandinavian Approach”. This international fertilizing effect was strongly enhanced by an extraordinary personal openness and helpfulness to individual researchers from all other Nordic countries exerted by the Stockholm institution.

Furthermore, the many Nordic academics who in one way or another had the privilege to contribute to the development of the former Department of Administrative Information Processing, now DSV, do have good reason to feel proud of having contributed, albeit marginally, to the emergence of an important and viable research tradition, and to a great university institute.

### **Epilogue**

This article is intended to be a contribution to the history of DSV, the former Institute for Administrative Information Processing. However, because the author also had the honor and pleasure to be an actor in the organizational processes described, the article inevitably will have a strong subjective bias, thus being a dubious contribution to the official history of the institution. Other actors will certainly have different conceptions of what is described herein.

Because the article mentions specific persons by name, the author apologizes for possible misinterpretations and misunderstandings related to them. Hopefully they are not in any way felt offensive. Another excuse is directed to the many actors in the history of DSV not being mentioned here, although they certainly may have played significant roles. This includes for example a number of great Finnish researchers contributing to the Langeforsian heritage, where *Pentti Kerola* stands as a life long contributor. The innovative Danish research spin-offs also deserve mentioning, *Niels Bjørn-Andersen* being the most viable researcher and organizer.

The reason for these severe omissions is of course the severe and painful space limitations imposed upon this article by the editor, but also – the fading memory of the author.

Anyway – this article is written with affection and admiration of a great university institute.

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# FROM AI TO UI

## ABSTRACT

In my work I have come to, step by step, respect the complexities of designing software systems for people. When I started doing research I naively believed that we could model users' behaviour and adapt to it. Today, what thrills me the most is when I can design systems that allow users to be the incredibly adaptive, creative, always learning people that we are. Meaning is created by the people and their activities in the space – not by computing systems. A computer system is not built by bricks and wood, but in software that is a fantastically fluid and changeable building material. What we need to do is to extend on this material to provide the end users with substantial power over both the 'material' and the content in the systems we build.

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## In the beginning...

In the early 1990s the future looked bright and just about anything was possible, even when it came to computers and their use. The field of artificial intelligence (AI) had just about found its shape and goals and the promises given were fantastic. Soon we would be able to create systems that people could talk to, that could tutor our kids individually, that would adapt their way of functioning to us rather than the other way around, that would have humanoid characteristics and that would be able to act on our behalf, knowing what we wanted even before we knew it ourselves. My own interest was already then in how people and machines should interact. I wanted to invent novel ways for computers to behave so that we would make them accessible to all. There had recently been some insights pointing out that a so-called normal user was probably more than a 30-year old engineer with good programming skills. A normal user could in fact be someone without those skills – still male and young of course – but at least someone who did not understand computers inside out.

## Learning – the key in our thinking

Some believe that if we could only make programming languages that had a similar structure to how the brain worked, then people would just have to express their thoughts and the computer would understand and execute the given statements. Thus, there was a great need to understand human cognition and the brain. How do people really solve problems? And I was one of them. I was very curious as to how people solve problems and how they understood one of the, at the time, very popular programming languages, Prolog. I had done one study while visiting Sussex University, and as it turned out in our study, people solve problems using all kinds

## Kristina Höök

Kristina Höök is professor in Human-Machine Interaction at DSV since 2003. She also upholds a part-time employment at SICS where she is the manager of the Interaction Laboratory. She became Associate Professor (docent) in 2002, PhD in 1996, Ph Licentiate in 1991, and MSc in 1987.

***“...learning is key in our thinking and cannot be confined to one small process that works only in one way.”***



Carl-Gustaf Jansson – a true image of a professor to be.

of resources, drawing upon everything they new, real-world knowledge, and not only that, they also made things up as they went along! In fact, they were even learning and changing their behaviour during my one-hour study with them – without any feedback from me! While on the one hand this is indeed a rational behaviour, it was on the other hand nothing that easily translated in a one-to-one manner to programming statements.

This experience made me forever reluctant to claim anything about when and why people learn anything – my firm belief was and still is that learning is key in our thinking and cannot be confined to one small process that works only in one way.

### **Moving to DSV**

In this state of mind, I first met Carl-Gustaf Jansson at DSV. He looked exactly as he does today. Long arms waving around in excitement and all that unruly curly hair and beard – a true image of a professor to be. At the time, he was very interested in learning processes just as I had been. His interest was both in human learning, but also, perhaps more important to him, machine learning. He was a true believer in that machine learning was the key to creating intelligence in machines. I am bent to believe that he is still right. Machines that mimic human reasoning without the ability to associate and learn, will not behave intelligently as soon as they are removed out of context.

I had got employed at SICS at the time and as DSV was located in the same building, Electrum, several of us young researchers at SICS became PhD-students at DSV. Calle was building his first research group and it was a fantastic bunch of very interdisciplinary students many of which are still around in Kista, amongst others: Robert Ramberg a very young psychology student, Jussi Karlgren who had studied linguistics, Henke Boström doing machine learning, and many, many others. In a sense the group was spread over both DSV and parts of SICS. We would have joint meetings and study groups from time to time. Calle organised, and still does, a meeting in Åre where we from SICS would sometimes be invited to join in. The meeting in Åre was probably the most intense meeting I have ever been to. Calle would bang on our doors at 7 in the morning, making us work all morning, and after skiing all afternoon, he would make us work again for several hours before dinner. As we were all young and energetic we would stay up all night, and then Calle came banging on the door again at 7, asking us to get up and be creative again. After several days of this treatment we would stagger home again, dead-ly tired, but also with a bunch of great research ideas and with a strong group feeling.

### **Meeting reality**

It was a glorious time in terms of funding as well. After some initial struggling with building route guidance systems for cars

making use of various intelligent route planning methods, me, Annika Waern, and some of my colleagues at SICS applied for money from Ellemtel AB (jointly owned by Telia and Ericsson). Through Calle we also applied for money from NUTEK. We were granted money from both sources for 3 years! Given this money we started to investigate whether it was indeed possible to create machines that would adapt to people and provide help just when it was needed. Our idea was that it should be possible to model users' help needs from their actions at the interface and then present only the most relevant information.

This project started a joint journey towards taking people and their interactions with systems seriously. We spent lots of time at Ellemtel trying to figure out what people were doing and what their help needs were. And of course, the real-life needs of people trying to create complex systems was not at all as neat and tidy as those we had imagined in the research lab. It turned out that when seeking for help, most users had very little use of on-line documentation. Their foremost urge was to get to talk with someone who had experience of the task they were attempting. The information needed to be contextualised to their special problem at hand. And similarly to how I learnt that learning is such a fantastic, fluid, on-going process, I now learnt that information search is not a simple rule-based process where a need can easily be matched with some information items. Again, while someone was searching for one piece of information, they would discover other items, learn more about the structure of the overall information, and their help need would change – while searching! We are indeed incredibly adaptive and creative beings.

***“...the real-life needs of people trying to create complex systems was not at all as neat and tidy as those we had imagined in the research lab.”***

## **Users are people**

In our joint project, we now had to search for the theoretical and practical foundations needed to understand and address this problem. We found those foundations in the (at the time) recent critique by Lucy Suchman of AI-solutions. She had analysed some of the assumptions made by early AI-researchers and found that their rule- and plan-based approach was not at all capturing the real behaviour of people. People are situated. We act based on changes in our information. Plans are resources for us in these situations, but we change them quickly as soon as some new facts arise. Suchman had an enormous influence on the field she was critiquing. AI researchers turned to new kinds of knowledge representations and rapid situated planning algorithms.

We did the same turn in our project. The system for help that we built continuously adapted to the user behaviour. It did not assume that the user had one and only one information goal. In addition, we made sure that the user could both understand what was going on with the adaptations and that they could reverse them if they did indeed not match the user needs. Annika Waern, Jussi Karlgren, Calle, myself and the other colleagues in the

project wrote up our experiences in a journal paper that according to my current favourite programme, scholar.google.com, is the most cited of all mine and Calle's scientific writings.

The work we did in this project did of course not exist in a vacuum. The whole AI-world was turning more towards solutions in which the context and context limitations were key. At DSV there were several projects along these lines – studying learning processes as situated learning, studying distributed intelligence, and creating machine learning systems. In a sense, it became a whole strand of work that lay the foundations for both the K2-lab at DSV and the HUMLE-lab at SICS. The K2-lab at DSV, lead by Calle, grew and soon consisted of more than 30 researchers. The HUMLE-lab at SICS, lead first by Annika Waern and then by myself, grew to be about 25 researchers. Not all the research was done from exactly the same theoretical foundation or perspective on the world, but in common was a keen interest in applying AI-techniques in more realistic and humanistic ways.

### **People are social**

My own work after this point was inspired by the social processes around information search that we found at Ellemtel. If information is not and cannot be de-contextualised and people typically want to either talk directly to others or be able to see what they have done in similar circumstances, then why not try to facilitate this process? We named the process *social navigation* and have now spent several years trying to figure out exactly how systems can be implemented that make other users' actions visible, or aggregates their behaviour to provide recommendations, or simply just puts users in contact with one-another so that they can help each other. In a sense, this strand of work took me even further away from the original AI dream. Instead of modelling this or that abstractedly, it became more important to let users' intelligence come to use – putting the human in the loop. The problem, in my mind, shifted from being an AI problem to becoming an UI (User Interface) issue building upon human intelligence rather than artificial intelligence.

### **The system space turns into a place**

If we, metaphorically, look upon system design as a building where the walls have been set up, the floor is laid, the roof is securely in place, we also know that once the building starts to be used, people will start leaving their traces in it. They will put up wallpaper, furnish it, sometimes tear down walls to create the kind of spaces they need for the kinds of activities that the building will host over time. Depending upon the activities in the building and the traces they leave in the physical layout and social activities, new visitors to the building will be able to 'see' how to act, where to interact, whom to talk to. The space will be turned into a place, as phrased by Harrison and Dourish in 1996.

There are two important aspects of this activity that we need to consider. First, it is important to remember that meaning will not arise from setting up the walls. Meaning is created by the people and their activities in the space. Second, the design of the building seems to be an on-going process where certain spaces are left 'open', inscribable, sometimes purposefully by the architect, sometimes because the inhabitants take charge of the house and rebuild it, but in any case, allowing for the inhabitants of the house to leave their marks on it.

If the architect has made a very strong statement in the building design, it might be harder for users to appropriate the building. They will hesitate to change it because they are scared of destroying the intended meaning. Nevertheless, over time the activities do leave their marks on it – it gets worn, wallpapers have to be changed, new tenants move into the house. And in our daily activities in the building, other people can see what we do and will react to it.

What is truly interesting about computer system architecture is that it is so much easier to change. A computer system is not built by bricks and wood, but in software, which is a fantastically fluid and changeable building material. It is not impossible to provide the end users with substantial power over both the 'material' and the content.

### A fluid design material

Similarly to how I turned towards social navigation, K2-lab took a similar turn where some researchers, such as Robert Ramberg, Klas Karlgren, and others, turned to new theoretical viewpoints in order to provide for human learning processes. They were inspired by the idea that much of human learning can be characterised as language games – we learn the lingo of some subject area and thereby learn both how to talk about the subject matter but also obtain the tools that enable us to think about problems in novel ways. In the area of learning, K2-lab also had several projects looking at children's learning processes. The most recent advancements lies in the work by Jakob Tholander and Ylva Fernues. Jakob and Ylva are interested in making the new medium that computers and programming offers available also to kids.

In school today we learn how to write, draw, paint, we get music lessons, do woodwork, sewing and cooking, but we do not teach children how to express themselves



### Programming available to kids

The researchers Jakob Tholander and Ylva Fernaeus are sitting on a carpet together with a group of children. Cards with pictures created by the children are placed on the carpet. Electronic components are placed inside the carpet. A big display screen on the wall shows what is happening. By moving the cards, the children see the pictures on the screen and can program simple games. (See <http://dsv.su.se/research/kids/index.htm>)



***“In school today we learn how to write, draw, paint, we get music lessons, do woodwork, sewing and cooking, but we do not teach children how to express themselves through programming or other IT-artefacts.”***

through programming or other IT-artefacts. Jakob and Ylva have attempted to make this medium accessible to children through making parts of it tangible. That is, kids programme through manipulating physical objects that in turn interact with the digital world, translating their activities into digital activities.

Research in the area that originally had interested us in HUMLE and at K2-lab can perhaps, today, be best characterised as an exploration of the fluid design material that computing is. We are trying to understand its inherent and emergent properties as well as extending it using sensors, tangibles, music, colours, haptics, and just about any material at hand. We are applying it to new areas, such as learning, collaboration, affective interaction and meeting situations.

Through all the research that I have briefly touched upon above, I would say that we are inspired and humbled by one simple fact: *people are fantastic!* And as long as we humbly address and attempt to build systems that harmonize with this fact, we cannot fail. Using AI techniques in user interaction design might be very fruitful indeed, but most important is the user intelligence. Thus, from AI to UI.

***“Using AI techniques in user interaction design might be very fruitful indeed, but most important is the user intelligence. Thus, from AI to UI.”***



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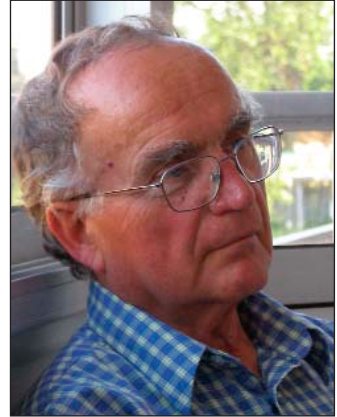
# WHITHER COMPUTERS AND SYSTEMS?

## CONFESSIONS OF A 2006-EMERITUS

### ABSTRACT

This contribution by an early graduate student and late professor emeritus covers some facts and reflections related to the first doctoral dissertation which was completed at the department in the year 1972. It starts describing some of the context of the department, of its graduate studies, and the later development of Swedish universities. The subsequent sections deal in turn with experiences of eclecticism and ephemerality of the studies, memories of conflicts, impressions from various trends in the development of the discipline, and the pervasively lasting importance of the concept of “system”<sup>1</sup>. The conclusion is permeated by bittersweet feelings about all these memories and reflections: their meaning is seen portrayed at its best in the Bible’s classic book of the Ecclesiastes, applicable to an understanding of the end of all academic careers.

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### Kristo Ivanov

Kristo Ivanov was full professor of informatics (earlier administrative data processing) at Umeå university between 1984 and 2002, where he also acted as head and chairman of the board of the department between 1986 and 1998.

He has also degrees in several areas of interest such as electronic engineering, psychology, industrial economics, statistics, and political economy. Home-page: [www.informatik.umu.se/~kivanov/Bio.html](http://www.informatik.umu.se/~kivanov/Bio.html)

My whole image of CSS’ (Computer and Systems Sciences) environment and mission transcends Stockholm’s academia, which I frequented only during a few years until completing in 1972 my Ph D dissertation. It happened to be the first doctoral dissertation at the department<sup>2</sup>. Its message, on quality control of information, belonged to the counterpoint, rather than the mainstream of ongoing research, and it was later popularized and applied to issues of security, privacy, and integrity in a way that is still relevant today<sup>3</sup>. Launching such counterpoint-research based on systems-trends originated at the University of California at Berkeley, but was at the time unknown in CSS. It speeded up my dissertation efforts since, as an “outsider”, I was not seen as a competitor in academic politics. My image of CSS, however, is also grounded in later experiences including other related university and business environments.

As a matter of fact, I felt much as an outsider in relation to many of my Ph.D. student colleagues at the CSS Department, who were mostly employed there as instructors or assistant professors. I also felt as an outsider in the sense that I was one of the few who, being an electronic engineer, had worked many years in both line and managerial staff positions in industry, and was still employed but on leave from a dominant computer business firm. As such I was more a “practitioner” and, a representative of “users”, rather than of “programmers” or computer technicians. This background may explain my particular way of experiencing the Department.

The following is then the short version of my provocatively subjective and unavoidably superficial view of the development of the Department’s field, for which I apologize in advance to all optimists and supposed realists. It will be kept at a somewhat

abstract level because of reasons of diplomacy and available space. Parts of my account, below, may appear to be pessimistic, but, in the spirit of the “Ecclesiastes” (cf. below) I see pessimism and optimism as only the secularized westerner’s attempt to confront, alternatively to escape, reality and truth!

The birth of CSS was made necessary by problems caused by the increasing use of computers and electronic communication, in the gap between technology and human sciences. In this respect many of us felt that CSS, both the original Department and the various kinds of knowledge or various CSS-relevant disciplinary fragments that it attempted to bring together was exemplary. Information processing, administrative data processing, and informatics were innovative labels which had the ambition of integrating pieces of knowledge which other older and more established disciplines like mathematics and economics comfortably considered to fall outside their disciplinary limits. In this respect this was a unique pioneering deed in the Swedish academia as compared to foreign tendencies, still prevalent today, to allot disparate CSS problems to either institutes of technology, (as for the case of programming and computer architecture), or to business schools (as for the case of softer issues restricted to or redefined as business administration, organization, or sheer accounting and auditing). In this respect CSS in Sweden, originally associated to multiple university faculties (cf. Stockholm University and Royal Institute of Technology), resembles what was also being attempted in other countries and in other contexts under the label of operations research and later systems approach. Such multidisciplinary is still to this day vaguely aimed at under the label of contextual computer-human interaction, CHI.

***“In this respect this was a unique pioneering deed in the Swedish academia as compared to foreign tendencies, still prevalent today, to allot disparate CSS problems to either institutes of technology, (as for the case of programming and computer architecture), or to business schools (as for the case of softer issues restricted to or redefined as business administration, organization, or sheer accounting and auditing).”***

### **Departmentsts and universities**

Later political recognition of the underlying computer-related problems fostered all over Sweden the awakening of other older academic disciplines and academic departments with their own competitive not to say opportunistic research proposals, designed to tap money in view of the growing availability of research grants. This engendered gradually a general dissolution of disciplinary limits and, consequently, also of possibility to evaluate competence for work on opportunistically defined short-lived trends of hardware and software. Whatever wheel had been invented by the original CSS-efforts, it was occasionally reinvented and given a new label or acronym by various departments and research centers mushrooming everywhere.

The decreasing integrity of universities working for research and development controlled by the industrial-economic complex, turned them gradually into a sort of auxiliary, cheap, tax-funded industrial laboratories for technical and commercial advantage of export firms. The universities’ expansion, forced by government

in view of vote-raising doubtful political purposes <sup>4</sup> but without proportionate increase of public funding, required their increased dependence upon commercialization, and a gradual decline of admission requirements and staff competence. Abdication from historically justified but narrow rigorous thinking fostered a multitude of methodological sub-cultures, which appeal to soft postphenomenological, non-modern, and postmodern “weak thinking” borrowed from fashionable trends in the human sciences. Terms like information, data, system (and therefore systems science), information (and therefore information systems), knowledge, evaluation, productivity, communication, and organization tend now to mean nearly anything. And, concerning techno-optimism and belief in progress, what about “productivity”? <sup>5</sup> . Theories and models are substituted by ad-hoc shortlived “models”, “conceptual frameworks”, “tools”, or whatever, with scanty place for ethical, let alone economic and political considerations. This attitude of neglect is lately exemplified during the ongoing bankruptcy of thinking about privacy, security, rule of law, and personal integrity as affected by computer systems. Weak thinking, however, continues to clash with, and to be overpowered by, hard profit-economics and hard byproducts of military technoscience. Academic survival is then obtained by means of big promises coupled to time consuming, frustrating attempts to tap money from either commercial-industrial sources or large-scale national and EU bureaucracies. Universities compete to become institutes of technology and business schools <sup>6</sup>.

***“Terms like information, data, system (and therefore systems science), information (and therefore information systems), knowledge, evaluation, productivity, communication, and organization tend now to mean nearly anything.”***

### **Eclecticism and ephemerality**

Enough, now, on the development of the CSS field which in some sense must correspond to the development of the related academic departments in general. I think that one main consequence has been (a) an initial twenty years’ clash between “hard” and “soft” part of the CSS field, followed by a still ongoing reaction of permissive or uncommitting, eclectic, relativistic, postmodern coexistence between the two, and (b) ephemerality of doubtful scientific and educational results all over the years. One makes research today on yesterday’s visible effects of the use of externally given technology, which was adopted the day before yesterday. When the results happen to be published tomorrow they will be obsolete and used to justify new research to start the day after tomorrow about the consequences of today’s technology, which is already becoming obsolete.

I used to say that academic education should strive for more long-lasting results on more basic and stable problems, as opposed to short-lived industrial and commercial skills, which follow occasional random trends. This has not been strived for, but it does disturb young students and professionals who have not yet had the opportunity to perceive the “posthumous” feeling of emptiness

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***“In some way this enhances the importance of history and of interchange of ideas between young and older people. Furthermore, young and old age are not symmetrical in the sense that older people have already been young and have most of the young’s experiences, while the other way round is not the case.”***

when comparing repeatedly new big promises with later disappointment and oblivion. In some way this enhances the importance of history and of interchange of ideas between young and older people. Furthermore, young and old age are not symmetrical in the sense that older people have already been young and have most of the young’s experiences, while the other way round is not the case.

What is left of the various projects, models, theories, courses or controversies about programming of the sixties and seventies? Von Neumann computer architecture, structured programming and relational data bases? What about the seventies’ or eighties’ science fictions of logic programming, office automation, and artificial intelligence, AI, compared to the fragmented pieces of particular software embedded in today’s products? What if academic CSS had never been created and the whole historical development had been entrusted to the USA military complex, computer industry and the international market? It would be exciting to do a bit of historical counterfactual research, and to try to apply the pragmatist test of “did it make a difference?”, in order to draw some conclusions about what should be done today for a more enduring meaning in, say, ten and twenty years from now.

Ephemerality in this context has two sides: deserved and undeserved. Deserved when results are ill conceived or tied to particular products, hardware and software that last a few years. I do not dare to give examples since wise people already know them (particular programming trends, methodological innovations with beautiful acronyms etc.) while unwise people may only feel anger and become my sworn enemies. Economic literature seems to be more self-critical in this respect than the literature of the CSS-related field <sup>7</sup>. Undeserved when quality is not recognized as when it is supposed to be defined as “survival of the fittest” in the spirit of a supposed “Darwinian” social evolution. Valuable thoughts about, for instance, the meaning of systems and information are forgotten in the name of ill-conceived vague speculations about, say, knowledge, communication, experience, contexts, networks, or environment.

Ephemerality is also evidenced (another repeated CSS-experience repeated during the last 30 years) when most researchers in the CSS field do not care to read or recommend their own dissertations, and still less others’, only a few years after they have got them printed. Sometimes as soon as they are printed! The reader of these lines can make an own self-examination, and an examination of what happened to the work of colleagues and supposed luminaries of the field.

Unfortunate ephemerality is also fostered by the neglect of lessons from philosophy of science and technology. The neglect of philosophy has also had the unexpected effect of opening up the CSS field to the equally unexpected leadership by philosophers’

kings. “No names mentioned, nobody forgotten”. I got the impression that certain philosophers or philosophically educated researchers from other than CSS could in a relatively short time period conquer several CSS-truths, and claim to develop them on a more professional basis than some CSS home-prophets could master. I reflected that “Among the blind the one eyed is king”.

I think that such neglect, together with psychological realities about the sharp difference between personal aptitude profiles, also stands at the center of the origin of the clash between the “two cultures”, softer and harder, human science vs. formal and natural science. Only exceptionally gifted CSS-people (Joseph Weizenbaum, Börje Langefors, Terry Winograd, Werner Schneider?) could attempt to manage the bridge between the hard and the soft.

### **Conflicts and memories**

The clash between the hard and the soft, improperly labeled as they may be, was one of my strongest impressions of the CSS department in the sixties and seventies. I cannot forget the show at the disputation of my dissertation, which awakened particular interest also for being, as mentioned, the first one to be completed at the department. I was ferociously attacked by a legitimately self-appointed extra-opponent who, being an exponent of a trendy programming fad at the time, condemned my work with “religious” passion.

Later, during the seventies and eighties, I had the occasion to witness bitter clashes between exponents of the hard and soft CSS people. Interestingly enough, it was always the hard people who wanted to oust the soft ones from the CSS field, and this phenomenon was most prominent during the process or “game” of evaluation of candidates to professorial chairs in various universities around the country. It was often the case of hard people in their role of experts in evaluation and recruitment committees, who experienced a passionate commitment to demean, disqualify and prevent softer colleagues from gaining tenured or influential positions at the universities. In defense of this hard militant approach to academic politics it can be said that it was as if its proponents foresaw and in a heroically self-defeating way were trying to prevent the later advent, in the nineties, of the plague of supersoft post-phenomenological “weak thinking”, “non-modern” qualitative methods, and relativistic postmodern design, to be mentioned below.

These experiences, as well as the “religious” wars between enthusiasts of different software philosophies prompted me to study later the psychology of computer science as a branch of CSS-oriented philosophy of science, and to explore the ethical, political and theological foundations of CSS. Eventually I came to the conclusion that much CSS disciplinary development is ultimately a theological matter in the original sense of the word.

A second lasting impression from my early life at the CSS Department, was also related to a lack of interest or unconsciousness about the philosophy of science underlining its theories and methods. I “discovered” by myself that most of the “dogmatically” taught basic stuff at the Department was based on logical positivism. When I tried to share this problematic insight with one of the most aggressively successful young stars and “crown princes” at the department I was startled by his justification (roughly): “I have no objections to be called logical positivist since I am both logical in my thinking, and have a positive optimistic attitude in my scientific effort!”.

A related experience was my observation of how easily ephemerality of scientific projects could be countered with equally ephemeral flexibility of terminology: I think I dare to mention, if I remember it right, that a project named ISAC, meaning Information Systems for Administrative Control came simply to be renamed Information Systems for Administration and Change as soon as marxist critique became trendy in the seventies, making “control” sound reactionary and outdated. Needless to say, it is difficult to see what heritage is left today from the theorizing behind various projects and acronyms such as ISAC or CADIS, computer aided design of information systems, not to mention PROLOG. One can only guess what will be left in ten or twenty years out of today’s theorizing behind, say, the fashionable trend of interactional design.

***“I think I dare to mention, if I remember it right, that a project named ISAC, meaning Information Systems for Administrative Control came simply to be renamed Information Systems for Administration and Change as soon as marxist critique became trendy in the seventies, making ‘control’ sound reactionary and outdated.”***

### **The mystics of design – or religion?**

As I have written in one of my papers referenced in a note below, (The systems approach to design), the clash between soft and hard aspects of CSS is today no longer associated to any dominance of logical positivism in academia. It is, rather, associated to products and concrete expressions of the logical positivism of the hard military-industrial complex. These products are then given to or bought by the academia, which claims to study them by soft qualitative methods and postmodern “design” fostering Internet-services, games, edutainment, “eXperience” and X-economy. So, today’s research speaks often about experience design, aesthetic computing, sensible computing, and such. One of the latest innovations is supposed to be virtual reality being displaced by “real virtuality”, which stimulates “as many of the five senses as possible”.

This reminds me of another strong impression linked to the CSS department’s history. Some solitary marxist colleague at the CSS department during the early seventies joined other Scandinavian colleagues who had been prophetizing academic revolution supported by labour unions. Their theories made admiring and rich references to Marx, Mao, and to the Yugoslavian models of workers’ participation in systems design. They met, however, difficulties after the debacle of the Soviet system. Their academic politics

and ethics were suddenly metamorphosed into aesthetics and “design”, or, rather, interactional aestheticism, a fashionable and profitable field offering rich research funds, where today nobody needs to feel neither solitary nor dependent upon collaboration with labour unions. Politics and ethics became postmodern design and aesthetics run by actor networks. References to marxist literature were followed by references to phenomenology, post-phenomenology or non-modernism, Heidegger, Foucault, Latour, and such. This trend is still going on today. Textbooks on IT-design sometimes even refer to “tremendous mysteries” and soft esoteric terms, but do not dare yet to mention religion <sup>8</sup>. I tried to depict the import of this remarkable and symptomatic development in my named paper on the systems approach to design, but it is also the object of other interesting in-depth studies of the relation between academia and politics.<sup>9</sup>

### **Concluding remarks**

If the logical positivism of science and its coarse economics are seen, in oversimplified terms, as a reaction against earlier defective weak thinking, and if relativistic eclectic postmodernism is seen as a reaction against logical positivism, then what? Why-not? I have claimed on earlier occasions that the why-not strategy belongs as several other CSS-strategies such as so called pluralism or, rather, eclecticism, to the department of easy questions and difficult answers: it shifts the expensive whole burden of proof to the occasional questioner. Is it enough to go on, to live and let live, letting every university and every department have its own ad-hoc profile, and to give up the idea of any cumulative scientific knowledge or of the value of historical knowledge? Why not let “the pendulum swing back and forth again” while the only supposedly stable truths left at the universities are the governmental injunctions of gender studies and ethnic-cultural diversity? Or is the supposed pendulum the “cross-sectional view of a spiral screwing itself down into hell”?

Against such a background the only joyful remembrance which stood and still stands at the heart of the CSS Department and its disciplines is the theory-laden concept of SYSTEM <sup>10</sup> which today also tends to be thoughtlessly diluted in a non-committing mystical “whole” or “wholeness”, or, worse, in a interconnected multitude of technical gadgets. It was intended, however, to aim at a philosophically grounded integration between so called hard and soft knowledge, encompassing formal, natural, and human science. This would include the hard realities of global economics and global politics, which seem to be conspicuously absent from CSS-theorizing despite their influence of technological development. From this point of view the old clashes between hard and soft were pointing at something legitimate and potentially very fruitful, calling forth a systems thinking which unfortunately did not materialize.

And what about “religious passion” or, rather, Christian passion in relation to CSS today? If my misgivings as related above happen to be justified, either the Apocalypse itself or the following quotations from the Ecclesiastes (New English Bible, 1970) may serve, after some interpretation, as a retirement guide consistent with emeriti’s experiences. As such they may also be valuable for non-secular evaluations of “whither CSS?”:

“What has happened will happen again, and what has been done will be done again, and there is nothing new under the sun...The men of old are not remembered, and those who follow will not be remembered by those who follow them...” (1:9, 11)

“So I applied my mind to understand wisdom and knowledge, madness and folly, and I came to see that this too is chasing the wind. For in much wisdom is much vexation, and the more a man knows, the more he has to suffer...” (1:17)

“Yes, indeed, I got pleasure from all my labour, and for all my labour this was my reward. Then I turned and reviewed all my handiwork, all my labour and toil, and I saw that everything was emptiness and chasing the wind, of no profit under the sun...” (2:10)

“What sort of man will he be who succeeds me, who inherits what others have acquired? Who knows whether he will be a wise man or a fool? Yet he will be the master of all the fruits of my labour and skill here under the sun. This too is emptiness.” (2:18)

“One more thing I have observed here under the sun: speed does not win the race nor strength the battle. Bread does not belong to the wise, nor wealth to the intelligent, nor success to the skilful; time and chance govern all...” (9:11)

“One further warning, my son: the use of books is endless, and much study is wearisome.” (12:12)

## Notes with references

- <sup>1</sup> Ivanov, K. (1984). Systemutveckling och ADB-ämnets utveckling [Systems development and the development of the discipline of informatics/ADP]. In H.-E. Nissen (Ed.), Systemutveckling, av vem, för vem och hur? [Systems development, by whom, for whom, and how?] (pp. 1-14). Stockholm: Arbetarskyddsfonden. (Report No. K4/84. Orig. also as report LiU-IDA-R-84-1, University of Linköping, Dept. of Computer and Information Science, 1984, and as contribution to the Universitet- och Högskoleämbetet UHÅ-report “Den rena vetenskapen och den goda tillämpningen”, 21-26 April 1985, Lilla Vik. The essay’s diagram of key philosophers’ names for information systems development is also found adapted by Hirschheim, R. A., 1985, Information systems epistemology: An historical perspective, in E. Mumford, et al., eds, Research methods in information systems, Amsterdam: North Holland, 1985, pp. 37-38. Reprinted in R. Galliers, ed., Information systems research: Issues, methods and practical guidelines, pp. 28-60, Oxford: Blackwell Scientific Publications, 1992.)

Ivanov, K. (1984). Mot ett ingenjörsvetenskapligt universitet: Några tankeställare inför universitetets samarbete med intressenter på data-området. [Towards or against a university of engineering science]. University of Linköping, Dept of Computer and Information Science, Report LiU-IDA-R-84-2. (Cf. a revised minor excerpt as "Universitetets bidrag till näringslivets och förvaltningens samhällsnytta". In C. Knuthammar, & E. Pålsson (Ed.), Vetenskap och vett: Till frågan om universitetets roll (pp. 52-62). Linköping: University of Linköping. (ISBN 91-7372-925-6. With a bibliography of 95 entries - pp. 124-127.)

Ivanov, K. (1995). A subsystem in the design of informatics: Recalling an archetypal engineer. In B. Dahlbom (Ed.), The infological equation: Essays in honor of Börje Langefors (pp. 287-301). Gothenburg: Gothenburg University, Dept. of Informatics. (Pre-publication version at <http://www.informatik.umu.se/~kivanov/BLang80.html> and in pdf format at <http://www.informatik.umu.se/~kivanov/BLang80.pdf> 30 Dec 05.)

Ivanov, K. (2001). The systems approach to design, and inquiring information systems: Scandinavian experiences and proposed research program. Information Systems Frontiers, 3(1), 7-18. (Abstract at <http://www.wkap.nl/oasis.htm/324218>). 1 June 2001, pre-publication version at <http://www.informatik.umu.se/~kivanov/Chu-SysAppDes.html> 23 Dec 05.) See also:

Ivanov, K., & Ciborra, C. (1998). East and West of IS. In W. R. J. Baets (Ed.), Proc. of the Sixth European Conference on Information Systems ECIS'98, University of Aix-Marseille III, Aix-en-Provence, June 4-6, 1998. Vol. IV (pp. 1740-1748). Granada & Aix-en-Provence: Euro-Arab Management School & Institut d'Administration des Entreprises IAE. (ISBN for complete proceedings: 84-923833-0-5.). Cf. <http://www.informatik.umu.se/~kivanov/chinese.html>.

<sup>2</sup> Ivanov, K. (1972). Quality-control of information: On the concept of accuracy of information in data banks and in management information systems: The University of Stockholm and The Royal Institute of Technology. (National Technical Information Service NTIS No. PB-219297, summary at <http://www.informatik.umu.se/~kivanov/diss-avh.html>).

<sup>3</sup> Ivanov, K. (1986). Systemutveckling och rättssäkerhet : Om statsförvaltningens datorisering och de långsiktiga konsekvenserna för enskilda och företag [Systems development and rule of law]. Stockholm: SAF:s Förlag.

<sup>4</sup> Wolf, A. (2002). Does education matter? Myths about education and economic growth. London: Penguin Books. (Reviewed in The Economist, June 8th 2002, p.71. "The education shibboleth. Extra years of schooling and wider access to university are everywhere supposed to be good for growth. Think again".)

<sup>5</sup> Anonymous (1997). Productivity: Lost in cyberspace. The Economist, (September 13th), 78. (Cf. Assembling the new economy, in same issue, pp. 77-83.)

<sup>6</sup> Ivanov, K. (1984). Mot ett ingenjörsvetenskapligt universitet...Op.cit.

<sup>7</sup> Adam, F., & Fitzgerald, B. (2000). The status of the IS field: historical perspective and practical orientation. *Information Research*, 5(4). (<<http://InformationR.net/ir/5-4/paper81.html>> accessed 23 August 2001.)

Anonymous. (2000). Europe's Neologistical reforms. *The Economist*, (January 22nd), 30.

Anonymous. (2000). Thought followership. *The Economist*, (May 20th), 24.

Shapiro, E. (1995). Fad surfing in the boardroom: Reclaiming the courage to manage in the age of instant answers. New York: Addison-Wesley. (Referred to in *Harvard Business Review*, March-April 1997, pp. 142-147, and in the Supplement of March 22nd, p. 20.)

Skarin, U. (2002). Floskler för miljoner: Sveriges hetaste pratmakare. *Veckans Affärer*, (43, 21 oktober), 10-13.

Anonymous. (1997). Management consultants and their clients: Princely sums. Review of *Dangerous Company*. By James O'Shea and Charles Madigan. *Time Business & Nicholas Brealey Publishers*. *The Economist*, (August 16th), 75-76.

<sup>8</sup> As a matter of fact, "tremendous mysteries" in the aesthetics and phenomenology of design have their legitimate origin and place in religious experience as expressed e.g. in Ratzinger, J. (2005). *On the Contemplation of Beauty*. 2002 Message to the Communion and Liberation. (Published 2005-05-02. Available at <<http://www.zenit.org/english/visualizza.phtml?sid=70258>> accessed 051228. Swedish translation "Skönheten skall befria oss" in *Signum*, No. 5, Vol. 31, 11-16, <<http://www.signum.se/signum/template.php?page=read&id=1356>> accessed 060115.) The lack of a legitimate theological dimension in science fosters pseudo-religious passions and pseudo-mysteries in techno-science.

<sup>9</sup> Cf. Bengtsson, J.O. (2001). Left and Right Eclecticism: Roger Kimball's Cultural Criticism. *Humanitas*, vol. XIV, No. 1. (Also at <<http://www.nhinet.org/bengtsson14-1.pdf>> accessed 060228).

<sup>10</sup> Churchman, C. W. (1971). *The design of inquiring systems: Basic principles of systems and organization*. New York: Basic Books.

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# KNOWLEDGE AND COMMUNICATION

## AS IMPORTANT ASPECTS OF COMPUTER AND SYSTEMS SCIENCES

### Abstract

This essay argues for the occurrence of two shifts of subject focus for DSV, originally a classical Computer and Systems Science department. The concerns are the shifts towards making the aspects of Knowledge and Communication important for the subject, two shifts in which I personally have been instrumental. The essay focuses on the period 1975-1995.



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The goal of this essay is to argue for the occurrence of two shifts of subject focus for DSV, originally a classical Computer and Systems Science department, during the last thirty years (1975-2005). The concerns are the shifts towards making the aspects of Knowledge and Communication important for the subject, two shifts in which I personally have been instrumental. The essay focuses on the period 1975-1995.

The subject focus for a department is reflected in the profile and competence of its faculty, its research projects, its publications, the profile of its theses (licentiate and PhD), the theoretical and methodological perspectives embraced and finally in its courses and programs. It is by demonstrating shifts in all these respects that I will try to advocate my case.

The shifts of focus I am interested in, are of course not the only important ones during all these years. They are embedded in a rich web of other changes. The format of this essay is not large enough to sort out this intricate web of changes in detail. Instead, I will start by presenting two simplified and radicalized scenarios representing the perspectives thirty years ago and today.

In the 1970ies the focus was on single humans, using single computers for specific data-storage and computational purposes. Computers were used almost only in professional settings used by comparatively few people, computers were peculiar unique artefacts, powerful but still viewed primarily as passive tools.

Today the focus is on large groups of humans communicating and collaborating, assisted by large networks of fine-grained computational elements. Computational elements penetrate into all human activities and are used by virtually everybody, they are rapidly more embedded in and not distinguishable from other artefacts and they are typically more active participants in the

***“ In the 1970s the focus was on single humans, using single computers for specific data-storage and computational purposes ...***

***Today the focus is on large groups of humans communicating and collaborating, assisted by large networks of fine-grained computational elements.”***

collaborative processes in contrast to being passive tools.

By the *Communication aspect of computational systems*, is in this essay meant both the role of the systems as support for human-to-human communication as well as the communication interfaces between humans and elements of the computational systems.

By the *Knowledge aspect of computational systems* is in this essay meant, these systems abilities to act as equal partners to humans in the accomplishments of nontrivial tasks and to contribute to the build up of knowledge in such contexts. These abilities presuppose the operational representation of facts and skills relevant for the tasks within the computational system.

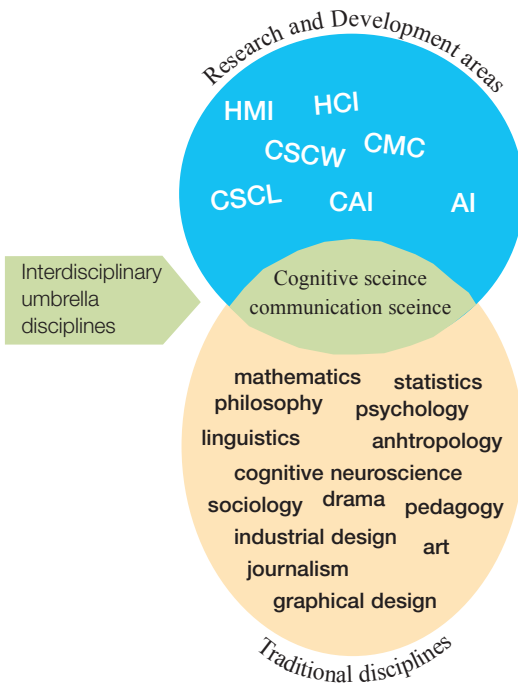
During the period of consideration, several fields of Computer Science and Systems Science which highlight the Communication and Knowledge aspects have been developed.

The Communication aspect is highlighted in fields such as: Human Machine Interaction (HMI), Human factors research, Human Computer Interaction (HCI), Computer Supported Cooperative Work (CSCW), Computer Supported Collaborative Learning (CSCL), Computer Aided Instruction (CAI) and Computer Mediated Communication (CMC). The Knowledge

aspect is highlighted in fields such as Artificial Intelligence and Knowledge Engineering as well as in the Complex systems. Artificial Intelligence (AI) as a field was christened already in the 50ies but had reached a mature state in the mid 1970ies. The core objective is to mimic sub-functionalities of human cognition. Its main topics are representation of knowledge, automated reasoning and machine learning (techniques to adapt system behaviour).

A property of most of the above fields is that they borrow from and reach into other traditional disciplines such as applied mathematics, statistics, logic, philosophy, psychology, linguistics, anthropology, cognitive neuroscience, sociology, pedagogy, subject specific didactics, industrial design, graphical design, drama, arts and journalism etc. In order to capture relevant overlapping parts of such disciplines, interdisciplinary umbrella disciplines like cognitive science and communication science have been defined.

With the above as a background, the goal of this essay can be rephrased as the illustration of how these fields and subfields have grown in importance within Computer and Systems Sciences but also how the influence from our neighbouring disciplines has



grown and how knowledge in these disciplines has been included in our subject. Of course, both of these changes have to be manifested in terms of the development of faculty competence, publications, projects, theses, courses and programs over the studied period.

### **Recruited to DSV to participate in PRINCESS**

In 1975 I was recruited to DSV (at that time named Information Processing/ADB) to participate in a project called Princess, funded by the National Swedish Board of Education. The overall goal of the project was to investigate how computational tools could support education/learning (CAI). As part of the work in this project I had the specific responsibility to make a survey of a new and exotic field of artificial intelligence called “Intelligent Tutoring”. A core ambition in intelligent tutoring systems was to manage explicit models of the users, observe and classify the state of the users and finally to adapt the system to the specific situation at hand. Another component of the Princess work was to explore the impact of simulation models and visualizations in education. A third component of the project was the introduction of systematic empirical studies in realistic school settings. A fourth component was the creation of authoring tools that should simplify educational support systems of a certain kind and that separated the user interface design from the domain model design. The Princess project inspired me in many ways which will be obvious from the forthcoming pages. I am still grateful to my collaborators in this project, in particular to Anita Kollerbaur, Louise Yngström and Hans Köhler, who had the foresight 30 years ago to launch a project with so many novel and far-reaching ingredients.

A minor but not insignificant side-effect of this project, was how it affected the DSV education in Programming Methodology. For many years, starting in the late seventies, I was responsible for a programming methodology course focussing on programming in the large which used the language *Simula* (used in the Princess project) and emphasized high level modelling of an object-oriented character as the preferred basis for programming of large systems. More than 20 years later, old students express their appreciation that they were taught what is today object-oriented industrial practice.

When I joined DSV, I had very few bindings to the classical DSV subject traditions (frankly I had not taken a singular DSV course during my undergraduate education). On the contrary, I had an undergraduate education representative for the early computer scientists, i.e. an engineering physics education specialized in applied mathematics and as many computer science courses as were available at that time. Maybe this lack of bindings to the old department traditions made me more susceptible to contribute to some shifts in subject focus. Maybe it also made it difficult for me to early and efficiently find a good focus for my PhD studies.

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**To SYSLAB and object-oriented programming...**

However, in the early 80ies, I found a new research environment within the dept., SYSLAB, directed by professor Janis Bubenko. Here I got the opportunity to pursue my interests in object-oriented programming and modelling, towards frontline research issues in knowledge representation (artificial intelligence). My supervisor, Janis Bubenko, represented the mainstream research tradition within DSV but had developed the field of data-modelling into what he called conceptual modelling, contributing to this new area both theoretically and practically. Janis was broadminded enough to accept more exotic research orientations like my own, and I am very grateful for his methodological advice in finalizing my PhD thesis on the topic of “Taxonomic Representation” in 1986, i.e. the role of concept hierarchies as used in representational schemes. At the core of the thesis were the formal analysis of the properties of conceptual hierarchies and methodological issues for creating such representations. Two issues that were relatively marginal in the theses came to be important for my further academic activities in the early 90ies: the cognitive aspects of conceptual structures and the automatic formation of conceptual structures.

During the above period, my interest in artificial intelligence had been further strengthened by a guest researcher, Dr Kenneth Kahn, with a PhD from MIT and educated in the tradition of artificial intelligence foreground researchers like McCarthy, Minsky, Hewitt, Abelson, Sussman, Steele, Lieberman and Winston. Ken had very early introduced the first basic course in Artificial Intelligence at DSV and as a role model illustrated the AI attitude that no problem is too difficult and particular to attack by computational means.

During the 80ies we gradually developed the AI curriculum and shortly after my dissertation in 1987/88, DSV could offer a 40 credit specializations in AI optional on programs both at SU as well as KTH. The courses included introduction to AI, logic and formal techniques, AI programming, knowledge representation, expert systems and logic programming. In parallel with this also a set of more specialized graduate level courses were developed: machine learning, intelligent tutoring, analogical reasoning and qualitative models. DSV has since this time maintained a set of courses in artificial intelligence but gradually on a less ambitious level.

Inspired by my interest in the cognitive aspects of conceptual structures, I became in 1988 engaged in a very fruitful collaboration with three professors within Stockholm University, Dag Prawitz in Theoretical Philosophy, Östen Dahl in Linguistics and Ywonne Waern in Cognitive Psychology. For me personally this collaboration meant a lot, as it widened my perspectives considerably and resulted in many positive strands of development.

The first concrete fruit of this collaboration was a 40-credit program in Cognitive Science, launched in 1989 at Stockholm

University jointly by the four departments. Apart from introductory courses in computer and systems Sciences, theoretical philosophy, linguistics and cognitive psychology it comprised an overview course on cognitive science and courses on cognitive aspects of human computer interaction, representation and reasoning as well as natural language discourse. Several of the students taking this program became graduate students at DSV and the other departments, bringing to their PhD studies their acquired interdisciplinary profile. The program was discontinued for administrative reasons after a few years but has recently been revived in the form of a masters program, which is a good candidate for being extended to an 80-credit masters program in the Bologna model.

A second consequence was the establishment of the Centre for Information Technology and Cognitive Science (shared between KTH and Stockholm University) in September 1992. Apart from the original “gang of four” as described above, the centre was supported by the Departments for Numerical analysis and computing science, Speech, music and acoustics, Work science and Manufacturing systems all at KTH as well as neurophysiology at KI. I had the role of director for this center until 1998.

As a result of the work in the centre during its first two years and particularly in partnership with professor Yngve Sundblad, I worked with the introduction of a track in Cognitive Engineering on the Technical Computer Science civil engineer program (D-line) in 1993. D-line students studied artificial intelligence, artificial neural networks, human machine interaction, linguistics, neuroscience, cognitive psychology and theoretical philosophy for a year as an option on the third year. Development of new civil engineer educations had been very slow up to this point and the introduction of this option in the middle of the education was pretty radical and novel at that time. After the first round of this track, more than one third of the D-students chose this track.

The sum of the curriculum development in artificial intelligence, human machine interaction and cognitive science around 1990 had a major impact on DSV’s undergraduate education as a whole. It was therefore not strange that our design of the remodelled Computer and Systems Master of Science education in 1993 included Cognitive Science in a wide sense as a basic block on equal terms with Computer Science and Systems Science. This was one of the first IT-related higher education programs in Sweden that included a significant amount of mandatory HCI courses.

Having been occupied with the development of the undergraduate study program for a while, I will now switch to the postgraduate studies and the coupling to research projects. After a few decades of academic career, you start to become more proud of the results of your students, than of your own personal contributions. I have had the privilege to supervise more than thirty PhD students

***“It was therefore not strange that our design of the remodelled Computer and Systems Master of Science education in 1993 included Cognitive Science in a wide sense as a basic block on equal terms with Computer Science and Systems Science. This was one of the first IT-related higher education programs in Sweden that included a significant amount of mandatory HCI courses.”***

up to their PhD exams: Jan Olsson (Olsson 91), Lars Henrik Eriksson (Eriksson 93), Manny Rayner, Lars Asker, Henrik Boström, Peter Idestam Almquist, Martin Aronsson (Aronsson 93), Christer Samuelsson, Fredrik Kilander, Harald Kjellin, Kristina Höök, Annika Waern, Klas Orsvärn (Orsvärn 96), Peter Holm, Hercules Dalianis, Magnus Stensmo (Stensmo 96), Love Ekenberg, Pierre Wijkman, Mats Danielsson (Danielsson 97), Björn Gambäck, Åke Malmberg (Malmberg 02), Anna Lena Johansson (Johansson 95), Fabian von Scheele (von Scheele 01), Agnetha Eriksson (Eriksson 03), Stefan Zemke (Zemke 03), Jakob Tholander (Tholander 03), Fredrik Espinoza (Espinoza 03) and Eva Jansson (Jansson 05). Many have continued their academic careers on tracks relevant for this essay. Others have pursued successful careers in industry and in research institutes. The subject focus has shifted from the formal work by Ekenberg (Ekenberg 93) to the applied and philosophical work by Holm (Holm 96). It is not possible here to comment on all individual works, but I will shortly comment on a few thematic areas that are appropriate to highlight.

The first thematic area relates to the last thread to follow up from my thesis work in 1986, is the formation of conceptual structures (an obvious sub-field of machine learning). From a modest start in 1986, a research group (ACTA) was built up which peaked in the early nineties to scale down after a decade. The PhD theses of Idestam Almquist (Idestam-Almquist 93), Boström (Boström 93), Asker (Asker 94), Kilander (Kilander 94), Samuelsson (Samuelsson 93), Stensmo (Stensmo 95), Wijkman (Wijkman 97) and Zemke represented different aspects of this field. The early projects were funded by NUTEK, the later by TFR and in particular by EU through the very successful, six year long Inductive Logic Programming project, which apart from funding provided us with a work environment with the best and most exciting research groups within the field in Europe. Research work has been kept up in this area at the department, driven by Henrik Boström and Lars Asker, both now associate professors and the latter returning after a postdoc at NASA AMES. They have in turn already examined several PhD students in this area including Anette Hulth and Richard Cöster. Over time the focus has moved more and more to data-mining with information retrieval and medical domains as the main application areas. Henrik and Lars have also set a good example by establishing a spin-off company in the data-mining field.

### **Adaptive systems and adaptive interfaces**

Very little work was spent in the machine learning group on the other obvious application of machine learning: adaptive systems or in particular adaptive interfaces. However, two of my other graduate students contributed to this thematic area: Annika Waern and Kristina Höök. Both started their work in the AI camp, but

gradually moved towards a more articulated HMI profile. Annika's thesis (Waern 96) was still clearly an AI thesis but Kristina had already crossed the border (Höök 96). The core of Kristina's work was based on work on a joint NUTEK-funded project within a program called "Cognitive engineering", the existence of which was clearly dependent on the development in the cognitive science arena described above. Annika's and Kristina's thesis works are also good examples of a phenomena that was important in the first half of the 90ies, the very good PhD study cooperation that was established between SICS and DSV, resulting in many PhD thesis for graduate students employed by SICS. This tradition is still kept up. Annika and Kristina have both individually pursued distinguished careers after their dissertations. Annika is now one of the key researchers within the European computer game research arena, a field recently of high relevance to DSV because of our undergraduate study initiatives. Kristina is appointed on a new DSV/ SU chair in Human Computer Interaction. I had the pleasure of advising Martin Svensson upto his licentiate and to co-advise him together with Kristina up to his PhD, focussed on social navigation.

### **Language technology**

The third thematic area is the introduction of language technology in our subject. The PhD theses of Emanuel Rayner (Rayner 93), Hercules Dalianis (Dalianis 96), Christer Samuelsson (Samuelsson 94) and Björn Gambäck (Gambäck 97) are examples of that. Jussi Karlgren's and Ivan Bretan's licentiate theses also reflect this development. At the time funding for language technology research was good. A research group was formed at SICS, and IBM Nordic laboratories also established a strong group. An interesting aspect of this is the relation to neighbouring disciplines. I was always careful to ask my colleagues in linguistics how they viewed the topics of the theses put forward at DSV at this time. Fortunately they applauded the work, but did not consider it linguistics in the strict sense that they defined their discipline.

We have never contributed to the speech area which has since long been handled by our colleagues at the Speech group at KTH. However, over time we have both moved into the area of multi-modal interfaces, where the borderlines are not so clear anymore. However, our collaboration with the speech group: Rolf Karlsson, Björn Granström and others has always been good. Many of my graduate students in this field have made exceptionally good careers. Emanuel Rayner is an internationally well-known and still active researcher. Christer Samuelsson, Björn Gambäck and Jussi Karlgren have all been judged competent as professors. Jussi and Björn are still driving the language technology research at SICS. Hercules Dalianis left us for a post doc, but is now back at DSV as associate professor continuing his research in the border land between information retrieval and language technology.

### **IT and learning**

The last thematic area that I want to mention at this point relates to the project that made me come and work at DSV in the first place. The Princess project as described above investigated how information technology can support learning and education. For some time my engagements were elsewhere, but I had not forgotten this area, and in the 90ies a number of opportunities emerged which made it possible to take it up again at least with a bias towards subject-specific didactics. For me personally a two-year engagement in the European Science Foundation Program on Learning in Humans and Machines meant a lot. Another important factor was the recruitment of Robert Ramberg to DSV. Robert had already in his thesis treated learning technology in an industrial setting from the perspective of cognitive psychology, and he was eager to pursue research in this direction even at DSV. NUTEK funding made it possible to pursue studies on how to learn novices to express themselves in complex languages for modelling and specification. This was one of the domains used by Klas Karlgren as basis for his thesis on language use in learning support systems. Another kind of studies, carried out in parallel, concerned the support for physics learning for college level students. Finally, in a project funded by the Wallenberg Foundation, the role of visualization for improving mathematics education was studied. Of great importance has also been the totally six years of work in the two consecutive EU projects: Playground and Weblabs. The target groups here are lower levels of the school system (age group 8-12) and the goal is to promote learning of problem solving, mathematics and science. The work in the earlier project, Playground, has formed the basis for Jacob Tholander's thesis work which is well positioned within the field of CSCL. The work in the latter will be the basis for Ylva Ferneus' thesis work. A final parallel work in this area is Eva Fåhreus' (Jacob Palmes graduate student) work on the uses of CMC system to promote Learning.

### **K2LAB**

Right in the middle of all the work described above, in 1994, I founded the Laboratory for Knowledge and Communication Engineering (K2LAB), which has existed in different shapes since then and now constitutes one of the organizational subunits within the present DSV. In average K2LAB has had a senior faculty of ten people and twenty graduate students.

K2LAB was when founded the aggregation of my own research activities as described above and Jacob Palmes' group focussed on Computer Mediated Communication, the activities of Magnus Boman, another of Janis Bubenko's graduate students with a focus on applied logic, multi-agent systems and decision support systems as well as Douglas Busch, a logician from Linköping who joined us in this period. K2LAB had the ambition

to pursue work that combined the communication and the knowledge aspect as envisioned above and to include both formal, engineering and empirical elements. During its lifetime K2LAB has also had a good collaboration with the HUMLE laboratory at SICS, established at about the same time and with a similar profile, as well as with IPlab at NADA/KTH.

The subject shift has continued in the last ten years, but the format of this paper does not allow for the coverage of these further events.

It is always difficult to choose the right labels for projects and organizational units. Often you regret your choices as soon as they have been frozen. However, I must admit that I am still very happy with the naming of this laboratory. We could have chosen a label combining any of the following: Artificial Intelligence, Human Computer Interaction, Computer Supported Collaborative Work, Computer Mediated Communication, Cognitive Science, Cognitive engineering, Knowledge engineering, Knowledge systems, Interactive systems etc, but it seems in retrospect that the terms Knowledge and Communication in combination have a better coverage and longer lifetime than any of the others.

## References

- Aronsson M (1993). GCLA. The Design, Use, and Implementation of a program Development Systems – Dissertation SU.
- Asker L (1994). Partial explanations as a basis for learning – Dissertation SU.
- Boström H (1993). Explanation-Based Transformation of Logic programs – Dissertation SU.
- Dalianis H (1996). Concise Natural Language Generation From Formal Specifications – Dissertation KTH.
- Danielsson M (1997). Computational Decision Analysis – Dissertation KTH.
- Ekenberg L (1994). Decision Support in Numerically Imprecise Domains – Dissertation SU.
- Eriksson L H (1993). Finitary Partial Inductive Definitions and General Logic – Dissertation KTH.
- Eriksson Granskog A (2003). General Metarules for Interactive Modular Construction of Natural Deduction Proofs – Dissertation SU.
- Espinoza F (2003). Individual Service Provisioning – Dissertation KTH.
- Gambäck B (1997). Processing Swedish Sentences: A Unification-Based Grammar and Some Applications – Dissertation KTH.
- Holm P (1996). On the Design and Usage of Information Technology and the Structuring of Communication and Work – Dissertation SU.
- Höök K (1996). A Glass Box Approach to Adaptive Hypermedia – Dissertation SU.
- Idestam-Almqvist P (1993). Generalization of Clauses – Dissertation SU.

- Jansson E (2005). Working Together when Being Apart – An Analysis of Distributed Collaborative Work through ICT from an Organizational and Psychosocial Perspective – Dissertation KTH.
- Johansson A L (1995). Logic Program Synthesis Using Schema Instantiation in an Interactive Environment – Dissertation SU.
- Kilander F (1994). Incremental conceptual clustering in an on-line application – Dissertation SU.
- Kjellin H (1994). A method for acquiring and refining knowledge in weak theory domains – Dissertation SU.
- Malmberg Å (2002). Notations Supporting Knowledge Acquisition from Multiple Sources – Dissertation SU.
- Olsson J (1991). An Architecture for Diagnostic Reasoning Based on Causal Models – Dissertation KTH.
- Orsvärn K (1996). Knowledge Modelling with Libraries of Task Decomposition – Dissertation KTH.
- Rayner M (1993). Abductive Equivalential Translation and its application to Natural Language Database Interfacing – Dissertation KTH
- Samuelsson C (1994). Fast Natural-Language Parsing Using Explanation-Based Learning – Dissertation KTH.
- Von Scheele F (2001). Controlling Time and Communication in Service Economy – Dissertation KTH.
- Stensmo M (1995). Adaptive Automated Diagnosis – Dissertation KTH.
- Tholander J (2003). Constructing to Learn, Learning to Construct – Studies on Computational Tools for Learning – Dissertation KTH.
- Waern A (1996). Recognizing Human Plans: issues for plan recognition in human-computer-interaction – Dissertation KTH.
- Wijkman P (1997). Contribution to Evolutionary Computation – Dissertation SU.
- Zemke S (2003). Data Mining for Prediction – Financial Series Case – Dissertation KTH.

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# DSV IN THE INTERNATIONAL COMMUNITY

## ABSTRACT

A university department needs to be an active player in the international research and education community. There are many different ways to participate internationally, including workshops and conferences, international projects and networks, as well as joint education programs. In this chapter, I will reflect about DSV's participation in the international community from the perspective of the information systems area and also include some of my own personal experiences.



**Paul Johannesson**

Paul Johannesson holds a position as professor at the Royal Institute of Technology, where he works in the area of information systems. Johannesson has published work on federated information systems, translation between data models, languages for conceptual modelling, schema integration, the use of linguistic instruments in information systems, process integration, e-commerce systems design, and analysis patterns in systems design.

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In this chapter, I will reflect about some events around DSV's participation in the international community from the perspective of the information systems area, including research as well as education.

## Research and conferences

Starting with research, the traditional and most basic form for international contacts is participation and publishing in conferences, workshops, and journals. People from SYSLAB (the Information Systems Laboratory at DSV) have since a long time been active participants in international information systems events with more than twenty publications and presentations yearly. DSV has also (together with SISU, the Swedish Institute for Systems Development) helped to start one of the most successful conference series in the information systems area – the CAiSE, Conference on Advanced information Systems Engineering, series. Conferences and workshops provide opportunities for researchers to present and spread their ideas and results to a wider audience. They also provide a forum for discussing research results and visions, thereby promoting more and deeper contacts among researchers.

However, there is not only a scientific dimension of meeting at international events but also a social dimension, which gives a basis for closer cooperation in different forms. To promote this dimension, most conferences include a social event, ranging from receptions and dinners to boat tours and organ playing. This event is often a high point of a conference. As one old professor with many conferences behind him once expressed it, “after a few years, the only thing you remember from a conference is the social event”. To this I would add that after a few years more, you may

***“DSV has also (together with SISU, the Swedish Institute for Systems Development) helped to start one of the most successful conference series in the information systems area – the CAiSE series.”***

***“As one old professor with many conferences behind him once expressed it, ‘after a few years, the only thing you remember from a conference is the social event’.”***

**“Social event”  
at NLDB’02**

Birger Andersson,  
Paul Johannesson  
and Berhard Thalheim  
at Stockholm City Hall.



not remember anything, except for some very special events. The most special events I have seen are those of the CAiSE conference. For example, two respectable professors, Janis Bubenko and Arne Sölvberg, singing Tom Lehrer’s “I hold your hand in mine” and “Poisoning pigeons in the park”. This is only topped by the same solid gentlemen singing and dancing the old Scandinavian ballade “The man who went out for beer” together with a delicate French professor, Colette Rolland. There is no risk of forgetting events like these ones.

**Long-term projects as international cooperation**

Conferences are fine places for meeting, presenting, discussing, and establishing contacts. But they do not by themselves allow for more sustained and deeper cooperation between research groups in different countries. In order to enable this, more long-term projects are required. For SYSLAB (sometimes in cooperation with SISU), such projects have often been EU-funded projects. These projects started already in the mid and late 80’s, when Janis Bubenko initiated DSV’s participation in a number of European projects, thereby in fact pioneering Swedish involvement in the ESPRIT programs. The projects have ranged over many areas, from federated systems and deductive databases over temporal modelling and requirements engineering to knowledge management and interoperability. It is possible to see some development over the years of the types of European projects that have taken place at SYSLAB. In the late 80’s and beginning 90’s, the projects often had more of a basic research flavour. One example was NATURE (Novel Approaches to Theories Underlying Requirements Engineering), whose very name indicates a basic theoretical approach to a very applied topic. Later on, the focus shifted more to applications in specific domains, such as data warehousing for banking, knowledge management in the energy sector, or interoperability of health care systems. Recently, there has also been a shift towards more of networking between large numbers of loosely connected groups rather than focused efforts by a few participants. The projects SYSLAB has participated in have had a heavy impact on its research direction, also by providing a basis for

many PhD theses.

In addition to knowledge exchange, inspiration and vision, the projects have also given much understanding of other ways of working and getting things done that are common in Sweden. It goes without saying that all projects always have been a smooth ride. I still remember how one project participant, after a heated discussion on project management, shook his head and commented “This is how the third world war will start”. This was followed by renegotiations, where I learned to understand and appreciate phrases like “the termination process of the project has been cancelled”. All this seemed at the moment quite ominous, but in the end everything came together and the project delivered according to plan.

### **Cooperation with countries in the developing world**

In addition to European cooperation, there is also a trend towards cooperation with countries in the developing world. Funded by Sida (The Swedish Agency for International Development Cooperation), DSV has pioneered new forms of relationships between Swedish and developing country universities in the area of ICT. A main goal for this work has been to help new universities to develop research as well as higher education. A basic idea has been that a country should not only focus on the lower levels in its education system – the higher levels must also be nourished so that they can support other parts of the system. A major element of the cooperation has addressed PhD education in so called sandwich programs, meaning that students have alternated between countries during their study time; each year first half a year at DSV followed by half a year in their home country. This procedure is intended to give the student good contacts with his or her supervisor and the research group at DSV, while ensuring that the student also retains the connection with his or her home university and department. SYSLAB has been much involved in these programs with students from Sri Lanka, Tanzania and Mozambique working on theses in enterprise modelling, process management, and information systems design. The external conditions for the students taking part in these programs have not always been uncomplicated being uprooted from their original environment and placed in a foreign culture. Success was not easy for all students but finally achieved through a firm determination to reach the goals.

***“A basic idea has been that a country should not only focus on the lower levels in its education system – the higher levels must also be nourished so that they can support other parts of the system.”***

### **International software engineering**

One of the most mind-boggling international activities I have been involved in was a software engineering project, Lyee, supported by a private Japanese company. The overall purpose of the project was to develop a methodology that could increase productivity in software design by an order of magnitude. The basic idea was to

divide software engineering work in such a way that large parts of it could be carried out by unskilled personnel, while only a small part of the work required experienced software developers. The goal itself was highly ambitious and the path to the goal was equally grandiose. The method was to be based on a holistic approach integrating next to all areas of human knowledge from mathematics and programming languages to ontology and theology. This required novel ways of thinking about almost all concepts, leaving no stone unturned, and even going to redefining basic notions like “integer”. This approach differed totally from the typical analytical approach prevalent in most software engineering research. Equally different was the way of working, where the project leader, a prominent samurai, softly but unwaveringly set up the direction of the work, thereby accepting and embracing views that for a Western mind would have looked conflicting or even contradictory.

### **Bringing the world to the campus**

In recent years, not only research at DSV but also basic education has become more and more international. Many students at DSV have for a long time gone abroad for a year’s study, and individual students from other countries have come to DSV. In 1993, education at DSV got a much more international profile through the introduction of two master programs for international students followed by yet another program in 1994. These programs have contributed to “bringing the world to the campus”. More than 150 foreign students now start their master studies at DSV each year. They bring fresh knowledge, different perspectives and new ways of working to the department, benefiting their Swedish co-students as well as the staff. Many of the new students are bright and well motivated and we hope to be able to recruit some of them to PhD studies.

***“More than 150 foreign students now start their master studies at DSV each year. They bring fresh knowledge, different perspectives and new ways of working to the department...”***

### **DSV’s role in the future**

While international cooperation has been a big part of DSV’s past, it will become even more important in the future with increasing requirements on profiling and integration of research and education in Europe. New developments in ICT, leading to ubiquitous and disappearing computing, will also facilitate cooperation among geographically distributed groups – an area where DSV should be able to be at the front of the line.

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# FROM BOXES AND ARROWS TO CONVERSATION AND NEGOTIATION

## Or how Research should be Amusing, Awful, and Artificial

### ABSTRACT

The story of how a graduate student went from formalism to data, a brief tale of how engineering without tradition can lead thought in the right direction, and a mild caution of how intellectual skepticism is worth little without a corresponding dose of intellectual enthusiasm.



When I first came to DSV in the Fall of 1987 I was looking for diversion. I was busy finishing up my Bachelor's degree in Computational Linguistics and felt I needed classes to broaden my perspective.

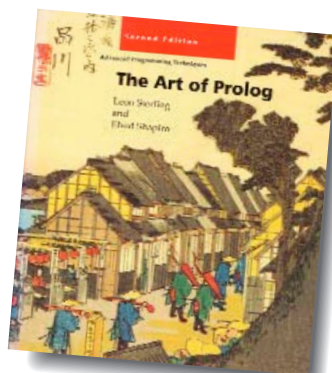
This was at a time when DSV was within easy reach for curious students from other departments – located on campus at the university instead of in an industrial park, so I could simply walk over from my department to the other hallway and look for interesting things to think about. DSV had plenty to offer, and I signed up for a class called “Artificial intelligence programming” which, as it turned out, taught the basics of structured programming in high-level languages such as Prolog, Lisp, and Smalltalk. It was taught by Carl Gustav Jansson and several seasoned graduate students – most of whom today indeed have graduated and many of whom still can be found at the department or in its close vicinity.

Even today the sense of awe and possibility the classes instilled in me is easy to recollect. The course books are still some of my favourite volumes: “The Art of Prolog” and “The Structure of Computer Programs”. One with Asian artwork, the other with crudely drawn wizards on the cover. The contents were no less inspiring – they expressed the sense that everything was possible given the appropriate computational model. Wizards! Exotism! Fun!

This is where the subtitle above comes in: an apocryphal anecdote tells us what the then King of England (it is unclear which one – the story is attributed to various monarchs) said when first confronted with the design of St Pauls cathedral: “Amusing, Awful, and Artificial”. The king intended this as praise, meaning that the building was pleasantly thought-provoking, awe-inspiring,

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One of Jussi Karlgren's favorite course books, “The Art of Prolog”.

and artful. The words have since shifted in meaning (which is why the story is told today) but the combination of the three is what most of us in research strive for in what we do. We would do well if we more often and more explicitly thought along those lines. Linguistics is a methodical area of study.

Linguistics is mostly about applying formal models to arguably that most fluid of symptoms of human intellectual activity: verbal communicative behaviour. But linguists expend or used to expend enormous effort on debating the absolute merits of various different formalizations rather than working on applications of the same. At the time I am writing about, linguists in general, and leading researchers here at the department in Stockholm in particular, had already started turning to more data-oriented and less theory-oriented methodologies: corpus linguistics, focusing on the methodology of collecting data; typology, focusing on the differences and relations between languages rather than the specifics. But this reform had not yet percolated down into the undergraduate curriculum, nor made its way into basic textbooks. I had spent a long time trying to make sense of arguments of formalism rather than understanding people, how they speak, and how they think.

The field of artificial intelligence in the eighties was neither straight-laced nor crabby. Thinking about it, I can still feel that rush of boundless potential I experienced in taking those first classes. I still believe in those first realizations. Yes, we can model human cognition! Since I had already burnt my fingers on the fruitless representational debates of linguistics at the time I knew from the start that finding the perfect model counts for little in the end, whereas representing the salient aspects of behaviour does.

So far, this, of course, has been a common story, told and told again: a young and enthusiastic graduate student finds that many of the theories of the preceding generation of researchers is overloaded with ideology and not sensitive enough to the reality they model. That realization, in fact, drives much of research. The risk every disillusioned researcher runs in this situation is to tumble into unproductive agnosticism: collect data, gripe about dysfunctional models, and do nothing. In the words of a traditional linguist: “Viel Data und wenig Theorie”. Skepticism rampant leads nowhere!

***“In the words of a traditional linguist: ‘Viel Data und wenig Theorie’.***

### **From DSV to SISU**

I continued studying at DSV taking classes such as “Knowledge representation and reasoning”. After gaining my degree I signed up as a graduate student at the department in Carl Gustaf Jansson’s research lab (which was more difficult than it sounds – Anne Marie Philipson spent a fair amount of effort to help me dodge the bureaucratic obstacles). I almost immediately found employment at SISU, a research institute closely associated with DSV.

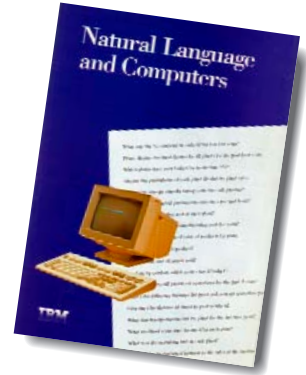
SISU busied itself mainly with applications of conceptual

modelling, building models of human knowledge using a generalized entity –relationship framework. The approach taken at SISU was to build models that could be put to use. Their exact form and principles were of less consequence than their quality – and this was best assured through judicious editing and non-trivial intellectual investment on the part of the knowledge engineer. The project I worked in was a project at IBM, to build a written English-language dialogue interface for a relational database. To make it work, it needed a fairly complete model of the domain it was to be employed in. The amount of human knowledge engineering put into constructing conceptual models at SISU, while quite rich, practical, and useful, was neither Artificial, Amusing, nor Awful for those of us who, like me, were more interested in modeling conceptual behaviour than in representation. I was looking for mechanisms to model automatic acquisition and maintenance of conceptual structures. Many of the graduate students at DSV seemed to work with exciting machine learning experiments – much more Artificial, Amusing, and Awful as far as I could tell.

### How find The Optimal Representation?

So I gave up the job at SISU, better to study the behaviour of human communication, and returned to DSV. Back at the department – still located in its less than stylish but intellectually stimulating environment on campus – I spent hours on end in the cafeteria, in Jacob Palme's classes and seminars on computer-mediated human communication, and on the Usenet discussing Chinese rooms (Searle, 1980; Harnad, 1989), human communicative abilities and human cognition. Is adequate communicative behaviour a sufficient condition to postulate cognitive realism? If something passes the Turing test ► – is that something sentient? And is it not sentient if it fails the test? Computer science is not equipped to answer those questions without reaching out to other areas of study. Fishing about, I found parallel distributed programming and connexionism, which seemed to be the answer to many of my doubts (Rumelhart and McClelland, 1986). Here I found a representation intended to model behaviour rather than formal characteristics! I went to a Summer school to further study neural networks and connectionist representations where details of the representation were carefully and anxiously scrutinized by leading proponents of the field with regard to their orthodoxy of representation. That summer school cured me of that remedy, and in consequence of all remedies. This is one of the major lessons I learnt in my early graduate years: I ceased to search for The Optimal Representation and have since then used numerous different representations and conceptualizations of data in the projects I have worked on.

My main project in the late eighties concerned recommender systems (Karlgrén, 1990). I built prototypes to use algebraic



A group of “natural language” researchers, among them Jussi Karlgrén, worked at the IBM laboratory on the island of Lidingö outside Stockholm. The information pamphlet describing the project is from 1988.

### ► The Turing test

was introduced by Alan M. Turing (1912-1954) in his 1950 article “Computing Machinery and Intelligence” (Mind, Vol. 59, No. 236, pp. 433-460)

The Turing Test is meant to determine if a computer program has intelligence.

analysis to extract user preferences from observations on user information access behaviour: the objective was to build a system which would recommend users a document based on both their individual reading behaviour and on the reading behaviour of other users like them. The behaviour I wanted to model is that of a competent librarian: “If you like that book, you might like this one.” As it turned out, data to get the system in the air were difficult to come by. Even today, with the WWW in general use, bootstrapping is a major task for the productive deployment of recommender systems; then, obtaining data, any data, was a real challenge. And in fact, data collection has been a major bottleneck for any fruitful representation and modeling of intellectual behaviour: it is difficult to obtain realistic amounts of data to prove or disprove the models in question. In the end, a few years later, I ended up using .newsrsrc files extracted from my colleagues home directories (Karlgrén, 1994 a) which rendered me a severe dressing down by reviewers who felt I had been disrespectful of my colleagues' integrity. This project used simple raw data, manipulated them minimally, and extracted knowledge from them in the simplest manner conceivable. Today, numerous commercial implementations operate using these and similar algorithms. An interesting facet of intelligent behaviour can be modeled with simple tools – if the data are there.

### **Research at SICS**

My experiences with conceptual modeling made me think about how to transmit the fairly stable representations to the more flexible counterpart in conversation – how to teach the user the representation the system purported to have learnt from users. I went back to the project I had worked on with SISU (which in meanwhile had completed its system development phase without my help and were shipping systems to delighted users) and studied how users mirrored the linguistic usage of systems. Under Carl Gustaf Jansson's supervision, this gave me my licentiate degree and a platform for several years of continued research at SICS, another research institute in the department's vicinity, where I still work (Karlgrén, 1992). I continued to study how a system might be built to express itself through superficially spurious and redundant conversational moves and thereby enrich the interaction (Karlgrén, 1994 b). The idea was to use a stable, fixed, and unchangeable conceptual model as a base, and to build an interaction module which traversed it in cases where user input was ambiguous or inexact, mumbling about related content: “Salaries for consultants? Consultants have costs. Employees have salaries.” Here, even a simple symbolic interaction module with a static representation could produce something which gave a much more flexible interaction model. Again, an interesting facet of intelligent communicative behaviour can be modeled with simple tools – if the knowledge of counterpart adaptivity is there.

### The trap of doubting everything and building nothing

So these were the more important lessons I have learned during my time at DSV. Most of the pieces of the puzzle were there all along. It has taken me a while to compose a picture out of them. Some things I know now: First, and this is a personal lesson I have chosen to learn, knowledge, whether in human or machine, is to be made and created on the fly. Second, no representation is better than its use. It took a number of false starts to learn this. I am not alone in this insight: several other contributions in this volume will bear witness to the same intellectual progression. Third, and this is the most general one, and one I would like to have other young researchers remember: we cannot do sensible things if we do not try for awful, amusing and artificial! While we should be wary of representational conviction, spending time discarding representation after representation is not enough. One should not tumble into the trap of doubting everything and building nothing. There is nothing amusing, awful, nor artificial in critique alone, deconstruction is not a sufficient goal for research, and skepticism needs to be tempered with enthusiasm to lead anywhere.

***“There is nothing amusing, awful, nor artificial in critique alone, deconstruction is not a sufficient goal for research, and skepticism needs to be tempered with enthusiasm to lead anywhere.”***

The road from representational pettiness via the unproductive reaches of viel Data und wenig Theorie to a theory of data, its use and the behaviour of its users is long and no less laborious than the work involved in proving or disproving theories. But it is more productive! And turning back to the theme of this present volume: how did we get here? The group at DSV running research projects on representation and reasoning proceeded seamlessly from one false start to another – typically for computer science, with no preset intellectual compass founded in old schools of thought or solid convictions, luckily the then young researchers never got bogged down into limiting and constraining tradition. The short and unfettered intellectual direction coupled with the enthusiasm for experimental engineering that is computer science is to thank for much!

### References

- Harnad, Stevan. 1989. Minds, Machines and Searle. Journal of Theoretical and Experimental Artificial Intelligence 1: 5-25.
- Karlgren, Jussi. 1990. An Algebra for Recommendations: Using Reader Data as a Basis for Measuring Document Proximity. SYSLAB Technical Report 179. Stockholm University, Stockholm, Sweden.
- Karlgren, Jussi. 1992. The Interaction of Discourse Modality and User Expectations in Human-Computer Dialog. Licentiate thesis, department of Computer and Systems Sciences, Stockholm University
- Karlgren, Jussi. 1994 b. Mumbling – User-driven Cooperative Interaction. SICS Technical Report T94:01. Swedish Institute of Computer Science, Stockholm, Sweden.

Karlgren, Jussi. 1994 a. Newsgroup Clustering Based On User Behavior – A Recommendation Algebra. SICS Technical Report T94:04. SICS, Stockholm, Sweden.

Rumelhart, David E.; McClelland, James L. Parallel Distributed Processing: Explorations in the Microstructure of Cognition: Psychological and Biological Models. Cambridge, Massachusetts: MIT Press. 1986.

Searle, John. 1980a. Minds, Brains, and Programs. Behavioral and Brain Sciences 3: 417-424.

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# ON METHODS IN THE EARLY DAYS OF A NEW DISCIPLINE

## ABSTRACT

No one has had a greater impact on information systems research and practice in Scandinavia than professor Börje Langefors. In his inaugural address as professor, Langefors presented four method areas in information systems development: Object system analysis and design, Information analysis, Data system architecture, and construction, as well as Realization, implementation, and operation. In the ISAC (Information Systems work and Analysis of Changes) group we performed research toward a new approach to information systems development. Our work started with the method area Information Analysis, and gradually grew to include further areas. This growth was largely influenced by Langefors' method areas as well as by practical application in different business firms and other organizations. This article gives a popular description of how parts of this growth took place. The article ends with some reflections on experiences and findings from the early days of the new discipline seen from today's perspective

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## Introduction: The Person behind – Börje Langefors

Reflecting about the early days of the department of Information Processing, especially Administrative Data Processing, you have to start with the man behind it all, Börje Langefors. No one has had a greater impact on information systems research and practice in Scandinavia than Börje Langefors. Much of his work has been devoted to developing a general information systems theory defining the discipline independent of a changing technology.



Börje Langefors

His seminal book, “Theoretical Analysis of Information Systems”, known by many students as THAIS, provided the theoretical foundation of the discipline. His influence has not been limited to Scandinavia. He has been very active internationally, including being an organizer and the first chair of Technical Committee 8 (Information Systems) of the International Federation for Information Processing.

Many of the existing information system theories have their roots in research that Börje initiated in the sixties. He understood the important role that theories and methods play in building information systems to meet the needs of business activities and users. He believed that information technology systems involve organizational, human, and technical phenomena. He had the vision that information systems must be built on a deep understanding of the special character of each of these areas and their interactions. Börje introduced the concept of “Information Systems” at the third International Conference on Information Processing and Computer

## Mats Lundeberg

Mats Lundeberg is professor at the Stockholm School of Economics and head of the Centre for Information Management at the Economic Research Institute (EFI) of the School. He is also head of the Institute for Business Process Development, a research institute affiliated to the School. He has published several books, including *Information Systems Development – A Systematic Approach* (1981) and *Handling Change Processes* (1993).

***“Börje pioneered the infological approach, building on his distinction between information and data.”***

Science in New York in 1965. As chairman of the scientific program committee, he proposed that one of the five major subject areas of the congress be “Information Systems”. This was a new concept at that time. He used the term “information system” to refer to a system of information. Börje pioneered the infological approach, building on his distinction between information and data. The approach distinguishes between infological and datalogical work areas. The infological problem is how to define the information to be provided by the system in order to satisfy user needs. The datalogical problem is how to organize the set of data and the hardware in order to implement the information system. In his inaugural address as professor, Börje presented four method areas in information systems development:

- Object system analysis and design
- Information analysis
- Data system architecture, and construction
- Realization, implementation, and operation

The first two areas are infological and the last two are datalogical. The object system is the utilizing system (usually some part of a business firm) to be served and supported by an information system.

Given the scope of this article, it is an impossible task to do Börje justice and elaborate on all his achievements. Instead, I will focus on giving some illustrations of how the four method areas above played a fundamental role in the early work of research group ISAC. I will also give some reflections on how you can view this development from today's perspective.

In the middle of 1966 I met Börje for the first time. I met him in connection with my employment interview. He was then acting professor for the department of Administrative Information Processing. The interview was rather brief. As often was the case with Börje, much of our talk was about some of the recent ideas that Börje had on his mind.

When I started working at the department in the fall term of 1966, we were five persons engaged in the initial teaching of the new academic curriculum: Börje Langefors as professor, Janis Bubenko as senior lecturer and Rune Engman, Olle Källhammar and Mats Lundeberg and Tomas Ohlin as teaching assistants. It was a very interesting experience to participate in the establishment of new academic courses in an entirely new subject area. Under Börje's and Janis' guidance, I read the course books about a week before the students. From a pedagogical point of view, this was certainly not a preferred situation. From my point of view it was a very exciting learning and teaching experience in a dynamic environment.

After the initial teaching intensive years of the department, the focus turned more and more to research. Two of the research groups that started their work in 1969 were

- CADIS (Computer Aided Design of Information Systems)
- ISAC (Information Systems work and Analysis of Changes)

The CADIS research group was led by Janis Bubenko and the ISAC research group by Mats Lundeberg. Together these two groups covered Langefors' method areas above. In the ISAC group we performed research toward a new approach to information systems development. Our work started with the method area Information Analysis, and gradually grew to include further areas. This growth was largely influenced by Langefors' method areas as well as by practical application in different business firms and other organizations.

In this article, I will give a popular description of how parts of this growth took place. I will also give some reflections on our experiences and findings from the early days of the new discipline seen from today's perspective.



Four of the members of the ISAC group: Mats Lundeberg, Göran Goldkuhl, Anders G. Nilsson and Hans-Erik Nissen.

## A STORY ABOUT INCLUDING FURTHER METHOD AREAS

The story about the growth to include further method areas starts with some background experience that I had before joining the department of Administrative Information Processing.

### Information Systems Design – Information Systems

My first job in the middle of the sixties was about designing, building, and implementing a simple information system. I produced drawings of an information system (Figure ①), which I then built in order to be operated and used on the existing computer. The information system was implemented and worked OK. However, I was not sure of whether the information system I built met the information needs of the users or not.

At this point in time, I started to work at the department of Administrative Information Processing.

### Information Analysis-Information

I felt I had to do something about meeting the information needs of the users. I therefore involved myself in the area "Information Analysis" under the guidance of Börje Langefors. The purpose of information analysis was to find out about the larger context of information systems – in this case about the information needs of the users of the information systems (Figure ②). As part of the ISAC work, we developed and published a methodology for information analysis, which was applied and used in numerous cases in various Scandinavian businesses. The methodology was described in the book "Systemering-Informationsanalys" written by Erling S Andersen and Mats Lundeberg.

Information  
Systems  
Design

Information  
Systems

- ① Information Systems Design produces descriptions of information systems.

Information  
Analysis

Information

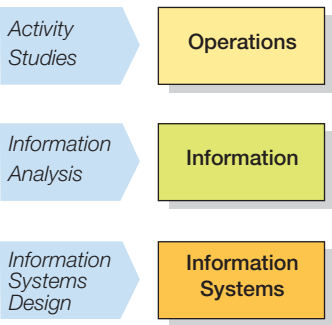
Information  
Systems  
Design

Information  
Systems

- ② Information systems fulfill information needs.

People were enthusiastic about information analysis. The espoused purpose of information analysis was to arrive at good specifications for building information systems. However, the astonishing thing was that all these eager people were not especially interested in good specifications; they were excited about something else. They said that this was the first time they were able to see their own work in a larger context, and that this meant a lot for their understanding of their activities in the business and how these activities were related to other activities. In short, they wanted to know more about the larger context of the information – in this case about the activities of the business operations.

**Activity Studies — Business Operations**



③ Information supports business operations.

Again, we – the members of research group ISAC – felt we had to do something about what we had learned. We wanted to meet the need to show the relationships between information and business operations. We split what we originally called information analysis in two areas: “Activity Studies” and “Information Analysis”. The objective of activity studies was to describe the activities of the business operations in order to find out where information was needed, before the detailed information needs were analyzed (Figure ③). Hans-Erik Nissen and Erling S Andersen described this method area in their book “Systemering – Verksamhetsbeskrivning”.

Equipped with a methodology for these two areas, we carried out eight larger application projects together with major businesses in the Stockholm area. Two persons from the research group participated in each application together with persons from the firm. On average, the applications took about a year and a half in calendar time. The results from these eight projects were used only in about half of the cases. This was very frustrating. Here we were, having spent a year and a half of our lives developing information systems of good quality – and they weren't being used!

Obviously, we had to find out why. Our analysis showed that we had taken parts of the larger context for granted without challenging it. For instance, we had presupposed that information systems were to be developed, without inquiring what the larger context was, that is what the need for changes was. At this point in time, we extended Börje Langefors’ method areas above with an additional method area.

**Change Studies — Business Results**

Our strategy for doing something about taking parts of the larger context for granted was to add yet another area, which we called “Change Studies”. The purpose of change studies was to check what the need for changes was in a larger context, before deciding about developing information systems or doing something else

(Figure ④). We developed, tested, and published a methodology – the “ISAC Approach to Information Systems Development” – along these lines. The ISAC Approach was described in the book “Information Systems Development-A Systematic Approach” written by Mats Lundeberg, Göran Goldkuhl and Anders G Nilsson.

Including change studies worked fine in many cases. We were able to avoid taking things for granted and to discuss several alternatives before moving on. Numerous change studies have been carried out according to the ISAC methodology. However, we found some cases that surprised us. These were cases where the change studies were carried out according to the book and where the contents seemed thorough and reliable. Yet, when it was time to implement the study, nobody was standing behind. Nobody wanted the results of the study to be implemented.

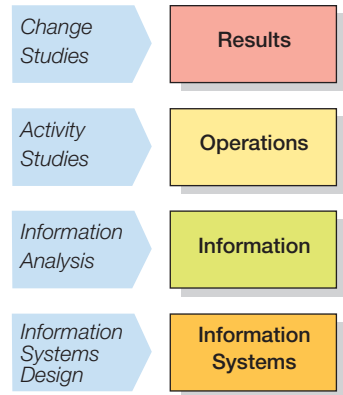
### Persons behind as a Larger Context

After the work in the ISAC group, the continued search for the larger context has led to the incorporation of work areas in order to find the persons behind the business operations. This has for instance been described in the book “Handling Change Processes-A Systems Approach” written by Mats Lundeberg. Business operations are influenced by persons, their personalities, their goals, and their behavior (Figure ⑤).

The logic of Figure 5 goes like this. There are a number of persons (actors, stakeholders or interest group members) with individual personalities and goals. These persons behave in certain ways in order to demonstrate that they stand behind the achievement of certain results. In order to achieve such results, business operations are carried out. These business operations need information. The information is provided by information systems.

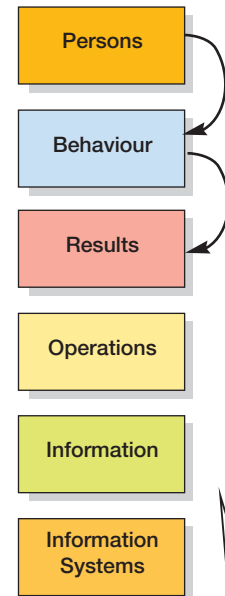
Figure 5 contains three main types of descriptions – descriptions of operations (business goals/results and business operations), persons (person goals and behavior), and information (information needs and information systems). These main types are connected to an important message from our experiences: Work with operations, information, and persons as a whole.

Figure 5 describes six typical levels in business, which can be seen as representing “A Multilevel Approach”. The leading idea behind the multilevel approach is to distinguish between different levels in business and to look for different contexts on different levels. In fact, the story behind I just told you above can be seen as a constant search for bottle-necks or contexts on higher levels.



④ Business operations are needed to achieve business results.

⑤ Business operations are influenced by persons, their goals, and their behavior.



**“Work with operations, information, and persons as a whole.”**

## **REFLECTIONS ON THE STORY**

Many of our experiences and findings from the early days of the new discipline are still relevant today. Below follow some characteristics of the search described above seen from today's perspective.

### **Reflections on Information Systems Design — Information Systems**

There was nothing inherently wrong with the first information system I built. The question was just whether it complied with the context. Of this I knew very little at the time.

Although this part of the story now dates forty years back, it is still relevant in today's business firms. Quotes such as: "Many of the people at our company do a fantastic job. It is just that the pieces do not always fit together in the larger context" can be heard in many businesses. It is such a waste not being able to use all the good work people are doing.

The solution here was to calibrate to the larger context. Larger context according to whom and to what criteria? In the story, I thought that finding the information needs behind the information system would solve my problems.

### **Reflections on Information Analysis — Information**

In analyzing the effects of information analysis, we were surprised to find out that all those different actors and stakeholders had such different perspectives. As an information system designer, I was interested in good specifications. The users of the information systems wanted to know more about the larger context of the information – in this case about the activities of the business operations.

Again, this is a general reflection that still holds today. Different persons have different perspectives. What is self-evident for me is not self-evident for you. Different actors focus on different of the typical levels in business shown in Figure 5.

The solution was once again to calibrate to the larger context. We now thought that describing the activities of the business operations in order to find out where information was needed, before the detailed information needs were analyzed, would remedy the situation.

### **Reflections on Activity Studies — Business Operations**

When working with activity studies, we presupposed that information systems were to be developed without finding out what the situation really was about. We took things for granted. We thought we knew what the solution was. It just so happened, the solution coincided with our competence: To develop and build information systems.

This is not an unusual situation. If you ask a marketing specialist about what you should do to take your business forward, (s)he will probably suggest some measures in the marketing area. If you ask somebody from financial control, (s)he will most likely suggest financially oriented measures and so forth. We see what we are trained to see. We suggest measures that we know how to do.

The solution in the story was to try and avoid taking things for granted and to make sure that all relevant alternatives were put on the table.

### **Reflections on Change Studies — Business Results**

Find the persons behind. This lesson from change studies is one of the most important lessons from the story. In processes in business firms, task and relationship are an inseparable whole. Make sure you consider both task and relationship, both subject matter and persons. Again and again, we find cases where nobody stands behind a particular solution, which then falls flat to the ground. It is amazing and frustrating that so much money goes down the drain because persons behind are missing.

***“Find the persons behind. This lesson from change studies is one of the most important lessons from the story... It is amazing and frustrating that so much money goes down the drain because persons behind are missing.”***

### **Reflections on the Story as a Whole: What Is It Really About?**

The story above is a story about the search for bottle-necks or for larger contexts. In a sense, the same interest as in the beginning of the story is still there: How can we take businesses forward by implementing various solutions.

The story can also be seen as a trip from technology (in this case information technology) to persons. The paradox is that in such a technical area as information technology, people turn out to be one of the big bottle-necks. Task and relationship are an inseparable whole.

Thirdly, the story can be seen as a trip upwards in the value chain. Competition has a tendency to move upwards in this chain. If we take examples from information technology, IBM used to be a strong player in computer hardware in the early days during the sixties and seventies. Computer hardware is now much more of a commodity. Microsoft has been and still is a strong player in operating systems and computer software. IBM has just announced that it will manage and carry out specific business processes for other firms. This raises the competition to the next level. Where will the competition be in the future?

### **EPILOGUE: ON BÖRJE LANGEFORS' INTERNATIONAL RECOGNITION**

In this article I have given some illustrations of how Börje Langefors' four method areas played a fundamental role in the early work of research group ISAC. I have also indicated that many of our experiences and findings from the early days of the new discipline are still relevant today. The idea of this focus was

to give a small glimpse of Börje Langefors' impact on information systems research and practice. As stated before, it is an impossible task to do Börje justice and elaborate on all his achievements within the scope of this article. In a similar manner, it is impossible to elaborate in detail on Börje Langefors' international recognition. However, I would like to recognize the fact that Börje in 1999 was one of the first scholars to receive the Leo Award for Lifetime Exceptional Achievement in Information Systems.

Börje's receiving of the Leo Award can be seen as the closing of a circle. Above, I touched upon the fact that Börje Langefors introduced the concept "Information Systems" in 1965. I also mentioned that he was the first chair of IFIP's Technical Committee 8 on Information Systems, which was established in 1976. In 1994, the Association for Information Systems (AIS) was founded. AIS is a professional organization whose purpose is to serve as the premier global organization for academics specializing in Information Systems. AIS describes the intentions with the LEO Award as follows:

Established in 1999 by the Association for Information Systems and the International Conference on Information Systems, the Leo Award honors outstanding individuals who have contributed to the Information Systems community. The award recognizes seminal contributions to research, theory development, and practice in Information Systems.

Like its namesake, The Lyons Electronic Office, one of the world's first commercial applications of computing, these outstanding scholars/practitioners are pioneers, extending knowledge and insight.

The contributions of the Award winners have been sustained throughout their careers. They have made exceptional global contributions in the field of Information Systems and are regarded as important representatives of their national or regional Information Systems community.

Leo Award winners are role models. They inspire colleagues and students within the Information Systems field. They command the respect of individuals from outside the field because their contributions also have had an impact in fields other than Information Systems. Leo Award winners are recognized for exemplary professional and personal integrity.

To quote from above: Börje Langefors is an exceptional role model. He has inspired colleagues and students within the Information Systems field. He is recognized for his exemplary professional and personal integrity.

It has been a privilege to work together with Börje in the early days of the new discipline.

## References

- Langefors, B. (1966, 4th edition 1973) Theoretical Analysis of Information Systems, Studentlitteratur, Lund, Sweden & Auerbach, Philadelphia, Pennsylvania.
- Lundeberg, M. (1993) Handling Change Processes – A Systems Approach, Studentlitteratur, Lund, Sweden.
- Lundeberg, M. & Andersen, E.S. (1974) Systemering – Informationsanalys, Studentlitteratur, Lund, Sweden.
- Lundeberg, M., Goldkuhl, G. & Nilsson, A.G. (1981) Information Systems Development – A Systematic Approach, Prentice Hall, Englewood Cliffs, New Jersey.
- Nissen, H.-E. & Andersen, E.S: (1978) Systemering – Verksamhetsbeskrivning, Studentlitteratur, Lund, Sweden.



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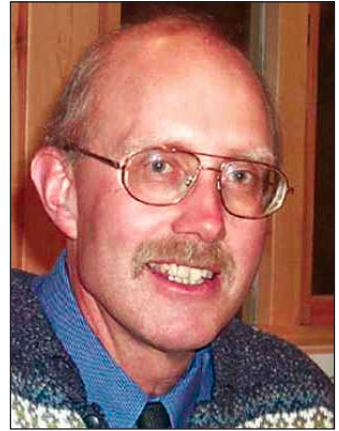
# INFORMATION SYSTEMS DEVELOPMENT

## – SOME HIGHLIGHTS FROM INFOLOGY

### Abstract

DSV has as an academic institution a very good reputation for starting up pioneering research on models and methods for information systems development (ISD) in organisations according to the founder Börje Langefors' infological approach. My own perception of information systems development can in this case be described in different ways. This contribution will try to highlight some milestones in the evaluation of the ISD field which originates from the infological approach. This will be done as some changeovers during the years in a "From ... to ..." notion, in our case for nine important dimensions. In conclusion there is a strong interplay between computers, people and work tasks in organisations – a lesson learned from the history of Infology!

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**Anders G. Nilsson**

PhD, professor (chair) of Information Systems (IS) since 1997 at Karlstad University. Formerly enrolled as an academic at the DSV institution for 15 years (1973-88). Research interests cover areas such as systems development methodologies, enterprise systems (ERP-systems), business modelling and multimedia applications. Author of 15 books of various IS subjects.

### **“Open up the systems and let the people in!”**

This would be the lodestar for building up a new subject of Information Systems in the middle of the 60's in Sweden. Professor Börje Langefors is well recognised for the establishing of Information Systems as an academic discipline – at the first university department of its kind in the world! The approach is well-known as “Infology” (Langefors, 1995). The infological approach is based on the observation that the end users should have real control of the development of information systems in their organisations. This line of systems thinking is indicated by the loadstar above.

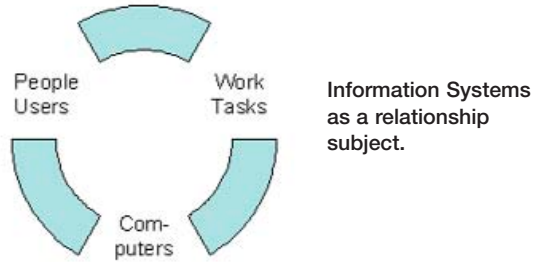
### **“We need systemeering before programming or in other words: Think first – Act then!”**

This would be the lodestar for the Scandinavian school of information systems development that emerged from Langefors infological approach. ‘Systemeering’ was at the time being a newly invented Swedish word for ‘systems engineerin’ – explained as the definition of requirement specifications of the user’s information needs for managing business operations in companies. Systemeering was a solid modelling work (“Think first”) as a platform for a reality based programming (“Act then”) from an end user perspective. A first step to a systematic approach for information systems development was taken!

### **“Developing information systems – people, computers and work tasks in concert!”**

This would be the lodestar for succeeding in the “Art” of information systems development. Information Systems as an academic discipline has from the beginning emphasised its nature as a

“relationship” subject trying to integrate knowledge from computer science (computers and information technology), behavioural science (people and learning), and business administration (work tasks in organisations). The mission is to investigate how people or users develop IT solutions to support and improve work tasks in their social life. There is a strong interplay between people, computers and work tasks. See the figure below.



DSV has as an academic institution a good reputation for starting up pioneering research on models and methods for information systems development (ISD) in organisations. My perception of information systems development can in this case be described in different ways. I will try to highlight some milestones in the evaluation of the ISD field, which originates from the infological approach. This will be done as some changeovers during the years in a “From ... to ...” notion.

### From Efficiency Focus to Usability Focus

From the beginning systems development had a flavour of efficiency focus in organisations. In this early stage the focus was on automating certain business operations – to do things right, faster and cheaper with systems support. The primary use of information systems was to increase the efficiency of different functions or activities in organisations, e.g. by automating jobs that were earlier carried out manually. This way of working could lead to “information islands” more or less isolated from each other. The infological approach was advancing this kind of problem to the “surface”! Business people or end users often think in terms of workflows or core processes for achieving expected results. Therefore integration of information systems always has been a key issue. The infological approach promotes that bridges are being built between “information islands” in organisations.

The academic discipline of Information Systems has broadened up the perspective for systems development. Since the mid 90’s the development work is regarded more as a “design for usability” in the words of Professor Pelle Ehn. The target for a usability focus is to design information systems in a wider context as a tool or artifact for carrying out work practices in organisations.

The art of information systems development is here full of nuances comprising functional, technical, economical, aesthetical, ethical, knowledgeable, psychological as well as physiological considerations. This is a more complex task than only to take care of administrative rationalization in organisations. The information systems should be usable for multiple purposes and also fulfilling conflicting demands from various interest groups.

### **From User Orientation to Stakeholder Orientation**

From the infological approach we have learnt the lesson to proceed from user needs, demands and requirements during the development process. The simple argument is that there are the end users who in their daily work should live with the new information systems. They have the best knowledge of the business operations for creating effective systems solutions. The principle of user orientation goes back to the theory of infology that states the significance of designing and operating information systems from a user point of view in order to achieve desired results in organisations.

Development work in organisations can be seen as a social field of forces between different interest groups or stakeholders. There usually exist communication gaps or misunderstandings when people from various interest groups try to deal with information systems development. Therefore it is important to find constructive ways to bridge the communication gaps between key actors such as general managers, business people and systems experts during the development process. One way to achieve this is to highlight and illuminate the needs and demands from all stakeholders' points of view. A future trend with a stakeholder orientation is a more general principle for change work in organisations and in this sense includes the former ways of user orientation for information systems development.

***“Therefore it is important to find constructive ways to bridge the communication gaps between key actors such as general managers, business people and systems experts during the development process.”***

### **From Data Systems to Enterprise Systems**

The infological approach for ISD work was focused on designing a set of well-specified *data systems* each supporting a certain type of business process in companies. These systems were interacting in a business context and the system interfaces are therefore important to outline and specify. The data systems could be implemented by tailor-made solutions, ready-made software or object oriented architectures. A productivity or cost-reducing motive lies behind the development work.

*Enterprise systems* or ERP-systems are a recent trend since the mid 90's with the aim of offering companies mega-based systems for their business operations. By enterprise systems we refer to large standard application packages that fully cover the provision of information required in a company. An important criterion is that the included parts or data systems are closely integrated with

each other through a central database. A possible strategy for a company is to acquire best-of-breed solutions by selecting the most excellent parts from different vendors of enterprise systems on the market. An integration or coupling motive lies behind the development work with enterprise systems.

**From Information Support to Business Enablers**

The infological approach has traditionally focused on designing systems in order to give information support to various business operations in companies. These systems are regarded as resources and are embedded in the organisations. Starting with the needs of the users, a business process specification is made which provides both content-based and structural requirements on the information systems. An information system is not an end in itself but rather a productive tool to gain expected business effects! See the figure below (left side).

Since the mid 90’s we have tried to devote a lot of efforts for designing information in our systems to create new business opportunities for the organisation, and hence strengthen the competitive edge on the market. The information systems are regarded as business enablers for change. Here the focus is on the potential that a new information system represents for the company. The system becomes an enabler for renewing the business. New technological innovations in multimedia, the Internet and electronic commerce become new value-adding enablers to the business of the company. Instead of a detailed requirements specification we outline a scenario description for analysing the business potentials of information systems. See the figure below (right side).



**From Systems Work to Change Work**

Information systems or nowadays IT-systems have been a natural construct to start from when establishing the practice of systems work. The concept of systems work was preferred according to the infological approach in order to illuminate both systems development and maintenance management. The Information Systems field is traditionally defined in a rather broad sense to also include relevant issues of software maintenance. A significant feature for setting out a genuine practice of systems work has been the innovative research of useful methods for information systems

development (ISD). The profession of ISD has over the years shown to be heavily dependant on practically oriented methods such as the ISAC, YSM, SADT, CS4, EAR, NIAM, JSD, IE, SSM, UML and RUP approaches for systems work.

The ISD practice has gradually evolved to regard systems work in a larger context as a fraction of more comprehensive change work in today's companies. Development of new information systems leads to a major change for affected people and their business operations. Change work implies a purposeful growth and development of organisations and means that we are advancing the business towards some concrete visions or goals. Changes of different kinds should be a starting-point for discussions between different stakeholders in business development. In the Information Systems field we have learnt the significance to start up development work from a change analysis (cf. the ISAC method), which builds a platform for further development of information systems and other types of measures.

### **From Formalised Methods to “Hands-on” Methods**

The use of *formalised methods* builds on an engineering paradigm for information systems development. The methods are precisely defined in coherent work steps and well-formulated description techniques for documentation. The development work is formalised in a planned or predictive manner. A requirements specification should reflect the user needs in a complete and consistent way. Information systems development is performed with a harmony perspective where stakeholders are regarded to have common goals for the development work. This was the starting-point for working out the ISAC method for information systems development in organisations based on the infological approach (Lundeberg, Goldkuhl & Nilsson, 1981).

The use of so-called “*hands-on*” *methods* builds on a rather pragmatic oriented paradigm for information systems development. The leading idea behind this future trend is to use a combination of existing methods available on the market instead of innovating totally new ones. In this scenario it is useful to apply tool-boxes of methods where you select suitable combinations adapted to specific development situations. These combinations can be worked out in different ways for example using the concepts of method chains (through the development cycle) or method alliances (across the same development phase). “Hands-on” methods are often worked out as checklists, templates and best practice models.

### **From Life Cycle Strategy to Evolutionary Strategy**

Systems work in organisations goes through a life cycle with sequential, parallel and/or iterative phases. A life cycle strategy for systems work is in line with the infological approach.

Börje Langefors presented in his inaugural lecture as professor (1967) an original proposal for partitioning of the system's life cycle. The result was four classical problem areas which have had a great impact on subsequent methods for systems work:

- (1) object system analysis and design,
- (2) information analysis,
- (3) data system architecture and construction, and
- (4) realisation, implementation and operation.

The two first areas treat infological or user-oriented problems, while the two last areas treat datalogical or technical problems. The traditional ISAC method was built on these four classical problem areas within information systems development.

We are nowadays more facing a strategy for *evolutionary development* of information systems. The idea behind an evolutionary strategy is to implement a new information system in minor parts, which are distributed over a certain period of time. Characteristic for this situation is that the information system will be delivered step by step in smaller turns. It is regarded as a safer strategy to have a successive renewal of the business operations than to dramatically change the whole organisation. The borderlines between systems development and maintenance would be more or less erased. In an evolutionary development we rely on the principle that it would be better to have a continuous improvement of the business instead of more risky "big bang" solutions.

***"In an evolutionary development we rely on the principle that it would be better to have a continuous improvement of the business instead of more risky 'big bang' solutions."***

### **From Information Modelling to Virtual modelling**

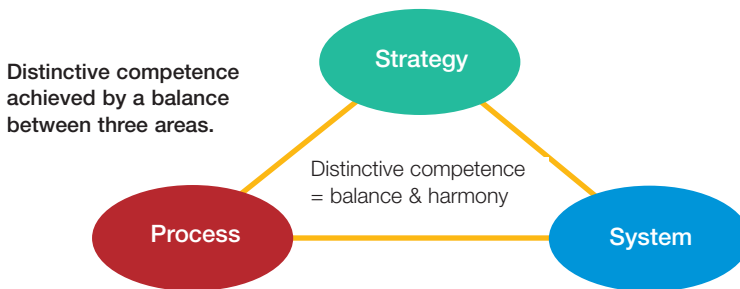
The justification for starting up the new field of Information Systems in the mid 60's was to propose the work with information analysis before "jumping down" to program construction and database design. Information modelling was invented as a useful tool for analysing information flows and elementary messages (e-messages) in organisations, which after that would be realised by so called computer-based systems. Information modelling is still an important kernel or cornerstone in the today's theories of information systems development.

New investments in information systems are today made in a changing world, where the progress of society moves towards horizontal organisations and electronic business. In the future, information systems development will be oriented to model how companies will operate in the on-coming virtual markets. The modelling area of interest will become how different kinds of inter-organisational IT-systems can support electronic commerce applications and web-based business solutions. The future trend is towards more service-based operations in companies, which means that virtual modelling will be a necessary extension to the earlier tools of information modelling. There is a challenge to integrate systems development with service improvement in networked organisations of tomorrow.

### From Technology Competence to Distinctive Competence

In the beginning, systems development was based on a high degree of technology competence from the EDP or IT department in a company. The infological approach stressed the demand for a more comprehensive user influence in development projects. Development of information systems was regarded as an organisational design and that the information needs analysis could be free from technological aspects. In this connection systems development was no longer just a matter for the technology people in a company.

Information systems are more and more becoming strategic investments for a company. It is therefore a vital issue of growing importance on the management agenda. When making organisational changes, we need to work concurrently with the corporate strategy, business processes and information systems of the company. According to the organisation theory, a successful company acquires unique or distinctive competence by creating a good balance between strategy, process and system areas, thereby achieving harmony in the organisation. In change work, we need to combine specialist competence for strategy formation, business process improvement and information systems development. See the figure below.



### Closing Words

In conclusion I would like to give our Information Systems discipline a challenge for the future. From this respect I will refer to a well-known formula for performing success in business by applying it to the area of information systems development (ISD):

$$\text{Degree of success in ISD} = f(\text{Quality} \cdot \text{Acceptance} \cdot \text{Value})$$

The success formula states that to attain a successful result for information systems development in organisations, we must have a sufficient quality in the designed IT solutions and a good acceptance among the users or people to give them a motivation for using the information systems. The designed IT solutions should also create a business value to the ultimate beneficiaries or

customers to the company. A low figure in either quality, acceptance or value will lead to an unsuccessful result – hence the multiplication sign in the success formula. There is a strong interplay between computers, people and work tasks in organisations – a lesson learned from the history of Infology!

### References

Langefors, Börje (1995). Essays on Infology – Summing Up and Planning for the Future, Studentlitteratur, Lund.

Lundeberg, Mats, Goldkuhl, Göran and Nilsson, Anders (1981). Information Systems Development – A Systematic Approach, Prentice-Hall, Englewood Cliffs, New Jersey.

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# COMPUTER SUPPORTED EXAMINATION

## Abstract

Early computerized university examination (late 1960s) is described. Examinations used preprepared punched cards for multiple choice questioning. The system was successfully expanded to broadened examination administration. User experiences were positive.



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## Educational background

The early Stockholm University/Royal Technical University curricula concerning Information Systems were innovative. We teachers were a number of educational newcomers. Surely, we were fairly experienced with own personal university results, and most of us had already at least some teaching experience. But the creation of a new educational curriculum in a field that was quite unripe certainly demanded innovative thinking.

We created courses based on knowledge and intuition. The increasing student demand in the 1960s pushed us to work fast. Some courses were defined as late as at the immediately previous semester. We were aiming at content creativity. We wanted to be part of something new, something that was neither computer science nor applied mathematics or conventional business data processing. Many of us early teachers had natural science as our educational origin, but we shared the desire to create something scientifically broad. We were inspired by our creative new professor, Börje Langefors, who developed new thinking in information systems design.

The desire to avoid the conventional did not prevent us from defining and providing courses in programming languages. In the late 60s, this was natural. In the beginning, the courses in programming were often related quite strongly to computer language grammar. A move towards characteristics of different types of programming models and structures took place successively.

Also, at the time some knowledge about the inside of computers was natural. Secondary storage (hard disk) data organization turned increasingly important. The concept of data bases started to be used more and more often, as sequential access was complemented by random access that was made possible by adequate

## Tomas Ohlin

Tomas Ohlin, fil. lic., prof.  
University education and research, software industry and consulting, with interest in user interfaces and participation.  
Public IT Committees, among them secr. general to first Swedish IT Commission.  
Later years of last century, professor (Economic Information Systems) at Linköping University.

***“We wanted to be part of something new, something that was neither computer science nor applied mathematics or conventional business data processing.”***

hardware development.

As the number of students rapidly increased, administrative work related to the delivering of these courses came to be more and more teacher resource consuming. In 1968, we had 600 students. We divided each semester in short packages, and arranged separate student examinations at the end of each package. For some of the first year courses it turned out to be natural to use multiple choice questioning. The large amount of students demanded some type of rationalization, for lecturing but also concerning examination. The question was close at hand – could computing technology be used also for the examination? Surely, computerized records of student personalia were kept, as well as examination results. But the examination itself – could it be to some extent automatized?

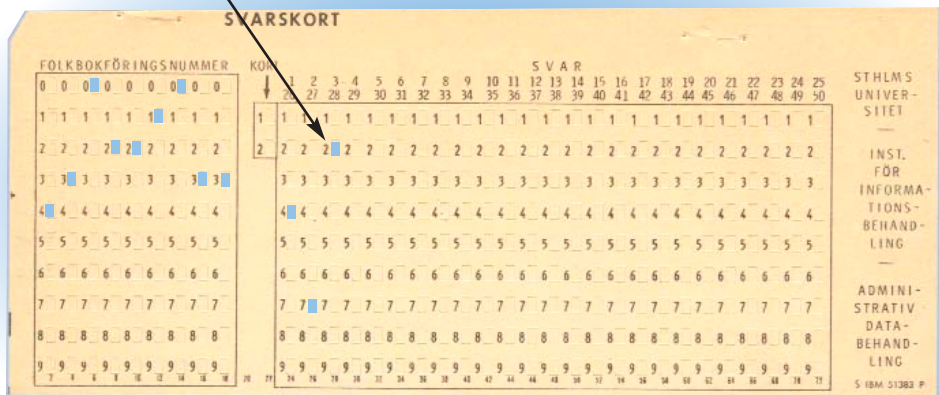
### Multiple choice, supported by hand punched cards

The type of questioning that was named Multiple choice was pedagogically considered somewhat stereotypical. However, this form was inviting for rationalization. For this use, optical reading was considered. But this turned out to be technologically sensitive, and the readers were expensive. We switched to punched cards. At the time, punched cards was a quantitatively dominating data and program storage medium, especially for US related computer systems.

There was a type of technology available that had not been tried very much practically – the use of “marking cards” or “needle cards”. Each card, of ordinary punched card size, here was prepared so that it was easy for a user with a thin stick (needle) to punch out predefined small rectangular holes in the hard paper card, to make it machine readable for input. To find the right manual marking force from the beginning, the card would preferably need to be placed in a hand-size cardholder. For a question with

#### “Needle card”

The card was prepared so that a user with a thin stick could punch out predefined holes in the card.



up to 9 suggested choices, it would be easy to mark one as the choice chosen.

A card layout was chosen where the student on each card identified herself or himself by birth date plus a three-digit number, a type of identification that was socially common at the time. After that, it was necessary to mark the sequential card number, plus the answers, the desired choices concerning up to 25 different multiple choice questions. The cards could then be read and processed by ordinary computer equipment.

For security, we invited each student to give her or his initials in handwriting in the upper right corner of each card that was used. This was done to make cheating difficult.

At this time, there was no specific personal integrity problem for an application like this where student examination results were stored centrally. This was so although Sweden was the first country in the world to create and adopt a fairly complete integrity legislation, a law that was taken as early as 1963. This university examination application was in this respect considered quite harmless in terms of integrity.

***“At this time, there was no specific personal integrity problem for an application like this where student examination results were stored centrally.”***

Each student first filled in a paper based complete question form, and then as a separate activity transferred the full list of choices to the (usually two) punched cards. The paper version was kept by the teacher for later security checking. We found that the students in average needed 10 minutes for the transfer from paper form to punched cards.

The computer system used was a Control Data 3200, an at the time medium-sized system, and the software was written in Algol, incorporating input/output features according to the so called “Knuth's proposal”.

## Systems features

First, the technology was used as input only to checking of examination results. We developed practical ways to handle the punched card technology, and tried it out in practical tests. The examinations naturally had to be administratively integrated with other parts of the university administration.

It turned out that a certain amount of contact between the formulation of the examination alternatives and the practical technology was needed. Questions had to be

- distinct
- not overlapping
- with an adequate number of choices
- with only one single answer
- with the same degree of complexity between exams
- chosen from a list of questions that would be publically available before the exams

Usually, the number of separate questions in each examination was quite high, around 50.

The first sharp tests showed some practical punched card problems, but these soon were taken care of. We became dependent of access to card readers in the then “computer room”, access to which at times demanded some waiting. Anyhow, once there, the examination results naturally were produced, for the time, quite fast.

At the exams, we invited the students to “guess” if they did not know the correct answer. In this way, we thought, guessing would be spread as evenly as possible among the student groups.

We found it natural to complement the examination software with a number of administrative routines. We developed additional software for:

- provision of a full list of all for a certain exam possible questions
- production of a sampled complete question form for an exam
- checking of the names of all students that were present at an exam
- checking of groups that were entitled to participate at a certain exam
- updating of student files with examination results.

All pieces of software were thoroughly documented.

### Usage impressions

As the system was introduced, the teachers seemed happy, because examinations were formalized, and that the teacher examination workload could be reduced. The students also seemed happy mostly, they found it fun to use new technology, especially in a field of education like this.

The time saved by having the chance to produce examination results extremely fast, was appreciated by all. As an example, for the computing system it took 8 minutes to calculate the results from an exam with 50 questions, answered by 200 students out of a total student amount of 600.

The cost for using the computer at the time was 100 US dollars per hour, indicating 5 cents per student for this exam, a reasonable amount.

In the ideal situation, student punched card information was transferred to the computing system without problems. In practice, however, certain cards at times were mechanically damaged, which led to certain duplication problems.

### Perspective

The system was used practically for a number of years at the end of the 1960s. After certain practical initial problems, the system ran smoothly, and provided cost efficiency to the Institution at the University. At the beginning of the 1970s, however, use of the system successively decreased. The reason for this was not technological. It was found to be too pedagogically simplified, and awk-

***“... the teachers seemed happy, because examinations were formalized, and that the teacher examination workload could be reduced.”***

ward, to use multiple choice technology for examinations related to an education that turned out to be increasingly complicated in structure and contents. Also, the number of courses that stressed group work increased.

However, the parts of the system that were used primarily to rationalize the student administration turned out to be useful for a longer time.

It was suggested that the system should be used also for commercial questioning environments, political polls etc. However, unfortunately there were no resources available to inform about and market the system for that.

This complete system was an early attempt to rationalize university examination. Seen in perspective, it was successful. It was probably one of the earliest systems in the field of computerized education support.

***“It was found to be too pedagogically simplified ... to use multiple choice technology for examinations related to an education that turned out to be increasingly complicated in structure and contents.”***

## Reference

“Datamaskinstödd examination”,  
by Mats Lundeberg and Tomas Ohlin, 1968

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## BEFORE THE INTERNET

### ABSTRACT

In the 1970s, there were some people who believed in using computers for making almost any information available to anyone and for supporting information exchange and discussions independently of geographical distances. These ideas were at that time novel and revolutionary. Some people regarded our ideas as dangerous, for example the Swedish Data Protection Agency (Datainspektionen) which forbade us from storing email longer than one month, and forbade us from discussing political and religious issues using computers. We tried hard implementing systems with some limited success, but the real success of our ideas came with the public usage of the Internet in the 1990s. Many of us had hoped to realize this much earlier.

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**Jacob Palme**

Professor of Computer and Systems Science. Special interest in computer mediated communication and internet information retrieval. Technically responsible for the medical web site <http://web4health.info/>. Home page <http://dsv.su.se/jpalme/>

In the 1970s, when DSV was young, the general public attitude to computers in Sweden was that <sup>1</sup>:

1. Computers will impoverish work tasks, causing more repetitive work and less capabilities for employees to influence their work situation and improve their skills. Skilled experts like typesetters will be replaced by computers or unskilled labour.
2. Computers will be tools for the government and large companies and organisations to control people to an unprecedented degree.
3. In spite of these two serious drawbacks, we unfortunately have to use computers, because otherwise we will be outcompeted by other countries. Computers are a necessary evil needed to keep industrial compositeness.

It is not surprising that people had this view of computers in the 1970s. Computers were at that time so expensive, that only the government and large organisations and companies could afford them. Computers were tools for use only by large organisations, not by ordinary people.

There were a few people, who worked with computers and saw the potential for something vastly different:

Torgny Tholerus <sup>2</sup> wrote a paper with the title “Computers for everyone” (Swedish title “Allmänhetens informationssystem”), which proposed that computers could be used as tools for a new kind of free speech – where everyone was able to have their say in ways where everyone was able to listen.

Myself, Jacob Palme <sup>3</sup>, wrote a paper with the title “The general Public Information System” which proposed that computers should be used to handle textual messages, where anyone could write what they wanted and everyone could access the information

***“I also wrote an article in Dagens Nyheter in 1975, proposing that the new Swedish national encyclopaedia should be published on computer networks, available to everyone, instead of as a set of printed volumes.”***

Today Jacob Palme's proposal is a reality. You could even get articles from the Swedish National Encyclopedia (NE) in your mobile telephone!



and comment on it. I also wrote an article in Dagens Nyheter in 1975 <sup>4</sup>, proposing that the new Swedish national encyclopaedia should be published on computer networks, available to everyone, instead of as a set of printed volumes.

Murray Turoff said that computers are as books of white paper, where anyone could write what they wrote on the pages, and everyone could read what had been written by other people. In 1978, Turoff wrote, together with Roxanne Hiltz, a book <sup>5</sup> with the title “The Network Nation” which described much of what Internet has become today. At two occasions in the late 1970s, Tomas Ohlin invited Murray Turoff and Roxanne Hiltz to Stockholm, to present their ideas to a group of people, including me, Ohlin and Tholerus. Their talk was pivotal in stimulating our work in this area.

Tomas Ohlin wrote an article in Svenska Dagbladet in 1971 <sup>6</sup>, proposing home terminals to give citizens better access to government documents, and take part in computerized citizen's panels, in order to enhance democracy. 1978-1981, he was also secretary of several government committees (Information technology committee, – Informationsteknologiutredningen, Commission on new media <sup>7</sup>) which among other things, proposed that simple, low-cost home terminals could provide access to data bases of linked pages, and also that consumer information should be available through the same terminals.

### More information to more people

Common to all of us was that we saw computers as tools for making all information available to everyone. We thought that computers could be used to give more information to more people, and allow more people to make their ideas available to other people. This was the opposite of the then current view of computers as tools for the government and large companies to watch over and control ordinary people.

Today, of course much of Ohlin's, Palme's and Tholerus's ideas are realized everywhere, with the Internet providing the basis of the free exchange of ideas and knowledge, where everyone can put up whatever they want, and anyone can read what others have written.

But in the 1970's, we were a kind of underground movement, trying to further our ideas to the, at that time, rather unwilling public opinion.

In the mid 1970s, Ohlin was working at a government agency for research funding. Together with a small group of partners, he started project Terese (Telecommunications and Regional Development in Sweden), which included studies of communicatively pioneering software. This project carried through social trials with computer conferencing in the north of Sweden in 1976 - 77, using the then unknown Planet narrowband communication

system, with 50 writing terminals equipped with acoustic modems. The system was tried on applications concerning transport, education, health services etc.

Planet was also used by a small number of people, mainly researchers at DSV, KTH-NADA and FOA (the Defence research institute in Sweden). We were fascinated by the potential. At that time, the Swedish government decided that FOA was to be split into parts in different places around Sweden. This decision made it possible for me to get FOA to finance the development of a new, more powerful forum system<sup>8</sup>.

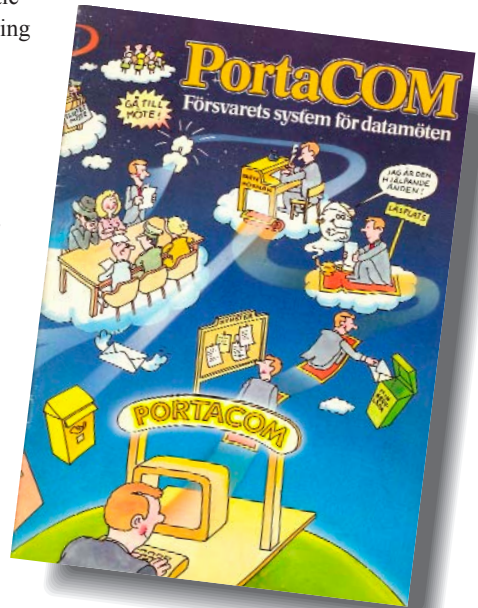
Our system became rather popular, at its peak in 1987 it had thousands of users. Small compared to the Internet today, but the largest of its kind in Sweden at that time. We also connected to the Internet in 1982, the cost partially funded by Skandinaviska Enskilda Banken. The Internet connection was restricted to e-mail and mailing lists, not full Internet connectivity.

We made a number of studies on the effects of this kind of software<sup>9</sup>. Among the results were that people agree more often than they disagree in online discussions, that online discussions increases the communication between people organisationally or geographically far apart, and that this increase is especially marked for younger people, non-bosses and people without higher education (because the older people, bosses and people with high education had access to cross-organisational and cross-location communication through travel already before using computerized communication). We also found that computerized communication gives more equality between different people in having their say, compared to previous communication methods.

In 1982, we made the system distributed, installed on three computers, at QZ (The Stockholm university computing centre at that time, including FOA), at DSV and at KTH-NADA, with exchange of messages between the systems. The system became a major tool for internal communication within DSV for many years. Today, DSV is using First Class for this purpose.

### Freedom of speech through computers?

Our first attempt at starting this system met with disaster, in the form of the Swedish Data Protection Agency forbidding our system. According to the Swedish Data Protection Agency, our system allowed people to store “free text” where they could write “anything they wanted” while the Data Act, according to their interpretation of it, forbids storing information in computer except in well defined fields with specified limits on what can be stored in them! The bosses at FOA did not dare appeal this decision to the Swedish government. Such an appeal would have been an



“PortaCOM”, a forum system used by the Swedish armed forces in the 1980s. The system was developed by Jacob Palme. In this manual the system is described as a journey in the “cyberspace” to meetings and mail-boxes.



Jacob Palme at a computer terminal (FOA in the 1970's).

interesting test of whether freedom of speech through computers was thought to be legal or illegal. Instead, the bosses at FOA decided to negotiate an agreement with the Data Protection Agency, where we had to accept restrictions that we were not allowed to write any messages on subjects designated as sensitive information, according to the Swedish Data Act, such as political opinions, etc(!). We were also restricted to delete all personal messages after 30 days and all discussion messages after 2 years (!).

We got our permission, started the system again, and promptly disobeyed the rules, discussing such sensitive political issues as whether nuclear power should be allowed or not. I also archived all public discussions for more than two years, contrary to the instructions from the Data Protection Agency. I have put up a selection of them on the Internet <sup>10</sup> for anyone to view even today, twenty years later. I am still waiting for the Data Protection Agency to prosecute me for this.

### **Freedom of speech more important than the Data Act**

In other cases, the Data Protection Agency has tried to forbid an author from writing a book with personal information in it. This decision was appealed to the government, who wisely said that freedom of speech is more important than the Data Act. Then they prosecuted a person who used the Internet to criticize practices of Swedish banks. The person was found guilty in the lower courts, but not guilty on appeal to the highest Swedish court of appeal.

Probably the Data Inspection Agency will not prosecute me for violating their rules, because they are maybe a little bit ashamed of their history of trying to prevent freedom of speech on the Internet. They have tried again to do this a number of times, but their decisions have mostly been declared illegal on appeal. Apparently those deciding on the appeals had more understanding of the democratic principles protected by the Swedish constitution than the Data Protection Agency.

In 1982, I asked a friend of mine, Olle Wästberg, who was at that time a Swedish member of parliament, to submit a private member's bill (proposal) to the Swedish parliament, specifying that freedom of speech should override the Swedish Data Act. The bill was rejected by the parliament without any specified reasons (!).

***“ Our computer system for information exchange got lots of users, but mixed reactions in the media. ... My belief is that the media, at that time, were afraid of losing their monopoly of providing information to a large number of people.”***

Our computer system for information exchange got lots of users, but mixed reactions in the media. Some of them wrote positive articles about the opportunities, other wrote scandal articles, selecting the most dumb texts written by any of our thousands of users and presenting this to scandalize our system. My belief is that the media, at that time, were afraid of losing their monopoly of providing information to a large number of people. Several attempts were made during the 1980s by other organisations to develop similar systems. Some met with partial success,

some not. Notable non-successes were the Teleguide system in Sweden and the Prestel system in the U.K. Notable success was the Minitel system in France. Minitel was the only system comparable to the Internet today, which existed before 1990. Why did Minitel succeed, when others did not? The main reason is that Minitel allowed any information provider to put up whatever they wanted on the Minitel network. Just like for the Internet today, the competition between information providers, developing lots of services, many of them unsuccessful, but some of them successful, was the cause of Minitel's success.



The Teleguide terminal

## Notes and references

- <sup>1</sup> Palme, J.: A Personal History of CMC, Honorary publication dedicated to Yvonne Waern, 2000, <http://www.tema.liu.se/people/chrge/yw65/start.html> and <http://www.tema.liu.se/people/chrge/yw65/pdf/palme.pdf>
- <sup>2</sup> Tholerus, Torgny: The general public democratic information system, Datalogilaboratoriet, Uppsala, 1974.
- <sup>3</sup> Palme, J.; The General Public Information System, Data No. 3, 1974.
- <sup>4</sup> Palme, J: L  gg nationalencyklopedin p   data (Put the national encyclopedia on a computer medium). Dagens Nyheter, 28 februari 1975.
- <sup>5</sup> Turoff, Murray and Hiltz, Starr Roxanne: The Network Nation, Addison Wesley 1978, Revised Ed. 1993, MIT Press,.
- <sup>6</sup> Ohlin, Tomas: Local democracy in telecommunications age, Svenska Dagbladet, August 8, 1971.
- <sup>7</sup> Ohlin, Tomas, in "New media", the commission on new information technology, Dept. of Education, Sweden 1981.
- <sup>8</sup> Palme, J.: History of the KOM Computer Conferencing System, <http://dsv.su.se/jpalme/s1/history-of-KOM.html>.
- <sup>9</sup> Palme, J.: Experience with the use of the COM computerized conferencing system. FOA Report C-10166E, 1981, revised 1984. <http://dsv.su.se/jpalme/reports/c10166.pdf>
- <sup>10</sup> Det var en g  ng f  r l  nge sedan, Diskussioner ur KOM-systemet vid QZ, Sveriges f  rsta BBS, Dokument ur den svenska datorhistorien, <http://dsv.su.se/jpalme/qzkom/>.



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# WHEN COGNITIVE PSYCHOLOGY CAME TO TOWN:

## AN INTROSPECTIVE ANALYSIS OF WHEN A COGNITIVE PSYCHOLOGIST MET COMPUTER SCIENCE

### ABSTRACT

The story I am about to tell is not purely fictional. The story consists of a blend of memories, reconstructions and mind you perhaps also one or two rationalizations. Since my background is in psychology, cognitive psychology more precisely, I have chosen to focus on how it happened that a PhD-student in cognitive psychology could end up at the department of computer-and systems sciences



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### The first encounter

Before starting my PhD studies at the department of psychology I worked as a research assistant at the department while finishing my candidate degree. It so happened in 1989 that a 40-credit course in cognitive science for the first time was offered at Stockholm University. I learned that particularly three departments at Stockholm University had struggled to make it possible to deliver this course. The department of computer- and systems sciences (DSV) was one of them. By that time I had little knowledge of DSV, but that was about to change.

Since I had a strong interest in theories of learning, knowledge representation, problem solving and how computers could be used to support various activities humans engage in, I decided to take that course, something I have never regretted. While taking that course I came to meet with students that had a background in philosophy, linguistics or computer science. In fact, one of the fellow students with a background in computer science I met back then is Klas Karlgren. He has since then become a close friend and a colleague at DSV. In that course we naturally met with teachers representing the various disciplines and studied various subjects. However, when trying to remember or rather to reconstruct memories, there are certain things that stand out. I particularly remember a teacher giving a lecture in knowledge representation. This was a person who already then, but perhaps particularly since then has played a major role in the development of DSV. By my fellow students I learned that he was a teacher at DSV. This particular teacher was very enthusiastic about his subject, drawing boxes and arrows (and an occasional circle) on the white-board while vividly waving his arms. In fact, it is a mystery still

### Robert Ramberg

Robert Ramberg got his Ph.D. in Cognitive Psychology in 1996 at the department of Psychology, Stockholm University. In 2000 he was appointed a permanent position as associate professor at Stockholm University. In 2004 he was appointed professor at Stockholm University in computer- and systems sciences. His research is inspired by socio-cultural perspectives on cognition and learning and more particularly on how representations of various kinds (and in various domains) mediate human action, particularly collaboration and learning.

***“This particular teacher was very enthusiastic about his subject, drawing boxes and arrows (and an occasional circle) on the whiteboard while vividly waving his arms. ... This was my first encounter with Carl Gustaf Jansson, a.k.a. Calle, who is now a Professor at DSV.”***

today how he could finish the drawing of boxes and arrows (and occasional circles) in spite of his constant wavering back and forth and sideways over the floor while talking. At several occasions during this particular lecture the teacher came very, very close to stepping into the waste paper basket close to the whiteboard. Needless to say, it was an interesting lecture. This was my first encounter with Carl-Gustaf Jansson, a.k.a. Calle, who is now a Professor at DSV. Calle would also later on play a major role in arranging for me to come to DSV.

### **How design explanations i expert systems?**

After having finished the course in cognitive science I was enrolled as a PhD student at the department of psychology in 1992. Inspired by what I had learned in the cognitive science course I started out my work by investigating how explanations in knowledge-based systems (expert systems) could be designed to support understanding and learning of complex processes within bio-chemistry. After completing a series of studies at a pharmaceutical company I moved on to approach the domain of physics and how explanations could be designed to support learning of complex phenomena within physics. Looking back at that period I realize that most of my work was carried out in collaboration with other departments at Stockholm University and, or industry. Important to note is that at the department of psychology at that time, there was very little interest into doing research about humans and computers, i.e. the area now known as human machine interaction (HMI). Fortunately, my supervisor was Yvonne Waern (Professor Emeritus) and she was one of very few who intensively struggled to convince other researchers at the department to embark on the adventure of doing research within the area of HMI. A struggle it was, and although the results of this struggle were only to appear much later, the strong enthusiasm and support I received from Yvonne made it possible for me to proceed with my studies and to finally present my thesis in 1996. By the time I presented my thesis however, I had already been at DSV for a year. How did this happen? Well, to try to shed some light on this I need to back up a bit and follow another thread.

By the time I got enrolled in the PhD program at the department of psychology the center for cognitive science and information technology was founded. The center had representatives from various departments at Stockholm University and the Royal Institute of Technology, as well as from industry. The department of psychology had representatives on the board of the center and I was appointed deputy member of the board. DSV was also one of the departments in the center and I learned that DSV had played a major role in the forming of the center. This is also where I again stumbled into Calle, who at that time was the chairman of the center.

***“Important to note is that at the department of psychology at that time, there was very little interest into doing research about humans and computers, i.e. the area now known as human machine interaction (HMI).”***

In fall 1992 (actually just a few months after I was enrolled in the PhD program), I received a phone call from Calle asking me if I would be willing to give five or six lectures in cognitive psychology on a recently started course that was delivered at KTH. I gladly accepted, and little did I know that I soon thereafter would become responsible for the course.

Well, to make a rather long story shorter the years passed and I visited board meetings in the center for cognitive science and information technology, gave lectures on the course in cognitive psychology (which formally was administered and delivered by DSV) and carried on my research in various projects striving for that PhD. Then suddenly in spring of 1995, I received a new phone call from Calle, whom I had got to know rather well by that time, asking me if I would be interested in working together with Klas in a research project on information technology and learning within physics. Since I, at that time, already was conducting studies of learning of complex phenomena within physics and would be working with Klas, this seemed like a wonderful idea. Soon thereafter, Calle arranged for me to have my own room at DSV, which made it much easier for me and Klas to collaborate on a daily basis. This of course also made it easier for me to meet other people at the department. So there I was, a PhD student in cognitive psychology situated at the department of computer- and systems sciences, doing research within HMI in collaboration with other PhD students also doing their research within HMI. Naturally, it felt like home.

So when looking back there were above all four somewhat unrelated events and choices I made;

- taking a course in cognitive science,
- being deputy member of the center for cognitive science and information technology,
- giving lectures on a course in cognitive psychology, and finally
- working in a research project together with Klas, that gradually made me move from the department of psychology to DSV.

### **The eagle has landed**

There were several things that struck me when I came to DSV. One thing was that there were so many young researchers as compared to what I was used to at the department of psychology. Also, these young researchers and PhD students were all engaged in projects that in one way or another involved contacts with industry. Now, this was nothing new to me since my own PhD work involved collaboration with other departments and industry, but at DSV I met other PhD students who had similar experiences and interests as I had. Another thing was that there were so few Professors (at that time). But what struck me the most was that there were people coming from various disciplines working together, something I had not encountered at the department of

psychology. There were, apart from computer scientists, also philosophers, linguists and now also a psychologist. No wonder then, I thought, the center for cognitive science and information technology is administered by DSV.

Although my first year at the department was mostly devoted to my course, to the project I worked in and to writing of my PhD thesis, I also got engaged in other things. I particularly remember the work we put into the planning of a national research network and graduate school in human-machine interaction (the HMI graduate school). I and others that participated in the planning of the graduate school were doing our utmost to see to that future PhD students doing their thesis work within the area of HMI would have an easier job than we had in finding relevant courses, meeting and sharing experiences with other PhD students with similar interests, etc.

***“During my first years at the department I also got exposed to a new vocabulary or language if you like, consisting of strange abbreviations and acronyms.”***

During my first years at the department I also got exposed to a new vocabulary or language if you like, consisting of strange abbreviations and acronyms. To someone used to this, there is nothing strange or odd about it, but to a cognitive psychologist or anyone else who is used to actually pronouncing whole words or sentences, this might be quite confusing. There were many meetings in which I had to ask for a translation of a seemingly random set of letters. Over the years I eventually got the hang of it and I have also started talking in the same way, now exposing my contacts at the department of psychology (and other departments) with the same confusing experience.

### **All is clear!**

There are far too many memories and impressions to give account for in this short story. But of course there are some perhaps obvious conclusions that can be made. I came to DSV in 1995 as a PhD student in cognitive psychology. I am still at DSV, but now as a Professor in computer- and systems sciences.

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## SOME DAYS IN THE EARLY 1970s

### ABSTRACT

After one year of commuting to the capital we decided to move from Gothenburg. The first time at the Department for Computer and Systems Sciences was adventurous. We tried to build up some kind of academic traditions. For some of us it was important to take care of not only of the education part but also of the leisure time. So we started to have Thursday meetings with dinner and afterward either some sport activities or PhD classes. We worked hard but also had a lot of fun. We made friends for life.

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### Péter Révay

Péter Révay was born 1945 in Budapest. He came to Sweden as a refugee in 1956 at Christmas time. He started his University education at Gothenburg University and became BA in 1969. The year after he entered the PhD studies at KTH/SU and finished 1977. After 18 years at the Department for Computer and Systems Sciences he became professor at the University of Gothenburg. During the past twenty years he has had office at Kalmar University, MIT Boston, Miskolc University in Hungary and is now professor and head of department and responsible of R&D at Mälardalen University.

When I woke up on Monday morning I realized that my train from Gothenburg to Stockholm would leave at eight o'clock. Why to Stockholm and why to the Royal Institute of Technology?

Well, it started in the spring semester of 1968 when I studied Mathematical Statistics and one of the core classes was "Computer Science". It was a five-week course in the programming language Algol. The task we were to solve was to exchange one Swedish Crown in all possible ways. During the class we were informed that a new major/program was planned to start next semester; Information Processing, or more specifically, Administrative Data Processing (ADB) at Chalmers Technical University and Gothenburg University.

### Starting up

In September there were about 20 optimistic students at the first lecture in house A at Chalmers. The first course was "Introduction to Information Processing" based on the book with the same name by Börje Langefors. The next class was about programming. We studied three program languages: Algol, Basic and COBOL. After all this time I can confess that the only final exam that caused me problems was this programming course. It was a four-part exam. One theory part and one part for each programming language. In order to pass the final exam a certain average grade was required, but there was also a minimum sum of points one had to achieve in all four parts. For instance, one could achieve a satisfying average grade but still score below the minimum requirement in one of the individual parts. This is exactly what happened to me.

In the group, we knew that this education had started a couple of years before at Stockholm University, and we also had the same education plan and list of literature. The next class was "System



***“Three days before the examination he sent a list of literature, at least eight titles, to read. Of course it made us confused.”***

Development” and for the first time we met teachers from Stockholm University. The lectures were given by Torsten Lundqvist and the exercises were lead by Eva Lindencrona. Both of them were very enthusiastic and dedicated to the subject.

We read the book “Theoretical Analysis of Information Systems”, THAIS, by Börje Langefors, part one, and we struggled with part two of THAIS on the next level (B).

The department in Gothenburg had staffing problems. Of course, there were no competent teachers available so most of the courses and classes had to be run by teachers from Stockholm. So during my time at Chalmers I met Janis Bubenko jr., Databehandlingsteknik, Kjell Samuelson, Informatologi, and Börje Langefors.

Professor Langefors was examiner for the whole program and especially for the Bachelor theses. When he held the theses seminars in the autumn of 1969 he informed us about his plans to start up doctoral studies in September 1970 at the Department in Stockholm. Obviously, he liked my thesis because he invited me to start the doctoral studies. The teachers from Stockholm gave a very professional and strong impression. Kjell Samuelson, a true character, was always late and sometimes he never turned up. Three days before the examination he sent a list of literature, at least eight titles, to read. Of course it made us confused. The consequence was, naturally, that only a few of the students passed. I happily managed with distinction.

### **The first visit**

So now I was ready to continue my journey to Stockholm. It was a very nice sunny day in May 1970. I had made an appointment with Professor Langefors. I had two issues on my agenda.  
1: to get my examination book back with Langefors' signature and  
2: to discuss the PhD studies.

I had never been at the Royal Institute of Technology and it all seemed rather frightening. The entire environment, the capital as well as higher studies were something new and strange for me. I had brought a map that I studied carefully during the journey, which actually took more than five hours. When I arrived at the Central Station in Stockholm I decided to walk to KTH. The route was Mäster Samuelsgatan-Birger Jarlsgatan-Sturegatan-Valhalla-vägen-Lindstetsvägen. Upon arrival, Börje was out so Louise Yngström took care of me while I was waiting for the professor. We talked about studies, education and about the department etc. She asked me how I would finance my PhD-studies.

- By student loans, I replied.
- Why not start working with us?
- Is that possible? I asked.

When Börje turned up Louise showed me into his room. The first Louise said to Börje was:

- Couldn't we hire Péter? He has a BA and the highest grade in

Information Processing (Fil kand och tre betyg i ADB). We need some assistant teachers.

Börje considered it a good idea and asked me to contact Janis Bubenko jr. and Tord Dahl to arrange the practical matters. At the end of the day (my train went back at 18.00), I found myself employed from September 1, 1970, and registered to the PhD-studies. I also had my examination book back with all relevant signatures so I could get the diploma (BA).

Back home I started to discuss with my wife Suzanne how to manage this situation. She had just started her professional career as physiotherapist at Sahlgrenska Hospital and could, of course, not imagine leaving her job nor her family and home-town just like that. We decided to give it a try for one year. But still, we had to arrange a lot of practical things.

Through my parents-in-law we found a single room for hire at Sturegatan 48, a very good location and near to KTH. The room was OK but there were no possibilities to cook or to take a bath, and even worse, I was not allowed to host my wife for the night. So during my first year I commuted to Stockholm. We moved permanently in the summer of 1971.

### **The students' office**

In these days, the department had the policy that newly employed assistants should begin by working at the students' office. The reason for this was that it was easy to learn about the organization, the administration process and to become familiar with the courses and even with the study administration. We had to serve every day for four hours. The study counselors worked together with us. From time to time, some of us worked half-time as a counselor and half-time as an assistant. At the office I often worked together with Helle Konga. I was supposed to work there for a couple of months but my career in the cellar ended in two weeks. (The office was located in the cellar.) I was promoted to become a class assistant.

### **Teaching assistant**

Every class had two teachers. One lecturer, who was responsible for the whole class, and one assistant teacher, who assisted the lecturer and held lab classes. I worked together with Eva Lindencrona in the class A:3b, Systems Development. To fill up the post I had to teach other classes as well. My duties included preparing the classes, developing basic tasks, taking care of all relevant material for the lessons, writing questions for the examinations etc. Eva, my boss, was very careful with the preparations of the material for the classes. Long before we started the class, she examined me. I recall wanting to give up my teaching career on many occasions. Otherwise, in the beginning I found A3:a, Systems Algebra, more amusing. I had classes in every course on the first level (A). I remember my first class in Systems

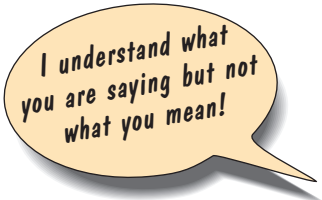
Development. I was extremely nervous. Tomas Montelius, one of the lecturers, saw it and he gave me a lot of advice and pep-talk. We smoked at that time and he offered me a very good Chimmerpenick cigarillo, which we smoked on our way to the lesson. It was quite a long way up to M in Brinellvägen where we had the classes. I am still grateful to Tomas for his support.

As mentioned above, my contribution at the students' office ended very quickly because we had a huge amount of students at that time. Admission to higher education was unlimited. At maximum, we had more than 1000 students at the first lecture. For several years, we had 8 to 20 parallel classes, and every assistant and teacher was engaged in the classes.

Thursday was free from lectures. This day was reserved for our own studies. At that time, no one in the staff had a PhD degree, not even our professor. So we were very happy to start the PhD studies in September 1970.

### The PhD studies

Some time in September, we started up the PhD education, for the first time in history. Professor Langefors started with a series of higher seminars and at the first occasion he gave us the conditions. He encouraged us to hold our own seminars for each other and he even gave us the opportunity to have our own classes. So, for instance, Sten Åke Tärnlund gave a class in Logics. We had an elder gentleman, Berglund, aiming to be a PhD. At some occasion during Sten Åkers course he said to Sten Åke:



*I understand what  
you are saying but not  
what you mean!*

“I understand what you are saying but not what you mean.” After this we always used these words when we did not understand the teacher. Janis Bubenko jr. had the RT-course (Real time systems). In fact, it was a “real time version of KOSAB”. Mats Lundeberg had the course System Development and Analysis. Börje himself gave classes in Science and Scientific Theories and Business Control. A lot of the class exercises were based on group work. Consequently, we formed different groups. I became a member of the “SCB-group” because the other members were employed at SCB. They were Christer Arvas, Björn Nilsson, Bo Sundgren, Eric Roupé, and Hans Lundin. We often worked in the SCB database group's place at Stureplan and had a lot of fun. From time to time we had competitions in “who read and produced most” and we often had homework. Most of the time, Bo Sundgren was the winner with me as good runner-up. Since there was a lack of relevant PhD courses and a lack of competent lecturers, a lot of the required credits had to be achieved through project works and through production of project reports. No project or research money existed either. On several occasions, I produced papers to conferences that were accepted, but I never received any financial support that would give me the possibility to participate. It was tough times.

## The Academic tradition

Our offices were very under-dimensioned, because the Department grew fast. So Tärnlund and his group: Bo Steinholz, Katrin Sundling, Anita Öqvist, Ann-Marie Lind and later even Åke Hansson moved to a flat. Every Thursday they served pea soup and warm punch in the flat. In the afternoon we had a PhD course. From time to time, we had some common activities in the evening. Sometimes we went swimming in the GHI swimming hall or we played basket at the Tennis Stadium. I recall that Anita Kollerbaur was a good swimmer. Janis Bubenko jr. had played a lot of basket when he was young and he played good. So good that he once gave Anita Kollerbaur a black eye in the spirit of the fight.

Another tradition we established was the annual soccer match against the Department of Numerical Analysis and Computer Science. It was always in the end of May at Gärdet (Ladugårdsgårde). It was mix seven person team and we played a “seven-a-side” game. ADB were far superior; some of us had played soccer earlier. Tärnlund was a good dribbler but too egoistic, Lars Söderlund had technical talents and was rather fast, Révay had earlier played in the national league, Tord Dahl was a good defender and Gunnar Björkman was very enthusiastic.

NA enrolled among others their professor Germund Dahlquist who had probably never played before, Ingrid Melinder who played soccer in some team, and Yngve Sundblad who could only run in one direction.

These matches always resulted in, at least, a couple of injuries. Björkman in our team got a black eye and sprained ankles several times. Ingrid Melinder was worst. She would run along like a hurricane and everything circulated around her. So for instance she took all free kicks. Once she got the chance about 15 meters from our goal. She backed off about ten meters and started to run like hell, but unfortunately she got caught in the ground behind the football and broke her foot.

The most exceptionally looking person was professor Dahlquist. He was wearing something like a tropical dress but instead of boots he had ordinary shoes in a typical 70s style. That means a very sharp model, so-called “mosquito hunters”. It meant danger for life to meet him in the field running around without any predictable direction and kicking at everything that moved. Nevertheless, he had fun and we had fun and enjoyed ourselves.

## Epilogue

We were pioneers; we worked a lot and hard, we had fun and some of us even managed with our efforts in the PhD studies. It was very hard times, to have classes for eight hours in one day, and then do our own homework. Still, ten of the students in the first PhD class became university professors, which must be considered as a rather good result.

***“Another tradition we established was the annual soccer match against the Department of Numerical Analysis and Computer Science.”***



Mosquito hunters  
in a typical 70s style.

***“...ten of the students in the first PhD class became university professors, which must be considered as a rather good result.”***

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# INFORMATICS AND SYSTEMS SCIENCE

– INCLUDING CYBERNETICS AND NETWORKS

## ABSTRACT

This invited article is an abridged and synoptic survey of the Swedish graduate program in Informatics and Systems Science (ISS) at Stockholm University & Royal Institute of Technology (KTH). It was initiated and outlined to be a third wave, embracing subject areas outside numerical and administrative data processing. Informatics and Systems Science represents a metadisciplinary and generic trans-science above and beyond the traditional academic topics and special technology niches. It is aimed at scientific rigor, when integrating an emerging breed of such complementary domains as Cybernetics, Bionics, Information Retrieval, Network Communication, Systems Engineering & Management etc (see Figure).



## Introduction

The Swedish graduate program in Informatics & Systems Science (ISS) at Stockholm University & Royal Institute of Technology (KTH) is hereby synoptically surveyed, spanning more than forty years. Curriculum and course contents are mentioned in brief. Like several other academic programs, ISS was built on scholarly research, and has progressed by annual updates, professional exchange, and international networking.

### Kjell Samuelson

M.D., Karolinska Institute.

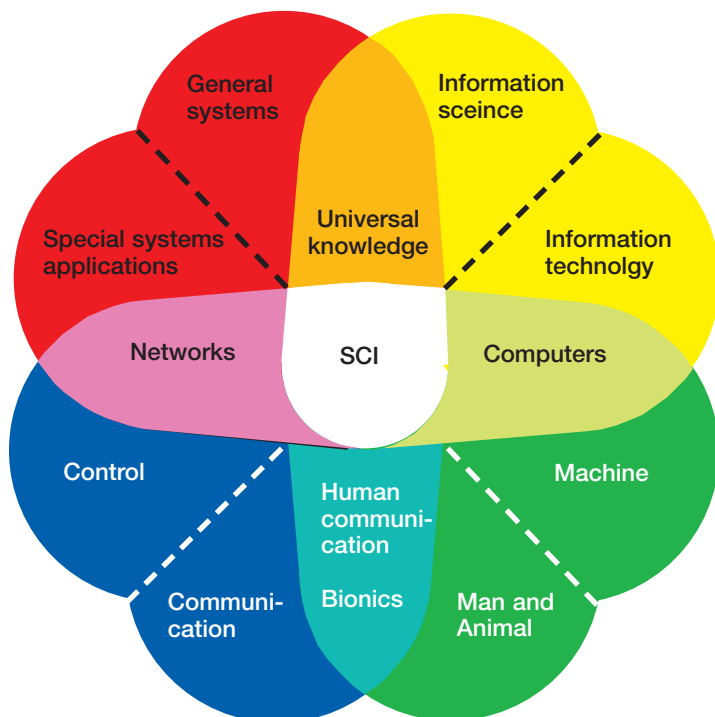
Technology Doctoral degree, Royal Institute av Technology (KTH) on his dissertation

“Informatics by General Systems and Cybernetics”.

Professor Samuelson launched the new graduate education in Informatics and Systems Science (ISS) at Stockholm University, with an endowed chair as its first professor in Sweden.

Conducts R&D internationally on TeleCom Systems, Satellites and Networks, as sorporate Sci-Tech advisor.

Invited professor of Information Science, Computers, Systems Engineering and Management at major North American universities.



◀ Systems, cybernetics and informatics as an emerging breed.

## Background

During the early 1960's, we were five scientists who collaborated weekly as a transdisciplinary study group on information retrieval, systems and classification research. My colleagues were N. Bäcklund (FOA), B.V. Tell (AB Atomenergi), T. Wikland (TUAB) and E. Wåhlin. Since graduation in 1955, with a background in the biomedical & life sciences, my interests were cybernetics, comprising communication and control systems, networks, systems engineering (SE), bionics and living systems theory, extended 1964-65 while working in the USA.

In addition to technical reports, our study group in 1963-64 produced the outline of a postgraduate course on the fundamentals of "Scientific Information Transfer and Retrieval". It was running over an 8-month period with 20 credit units. The course was given at the Royal Institute of Technology, with financial support by the Council for Applied Research (Tell, 1965). Course modules treated topics such as information transmission and retrieval (IR), systems analysis, cybernetic systems, neuronets, automata, selforganization, classification & clustering, coding & redundancy. A new speculative module was coined "informatology" to denote a research field combining intuitive, heuristic procedures with augmentation of human intellect and reasoning by computers and other media (Engelbart, 1963). Some of us in the group contributed by teaching course modules, and a few guest lectures were supplementary. Altogether the course served as a pilot step to permanent education in an up-and-coming field.

## Formative Years

In contrast to the USA, Sweden had no research institutes like RAND, SDC, MITRE, SRI or A.D.Little. Hence, our study group triggered FOA to allocate seed money for a few years sponsoring of a Research Group. This became the "Research Group for Information Processing" of Stockholm University located at the Royal Institute of Technology (KTH).

In addition to myself, the research members were N. Lindcrantz, recruited from ASEA to work on Computer Assisted Instruction (CAI), and L.E. Thorelli working on programming at KTH. Our original study group had already recommended that B. Langefors at SAAB be invited to an opening position as professor of ADP. Thus, during the year 1966-67, the new program in Administrative Data Processing (ADP) opened to masses of undergraduate students. This was a bit of an impedance to R&D, but we gave a few graduate courses and doctoral seminars. My own course lecturing covered informatology, information retrieval and systems.

Meanwhile, I was also during 1965-69 assigned to a nationwide committee for specifying future university tracks of new frontier disciplines. Site visits were made in 1968 to leading US

***"... my interests were cybernetics, comprising communication and control systems, networks, systems engineering (SE), bionics and living systems theory..."***

***"A new speculative module was coined 'informatology' to denote a research field combining intuitive, heuristic procedures with augmentation of human intellect and reasoning by computers and other media."***

universities with advanced prototype education. As a result the graduate program in Informatics & Systems Science (ISS) was established at Stockholm University and also doctoral courses at KTH (Samuelson, 1975, 1982, 1985).

### Curriculum Topics

The Informatics & Systems Science curriculum covers the major facets of systems, cybernetics and networks:

- Cybernetics is communication and control in man and machine. Bionics is the reverse, yielding artifacts by humanoid design principles.
- Informatics is Information Science and Technology (IT) for multidirectional information flows through and between living systems: individuals, groups and organizations, foremost international knowledge transfer and retrieval, in behavioral harmony with matter-energy flows. The name “Informatics” is adapted from the French “Informatique” and frequently used in translations to European languages (Informatik, Informatikka).
- Living Systems Theory (LST) verifies the integrated and behavioral flows of matter, energy and information in concrete human contexts and critical subsystems.
- Encountered are also niches such as synergetics, praxiology, ontology, semiotics, automation, systems engineering & design, ecosystemics, logistics and OR.

***“Informatics is Information Science and Technology (IT) for multidirectional information flows through and between living systems: individuals, groups and organizations, foremost international knowledge transfer and retrieval, in behavioral harmony with matter-energy flows.”***

The combined domains constitute a solid scientific foundation of:

- Systemic nature laws
- Physical principles
- Longtime experience rules

A core of more than a hundred course modules have been elaborated on this base plate.

### International linkages and Networks

Our intercontinental research ties were catalyzing from an early start in 1960. During more than ten years 1965-75, I served as chairman, running the international science secretariat FID/TM – Theory and Methods of Systems, Cybernetics & Information Networks. It resulted in the FID/IFIP 1967 Rome Conference, where network schemes were introduced. The TM-secretariat assistance by A.M. Bodor gave competent and much appreciated service to course administration in the Informatics & Systems Science graduate program. Internationally an ARPANET communication started early via my network address KSAM@SURIT.

Additional activities were launching the North-European chapters of SGSR and ASIS operating 1975-85. The International Network Working Group (INWG) finalized the X.25 packet

***“More than 30 years of sci-tech R&D was significantly focused on worldwide networks, global telecom and international systems linkage.”***

protocol during the IFIP/ICCC conference in Stockholm 1974. When chairing the Inter-Nordic Satellite Consortium for Informatics, Systems Science and Telecommunications (INSIST) I allocated InformatiCom as a pilot system for multiway video-communication with total feedback. It was applied for interregional doctoral seminars between several universities. Research and advice were also contributed to UNESCO, UNITAR, NATO Advanced Institutes, OECD, and FISCIT. More than 30 years of sci-tech R&D was significantly focused on worldwide networks, global telecom and international systems linkage.

### **Course Contents**

Within the Swedish ISS program and as professor at several US universities, I have been challenged to develop about one hundred graduate courses and doctoral seminar series. Parts of the curricula, syllabi and course modules were implemented in Japan and Southeast Asia by UNESCO sponsoring 1973-75. In 1977 new courses shaped an International Institute for General Systems and Information Networks at UCLA, resulting from my presidency of SGSR (Society for General Systems Research), and for inter-university course credit transfer.

Only a few additional course topics are mentioned in random order:

Systemic Measurement & Evaluation,  
Teleinformatics & Network Structures,  
Satellites & Space Systems,  
Automation & Production Systems,  
Large-scale Systems Engineering & Management,  
Systems Testing & Fault-Tolerance (FT),  
Leadership & C4ISR Functions,  
Systemic Visualization & InformatiCom Presentation,  
Bioinformatics & Medical Systems,  
Systemic Infrastructures & Industrial Plant-Engineering.

### **Faculty Progress**

Other lecturers as well as doctoral graduates of ISS have contributed specialized niches. I. Karlen in his doctoral dissertation made advancements of “Building Informatics”. He became a supportive resource person for systems architecture and design methodology. L. Yngström was teaching courses early as a graduate. She later explored her own specialization in “Security Informatics”, all this, while working at becoming a professor today. S. Holmberg started as an engineering graduate and enrolled in many doctoral ISS courses, including GeoInformatic Systems (GIS). Today he is a professor at the Mid Sweden University.

Two early students from the 1970’s got their doctorate in the 1980’s. A. Malmsjö is professor of Informatics & Systems Science in Skövde. I. Wormell is a professor in Borås and

Copenhagen. P.Agrell became a Ph.D. about the same time after two decades as researcher-scientist at FOA. Besides being one of our lecturers he has been a professor in the UK and France. P.Revay who originally got his doctoral degree in ADP worked for ISS in the 1990's, and has since been a professor at a few different universities. The list of achievements stops here, for space reasons, so the remaining acknowledgments are somewhat limited.

### Related Acknowledgments

Over the years a few senior colleagues from neighboring academic domains are truly acknowledged. Foremost, B. Langefors during his 15-year tenure as chair of ADP. Our interactions on formalizing the fuzzy borders of "Information and Data in Systems" were early scholarly efforts toward informatology (Langefors & Samuelson, 1976). In parallel, international R&D projects explored more than thirty complementary notions, especially as Information Science (IS) in the USA, Canada, UK and Australia (Debons, 1972). Within ISSS (International Systems Science Society) we are continuously engaged in applied research over the holistic spectrum from knowledge to insight and wisdom.

Since the 1970's, any dialog with H.E.Nissen has always been stimulating, by adding fresh aspects, off the beaten track. As professor at the University of Lund, he spelled out open statements on "Administration" growth and the counterproductive deluge of "tech-packages" (Nissen, 1984,1987). These are milestone warnings of proliferating governmental bureaucracy – today more than ever! Professor H.Sackman is an innovative American friend and coworker, and we jointly concur with H.E.Nissen's alerting commentary (Sackman & Samuelson, 1985).

Professor J.G.Miller was an outstanding scientist-colleague. He pioneered the EDUCOM/EDUNET idea in 1967 that became a masterminding plan for the ARPANET. During a quarter century (1953-78), he worked with hundreds of researchers to formalize Living Systems Theory followed by current applications. We became friends as SGSR presidents, and collaborated on Systems Science and networks over nearly four decades.

### Epilog

Forty years appear bright and fast, considering landmarks like "Information Age & Systems Era", accompanied by networking and high-tech advances. Yet, 1966-67 seems like medieval days in retrospect. At that time Swedish academe was targeted by totalitarian beliefs in centralized maxi-computers of governmental possession. Our "Research Group" was plagued by quasi-lectures from data-center preachers. Such intellect-draining moments were enlightened, when next-seated T. Ohlin handed over a square-print math-paper inviting to a game of vagabond chess, the domestic five-in-row version of tic-tac-toe. He later mastered the computer-economic and micro-political gamesmanship in quite a few battles

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***"Yet, 1966-67 seems like medieval days in retrospect. At that time Swedish academe was targeted by totalitarian beliefs in centralized maxi-computers of governmental possession. Our 'Research Group' was plagued by quasi-lectures from data-center preachers."***

as a winner. Mini-computers, PC's, communications, telenets and video had been step-by-step interlinked, as I met T. Ohlin at an OECD conference in Spain around 1978. He is now the editor of the compiled invited recollections, – and the rest is history.

### References

Tell, B.V. A Swedish Course in Scientific Information Transfer and Retrieval. In: Proc. FID International Conf., Washington Oct. 1965. Spartan, Washington D.C. p.41-47.

Engelbart, D.C. A Conceptual Framework for the Augmentation of Man's Intellect. In: Vistas in Information Handling, Vol. 1. Spartan, Washington D.C., 1963, p.1-29.

Samuelson, K. An Informatics Curriculum and its Similarity to other International University Programs. In: Proc. IFIP World Conf, on Computers in Education. Part 1. Marseille 1975, North-Holland, Amsterdam/American Elsevier, New York.

Langefors, B. & Samuelson, K. Information and Data in Systems. Petrocelli, New York, 1976.

Debons, A. (ed.). Information Science. NATO Advanced Inst., Dekker, New York, 1972.

Samuelson, K. General Systems and Information Networks. International Institute at UCLA, 1977, coorganized with SGSR, UNESCO, UNITAR. Director's Report.

Samuelson, K. Systemvetenskap Internationellt. Informatik med Systemvetenskap. Stockholms Universitet & KTH. TRITA-IS-5021. 1982-01-04.

Samuelson, K. Informatics and Systems Science in Universities. an International Graduate Curriculum and Doctoral Program. In: Global Workshop on Systems Science Education, joint organized by USC-SJSU-SU&RIT. Long Beach, 1985. Intersystems Publ., Seaside, Calif.

Nissen, H.E. Varför utveckla system för administrativ databehandling. – Varför inte avveckla administration? ASF seminarium, 1984-03-15, Göteborg, p.15-25.

Nissen, H.E., Sandström, G. Why always develop administrative systems. – Why not sometimes eliminate administration? Presented at 10th IRIS, 1987-05-01. University of Lund, Dept. Information & Computer Science.

Samuelson, K. Systems of Information, Communication and Computers – What Kinds and How Much? (Keynote). In: Sackman, H. (ed.) Comparative Worldwide National Computer Policies. IFIP TC9 Conf. In Stockholm, 1985. North-Holland, Amsterdam. p.35-49.

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# WORKING IN EU PROJECTS AT DSV AND SISU

## ABSTRACT

The author of this article was together with many other DSV researchers involved in quite a number of EU projects during the years 1989 to 1999. The article provides a brief account of some of these projects, their results and the experience they gave. Some projects were concerned with foundations for requirements engineering and in particular requirements representations involving business rules with time from which an executable system prototype could be derived. Another project was concerned with data warehousing and mining for customer profiling in banks. Some general experiences from working in EU projects are also accounted for.



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## From DSV to SISU

The Swedish Institute for Systems Development (Svenska Institutet för SystemUtveckling – SISU) was formed 1984 and started its operations in January 1985. Initiator was most of all professor Janis Bubenko jr. Initially, 10 persons moved from DSV to SISU completely or on a part-time basis. More people came from SYSLAB in Gothenburg to form a branch of SISU in Gothenburg. Over the following years, the number of employees grew step by step to 30-35 persons. The relationship and collaboration between SISU and DSV remained to be quite close.

SISU was financed partially by fees paid by partner organisations and partially by research grants most importantly from NUTEK. Little by little a good deal of funding came also from EU projects.

The SISU venture came gradually to be directed towards three areas, namely (basic) research mainly concerning business and systems development methodology; business analysis and development for partner companies; and development of computerized modeling tools and intelligent user interfaces to databases. In terms of research, quite a large amount of efforts were put into a number of EU projects that became important also for DSV in that DSV staff were given the opportunity to work and do research within these projects.

Among PhD students from DSV that were involved in these projects and that have later defended a thesis at DSV to some extent based on that work, may be mentioned Danny Brash, Sari Hakkarainen, Peter Holm, Paul Johannesson, Anne Persson, William Song, Janis Stirna, Benkt Wangler, Petia Wohed and Rolf Wohed. A number of project participants were also awarded Licentiate degrees.

## Benkt Wangler

Benkt Wangler is a professor of information systems engineering at the University of Skövde. He received his PhD from DSV and worked for DSV for many years as a senior lecturer and professor in parallel with work for SISU as a researcher and research leader. Prior to that he was working as a systems analyst and designer in Swedish industry.

### **SISU and DSV in EU projects**

During my years at SISU and later at DSV, I was more or less involved in about 8 different EU projects. In the following, I will give a brief account of some of these.

When the 2<sup>nd</sup> European framework program was introduced, partners from the EFTA countries were allowed to participate. Hence SISU was invited to take part in two such proposals that were later accepted. These two projects were KIWIS (federated databases) and TEMPORA. The KIWIS project was a three-year project that concerned the development of a federated database platform. This project will not be further dealt with in this piece of writing.

The TEMPORA project for which the SISU part was led by the author of this article, concerned development of a systems development environment that was based on two fundamental ideas:

- The ability to explicitly (and formally) represent business rules and
- It should be possible in the formalisms to take the temporal aspect into account (hence, the name of the project).

The project partners in TEMPORA were SISU, UMIST (University of Manchester Institute for Science and Technology); Imperial College, London; University of Liege; the research Institute SINTEF, Norway; and the companies Hitec, Greece, BIM, Belgium and LPA, UK.

The project started in January 1989 and went on for a little more than 5 years, hence coming to an end in early 1994. The project was reviewed by the European Commission once each year. After three years there was a more thorough review to assess whether the project would be allowed to go on for two more years. The latter took place just before Christmas 1991 and was successful. Plenary project meetings were held about four times each year with smaller meetings sometimes in between. This was typical for all EU projects.

The platform developed was based on Prolog and temporal logic and comprised a number of graphical and textual formalisms for modeling the structure and behavior of the system to be built. The SISU meta tool Ramatic was used to create a modeling tool from which executable Prolog code was derived. To check the modeling formalisms, a huge case study was carried out at Sweden Post that resulted in several hundred business rules. The complete systems development platform actually ran at the end of the project, although it was yet far from fit as a commercial tool.

The project was extremely successful as a learning experience. Not only did we develop new knowledge concerning modeling and building tools, but a number of PhD:s (among them the author of this article) were produced internationally during the course of and partially as a result of the project.

### **F3 and Nature – two follow-ups to Tempora**

TEMPORA and KIWIS were followed by a number of projects in the 3<sup>rd</sup> EC Framework Program. Among those I would like to mention two projects that concentrated on the early phases of systems development and hence were sort of follow-ups to TEMPORA. The first of these, F3 (From Fuzzy to Formal), concerned developing methodology and tools that helped bridging the gap between early requirements statements and a formal requirements representation.

The second project was called NATURE (Novel Approaches to Theories Underlying Requirements Engineering) and was more basic research-oriented. Since I was myself involved in this project, I will give a brief presentation.

The partners in this project were RWTH (Rheinisch-Westphalische Technische Hochschule) in Aachen, University of Paris 1 (Sorbonne), City University in London, a branch of the Greek research institute Forth in Heraklion and SISU. As the name suggests, the project concerned development of theory rather than practical tools. Among ideas that were elaborated and spread as a result of this project may be mentioned the four worlds of requirements (engineering) modeling, the requirements engineering process, goal-driven requirements capture and much more.

### **ESPITI – a training program**

A different kind of project was ESPITI (European Software Process Improvement Training Initiative). As the name suggests this was a training program and hence courses on topics such as software metrics, ISO 9000, CMM and the alike were organized throughout Europe. The project comprised partners from all the 15 countries of EU, and also from Norway and Iceland. The Nordic countries Iceland, Norway, Sweden and Finland comprised a special group that worked closely together. Following an initial questionnaire directed towards industry, a number of courses were held in Stockholm and Gothenburg with attendees mostly from industry but also from academia.

***“The ESPITI project comprised partners from all the 15 countries of EU, and also from Norway and Iceland.”***

### **DSV partner in the ORES and ELEKTRA projects**

Not all project proposals were successful. Among those that were not may be mentioned the proposal CHRONOS, another TEMPORA follow-up that concerned temporal databases. The proposal was not accepted simply because it was so huge, i.e. asking for a lot of money, and had so many partners. However, it was reborn and accepted in a much smaller version, the ORES project, with only a few partners: the University of Athens, a Greek company 01-P, UMIST, a Hospital in Madrid (Hospital Clinica Puerta de Hierro), and in fact DSV, since the project had been transferred from SISU to DSV. The project developed a temporal database manager that was tested on some application at the hospital.

***“The ORES project ... developed a temporal database manager that was tested on some application at the hospital. Temporal databases were considered important in healthcare applications since they made it possible to represent illness and treatment histories in a natural way.”***

Temporal databases were considered important in healthcare applications since they made it possible to represent illness and treatment histories in a natural way.

Also, other EU projects were run by DSV and I would like to mention the ELEKTRA project, which was further developing and putting into practice results from F3. The user companies involved were energy companies. Hence the Swedish company Vattenfall and its Greek counterpart were involved as partners.

### **HYPERBANK – data mining in a banking environment**

A DSV project in which I took part, after I moved from SISU to DSV in October 1995, is HYPERBANK, which was concerned with data warehousing and data mining in a banking environment. The project was led by a British firm named Datel. Other partners were DSV, UMIST, 01-P, and three European banks, i.e. Postgirot, Capital Bank UK (a British finance house), and National Bank of Greece (a private commercial retail bank - actually the biggest in Greece). The Belgian partner, Carleton, offered a data extraction tool that was used by some of the banks. A special task in which DSV was involved concerned creating patterns for customer profiling. Together with Postgirot an application was developed for estimating customer profitability based on the flow of money between accounts in the bank's stock of customers. Customers that circulated much money frequently were considered more profitable for the bank. It was really interesting to work with Postgirot and to get some insight in the kind of analyses they were interested in doing, as part of their market research.

HyperBank post meeting dinner at “Blå Porten”, Stockholm.



### **Preparing for EU projects**

There was also much job to do in preparing for EU projects. First of all it was the work to put the proposal together, a job that often went on for many months and took quite a lot of traveling to meetings throughout Europe. Sometimes we tried to combine this with other travel e.g. to conferences. In particular, I remember VLDB

1991 in Barcelona, where I was involved in discussions of three projects, and had to go to so many meetings, that I only had time to register and pick up the proceedings at the conference - and participate in the social events, of course. One and a half of these proposals were later successful (Lynx and Chronos/ORES). However, even those proposals that were not successful in the end brought useful experience, ideas and good contacts.

Secondly, after the proposal was accepted, there was a period of negotiation in Brussels between the partners and with representatives from the commission, before the contract could be signed. Usually the proposed budget was cut, sometimes with as much as 40 percent. This of course meant that the budget had to be more or less redistributed among the partners. I remember one occasion where some quite hard words were exchanged between some of the partners, and another where one of the partners was practically kicked out of the project during the negotiation. But these were exceptions; usually the budget cut was distributed evenly among the partners.

As a whole, a number of theoretical and practical results came out of these projects, as can be seen from numerous publications in journals and at conferences. Techniques and tools were developed, sometimes tried out in practice and further refined; parts of methodologies did in fact affect methods development in industry. However, more importantly, each and every one of the projects was a huge learning experience. Not only did we learn and develop knowledge about business and information systems analysis and design, but the projects were also important as an exercise in associating and working with people from different European countries. As a means for creating fruitful contacts between researchers in European universities, the EU project experience can hardly be exaggerated. Participating in all these projects (TEMPORA, MILORD, LYNX, NATURE, ESPITI, ORES, HOD, and HYPERBANK) for more than 10 years (1989 - 1999) took me to many, if not most, countries of Europe including Norway, Iceland, Finland, Germany, Belgium, France, Italy, Greece, Spain, Portugal, UK, Ireland and even Northern Ireland. One of the Greek participants in HyperBank was a sister of the leader of the Parthenon temple restorations and hence we were allowed to enter and walk through the inner of the temple, something which is normally only offered to heads of state, prime ministers and the alike.

After the project meetings in daytime, the discussions usually continued in restaurants and bars, sometimes until quite, not to say very, late. Many lasting friendships were created. Having been given the opportunity to work in these projects is perhaps the best thing that has happened to me in my professional career.

***“Not only did we learn and develop knowledge about business and information systems analysis and design, but the projects were also important as an exercise in associating and working with people from different European countries.”***



# SECURITY INFORMATICS IN RETROPECTIVE, 1985 – 2006

## ABSTRACT

The aim of this presentation is to show how Security Informatics developed from the roots of the classical Computer and Systems Sciences as interpreted within the department in the 1960-70's, blended with national and international efforts to capture the multidisciplinary of securing IT systems in making efforts towards creating viable structures for humans, organizations and societies.



## Historical background

I started my career at the department of Informationsbehandling särskilt ADB in fall 1967. My interests were management and economics and my father – a manager of an electric power company and a MSc in civil engineering – advised me to look at this “new subject called ADB” because of its future potentials for management. From then on I was hooked on IT – my friends had to listen to endless talks on how important this new “thing” would be to everybody – it would be as ordinary as going to the Post Office.

Mad, unrealistic and academic was my epithet amongst friends outside the department. Professor Börje Langefors was our inspiration, he pointed to breathtaking news that would occur soon: the rise of separate software and hardware industries and the appearance of smaller and more user-friendly computers. Computers would be used everywhere, provided people were educated. The task of the universities to partake in information and education outside the academic world was not invented yet, but Börje supported this fully and made most of us young teachers roam Sweden offering university credit courses in corporation with Swedish educational associations. We met EDP practitioners all over the country during weekends, while teaching our ordinary university courses; this lay my foundation to the importance of interactions between theory and practice. I was a travelling salesman in knowledge, spending every second Friday night – Saturday in Borlänge, Gävle, Sandviken, Hofors, Västerås, Linköping or Eskilstuna 1968 - 1975. In parallel we studied, discussed and took exams; at the final oral examination with professor Börje Langefors he started by saying “in this department we don’t use titles, but call each other by first names” – a real challenge to a

## Louise Yngström

Louise Yngström (PhD, Docent) was appointed professor at Stockholm University in 2004. Her main research areas have been Databases (1969-79), Computer Aided Instruction (within the PRINCESS project 1973-83) and Security Informatics (1980 -). Within IFIP she has been engaged in TC3, TC9 and TC11.

She is presently the head of SecLab and the study director of the PhD programme at CSS.

► SOU: The Swedish Government Official Reports

►► Ingenjörsvetenskaps Akademin, eng Royal Swedish Academy of the Engineering Sciences.

►►► One of the early students was Professor Irene Wormell at University College Borås.

young woman in those days! I used more thinking on how not to violate his and my social rules than on the subject of the exam itself. The subject was my favourite – Applied Systems Theory. Ever since have I applied systems theories; in life, in teaching, in researching, in communication. At first, the interest manifested itself within Informatik med System; an educational program at the department in parallel to Informationsbehandling ADB, focusing information retrieval and databases targeting specifically the introduction of computers within research libraries.

The program came out of SOU ► 1969:37 *Utbildning för bibliotek, arkiv och informatik*<sup>1</sup> sparked off by the (later) professor Kjell Samuelson. He is mentioned as medicine licentiate – the academic exam for medical practitioners – at the department at that time. Through him I was offered the possibility to take part in IVA's ►► body appointed to comment on the investigation – my merits being that I had written an undergraduate thesis (C-uppsats) on the new subject databases. For a year, Kjell Samuelsson, Sten-Åke Tärnlund (also to later become a professor in our subject), Ann-Marie Lind and I had a dinner-study group on databases where we would roam the city's best restaurants discussing this new subject from all angles to eventually come up with a report. The academic program Informatics with Systems came into being in the early 1970's targeting primarily the specialist driving 'the computerization of the libraries' but one could probably interpret the Informatics program to be designed to target the specialists who would drive 'the informatisation of society' ►►►.

Towards the end of the decade our Informatics courses included amongst others:

- IS-1 Informatics with General System Theory and Cybernetics,
- IS-3 Networks and Communication,
- IS-4 Computer-based Information Retrieval and Management,
- IS-5 Informatics with Systems in Industry and Organisations,
- IS-8 Security and Integrity for Information Systems, Nets and Data,
- IS-16 Legal Informatics (taught jointly with Juridicum at Stockholm University),
- IS-29 System Tests, Trust and Fault-tolerance.

At the time of the development of the program the Swedish society matured into its computerization, sparking off also the first debates on privacy. Kjell Samuelson got us informaticians in the faculty involved with the parliamentary pre-work of the 'Data Law' – the first national law on privacy enacted in 1973.

Following the tradition of the department to marry theory and practice I took participants in my courses on 'field trips'. At one instance of the course IS-8 Security and Integrity for Information Systems, Nets and Data I met with Kristian Beckman, then the security manager of the Swedish Savings Bank<sup>2</sup>. Kristian in a letter of April 27, 1982:

*“...It was nice to have visitors from your course, the discussions were stimulating, and maybe unintentionally even of more interest to us...your suggestion for an academic program in security has left me restless and I enclose some thoughts for you to react to...I also imagine Allan Eriksson for the report of the Vulnerability Board may be interested, he has promised to include suggestions for education in security but no one has before us thought of it as an academic education...”*

Our communication included suggestions from Kristian to call this new breed of people “Security Analysts” acknowledging that applicants would be ex-something (militaries, policemen, system analysts, programmers) with as well, practical experiences as previous academic studies – the program would complement existing knowledge.

The first edition of the program was dated September 29, 1982, presented to an international audience at the IFIP/Sec’83 <sup>3</sup> as “Education in Safety Systems and Security Analysis – suggestions for a One Year University Program” (Yngström 1983).

### **Security Informatics evolving through integration of education and research**

The Security Informatics Program started at the third year of a bachelor at the Department of Computer and Systems Sciences, DSV in 1985 financed by an extra budget offered by the Swedish Vulnerability Board <sup>4</sup>.

The scientific base of Security Informatics evolved from Applied Systems Theory strongly connected to the mentioned Informatics Program, but also to interpretations of the Scandinavian approach to information systems development applied to the area of information security <sup>5</sup>. In this approach and its following transfer of technology the issues of Awareness, Experiences, Needs, Possibilities, Employment, Education, Policies and Organizational Change – that is practical use by knowledgeable persons – are focused (de Geer 1992). Security Informatics was defined as “encompassing system related and holistically oriented views of threats-risks-safeguards for communication, information, data and information technology structures with the aim to educate students who in the future will be responsible for designing, building, evaluating, managing and maintaining robust, survivable, safe and secure IT systems and structures” (Yngström 1991); later more generally defined as a “cross-disciplinary area encompassing theories and methods for handling information safely and securely in an organization or a technical system. The area also includes the use of IT as facilities in security dependent social, socio-technical and technical circumstances.” (ITS94 p 14).

Academically, the field of knowledge was identified as the intersections of Computer and Systems Sciences (DSV), Legal

***“Security Informatics... later more generally defined as a ‘cross disciplinary area encompassing theories and methods for handling information safely and securely in an organization or a technical system. The area also includes the use of IT as facilities in security dependent social, socio-technical and technical circumstances.’ (ITS94 p 14).”***

► A population of 72 students out of which 58 finished the full program

Informatics and Business Administration/Micro Economics, with a strong bias towards DSV. The scientific base was General Systems Theory (GST) and Cybernetics, The Theory of Living Systems and (to some extent) Soft Systems Methodology (Yngström 1992, 1996). The program including its basic – but initially unformulated – hypotheses on how the specific scientific base would contribute to participants' abilities in working life of problem specification and awareness, work efficiency and effectiveness, personal development and learning was evaluated and reported closely during the full 1980s. In 1991, former students ► were studied in their companies, especially how the scientific base had facilitated them with knowledge useful for their security careers. The group was characterized as

*“... consisting of well established, middle-aged, mostly males, acting in leading positions within the security area with a large bias to IT security. They are active members of societies and associations which are of importance for their careers. Many have advanced in their careers after completing the program and many of them have practical as well as theoretical knowledge from more than one discipline. More of them have 1990, as compared to 1987, knowledge in law, and the three most frequent disciplines are, in order, computer science, economics and law. Most of them have worked at least two years within the security area.”* (Yngström 1992, p 97-98).

►► Instrumental in planning for the SIIS project was S Ingvar Åkersten, FMV. Financial support was also given by Statskontoret, FMV and Swedish Post.

After initiating and settling the academic program 1980-88, focus was changed towards initiating research. As later became evident, internationally academic courses and programs in IT security mostly sprung out of research activities – and here we had gone the opposite way! Security Informatics was granted research funding within the IT-4 security program financed by FOA and NUTEK 1988-92 with the project “Basic Models for Information and Computer Security – System Integrity and Information Security, SIIS” ►►. Funding covered two half-time and one quarter-time researcher in the department as well as collaborative researchers from the Data Inspectorate and SÄKDATA AB. The project participated in, reported on and synthesized the international modeling research efforts; in those days stressing security modeling as such and the development of evaluation criteria for secure IT structures. In parallel all research efforts and projects were continuously fed in and included into the courses.

The SIIS project resulted in 34 bachelor theses (53 students), three Licentiate thesis <sup>6</sup>, one Sig Security Student Award for an outstanding contribution, one software package for risk analysis interpreting the guidelines for the Swedish Privacy Act (Yngström 1992b) – and later one Licentiate and two PhD theses <sup>7</sup>.

The funding also made it possible to invite international academics to participate in research and education, amongst these



**John M. Carroll**, professor, Canada, and Louise Yngström visiting a conference in South Africa, 1995. Carroll is author of one of the very first international text-books in Computer Security.



**Sead Muftic**, professor at DSV/KTH. Extended the research and education into security in distributed environments.

professors John M. Carroll, Canada and Sead Muftic, Yugoslavia. Both brought knowledge and experiences into Security Informatics that DSV in those days did not possess. Notably, John Carroll was the author of one of the very first international text-books in Computer Security (Carroll 1987) but his interests in the area were sparked off by participatory design in societal information systems and the then identified problem of privacy – a very similar heritage as Security Informatics. And Sead Muftic, today a professor at DSV/KTH and a member of our faculty, made it possible to extend the research and education into security in distributed environments.

### **IFIP – an important role for building Security Informatics**

During and before the times of the SIIS project, the International Federation for Information Processing ►, IFIP, played an important role for building Security Informatics. IFIP is organized into Technical Committees, TC's, with dedicated working groups, WG's. As organization IFIP is a non-political, non-religious truly international scientific body with the aim to further all sorts of research in relation to IT. Its members are the National Computer Societies. Each TC has national representatives from those nations that want to participate in a specific area, while WG's consist of researchers who out of free will with no demands of external funding are invited to contribute to the area of the WG.

During the 1970s Janis Bubenko introduced me to TC3 (Education) and its WG's where I learnt to cherish the international networks an active membership offers. When plans for TC9

► More info at [www.ifip.org](http://www.ifip.org).

(Relationship between Computers and Society) were initiated it was possible for me to participate in producing Aims and Scope for the TC. Through involvement particularly in the WGs9.1 and 2 – Computers and Work, respectively Social Accountability – I met with many noteworthy, exciting and dedicated academics and practitioners trying to bring ‘human sense’ to the computerization of society through efforts in research and development. Privacy – and later Information Security were areas of great interest, just to mention a few. Within TC9 computer science was intersected with other disciplines such as philosophy, sociology, law, etc., forming a ‘holistic’ view of various phenomena in the IT society<sup>8</sup>.

Members of TC9 were instrumental to organize TC11 – Security and Protection in IP Systems, and also to start a joint WG 9.6/11.7 – Information Technology: Misuse and the Law. All these people, efforts, meetings and conferences taken together influenced the evolving area of Security Informatics, SI.

### **DSV/SI's participation in ERASMUS/SOCRATES**

Another area of strong influence was DSV/SI's participation in the EU ERASMUS/SOCRATES program where European universities came together to form a united European academic program in Information Security (Katsikas et al 1995, Gritzalis et al 1995). Within the group of academic teachers in Information Security there were European as well as international affiliations; the activities of the ERASMUS program were blended with IFIP TC11 WG11.8 – Information Security Education. This way DSV/SI was linked worldwide with most university departments engaged in academic research and education.

***“This way DSV/SI was linked worldwide with most university departments engaged in academic research and education.”***

### **Interdisciplinary versus disciplinary approaches**

Quite clearly, in the mid 1990s, there were basically two approaches to academic education, research and development: interdisciplinary approaches (such as Security Informatics) versus disciplinary approaches. The interdisciplinary ones were similar in structure, extent, duration, level, and more-than-one-subject orientation, and showed differences in prerequisites, orientation and depth. Taken together they covered a wide range of scientific disciplines: mathematics, computer science, computer engineering, business administration, administrative science, management science, social science and law. Their efforts focused primarily on knowledgeable design and use of IT security functionality. The disciplinary programs were housed in departments of either mathematics, computer science or computer engineering; focusing efforts on more detailed research such as IT security mechanisms and functionalities (Yngström 1996). Today, the two approaches are merging in various ways leaving various focuses possible for research and education in the IT security oriented area.

During the 1990s I was the co-chair and chair of the IFIP/TC11/WG 11.8 – Information Security Education; the WG

has today an established biannual conference WISE ► building on a series of workshops on Information Security Education – Current and Future Needs, Problems and Prospects where research in education for the area is presented and discussed. The very first WISE was held at DSV in 1999 <sup>9</sup>.

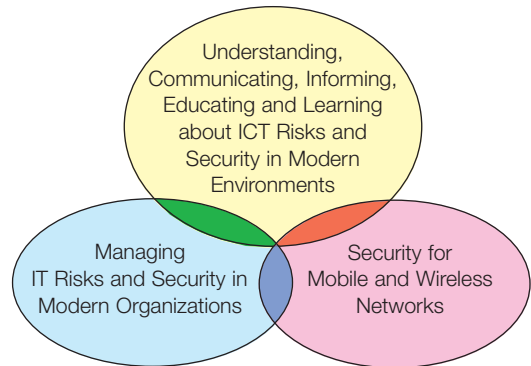
► World conference on Information Security Education.

### Seclab at DSV today

Security Informatics – Seclab – at DSV today, scientifically grounded in our history offers four different intersections for our educational programs: the original Security Informatics program for students at the DSV/SU master program, a disciplinary program for students on the KTH M.Sc. Computer Science program, a comprehensive (a mixture of both) International Master Program on KTH and an integrated program (between software engineering and IT security) for students on the KTH M.Sc IT program. For research our interests are voiced as three areas, albeit linked in various ways and also strongly connected to the educational programs and students' projects:

- Techniques, methods and models for *Managing IT Risks and Security in Modern Organizations* <sup>10</sup> including risk- and vulnerability analyses for various purposes such as for instance steering and control, value chains, auditing, etc.
- Techniques, methods and models for *Understanding, Communicating, Informing, Educating and Learning about IT Risks and Security in Modern Environments* <sup>11</sup>.
- *Security for Mobile and Wireless Networks* <sup>12</sup> covering areas such as security of management and application levels, of mobile agents technologies: security for ad-hoc WLAN and wireless communication protocols, security in radio communication networks and security for sensor nodes, protocols and networks.

Three research areas linked in various ways:



Somehow, the initial goal of Security Informatics to develop education and research for robust and survivable IT structures to influence the development of human choice for IT security through knowledgeable and wise participants in Society is underway...

<sup>1</sup> " BU föreslår att informatikutbildningen äger rum inom ramen för den grundläggande utbildningen vid filosofisk fakultet....föreslås bli knuten till ...ämnesområdet informationsbehandling som en alternativ linje... bör omfatta en grundkurs i informatik om 30 poäng... För tillträde till grundkursen krävs... tio poäng i ADB inom ämnesområdet informationsbehandling... Vidare fordras baskunskaper om minst

80 poäng... Vid en eventuell begränsning... bör företräde lämnas sökande som fullgjort partiell biblioteksutbildning... med fördel bör antas till informatikerutbildningen... agronom, apotekare, arkitekt, arkivarie, bergsingenjör, bibliotekarie, civilekonom, ... utbildningen vid starten lokaliseras till den för Stockholms universitet och tekniska högskolan i Stockholm gemensamma institutionen för informationsbehandling och där bedrivs i nära anslutning till ämnesdelen ADB.” (pp112-113)

- <sup>2</sup> Kristian started, on behalf of the Computer Society of Sweden Special Interest Group SIG-Security the Technical Committee No 11 (Computers and Security) within IFIP, the International Federation for Information Processing in 1984, and was instrumental to the First Security Conference, IFIP/Sec'83 in Stockholm, Sweden, 16-19 May, 1983. TC11 today honours him through the annual KBA – the Kristian Beckman Award – recognizing an individual who has significantly contributed to the development of information security, especially achievements with an international perspective.
- <sup>3</sup> IFIP/sec'83 shows the Swedes in 1983 were prominent in what today would be called IT security. Papers were given by Jan Freese, Thomas Osvald, Alan Eriksson, Tommy Svensson, Gunnar Welanders, Per L. Hoving, Åke Carlsson, Rolf Blom, Jan-Olof Bruer, Rolf Öhlund, Axel Ancker, Vivi Ann Lundberg, Louise Yngström, Lennart Bernhede, Ulf Leopoldson, Leif Gardeback, Ragnar Eriksson, Kristian Beckman, and Christer Lindén.  
In the Steering group, the Organizing committee and the Program Committee the following Swedes were engaged: Per Svenonius, Knut Harnaes, Anders Rönn, Kristian Beckman, Johan Essen, Jan Freese, Viiveke Fåk, Bengt Rudolf, Birgitta Olsson, Per Hoving, Bengt Nordquist, Jöran Wester and Rolf Åstrand.  
Sponsors were Statskontoret and Honeywell Bull AB.
- <sup>4</sup> The initiation was supported by professor Janis Bubenko, DSV, who commented that I actually should pursue my PhD instead but if this was such an urgent area for the Society and if there was extra funding for the start-up, he would give his full support.
- <sup>5</sup> A thorough investigation of the importance of the “Scandinavian approach” – or rather the Nordic approach – to information systems development is given by Juhani Iivari in “Is Scandinavian Information Systems Development becoming passé?” In Bubenko, Janis Jr, Impagliazzo, Johan and Sölvberg Arne (eds) History of Nordic Computing, Springer 2003 pp 339-356.
- <sup>6</sup> Nilsson, Peter: “Information Quality – an analysis of quality aspects of information used in problem solving”, Department of Computer and Systems Sciences, Stockholm University, 1990.  
Perez, Eduardo: “Information Security Management in IT systems and organizations – a conceptual model”, Department of Computer and Systems Sciences, Stockholm University, 1992.  
Yngström, Louise: “Towards a Systemic-Holistic Approach to Academic Programs in the Area of IT security”, Department of Computer and Systems Sciences, Stockholm University, 1992.
- <sup>7</sup> Kowalski, Stewart: “IT Insecurity: A Multi-disciplinary Inquiry”, PhD Thesis, Department of Computer and Systems Sciences, KTH, 1994.  
Yngström, Louise: “A Systemic-Holistic Approach to Academic Programmes in IT Security”, PhD Thesis, Department of Computer and Systems Sciences, Stockholm University, 1996.

Wahlgren, Gunnar: "A Proposal for a Computer Aided IT Risk Management System – an Object-Oriented Approach", Licentiate thesis, Department of Computer and Systems Sciences, Stockholm University, 1996.

<sup>8</sup> Many contradictory and difficult research problems were initially dealt with in conferences; see for instance Yngström et al 1985, Sizer et al 1994. Prior to conferences TC9 issued a Newsletter with four editions annually, which were edited by me 1975-79.

<sup>9</sup> Yngström, Louise and Fischer-Hubner, Simone:  
WISE 1, Proceedings of the IFIP TC 11 WG 11.8 First World Conference on Information Security Education, 17-19 June 1999, Sweden. DSV Report Series 99-008, ISBN 91-7153-910-7.

<sup>10</sup> PhD's within the area are:  
Magnusson, Christer: "Hedging shareholder value in an IT dependent Business Society", Department of Computer and Systems Sciences, Stockholm University, 1999.  
Frisinger, Ann: "A Generic Security Evaluation Method for Open Distributed Systems", Department of Teleinformatics, KTH , 2001.  
Björck, Fredrik: "Discovering Information Security Management", Department of Computer and Systems Sciences, Stockholm University, 2005

Licentiates are:

Ann Frisinger, "Security in the Networked Education Process", Department of Teleinformatics, KTH , 1998 TRITA-IT AVH 98.02.  
Fredrik Björck, "Security Scandinavian Style. Interpreting the Practice of Managing Information Security in Organisations", Department of Computer and Systems Sciences, Stockholm University, 2001.  
Bakari, Jabiri K: "Towards using BRITS framework to manage IT Security in non-commercial organizations in Developing Countries: A case study of Tanzania", Department of Computer and Systems Sciences, Stockholm University, 2005.

<sup>11</sup> PhD's within the area are:  
Näckros, Kjell: "Visualising Security through Computer Games", Department of Computer and Systems Sciences, Stockholm University, 2005.  
Casmir, Respickius: "A Dynamic and Adaptive Information Security Awareness, DAISA, Approach", Department of Computer and Systems Sciences, Stockholm University, 2005.

Licentiates are

Kjell Näckros, "Game-Based Instruction within IT Security Education", Department of Computer and Systems Sciences, Stockholm University, 2001.  
Respickius Casmir, "An Approach to IT Security Education for Developing Countries", Department of Computer and Systems Sciences, Stockholm University, 2003.  
Charles N Tarimo, "Towards a Generic Framework for Implementation and Use of Intrusion Detection Systems", Department of Computer and Systems Sciences, Stockholm University, 2003.  
Job Asheri Chaula, "Security Metrics and Public Key Infrastructure Interoperability testing", Department of Computer and Systems Sciences, Stockholm University, 2003.

<sup>12</sup> PhD's within the area are:

Kapidzic, Nada: "Extended Certificates Management System: Design and Protocols" Department of Computer and Systems Sciences, KTH, 1997.

Ciobanu Morogan, Matei: "Security systems for Ad-hoc Wireless Networks Based on Generic Secure Objects" Department of Computer and Systems Sciences, KTH, 2005.

de Zoysa, T. Nandika Kasun: "A Model of Security Architecture for Multi-Party Transactions", Department of Computer and Systems Sciences, Stockholm University, 2005

Licentates are:

Cheng, Yi: "A Comprehensive Security Infrastructure for Mobile Agents", Department of Computer and Systems Sciences, KTH, 1997.

Davidson, Alan: "Availability, Integrity and Consistency in Certificate Management Systems", Department of Computer and Systems Sciences, Stockholm University, 1999.

Ciobanu Morogan, Matei: "Generic Security Objects. A Comprehensive Java Security System for Open Networks", Department of Computer and Systems Sciences, KTH, 2000.

De Zoysa, T. Nandika Kasun: "The Concept of A Secure WWW System Based on Smart Cards and Certification Technologies", Department of Computer and Systems Sciences, Stockholm University, 2000

Mwakalinga, Jeffy: "Security Management of Global and Integrated Security Systems", Department of Computer and Systems Sciences, KTH, 2002

---

## References

Carroll, John M.: Computer Security, Butterworth-Heinemann, Toronto 1987.

De Geer, Hans: På väg till datasamhället. Datateknikken i politiken 1946-1963, KTH, Stockholm 1992.

Gritzalis D. (Ed.), University Programmes on Information Security, Dependability and Safety, European Commission, Erasmus ICP, Project ICP.94 (&95)-G-4016/11, report IS\_CD-3c, Athens, July 1995.

Katsikas S., Gritzalis D. (Eds.), A proposal for a postgraduate programme on information security, dependability and safety, European Commission, Erasmus ICP-94 (&95)-G-4016/11, Report IS- CD-4a, Athens, September 1995.

Sizer R., Yngström L., Kaspersen H. and Fischer-Hubner S. (Eds.), Security and Control of Information Technology in Society, Proceedings of the IFIP TC9/WG9.6 Working Conference on Security and Control of Information Technology in Society on board M/S Ilich and ashore St.Petersburg, Russia, 12-17 August, 1993, North-Holland 1994.

Terminologi för informationssäkerhet, ITS6, Informationstekniska standardiseringen, 1994.

Yngström, L. :Education in Safety Systems and Security Analysis – suggestions for a One Year University Program, in V.A.Fåk (ed) Security, IFIP/sec'83, North-Holland 1983, pp 295-303.

Yngström L., Sizer R., Berleur J. and Laufer R. (Eds.),  
Can Information Technology Result in Benevolent Bureaucracies,  
Proceedings of the IFIP TC9/WG9.2 Working Conference: Can  
Information Technology Result in Benevolent Bureaucracies?,  
Namur, Belgium, 3-6 January, 1985, North-Holland 1985.

Yngström, L. Utbildning och forskning i Säkerhetsinformatik, Research  
Report, Department of Computer and Systems Sciences, Stockholm  
University/RIT, SIIS-R-91, Stockholm 1991.

Yngström, L. Towards a Systemic-Holistic Approach to Academic  
Programs in the Area of IT Security, Licentiate thesis, Department of  
Computer and Systems Sciences, Report 92-026DSV, Stockholm  
University, Stockholm 1992.

Yngström, L. Final Report System Integrity and Information Security  
Project, Department of Computer and Systems Sciences,  
Report 92-041-SIIS, Stockholm University, Stockholm 1992b

Yngström, Louise: "A Systemic-Holistic Approach to Academic  
Programmes in IT Security", PhD Thesis, Department of Computer  
and Systems Sciences, Stockholm University, 1996.



# Complementary memories

from students, teachers and administrators

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DSV success relies to a large extent on the thousands of hours of work that belong to teaching, planning, administrating, studying – and having fun. The editorial board invited a number of collaborators to contribute with some of their memories from DSV.

*Lars Gunnarson* recollects how being an undergraduate student influenced his professional life.

*Gunnar Björkman*, a teacher since 1969, describes the processes surrounding DSV's theses on Bachelor level including giving some statistics.

*Josef Swiatycki*, a DSV personality since 1980, presents a personal overview and analysis of the education in programming languages, teachers, courses, and students' reactions.

*Anne-Marie Philipsson*, describes the growth of DSV through her perspective as an administrator at DSV since 1972.

An analysis questioning whether a generality of the development of tools can be spotted or not is given by *Stig Berild*, a researcher related to DSV since 1969.

*Åsa Rudström* uncovers her development from being a student, to a teacher – and finally a PhD.

*Peter Bagge* was engaged within an early development group testing Langefors' theories, his presentation gives a historical touch to DSV's ambitions.

The editorial board would like to thank all these persons for sharing their memories with the reader

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## STUDENT LIFE AT DSV

In 1999, the IT bubble was inflating rapidly, only to burst loudly less than two years later. I was happily unaware of this on that autumn day on my way to Electrum and my studies in the four year programme in computer and systems sciences. I was looking forward to being on the front edge of technology when Sweden conquered the rest of the IT world. We all know how the story ended...

Already when I started at DSV, I had decided to take an active part in students' life. During "the herding", when DISK presented its different sections, I was particularly attracted to the Section of Trade and Industry, "NärS"). I immediately took a liking to the section, there were nice people and thrilling assignments, although I faced a tough challenge when I, at my first NärS meeting, was assigned the task to arrange a pub evening for three companies. It all went well, though, and I continued arranging social evenings for companies, attending company-mingling parties, preparing the labour market's day "Systemvetardagen" and other fun activities. After one and a half year, I was appointed chairman of the section. However, NärS was not the only thing that kept me occupied, I also took an active part in the sports section, and ended up in the DISK committee as one of two student representatives elected for planning of the institution's change of address from Electrum to Forum. During these years, my engagements more numerous, and I seized upon both the students' magazine "Systembladet" and later also the Café. In 2002, I entered the post as chairman for the whole association, and remained there for two years.

As an active student, I had frequent contacts with the department and its management, who was always there, and still is, for DISK and the students. I am not saying we always agreed, but there was an atmosphere without prestige where everyone spoke their opinion openly, and the result was usually great. The student café and the pub Foo Bar are two excellent examples. The contrasts have been large, from the first years when the companies poured money over DISK and snatched half-baked students from the education, to the years when we were forced to work hard convincing companies of the importance of being visible among students, and to struggle for the slightest karaoke DVD to be sponsored. From having the highest admittance grades to facing problems making students even apply to DSV.

Apart from all the time I spent on DISK, I studied a bit as well. I chose to study the specialization towards interactive systems, and wrote my masters thesis together with a friend from DISK. We were lucky to get an assignment at Bofors Defence in Karlskoga, where we designed a graphic interface for a remote-controlled vehicle. The fact that we were even paid to do it made it all even more exciting!



**Lars Gunnarsson**

Chairman of DISK 2002 & 2003.  
Engaged with former Chair(wo)man  
of DISK 2004, Emily Rosenqvist.  
Qualified from DSV programme.

In the summer of 2004, I sent two job applications, just to give it a first trial. My true intention was to devote that autumn to taking rest credits. Destiny wanted otherwise, and three weeks later I had an employment as substituting IT coordinator at Karolinska University Hospital (Karolinska Universitetssjukhuset) in Huddinge. Apart from my education in computer and systems sciences, my experiences from DISK were of decisive importance for my getting the job.

Despite the fact that I nowadays have a permanent job and have moved on to professional life, I am in some ways still part of DISK and NärS. In spring 2006, I was asked if I wanted to be a member of the recently started “marshal’s office”, and of course my response was positive. On the wall at home, I have a diploma proving I am also an elected member of DISK’s Senior Section. Some people might find it a bit silly that a grown-up person considers being appointed to a students’ association as important as to hang the diploma on the wall. For me, it is a natural thing to show it; DISK was my whole life during my years at DSV, and I am incredibly grateful for having been part of the organization. I grew both as a fellow being and as a professional person, I made friends for life and I look back upon my time at DSV and DISK as one of the best periods of my life. For me, the diploma proves that all the hours I put in and all hard work in Kista was not wasted, and that I – hopefully – contributed to making my fellow students’ time in Kista worth remembering. For this possibility, I thank the department that has created a student-friendly atmosphere. I also thank DISK, who kindly let me in.

***“Some people might find it a bit silly that a grown-up person considers being appointed to a students’ association as important as to hang the diploma on the wall. For me, it is a natural thing to show it; DISK was my whole life during my years at DSV...”***

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## WHAT ARE WE REALLY EXAMINING?

With a certainty of 99 percent, no one except those who are obliged to read an essay will ever read it. So, of what importance is an uncertain conclusion? A bad object? Some vague inquiry questions? An unclear wording? A misspelling? A confusing division? Where is the limit to obtain a pass? Why do we give a conditional pass? What are we actually examining?

What happened to the group that should only correct a few divisions before the final seminar, never to return? Why is an easy task like that not accomplished? Are we examining maturity? What are we actually examining?

What happened to those groups who finished their own essays, but never induced themselves to act as opponents? Was it cowardice? Was it lack of time? Or was it lack of power of initiative? What are we actually examining?

Be it right or wrong, some groups blame it on bad supervision and simply give up. Some run constantly to the study counsellors and to ten different supervisors, tiring out half the department. Others send in a new version every month during a period of two years. Are we examining endurance? What are we actually examining?

A well-written essay with an elegant layout always gives a good overall impression. Are we examining a good Swedish language and a nice layout? What are we actually examining?

In June, when you lean back to summarize this year's essays, it is not the essays you remember – but the authors. The people who carried through those unforgettable seminars, who formulated the clever titles, who wrote the thrilling introductions, those mad purposes, these incomprehensible problems, who did the crazy divisions, came up with those rash suggestions for essay structure, who wrote the inexplicable conclusions. And, unfortunately, those “five percent” who never ought to have started writing.

What you should remember is, of course, those essays that drew the most creative conclusions, but you don't. They just pass briefly, no problems, three or four supervision meetings, the final seminar passes and then just: “Bye bye, congratulations to a successful essay”. Perhaps you will say: “Hope to meet you again some time”, but in practice you never do. And if I do meet them again, I will not recognize them.

Of course, a few essays written during these years have engraved themselves on my memory. Some have been good, some have belonged to the “five percent”. The majority have been neither good nor bad, only that something out of the ordinary has happened.



**Gunnar Björkman**

is a teacher at DSV since 1969. He is responsible for thesis texts at Bachelor level, and was during a long period also responsible for the project work in systems development using the “KOSAB” case.

The first thing that meets you as a reader is the title. It is the most important reference of an essay, but it should also mirror the essay's content and attract readers. Few essay titles have dominated a seminar, but one that really did was "Co-ordination – a threat or an opportunity?". The first speaker considered the title to be even "too good, it does not fit in an academic essay!". What a reaction! Everyone had an opinion! "Newspaper headlines are not science"; "The title really reflects the contents of the essay". A quarter of an hour passed before order was fairly restored, and since then, I am convinced of the journalistically biased title's significance for an essay.

The final seminar is something that most authors look forward to with enthusiasm mingled with terror, and few things can make an author as disappointed as a seminar without participants. After having struggled for almost ten months with purpose, data collection and conclusions, the final seminar is an opportunity for feedback and acknowledgement. The very final seminar is the definite proof of a completed education, the evidence of an academic exam. The author is probably extremely nervous at the prospect of the probably two most important lessons of his or hers whole life, the crowning glory after 16 years of studies.

Naturally, this nervousness can cause problems. I will never forget the poor girl who, in her introductory speech, wanted to concretise her supervisor's constant dwelling on the great importance of the structure in an essay. She began by saying "we have made a great effort to keep a red thread (Swedish expression meaning a main thread. Translator's comment) throughout the whole essay." Meanwhile, she intended to pull a red thread out of her pocket, about one decimetre long. Unfortunately, the thread broke, and just a tiny little piece of thread emerged, hardly visible.

One of the first essays I supervised brought up the problem concerning "Hospitals, data and integrity". The authors initiated the essay with a conclusion, which is sometimes justified, particularly when the conclusion is as strong as this one:

*"The best protection against illegal access to data seems to be to let the terminal be rather hard to find. It is located in a cubby-hole, discretely marked 'cleaning'."*

On a few occasions, I have received a gift from the students after the seminar. The gift has consisted of everything from a totally unusable tie to a fantastic, Chinese wine and a present perhaps finer than all other; a Mexican student gave me a little deer made out of wood. He had certainly learned "a lot of IT during my time in Sweden". But most importantly, he said, was to learn that there are countries and cultures where you give a present after you have received your grade. In Mexico, it is a matter of course to give a present before receiving your grade. To him, this was natural, he could not imagine another way of doing it.

To supervise essays is inspiring, absorbing, fascinating, and not least, instructive. You never know how, or even if, it will come to an end. If only you did not have to deal with the “five percent”.

In my instructions, I have for many years included poem that has attracted a lot of attention. Jozef wrote the draft, and together we made some modifications during an unforgettable evening, approximately ten years ago. Since then, it is a permanent feature in my instructions, much to the open appreciation from the students.

### Uppsatsen har lämnats in

*Uppsatsen har lämnats in!  
Inget mer skall itereras,  
ändras, bytas, revideras,  
skrivas om och läggas till.  
Uppsatsen har lämnats in.  
Allt är klappat, allt är klart,  
vi kan gå och spela dart,  
dansa, spela mandolin,  
hälsa på hos tjejen sin,  
dricka öl och pratas vid,  
snacka strunt och dricka vin  
– har vi lust så har vi tid  
– Uppsatsen har lämnats in.  
Vi är fria du och jag!  
Inget Word som ger en fnatt,  
inget syfte gör en matt,  
ingen bakgrund, ditt och datt.  
Ingen uppsats varje natt!  
Vi är fria du och jag!  
. . . . .  
Va fan skall vi göra nu?*

### Our thesis has been handed in!

*Our thesis has been handed in!  
No more writing, fighting, changing  
fixing, spelling, rearranging,  
grammar checks, adjusted margin.  
Our thesis has been handed in.  
All the ends are neatly tied,  
we can go and play outside,  
sing and dance, take wine and cheese,  
go and look up my old squeeze  
(maybe catch some new disease),  
take a course in Cantonese.  
We have time for every whim.  
Our thesis has been handed in!  
We are free the both of us.  
No more Word to make us cuss.  
No more goal and problem fuss.  
No more all night final rush.  
More work than reason can allow,  
then working next day anyhow.  
We are free, so take a bow –  
. . . . .  
What the hell do we do now?*

As will be seen from the table on the next page, the number of essays submitted during the department's existence has varied a great deal from one year to another. Naturally, no essay was submitted during the very first year, but by the beginning of the 1970s we saw the first peak. It was followed by a decrease, but in 1980-81 the number increased again. This was partly due to a general increase in the number of students, partly to the fact that the very first group of students from the three-year long Programme in Applied Systems Science reached the third year.

**C-essays per academic year**

| Yr    | No./Yr | •    |
|-------|--------|------|
| 67-68 | 5      | 5    |
| 68-69 | 1      | 6    |
| 69-70 | 21     | 27   |
| 70-71 | 28     | 55   |
| 71-72 | 29     | 84   |
| 72-73 | 19     | 104  |
| 73-74 | 13     | 116  |
| 74-75 | 13     | 129  |
| 75-76 | 4      | 133  |
| 76-77 | 5      | 138  |
| 77-78 | 6      | 144  |
| 78-79 | 11     | 155  |
| 79-80 | 10     | 165  |
| 80-81 | 20     | 185  |
| 81-82 | 27     | 212  |
| 82-83 | 30     | 242  |
| 83-84 | 18     | 260  |
| 84-85 | 37     | 297  |
| 85-86 | 41     | 338  |
| 86-87 | 50     | 388  |
| 87-88 | 51     | 439  |
| 88-89 | 41     | 480  |
| 89-90 | 43     | 523  |
| 90-91 | 44     | 567  |
| 91-92 | 47     | 614  |
| 92-93 | 58     | 672  |
| 93-94 | 67     | 739  |
| 94-95 | 73     | 812  |
| 95-96 | 38     | 850  |
| 96-97 | 53     | 903  |
| 97-98 | 34     | 937  |
| 98-99 | 26     | 963  |
| 99-00 | 31     | 994  |
| 00-01 | 28     | 1022 |
| 01-02 | 28     | 1050 |
| 02-03 | 29     | 1079 |
| 03-04 | 17     | 1096 |
| 04-05 | 28     | 1124 |
| 05-06 | 23     | 1147 |

The increase in the mid-eighties can be explained by the fact that the students from the two-year long Programme in Information Processing and Computer Sciences initiated their essay writing during that particular year.

The absolute peak was reached during the academic year of 1994-95 and the years immediately preceding and succeeding it. Except for the Advanced course students, the students from the Programme in Applied Systems Science, from the Programme in Information Processing and Computer Sciences as well as students from the Computer and Systems Sciences (80 credits) also wrote their essays.

The fact that the number of C-essays has decreased during the end of the last decade and the beginning of the current decade is due to the fact that almost all programme students, as well as many taking the Advanced course, from the mid-nineties and on have started writing Swedish Master essays instead – a new type of essay which has practically never existed previously.

Up to and including the academic year of 05-06, a total of 2083 students have submitted their C-essays at the Department, and they are distributed among the different courses/programmes as follows (the numbers are to some extent uncertain, since many students shift courses/programmes during their period of study):

- Advanced course/Specialized course .....784
- Programme in Applied Systems Science .....793
- Programme in Computer and Systems Sciences .....2
- Programme in Information Processing  
and Computer Sciences .....197
- Computer and Systems Sciences, 80 credits .....292
- Programme in IT and Communication Science .....15

Slightly less than 80% of the submitted essays have had two authors, 23 essays have had three authors, which is something we no longer allow.

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## A SHORT HISTORY OF PROGRAMMING EDUCATION AT DSV

It is not easy to summarise 28 years of teaching programming in a couple of pages. It is, of course, impossible to mention all the courses, languages, computer environments, teachers, students, episodes, anecdotes, etc, and to effectively convey how fun it all has been.

Below I give a short history of the courses, naming people who designed them and languages used on them. The teachers on those courses fall into two categories: those with the vision, the knowledge, the drive to design new courses, introduce new languages and influence the education for generations of students, and those who carried out the courses, making pedagogical improvements and colouring the courses with their personalities. In the first category I would count Carl-Gustaf Jansson, Anna-Lena Johansson, Istvan Orci, Marianne Janning, Magnus Karlson, Bo Steinholtz and others. In the second category there are many memorable personalities, such as Stefan Möller, Åsa Rudström and myself, but, regretfully, we are too many to mention in this short history.

### Starting with Simula – changing to Pascal...

When I started teaching on the three year DSV programme in 1978, it began with a module of programming and introduction to computer systems. The language used was Simula. Even though Simula was an object-oriented language, the main content of the course was basic imperative programming. It was not an optimal situation – tutoring about problem solving, algorithms, and data structures was complicated by the object oriented aspects of the used language.

A couple of years later, Istvan Orci took over the responsibility for the module and developed it, introducing elements of structured programming, software testing, software quality, logic etc. He also exchanged the object-oriented Simula language for the imperative Pascal language – a clean, well-defined, educational language. While the introduction of theoretical elements was challenging but the change of language was very successful, making many basic concepts much more clear and comprehensible for students.

The introductory programming module was followed in the second year by two integrated modules of programming and programming tools, the peak among programming courses on the three year program.

While shorter programmes concentrated on administrative applications (in the form of a Cobol-module in the first semester), the three year programme put emphasis on general programming techniques: advanced algorithms and data structures, construction of programs in modules, recursive programming techniques,



**Josef Swiatycki**

is since 1978 a teacher in programming languages and programming methodology.

software engineering techniques and already in the late 1970's, object oriented programming with Simula as the programming language. As I remember it, administrative applications and programming in COBOL, were ignored to begin with but later included at the request of the students.

The integrated two-module course in the second year included a project in which the students, divided into groups, constructed an application generator in Simula, including an interpreter for a Lisp-like language. The course was created and held by Carl-Gustaf Jansson, whose personality cast an influence on the course and on the way the students (who later became teachers) viewed programming and programming languages until the programme ceased in the early 1990's. In the early 1980's, Carl-Gustaf was assisted by Christer Wikmark, who added his talent, fantasy and humour to that of Carl-Gustaf.

In the late 1980's, a software engineering module was added in the second semester of the three year programme. I was given responsibility for developing and holding the module. It was mainly a project course, where students were divided into teams of ten persons and given the task of designing, implementing and testing a small system, following modularization, specification, and testing techniques presented in lectures.

As stated above, during the 1980's and most of 1990's, the shorter programmes had a bias towards administrative programming, with COBOL as the main programming language. They began though with an introductory module with introduction to general programming. When I took the course as student, the language was Basic, run on the Department's legendary HP 2000A with Teletype terminals with punch tape readers/punches.

Some years later, the module was taken over by Hans Köhler. Hans was interested both in programming and technology, as well as in sociological and organisational aspects of computerized society, and his introductory module reflected this. He wrote a textbook for the module, and together with Christer Wikmark they designed and implemented a special programming language, Asta (named after a cat), to be used on the course. Asta was a very interesting language: interpretative, with an integrated programming environment, dynamically typed, supporting both imperative and object-oriented style of programming, and using novel debugging techniques with tracing (rather than breaking) execution. After a couple of years the module was split: programming was removed from the introductory module and extended to form an independent module with Pascal as programming language (mirroring the corresponding module on the three year programme).

During most of the 1980's the responsibility for the module on programming of administrative systems was held by Marianne Janning, who continuously worked on improving the course. She brought to the module elements of Jackson Structured

***“When I took the course as student, the language was Basic, run on the Department's legendary HP 2000A with Teletype terminals with punch tape readers/punches.”***

Programming, gave emphasis to structured programming in COBOL, structured and restricted the algorithmic portion of the course to the most important algorithms and produced excellent documentation for the course (resulting, in cooperation with Eric Roupé and Lennart Fosselius, in a textbook on structured programming in COBOL). She also brought in end-user programming with CS4, a query language for an associative database system, developed at the Department.

### **From COBOL to Simula and Java**

Towards the mid 1990's, administrative programming and COBOL were gradually faded out, replaced by more general, object-oriented programming first in Simula, later in Java.

I concentrate here on the compulsory courses, but there were of course optional courses to choose from in later semesters/years. As I remember it, there were not so many advanced courses in programming in the end of 1970's – I remember just one: discrete event simulation with Simula, held by Christer Hultén. In the early 1980's, though, there were courses in logic programming in Prolog, held by people from the group around Sten-Åke Tärnlund (Anna-Lena Johansson and Agneta Eriksson, who also wrote a textbook on Prolog programming) and courses in functional programming in Lisp (held, as I remember it, by Carl-Gustaf Jansson). There were also courses in end-user programming with APL, held by Ante Grubbström and external teachers.

During the course of the years, a variety of optional programming courses arose, some to disappear after a couple of years, some to live on year after year, possibly spawning new courses and developing into mini-programmes. Some of those courses started out as a faculty seminar to study a new language or technique, e.g. Ada in the late 1980's started by Carl-Gustaf Jansson and later taught by me, or Java in the middle 1990's, started by Peter Idestam-Almqvist and later taught by Pierre Wijkman. The course on Ada lived only for a couple of years, the course on Java resulted in Java becoming the main programming language on the intermediate level (replacing Simula), and spawning a whole sequence of courses on Internet-programming. Another important course on the advanced level was the course in object-oriented programming languages given by Alan Davidson – the main language used on the course was Smalltalk-80, but many other languages and models were taken up, both class-based and prototype-based.

*“...the course on Java resulted in Java becoming the main programming language on the intermediate level (replacing Simula), and spawning a whole sequence of courses on Internet-programming.”*

### **The “guru course”**

In the middle 1980's, Magnus Karlson started a course named Systems Software. It was a very hands-on course on systems programming and maintenance, introducing Unix, Unix system calls, the programming language C and various techniques and problems of systems programming. Magnus employed some novel

pedagogical ideas, such as having students develop an assignment project in many phases, never knowing beforehand what the next phase would be, and switching the programs between phases (to make students learn to construct extensible and modifiable programs, and to read, analyse and modify programs written by others). The course became known as the “guru course”. As C’s popularity and importance grew in the industry, there was an increasing student demand for a more general course in C. The course was split into a general course on C-programming and some sequels: systems software, C++, the X Window Systems etc.

### **Four year programme with high ambitions**

In the mid 1990’s, the three year programme was replaced with a four year programme. With this came a major revision of the programming modules. The resulting modules were very ambitious: the introductory programming module covered basic programming, algorithms and data structures, discrete mathematics and more. It was designed by Bo Steinholz, following international curricula in computer science (Bo also headed the software engineering specialization in the third year, introducing, among other things, object-oriented software construction with Eiffel). The programming module of the second year, designed and held by a team of teachers (Magnus Boman, Lars Asker, Alan Davidson and Patrik Nyblom) covered three programming paradigms (functional programming with Scheme, logic programming with Prolog, and object-oriented programming with Java and the specially developed D++, based on C++), and computational theory. In a couple of years it became apparent that the ambitions were set too high, and the modules were restructured, giving two pure programming modules: the first on basic programming with Pascal, the second on object-oriented programming with Java.

In the late 1990’s, Java gradually became the main programming language at the Department, replacing Simula as the object-oriented language but also being used as the main introductory language on several programmes, e.g. on the IT-programme at KTH, on the three year programme on IT and communication, and, lately, on the short programmes.

Now, in the mid 2000’s, I have a feeling that programming education has a kind of identity crisis. As system development became the art of putting together library components, the value of teaching basic constructs, algorithm design and data structures is being questioned. On the other side, the basic constructs seem necessary to understand the mechanisms of construction of programs from components. The compulsory part of the programming education is being discussed and I am sure it faces some drastic changes, even if we are not yet sure about the direction.

On the optional level we have quite a rich selection, e.g. a block of Internet programming courses, the “classic” courses

***“The compulsory part of the programming education is being discussed and I am sure it faces some drastic changes, even if we are not yet sure about the direction.”***

on programming in C and in C++, courses on programming computer games, courses on programming with multi-media. Tobias Wrigstad has taken up the course on object-oriented languages, developing and updating it. A new course on dynamic programming languages has also been developed by him and his colleagues.

I would like to conclude this recollection by some words on the atmosphere of those years. I know that I am not alone in finding teaching programming to interested beginners fascinating. During the 1980's and 1990's, there was at DSV a community of teachers that seemed to take teaching programming as a life style. During those decades, though the number of courses and students were increasing continuously, it was still possible for a teacher to be familiar with all courses in his subject area in the different programmes, to know all the other teachers in the same subject area and to know most of the students by name. The class teachers and tutors were recruited among senior students, there was a rich social life among junior teachers and senior students, the transition from student to tutor, to class teacher and possibly to doctoral-student and lecturer was quite seamless. When there was a need for a tutor or a class teacher, it was possible to go to the terminal rooms and recruit a talented senior student in 10 minutes flat. On some programming courses, when the approximately 120 students were to be divided into project groups of ten students each, with fairly equal distribution of programming skills, discipline, motivation and personality, the teachers on those courses could do it with just a list of student names – we knew the names and characteristics of every student.

***“During the 1980's and 1990's, there was at DSV a community of teachers that seemed to take teaching programming as a life style.”***

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## MEMORIES FROM DSV



**Anne-Marie Philipson**

is an administrator at DSV since 1972. From 1995 she was Head of administration at DSV until she retired in 2006.

I started working at DSV, on October 1, 1972. I had applied for and been accepted to a half-time post as assistant at the department's students' office.

At this time, the department was located in the F-building in Frescati, and the students' office was situated on the 4th floor. Students' offices for three of the departments were situated on this floor; the English Department, the Department for Oriental Languages and the Department for ADB. The offices were located in a large room divided by bookshelves, and during opening hours a counter window was opened to receive the students. The other departments had employees who came to receive the students during opening hours, but who had their regular workplaces in their respective departments. I was the only one to be situated in the students' office even when the office was closed.

Initially, it was quite lonely and my situation made it hard for me to establish contacts with other employees at the department, partly because I only worked half-time and partly because my workplace was separately situated.

One month after I got the job, Åke Hylin was employed as student counsellor, and he also had his office on the 4th floor. However, he also had other tasks assisting the director of studies and was not permanently located on the 4th floor, although his office was adjacent to the students' office.

Before I was employed, the graduate students had, as part of their duties at the department, been taking turns to receive students at the office, to handle registrations and to report results. Cornelius Pitula was the graduate student, who helped me become acquainted with my tasks, and the one whom I could ask when facing different problems.

Compared to how education and the tasks for those working with education administration at the students' office looks like today, it was all very uncomplicated back then. The number of students registered was high, since there were no restrictions in the admission process, all qualified students who wanted to take an education program could register.

There were three levels, A = basic course, B = intermediate course and C = advanced course. Each level had four elements, and some elements included both examination and an assignment to submit. The job consisted in registering the students at the beginning of the term, and to fill in a registration card for each student. Registration lists should also be filled out, which were sent to the Study Administration Unit at the university, either filled in by hand or typed. The registration cards were also used for registration of examination results, and to enter grades for completed courses. All this was then to be reported centrally to Studok, the precursor of Ladok.

At the start, all who registered were supposed to hand in a photo, which was attached to the registration cards, but this process had been abolished when I was employed. However, registration cards are still to be found on students who started studying the subject previous to this, for example Gunnar Björkman, Tord Dahl, Anita Kollerbaur, Eric Roupe and Louise Yngström. Students registered for examination on hand-punched cards, which then produced place lists and marking templates for the responsible teacher.

In the beginning, I did not enjoy working at the department, and I felt that there was a great gap between teachers and the administrative staff. There were also tensions between persons in the administrative staff, as well as hierarchies, and it was of great importance who did what. Despite these facts, in retrospective I still realize that I must have been accepted among my colleagues relatively fast. Already after three years, I was involved in the planning of the election of the department's board and also elected as representative for the technical-administrative staff. In fact, I have been part of the department's board for over 30 years! Afterwards, it seems an inconceivably long time.

I have witnessed two changes of the department's name, seen it becoming a separate department in 1977, two changes of address, one from Frescati to Electrum in Kista and one from Electrum to Forum. When I was employed, the department had recently moved into the newly built F-building in Frescati and thereby managed to gather everyone including researchers at the department into one location.

When I started, electrical IBM golf ball typewriters were used, and a lot of material was stenciled, to be copied into compendia by the porter. Corrections were made with stencil varnish, then the copy-and-paste method was used to get everything right! When we later got our first MacIntosh computers, it was like a revolution. We typed using a line-based word processing system called Vided, and later on we were took courses in Lotus 1,2 and 3 as well as in WordPerfect. But this is far from today's equipment, including computers and copying machines which also functions as printers, faxes and scanners. Today, with Internet and e-mail it is hard to understand how we even managed to do our job before.

Personally, I gradually extended my area of assignments and simultaneously increased my working hours, first to 75% and from 1983 to 100%. I became responsible for making the timetable, which was far from as extensive as it is today. I also became responsible for the study manuals, which were published every academic year. When Kriss Holmberg left her post as teacher and study counselor, I took over responsibility for the admission process, including information to applicants, admission and calling for reserve applicants.

I remember that by the beginning of the 90s, after we had moved to Electrum, we had more than 2000 applicants for the

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basic course. Just the lists for the basic course filled an entire, thick binder. 2006, one binder is sufficient for all courses! Since we were located in Kista, we also administered parts of the admission process that were normally centrally managed in Frescati, and we do so to even a greater extent today when we also have the advantage of having the students' union DISK in Kista, handling all contacts with the students' union in Frescati.

By the middle of the 90s, I was assigned other tasks as head of administration, tasks that involved more responsibility mainly for staffing issues, but also for premises, security alarm systems and other administration issues.

Since DSV is a joint department for SU and KTH, all administrators, financial-, staffing- and educational administrators must have a good knowledge of both SU's and KTH's sets of rules within the different areas. It also means having a lot of contacts both with SU and KTH, and to always stay updated on current events in both universities. Personally, I think the administrators at DSV are successful in doing this!

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# WHAT? IT as perishable knowledge?

**Or; a professional life with concept – and information modeling as a constant companion**

## The decade of Cadis

It all began in the end of the 1960s with an employment in the Cadis project (described elsewhere). Modeling and modeling languages were part of the agenda. Discussions flowed through the project. A binary modeling language was developed as a basis for an associative database manager. Enthusiasm and creativity in every corner. An advanced associative database manager was realized in several prototype versions (Cadis System 1-4 or for short CS1-4). Research and development around conception modeling and complex data structures was the focus. International collaboration gave perspectives and guaranteed quality. The different types of Entity-Relationship models which, at this time, sprung up like mushrooms were analyzed and discussed. The Cadis-project was at the front edge of development. So far the 1970s.

An invitation to the IBM Research Laboratory, San José, USA, resulted in a one-year long close contact with the project behind the development of the relational model, for instance the first version of SQL (under the name of System R). Discussions on different possible and impossible so-called normal forms arose everyday. Modeling principles, that is, if yet on a level closer to implementation.

## The decade of DBK/Infocon ...

...involved commercialization and further development of CS4 ►, among other things an advanced inquiry language as well as advanced form managers. A number of applications came to be developed, the majority were based on complex information models. Of course, these intensive contacts with “reality” generated further experiences, which were brought back to the product and to general knowledge in methodology.

## The decade of SISU/STATT...

... came to follow several different tracks within modeling. An early track consisted in development of concept modeling languages for the Stanli project ► based on knowledge within the area that Cadis, Syslab and SISU had acquired through the years. Stanli advocated and advocates the vision of an open market place for geographically related information, a hub where free-standing actors can exchange information. A prerequisite is that exposed information can be given an unambiguous, semantic interpretation. The Stanli language was specified in 1990 later to be frequently used during the years in many different modeling contexts. Seen in its own time, it was a rich concept modeling language that still



**Stig Berild**

has been employed by the Department for 16 years, and has been an active researcher in database technology at CADIS, SYSLAB and SISU for several years.

► See spinoff companies in another chapter.

► Stanli = Standardisation for Landscape Information, now part of the Swedish Industrial Standardisation, SIS.

***“Databases can be huge. Each source delivers its own information in accordance with its own information model. To merge these disparate conceptions of the world in a reasonable way, into one, united conception with maintained semantic stringency and with a reasonable quality, was and is a great challenge!”***

deserves its good, current reputation.

The Data Warehouse-track gave entirely new perspectives on models and modeling. In a Data Warehouse, information from several (many) different sources and for different types of analyses is joined. Databases can be huge. Each source delivers its own information in accordance with its own information model. To merge these disparate conceptions of the world in a reasonable way, into one, united conception with maintained semantic stringency and with a reasonable quality, was and is a great challenge.

Another track rather involved analyses and estimations of what others did, seen from the viewpoint at STATT (“Swedish Technical Attachés”) in Silicon Valley. During these years, many ideas, trends and products that attracted a lot of attention reviewed with bearing on models and modeling. Even the time at SISU was to a great extent devoted to the corresponding analyses of the surrounding world.

A small selection:

- IBM's Information Model connected to AD/Cycle, an impressive effort seen in its own time.
- Object-oriented languages, methods and database managers.
- The interesting, or rather funny, struggle between a number of method approaches for system design, which in time concluded with UML (Unified Modeling Language), initiated by Object Management Group (OMG).
- Information exchange in free forms became increasingly important. XML became a standard. Initially, XML consisted mainly of a syntax to describe the different information elements in an exchange, but was gradually developed into a modeling language through the addition of XML Schema.

### **The years at Saint Anna**

By the means of financial support from the SISU foundation, the last few years have been devoted to research as well as to analysis of the surrounding world.

Among the analyzed, interesting trends with bearing on models and modeling, the following examples can be mentioned:

- Meta-data enters the arena by the end of the 1990s, and as a result of this, various reinventions of the “wheel”. Meta-data is considered being as special as to demand its own modeling language. RDF was thus formulated. The fact that the World Wide Web Consortium (W3C) was behind the language made it even more pregnant. (The similarity with our 30-year old binary approach was striking.) The academic world took a liking to it, by specifying the more advanced language OWL, among other things. To be continued.
- The notion of the “semantic web” was coined a few years ago. There are several different opinions on what this concept

actually means. Perhaps it is the very vagueness combined with a diffusely future-oriented vision that continually attracts attention.

- During the past few years, Service Oriented Architectures (SOA), primarily represented by Web Services Architecture, have increasingly dominated the IT arena. Admittedly, XML is part of the concept, but the interest in concept models and closely connected languages still seems limited. Surprising, considering their presumably central roles in the context.

Much remains to be done in this area.

Research specialization, lastly, has bore the more and more explicit need for service- and information collaboration in mind. In a way, the work has been based on and consisted in a merge of knowledge and experience from all these years. The outcome is a very detailed and extensive specification of a binary collaboration architecture. However, its future destiny is written in the stars.

As is clear from this text, context- and information modeling has basically been the so-called “main thread” through all these years. Who would believe that 35 years ago! I do not regret a minute of it.

What? IT knowledge a perishable product? Rather a life-long learning in the magical world of modeling.

Thankyou Cadis, SISU, Infocon, Saint Anna Institute and all colleagues for letting me join.

***“ What? IT knowledge a perishable product? Rather a life-long learning in the magical world of modeling.”***

## FROM STUDENT TO PHD, A RECOLLECTION OF 24 YEARS WITH DSV



**Åsa Rudström, undergraduate student 1982**

Åsa started her career at DSV as a student in the ASY programme 1982, continued as a teacher 1985, was research assistant as well as graduate student. She left DSV for SICS – Swedish Institute for Computer Science – in 1984, returned to DSV to finalize her doctors degree in 2005.

► Bo Hedberg, *Konsten att inflyta – Handbok för omäktiga*. Liber Läromedel, 1980.

My relationship with the department is a long one. It started in 1982, when I entered the large Frescati university building as a young and eager undergrad student, and ended (sort of) in 2005 when I finally passed my Ph.D.

Back in 1982, graphical interfaces had not been invented yet. The Internet as we know it now was not even “a glimpse in its father’s eye”, although it did exist as a network used for information exchange between real computer nerds (Coca Cola had been invented). When I started as a student at DSV, the punched card readers had just been removed from the computer rooms, where printouts were made on “pyjama paper”, i.e. long stretches of striped interconnected papers that had to be ripped apart before handing in assignments. Breathlessly, I took place in the glowing green light of a computer terminal and entered my first “Hello world” computer program. From that day on, I was hooked.

Computer time was hard to come by and I used to get in really early in my blue Volkswagen Beetle. Oftentimes, Pascal programming teacher Jozef would find me and my coffee thermos on the parking lot, waiting for the building to open at 7 am. This was the beginning of a still lasting friendship, one of many with the people at DSV.

I remember being a bit confused about the university at first. While I had envisioned myself sitting at the feet of the masters engulfing knowledge, hands-on exercises and group work took most of our time. It is not until now that it has dawned on me how new – even revolutionary – the education was. Object-oriented programming was strongly advocated although it had just been born. Our books had titles such as “the art of influencing ►” and dealt with what has come to be known as “the Scandinavian School” in computer system development. It keeps astonishing me that nowadays, a good 20 years later, participatory- and user-centered design are put forward as the latest and hottest way to go!

During my second year, I was lured into teaching. It started with assisting at computer exercises and went on to classroom lessons, and soon I could make a meagre living out of it. Teaching meant having to go to the copy room and face Erkki the postman. No matter how many times I went there, he never faltered in asking me who I was. When I got properly employed and showed up on the list of employees, things improved; and by being friendly but most of all by being kind and gentle with the machinery I finally gained favourite status by the end of the nineties!

Life as a teacher was fun but hard. The department moved to Kista, and I had the honour of giving the first lecture in the new, fancy auditorium. I also had the honour of teaching the first programming course in the new computer rooms, while the computers

were still being installed. Luckily, it was a 7-week course and the first two weeks of “dry” programming – on paper – eventually led to the best exam results ever!

I also participated in the design and development of the 4-year programme in computer and systems sciences implemented in 1993. Getting this programme together was a challenge, trying to marry many different views on the topic and on the pedagogical format of the education. However, we seem to have been successful, since this work was behind the Stockholm University pedagogical prize awarded to DSV in 1997.

My teaching role in the new programme was to handle the first four weeks in a course that was to give an introduction both to computers in general and to scientific writing. Again, there were technical problems, this time with the word processor we selected (remember: this was before MS word had become the norm). The class of -93 will probably always remember me as the sadistic lady who forced them to use a terrible word processor for no apparent reason. Well well, you can't win them all, can you?

On the research side, I became a grad student, and after a few years I took on an administrative role, as an assistant to Carl Gustaf Jansson. Among other things this work led to collaboration with other departments to create an education in cognitive science, and involvement with the Swedish Artificial Intelligence society. The latter involved many years of lobbying for the main AI conference, IJCAI ►, to be held in Stockholm. In 1999, this finally became true. Oh my – all of us involved but especially Anita Kollerbaur put in many long hours to make this a successful event, and indeed it was!

In 1998 I finally left DSV for the Swedish Institute of Computer Science. SICS has a long history of collaboration with DSV, and at the time the organisations were physically about 10 meters apart. Needless to say, the transition was very smooth! As a grad student, seminar attendant and friend I have kept in contact with DSV ever since. May our future relationship be as pleasurable as the first 24 years!

***“Getting this programme together was a challenge, trying to marry many different views on the topic and on the pedagogical format of the education. However, we seem to have been successful, since this work was behind the Stockholm University pedagogical prize awarded to DSV in 1997.”***

***“The class of -93 will probably always remember me as the sadistic lady who forced them to use a terrible word processor for no apparent reason. Well well, you can't win them all, can you?”***

► International Joint Conference on Artificial Intelligence

#### Åsa Rudström

Licentiate 1995  
and Doctor 2005



## EARLY EXPERIMENTS CLOSE TO LANGEFORS' THEORIES



**Peter Bagge,**  
was one of the first  
researchers at DSV  
testing Langefors'  
theories.

In the negotiations before his professorship, Börje Langefors had demanded that his theory should be complemented with practical applications, preferable performed within the Department. This proposal was accepted. These activities were prosaically referred to as “Utredningsgruppen”, the Investigation group. It included Peter Bagge, Maria Bergendahl, Gunhild Sandström (now Sigbo) and Anita Kollerbaur (Hellberg).

At KTH, the professors had always, with encouragement, been able to act as consultants, but this investigation group was treated as part of the University, unfamiliar to such external commissions. A government decision had to be made in order to let the investigation group share office space with the rest of the department. Otherwise, the bureaucracy were limited to an account. Börje Langefors was able to manage this business with minimum formal limitations. It could hardly be called consulting, even though many persons from outside saw it that way. It contained testing of still draft oriented systemeering ideas, including a small element of numerical, engineering oriented system's work.

### **A proposal to investigate AMS – the National Labour Market Board**

The first, fairly short report written by Janis Bubenko concerned the IT requirements at Sjöfartsstyrelsen (the Swedish Maritime Board), although the concept of “ICT requirements” had hardly not yet been invented. That commission came from Statskontoret (the Swedish Agency for Public Management). Almost by mere accident, the next proposal from the same agency was to investigate Arbetsmarknadsstyrelsen (AMS, the National Labour Market Board). The only delimitation was that the analysis should cover the organization's long-term computer demands, as Statskontoret was investigating the plans for AMS's short-term rationalization under its own management. What we did, to the best of our abilities and in accordance with Börje Langefors' intention, was to deal with information analysis that was quite general. ICT in its wider sense, as expressed in today's jargon.

Sweden saw a recession around 1960. AMS was then headed by Director-General Mr. Bertil Olsson, who almost was in a position as powerful as that of the Minister of Finance Gunnar Sträng. Quickly, without consultation, Olsson initiated public relief work in such a large scale that some of Sträng's entire estimates lost balance. A furious minister decided to prevent a repetition of events, but not even a man like he could get at AMS (nor LO, the Swedish Trade Union Confederation).

Statskontoret was an agency reporting to the Ministry of Finance, AMS was not. Statskontoret had more money than it

***“The only delimitation was that the analysis should cover the organization's long-term computer demands ... What we did, to the best of our abilities and in accordance with Börje Langefors' intention, was to deal with information analysis that was quite general.”***

could possibly spend, so the department got a commission on several years through Börje Langefors and Jan Rydén at Statskontoret. Initially, the investigation group did not realize that a full-scale war was going on at the authorities' highest level.

It is no exaggeration to say that AMS, at that time, lacked everything in terms of modern, administrative technology. If AMS bought a simple calculator, the Director-General was to approve the purchase at three stages in the decision process. The last stage was to pay the received and account coded invoice. His approval applied both to the payment and to the account used for coding. AMS, at that time, was like a dream project to computerize, where smaller computerization projects were quickly paid for. If they were allowed to start at all, that is. And if they worked.

At that time, AMS was run without one single computer. We soon found the cause, as did many others. It was simply because Bertil Olsson was an exceptional skillful director. When he left his post, everything continued for a time, only soon to collapse like a house of cards. In the investigation group, we also found Sträng's critique to be correct. The organization created by Olsson was incapable of short- and long-term planning.

The internal world of AMS was characterized by staff recruitment being dominated by a special policy, established by the Riksdag (Parliament). Connection to popular public movements, "folk rörelseanknytning", was an absolute demand. AMS employed few academics. AMS lacked an organizational department. However, there were paper form technicians. During the very first months, education went backwards. We investigators learned about the environment in Swedish authorities. Field interviews carried out by the investigation group, which were only allowed after a special permission for each particular case, ended up as (kindly expressed) cultural clashes. A director at a county labour board assured us that he had control over every single document in his office. We accepted it as truth at the level of a doctoral thesis.

Almost desperately, we initiated the project by an attempt to try to survey AMS in all its parts. After all, we were business economists and computer experts. We named the process "partitioning". The word came to circulate far beyond the Department. Its designation was prosaic for a data systems engineer starting by getting a rough, overall picture of the business by splitting it into parts in the cleverest possible way. A truism, according to today's knowledge, but at that time, in this AMS investigation and against this hostile attitude at AMS, a revolutionary, subversive proposal which threatened almost the entire AMS. However, those opinions were rarely forwarded to us directly.

Ideas about partitioning were entirely without our participation carried out at AMS. It was done with program budget technique. There were no concrete evidence that we could take any credit. Program budgets were common innovations in those days. We

***"It is no exaggeration to say that AMS, at that time, lacked everything in terms of modern, administrative technology. If AMS bought a simple calculator, the Director-General was to approve the purchase at three stages in the decision process."***

tried to calculate the value of this program budgeting in AMS; that is to say “overview of the business” or with our own word “partitioning”. Certainly a number guessing competition, yet a pedagogic such. We found the refund fabulous, yet it provided no really new knowledge about AMS. At that time, the majority of all experienced administrative system analysts knew that the analysis solely, the process before one single computer program line had been coded, was usually worth its investment.

AMS’s contra tactics was to implement every proposal from Statskontoret in their own direction, without interference. It sounds ridiculous, and so it was, but this is how things worked in a time when everyone expected a constant growth of GNP. For instance, AMS and Statistiska Centralbyrån, (the Swedish Statistics Bureau), each kept their own complete, public labour market statistics, parallel to the other. The two Director-Generals were incapable of collaboration. This idiocy was well known long before Statskontoret got their commission. It continued for years. The other contra tactics was clandestine, although we saw traces of it. Bertil Olsson established a new unofficial function, designed simply to resist Statskontoret’s project.

### **“Matching” vacancies and applicants**

Naturally, Arbetsförmedlingen (the Swedish Employment Service) was studied. No one but the investigation group added the ugly Anglicism of “matching” to Swedish language, in this case of vacancies and applicants. The word is still used at AMS as the only archeological trace of the group’s work. As mentioned, Statskontoret had a parallel group with computing staff and office rationalizers. These people tried out matching at the employment service in Huddinge, through a project that was indeed quite full-scale in its implementation. Information in the shape of punched cards was entered into the data register, and out came lists on so-called pyjamas paper. All was done in DAFA, the public computer center. The first result met all expectations: an 80-cm thick pile of papers. All applicants had been recommended all available vacancies. (The idea became useful many years later, when the job agent could use a data terminal in the presence of the applicant. At the time for the experiment in Huddinge, data terminals existed only for ticket reservation systems and in the Defense Authority.)

In Kalmar, an attempt to measure achievements and program budgeting was implemented. The job agents got one point for each mediated job. Suddenly, one-day lawn moving jobs were mediated at high pace. Jobs to be performed during several days were divided into one-day jobs, thereby producing more points. The investigation group was not involved in this experiment, but we used it later as an example of the formidable power of objectives when transformed into measurable, operational means of control and not necessarily involving computers. No such was used in Kalmar.

As far as possible, the investigation group also analyzed future computer applications with traits from theoretical, logical ICT analysis, so-called information requirement analysis. The future, in the way we described it, that is, scared the then AMS management. The investigation group became a popular bat between AMS and Statskontoret, as well as between the Ministries of the Interior and the Finance. Yet, our own experience was not that of being involved in power struggles. Many people at Statskontoret were friendly and said that our way of tackling problems as worth considering, even useful. Everyone was grateful that we also guaranteed our ideas to be implemented only in ten years, at the earliest. That always disarmed them. Without our intention, we became idea providers for staff at Statskontoret rather than internal idea providers for the students at the institution. Why not? Statskontoret generously paid for the show.

Based on the example from inter alia Kalmar, a thesis was formulated. If AMS did not prepare a written objective, those designing future data systems were to integrate these in the programming, beyond control of the AMS management. This is what happened when Försäkringskassan (the Swedish Social Insurance Administration) was computerized. It might seem far-fetched, but principally correct. There we were, a group of young academics explaining to the most powerful authority management in the country that they were about to loose control. It was even mentioned to the AMS' Board of Directors as an example of what sort of deeds Statskontoret was up to. As usual, we did not hear about this until afterwards, through Börje Langefors.

The investigation group was then sent to LO's förhandlingsombudman (Chief Negotiator) for a presentation. His comments were a bit ironic, but there was no bloodbath. A few days later, a LO economist told us in private that we never ought to have been recruited for this commission. Moreover, we were overpaid. Consequently, we moved on to TCO (the Swedish Confederation for Professional Employees). To our bewilderment, the result at TCO was that the deputy chairman made a public speech the following weekend, where he demanded computerized "matching" to be introduced at ALL employment service offices "without delay".

***"If AMS did not prepare a written objective, those designing future data systems were to integrate these in the programming, beyond control of the AMS management ... There we were, a group of young academics explaining to the most powerful authority management in the country that they were about to loose control."***

### **Matching could reduce the waiting time for a new job**

In our views on system investments, we were likely pioneers. We identified a number of minor profits, but only one big: each unemployed person had in those years to wait six weeks for next job. We guessed that matching could reduce that to five weeks. All costs were to be included. In the authority environment – in those days as well as today – investments in huge registers exceeded costs for software and computers. The registers should have been entered into the accounts as assets, equal to buildings and machines. We certainly included everything in our calculus. If no

other information was available, we set the productive value of a Swedish bureaucrat to 187% of the salary. (salary + costs). Scarred civil servants laughed uncontrollably. How could we ever believe that people were that productive? Then they suddenly realized what we had written, and insisted instead upon at least a doubling of that value. We also added that the employee chosen to build up the new data registers must be replaced by a temporary substitute. And that the register quality required control extracts sent by mail to the registered person. In this last point we were perhaps wrong, but the rest is still defensible. Naturally, computers, software, education etc were also additional costs. Eventually, we suggested an approximate figure of 100 MSEK to computerize AMS around ten years later. The condition “ten years later”, resulted in the figure being unchallenged. If computer directors were of any opinion at all, the sum was considered a mere fantasy.

Our estimate had a remarkable and entirely real effect. The planning section at the Ministry of Justice published a figure for the data register costs per property in their planned huge real estate register data project. Bothered by the critique against us, that AMS would cost 100 MSEK, we multiplied the costs from the Ministry with the number of properties, and came up with a similar figure. Despite its name, the planning section had not done that multiplication. Through unknown sources, our sum reached the eyes of the Ministry of Finance. The result – which we heard about long afterwards – was that Gunnar Sträng, before the eyes of the current board of cabinet ministers, scolded a totally unprepared Minister of Justice for having initiated an enormous public investment behind the back of the Ministry of Finance.

At a gathering at Dataföreningen, the computer Association, a member of the group suggested that system investments in the private sector should be as carefully calculated as buildings and machines, and that a legal possibility should be introduced to mortgage computer systems as security for loans, as was done with ships and airplanes. Not that the suggestion was taken seriously, yet it serves as an example that our findings were brought outside of the institution.

Words spread, totally out of our control. Someone in Försvarsstaben (the Defense staff) had got hold of a partial report, saying that a director was supposed to use at least half of his time planning the business. That report is said to have been circulating among defense staff for some time, referring to us as “scientific” authorities. We heard about it by mere accident. Supposedly, some internal power struggle was behind this, too.

Even though we were early in terms of system investments, we also learned our lessons at Statskontoret. Under condition that they worked properly and that they were initiated in time and documented, simple computer routines with punched cards in and paper lists out could be highly profitable. Recovery time was usu-

***“Under condition that they worked properly and that they were initiated in time and documented, simple computer routines with punched cards in and paper lists out could be highly profitable.”***

ally one to two years. We realized then, taught by our colleagues at Statskontoret, that our deeper academic theories of business economics were useless. Its norms did not work for such quick recovery. Investment calculations, go to blazes! To say we learnt a lesson is an understatement. But we also realized that two conditions were habitually not met. The requirement specifications were not being kept really frozen. Many new systems simply did not work. The result was angry users at AMS from these first computerizations. Eventually, we came to the conclusion that calculations in this milieu should not be done to prove profitability, but because they constitute a useful, pedagogic introductory system-meeting- and objectives analysis.

At this time, huge amounts of money was spent on building of large, central computer systems. In the investigation group, we were against this, but it was still difficult to find small, reliable computers. PDP-8 was available for calculations. We found a type called Sigma. Around Sigma, we built a proposal consisting of small computers in a national network. Much can be said about the investigation group, but we were clearly pioneers in suggesting small, local computers in networks for large, administrative systems. However, US Defense preceded us, for security reasons. But those security reasons were also valid for AMS, we thought. A local computer could keep employment service and allowance payments running even when telecommunications crashed. Should one computer be overcharged, the problem would be solved by buying a new one, and so on. Our system was not supposed to be initiated until in ten years, so the Sigma model was only used for cost calculations.

All this took place in a time when Telegrafverket (the Swedish Telecom) refused to sell data communication, claiming adamantly that it was only commissioned by the Riksdag to sell simple uniform telephone service. Channels for data communication were only rented as long as there was spare capacity, and neither with guarantees nor enthusiasm.

### **Large national systems – or collaborating small computers?**

During these years, the large and principally misplanned and over-integrated national systems were built at social insurance offices, car registration authorities, tax administration authority, the property agencies etc. They were all imperialistic constructions. The projects begun as political reforms, but had ten year later evolved into cumbersome barriers against development. Internally, within Statskontoret, we used to relate to the parallel of the Swedish inland waterway Göta Kanal. Just one calculation was made to get money. None more was done. Construction was initiated at six different places simultaneously, so that the Riksdag would not be able to stop the project. When the project started, the locks were the biggest in the world. When the Kanal was ready, these were too small and out of date.

***“At this time, huge amounts of money was spent on building of large, central computer systems ... Much can be said about the investigation group, but we were clearly pioneers in suggesting small, local computers in networks for large, administrative systems.”***

In comparison the investigation group presented a proposal that AMS should have a national system consisting of a net of collaborating, small computers. Without boasting, it was a pioneer accomplishment within civil administrative computer processing. The reasons for this approach were also correct, according to what future experiences would prove.

Some things we said and wrote were inconsiderate and theoretical, which was also expressed by those skilled in everyday drudgery at AMS. Mutual understanding grew later, when the barely controllable, uncomputerized AMS had been replaced by a barely controllable yet office-computerized AMS, filled with numerous, separate, hardly functioning computer systems with roots in the technique of punched cards. When AMS recruited their first generation of internal organization consultants, computing people and systemeering experts, requirement of experience from popular movement, “folkrörelseerfarenhet”, was still considered important.

It had been a beautiful idea that experiences from the investigation group should be transferred to the university education. This did not work out. The commission at AMS was too odd, too much characterized by the public sector culture to suit future systemeering experts in trade and industry. What was eventually to transform systemeering from being an ad-hoc craft into an engineering approach, was to occur from another part of the department, top-down technology etc. But mostly, this was due to the fact that the Department at the time was overloaded by the massive influx of students. There was no room in tuition for the investigation group’s proposals – partly speculations – for a situation ten years ahead.

***“It had been a beautiful idea that experiences from the investigation group should be transferred to the university education. This did not work out. The commission at AMS was too odd, too much characterized by the public sector culture to suit future systemeering experts in trade and industry.”***

# *In memory*

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of Terttu Orci  
and Bengt G. Lundberg

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## IN MEMORY OF TERTTU ORCI



Terttu Orsi

Professor Terttu Orsi died in 2001 at the age of 53, after a short period of disease.

She defended her thesis in Computer and Systems Sciences, "Temporal Reasoning and Data Bases", at KTH in 1993. In 2001, she was promoted to professor at Stockholm University in Computer and Systems Sciences, about six months before her decease.

During the major part of her professional career, Terttu Orsi has worked for several different universities and colleges of higher learning. She appeared for the first time at DSV and Stockholm University/KTH in 1982, when she was employed as university subject teacher, and as research assistant at SYSLAB, 1993 she got a permanent position as a senior lecturer at the department.

To start with, her main research- and teaching area was focused on different aspects of data bases, data base structures, conceptual modelling and temporal aspects of data bases including models and algebra for multi-temporal data bases. Shortly after she defended her thesis, she accepted the challenge to take on an area quite new for her, software technology, where she came to specialize in issues on quality and measurement, as well as on process improvement. In her research, she intended to develop practically usable models, education and methodology for increased efficiency and predictability in software production. During her last year, she became increasingly interested in creating better working environments in IT-producing organizations, especially in smaller companies. Terttu Orsi was the initiator of the Swedish Software Metrics Association, whose purpose is to promote aspects of measurement and quality in software production.

From 1992 and on, Terttu Orsi held a number of research grants and was also the leader of several national research projects. She also participated in international projects financed by the EU. She published scientific reports on a regular basis. She participated in the internal scientific debate and was an appreciated lecturer at several Swedish and foreign universities.

Terttu Orsi was also a talented administrator and a great leader, she acted as director of studies for the KTH educations at DSV since 1994, and during a short period of time she was also director of studies for the graduate education. She had duties in the Faculty of Social Sciences and in the Appointments Board (Tjänsteförslagsnämnden, TFN) within the educational committee for the KTH educations at the IT University.

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## IN MEMORY OF BENGT G. LUNDBERG

Professor Bengt G Lundberg died in 2001 at the age of 55, after a short period of disease. Bengt G Lundberg defended his thesis “Contributions to Information Modelling” at KTH in 1982.

In 1984, he was appointed senior lecturer at KTH and in 1991 professor in Administrative Information Processing at Stockholm University. Since 1982, Bengt was employed at the Department for Computer and Systems Sciences (DSV) at Stockholm University/KTH.

In the beginning of the 80s, Bengt G. Lundberg’s research interest was directed towards studies of theoretical problems concerning information modelling. At the end, he turned his interest towards studies of computer-supported decision-making. He was particularly interested in the use of unstructured information in strategic decision-making. Further on, his interests became less formal; he was one of the first to bring up ethic issues related to IT, among other things. His international commitment included being a guest professor at Delft University in the autumn of 1985, as well as being vice chairman of the IFIP workgroup 8.3 Decision Support Systems.

Bengt G Lundberg felt a great responsibility for the research education at minor universities. By the beginning of the 90s, he was engaged as professor to the Mid Sweden University in Sundsvall, and later on to the University of Växjö. At the time when he deceased, he had doctoral students at the universities in Halmstad, Växjö and Mälardalen, as well as at the University of Kristianstad. It is an impressive fact that he maintained a half-time employment at DSV during all this time, and in addition to this supervised a number of doctoral students, spread out over the southern part of Sweden. He found this situation stimulating, and it became part of his strivings to take responsibility for the development of the subject field. In Kristianstad, he had started to develop the subject field Information Science, and he committed himself to the task with great enthusiasm and a vast knowledge. He wanted to – and did – have influence not only on the university but on many other missions and projects aiming at a positive development of the region.

In his will, Bengt donated funds to Stockholm University for promoting research in the Department.



Bengt G. Lundberg

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# *Evolution of an academic discipline*

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# EVOLUTION OF AN ACADEMIC DISCIPLINE

In this chapter our objective is to present an overview of how the discipline of Computer and Systems Science has evolved from the mid sixties until present days. More detailed descriptions are found in the following chapters.

## The first decades

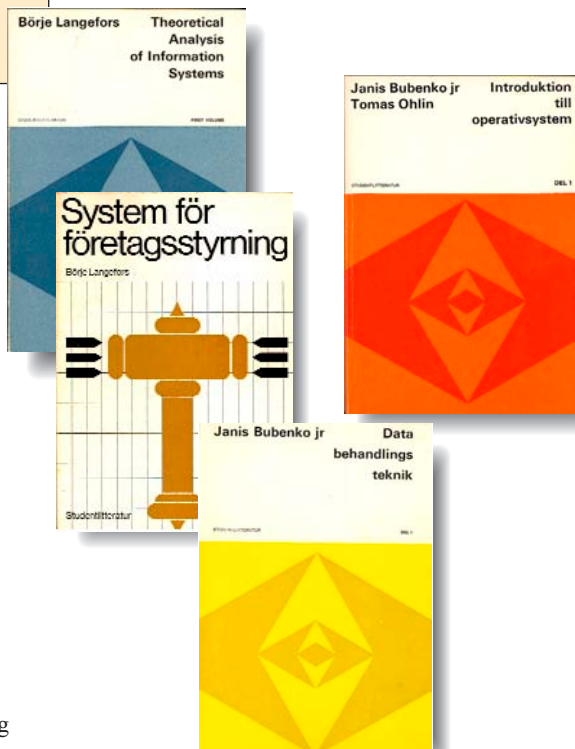
A substantial part of the early core of our discipline was contained in the book “Theoretical Analysis of Information Systems” (Langefors 1967).

This internationally well-reputed book was used in our educational programme, particularly in second semester studies. During the seventies it became a “bible” for most academic “Information System” courses and researchers in Sweden. Another book of substantial impact on the discipline was “System för Företagsstyrning (Systems for Enterprise Control)” (Langefors 1968). Technical parts of the discipline Information Systems were to a large extent reflected in the textbook “Data Processing Techniques” (Bubenko 1967), and to a certain extent also in the textbook “An Introduction to Operating Systems” (Bubenko and Ohlin 1971).

Another textbook that had a impact on DSV’s first semester courses in 1966-67, and to some extent also on the technical parts of our discipline, was “Computers and Data Processing” (Dopping 1966).

Consequently, when it comes to defining and delimiting the discipline “Information Systems” it is only natural to cite Börje Langefors<sup>1</sup> (Langefors 1979):

“Already at the beginning we felt that programming should not have the dominating importance in the information systems development process as it was believed earlier. A number of problems of scientific as well as of technical nature can be found in activities



preceding programming. Therefore programs should be constructed and analysis of the constructed programs should be done before the start of coding. Methods for this kind of construction and analysis should be developed and taught. (This viewpoint has been generally accepted only during the very last few years).

Furthermore, it became apparent that program construction should be preceded by construction of the whole computing and data processing system, e.g. construction of file- and database structures. Consequently, we gained the insight that construction of data processing systems should, in its turn, be preceded

<sup>1</sup> The text is translated from Swedish

by information analysis (determination of information requirements or of the utility of information) in its turn preceded by studies of the desired future object system (the enterprise, the organisation) and the ways of working one would like to apply there. These considerations led to the viewpoint that the topic of administrative information systems should encompass two aspects: firstly the *infological* (focussing on needs and pre-conditions of humans to be informed by data and in co-operation with computers) and, secondly, on the *datalogical* aspect (focussing on “technical efficiency” in programs and in the machinery). The infological, human-oriented part, ignored by the traditional research on data processing systems, appears today not only as equally important, but also as covering a rich and growing set of research activities and publications.

It is almost impossible to keep up with scientific publications in the datalogical part of computing today (datalogy, computer science). Consequently, this field is today partitioned in several more narrow sub-disciplines. The infological side is equally impossible to keep up with as a whole. When one realises this, it becomes apparent that a person who tries to seize the whole topic area by necessity must do it on a superficial or abstract level. This “holistic view”, while of course desirable, cannot be achieved with a sufficiently thorough knowledge of the details of the topic. The sooner one realises this, the better it is.”

In short: the discipline Information Systems focuses on different kinds of knowledge and skills needed to analyse, design, develop, and maintain information systems in organisations. Problems and methods related to Information Systems can be seen as belonging to the infological or to the datalogical realm. In the infological realm, we focus on analysis of organisations regarding different aspects such as its objectives, processes, and information requirements. Our aim is to design a fit between the information system and the organisation. We deal also with additional infological aspects such as information modelling and supply as well as with usability

issues and human-computer interaction.

In the datalogical realm, we focus on software engineering, efficient storage, processing and communication of data. Particular topics are data modelling, data base management, data manipulation languages, and query languages and CASE-technology.

Langefors’ description of the discipline also conveys the insight that Information Systems is a discipline with no fixed borders – it is continuously changing and expanding. This means that new types of problems, infological as well as datalogical, are constantly emerging while other kinds of problems become less relevant as time passes. Many of these changes are triggered by advances in computer-, programming- and communication technology. A second insight is that the discipline of Information Systems is very large, i.e. it encompasses a very large set of different kinds of problems to be addressed. The nature of these problems can be technical, economical, social, or even political. There is no possibility for one university department alone to develop expertise in more than a fraction of all topics that can be related to the discipline of Information Systems.

Information Systems is today taught at more than 20 universities and university colleges in Sweden. It is presented in departments having different names such as Computer and Systems Sciences, Informatics, and Business Information Systems. The content of the academic discipline differs to a greater or lesser extent from university to university. Following Langefors’ insight above, what we see is not different academic disciplines at different departments, but rather different subsets of the large set of topics and viewpoints included in the academic discipline Information Systems.

An academic discipline is developed and matured through research that is carried out by its scholars. During the end of the sixties and beginning of the seventies, research at DSV was carried out in the following areas

- Use of information systems in order to enhance decision making in organisations
- Methods for determination of information requirements and for description of infological structures (information sets and processes)

- Performance analysis of real-time systems through discrete event simulation
- Design and development of an associative data base management system to be used for storing and managing system descriptions in future CASE tools
- Adoption of a cognitive approach to the use of computer technology for learning in Swedish schools
- A logic programming approach to the specification of information systems
- Informatics communication system, early steps in videoconferencing.

The main actors in performing the above research were grouped in research groups CADIS, ISAC, PRINCESS, a group for informatics with systems, and the logic programming group.

- CADIS (Computer-Aided Design of Information Systems) initiated 1969 and led by Janis Bubenko, from 1980 the research centre SYSLab-S (Systems Laboratory in Stockholm)
- ISAC (Information Systems and Analysis of Change) initiated 1970 and acting up to 1980, initiated and led by Mats Lundeberg.
- Research on computers and education initiated 1973 and led by Anita Kollerbaur in the PRINCESS - project (PProject for Interactive Computer-based Education Systems), from 1980 the research centre CLEA (Centre for computer-based EducAtion systems).
- In the middle of the 70's the research on informatics communication system was started by Kjell Samuelsson
- The Logic Programming group was initiated 1976, by Sten-Åke Tärnlund.

The main funding for these activities was external via STU (the Swedish National Board for Technical Development) and SÖ (the Swedish National Board of Education).

For more detailed descriptions of the research of these groups, the reader is directed to papers in this book by Bubenko, Lundeberg, Yngström, Samuelsson and in the section about Research on IT and education and early HMI-research. Regretfully, the editors have not been able to solicit a paper by a member of the former logic programming group.

## The discipline of today

The fact that the discipline was established as joint for the faculties of social sciences and of technology already from the beginning, has influenced the development heavily. Even today, the subject combines social science-related as well as technical aspects in an integrated way. The connection between computer science (data-logic) and systems science is already built-in in our name – Computer and Systems Sciences. While computer science covers the most fundamental engineering-related parts of the subject, systems sciences is usually interpreted in two, closely related ways. On the one hand, information technology, seen in its human- and organizational context. On the other hand, models and tools to analyse and design complex systems that include both human beings and technology. Both these aspects have characterized our subject's development already from the beginning.

Our current location in the academic environment in Kista, where the subject designation Information Technology (IT) is used as an umbrella term, has resulted in our subject being classified as placed high on the system levels of an IT system. While other departments and subjects are responsible for technology on lower systems level, the role of computer and systems sciences is to cover everything from application software to general aspects of systems.

This development is in contrast to what has been seen at many other Swedish university departments that started from approximately the same position at the beginning of the 70s, but who have maintained their focus on administrative systems, systems development, and a strong connection to business economics. It should be observed that the use of the word informatics here differs in meaning from the central-European language use, where "Informatics" in many cases is used as a synonym to "Computer Science".

We have chosen to maintain the broad profile established by Langefors, as a subject including fundamental technical aspects as well as usability issues and systems theoretical issues. The educational programmes within computer and systems sciences at DSV has systematically strived for

integration of the different parts of the subject. Today, DSV has research activities in five main areas:

- Information Systems and Software Engineering
- Knowledge and Communication
- Security
- Systems Analysis
- IT in Society

These areas do not directly correspond to the actual organisation, which is an advantage for development of research. E.g. 'IT in society' is so far distributed over all sections.

Below, a brief presentation of the areas is given. More details are given in other parts of this book.

### **Information Systems and Software engineering**

Presently, the most active areas are enterprise modelling, knowledge management, software evolution and maintenance, systems development methods, and object-oriented language design. Many researchers work in the area of enterprise modelling with the intent to develop techniques and methods for designing systems and services that are flexible and transparent. Enterprise modelling constitutes a basis for such systems development methods by providing explicit and comprehensive languages and ontologies for business design, ranging from value models to conceptual and process models. Several industrial applications are being carried out in this area, including process integration in health care, referral management in eye health care, defence and crisis management, and process support for lobbying by NGOs. There is also much international cooperation in this area, particularly in European projects like the Network of Excellence INTEROP that looks into interoperability of enterprises and software. Enterprise modelling has also been applied to knowledge management with applications on leg ulcer care utilizing multimedia in combination with knowledge management. A closely related area is information search and business intelligence with applications on text summarization and techniques for frequently asked questions as

well as multi-lingual query services with applications on the Nordic languages.

In addition to the use of enterprise modelling for model-driven systems development methods, much work has also gone into agile software development. Several applications have been carried out, including studies on the development of financial service systems, Internet games, and micro finance systems in developing countries. Within the area of software evolution and maintenance, advanced models have been developed, in particular for corrective maintenance. There has also been much work in designing next generation object-oriented languages, including techniques for alias management and dependency management.

The areas of program development span a variety of topics. One aspect is bringing together networks, learning, and adaptivity in a free, creative research environment and concentrating Internet-based learning, content management for embedded systems and centralized distributed adaptive networks. Furthermore, contemporary object-oriented programming languages' support for alias encapsulation is mediocre and easily circumvented. To this end, several proposals have been put forward that strengthen encapsulation to enable construction of more reliable systems and formally reasoning about properties of programs. These systems are vastly superior to the constructs found in, for example C++, Java or C#, but have yet to gain acceptance outside the research community. Thus even more formalized topics are covering external uniqueness and existential owners for ownership types. Also formal aspects of object-oriented model approaches are covered herein.

### **Communication and cognition**

Today, the focus is on large groups of humans communicating and collaborating, assisted by large networks of fine-grained computational elements. Computational elements penetrate into all human activities and are used by virtually everyone, they are rapidly more embedded in and not distinguishable from other artefacts and typically more active in the collaborative processes in contrast to being passive tools.

Several fields have developed which highlights the Knowledge, Cognition and Communication aspects: Human Machine Interaction (HMI), Human factors research, Human Computer Interaction (HCI), Computer Supported Cooperative Work (CSCW), Computer Supported Collaborative Learning (CSCL), and Computer Mediated Communication (CMC).

Important subfields of HCI are interaction design, multimedia technology, tangible interfaces, virtual and augmented reality techniques, social and affective computing. The knowledge aspect is highlighted in fields such as Artificial Intelligence (AI) and Knowledge Engineering as well as in the Complex Systems field. In the borderland between AI and HMI sub-fields such as language technology, intelligent interfaces, multimodal systems, intelligent tutoring systems and ubiquitous computing can be found.

A property of most of the above fields is that they borrow from and reach into other traditional disciplines such as applied mathematics, statistics, logics, philosophy, psychology, linguistics, anthropology, cognitive neuroscience, sociology, pedagogic, subject specific didactics, industrial design, graphical design, drama, arts and journalism etc. In order to capture relevant overlapping parts of such disciplines, interdisciplinary, umbrella disciplines like cognitive science and communication science have been defined.

### Security Informatics

Security Informatics is founded on General Systems Theory with Cybernetics, the Theory for Living Systems and Soft Systems Methodology (Yngström 1992, 1996), viewed as intersections of Computer and Systems Sciences with Legal Informatics and Economics including Management. Members of SecLab are in their research approaches influenced by the scientific history of Security Informatics and demands of the environment, i.e. to approach scientific problems systemically (problem-oriented) and interdisciplinary founded on system theories and cybernetics oriented towards civilian and organizational applications. The analogy of a fork for ICT-related security problems may be used; security problems are approached at many levels,

technical as well as applicational including interacting/cooperating with other items/aspects. Overall we view the ICT security area as an area of control where systems, cybernetics, feedback and feed-forward in a systemic setting play important roles.

Research is performed from mainly three points of departure; from a Use/Paradigmatic perspective with understanding, communicating, informing, educating and learning about ICT risks and security in modern environments; from a Managing perspective with risks, vulnerabilities, controls, and audits; and from an Architecture perspective with security architecture for mobile and wireless networks; building prototypes including elements such as security servers, wireless and mobile workstations and devices, security protocols, and security interfaces, which in total will support all standardized network security services, be transparent to multiple wireless communication protocols and be able to support different network topologies.

Examples of research problems with the *Use/Paradigm* perspective are:

- demands of ICT security in a developing country for education
- security readiness of users
- risk analysis models
- computer games for education in security.

Examples of research problems with the *Management perspective* are:

- assessment of ICT security
- security management
- assessment methodology for privacy
- outsourcing of ICT security.

Examples of research problems with the *Architecture* perspective are

- comprehensive security functionalities for web-based applications
- security for ad-hoc networks
- security for mobile and wireless applications.

### Systems analysis

Systems analysis is the science dealing with analysis of complex, large scale, and dynamic systems. This includes the use of algorithms, mathematical models and statistics as aids in

decision-making. Research within systems analysis at DSV has a long tradition, spanning two decades, although the actual label of the field has varied over time. Current activities can be grouped in two major themes – decision analysis and data mining.

One criticism of traditional decision analysis has been that it imposes strong demands on a decision-maker with respect to the precision of the input data. The main focus of the research within decision analysis at DSV is to investigate higher-order decision models. The main result of this research is a computationally meaningful theory of decisions and decision analyses admitting imprecise information. Another focus of the research is the empirical validation of decision models. The collection of theories above has been combined into computer tools, implemented and employed in many real-world applications, e.g. decision problems in malaria distribution, public planning, storing spent nuclear waste, purchase of railway equipment, and catastrophe management.

Data mining is a process that is performed with the purpose of identifying useful and valuable knowledge in available data. The focus of the research on data mining at DSV is on developing, evaluating and applying methods that allow for learning from complex data, such as structured and high-dimensional data, in order to support decision-making and whose result allows for human understanding. The research at DSV contributes with theoretical results, methods, systems, and applications mainly within the field of rule learning. Theoretical results and methods include analyses of rule learning methods, new rule learning algorithms and new methods for applying learned rules. Areas of application include computational chemistry, bioinformatics, natural language processing and information retrieval.

### **Interdisciplinary work**

In the same way as the area of information systems out of necessity has demanded strong connections to economics and law, human-machine interaction and complex systems have required other interdisciplinary interactions. Within the

area of cognition science, DSV relates to subjects such as psychology, linguistics, philosophy and ethnology. During the entire 1990s, DSV has strengthened its activities in the borderland to these subjects both in undergraduate education, graduate education, and in research. A centre has been established (“Kognitionscentrum”), in order to reinforce contacts with relevant subjects/departments in the Stockholm area. A specific trait for complex systems is a close connection to subjects such as logics, statistics, and other areas of applied mathematics. During the past five years, contacts have also been strengthened with other disciplines, such as pedagogy and subject-specific didactics, disciplines related to communication such as journalism, media and communication and graphics as well as aesthetic and subjects within arts. Within the last categories, industrial design should be in particular mentioned.

### **IT in society**

Three important application areas of research concern, that reinforce the interdisciplinary character of our subject, should be mentioned.

- Medical informatics, in which information management in medical care is studied, focusing on the patient. The area covers collection, representation, processing, visualization as well as other communication relevant for the information on the patient’s medical services.
- The use of information technology in developing countries, which within the scope of primarily SIDA’s programme, deals with different aid efforts in developing countries supported by information technology, such as building of networks, collaboration in higher education and risk analysis in connection to catastrophe scenarios.
- Consequences in society as a result of the increased use of IT technology. This includes health provision as well as risks, social and environmental changes, citizen integration effects and the use of IT for participatory democracy.

## References

Bubenko, J. A., jr (1967). Databehandlingsteknik. Lund, Studentlitteratur.

Bubenko, J. A., jr and Ohlin, T (1971). Introduktion till Operativsystem. Lund, Studentlitteratur.

Dopping, O. (1966). Datamaskiner och Databehandling. Lund, Studentlitteratur.

Langefors, B. (1967). Theoretical Analysis of Information Systems. Lund, Sweden, Studentlitteratur.

Langefors, B. (1968). System för Företagsstyrning (Systems for Enterprise Control, in Swedish). Lund, Studentlitteratur.

Langefors, B. (1979). "Behovet och framväxten av universitetsämnet Administrativ Databehandling." SSI medlemstidning.

UHÄ (1964). Akademisk utbildning i akademisk databehandling. Betänkande avgivet av en av kanslern för rikets universitet tillsatt kommitté. Stockholm (Distribution: Nordiska Bokhandeln).

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# Research

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In this chapter we present snapshots of research activities carried out at the Department since the late sixties. The first section deals with early research activities on *Information Systems Theory* performed by Professor Langefors during late sixties and early seventies. It also gives a brief summary of work on *methods for information systems development* within the research groups CADIS and ISAC. In the next section research on *IT and education*, as well as early work on *Human Machine Interaction* is presented. The period of this work is early seventies to beginning of the nineties. Another section describes research on *Knowledge and Communication*, essentially covering the period from late seventies until today. The section on *Security* presents research on information and systems security during the last three decades. The section entitled *Information Systems and Software Engineering* gives an account of recent work in the areas of Business Process and Enterprise Modelling, Knowledge Management, and Software Maintenance. The section on *Systems analysis* deals with research in Machine Learning and in Decision Analysis. The chapter is concluded with emerging work regarding *IT in society and in developing nations*.

The chapter fails to give a full account of DSV's research in the 40-year period. The reader is directed to chapters authored by Janis Bubenko jr, Mats Lundeberg, Göran Goldkuhl, and Anders G. Nilsson in the "Memories and reflections" part of this book in order to get a somewhat fuller picture of research performed at or in association with the Department during the periods late seventies and early eighties.

The total "output" of the Department's education and research is indeed impressive. More than eighty persons have been awarded Doctors degrees. More than ninety Licentiate degrees have been awarded. Roughly one fourth of them all are women. More than thirty persons, with a background at DSV have been appointed professors. The Department's collaboration in international projects, conferences and in professional societies is equally impressive. These activities are, however, described in a separate chapter.

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# INITIAL RESEARCH ON INFORMATION SYSTEMS DEVELOPMENT AT DSV

## Who were the researchers?

Initial research was performed within Langefors' small research group for Information Systems. This group was formed in mid 1965 and was at start located on Hagagatan (Department of Statistics<sup>1</sup>, Stockholm University). The group was financed by FOA<sup>2</sup>. Members of the group were Peter Bagge, Janis Bubenko jr, Nils Lindecrantz, Kjell Samuelsson, and Lars-Erik Thorelli. Bagge later returned to Statskontoret. Bubenko was appointed professor in Information Systems at Chalmers and Gothenburg University in 1977 and in 1981 at KTH and Stockholm University. Lindecrantz passed away in mid seventies. Samuelsson became professor in Informatics and Systems Science at Stockholm University in early eighties. Thorelli was appointed professor of Computer Systems (Datorsystem) at KTH in late seventies. The group had initially a young secretary<sup>3</sup>, a girl that Langefors had had employed at his former place at SAAB.

The group's office space at Hagagatan was extremely undersized – the group had only one room to use. But it did not matter that much. Most of the time was spent on reading and understanding Langefors' books and other research papers by him. Langefors also recommended the group to read a number of primarily American books on data processing systems development. This could equally well be done at home. The group met essentially for seminars, discussions, and other meetings.

In the fall of 1965, the group moved to new and more adequate offices at KTH. The address became Stora Gården 12 or Linstedsvägen 15, Stockholm Ö. This was a very pleasant change. Langefors managed to get different practical assignments. One of the first tasks during the fall

of 1965 was to perform an information requirements and systems development study at Sjöfartsverket. In this study some of Langefors' ideas presented in THAIS were used. However, the application was not analysed down to the "elementary message level". It would have taken more time and money than there was available. Neither was the "topological transport factor" analysed and calculated. The group members were working as consultants and had to be practical.

In the spring of 1966 the first course was given to students at Stockholm University and at KTH. It was a "lightweight" introductory course (about 50 lecture hours) about computers, programming, programming languages, applications of computers, etc. The location was the "Law School" at Norrtullsgatan. The attendance was about 150 or more. Many of these students later became students in the program of two to three semester studies.

At this stage, it had been decided that a university topic named "Informationsbehandling, särskilt administrativ databehandling"<sup>4</sup> and a department (and a professors chair) should be formed at KTH. An educational program should be developed and launched as quickly as possible. There was a need to recruit more staff. Tomas Ohlin (BSc in mathematics) came in from Industridata AB, and Olle Källhammar (MSc in engineering) was recruited from Univac. Both were experienced programmers and could be put into use as teachers immediately. Later Mats Lundeberg and Rune Engman were recruited. They knew programming and computers so they could start teaching without much initial training. Both were MSc in engineering. Lundeberg had also a degree in economics from the Stockholm Business School.

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<sup>1</sup> One of the supporters of Börje Langefors at that time was Ulf Grenander, Professor in Mathematical Statistics at Stockholm University.

<sup>2</sup> The Swedish Defence Research Establishment.

<sup>3</sup> Langefors was at this time the program chair of IFIP's Worl's Congress in New York. He and his secretary were extremely busy in managing submissions and reviewing of all paper contributions to IFIP 1965. About a year later this secretary quit and was replaced by Marianne Swendsén.

<sup>4</sup> In English this could correspond to the university topic "Information Systems". We will call it ADB, for short.

The first 20 credit (ett-betyg) course <sup>5</sup> on Information Systems was to be launched in the fall semester of 1966. Teaching and examination of students was carried out by Langefors, Bubenko, Ohlin, Källhammar, Lundeborg, and Engman. This educational programme continued on the next level (2-betyg) with additional 20 credits in the spring of 1967. The 40 credit effort gave us the possibility to recruit additional assistants (part time) to the department in 1967. Names we remember are Christer Arvas, Olle Björner, Björn Nilsson, Olof Hesselmark, Hans Lundin, Björn von Boisman, Eric Roupé, Hans Dahlborn, Ingrid Karlmar, and Thomas Röhr.

The department grew rapidly. In the years to come additional persons joined the department: Anita Kollerbaur, Gunhild Sandström, Eva Lindencrona, Tord Dahl, Stig Berild, John-Erik Johansson, Agneta Lindhé, Ewa Lindström, Anna-Stina Eskilsson, Lars Kahn, Sam Nachmens, Göran Goldkuhl, Anders G. Nilsson, Sten-Åke Tärnlund, Åke Hansson, Pelle Ehn, Marianne Janning, Clary Sundblad, and many, many others. They were almost all graduates from our educational programmes, typically BSc with a major in ADB.

### Research on Information Systems Development

Relatively little systematic and funded research was performed during the end of the sixties. There were practically no research funds to apply for. All were fully occupied in developing courses and in producing course material and textbooks <sup>6</sup>. Some people were engaged in Langefors' applied research work, e.g. Bagge, Kollerbaur, Sandström, and Marianne Bergendahl worked on developing an information system design for "Arbetsmarknadsstyrelsen". Others were engaged in various consultation activities. For instance, Bubenko was engaged in discrete event simulation (using SIMULA) of real-time

system performance for some organisations in Sweden.

At the end of the sixties an applied, technological research funding organisation was established – STU <sup>7</sup> (Styrelsen för Teknisk Utveckling). In the systems development area two research groups were formed, one around Janis Bubenko jr and one around Mats Lundeborg. They were named CADIS and ISAC. So, at the end of the sixties, systems development research was clustered around three "gravity centres": Börje Langefors, The CADIS group and the ISAC group. Both groups obtained sponsorship from STU, about 200 KSEK per year each. Langefors worked mainly alone, but gave numerous ideas and advice to the CADIS and the ISAC groups.

Langefors performed research primarily in general systems concept and theory development, object system <sup>8</sup> analysis, information analysis and information system structuring. Langefors argued (see working paper IB-ADB 68, nr 10 in (Bubenko, Källhammar et al. 1970)) that the *essential problems* <sup>9</sup> of systems development were:

- **Specification methods:** What shall the information system (IS) be able to perform and what may the system cost? How shall we describe the specification (i.e. description methods)?
- **Analysis and description:** How to perform the analysis in such a way that all relevant information sets and relations between information sets are defined? How to make the description in such a way that it can be systematically worked upon? Formalisation of the description should be done to the extent necessary in order to be able to use computer-based tools in systems development work.
- **Design:** How should data and data files be structured and organised in order to be adequately stored, communicated, and processed in the computer system to be used? How shall

<sup>5</sup> The first courses of the department are described in a special section in the book: "The first courses 1966-1967"

<sup>6</sup> At this stage our department was, I think; the leading producer of textbooks on Information Systems and related topics in Sweden. Our publisher was Studentlitteratur in Lund.

<sup>7</sup> The National Board for Technical Development.

<sup>8</sup> The meaning of "object system" was, at this stage, the people and the organisation to be served by the information system to be developed. In today's terms "object system analysis" could be named "business analysis" or "business engineering".

<sup>9</sup> The list below is a slightly edited translation from Swedish.

the data processes be organised? How shall the system be designed in order to gain acceptance in the user organisation?

- **Planning of stages:** How to partition the systems development work in stages in order to achieve the best economic control, performance control, and planning control.
- **Partitioning in subsystems:** Which subsystems shall the IS consist of? How shall we describe the external properties of these subsystems, so that their usefulness in the total system can be verified in advance, and such that this description can be used as a basis for designing (the inner structure) of these subsystems?
- **Connections between subsystems:** How shall the structure of subsystem interfaces be described in order to maximally facilitate the coupling of them?
- **Management and administration of systems development work:** Systems development work is becoming increasingly of a large size as well as very complex. Carrying through such a large and complex set of tasks becomes efficient only if it is performed in smaller, well-defined projects. Each project is led by a project manager who has at his/her disposal all necessary systems development specialists as well as all needed specialists of the organisation and the application domain, and representatives for users and consultants.

We can immediately see that most of these problems, on a general level, still exist. But we can also see that Langefors at this stage had the foresight of, among other things, CASE-tools as well as of the importance of participatory systems work.

Langefors' general conception of method areas of the systems development life cycle, including its initial, softer, user and organisation-oriented parts, were the following:

- Methods for management and control of organisations
- Methods for analysis and description of information systems at an elementary, "problem-oriented" level.
- Methods for design and analysis of comput-

erised information processing systems

- Methods for implementation of the information system on computer hardware (processors, storage units, communication channels, etc.) and choice of hardware. Methods for installation.

The first method area deals with problems of the application area, the business or the organisation. Langefors' conception was that this area should be divided in two main partitions: the operative part and the controlling, directive part. The first part is responsible for producing the results of the organisation. The directive part controls the operative part and seeks to satisfy the organisation's goals. In the same way, we can talk about operative and directive information systems. Their information needs, information content and processing procedures are different. In the operative partition information is needed to control the elementary processes in the organisation, e.g. to order the delivery of a set of inventory items to a customer. Directive information can exist at several levels of abstraction. Langefors gives examples of directive information such as forecasts, standards, state information of various parts of the organisation, information about the organisation's environment, information about different goals of the organisation, etc. It is at this stage, in this method area, where we select the ambition level of the computerised information system. The crucial questions in systems development are: 1) what will the organisation gain by using the (new, computerised) system and 2) what will it cost to build and to operate the system. It is at this stage we decide which operative, elementary processes will be supported by operative information, and which kinds and levels of directive information will be produced to guide the operative information. Alternative designs should, of course, be analysed and evaluated.

In the second method area directive as well as operative information for the chosen control and ambition level is analysed and described. The description is preferably done by decomposing crude information processes and information sets down to finer and finer levels.

This decomposition ends when we have broken down all information into elementary messages<sup>10</sup>, and all processing into elementary processes. E-messages of the same attribute name formed elementary files. Elementary files were processed and new files produced in elementary processes. E-processes could be described by for instance algorithms, flowcharts, or decision tables. Systems of e-files and e-processes were described by incidence matrices. Ideally, the system described by e-processes and e-files can be used to better predict the costs of building it and operating it.

The third method area deals with how to cluster the e-files and e-processes in order to gain better computational as well as file transport (input, output, space) performance. This was considered important as at this time when computer hardware was extremely expensive. A medium-sized computer for relatively simple administrative processing had a price tag of 5 million SEK or more. It was therefore important to be as economical as possible when structuring information and processes for computer processing.

The fourth method area was design and implementation of computer-based information systems, as well as installation<sup>11</sup>. What we have to design here are data files on tape or data structures on secondary, direct access storage. We have to describe computer programs in a suitable language, e.g. Assembly level language, Algol, FORTRAN or COBOL. We have to select a suitable computer vendor to deliver the hardware and operating system plus different pieces of utility software. In the late sixties, a computer order and delivery contract was a big and expensive thing. Acquisition of a computer system was an affair that often took more than one year and implied costs of several millions for not only the hardware and software but also for hiring computer and

systems development specialists. Selecting the "right vendor" was, therefore, an important decision to be made. Often different kinds of performance analysis were made in order to make sure that the computer could handle the processing load specified in acceptable time limits. In many cases, vendors offered customers to write some of the customer's application programs free of charge, only in order to get the hardware delivery contract. In summary, the fourth method area deals with file and database design, program design, computer system configuration and choice of vendor, performance analysis, and also the design of computer-human interfaces (when real-time systems).

The above description explains the intellectual framework for the two young research groups CADIS and ISAC to work in. CADIS worked primarily in the third and fourth method areas while ISAC did research in the first two areas. CADIS was concerned with design of data bases and performance analysis of computer systems by the use of simulation, and on describing information and systems using associative networks<sup>12</sup>. ISAC first developed a systems description method that could be used in hierarchical decomposition of information sets and processes. It then moved on towards different problems in the first method area, such as activity studies and change in organisations. ISAC's approach became quite popular also in practical use. It was also recognised internationally, in particular in the Netherlands. CADIS developed a theoretical systems development method called "The temporal, deductive approach for specifying information systems". This theoretical approach had little practical applicability but it was theoretically interesting and therefore recognised in the international research community. As the work of CADIS and ISAC is described in separate

<sup>10</sup> An elementary message is a quadruple <system point, attribute name, value, time> with the interpretation the attribute with a given name of system point (read "object") has at the given time a given value. For instance: <inventory item X, quantity on hand, 157, 2006-04-30-12:33>

<sup>11</sup> It is interesting to note that system maintenance is not mentioned in this text. System maintenance is today one of the big "money-eaters" in the IT-business and consumes perhaps more than 50% of an IT-departments budget.

<sup>12</sup> An associative network as a system of triplets <A, R, B> that can be interpreted as object A is related to object B with a relation named R. This can be seen as the beginning of binary conceptual modelling. In some CADIS papers the triplet <A, R, B> was called an "elementary record".

papers<sup>13</sup>, we will not elaborate it further here.

It should be mentioned that Langefors' ideas of using the elementary message and process approach were also adopted by some international researchers, such as Daniel Teichroew and J.F. Nunamaker Jr in the ISDOS project at the department of industrial engineering, University of Michigan, Ann Arbor (in 1971). Nunamaker, for

instance, produced a program that designed an "optimal system" (in terms of processes and files) for producing a required set of outputs.

### References

Bubenko, J. A., jr, O. Källhammar, B. Langefors, M. Lundeberg and A. Sölvberg, Eds. (1970). Systemering -70. Lund, Studentlitteratur.

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<sup>13</sup> For further information about CADIS see the paper "From CADIS to SISU - Memories from Two Decades" by Janis Bubenko jr. For further information about the ISAC group see "On Methods Areas in the Early Days of a New Discipline" by Mats Lundeberg.

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# RESEARCH IN INFORMATION SYSTEMS AND SOFTWARE ENGINEERING SINCE 1990

The work since 1990 in the information systems area at SYSLAB has to a large extent focused on the development and application of conceptual modeling and enterprise modeling. Developing, maintaining and using information systems and services raise a large number of difficult problems, ranging from purely technical to organizational and social ones. Many of these problems are ill-structured, meaning that there are no algorithms or mechanical methods for solving them, or that they cannot even be precisely formulated. The problems are ill-structured mainly because the development and use of an information system involve many kinds of stakeholders with different and conflicting interests and perspectives, which need to be sorted out and negotiated. This is a difficult task as information systems and services are notoriously hard to illustrate and describe in terms that are easily understandable to non-experts. Communication problems are rather the rule than the exception. There is no panacea for these problems, but there are aids by which the problems can be described more clearly, in a more structured way, and sometimes even be formally represented. These aids consist of solid conceptual frameworks and clear notations to be used when describing and designing systems at the conceptualization and problem formulation level. Such frameworks and notation as well as associated methods, called *conceptual modeling*, can significantly improve the dialogue between stakeholders in information systems design and use.

## A new Business and Model Driven IST Architecture

Conceptual models have been used for a long time in business and in systems design, but they have not yet been put to their full potential. Typically, they have been used only for limited tasks in systems design and then discarded. To realise the full potential of conceptual models, there is a need for a business and technology architecture that places the models firmly in the

centre and lets them be the driving force in analysis, design, implementation, deployment and use of systems and services. There is a need for a Business and Model Driven IST Architecture.

A new Business and Model Driven IST Architecture should serve to enact the software specification contained in the models by composing the software and services at the time of need. This will remove the lag between changes in the model and changes in the software services driven by that model, and will create software systems that evolve seamlessly to adapt to rapidly changing business and organisational practices. Dynamic composition will enable the delivery of fine-grained software as services personalised to the exact user needs at the point of use. This will create unique working environments tailored to, and controlled by people. A Business and Model Driven IST Architecture will thus put people at the centre of new working environments supported by ambient model-driven software services.

## Enterprise modelling

This kind of Business and Model Driven IST Architecture has to be based on solid knowledge in many areas, in particular conceptual modelling and enterprise modelling. At SYSLAB, we have contributed to this body of knowledge through theoretical research as well as application in industry. A main theme has been that of *enterprise modelling*. An enterprise model is a more or less formal representation of the structure, concepts, activities, processes, information, resources, actors, roles, behaviors, goals, and rules of a business, government, or other organization. Most people at SYSLAB, including Janis Bubenko, Janis Stirna, Benkt Wangler, and Danny Brash have contributed to enterprise modelling techniques and methods. As for all other research at SYSLAB, the main part of the work has been carried out in national and international projects, often with close industry collaboration.

One of the major results in enterprise modeling is the EKD (Enterprise Knowledge Development) method jointly developed with several other European universities. EKD is also applicable in one of the other strong areas of SYSLAB, knowledge management. Knowledge management can be defined as an “approach to improving organizational outcomes and organizational learning by introducing into an organization a range of specific processes and practices for identifying and capturing knowledge, know-how, expertise and other intellectual capital, and for making such knowledge assets available for transfer and reuse across the organization”, see [www.wikipedia.org](http://www.wikipedia.org). In addition to leveraging knowledge management by means of enterprise modelling, researchers at SYSLAB, in particular Harald Kjellin and Terese Stenfors, have studied how to use organisational networks for knowledge management.

A subarea within enterprise modeling that has been studied extensively at SYSLAB is business process modeling as well as the wider area of business process and service management. In particular, several people, including Paul Johansson, Benkt Wangler, Erik Perjons, Petia Wohed, Martin Henkel, Jelena Zdravkovic, and Birger Andersson have worked on methodological support and improved implementation architectures for business process integration, where processes in different systems and organizations need to be combined to provide new services. Work on integration and interoperability has not been restricted to process aspects but also looked into semantic aspects investigating how to detect and harmonize discrepancies between different conceptual models and ontologies. Recently, this work has been carried out in the context of the Semantic Web with contributions from SYSLAB including Maria Bergholtz, Paul Johannesson, and Vandana Kabilan. Work on process modeling has also gone into the notions of process patterns with applications on reuse and language requirements and has been carried out in close collaboration with Queensland University of Technology. A recent stream of work has concerned business and value modeling, where the purpose is to design declarative models

describing the production and exchange of values between networked actors. Value models can form a basis for operational process models as well as strategic goal models.

### **Information systems and software engineering**

Research in SYSLAB has often been in the intersection between information systems and software engineering. Within the area of software evolution and maintenance, much work has been carried out by Mira Kajko-Mattsson, who has developed models for software evolution, in particular corrective maintenance. Another area within SYSLAB has been information search and business intelligence with applications on text summarization and techniques for frequently asked questions. This work has mainly been carried out by Hercules Dalianis and Eriks Sneiders, often in cooperation with researchers at K2LAB.

Another branch on research on software engineering was originally lead by Terttu Orci. Terttu defended her thesis, titled “Temporal Reasoning and Data Bases” in 1993. The road leading to the thesis had in her own words been “long and crooked, both literally and symbolically: Gothenburg, Stockholm, Umeå, and back to Stockholm”. In 1997 she was appointed associate professor at DSV and head of the Software Engineering group where she went on to work on software process improvement, software quality models, software metrics, and object-oriented, component-based software development. In 2001, she was promoted to full professor.

Terttu's students' research has been as diverse as Terttu's own interests. In 1998, Henrik Bergström started out as a PhD student interested in software metrics and focusing on software cost estimation. The same year, Harald Svensson started pursuing a PhD degree in the field of process improvement in general and PSP – the Personal Software Process by Watts S. Humphrey at SEI in particular. In the second half of 1999, Mats Skoglund and Tobias Wrigstad were accepted as PhD students, interested in programming, object-orientation and software components. Henrik worked with Terttu on SweSMA, the

Swedish Metrics Association, one of Terttu's initiatives, involving academia and metrics-interested companies in the software industry. At this point, the group was still part of SYSLAB, even though Terttu preferred to run things on her own.

The untimely death of Terttu in 2001 forced new research directions on many of her students. Henrik Bergström continued his work on metrics and in October 2002 defended his licenciate thesis "Investigating the Concept of CBR for Software Cost Estimation". Estimating the cost of developing a piece of software is a complex and yet open problem with high criticality for many software developing organisations. Henrik's research led to the development of a support tool for predicting such costs using the case-based reasoning. By the end of 2002, Predictor, as the tool was aptly named, had been downloaded about 1500 times.

Now, it was time for the next generation of software engineering researchers to graduate. After a one-year spell working full-time in the software industry after Terttu's death, Harald

Svensson returned to DSV to finish his thesis. It was presented in December 2005 and was titled "Developing Support of Agile and Plan-Driven Methods".

In May 2006, Tobias Wrigstad, under the external supervision of Dave Clarke, defended his PhD thesis, "Ownership-Based Alias Management", which presented mature constructs for programming with increased reference control, without sacrificing the power of object-oriented sharing. His work had ventured into the area of ownership types and contained the first formalism of destructive reads for unique pointers in a deep ownership setting.

After Terttu's death, Mats changed field into object-oriented testing. In June 2006, under the external supervision of Per Runeson, he defended his PhD thesis, "Curbing Dependencies in Software Evolution of Object-Oriented Systems", which contributed increased knowledge on the role of dependencies in software evolution of object-oriented software.

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# RESEARCH ON IT AND EDUCATION AND EARLY RESEARCH ON HUMAN-MACHINE INTERACTION

## Background

IT and education at DSV has its roots in the course Computer-Assisted Instruction given in 1968 by Nils Lindecrantz, based on his book “Data-maskinförmedlad undervisning”, Computer-mediated Communication. Inspired by the course, a program for exercises in the Data Processing course was developed<sup>1</sup>.

Another igniting spark was a meeting in Linköping, where Professor Donald Bitzer demonstrated a prototype of the Plasma panel. He is one of the inventors of the Plasma Technology, now widely used, but he is also the initiator and leader of the Plato-system<sup>2</sup>. After a visit in 1969 to the site of Plato, CERL – Computer-based Education Research Laboratory, and in-depth studies of the main systems used in the US, performed by Anita Kollerbaur in 1972 – 73, the ideas matured for initiating more extensive research at DSV. The studies resulted in a licentiate thesis, which outlined the research plan for the PRINCESS-project – Project for Interactive Computerbased Education Systems – starting in 1973.

Aside from the research at CERL, and the cooperation with Donald Bitzer and his team, the research in PRINCESS and its predecessors were

influenced by projects demonstrating early uses of computers as cognitive tools. The most important ones were the work at Xerox, with Allan Kay and Adele Goldberg (including Smalltalk, Dynabook and its use), and at Bolt Beranek and Newman, Inc. with John Seely Brown, Allan Collins and Wallace Feurzeig (using a database system in geography, an AI application for CAI).

The attitude to the use of computers for learning was extremely negative in Sweden in the beginning of the 1970's. Further, hardware and software environments were very primitive; terminals were mostly teletypes, personal computers were not introduced, communication was extremely expensive, interactive systems were rare, and software mostly lacked any signs of user-orientation.

## From Princess via CLEA to CIM

The early research about uses of computers for learning, and human-computer interaction, was performed in a number of projects 1973-1992, starting with the PRINCESS-project, extended into CLEA, and the CIM project.

CLEA - Centre for research on interactive computerbased LEARNING environments was established as one of ten centres within the program for Information Processing and Computer Science funded by STU, the Swedish National Board for Technical Development, 1980-1987. Main financiers for the research in PRINCESS and CLEA were STU and SÖ - the Swedish National Board of Education.

The centre, headed by Anita Kollerbaur, became central in Sweden for research on computers as interactive pedagogical tools in formal and informal education. In computerbased



**Dir. Arne Berglund** donated funding through the Sweden America Foundation, which facilitated studies leading to the start of the PRINCESS project. He was also a member of the reference group.

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<sup>1</sup> The feasibility study was done by Gunnar Björkman and Louise Yngström, later extended in a project performed by Louise Yngström, Hans Köhler and Anita Kollerbaur with support from KTH's unit for Pedagogical Development (Pu-enheten vid KTH).

<sup>2</sup> "Before Microsoft, Apple, The Web, AOL, The Internet. Before everything, there was PLATO: the first online community. The network that time forgot. The birthplace of instant messaging, chat rooms, MUDs (multi-user dungeons), personal publishing, screen savers, flat-panel plasma displays, one of the first spell-checking/answer-judging mechanisms, and countless other innovations. This site offers information regarding a book being researched and written about the PLATO system and the user culture that it spawned in the 1970s." From the history book of PLATO, <http://www.platopeople.com/>, Brian L.Lear.



### The core CLEA group.

From left to right: In the first row Anita Kollerbaur, Yvonne Westrin, Susanne Breitholtz, Hans Köhler. In the second row Mikael Kindborg, Karin Randerz, Rune Pettersson, Lars Bolander, Lars-Olof Jiveskog

learning environments the focus has to be on learning, thus the human-computer interaction and the system should be transparent to the users and interesting and effective to use. This led the group to more general research in the area of interactive systems.

The role as a national centre entailed close cooperation with other research groups in Sweden, with authorities in the sphere of education, and with potential users. In the mission for both PRINCESS and CLEA, the international frontlines in the area both in Europe, the US and

### Projects mainly focusing on computers and learning.

PRINCESS 1973/74-1982/83. The project analyzed, defined, realized and evaluated a whole system for the use of interactive systems in education. Funding from STU (Swedish National Board for Technical Development) and SÖ (The Swedish National Board for Education). Project leader Anita Kollerbaur.

DUN 1982/83-1985/86 studied how the level of use of computers to concretize data processing in school can be raised with special regards to software supplies and hardware solutions. Project leader Lars Bolander.

DUNS 1983/84-1985/86 investigated if and how general data processing tools can improve education. One study considered the use of database systems and analysed properties of userfriendly query languages. Project leader Anita Kollerbaur.

MOD 1984/85 -1987/88. MOD studied if and how modern information technology can be used in elementary school. Project leader Lars-Olof Jiveskog..

SISDA 1985/86-1988/89. In SISDA the focus was computerbased environments for learning foreign languages. An innovative approach to language learning was developed and tested in various empirical settings. Project leader Rolf Ferm.

### Projects mainly focusing on various aspects of Human-Machine Interaction

GIMP 1981/82-1984/85 studied if and how human problem solving can be supported by computerbased environments. Project leader Hans Köhler

DESCARTES 1980/81-1984/85 studied representation in different advanced system. The work is presented in a doctoral thesis 1986 "Taxonomic representation". Project leader Carl Gustaf Jansson.

COLOR 1982/83-1984/85 studied different aspects of presentation of information on colour screens. Project leader Rune Pettersson

CIM 1988 - 1992 studied human-computer interaction from a communication perspective. Project leader: Anita Kollerbaur.

also in Japan, were to be followed. Research in CLEA was yearly reviewed by international researchers <sup>3</sup>.

Relatively few CLEA articles were published internationally during the first period, as the young group in a young department was more oriented towards influencing the educational system than making academic careers. Publications expanded from 1980, and the research resulted in four academic theses, a number of published papers and a wealth of material, tools, methods, demos and software, including articles in Swedish. The early research about uses of computers for learning and human-computer interaction was performed in a number of projects during 1973-1992, starting with the PRINCESS-project.

Extensive efforts were also put into activities for disseminating information. 1973 the first conference was arranged in the Parliament Building in Stockholm, presenting the state of the art in the area both in Sweden and internationally. This 1973 conference was followed by national conferences 1977, 1984 and 1987. The conferences are commented on in a separate section of the book. PRINCESS took the responsibility of disseminating the results to a broad public audience. A brochure, in English and in Swedish, was produced and distributed to all Swedish schools, politicians, decision-makers and parties interested in the use of computer-aids in education.

## Approach

The research included both basic and applied parts. Basic research was partly initiated by problems revealed in the conduct of applied research, which in its turn provided the basic research with empirical environments for studies.

Further, the research was interdisciplinary, with particular emphasis on information processing, media technology and pedagogy. Systems thinking, holistic perspective, the conception that the development of methods and tools must be interchanged with empirical studies was applied. Users were to be in the centre. In pedagogical applications, the goal was to improve learning by

the aid of advanced use and adaptation of technology to pedagogical requirements.

In the research on human-computer interaction, knowledge from professional communicators was applied, with the common goals that the systems should be transparent for the user. Users should be able to interpret, understand and use information as intended. In both areas the system should be effective and stimulating to work with.

Finally, the principle was applied that people involved must participate in systems development.

In both areas of research prototypes were built and tested empirically either in the laboratory or in field trials, often used in regular learning situations.

In PRINCESS various terminal/workstations were studied and used: teletypes, STANSAAB Graphics terminals, and Plato-Plasma-terminals. The PLATO-terminals were adapted to the DEC-10 environment in use with support from CERL. From this basis the GLAS concept evolved, Graphic Low cost Advanced System. GLAS allowed graphic presentation and could be used both as a terminal and as a high performance personal computer. The system was put together from components imported from USA in 1980. In CLEA, GLAS was further developed to handle colors and also to include the possibility to digitalize video signals.



During 1977-80 PLATO- III and PLATO IV-terminals were used in PRINCESS' field studies in the upper secondary school "Tibbleskolan". Picture shows group work using a PLATO III terminal, communicating with the system by pointing at the screen.

<sup>3</sup> Report of the International Committee on the Computer Science Program, STU-info 782-1990.

### PRINCESS project

The PRINCESS research was to answer the questions concerning if and how education could be improved by the use of computer aids. A model of a system for computer-based education was iteratively developed and evaluated in four major stages of design, development, empirical tests and evaluation. Also the internal and external context was considered, apart from the regular partitioning of ICT for learning by then in hard-, soft- and courseware. Among these were changed roles of teachers and students, the interplay between ICT and other media, as well as analysis of requirements on curricula and school development.

The model was developed in cooperation with users and implemented and studied in situations as close to regular use of ICT for learning in schools as possible. The final period included almost all students, half of the teachers and many subject areas in Tibbleskolan outside Stockholm. Tibbleskolan is an upper secondary school with study programs in human and social sciences. At the experimental period there were around 1000 students and 80 teachers.

A number of tools were developed based on the cognitive tool approach, implying that knowledge is derived from the experience gained while performing meaningful activities and that it will facilitate analysis, reflection and discussions. ICT should be regarded as one tool among other tools and materials. Also, work with applications in groups of students should be supported as interactions among the learners were regarded to be of equal importance as individual interactions with the applications.

In PRINCESS, advanced use of ICT for learning was to be demonstrated. One group of examples was the use of general tools, the other group was the use of subject-oriented tools. As example of general tools, PRINCESS introduced word processing and spreadsheet systems in 1981.



Project work with the history program during the final full-scale experiment in PRINCESS. Interior from the specially designed computer room with 10 GLAS systems.

Both changed the normal approach to their respective areas.

Two major demonstrations of the use of databases were made, one in history and one in food sciences. Database handling tools were developed in SIMULA, but also user-friendly editors for the content of databases to be used by teachers themselves. In both cases professional, extensive sets of data were used. In history from a demographic data base, with data from Swedish parishes of two communities 1821-1899, also used by researchers in history.

In natural science, the database included data from Livsmedelsverket (National Food Administration) and from other expert bodies. The program, also allowed searches for food-stuffs containing particular nutrients, development of nutritionally balanced recipes, etc. With KOST, the students were able to use more advanced data than normally, they could also study their own eating habits. Diet surveys before and after the experiment showed that the students had grown more serious about what they ought to eat, and that they had altered eating habits. For the first time in school, students could do experiments based on their own data, which was seen as a strong motivating factor.

Another example was a laboratory used for teaching heuristic mathematics. The computer aid

made it possible for the students to study polynomial expressions and their graphic representations by constructing their own problems.

The applications were implemented in a DEC10 - SIMULA environment. A special method (PUSUM) was evolved and presented in Hans Köhler's doctoral thesis. PRINCESS also created new tools for development of interactive systems, called the program library PRINCIP, including:

- DESIGN to support development of the interactive parts
- Primitive tools for subject modeling in PRINCIP
- Magic for development of computer assisted games for educational purposes.

The core research group in PRINCESS included Anita Kollerbaur (project leader), Carl Gustaf Jansson, Hans Köhler, Louise Yngström, and Jerzy Hollenberg. The size of the group varied through the years. In total funding covered 40 man years.

Scientific advisors and a reference group were appointed to the project by the funders <sup>4</sup>.

Scientific advisors were Professor Börje Langefors (DSV) and Professor Bengt-Olof Ljung (Pedagogic, School of Education in Stockholm).

### CLEA and CIM

The research in the area of human-computer interaction had two main focuses, visual aspects of communication, and what was called communicative systems with focus on the interactive processes.

Many problems in interactive had their roots in bad communication between the model of a system and the user's knowledge and experiences. Three groups of problems were identified:

- discrepancies between the model of the system and the user's knowledge and experiences

- information not being communicated in a clear and unambiguous way
- actions to be performed not being understood "physically" and /or cognitively.

In-depth studies <sup>5</sup> of design in multimedia environments were performed by Rune Pettersson <sup>6</sup>. He studied communication with visuals including interpretation of image contents, the use of colors for presentation on text and numeric data, of attitudes to different variables in the presentation on visual displays properties on pixels. This research was presented at a large number of conferences.

Early in PRINCESS major problems for users related to communication in interactive systems were revealed. Support for navigation and information on available actions was considered in the designs, work processes were designed so cognitive load was reduced, to mention a few examples. An important aspect was the necessity of communicating the model that the system was based on. In nutrition it is important to know the quality of the data, assumptions in the model, for instance KOST didn't consider the specific nutritional requirements for vegetarians.

Continued studies on communicative aspects of systems were performed with

- analysis of methods of communicating information in non computer-based media. This analysis led to the conclusion to investigate the possibilities and effects of lexivisual presentation<sup>7</sup> to human-computer interaction.
- analysis of communication in existing tools and applications such as Word, Excel, Hypercard, Notecards, SuperKOM, (a system for group communication) and flight and hotel reservation systems.
- development and studies of two interactive systems.

<sup>4</sup> The reference group included financiers and specialists from different areas, the most important were: Dir Arne Berglund, Mercator International Group, Professor Germund Dahlqvist (KTH), Nils Erik Svensson, The Bank of Sweden Tercentenary Foundation, Lennart Levin, The National Swedish Board of Universities and Colleges, Tomas Ohlin, (then at STU), Bengt Dahlborn och Esse Lövgren (NBE), Stig Fägerborn och Peter Bagge, The Swedish Agency for Public Management

<sup>5</sup> Interactive graphics were used already in PRINCESS, but without colors.

<sup>6</sup> Rune Pettersson is now professor and research leader of Information Design at University College of Mälardalen

<sup>7</sup> Lexivisual presentation is a set of principles and techniques for effective communication of text and pictures. It is based on the idea that associated information shall be visually and spatially related, so that the reader does not have to switch back and forth between different pieces of information. The first modern application was in the Swedish encyclopaedia Focus.

- visual techniques for orientation in hypermedia structures. In this study an experimental hypermedia system for information about the solar system was developed.
- "Äventyrsresan" - a hypermedia tool<sup>8</sup> for children where the children could create their own learning material. It was iteratively developed and tested empirically in a school in Håbo. For a more detailed presentation see *Kollerbaaur, Kindborg 1991*.

Results from the studies on the use of lexivisual presentation can be found in *Kollerbaaur, Larnhed, Kindborg 1989* and *Kollerbaaur, Kindborg 1990*.

The problem of disorientation in hypermedia system were studied and presented in a Licentiate thesis, *Kindborg 1991*, followed by a PhD thesis, *Kindborg 2003*.

### Early results

A more detailed presentation of PRINCESS is found in *Kollerbaaur et al. 1983* and *Kollerbaaur 2005*.

Some of the results were:

- The use of the cognitive approach to IT for learning was found to be possible resulting in improved learning. Situated and collaborative learning was demonstrated.
- Introducing computers as tools for learning is a process of change, that has to be particularly considered; roles are affected, mainly the roles of teachers and students.
- Importance of the communicative aspects of interactive systems were stressed, particularly the support for navigation and communication of what we then called the subject model. Without explicit presentation of the model the curriculum is hidden. These are examples of early results in the area of Human-Machine-Interaction, HMI.
- Iterative methods for systems design and development need teams and user participation. The process has to be analogous to design disciplines, formulating properties of

a product through experimentation with prototypes. Evaluation techniques from different disciplines were adapted and used, for instance participant observation.

In the area of Human- Computer Interaction a number of factors essential to positive human-computer interaction were identified. It was shown that positive effects can be improved if certain types of information is communicated:

- information of the relation between the reality and the system's model, particularly limitations and basic assumptions are communicated
- the systems functions are organised and presented in a way such that they naturally support the tasks to be performed by the system.

Furthermore, communication was improved by applying lexivisual presentation to:

- present an overall view of the system's functions and data
- orient the user in the system
- communicate the structure or functions and data
- present related information together
- present detailed information in its context (related to the whole).

### Comments on impacts

This approach to ICT and learning was agreed upon by the Swedish National Board for Education, and it also influenced further activities in the area. Already in 1986 extensive financial support for courseware development was given, and a group for coordination at the Ministry of Education and Science was established. Later even more extensive support for the area was made available both from the Ministry and from the Knowledge Foundation in Sweden.

The functional requirements applying to GLAS provided the base for creation of a "school computer" supported by the National Board for Technical Development. This initiated a technical procurement project resulting in development

<sup>8</sup> Basic concepts in the system was scene, collage, text, picture buttons, links and actions. Functions include editing and integrating texts and pictures, for coloring and for linking presentations and for handling the database of presentation. The system was programmed in C, Windows 2.1 and for VGA-graphics.

of the school computer COMPIS: (English for PAL). COMPIS was introduced on the market in 1985. However, the effort failed, partly for the reason that schools did not accept a dedicated system<sup>9</sup>, partly due to the fast growing Mac- and PC-markets.

Since 1986, the research and applications of ICT for learning have grown, particularly during the late 1990s, when the concept of E-learning became widely used, mostly assuming the use of Internet. Most of the technical obstacles perceived in PRINCESS are now overcome. The general impression is, however, that independent of all efforts put into the area, the great breakthrough has not yet appeared in Sweden, at least not within the public educational system.

The research and the technical development in the educational area have opened new possibilities for communication, especially after the introduction of Internet. The problems studied in the 1980s like navigation, orientation problems and visual communication, surely exist also in 2006. A conclusion can be that although the research in the area of human-computer interaction at DSV was early, it failed in communication of the results.

Even if the impact on society at large has been limited, the influence on research and education within DSV department has been substantial. Courses in computerbased education and human-computer-interaction were introduced in the mid 1970s. The area grew into one of DSV's specializations for the master program in 1993. The laboratory for Knowledge and Communication, K2lab, has its roots in PRINCESS and CLEA, and is today the largest research laboratory at DSV. In a following section, the preceding development in the area is described.

## Bibliography and references

Brown, A.: Paradigmatic example of Artificial Intelligent Instructional system, Proc of the First Int. Conf. on Applied General Systems Res. Resent Dev. and Trends, June 1977.

Carbonell J.: AI in CAI. An Artificial Intelligence Approach to Computer-Assisted Instruction, IEEE Transactions on Man-Machine System, Dec. 1970.

CLEA progress reports to STU, yearly from 1980/81 to 1988, Dep. of Computer and Systems Sciences, DSV, Stockholm University/KTH.

Computer Aids in Education – PRINCESS Final Report, ISBN 91-970520-0-0, 1983 (in Swedish). A popular abstract is available in English, Computer Aids in education, Presenting the PRINCESS-project, DSV, 1983.

Jansson C-G J.: Taxonomic Representations, PhD thesis KTH 1986, ISBN 91-7170-991-6

Kollerbaur A., Analysis of Systems for Computerbased Education, and Hypothesis for Future Research, Licentiate thesis, DSV, 1973 (In Swedish).

Kay A., Goldberg A., Personal Dynamic Media, Computer, vol 10, no 3, March 1972

Kindborg Mikael: Visual Techniques for Orientation in Hypermedia Structures, ISSN 1101-8526, DSV, 1991

Kindborg M, Kollerbaur A, Avenyrresan CLEA-report, DSV, 1990

Kindborg M.: Concurrent Comics – programming of social agents by children, Linköping Studies in Science and Technology, Dissertation No. 821, 2003

Köhler H.: Methods for Systems Analysis and Development of Computerbased Educational Systems, PhD thesis 1981, Dep. of Information Processing, Stockholm University/KTH, 1981, ISBN 97-7146-121-3 (In Swedish).

Köhler H.: Methods for Systems Analysis and Development of Computerbased Educational Systems, PhD thesis 1981, Dep. of Information Processing, Stockholm University/KTH, 1981, ISBN 97-7146-121-3 (In Swedish).

Kollerbaur A, Computers as tools – a need for a new approach, in Proceedings from HINC, History of Nordic Computing, Editors Janis Bubenko jr, John Impagliazzo, Arne Sölvberg, Springer, New York, 2005

Kollerbaur A, Kindborg M.: Kommunikation – en försummad aspekt i användargransnitt, Norddata 90, Dataforeningen i Sverige, 1990

<sup>9</sup> GLAS was a general purpose PC.

Kollerbaur A., Analysis of Systems for Computerbased Education, and Hypothesis for Future Research, Licentiate thesis, DSV, 1973 (In Swedish).

Kollerbaur A., Köhler H., Yngström L., Computers in Education, Data Processing Technology, TRITA-EDU-010, March 1975 (in Swedish).

Kollerbaur, et al, CLEA – Summary of Research on Interactive systems. CLEA report, DSV, 1988

Kollerbaur A., Larnhed T, Kindborg M.,: Lexivisual Interfaces – The New Look, in proceedings from CASE'89, Stockholm, 1989

Kollerbaur A.: CIM- Communicative Interactive Multimedia Systems, p 157-165, Computer Science at Swedish Universities 1987-1992, Swedish National Board for Industrial and Technical Development, NUTEK, Dec 1992

Petterson Rune: Visuals for Information, Educational Technology Press, USA, 1989

Lindecrantz Nils: Computer-mediated Education, Studentlitteratur 1968

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# RESEARCH ON KNOWLEDGE AND COMMUNICATION

During the last thirty years (1975-2005), we have seen systematic shifts in Computer and Systems Sciences with respect to the inclusion of the aspects of Knowledge and Communication. In the 1970ties the focus was on single humans, using single computers for specific data-storage and computational purposes. Computers were used almost only in professional settings used by comparatively few people, computers were peculiar unique artefacts, powerful but still viewed primarily as passive tools. Today the focus is on large groups of humans communicating and collaborating, assisted by large networks of fine-grained computational elements. Computational elements penetrate into all human activities and are used by virtually everybody, they are rapidly more embedded in and not distinguishable from other artefacts and typically more active in the collaborative processes in contrast to being passive tools.

By the Communication aspect of computational systems, is meant both the role of the systems as support for human-to-human communication as well as the communication interfaces between humans and elements of the computational systems. By the Knowledge aspect of computational systems is meant these systems' abilities to act as equal partners to humans in the accomplishments of nontrivial tasks and to contribute to the systematic build up of knowledge in such contexts.

## Subfields

During the period of consideration, several fields have been developed which highlight the Communication and Knowledge aspects: Human Machine Interaction (HMI), Human factors research, Human Computer Interaction (HCI), Computer Supported Cooperative Work (CSCW), Computer Supported Collaborative Learning (CSCL), Computer Aided Instruction (CAI) and Computer Mediated Communication (CMC). Important subfields of HCI are interaction design, multimedia technology, tangible interfaces, virtual and augmented reality techniques,

social and affective computing. The Knowledge aspect is highlighted in fields such as Artificial Intelligence (AI) and Knowledge Engineering as well as in the Complex systems field. AI was christened already in the 1950s but had reached a mature state in the mid 1970s. The core objective is to mimic sub-functionalities of human cognition. Its main topics are representation of knowledge, automated reasoning and machine learning (techniques to adapt system behaviour). Important sub-fields of an applied nature are robotics, expert systems, multi-agent systems and data-mining.

In the borderland between AI and HMI you find sub-fields such as advanced perception in general, speech technology, language technology, computer vision, intelligent interfaces, multi-modal systems, intelligent tutoring systems, ubiquitous computing, human-robot interaction etc. A property of most of the above fields is that they borrow from and reach into other traditional disciplines such as applied mathematics, statistics, logic, philosophy, psychology, linguistics, anthropology, cognitive neuroscience, sociology, pedagogic, subject specific didactics, industrial design, graphical design, drama, arts and journalism etc. In order to capture relevant overlapping parts of such disciplines, interdisciplinary umbrella disciplines like cognitive science and communication science have been defined.

The following text will illustrate how these fields and subfields have grown in importance within Computer and Systems Sciences, but also how the influence from our neighbouring disciplines has grown and how knowledge from these disciplines has been included in ours.

## Computer-assisted learning

In the early seventies, pioneering work on computational tools as support for education/learning was pursued at DSV starting with a project called Princess (and followed up in CLEA) initiated by Anita Kollerbaur with her fellow researchers Louise Yngström, Hans Köhler, Jerzy Holleberg and Carl Gustaf Jansson. One work-part of that

project was to make a survey of “Intelligent Tutoring”, a subfield of AI, which had the goal to manage explicit models of the users, observe and classify the state of the users and finally to adapt the system to the specific situation at hand. The project also included work to explore the impact of simulation models and visualizations in education. Another novel feature was the creation of authoring tools that should simplify educational support systems of a certain kind and which separated the user interface design from the domain model design. Finally, the project was the introduced systematic empirical studies in realistic school settings.

### **Object oriented modelling**

From 1975 to 1985, DSV also contributed to very early work in object-oriented programming and object-oriented modelling. Janis Bubenko developed the field of data-modelling into what he called conceptual modelling. Christer Hulthen, Lars Söderlund, and Carl Gustaf Jansson worked in the border area between modelling and programming. In the early eighties, this work was developed further into the field of knowledge representation, a subfield of artificial intelligence in particular the cognitive aspects of conceptual structures and mechanisms for automatic formation of such structures.

### **Artificial intelligence**

The DSV work in artificial intelligence was much inspired and strengthened by a guest researcher, Dr Kenneth Kahn, with a PhD from MIT. Kahn had very early introduced the first basic course in Artificial Intelligence at DSV and as a role model illustrated the AI attitude that no problem is too difficult for being attacked by computational means. During the 80ties, Carl Gustaf Jansson and Istvan Orci gradually developed the AI curriculum and in 1987/88, DSV could offer a 40-credit specialization in AI, optional on programs both at SU as well as KTH. The courses included introduction to AI, logic and formal techniques, AI programming, knowledge representation, expert systems and logic programming. In parallel with this also a set of more specialized graduate level courses were

developed: machine learning, intelligent tutoring, analogical reasoning and qualitative models.

### **Human-machine interaction curriculum**

In parallel with this development of a curriculum in artificial intelligence, several undergraduate courses in human-machine interaction were developed, primarily due to the efforts of Anita Kollerbaur. Even if these courses initially were not mandatory, they were optional on most programs and frequently selected.

Inspired by the research in knowledge representation, Carl Gustaf Jansson initiated a very fruitful collaboration in Cognitive Science with three professors at Stockholm University, Dag Prawitz in Theoretical Philosophy, Östen Dahl in Linguistics and Ywonne Waern in Cognitive Psychology. The first concrete fruit of this collaboration was a 40-credit program in Cognitive Science launched in 1989 at Stockholm University jointly by the four departments. The program has recently revived and is a good candidate for being extended to an 80-credit masters program in the Bologna model. In partnership with professor Yngve Sundblad, DSV worked with the introduction of a track in Cognitive Engineering on the Technical Computer Science civil engineer program (D-line) in 1993. D-line students studied artificial intelligence, artificial neural networks, human-machine interaction, linguistics, neuroscience, cognitive psychology and theoretical philosophy for a year as an option on their third year of study.

A second consequence was the establishment of the Centre for Information Technology and Cognitive Science (shared between KTH and Stockholm University) in September 1992. Apart from DSV, linguistics, psychology and philosophy, the centre was supported by NADA as well as the departments for work science, manufacturing systems and speech, music and acoustics, all at KTH as well as neurophysiology at KI. The centre is administratively hosted by DSV, and currently directed by Robert Ramberg, professor at DSV with a background in cognitive psychology. The centre has now for more than ten years promoted interdisciplinary undergraduate courses, PhD work and symposia.

### Impact on education

The sum of the curriculum development in artificial intelligence, human machine interaction and cognitive science around 1990 had a major impact on DSV's undergraduate education as a whole. It was therefore not strange that the remodelled Computer and Systems Master of Science education in 1993 included Cognitive Science in a wide sense as a basic block on equal terms with Computer Science and Systems Science. This was one of first IT-related education programs in Sweden which included a significant amount of mandatory HCI courses. Specializations in interactive systems has been offered since then in many programs both at SU and KTH.

### Machine learning

In 1986, Carl Gustaf Jansson built up a research group in machine learning (ACTA), which peaked in the early nineties to scale down after almost a decade. The PhD theses of Idestam Almqvist, Boström, Asker, Kilander, Samuelsson, Stensmo, Wijkman and Zemke represented different aspects of the machine learning field. The early projects were funded by NUTEK, the later by TFR and in particular by EU through the very successful, six year long Inductive Logic Programming project, which apart from funding, provided DSV with a work environment with the best and most exciting research groups within the field in Europe. Research work has been kept up in this area at the department, driven by Henrik Boström and Lars Asker, both now associate professors. Over time the focus has moved more and more to data mining with information retrieval and medical databases as the main application areas. Boström and Asker have also set a good example by establishing a spin-off company in the data-mining field.

### Adaptive Interfaces and Social Aspects of Computing

The machine learning work has also inspired work on adaptive systems. Annika Waern and Kristina Höök both started their work with an artificial intelligence orientation, but gradually moved towards a more articulated HMI profile.

The core of Höök's work was based on a joint NUTEK funded project within a program called "Cognitive engineering", the existence of which was clearly dependent on the development in the cognitive science arena described above. Höök and Waern have both individually pursued distinguished careers after their dissertations. Waern has divided her time between industry and SICS and is now one of the key researchers within the European computer game research arena, a field recently of high relevance to DSV because of our undergraduate study initiatives. When DSV managed to launch a new chair in Human Computer Interaction, Höök applied and was appointed, still keeping up her research leadership at SICS. Höök's recent work has moved us in new directions into interaction design informed by social and emotional factors in particular for highly mobile everyday life applications. Höök has received strong funding both from EU (e.g. Humaine), SSF (Mobile Life) and Microsoft Research and has recently been granted a competence centre by VINNOVA focussed on technology for the mobile life.

### Language Engineering

A part of the cognitive science endeavour and another important subject change is the introduction of language technology in our subject. The PhD theses of Emanuel Rayner, Hercules Dalianis, Christer Samuelsson and Björn Gambäck are examples of that. Jussi Karlgren's and Ivan Bretan's licentiate theses also reflect this development. Around 1990, funding for language technology research was good and most of the above graduate students were employed in research groups at SICS and IBM Nordic laboratories. Many of our graduate students in this field have made exceptionally successful careers. Over time we have both moved into the area of multi-modal interfaces, where the borderlines are not so clear anymore. Collaboration with the speech group at KTH, Rolf Karlsson, Björn Granström and others, has always been good.

### Computer Mediated Communication

Since the early 80ties, Jacob Palme has pursued work in Computer Mediated Communication

(CMC) in a wide sense including pioneering work on Internet technology, electronic mail and computer conference systems. Palme's research group has developed a series of frontline computer conference systems (KOM and its successors). The group has also worked extensively with applications of computer mediated communication technology in education, medicine and general society settings (votings and society information systems). Sirkku Männikö's thesis applied ethnographic methods to study communities of computer conference users. Eva Fåhrens' thesis applied CMC systems to promote distributed learning and education. Recently, Palme has focussed on an extensive webservice in health-care and the issue of multilanguage services in computer conference systems.

### Formal Methods

A strong thread of research which should not be forgotten is the work on formal methods and logic. Janis Bubenko strongly pushed information systems technology towards the use of formal methods, a tradition pursued by Paul Johansson. Another proponent of this tradition is Magnus Boman, whose PhD thesis applied non-standard logic. He has since then made strong contributions on formal methods for both decision support, design of multi agent system as well as modelling of complex systems. Boman was in the late nineties appointed professor at KTH in intelligent software agents. The work on formal analysis of multiagent systems has been pursued by Verhagen in his thesis and continued research. The work by Lars Kahn, Istvan Orci and Terttu Orci applied formal methods to software engineering and programming methodology. Istvan Orci also made contributions within artificial intelligence to reasoning under uncertainty using a logic approach. On the borderline between applied logic and logic programming could be mentioned the theses of Aronsson, Idestam Almqvist, Boström, Johansson and Granskog. Within artificial intelligence we have the thesis by Waern. Finally should be mentioned the theses by Ekenberg and Danielsson on formal methods for decision and risk analysis. Ekenberg has successfully continued this research at DSV after having been appointed professor.

### IT and Learning

The above mentioned early work in IT and learning was revived in the early 90ties. An important factor was the recruitment of Robert Ramberg to DSV. Robert had already in his thesis treated learning technology in an industrial setting from the perspective of cognitive psychology and he was eager to pursue research in this direction even at DSV. NUTEK funding made it possible to pursue studies on how to teach novices to express themselves in complex languages for modelling and specification. This was one of the domains used by Klas Karlgren as basis for his thesis on language use in learning support systems. Of great importance has also been the totally six years of work in the two consecutive EU projects directed by Carl Gustaf Jansson: Playground and Weblabs. These projects targeted lower levels of the school system (age group 8 -12) and the goal was to promote learning of problem-solving, mathematics and science. The work in the Playground project formed the basis for Jacob Tholander's thesis work. The work in the Weblabs project formed the basis for Ylva Ferneus' thesis work. Another kind of studies carried out in parallel, concerned the support for physics learning for college level students, and the role of visualization for improving mathematics education was studied.

### The Laboratory for Knowledge and Communication – K2LAB

Right in the middle of all the work described above, in 1994, DSV was reorganized and Jansson became director for the Laboratory for Knowledge and Communication Engineering (K2LAB) including researchers Palme, Boman, Ramberg, Verhagen, Boström, Asker and others described above. K2LAB has in different shapes existed since then and now constitutes one of the organizational subunits within the present DSV. In average, K2LAB has had a senior faculty of ten people and twenty graduate students. K2LAB had the ambition to pursue work that combined the communication and the knowledge aspect as envisioned above and to include both formal, engineering and empirical elements. During its lifetime K2LAB has also had a good

collaboration with the HUMLE laboratory at SICS, established at about the same time and with a similar profile, as well as with IPLab at NADA/KTH.

### **The HMI Graduate School**

Of great importance for the research and graduate studies at K2LAB/DSV during the period 1997 up to now, has been “The National Graduate School for Human Machine Interaction” in cooperation with IPLAB at KTH and IDA, IKP and TEMA – Communication at Linköping University. Almost 40 PhDs has been examined within the School, among these a considerable number at DSV. DSV has played a major role in the planning and running of this School and was the host for the final workshop of the school in the spring of 2006. During the period, DSV has established HMI as a post-graduate study program and also acquired a specific chair with this profile at SU.

### **Ubiquitous and Collaborative Computing**

Since 2000, DSV has launched work on Ubiquitous Working Environment (Jansson and others) in the tradition of ubiquitous computing, i.e. environments which support collaborating mobile workers in a seamless way supporting: ad-hoc solutions for spontaneous collaborative work sessions, both distributed or co-located. One tangible result is the iLounge, a prototype of an interactive workspace and more flexible extensions of the environment (Teamspace). The research described has been made possible due to the generous grants from: Alice and Knut Wallenberg Foundation, The Swedish Foundation

for Strategic Research (SSF) in the PCC and AWSI programs, VINNOVA and the EU IST 5th framework program. The most important international partner has been the Computer Science Dept. at Stanford University represented by professors Terry Winograd and Armando Fox.

### **The IT and Communication Science Program**

In 2002, DSV introduced a new four-year masters of science program in Information Technology and Communication Science (the ITK program). The first year has a strong focus on IT and Communication. In the second year, the students choose a “minor”, that is studies in another subject like pedagogic, linguistics, journalism, media and communication etc. In the final years, the students specialize in media, IT and education etc.

### **Masters Program in Interactive Systems**

After some years of planning a new 60 credits masters program in Interactive Systems Engineering (ISE) was launched at KTH 2004. The program has a mixed profile with respect to the Communication and Knowledge aspects and is 2006 proposed to be extended to credits as a masters program according to the Bologna model.

### **The School of Information and Communication Technology**

In December 2004, DSV became part of the newly founded School of Information and Communication Technology (ICT-school) at KTH.

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## RESEARCH ON SECURITY INFORMATICS

The research part of SecLab, the official naming of ICT-related security education and research in the Department, has been strongly influenced by the history of Security Informatics. As described elsewhere in this Book, Security Informatics grew out of practical needs as defined by the Swedish Vulnerability Board during the late 1970s. The Swedish society was highly computerized and the professionals caring for the security of information systems had backgrounds in computer science, often in combination with law and management studies. Many of them also had practical experiences from civil or military oriented security work. The initial undergraduate program in Security Informatics aimed to strengthen the ICT-related security area by offering a final or complementary one-year undergraduate program leading to a bachelor degree in CSS, simultaneously providing a base for entering a PhD program in CSS with a security focus.

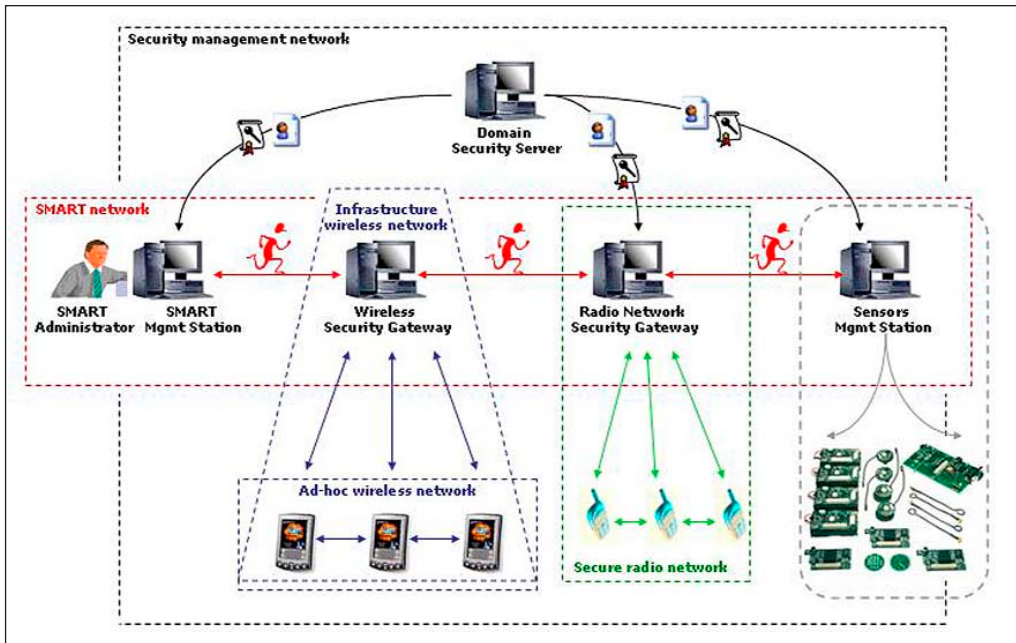
Early, demands for holistic approaches towards securing information systems in organizations were voiced leading to defining Security Informatics as “An interdisciplinary area encompassing theories and methods for secure handling of information within organizations or technical systems. The area also contains the use of information technology as means for security and safety in social, socio-technical, and technical environments.” (ITS 1994, p. 14) The undergraduate program was developed 1980-1988 in collaboration with professional bodies such as SIG-Security (the special interest group on IT Security of the Swedish Computer Society) the EDP and Law Association, ISACA (the Information System Audit and Control Association), NBB (the Employers’ Security Bureau) and ASIS (the American Society for Industrial Security).

1988-92, DSV was granted funding within the IT-4 research program for the project “Basic Models for Information and Computer Security – Security Integrity and Information Security, SIIS” which laid the foundation for further

research and also made it possible to extend the group with researchers complementing the original area of competence. Other influences worth mentioning were the research group’s activities related to the ERASMUS/SOKRATES ICPs, aiming for development of a European Master Program in Information Security and an Intensive Program in Information and Communication Systems Security, driving educational research questions within IFIP TC11 WG11.8 leading to constituting the biannual WISE conferences and strong relations to the Swedish project SEIS (Secured Electronic Information in Society).

Academically, Security Informatics is founded on General Systems Theory with Cybernetics, the Theory for Living Systems and Soft Systems Methodology (Yngström 1992, 1996), viewed as intersections of Computer and Systems Sciences with Legal Informatics and Economics including Management. Members of SecLab are in their research approaches influenced by the scientific history of Security Informatics and demands of the environment, i.e. to approach scientific problems systemically (problem-oriented) and interdisciplinary founded on system theories and cybernetics oriented towards civilian and organizational applications. The analogy of a fork for ICT-related security problems may be used; security problems are approached at many levels, technical as well as applicational including interacting/cooperating with other items/aspects. Overall we view the ICT security area as an area of control where systems, cybernetics, feedback and feed-forward in a systemic setting play important roles.

Research may be expressed from mainly three points of departure; from a Use/Paradigmatic perspective with understanding, communicating, informing, educating and learning about ICT risks and security in modern environments; from a Managing perspective with risks, vulnerabilities, controls, and audits; and from an Architecture perspective with security architecture for mobile and wireless networks;



The figure shows an overview of SecLab's research focus on Security Architecture for mobile and wireless networks.

building prototypes including elements such as security servers, wireless and mobile workstations and devices, security protocols, and security interfaces, which in total will support all standardized network security services, be transparent to multiple wireless communication protocols and be able to support different network topologies.

As examples of the three research perspectives Use/Paradigm (1), Management (2), and Architecture (3) can be mentioned the work of four PhD students from Tanzania pursuing their research with SecLab investigating demands of ICT security in a developing country for education (1), assessment of ICT security (2), security readiness of users (1) and security management (2) (Casmir 2005, Chaula 2003, Tarimo 2003, Bakari 2005), two PhD students from Sri Lanka investigating comprehensive security functionalities for web-based applications (3) respectively assessment methodology for privacy (2) (de Zoysa 2000, Dayarathna 2007). Three further

PhD dissertations in 2005 covered security for ad-hoc networks (3), computer games for education in security (1) and security management in practice (2) (Ciobanu 2005, Näckros 2005, Björck 2005). Further up-coming projects pursue research on outsourcing and ICT security (2), risk analysis models (1&2) and security for mobile and wireless applications (3).

## References:

- (ITS 1994). Terminologi för informationssäkerhet. Informationsteknologiska standardiseringen, Rapport ITS6, Stockholm, 1994
- (Yngström 1992) Yngström, Louise: Towards a Systemic-Holistic Approach to Academic Programs in the Area of IT Security, Licentiate thesis, DSV, 1992
- (Yngström 1996) Yngström, Louise: A Systemic-Holistic Approach to Academic Programmes in IT Security, Doctoral thesis, DSV, 1996.

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# RESEARCH ON SYSTEMS ANALYSIS

## The concepts

Systems analysis is the science dealing with analysis of complex, large scale and dynamic systems. This includes the use of algorithms, mathematical models and statistics to aid in decision-making. It is most often used to analyze complex real-world systems, typically with the goal of improving or optimizing performance. Some of the primary tools used within systems analysis are decision analysis, optimization, simulation, statistics, machine learning or data mining, forecasting, mathematical modeling, game theory, graph theory, queueing theory, resources allocation, project management as well as many others.

Research within systems analysis at DSV has a long tradition, spanning two decades, although the actual label of the field has varied over time. In this chapter, we present a brief history of the achievements at DSV, and have chosen to organize the presentation along two major themes – machine learning and decision analysis.

## Machine Learning

Early work on artificial intelligence at DSV was undertaken by Carl-Gustaf Jansson, who defended his Ph.D. thesis *Taxonomic Representation* in October 1986. His work in this area initially focused on knowledge representation, but even before the defense, his interest had turned to the field of learning systems, i.e., systems that improve their performance based on experience, which was gaining attention under the newly coined name *machine learning*. In 1985, he had already started gathering Ph.D. students and project workers around this theme: Lars Asker, Anna Danielsson, Åsa Rudström and Stefan Möller. A couple of years later the group was extended with Alan Davidson and Fredrik Kilander, and in early 1988, Bassam El-Khoury and Harald Kjellin joined the group as well. Soon after, in summer 1988, Henrik Boström and Peter Idestam-Almquist became two new members of the research group, which was named ACTA, an acronym whose reading fluctuated

slightly over time, but which at least for a period of time stood for Acquisition, Concept formation, Theory revision and Adaptation. The main focus of the group by that time was on case-based reasoning - how to solve new problems by relating them to previously solved problems. Work by Roger Schank and Janet Kolodner were highly influential on the group's attempts to build a world-class case-based reasoning system.

The research interests of the group members soon diverged, and in a few years, they spanned almost all active sub-fields of machine learning at that time, including explanation-based learning, version space learning, inductive logic programming, conceptual clustering, instance based learning, decision trees and genetic algorithms. The first Ph.D. thesis in machine learning that was output by the group was written by Henrik Boström and was defended on November 16, 1993. The thesis was entitled *Explanation-based Transformation of Logic Programs*, and showed how to solve the redundancy problem in explanation-based learning by formulating the learning method as a program transformation technique. One week later, Peter Idestam-Almquist defended his thesis *Generalization of Clauses*, which introduced new techniques for deriving generalizations from given observations in the newly established field of inductive logic programming. In the coming years, Ph.D. theses were produced *en masse* within machine learning at the department. In early 1994, Christer Samuelsson defended his thesis *Fast Natural-Language Parsing Using Explanation-Based Learning*, presenting one of the first real-world applications of explanation-based learning. This was followed by Lars Asker's thesis *Partial Explanations as a Basis for Learning*, which presented a new method for solving the incomplete theory problem in explanation-based learning. Also in spring 1994, Harald Kjellin defended his thesis *A Method for Acquiring and Refining Knowledge in Weak Theory Domains*, in which a method for capturing knowledge in the form of networks of keywords was presented, together with several real-

world applications, including one system that was in actual use at several labour-counselling offices in Stockholm. Fredrik Kilander's thesis *Incremental Conceptual Clustering in an On-Line Application* presented a solution to the problem of concept drift in clustering systems, and demonstrated its usefulness in computer network analysis.

After this very intense period of Ph.D. defenses, most of the former Ph.D. students turned their attention to new areas, and in some cases moved on to new places, while some of the Ph.D. students, such as Bassam El-Khoury and Åsa Rudström wrote licentiate theses in the field and completed their Ph.D. theses in other areas.

One area of research that attracted intense interest at that time was the newly established field inductive logic programming, which concerns searching for hypotheses in the form of logic programs that explain given observations, which also are in the form of logic programs. This interest was manifested by the participation of Carl-Gustaf Jansson, Peter Idestam-Almquist and Henrik Boström in two consecutive basic research projects funded by the European Union from 1993 to 1999, with many of the most prominent European machine learning researchers.

In parallel, Magnus Stensmo, who spent most of his studies in Terry Sejnowski's computational neurobiology lab at the Salk Institute in La Jolla, in 1995 put forward his thesis *Adaptive Automated Diagnosis*. In 1997, Pierre Wijkman defended his thesis *Contribution to Evolutionary Computation*, which presented extensions to the interpretation and implementation of the principle of natural selection.

In the late 90's, the second generation Ph.D. students in the field of machine learning at the department started their studies; Martin Eineborg and Tony Lindgren, having Henrik Boström as supervisor, and Anette Hulth and Rickard Cöster, having Lars Asker as supervisor. In 2002, Martin Eineborg defended his thesis *Inductive Logic Programming for Part-of-Speech Tagging*, which presented applications of inductive logic programming to problems in natural language processing, and also presented new methods for

classifying examples for which there are no applicable rules. In 2003, Stefan Zemke defended his thesis *Data Mining for Prediction – Financial Series Case*, which investigated the use of machine learning for stock market analysis. In 2004, Anette Hulth defended her thesis *Combining Machine Learning and Natural Language Processing for Automatic Keyword Extraction*, which demonstrated that the performance of an automatically generated keyword extractor may be improved by providing appropriate linguistic resources during the learning phase. In 2005, Rickard Cöster defended his thesis *Algorithms and Representations for Personalised Information Access*, which presented new methods for learning from relevance feedback and for collaborative filtering. The most recent thesis, at the time of writing, was defended by Tony Lindgren in March 10, 2006. The title of the thesis was *Methods of Solving Conflicts among Induced Rules*, and it put forward a series of solutions to the problem of classifying examples that are covered by multiple, conflicting classification rules.

## Decision Analysis

The activities in decision analysis at DSV can be considered to have started with a course held in 1991 by Prof. Per-Erik Malmnäs from the Dept. of Philosophy. Subsequently, Magnus Boman, Mats Danielson, and Love Ekenberg grew an interest in the area and started working within it; the two latter under the supervision of Per-Erik. Magnus took the ideas to the area of software agent systems and included a decision analytical paper in his thesis, whereas Mats and Love became more interested in various computational and conceptual aspects of decision theory and analysis and wrote their respective theses in that field. Together, the four also started the DECIDE Research Group in 1994. One year later, Johan Thorbiörnson from the Dept. of Mathematics joined, followed by the DSV students Karin Hansson and Anna-Maria Kessler in 1999. Around that time, the research activities also spread to Mid Sweden University, where Love and Mats have supervised the Ph.D. students Xiaosong Ding, Jim Idefeldt, Aron Larsson, and

Ari Riabacke. At DSV, Lourino Chemane, Avelino Mondlane, Mona Pålman, David Sundgren, and Orlando Zacharias joined a few years later and decided to start their Ph.D. studies in the field. All these students had quite disparate backgrounds and the current scope of the activities in the group spans everything from fundamental mathematical properties of decision models and efficient evaluation algorithms to empirical studies of actual decision makers' behaviour.

In short, the main work has since 1994 been concentrated to six research areas:

- (i) descriptive studies of how humans actually behave in situations under uncertainty,
- (ii) alternative representations of decision problems and investigations into the mathematical properties of interval decision analysis,
- (iii) algorithmic development,
- (iv) their impact on evaluation principles,
- (v) simulations and decision making in low probability/high loss contexts, and
- (vi) tool development.

A main problem in supporting decisions has been and is still that unguided decision-making is often difficult and can lead to inefficient decision processes and undesired outcomes. Therefore, computer-based decision support systems (DSSs) are of prime concern to organizations and there have been numerous approaches to delivering decision support from, e.g., computational, mathematical, financial, philosophical, psychological, and sociological angles. A key observation, however, has been that effective and efficient decision-making is not easily achieved by using methods from one discipline only. Consequently, the group decided already in the 1990's to approach decision-making tools in a cross-disciplinary way.

Decision support systems in general tend to present different views of the information available, while putting emphasis more on the presentational side than on the analytic side. But in order to make well-informed decisions, there needs to be an analytic component as well, guiding the decision-maker in formulating the actual decision problem and evaluating the avail-

able options using some kind of reliable method. Few of the current DSS tools support the actual decision making phase, leaving the user more or less unguided through this step in the decision process. Thus, the group has since the turn of the millennium focused on an analytic DSS approach based on decision analysis for supporting the *decision making process* (rather than only the decision process in general). The theories behind the research originate from various disciplines including computer science, economics, mathematics, operations research, and economic psychology. For example, the key areas decision theory and decision analysis constitute parts of economics as well as of philosophy.

Decision researchers have pointed out that most mathematical models of decision analysis are generally oversimplified. Normative science, typified by statistical decision theory, characterizes ideal inference or decision processes without assurance that the ideal conditions are met by the humans who must implement them. Already at the group's inception, it was clear that a normative decision theory needed to be sensitive to different risk attitudes, and to provide procedures for handling qualitative aspects as well as quantitative ones. This was explored already in the theses of Ekenberg and Danielson in 1994 and 1997 respectively.

One criticism of traditional decision analysis has been that it imposes strong demands on a decision-maker with respect to the precision of the input data. In the majority of real-life decision situations, the decision-maker does not have access to any significant amount of statistical data required to aggregate precise numerical data. Furthermore, if given the opportunity, individuals tend to avoid the use of precise decision parameter estimates. Thus, in most situations, a requirement of precise data is not particularly realistic and a number of models with representations allowing imprecise probability statements have been suggested by different researchers since the early 1960's. Although a common feature of these approaches is not to require a decision-maker to model and evaluate a decision situation using precise estimates, little has been done to demonstrate whether they are understandable for

a decision-maker facing a real decision situation. In particular, it is not always clear what a decision-maker expresses when providing, for instance, a set of intervals where dependencies do occur. The problem becomes particularly significant when evaluations of models are considered. The low-dimensional intuition of decision-makers (being able to consider at most a few dimensions at a time) further adds to the problem. This led the DECIDE researchers in 2001 and onwards to investigate higher-order decision models, allowing for deeper understanding of expressional power in decision models.

Few researchers have addressed the problems of computational complexity when solving decision problems involving interval estimates. Needless to say, it is important to be able to determine, in a reasonably short time, how various evaluative principles rank the given options in a decision situation. However, this requires a large number of computational steps. The group has for more than ten years developed algorithms for solving the complexity issues as

well as some conceptualisations around these problems. We have, consequently, provided a computationally meaningful theory of decisions and decision analyses admitting imprecise information.

The group has also focused on empirical validation of decision models. The collection of theories above has been combined into a computer tool, implemented and employed in more than 15 real-life cases ranging from a few man-days to several man-years, for example decision problems in malaria distribution, public planning and E-Government, storing spent nuclear waste, purchase of railway equipment, and catastrophe management.

Currently, the group has grown and DECIDE nodes have been added at Örebro University and Gävle University College, enhancing the network character of the group, which today has 12 members. The scientific output from the group to date is three Ph.D. theses, 12 Ph.Lic. theses, around 140 articles, and two patent applications as well as software packages.

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# IT IN SOCIETY AND IT FOR DEVELOPMENT

## ICT, a factor for development

The new Information and Communication Technology (ICT) is rapidly transforming our societies. ICT has become such an important factor in economic activity that no modern operation can function today without its support. Fundamental change in production and business practices, education, health services and public administration is being induced by ICT.

The increasing degree of interconnectedness and interdependence is accelerating the globalization process and countries need to develop their ICT capacities to avoid being excluded from the global economy.

Through ICT the developing countries can get cheaper and better access to information, markets and economic opportunities, thereby creating jobs and income. These new technologies may provide opportunities for technological and economic leapfrogging. Furthermore, it is recognized that ICT is playing an essential role in social change: It is a powerful tool for promoting democratisation - including freedom of speech, the free flow of information and fostering human rights.

On the other hand, the spread of ICT may deepen already existing gaps between poor and rich people and nations. Countries and people without access to the new technologies risk being further marginalized. It is therefore imperative that the development of ICT is strategically targeted towards obtaining a positive effect on social development in the long-term.

In the context of creating the conditions for development in today's world, the appropriate integration of ICT has become an important tool for facilitating economic and social development and - in the longer perspective - poverty reduction. This is why ICT is gaining foot in the developing world and is highly placed in many developing countries' development agenda. Coherent policies and plans are being established and the capacity to implement ICT actions has increased.

Considering Sweden's leading position in the

area of ICT internationally, many developing countries are especially interested in cooperating with Swedish organisations, and Sweden is taking an active part in promoting ICT in the developing world.

## ICT for academic development

DSV is one of the key agents in this cooperation in the area of ICT between Sweden and the developing world. Since 1998, DSV has been responsible for a number of projects where the goal is to support the development of human and technical capacities at universities and agencies in developing countries.

In these projects, DSV has a fruitful collaboration with partners at universities in Sri Lanka, Vietnam, Laos, Tanzania, Mozambique, Ethiopia, Burkina Faso, Bolivia and Honduras, as well as with other Swedish universities. The projects are for the most part supported by the Swedish International Development Cooperation Agency (Sida) and EU.

The projects address mostly the following three aspects of ICT development:

- Technical Infrastructure
- IT policies and organization development
- Human resources development

## Results and Mutual Benefits

A number of noteworthy results have been achieved through the projects, the most tangible being the following:

- It has engaged a total of 43 PhD students from developing countries (24 at DSV and 19 at other Swedish Universities).
- Sixteen of these students have got their Swedish Licentiate Degree (12 at DSV and 4 at other Swedish universities).
- Two of the programme's participants (both at DSV) have defended their doctoral thesis.

In addition, the following positive effects for the involved partner institutions can be mentioned:

- Competence in the area of ICT has been strengthened and developed.
- Less expensive and more reliable Internet

connections.

- Better access to computers and the Internet for researchers and other staff and students.
- More efficient administration of economy, research, staff, and students due to improved technical infrastructure and computerized information systems.
- More consistent and more widely accepted ICT policy together with related action plans for organizational development.
- More competent ICT staff.
- Improved academic working culture and working environment for the staff.
- A catalyst effect for other ICT activities to be initiated in the partner countries.

ICT issues related to international development are of substantial academic value as such. The projects contribute to the following benefits for the Swedish universities:

- They stimulate research on new problem areas and focuses on new questions (socio-economic and cultural factors, relations between technique and social development, new implementation strategies and applications, etc).
- They give an opportunity to be involved in, and influence a new, growing and exciting area of ICT.
- They give an opportunity to build useful contacts and networks between researchers from developing and developed countries.

The substantial competence on ICT pulled together at DSV and the IT-university, together with a keen sensitivity for the particular problems of developing countries (in general as well as specific ICT related) have been important factors of the projects' success.

## Research Issues

Research subjects covered by PhD students from developing countries at DSV are the following:

- Goal and Process Modeling
- A Methodology to Generate e-Commerce Systems: A Process Pattern Perspective (P3)
- Verification and Validation in Requirements Engineering
- An Approach to Information Security Education for Developing Countries

- Operational Problems Concerning Large Scale Cryptographic and Public Key Infrastructures
- Implementation and Use of Intrusion Detection Systems
- The Concept of a Secure WWW System Based on Smart Cards and Certification
- Repository Support to Enterprise Application Integration Based on Business
- System Integration IT Platforms for Value Networks, Some Case Studies
- Flood Risk Analysis and Management from the Economic and Social Perspective
- Formal Verification of Conceptual Schemata
- System Verification Models
- Epidemiological Model of Malaria Transmission Dynamics in Some Areas of Mozambique.
- An Agent-oriented Approach in Modeling and Design of Intelligent Computer Network
- Computer Supported Risk Handling Policies in Developing Countries
- Risk Elicitation in Vague Domains
- Measurement of Privacy and Forensic for Privacy in Social Context
- Communication and Decision Processes for Knowledge Activation and Contextualization
- Knowledge Intensive Business Processes
- Research into Effect of Mutual Relationship among Genes in Chromosomes in Genetic Algorithms
- Machine Learning Applications in Medical Image Analysis

For more information go to  
<http://www.dsv.su.se/research/sida/>

## DSV hosts SPIDER

SPIDER (the Swedish Program for ICT in Developing Regions), dedicated to the introduction, sustainable development, exploitation and management of ICT in the developing world, was started in July 2004 and is hosted at DSV.

The program is funded by Sida and KTH and its establishment is in agreement with the current Swedish official policy on international development cooperation, which defines the development



Swedish Delegation visiting Vietnam. Third person from the left is Prof. Love Ekenberg, third person from the right is Afzal Sher, Director of SPIDER.

of ICT as a Swedish profile issue. This policy promotes the coordination of the efforts to facilitate developing countries access to ICT competence

The mission of 'SPIDER' is therefore to support the formation and dissemination of knowledge and competence in the area of ICT, allowing developing countries to meet the challenges of deploying ICT resources in such a way that they are sustainable, and contribute to the socio-economic development, the efficiency of organizations and the quality of life of their people.

In particular, SPIDER is dedicated to the following tasks:

- promote ICT as a powerful means for poverty alleviation and human resource development
- establish close cooperation and partnerships with donor agencies in the "ICT for development" field.

- support awareness-creating activities on the importance of ICT for development.
- support the development of ICT strategies in developing countries.
- support a number of projects in carefully selected areas, preferably in cooperation with other organizations.
- play an active part in national telecommunication infrastructure projects, such as the current Sida/ SAREC university network programme.
- initiate and implement projects in close cooperation with local initiatives.
- function as a link between development cooperation agencies and industry.
- form partnerships with Swedish industrial enterprises.

For more information on SPIDER go to <http://www.spidercenter.org/>



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# *Undergraduate education*

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## UNDERGRADUATE EDUCATION AND ITS DEVELOPMENT

From the start, DSV was a joint department for Stockholm University (SU) and The Royal Institute of Technology (KTH) offering undergraduate education at both Universities. Courses and programmes are targeted to students either at Stockholm University or at KTH, while single-subject courses often are offered to joined groups.

The structure of the educations at SU and KTH differs. Courses at SU usually encompass 10, 20 or 40 credits, with 4-6 credits course modules. Contrarily, at KTH a course usually encompasses 4-6 credits and is principally part of a larger programme of 60-180 credits. The term “programme” is used at both universities meaning a coherent education to a specified degree.

At SU a two-year program programme leads to a University College Degree, a three-year programme to a Bachelors Degree and a four year program to a masters degree. KTH offers four and a half year programmes leading to a Master of Science (MSc) in Engineering degree (civilingenjörsprogram) and three year programmes to a Bachelor of Science in Engineering degree (högskoleingenjör). Both universities offer shorter programmes at an advanced level

leading to a masters degree. For these courses, a bachelor’s degree and previous knowledge in computer and systems sciences is required. Both universities also offers continued education.

DSV’s ambition is that the contents of the education should mirror the latest findings in research particularly within areas where DSV has special competence. The education should also meet the current need in trade and industry and be adapted to the profile and target groups of each programme. Consequently, courses designed specifically for the KTH education programmes have another focus than those designed for SU programmes. However, the contents of many courses/elements are relevant for both target groups.

Computer and systems sciences is a rapidly changing field and the education programmes must adapt to these changes. This in its turn means demands for changed teacher competence, as well as altered tuition- and examination forms. The changes also generate demands on the IT-support.

DSV has defined general objectives for the undergraduate education, which will be seen from the picture.

### DSV’s general objectives for the undergraduate education

- Those who have passed their masters degree with a major in computer and systems sciences should
  - be highly valued on the national and international labour market
  - be qualified to pursue graduate education at internationally leading departments within the IT area
- The education at DSV shall be among the most attractive IT educations in the country
- The education shall provide students with knowledge in the form of methodological and problem solving abilities
- The education shall also develop students’ team work- and project management competence, as well as provide continuous training in both oral and written communication
- The education at DSV shall contribute to cultural exchange and develop competence for international cooperation.

DSV has a long experience from using different types of IT support in education. Two IT platforms for teaching have been developed within the department, in connection with the programmes for commissioned education. Informacon was an early platform based on video communication (see “Informatics with systems” for further information), the other is based on computer communication, where each student has his/her own laptop computer. Both platforms have had impact on distance education. On advanced courses, the I-Lounge, a prototype for collaborative design work, is used. I-Lounge was primarily developed for research purposes.<sup>1</sup> Various laboratory facilities are also used for various specialized programmes. Approximately 50% of the teaching hours in DSV’s courses are laborative.

Computer-supported group communication was experimentally introduced in the late 70s, through the KOM-system – a result of the research of Jacob Palme. Since 1998, the group communication system FirstClass is used on all programmes at SU and some programmes at KTH. FirstClass is also used by all staff for internal communication within DSV. DSV has also developed a computer-based system for the department’s internal study-administrative processes called Daisy. For students, this system means a considerable improvement in terms of quality and access to relevant information. Their results are reported electronically, their time-tables are personalized, they can extract descriptions of all courses they have completed, view a summary of their results and get reminders of examination dates. For teachers and administrators, the system provides support for all central work processes. From the autumn of 2006 and on, Daisy will be used at all KTH programmes given in Kista.

The development of DSV’s engagement in undergraduate education over the years both at KTH and SU is shown in the table. The first course block was offered in 1966, with approximately 70 students enrolled at SU. In 2005 the undergraduate education had grown to approximately 1600 student places per year. The SU

education has always been of considerable proportions, yet the programmes at KTH have grown considerably since year 2000, and today they correspond to approximately 30% of the total undergraduate education.

As a whole, and contrary to most other departments in the same area, DSV’s undergraduate education has not only been stable but also grown since 2000. During the “hype” in the late 90s, 83 students /nominal place applied for the basic course. In 2005, the most attractive programme at SU was the four-year programme in IT and Communication Sciences, with 3 applicants/nominal place. The master programmes at KTH, which mainly recruit international students still have around 4 applicants/nominal place.

Possible explanations for how DSV has managed to maintain a reasonable level of applications during the critical years following after year 2000:

- the reputation of the DSV programmes has been good
- DSV has been very active in updating the portfolio of educational programme and marketing these programmes
- DSV has been part of both SU and KTH and cross fertilized the programmes on both Universities.

**The number of study places per year in undergraduate education at SU and KTH**

| Year                      | 1990 | 1995 | 1997 | 2000 | 2003 | 2005 |
|---------------------------|------|------|------|------|------|------|
| Study places/<br>year SU  | 707  | 775  | 905  | 970  | 1248 | 1128 |
| Study places/<br>year KTH | 50   | 100  | 106  | 180  | 300  | 470  |

The figures for students refers to those registered for 40 credits.

The growth of the IT area – both academically and in trade and industry – has created a demand for more educated students and for a variety of education programmes. The two extensive education reforms, implemented in 1977 and 1993, have also been of decisive importance for the development of our programmes. DSV is about

<sup>1</sup> Further described in DSV Computing facilities

to face the next reform, which will be effected in 2007.

The quantative expansion has been possible to realize with preserved quality, which was certified by the National Swedish Agency for Higher Education. In their national evaluation of all departments in the area 2003-2004, DSV's undergraduate education was judged as "First class" and one of the best in Sweden. Additionally, DSV was awarded SU's price for best undergraduate education department in 1997.

Due to the profile of the education programmes at SU, DSV has been very successful in recruiting women. The situation for the KTH programmes is less positive. The table below shows the variations over the years at SU. Sadly, it can be observed that the positive development up to 1999 has turned into a decline. This trend will be analysed and hopefully reversed again.

| 93/94 | 94/95 | 96    | 97    | 98    | 99    |
|-------|-------|-------|-------|-------|-------|
| 36,8% | 34,8% | 38,9% | 44,3% | 46,7% | 48,0% |
| 00    | 01    | 02    | 03    | 04    | 05    |
| 46,2% | 46,0% | 42,6% | 37,1% | 31,7% | 31,1% |

Below is presented a brief overview of the development of the educational programmes and courses at SU and KTH. Some of the programmes are also described in more depth in separate chapters.

### Undergraduate education at Stockholm University-SU

Initially, DSV offered education of a traditional academic style, where students combined studies in different subjects freely to achieve intended degrees. Today the focus is on entire academic programs with different profiles.

For all courses and programs at SU, strong efforts have been made to strike the balance between requirements for a professional and an academic career. They can be considered quite successful.

A particular mission for DSV has been to support the undergraduate education at some university colleges. Commissioned education was executed at the university college of Gotland

1989 -2000 and at the university college of Södertörn 1998-2004.

### Single-subject courses

Initially, the courses had a length of one term, and the educational programme included 4 courses on different levels. From the description of these first courses, it is evident that they represented the academic frontline. For instance, courses in Simula and Computer – Assisted Instruction on C-level 1967 can be mentioned.

The evolution of single-subject courses have led to specializations within different part of the subject, often requiring a bachelor's degree and previous academic studies or knowledge in the IT-area .

One example is the one-year course in "Informatics with Systems", which was established already in 1970. This course included truly interdisciplinary courses, blending elements of natural and social sciences with humanities, using system science (General Systems and Cybernetics) as the vehicle. The programme was later extended to C and D-level courses.

The importance of security aspects in IT-systems was developed in parallel with the "Informatics with Systems" programme and in 1985, the single-subject course programme in Security Informatics was initiated with courses from 10 up to 60 credits. Another development based in the Informatics programme was the one-year course package in Systems Analysis and Systems Analysis and Applied Systems Theory (the SATS-program) focussing the management perspective. Eventually also SATS/Informatics was used as elective course on the 3rd year of the ASY-programme that started in 1977. Also, the development of the MIT and ITM course packages has its origin in SATS/Informatics. Security and IT-management were later included in the four-year masters programme.

Another example is the development in the area of cognitive science resulting in shorter courses as well as a one-year course block on masters level, starting in 1989. The development was initiated by Carl Gustaf Jansson at DSV and carried out in cooperation with the departments

of Linguistics (Östen Dahl), Psychology (Yvonne Waern) and Philosophy (Peter Pagin) at SU. Prerequisites for the master course were 120 credits, with 60 credits required in one of the subjects: psychology, pedagogy, linguistics philosophy, technology and medicine.

Also courses in human-computer interaction were triggered by early research, the first course appeared as elective course in the ASY-programme in 1977. Other such examples are courses in artificial intelligence and databases, introduced in the late 70s. These courses expanded to a 20-credit course in database methodology in 1983, and in AI courses up to 40 credits introduced in 1984.

The most recent example is courses within the area of design and development of games, which started in 2003. In 2006 courses are offered up to 80 credits, proposed to be expanded to a bachelors programme in 2007.

At KTH, many courses specifically designed for continued education of active professionals have been given. At SU, a course of 10 credits is offered, in which course elements from the entire range of courses at DSV can be selected. The basic course, which has been offered as an evening course since the start, also attracts active professionals. In this context should also be mentioned the particular state-financed investment in teacher's education, which led to DSV developing tailor-made courses for different subject teachers at upper secondary school, and for teachers at senior compulsory school, totally 8 courses encompassing 5-10 credits. The education was implemented 1982-1985.

### Programmes up to the year 2000

A common characteristic of several of DSV's programmes is the ambition to integrate Computer and Systems Sciences with other disciplines. The most recent ones are the bachelor programme "Marketing education and IT" and the master programme "ICT for Development"<sup>2</sup>, starting in the autumn of 2006.

The first DSV programme was established in 1977, when a reform of Swedish higher education initiated a design of a national curriculum

for a three-year Applied Systems Science programme, the ASY programme (in Swedish "Systemvetenskapliga Linjen"). SU was one of 9 universities commissioned to implement a local adaptation of the education plan. DSV, represented by Tord Dahl, and the departments of Mathematics and Statistics had the responsibility for the adaptation and implementation.

Initially, the programme was designed to meet the requirements of the labour market, a major theme for the reform of 1977. Despite the national education plan, students had the freedom of choice to design their own education, only the first year included compulsory courses, while the second and third year consisted solely of optional courses chosen from a pool of single-subject courses. The research connection was strong already from the beginning in DSV's courses like systems analysis and design, object oriented modelling and programming, database methodology and human-computer interaction.

Already in 1981, the Department started to argue for a one-year extension of the ASY programme. The commitment to a national programme was abandoned in 1988. To DSV's great satisfaction, in 1993 the three-year ASY programme could be replaced by the four-year Computer and Systems Sciences programme, DSVL (in Swedish "Data- och Systemvetenskaplig linje")

Also, the opportunity to start this programme was an effect of an educational reform in 1993 which gave universities more freedom for their own decisions, coupled to a new resource allocation system. This was the second reform for higher education which strongly influenced the development of DSV's undergraduate education.

The whole department was engaged in an ambitious development project, starting in 1992. Major roles in this development had Tord Dahl, Carl Gustaf Jansson and Janis Bubenko, Eric Roupé and Anita Kollerbaur. The programme was developed with the goals of having a firm base in research and to meet international requirements on undergraduate education in the area, in addition to fulfilling high requirements

<sup>2</sup> Requiring entry knowledge at bachelor level in IT, Economics or Natural Sciences

for professional work. After a two-year basic block, the programme offered specializations in Information systems, Security Informatics, Software Engineering and IT-management. The programme has become a strong trademark for DSV both among students as well as employers, and the main concepts will be kept when the recent third reform of higher education takes place in 2007<sup>3</sup>.

DSV has also offered the two-year programme in Information Processing and Computer Sciences (in Swedish "Datalinjen"), 1983-1989, leading to university college degree.. It was a very popular programme, mainly composed of the four one-term courses on ranging from basic to specialized courses. It is now kept as a single-subject 80-credit course named Computer and Systems Sciences. It is often combined with studies in other disciplines or vocational training. 1989-1992, DSV also carried out a 60-credit programme inherited from the municipal college of higher learning, the Programme in Automatic Data Processing (in Swedish "ADB-linjen").

## 2000 - 2006

In 2000, the application pressure started to decrease. Even if the danger for DSV was not imminent, the department decided to plan counter measures. An extensive plan for redesign of the undergraduate education was outlined. Experience has shown that students prefer longer educations, consequently DSV decided to focus on new programmes. As part of this initiative, DSV has rapidly established and engaged itself in four new programmes.

In 2002 the four-year programme for *IT and Communication Sciences*, *ITK* was started. Part of the content of this programme has previously been included in of the specialization on DSVL: Interactive Systems. The reason for establishing a special programme was partly the developments in this academic area, but also an increased interest for education with this profile in industry and society. *ITK* is a master's programme but can also lead to a bachelor's degree.

The *ITK* programme consists of three blocks:

- Basic IT

- IT from a communicational point of view
- Communication science within other subjects than computer and systems sciences.

Year 1 encompasses the first two blocks, and provides orientation in the third block. Year 2 is entirely devoted to the third block, as students are supposed to study another discipline within communication science. During the third year, knowledge within IT and communication sciences is deepened. The last year involves a specialization chosen by the students, as well as a masters degree project.

In 2004, a collaboration with the department of Education was initiated on the three-year programme in Multimedia Education and Technology, which includes 40 credits in computer and systems sciences and 80 credits in pedagogy with a focus on IT aspects.

In 2006, the programme Market Communication and IT was established together with the department for GI/IHR.

In 2006, the two-year masters programme ICT for Development was initiated, primarily with international recruitment.

## Undergraduate education at the Royal Institute of Technology – KTH

Originally, the KTH education was concentrated on a few engineer programmes, and DSV offered a number of basic courses optionally available primarily on the engineering physics and electrical engineering programmes. Occasionally also students on other programs like mechanical engineering choose DSV courses. From an organizational point of view, DSV belonged to the engineering physics section.

An important step in the development was the introduction of the technical Computer Science Programme (D-line) in the early 80s. As the first new civil engineer programme developed in many years, its introduction symbolizes a break in a very conservative KTH policy of introducing new programmes. On behalf of DSV, both Janis Bubenko and Carl Gustaf Jansson contributed to the creation of the new programme. DSV became responsible for a small number of mandatory basic courses and a number of specializations.

<sup>3</sup> DSVL is described extensively in another part of the book.

DSV was also permanently represented in UFND, the board for the D-line. DSV specializations represented DSV's areas of strength: information systems, software engineering, artificial intelligence and human computer interaction (intelligent interactive systems). These were more recently completed with a specialization in a new strong area: information and computer security. DSV has also kept up a high popularity among KTH students with respect to diploma works and subsequently masters theses.

Due to the strengthened interest in Cognitive Science in the early nineties and the vision of a combined education in information technology and humanities shared by Carl Gustaf Jansson and Yngve Sundblad at NADA, planning of a new programme in Cognitive Engineering started. At one stage, the ambition was a new civil engineer programme, but due to the still conservative KTH attitude towards new programmes the feasible form turned out to be a track in Cognitive Engineering on the D-line. The track was introduced in 1993 and meant that D-line students on the third year and onwards could choose to study artificial intelligence, artificial neural networks, human machine interaction, linguistics, neuroscience, cognitive psychology and theoretical philosophy. For a number of years this track was very popular on the D-line.

The next step in the development had an organizational background. KTH activities in Kista have in two steps been more firmly coordinated. First, in 1999, the education area of Information Technology was formed with its own board and management, finally in 2005 to become the School of Information and Communication Technology (ICT). As part of the activities in 1999 a new broad civil engineer programme in Information Technology was planned. The IT programme was decided to start in the autumn of 2000. Carl Gustaf Jansson was responsible for the planning and the new programme's chairman up to 2004.

As input to the design process for the information technology programme, three programmes with different subject focus were defined:

- microelectronics
- computer and communication systems
- computer and systems sciences.

In the end a hierarchical programme structure was formed with two common years, where DSV contributed with a small number of mandatory courses. In the third year there was a choice of four tracks, where DSV was entirely responsible for one. In the fourth year there was a choice of several specializations, where DSV was responsible for three, corresponding to the competence areas of computer security/software engineering, information systems and interactive systems. Initially and before the crisis in the IT sector in 2001, the IT programme was supposed to scale up drastically to several hundred students/year. Now in 2006, the programme has survived the crisis, spawned of a separate microelectronics programme and is a well-established engineer programme but on a more modest level of 80 students. DSV has still the same kind of responsibilities within the programme.

When the recruitment of Swedish students to engineer programmes become more cumbersome, the KTH management in Kista turned to international students as a new promising group for recruitments. Several masters programmes were developed, the content of which roughly corresponded to the last 1.5 years of the engineer programme, but entirely taught in the English language. In parallel with the specializations on the engineer programme, DSV developed three such masters programmes:

- engineering and management of information systems
- information and communication security
- interactive systems engineering.

These very successful programmes are now decided to be upgraded to full two-year masters programmes compatible with the Bologna model.

In addition, DSV is also engaged in the four-year master programme in Medical Informatics, with KI as main responsible university. DSV's contribution is roughly 50% or 60 credits. Finally, DSV has also over the years strongly contributed to KTH schemes for continued

education with a wide range of courses that have successfully been offered.

### **Continuing development**

The current challenge for DSV is to transform the undergraduate education into the variant of the Bologna model for higher education decided by the Swedish government. Variants of the present education at SU is proposed to be transformed into a portfolio of new Bachelor and Masters programmes, planned to start from 2007.

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On KTH, DSV will contribute to the extended engineering programmes, the already developed Master programmes and a new set of proposed Bachelor programmes.

Apart from this, DSV will keep up to the ambition to maintain and even raise the quality of undergraduate education, despite the governmental demands on large volume and a still – hopefully temporary – cumbersome weak interest in IT from potential students.

## THE FIRST COURSES 1966-67

The first three-semester course structure at the department followed essentially the propositions given in (UHÄ 1964). The first semester included topics such as computer systems and components, low level programming languages, high level programming languages, and performance analysis. The second semester focussed on methods for systems analysis and design, as well as issues related to administration, planning and management in organisations. The second semester also included a substantial design exercise: the students were asked to develop and describe an information system for a business organisation according to requirements specified by the department. A course on operating systems was given as well. In the third semester, additional specialised courses could be taken but a large part of it was devoted to writing a thesis ("C-uppsats" or "trebetygsuppsats" in Swedish).

The contents of the above three-semester course structure includes what was believed, at that time, to be a minimum of necessary knowledge for designing and building computer based information systems to support operative as well as administrative tasks in business and in organisations in general. The course structure is therefore rather like an educational programme created for educating professionals for a particular job speciality – system analysts and designers. Clearly it includes topics which have to do with computers, programming, management, and organisations, but which do not belong to the core of the discipline.

The core of the discipline can best be described by the title of the professor's chair established in 1965: "Information Processing with a specialisation towards methods for administrative data processing" (in Swedish "Informationsbhandling, särskilt den administrativa databehandlings metodik"). This formal and very long name was later in everyday use replaced by the simpler "Administrativ DataBehandling"

(ADB). The content of what was taught in ADB resembled at that time to some extent what was taught in the discipline of "Information Systems" in USA and in Europe.

### The B-level package (fall of 1966)

The first regular <sup>1</sup> course offered by the department was a 20-credit course for one semester. It was called "a first level course" (ettbetygskurs), or a B-level course. The normal prerequisite to be admitted to the 20 credits B-course was a Swedish high-school degree (studentexamen) including mathematics at least corresponding to the level taught in the high-school specialisation towards social sciences (Samhällsvetenskap). Other backgrounds were permitted if accepted by the university authorities.

A typical combination of courses for a Bachelors degree (Fil. Kand.) was 40 credits of Information Systems, combined with 80 credits of other disciplines, such as mathematics, statistics, business administration, languages, or arts. At this point in time, no particular "program", such as "DSV-linjen" or "Systemvetenskapliga linjen" did exist.

Although the topic ADB was taught physically at the Royal Institute of Technology (KTH), most students were registered at Stockholm University. It happened frequently, however, that parts of our courses were taken as optional courses, also by students of KTH. Some of our early assistants, recruited in the spring of 1967, were actually KTH-graduates (Mats Lundeberg, Olle Källhammar, Rune Engman).

Initially, the courses were quite well appreciated by the students. If we remember it correctly, the initial B-level courses had an attendance of 400 - 500 students. We do not think we really had a limit of the number of attendees other than lecture hall space. There were surprisingly many female students, perhaps more than 30 %. Many students had already 60 to 80 credits in a number

<sup>1</sup> A regular course is a course formally offered by the university such that it can be included in the study programme of a student for a degree. In this text we use a direct translation to English of various concepts then used by the department in order not to change the "flavour" of the computer "era" of the late sixties.

of other university disciplines. They were interested in doing the ADB-course as they, rightfully, expected to find jobs related to this new discipline. Many students had background studies in disciplines such as mathematics, statistics, and business administration. Information Systems was a topic for the future.

### The courses

The B-level package included four parts, 5 credits each. It totalled 102 hours of lectures, and 62 class hours of exercises plus, of course, student individual and/or group work and homework. This implied roughly 8-10 contact hours per week.

#### B1 Introduction to automatic data processing (28 hours <sup>2</sup> lectures, 2 hours exercises)

It included topics such as

- the concept “information”. information needs and requirements in different organisations, formulation of problems, algorithms, flow-charts, programming.
- From algorithms in a problemoriented language to (low-level) computer programs, including the binary number system, compiling, diagnostics, object code, components of a computer system, etc.
- Data transports. Secondary storage units. Input/output, data communication.
- Operating systems, multiprogramming, multiple access. Economical considerations of programming work.
- Technical and scientific applications (batch processing, multiple access processing).
- Administrative data processing applications (batch processing, real-time processing).
- Process control, industrial real-time systems.
- Information systems theory. Data processing system development, stages of a systems development process (life-cycle).
- Study visit to a computer centre

#### B2 Introduction to programming (20 hours lectures, 10 hours exercises)

This part included lectures on topics

- Algorithms and flowcharts, including proof of algorithms
- The syntax of the problem oriented language Algol 60
- Data structures and their representation in a computer memory
- Program structures, including procedures and blocks in Algol
- Input/Output of data, including Knuth’s proposal for input/output in Algol

Exercises were made concerning algorithms, flowcharts, writing of programs in Algol, transformation of program to low-level code, etc. All students also had an individual assignment of completing a larger computer program including compiling and testing it (in batch mode) on a Control Data 3200 computer.

#### B3 Programming of a data processing problem and executing it on a computer (lectures 34 hours, exercises 40 hours)

This part included lectures on topics

- Programming in a low-level machine-oriented language (registers, instructions, interrupt management, etc.)
- An orientation of an assembly-level programming language
- Programming in COBOL – a thorough treatment
- Operating Systems – an introduction of the main principles
- Orientation about other types of high-level languages such as PL/1, LISP, TRAC, etc.

Exercises were made concerning low-level languages as well as the high-level language COBOL. The operating system of the current computer CD 3200 was explained. Programming in COBOL of a larger assignment was carried out in 2-3 person groups under the guidance of assistants.

<sup>2</sup> A lecture was normally 45 minutes and it was presented to a large auditorium of all students. An exercise hour was 45 minutes given to a group of 15 - 25 students.

**B4 Introduction to the theory of information systems and data processing system development work**

(lectures 20 hours, exercises 10 hours)

This part included lectures on topics

- Introduction to systems work (including the concept of precedence analysis, matrix representation of systems, etc.)
- Information Systems - an Orientation (including the economic quantity of information)
- Performance analysis of computing systems. Simulation.
- Practical aspects of system development work (including the systems life-cycle stages, choice of computer hardware, etc.)

Exercises were made concerning systems algebra and computer system performance analysis.

**Literature of the B-level study course**

- Langefors B., "Problem, algorithm, data-maskin" (Problem, algorithm, computer), Studentlitteratur, Lund, 1966 (about 25 pages). (B1)
- Langefors, B., "Theoretical Analysis of Information Systems", Studentlitteratur, Lund. (sections 12.1 - 12.11 and 22.1 - 22.2) (B4)
- Gregory R.H. and van Horn R.L., "Automatic Data Processing Systems, Principles and Procedures", Wadsworth, 1965 (pages 1 - 125). (B1, B3, B4)
- T. Ekman and C-E Fröberg, "Lärobok I Algol", Studentlitteratur, Lund, 1966? (B2)
- Bubenko jr, J.A., "Databehandlingsteknik", Studentlitteratur, Lund. (about 70 pages) (B4)
- CD 3200 Coomputer System – Reference Manual (No. 60043800) (B3)
- CD 3200 Computer System COBOL (No. 60132000) (B3)
- An Algol manual for the CD 3200 computer (B2)

Misc. material produced at the department.

**Voluntary study**

Favret A.G., "Introduction to digital computer applications", Reinhold Publishing Corp., New York, 1965 (238 pages). (This is a popular introduction to automatic data processing. As such it is not suited as a book to refer to <sup>3</sup> ).

**Examination**

Examination was done in written examinations as well as by "quizzing" <sup>4</sup> of the material presented at lectures and described in the literature studies above. The quiz questions are chosen among a large number of predefined questions distributed in advance to all students. A quiz question can be answered orally or in writing depending on the nature of the question. If a student had passed all quizzes for a course module, then s/he could be excused for the larger written exam of the whole module.

**The AB-level course package (spring of 1967)**

The B-level course package of 20 credits was followed in the spring semester by the next level package of 20 credits, the AB-level course package (tvåbetygskurs). However, not all B-level students continued on the next level – perhaps about one hundred of them. As we have seen, the B-level courses were focussing on computers, basic software, and programming. The AB-level courses focussed on information systems theory, IT in organisations, computing system analysis and design, and on a large case study.

This package of four parts consisted of 88 hours of lectures and 28 hours of guided exercises. It also included a large assignment (a case study) for group work.

**AB1 System theory and control theory**

(20 hours lectures)

This module was based on books by Langefors (TAIS), Miller & Starr, and McKean. Its main topics were Decision theory, Analysis of Criteria, Systems Theory, and Control of Organisations.

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<sup>3</sup> This comment to Favret's book was written in 1966. We have no memory of the reason for making the comment.

<sup>4</sup> Our recollection of the quizzing system is extremely positive. Students were examined orally three at a time. Face-to-face meetings between the examiner and the students made the students to work very hard from the very beginning of the course. Nobody wanted to show bad performance in front of their colleagues.

### **AB2 Information Systems Theory and Data Processing Techniques**

(30 hours lectures)

This module was based on books by Langefors (TAIS), and Bubenko. Its main topics were System Algebra, File Maintenance techniques, Performance Analysis of computing systems, Evaluation of Information, and Design of Information Systems.

### **AB3 Systems Development Work for Administrative Applications**

(20 hours lectures)

This module was based on books such as “Dansk standardlön”, case studies reported by Axelsson & Källhammar, and additional material handed out at lectures. It included a number of lectures regarding methods for systems work and a number of seminars of the different case studies.

### **AB4 Work on a practical case**

(18 hours lectures and seminars)

The students (in groups of two) were assigned a systems development task for a fictitious company called KOSAB (Köp och Sälj AB). Requirements regarding information support in various parts of the company were formulated and given. The task was to develop and design an information system first at an abstract, informational level, and second, to transform this description to a datalogical level design. The result was presented and discussed in a seminar.

### **Literature of the AB-package**

- Langefors, B., “Theoretical Analysis of Information Systems”, Studentlitteratur, Lund. (AB1, AB2).
- Miller and Starr, Executive Decisions and Operations Research, Prentice Hall, Englewood Cliffs, 1965. (AB1)

- McKean, R.N., Efficiency in Government through Systems Analysis, ORSA No 3, Wiley and Sons, 1964. (AB1)
- Bubenko jr, J.A., “Databehandlingsteknik”, Studentlitteratur, Lund. (AB2)
- Dansk Standardlön, published by the Danish Federation of Employers. (AB3)
- Axelsson and Källhammar, five case studies (AB3)

### **Examination**

Modules AB1 and AB2 were examined by “quizzing”. Modules AB3 and AB4 were examined by presentation in seminars. The whole AB package was, at the end, examined by a written exam as well as by an oral examination.

### **Higher level education**

The AB-level package was followed in the fall of 1967 by a C-level package (trebetygs kurs). The C package contained a number of courses on Information Systems Theory (advanced), IS and organisations, Real-Time systems, Database Management systems, Simulation and the Programming Language Simula, and that like. The main task for students of the C-level course was, however, to write a C-thesis (trebetygsuppsats).

The C-level courses were followed, in the spring of 1968, by D-level courses, primarily aimed at doctoral students – PhD candidates.

### **References**

UHÄ (1964). Akademisk utbildning i akademisk databehandling. Betänkande avgivet av en av kanslern för rikets universitet tillsatt kommitté. Stockholm (Distribution: Nordiska Bokhandeln).

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Undergraduate education:

*Programmes and courses  
at Stockholm University*

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## PROGRAMME IN APPLIED SYSTEMS SCIENCE, 120 CREDITS

### Background

In the study regulation of 1969 at the Faculty of Philosophy, there were programmes which to some extent related to the computer science area. This was the case, for instance, for the Programme in Mathematics and Systems Sciences and the Statistics Programme, which did not lead to any particular profession and which only attracted a small number of students.

DSV's "single subject courses" (described in a separate section) was of larger interest in terms of society's needs, but this education could not offer a sufficient number of student places. The demand for more courses within the area of computing was evident, and had also been given attention in the work performed by the user organization "Riksdataböndet", lead by C-G Bergman. "Riksdataböndet" expressed wish for an education in the intersection between traditional subjects within social sciences, and methodological subjects such as information processing and statistics.

Already in the preparatory work for the university reform of 1977<sup>1</sup>, it was suggested that a programme in Applied Systems Science for 120 credit points (ASY-programme) should be established. The programme should prepare students for work related to administrative systems, information processing, statistics and numerical analysis. To prepare proposals for the syllabus, the central authority UHÄ appointed a working group in 1976.

Based on the proposal from the working group, a three-year programme in Applied Systems Science was established as a national education at the universities in Stockholm, Uppsala, Linköping, Lund, Göteborg and Umeå, as well as at the colleges of higher learning in Örebro, Växjö and Östersund, with a first admission in the autumn term of 1977. From the autumn term of 1988 and on, the education was

also offered at the university colleges in Skövde and Sundsvall/Härnösand. The last admission in Stockholm took place in the autumn of 1992.

A so-called general syllabus was issued, from which the different universities were to make their own, local adaptations. As a result of this, the educations came to be unique at each particular site, and the differences grew greater and greater during the years. This was probably one of the reasons for the national syllabus to be discarded in 1988. However, it should be added that even this provided vast opportunities for students to individually personalize their education through free selections during the second and third year.

Resource allocation to the programme was also centralized. Decisions about the number of student places at the different universities were made by the Ministry, in the budget process. Initially, a total number of 258 places were provided, spread out over the country. Among those, SU were allotted 60. In 1988, the number had increased to 738 beginners places, with 90 at SU. To begin with, application pressure was low, slightly more than one first-choice applicant per place, then it increased, in 1988 there were 1349 first-choice applicants. The peak was in 1984.

### Local adaptation at Stockholm University

Undergraduate studies programme committees (Linjenämnder) were established for decisions in issues concerning the local adoptions of the programme. In the committees were members from responsible departments, representatives from society, trade and industry as well as students. At Stockholm University, mainly the departments for Mathematics, Statistics and Information processing – ADB were responsible for design and implementation of the programme.

SU's local syllabus prepared by a work group, consisting of Ralf Fröberg, Mathematics,

<sup>1</sup> The reform 1977 prescribed also that the education within the Faculty of Philosophy should be vocationally oriented and of high relevance to society. It was also stated that the main part of higher education should be organized in programmes grouped in five educational areas. The Applied Systems Programme was established for professions within the areas of administration and economics, and in the social sector.

Olle Sjöström, Statistics and Tord Dahl from DSV. Distribution of the amount of studies in each respective discipline can be seen from the summarized description of the programme below.

Within DSV, the courses were further developed in detail, by a working group consisting of Tord Dahl, Hans Köhler, Åke GO Hylin, Janis Bubenko, Göran Goldkuhl and Louise Yngström. Kjell Samuelsson was appointed substitute to the group.

## Goal

"The goal of the education was to provide knowledge and skills for work within such areas, mainly social sciences-oriented investigational-, analytical-, organizational-, developing- and with documentation, where system methodology, information management, statistical and other quantitative methods constitute a major part" <sup>2</sup>

The education was supposed to be both interdisciplinary and vocationally oriented, and provide students with an ability to see the overall picture in systems and to apply knowledge and skills within different application areas. For instance, the education should give knowledge on society and its structure, on human behaviour in social and technical systems, on knowledge and skills in problem solving and on consequences of alternative solutions, as well as knowledge in information management, computer technology, calculation methods and project methodology.

Also general knowledge and skills was specified. The education should develop the students' ability to acquaint themselves with research results, to apply their knowledge in practice, to work both independently and in group, to express themselves clearly, both orally and through writing, and to relate their own professional area to the current social debate.

## Prerequisites

For admission to the education, special eligibility was required in addition to the requirement of general eligibility, a prerequisite to be admitted to a college of higher learning. Knowledge in mathematics was demanded, corresponding

year 1 on a three- or four-year programme in upper secondary school, or two years on a two-year social or economy programme, as well as social sciences corresponding two years at upper secondary school. Moreover, the average grade in mathematics and social sciences should be 3 at minimum. However, it was possible to be accepted to the education if knowledge and experience had been achieved in other ways.

## The Local Programme Outline 1977

The education comprised three years of full-time studies. Students were free to design their education according to their personal preferences during term 3-6 of the education.

### Term 1 and 2

Basic course in systems sciences, 40 credit points, which included:

- Systems Analysis and Scientific Method in Social Sciences, 8 credits.
- Quantative Methods I, 5 credits (Department for Mathematics and Statistics)
- Computers and Programming methodology, 7 credits
- Quantative Methods III, 8 credits (Department for Mathematics and Statistics)
- Analysis and Development of Information Systems, 8 credits
- Application task, 4 credits

### Term 3

Structure of the Swedish society I, 2 credits, plus 1 out of 5 alternatives on 18 credits:

- courses in programming and systems development
- courses in informatics
- courses in mathematics
- courses in statistics

### Term 4

One or several courses in subjects relevant for the programme, on totally 20 credits.

### Term 5

During the fifth term, the course "Structure of the Swedish Society II, 2 credits" was studied, as well as courses on 18 credits in one or several

<sup>2</sup> Translation from the local educational plan, established in 1977.

areas represented in term 3.

Studies could include a deepening and/or broadening of knowledge acquired in the courses selected in term 3.

### Term 6

During the final term, studies within a relevant application area are pursued. These studies can consist of continued education within an area

studied during term 4. The selection of courses is in some cases determined by the selections made in term 3 and 5.

### Degree project

Independently of the selection of courses, the students shall accomplish a degree project on 10 credits after term 6.

## Further development

In the SU syllabus for 1984, the structure had been altered, so the choice of specialization applied to the entire year 2, not just to term 3. A majority of the students chose to study either ADB or Informatics during year 2. The Informatics course is described in the section for single subject courses.

During year 3, students could choose to study 20 credits within another subject or to take intensifying courses in the computer and systems sciences. The most popular choice among other subjects was business economics, but most students chose intensifying courses within DSV.

In other respects, the structural changes concerned minor adjustments of number of credits for course elements, the implementation order of course elements and the range of courses available for free choices during year 3. Pedagogic improvements were continually made to the courses.

By the mid-eighties, a change in the systems development courses was integrated in c course

block on 16 credit points in which theoretical studies and project work were combined. Normally companies or organisations provided the project cases for systems development which sometimes led to full-scale implementation. This was excellent from a pedagogic point of view, but involved big problems finding cases, and to administratively coordinate groups and companies.

The range of optional courses within the program increased from 9 in 1984 to 21 in 1992. This development can be explained by the expanding research and ambition among researchers to participate in the basic education. Among optional courses, there were already at an early stage courses in modelling, artificial intelligence, human-computer engineering, security informatics and decision methodology. Students became acquainted with object-oriented programming already during the first year, through courses in SIMULA and later also in Smalltalk.

## Compulsory Courses 1992

### Goals year 1

The goal for the first year of studies was to provide basic knowledge of essential concepts within computer and systems sciences, statistical mathematics, economy, law etc, which are important and which can be of use during the two following years of studies in the programme. Various problems, perspectives, methods to tackle a problem and methods for analysis are discussed within each respective subject area.

Moreover, the education is aimed to develop students' abilities to work both independently and in groups, as well as to develop their capacity to communicate with other people in the professional area, orally and through writing.

### Courses year 1

Computers and Programming (7cr)  
Discrete Mathematics (6cr)  
Applied Swedish (2cr)  
Statistics (5cr)  
Computing Law and Business Administration (4cr)  
Systems and Communication (4cr)  
Software Engineering (4cr)  
Statistics II (4cr)  
Database methodology (4cr)

**Year 2****Goals**

The goals of the education in year 2 was to provide deeper knowledge of

- system development methods with applications
- connection between information systems and businesses
- development of data processing systems
- program development
- programming methodology
- database construction with applications

**Courses**

Investigation Techniques from Social Science Perspective (4 cr)

Systems Design and Systems Development (16 cr)

This course was composed of 5 subcourses, corresponding to phases in the Case task)

Operating Systems (4 cr)

Programming Methodology (7 cr)

COBOL Applikation (2 cr)

Files and Databases (3 cr)

Models for Problem Solving (4 cr)

**Year 3****Goals**

During the third year in the programme in systems sciences, the student should:

- accomplish a degree thesis in ADB on 10 credits
- take optional courses on totally 10 credits, within the range of ADB courses for year 3
- take optional courses on totally 20 credits

**Courses**

The optional courses should consist of optional, but not earlier studied elements from the range of ADB courses for ASY3, or courses in other subjects relevant for the programme.

**Students and Teachers**

During the years from 1977 to 1992, totally 1300 students were accepted to the first year of the programme at DSV, the number of registered students in the third year adds up to 975. However, the number of completed degrees based on ASY are few, 181, but most probably some students have completed their exam without relating it to ASY.

The number of student places has varied during the years, during the first year DSV had an autumn admission to the programme where 42 students were registered, and during the period 1983-1988 when there were 90 places there was a spring admission with 30 places also offered. 1992, the last year of admission 120 students were registered, which was the highest number ever.

A number of teachers made significant contributions to ASY's success at DSV. At the risk of forgetting someone, we choose to mention a few of the teachers engaged in ASY at an early stage. Anna-Lena Johansson, Katrin Sundling, Carl Gustaf Jansson, Marianne Janning, and Istvan Orci. Several others made great efforts in the

programming education. This is described more in detail in Josef Swiatycki's text. Allan Junfors' efforts with company-linked cases should also be highlighted. Other important early contributors to the education were Eric Roupé, Stig Berild, Lars Söderlund and Christer Hultén.

**Epilogue**

The programme has corresponded well to the need that gave rise to its establishment. The demand of ASY students from trade and industry was great, during a certain period of time students were tempted to move on to a professional career before they had graduated, which, of course, was not desirable.

In this context should also be mentioned that many teachers/researchers at DSV have initiated their career through ASY. This is valid for Stefan Möller, Åsa Smedberg, Maria Bergholtz, Mats Wiklund, Magnus Boman and Åsa Rudström, to mention a few.

Already in 1981, the department started working for a four-year education, something that was not realized until in 1993 with the programme in Computer and Systems Sciences- DSV-linjen.

## PROGRAM IN COMPUTER AND SYSTEMS SCIENCES, 160 CREDITS

### Background

Already in 1981, the department started to argue for an extension of the three-year study program in Applied System Science with one year. This was supported by Undergraduate studies programme committee ("Linjenämnden") at SU, by representatives from other universities and in 1985 also by the computer user organization "Riksdataböndet". For different reasons, there was waiting for 12 years before realizing the extension in 1993, when a reform for Swedish Higher Education gave universities more freedom for own decisions, coupled to a new resource allocation system.

To plan for this change, all departments within the faculty had to present their analysis and proposals for activities after the reform. The report "DSV year 2000", documented the vision for development up to 2000, written by an internal drafting committee chaired by the dean Tord Dahl, with members representing the department in the faculties or equivalents, Anita Kollerbaur, Carl Gustaf Jansson, Eric Roupé and Anne-Marie Philipson. Arguments for a four-year program were based both on an academic point of view as well as on the perspective of educating professionals for the market. Among the more detailed reasons for an extension were the increasing complexity and growth of scientific problems and application areas, and that the Swedish education in the systems science area had to be competitive with the corresponding international programmes<sup>1</sup>, as increased internationalisation was already forecasted.

1992 "Linjenämnden" approved the establishment of a four-year programme to start 1993.

### Ambitious project

The new programme should have a firm basis in research and meet international requirements on undergraduate education in the area, in addition

to fulfilling high requirements for professional work. It was also important to create a programme that had an innovative structure and a pedagogical design. Quality development and assurance were to be integrated parts of the programme.

To realize these high ambitions Tord Dahl, head of the department, chose an innovative approach to development involving teachers and researching staff in close cooperation. The development project was performed in two main phases, the first before the first realization, 1992-1993, and the second when the first group of students had finished the program, 1997-1998.

A majority of the DSV teachers and researchers were involved in the development in various ways, in working groups and in discussions. Naturally, students were also involved. Six conferences for the whole staff were arranged during the period. Preparedness for the change was extraordinary.

Also influences from industry and organizations were regarded, external representatives were invited to participate in a reference group to the programme, active 1992-1998. We are grateful to Association Director Rabbe Wrede, "Dataföreningen", Head of Laboratory Bjarne Decker, Ellemtel and Dir. Gert Persson, Swedish Post, for their ideas, engagement and contributions to the program. DSV representatives constituted the planning group from the first phase of development (see below).

The project is documented in several reports, all in Swedish, summarized into two main reports with translated titles: The Basic Two Years in the Programme Computer and Systems Sciences, April 1993 and Evaluation of the Programme in Computer and Systems Sciences, the architecture and the basic two years, March 1998.

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<sup>1</sup> See references; Computer Curriculum 1991, Information System 1990 and Curricula for Human-Computer Interaction 1992

### Initial development 1992-1993

The initial development was organized in four main steps

- 1 Definition of goal and main architecture, performed in the so-called planning group lead by Prof. Carl Gustaf Jansson. Members of the group were Tord Dahl, head of Department, Prof. Bengt Lundberg, Ass. Prof. Istvan Orci, Prof Jacob Palme Research Ass. Bo Steinholtz, Director of Studies Eric Roupé, University Lecturer Louise Yngström, and Deputy Head of Department Anita Kollerbaur, also secretary. The work was done in March-October 1992.
- 2 Detailed specification of subject content in the first two years, one group each for
  - Information Systems, lead by Prof. Bengt Lundberg and Univ. Teacher Allan Junfors
  - Applied Computer Science lead by Research Assistant Bo Steinholtz
  - Cognition and Communication lead by Prof. Carl Gustaf Jansson
  - Supporting Sciences lead by ass Prof. Istvan Orci.Only chairs were appointed, all faculty was invited to participate. The work was done in October-November 1992.

- 3 Specification of courses and course structure for the first two years, in a group of teaching and researching faculty representing the different subject areas and student representatives. The work was done in December -April 1992.

The group was lead by Eric Roupé, members were Anita Kollerbaur and Åsa Rudström representing Cognition and Communication, Bengt Lundberg, representing Information Systems, Stefan Möller and Istvan Orci representing Applied Computer Science, Istvan Orci representing supporting Sciences, Karin Randerz, responsible for quality aspects in the program. Student representatives were Jacob Granert and Johan Lindgren.

- 4 Development of details in the specializations in one group for each of the specializations was performed during the study year 1993/94. This was delegated to the four research laboratories. Chairs for this work are the same as described in the section presenting the third and fourth year.

Comprehensive aspects, such as examination, methodology, evaluation and media were handled in a separate group.

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### A thorough evaluation 1997-1998

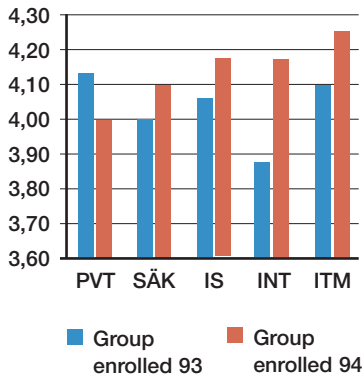
Two comprehensive evaluations of the program were performed; one after the first two years and one in 1997 when the first student group had completed the program. The evaluations included different perspectives of the program from students' and faculties' points of view. Improvement of individual courses had been done on a regular basis continuously during the years as in all DSV-courses. The evaluation was performed by a group chaired by Anita Kollerbaur, the deputy Head of Department, Petia Wohed, Pierre Wijkman representing teachers/researchers, student representatives Lena Norberg and Magnus Alzén.

All students recieved written inquires, supplemented with telephone interviews for selected groups. Teachers have contributed with written

reports stating progress and proposing changes for each course within the first two years.

Likewise, each specialization has been analyzed and reported by the responsible professors/corresponding. At a series of meetings, the interpretations of results and proposals for changes were discussed. A preliminary report was submitted for consideration to both staff and students.

The evaluation showed that the structure and general aims for the program were still valid, some changes in course structure and content for the first two years were necessary. In the following section the differences between the 1993 and 1998 version of the program are made explicit. Since 1998 no structural changes have been necessary, only changes within courses have been made.



The students gradings 1997 of the DSV-programme from groups enrolled 93 and 94.

One bar for each of the specialization showing means for the two groups.

PVT - Software Engineering, SÄK - Security Informatics, IS - Information Systems, INT - Interactive Systems and ITM - IT-Management.

1= very bad, 2 bad, 3 OK, 4 good, 5 very good.

The total mean for all students enrolled 93 was 4.05, for those enrolled 94 was 4.17.

### Scope and broad aims of the programme

The Computer and Systems Sciences study programme leads to a Swedish Master's Degree ("magisterexamen") and comprises 160 credits or four years' full-time studies offered at the Social Sciences Faculty at Stockholm University. A bachelor degree ("fil. kand.") can be awarded if the choice of courses over three years' study satisfies the general rules for a bachelor degree. However, when planning the course programme, no particular provision was made for studies to be broken off in this way.

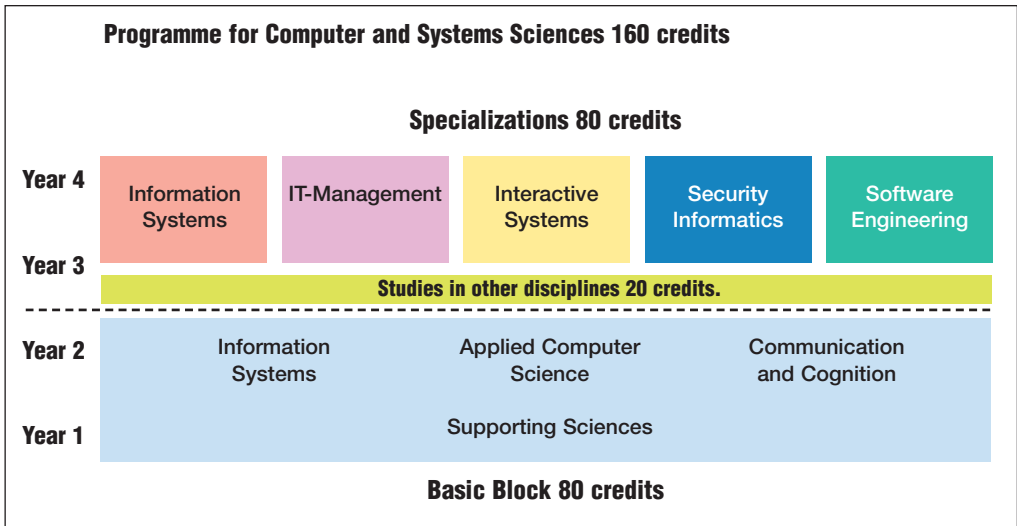
In the academic year 1993/94, the programme replaced the three-year Applied Systems Science study programme. Autumn 2006 will be the last admission to the programme due to the 2007 general reform of the Swedish higher education.

Entry requirements for the program are mathematics to university entrance standard in addition to the basic requirements for higher education. In the autumn of 1993, 130 students entered the program. The interest for the program is still high, in 2005 141 students were enrolled.

Examples of general aims for the whole program are

- to give knowledge of the subject that is up to date in international terms, and which has a scientific foundation
- to develop the ability of the students continuously to acquire new knowledge and apply their knowledge creatively to new problems
- to prepare students for qualified work in industry and commerce and in the public sector as well as to provide a good foundation for postgraduate work in the subject
- to convey a view of information systems as an important part of the infrastructure of organisations and to give good insights into the significance of information technology for the development of society
- to impart skills in presentation and communication of the results of one's work in both English and Swedish
- to make the teaching interesting and stimulating.

For each specific course within the program detailed goals are specified.



General overview of the Programme for Computer and Systems Sciences

### The architecture of the programme

The course programme is organized in two parts:

- a basic block comprising 80 credits (years 1 and 2)
- specializations comprising 80 credits (years 3 and 4).

The basic block provides students with fundamental knowledge of the subject and prepares for the specializations. The specializations in the third and fourth years give a deeper knowledge of the subjects in question, linked to topical fields of research at the Department and to subject areas in the basic block.

### The first two years in the programme – the basic block

The basic block breaks down into four main areas, see table, all of which should have equal status in the course programme from the beginning. The areas and distribution of credits

between the areas are shown in the table, included in Supporting Sciences are Systems Science, Mathematics and Statistics. Applied Computer Science was already in 1993 allotted more credits, as the area was considered to demand more learning time than other areas. The table shows the shift from 1993 to 1998, indicating an increased focus on applied computer science, and a slight decrease in the two other subject areas.

| Main subject area           | Credits 1993 | Credits from 1998 |
|-----------------------------|--------------|-------------------|
| Supporting sciences         | 20           | 19                |
| Applied computer science    | 24           | 30                |
| Communication and cognition | 16           | 14                |
| Information systems         | 20           | 17                |

Credit distribution of main areas in the basic block. The number of credits reflects the study time in weeks with full-time study.

## Courses within the basic block 1993

| First term                                 | Second Term                                      | Third term                                          | Fourth term                                                |
|--------------------------------------------|--------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------|
| Introduction till CSS (4cr)                | Human-computer interaction (3cr)                 | Systems Theory (4cr)                                | Methodology for Investigations and Empirical studies (5cr) |
| Computer science and mathematics (I) (2cr) | Logic and models (6cr)                           | Theory of Programming Languages (7cr)               | Operating systems and networks (6cr)                       |
| Information systems in organisations (4cr) | Database methodology (3cr)                       | AI and Cognitive Science (5cr)                      | Development of information systems (8cr)                   |
|                                            | Software Engineering (4cr)                       | Design and development of Interactive Systems (5cr) |                                                            |
|                                            | Methods for Information System Development (4cr) |                                                     |                                                            |

## Courses within the basic block from 1998

| First term                      | Second Term                                       | Third term                                                | Fourth term                                                |
|---------------------------------|---------------------------------------------------|-----------------------------------------------------------|------------------------------------------------------------|
| Human-Computer Interaction, 4cr | Models and Databases, 5cr                         | Computational Theory and Formal Languages, 4cr            | Introduction to Software Engineering, 5cr                  |
| Programming Methodology 1, 7cr  | Computer Architecture and Data Communication, 5cr | Systems Theory, 4cr                                       | Methodology for Investigations and Empirical studies (4cr) |
| Information Systems, 4cr        | Programming Methodology 2, 6cr                    | Discrete Mathematics, Algorithms and Data Structures, 5cr | Design and development of Systems, 11cr                    |
| Logic, 4cr                      | AI and Cognitive Science, 5cr                     | Project Management and Group Dynamics, 3cr                |                                                            |
|                                 | Models and databases, 5cr                         | Object-oriented analysis and design, 4cr                  |                                                            |

When comparing the basic block 1993 and 1998, the main changes were additional credits and more study time to the Applied Systems Science area, and consequently a revision of the courses in this area from 1998.

Further, the course structure was changed to make the order between subject areas more transparent. An important change within the areas of Information Systems area and Applied Computer Science was mainly to apply an object-oriented approach. Project Management and Group Dynamics became a new course in 1998.

Additional focus is given to formal methods with explicit courses in mathematics, logic and computational theory, which were integrated within other courses in the 1993 version.

Finally, the basic block was revised to end with a longer project-oriented course, compiled of the two courses Design and Development for Interactive Systems and Development of Information Systems into one course. The aim for this course was to design and develop an interactive system by applying modern methods and knowledge from the previous courses.

In addition to evaluation and revision of the main architecture of the program, all courses are evaluated and improved regularly.

## Specializations - the third and fourth year

During the whole period, five main specialization areas have been offered for the students. They are structured as follows:

- Compulsory courses for maximum 20 credits. This differs in the available specializations from 5 - 20 credits.
- Individual choice of courses for the specialization area for up to 20 credits.
- Individual choice of courses for at least 20 credits in other disciplines than Computer and Systems Sciences or individual choice of international studies for up to 20 points. This was compulsory in the beginning, then the students could also choose DSV-courses as alternative.
- Thesis: 20 credits. This can be presented in one part, or in two 10-credit parts, either separate or linked.

As the elective courses should support the thesis writing, individual study plans, which can be revised, are drawn up for each student.

Overall quality and development of the specializations are delegated to responsible faculty, normally a professor.

The specializations and responsible professors in 2006 are:

- Information Systems,  
Prof. Paul Johannesson.  
Until 2000 Prof. Janis Bubenko
- IT - Management, Fil. Lic. Eduardo Pérez
- Interactive Systems,  
Prof. Carl Gustaf Jansson
- Software Engineering,  
Prof. Love Ekenberg.  
Initially Dr. Bo Steinholz from 1998,  
followed by Prof. Terttu Orsi until 2001
- Security Informatics,  
Prof. Louise Yngström

During the years, students' choices of specialization have varied. From being very popular one year a specialization could only recruit a few students the next, without any rational explanations. However, all specializations have been offered every year from the start, which has been possible as courses often recruit students also from other programs/courses.

Courses within specializations are supposed to be closely coupled to research, both compulsory courses and the eligible ones, which have resulted in variations from year to year not directly coupled to the change of the basic block 1998. The only general change is a course in research methodology, 5 credits to be used in all specializations.

In the following, the 2006 versions of the specializations are briefly presented.

### Information Systems

The overall objective for specialization in information systems is to provide a basis for leading positions in areas such as planning of information systems, management of large IS-development projects, methods development, IS architecture design, enterprise development, information administration, database construction and data-

base administration as well as IS for decision support and as instrument for new business models.

The aim is to promote a view of information systems as an important part of the infrastructure in organizations, to provide subject knowledge that is of current interest at an international level, and to promote internationalisation.

Internationally, this specialization at DSV includes large areas such as "Business Engineering", "Requirements Engineering" and "Information Systems Engineering".

Within the area of Information Systems, concepts, methods, techniques, tools and processes for development and use of information systems for organizations are studied. Particular emphasis is placed on enterprise analysis, where the goals, processes, actors and concepts of an organization are analysed and described through different methods and models. Another important branch area is the use of information systems for decision-making and knowledge sharing, which also enables dealing with unstructured information. As most new systems must be built on or be integrated with existing systems, this specialization also offers knowledge about how to make systems interoperable. Within the area of databases, decentralized databases, object-oriented databases and data models for the Web are emphasized - a continuation within this area concerns how to make the Web comprehensible for machines, the so-called Semantic Web. Within the area of Information Systems Architecture, component- and service-based applications such as Enterprise JavaBeans, .Net and Web Services are discussed, among other things.

The range of courses within this specialization is based on optional courses, the only mandatory course being the course in research methodology (5 credit points). During the first years that the specialization was offered, it comprised 20 credit points as obligatory course elements. The course elements can be combined in different tracks, for example with focus on organizations and information systems, database techniques and information systems.

In 2006, the range of courses includes 18 course elements. A selection of those are:

- Software Evolution and Maintenance
- Relational Database Design
- Internet Information Search Techniques
- Business Intelligence
- Foundations of Information Systems
- Data Warehousing
- Knowledge and Software Reuse
- Mobile Businesses

Examples of suggestions for subject minors to be studied during the third year are:

- Languages – basic course on 20 credits in each respective language
- Business Economics, basic course, 20 credits
- Psychology, basic course, 20 credits
- Law, general course, 10 credits or introductory course in law, 10 credits.
- Linguistics, 10 or 20 credits.

The most popular subject minors are Business Economics and Law.

The Master's theses range from technical essays on database management and information search techniques, to more business-oriented essays on e-business and globalisation.

A few typical examples of Master's theses are:

- Semantic Web and Social Tagging
- Ontology Mapping for Business Models
- Requirements for Mobile Applications in Developing Countries

## Interactive systems

This specialization targets design of interactive systems, user-adapted services and Internet and WWW-based services.

Five core areas are:

- Design of computer support for collaboration and communication
- Implementation of prototypes of intelligent interfaces
- Design of Internet- and WWW-based services
- Design of multimedia applications
- High level programming of interactive systems
- Design of interactive systems tailored to specific purposes

Illustrative applications are:

- Group communication and private communication
- Distributed office and design work
- Information provision and decision-making in large organisations
- Public information systems and electronic publishing
- Interactive entertainment
- Education
- Services at home

The specialization had 20 credits mandatory courses apart from the course in research methodology:

- Agent Programming
- Ubiquitous Computing
- Artificial Intelligence
- Methodology for Design of Interactive Systems
- Machine Learning
- Cognitive Science
- Affective Interaction

Within the scope of the elective courses, it was recommended three tracks with focus on:

- Distributed and Object-oriented Programming
- Artificial Intelligence
- Cognitive Science and HCI

Other possibilities are courses like HCI-design, JAVA-programming, interaction technology, tele- and data communication.

As regards the subject minor, cognitive, communication and design sciences such as linguistics, psychology and media technology are recommended, but also courses in theoretical philosophy and mathematics.

Main areas for thesis work are User interfaces, Cognition, New IT-supported services, Agent Technology and Technical Perspectives of Interactive Systems.

Examples of theses are:

- Design of a Voice Browser Interface
- Children and Game Development from a User's Perspective
- A Study of Affective Input in Mobile Settings
- Trading Agents

- Tools for Building Advanced Electronic Commerce Systems across Company Boundaries

### Software engineering

Software engineering specialization in industry is mainly done in project form using tools, metrics and methodologies to design, implement, test and deliver project after project on a constrained budget. Different projects require different mixtures of design, programming, formal techniques and metrics. To have the competitive edge, it is also important to know how to acquire new knowledge in these areas that seem to be in a constant state of flux. This can mean following the trends, picking up the next programming paradigm before your competitors or getting on the extreme programming tracked vehicle in time.

The aim of the Software engineering track is to prepare students for various types of work in an industrial setting, or for further research in the area of programming language issues. The Software engineering competence track addresses the area both from a software engineering point of view, and from a computer science angle.

Traditionally, the track has a solid foundation in standard software engineering with courses in agile development, software testing, software metrics, modelling and use of tools for formal specification and verification for projects where cost of failure is high or even immeasurable. For the motivated student, there is even an open course, tailorable to each participant, which enables deeper studies of a subject, preferably in preparation for a master thesis or project works. These parts of the track do not prerequisite heavy programming skills, and are equally useful for students pursuing a team leader career as for students pursuing careers as software architect, developer and programmer. The computer science part of the track contains courses on advanced issues in object-orientation, dynamic programming languages, meta-programming and construction of domain-specific languages. Not mandatory, these courses require at least moderate programming skills.

After a quite significant modernization during 2005, the only mandatory course is Agile Software Construction (AGILE). The students may then choose between Software Testing and Metrics (TEME), Dynamic Programming Languages (DYPL), Effective Programming in C# and .NET (CSHARP) and Current Issues in Computer Science and Software Engineering (CISS).

From the autumn of 2007, Formal Methods in Software Engineering (MOOG) will also be a possible option.

Examples of theses are:

- Clustering for Feature Selection in the Classification of Microarray Gene Expression Data
- Reading Techniques for Object-Oriented Code Inspections
- Ownership Types in Practice

### Security informatics

The security informatics area is described in a separate section, which includes the specialization within the programme for Computer and Systems Sciences.

The compulsory part of the specialization is 20 credits with the following courses:

- Research Methodology
- Computer Security
- Security Management
- Network Security
- Contemporary IT-Security Problems

Courses for the individual choice in the fourth year can be either additional courses in Security Informatics or other related DSV-courses or other subject areas.

The interdisciplinary character of this specialization does not restrict the choice of minor subject area. Subjects within Natural Sciences, Humanities, Behavioural and Social Sciences are all possible.

Examples of theses are:

- Security requirements derived from technical recommendations in ISO 17799
- On measuring information security awareness
- Information security policy and routines for a public administration

- Biometrics in Swedish passports – implications for privacy
- Use and applicability of personality tests for recruiting information security personnel
- Appearance of Information Security in some selected North-American movies

### **IT-management**

ITM-management is described in a separate section, which includes the specialization within the programme for Computer and Systems Sciences.

The compulsory part of the specialization is 20 credits with the following courses in addition to the Research Methodology Course:

- Organization, IT Systems and Management
- IT Management
- IT Platform: Strategy, Architecture and Design

Recommended courses for the individual choice in the fourth year can be either courses from the other specializations or specialized courses in the ITM-area.

Recommended minor subjects for the first semester of the third year are Philosophy, Economic subjects, Subjects within Natural Sciences, but also Art.

### **Concluding remarks**

In the programme, students acquire professional knowledge and skills, both broad and more specialized. They have met and used a number of IT environments, methods and subjects at the research frontline. The programme was the first in Sweden to offer compulsory courses in the area of Human-Computer Interaction from the first year. Also a design approach to development of interactive systems was used as well as an object-oriented view for program and systems design and development. DSV were also first in Sweden with the specialization in Security, Interactive Systems and IT-management.

In addition to discipline-oriented knowledge and skills, the students learn how to work in projects and groups, thus training social competence, oral and written communication, and they are trained to acquire new knowledge in a variety of

areas. To summarize, they are well prepared both for a professional career and for a continued academic career.

In order to improve the course evaluation procedures, student course boards were introduced, which should be applied to all courses at DSV. This approach is further described below.

The Computer and Systems Science programme has become a strong trademark for DSV both among students and among employers. Even during the period of low interest in academic education in the area, the number of beginners has not decreased, but instead been steady or slightly increased, from 130 students 1994 to 141 students 2005.

The plan is to keep it in an adapted form also from 2007 as one bachelor program and one master program for each specialization. The experience from the project approach has been valuable for development of other programs, but has not been replicable, for resource reasons.

### **References:**

Computer Curriculum 1991 CC'91, ACM/IEEE Joint Curriculum Task Force, ACM 199.

Information System 1990: Model Curriculum for a Year Undergraduate Degree, Data Processing Management Association 1991.

Curricula for Human-Computer Interaction, ACM SIGCHI-ACM 1992.

DSV år 2000, DSV year 2000, in Swedish, Department report the Faculty of Social Sciences, 1991.

The Basic Two Years in the Programme Computer and Systems Sciences, April 1993, Basblocket i linjen för Data- och systemvetenskap, Department report in Swedish

Evaluation of the Programme in Computer and Systems Sciences, the architecture and the basic two years, March 1998, Utvärdering DSV-linjen, linjens arkitektur och basblocket, Department report, in Swedish.

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# PROGRAMME IN IT AND COMMUNICATION SCIENCES, 160 CREDITS

The education comprises four years, and leads to a Swedish Master. It is also possible to achieve a Bachelor's degree after three years of studies. The education was offered for the first time in autumn 2002, the first students graduated in spring 2006.

## Background

Previously, IT and communication science have partly been included in the specialization Interactive Systems on the third and fourth year of the Computer and Systems Sciences Programme, but it has also been possible to choose these courses from the range of separate courses.

The reasons for establishing a separate programme with this specialization was partly the development within the academic area, partly a significantly increased demand for education in the subject from trade and industry as well as from society. Another driving force was the decreasing influx of students; the need to carry out more radical changes in the range of courses offered by the department was evident. A meeting with the then head of the educations office at the faculty for social sciences autumn 2001, became the igniting spark for a project to design the new educational programme.

The time that passed between idea and the very start of the programme was short, the first draft was drawn up in November 2001 by Carl Gustaf Jansson and Anita Kollerbaur. The committee appointed a working team consisting of Prof. Emeritus Yvonne Waern, University of Linköping, Lena Norberg, Ken Larsson, Pierre Wijkman, Jakob Tholander and Kjell Näckros. The members had been chosen to represent the different competence areas that the education was intended to cover. DSV's managerial body (the prefect's consulting group) acted as reference group to the project. The decision to establish the education was taken by the faculty of social sciences in March, 2002.

## Goal

The programme for IT and communication sciences, in short "the ITK programme", is based on the facts that technical development increasingly leads to a communication society where use of and spreading of different techniques for communication between people intensify, and where people of all ages and personal profiles are affected. Ultimately, it is all about communication between and among people, supported by IT. The demand for interactive documentation and improved interactive help also increases with widened use of IT. IT products need improvements applications need to make better use of the potential in IT and understanding of the communication processes embedded in the applications must be improved.

Possible professions for graduates from computer and systems sciences specialized in the ITK-programme are: system developer – especially for communication systems –, game developer, developer of systems for different media such as digital radio and TV, designer of information systems for Internet, designer of graphic user interfaces, usability tester and researcher. As the education is new and the IT market is constantly evolving, it is most likely that new professional areas will emerge. Therefore the education also aims at educating and developing the students' own capacities in self-employment and entrepreneurship.

The goals of the programme are to:

- provide knowledge in the subject, including theory and methodology for analysis, design, construction and use of IT-based communication systems
- offer possibilities to specialization combined with a solid knowledge breadth and general education in the subject area
- develop the students' capacity to continually acquire new knowledge, and to creatively apply their knowledge on new problems

- prepare students for qualified work in trade and industry as well as in the public sector
- provide a solid ground for research education
- facilitate international student exchange.

In addition to these objectives, more general educational goals are specified, for example to

provide genuine understanding of the importance of information technology from different perspectives, to provide skills in presentation and communication of their own work, to offer varied and excellent possibilities to work with modern tools and systems.

### Contents and planning

The education consists of three central blocks:

- 1 Basic IT.
- 2 IT from a communications perspective.
- 3 Communications science within other subjects than computer- and systems sciences.

For an overview of the architecture of the education see the picture.

Year 1 and 2 shall provide students with basic knowledge within the three blocks. During the

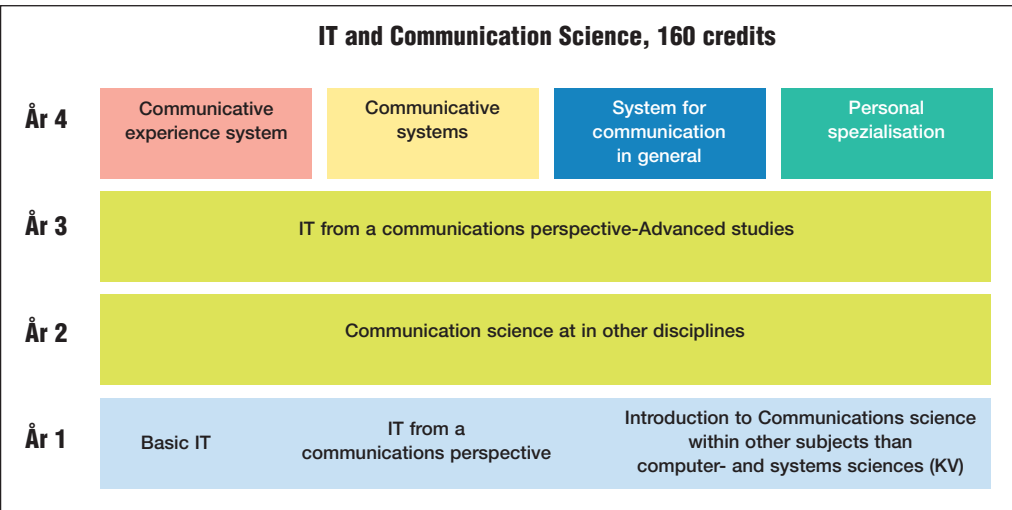
first year students study computer and systems sciences while other subjects with specialization in communication sciences are studied during the second year

Year 3 and 4 involve deepened studies in IT from a communications perspective, and includes a choice of a further specialization within which finally the degree thesis on 10/20 credit points will be written.

### General Architecture for ITK-programme

During the 4th year, the students choose specializations in which they will write their degree thesis.

The specializations in the figure indicate some examples.



In year 2, when students further their studies into communication sciences within other subjects than computer and systems sciences, recommended disciplines are linguistics, psychology, pedagogics, sociology as well as journalism with media and communication or

communications design – the latter being a one-year education at KTH, while all others are offered at SU.

Hitherto, more than 50% of the students have made the KTH one-year education their first choice while pedagogics is their second choice in

20% of the cases. From 2006, computer games and multimedia at DSV is also offered as a choice.

From autumn 2007, courses offered in year 2 will be

- Communications design at KTH
- Education at SU
- Multimedia with games development – elements within DSV's games development programme and the multimedia technology and education programme.

Students may also in consultation with DSV make a personal selection from another subject within communication sciences.

Teaching is to a large extent project- and problem-oriented, and provides plenty of time for interaction and reflection. An ambition has been to mix and overlap theoretical and practical elements. To provide consistency and to connections between the different courses, the initial thought was to design common exercises. This has been difficult to realize, partly because it requires a comprehensive view among contributory teachers, which takes time to achieve. For year 1, a great deal of this work has been done, whereas much remains to be done for year 3.

Aiming to apply skills and knowledge acquired during the education an extensive project is included during the third year. In addition, students have to the thesis work of 20 credits during the fourth year.

A natural part of the education is to, as far as possible, use new media and methods for communication and learning. As the first education ever at DSV's SU programmes, portable laptop computers have been used on trial instead of stationary computers, and students have been given the possibility to acquire/rent laptop computers via DSV.

Evaluations are carried out on a regular basis through questionnaires in Daisy<sup>1</sup>, both for each element and for entire terms and academic years. Regular evaluations are also made after year 1, 2 and 3, by students being asked to submit their

personal reflections and thoughts on their education. Based on the evaluations, among other things, interplay between the different elements has been improved, as well as a more extensive revision of the contents of the programming courses in year 1, to simplify coordination of those. Considering the fact that the programme is still new, these corrections must be considered minor.

### Courses in year 1

(number refers to central blocks)

- IT, communication and knowledge, introduction (1,2)
- Programming as communicative tool (1)
- Analysis and modelling of communicative systems and systems for cooperation (1)
- Construction of communicative systems (1,2)
- Interactions design and empirical methodology (1,2)
- Structuring, storing and access to information (1,2)
- Programming of interactive systems (1,2)
- Seminar- and literature series in communication science (2,3)

**In year 2**, students study at other departments, as specified above.

### Year 3

Intensified studies, principally within the block "IT from a communication perspective".

- Database methodology (1)
- Security (1)
- Project work (1,2,3)
- Design theory and creative methods (1,2)
- Multi-modal systems (1,2)
- Theory of Science (3)

After year 3, students may choose to finish their studies with a Bachelor's degree.

### Year 4

Specialization within a chosen direction:

- Communicative systems
- Communicative experience systems
- Or an entirely personal specialization

During year 4, the Master's thesis on 20 credit points is also written.

<sup>1</sup> Daisy - DSV's Administrative Information System, a system used for support of DSV's administrative processes for students and staff, the development of which started as a students' project

Examples of completed Master's theses:

- A case study on information society in sparsely-populated areas
- 24 hours-authorities' availability for visually handicapped and immigrants in terms of e-services,
- A comparison between "Försäkringskassan" (the Social Insurance Office) and "Arbetsmarknadsstyrelsen" (Board of Labour Market)
- A Security Evaluation of Emerging Wireless and Convergent Technologies Using the Common Criteria

Examples of Master's theses in progress

- Computer support for teambuilding
- A personalized web using metadata
- Interactive dramas

The programme has recruited more students than expected, the first year 74 students were enrolled, to be 125 students 2005. ITK-programme recruits almost 50% female students which is extremely unusual for an IT-education.

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### **ITK-programme – in the future**

Students who have completed the education are principally positive. However, it is too early to draw general conclusions about how graduated students are received by potential employers.

A project to evaluate the situation for those who have started their professional career has been initiated, the impression is that they have had a tremendous use of their education in their professional work.

DSV has decided to suggest a continuation of the programme in 2007, divided into a three-year programme with similar design as the three first years of ITK, followed by a Master specialized in user-centered design of interactive systems.

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# PROGRAMME IN MULTIMEDIA EDUCATION AND TECHNOLOGY, 120 CREDITS

Today, there is already a great demand for the combination of knowledge in human behaviour and in digital media- and communication techniques. This demand will probably increase. Understanding how the technique works will not be sufficient - in order to push the development forward, an understanding of the human being as creator, as user and as developer of information technology is also required. Examples of professions are orderers of IT productions, usability experts, information architects, project-leaders and IT pedagogues.

The Programme in Multimedia is an interdisciplinary programme for 120 credit points at Stockholm University. It was established in 1993 within the frame for the pedagogic department's teaching programme. Its aim is to increase knowledge of and understanding for the human being's relation to digital media – and communication technology, and it is primarily intended to function as a basic vocational training. Since 2005, the programme is operated and developed by the pedagogic department and DSV in collaboration.

The programme integrates pedagogy with digital media- and communication techniques. The pedagogical part, which focuses on new communication techniques, is on 80 credit points. In this part, the individual is discussed as user, as creator and as technical developer. Aspects of how we learn, communicate and act in a digital environment are also included. 10 credit points are represented by optional pedagogic elements.

In the technical courses on totally 40 credit points, for which DSV is responsible, digital media techniques are introduced, and the students can create video- and animated film. Next, digital communication techniques with a higher degree of interactivity are discussed. For example, students learn to produce interactive computer games and digital publishing tools.

More specifically, the course range at DSV includes the following courses:

## Year 1

- Digital media theory, 5 credit points
- Digital media production, 5 credit points
- Basics of programming, 5 credit points
- Animation, 5 credit points

## Year 2

- Digital communication techniques, 5 credit points
- Application development, 5 credit points
- Project work, 5 credit points

## Year 3

- Interactive environments design, 5 credit points

The programme is concluded by a digital project for 10 credit points with a pedagogic aim and direction. This project is to be implemented in co-operation between the departments, and it constitutes the degree thesis at Bachelor level. The students will study the pedagogic parts of the course at SU's main campus in Frescati, and the technical parts at the Campus IT University in Kista.

The education is pursued in a pedagogical environment, with experiments with different technical solutions. Some lectures are streamed, and students can follow them from home whenever they wish. There are also a few web-based video films with built-in search functions, as well as a well-developed conference system with e-mail and chat. Supervision is partly done through web-cameras. Some courses are run in computer game environments. The students have access to computer labs, a sound- and video studio, and they can borrow technical equipment for their work.

General eligibility is required for course admission. The planned number of places is 60. The education has proved to be attractive to women.

Dr. Kjell Näckros is responsible for co-ordination and implementation of the programme at DSV. Prof. Love Ekenberg is responsible for the subject field.

## SINGLE SUBJECT COURSES

The main difference between programmes as single subject courses are that students have to apply for each course, whereas in a programme they are guaranteed a place during the period of studies - provided that they fulfil the relevant requirements each year.

Since the beginning, single subject courses with a length of one term (20 cr points) has been offered on basic level, intermediate level, advanced level and specialized level. These are normally combined with other disciplines, to be

included in a Bachelors exam or aim at a Master in Computer and Systems Sciences, or in another discipline depending on the depth of studies.

These course packages of courses naturally have been updated continuously.

Also shorter courses are offered both at KTH and SU for vocational training and as optional courses for students in DSV programmes.

In certain areas courses have been organized in larger blocks, which are exemplified in this section.

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## Education in Informatics with Systems

### Informatics program 1971 - 1988

In the beginning of the 1970'ies, in parallel with the educational program in Information Processing – Administrative Data Processing, the program Informatics with Systems was run at the department. The background was a Swedish investigation on the future of the Swedish research libraries – SOU 1969:37 Education for libraries, archives and informatics – focusing on information retrieval and large databases in the light of then modern and large computer installations – initially for medical and chemical research – being adapted within US for use in space-oriented research.

Kjell Samuelson, later to become a professor in Informatics at the department, had while studying medicine at Karolinska Institutet, KI, come in contact with the challenges of modern medical research and plans for modernizing research libraries at KI and KTH. As part of the investigation he was sent to the US to gather information useful for the Swedish activities. He learnt how US and other international educational efforts were named and planned – hereby the name Informatics as contrary to Computer Science – underlining information for Informatics, while data belonged to Computer Science. The addendum “Systems” to Informatics

may be interpreted as forming structures which information could be enclosed into.

Naming the program Informatics also underlined that the media – then solely computers within computer science – were not of primary interest, but communicating the information as freely and as un-changed as possible within the structuring system was a main focus of research. (The convergence into IC&T was not known at the time.) The reader may remind him/herself of the origin: medicine and chemistry use full text, pictures, drawings etc in addition to plain data to explain living processes; the aim of Informatics with Systems reached for a different approach towards information processing and communication. Despite these differences, the investigation suggested this new Informatics education to be located at the department for Information Processing, and to be closely related to the section for Administration Data Processing.

The prerequisites for the Informatics program were academic education corresponding to two years of full time studies (80p), and one half term (10p) of basic Administrative Data Processing. Priority should be given for students with a general librarian education indicating the investigators' wish to educate specialists driving ‘the computerization of the libraries’<sup>1</sup>. However, the

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<sup>1</sup> One of the early students was Professor Irene Wormell, since 2000 at the Swedish School of Library and Information Science at University College of Borås.

program got a broader design, a more appropriate label of the program would be ‘the informatisation of society’<sup>2</sup>. The program aimed at creating so-called Informaticians or Information Scientists, with general and specific knowledge and proficiencies in organizing, handling and communicating information from a systems and management perspective, including guiding other researchers’ detailed information acquisition.

As Informatics was a new and developing area on the frontline, the education was from the very beginning closely related to research. Some courses even contributed directly to research results. Probably the most forward oriented action research project and course was InformatiCom where communication processes were studied within a framework of teleconferencing; real-time distance education was held between initially four universities in 1979 - Stockholm, Lund/Malmö, Göteborg/Borås and Linköping/Norrköping - when multi-way video-communication using available technologies at the four nodes were linked together. Despite many efforts the project InformatiCom did not get regular research funding, even if traces of activities during the 1990’ies in DSV still carry links to it<sup>3</sup>. Also the educational program Informatics with Systems, which ceased to exist

in its original form towards the end of the 1980’ies, left many traces in research and education at DSV today.

Active teachers and researchers in DSV within the program and its projects 1971- 1988 were apart from professor Kjell Samuelson amongst others professor Louise Yngström, PhD Kurt Samuelsson, Tech lic Karl Olof Wigander, Ph lic Björn Rosengren, Ph lic Peter Nilsson, MSc B Anders Eriksson, MSc Ejvind Bach-Kristiansen, and MSc Tomas Muth. Anne Marie Bodor was the anchor and secretary.

Specifically, research and development in the area of Security Informatics has its roots in the Informatics program. More about this can be read in the section Memos and reflections by Prof Kjell Samuelsson and Prof Louise Yngström and also in the more general section on Research.

### Course contents

Informatics with systems offered truly interdisciplinary courses blending elements of natural and social sciences with humanities using system science – General Systems and Cybernetics – as vehicle. Russel Ackoff’s proverb “we must stop acting as though nature is organized into disciplines in the same way that universities are” accompanied the development of courses and



**InformatiCom** – action-oriented research on multiway videocommunication including full feedback with group syntheses lead by professor Kjell Samuelson, DSV 1979-88, here together with Ann-Marie Bodor, research secretary, and researchers Björn Rosengren and Louise Yngström, DSV.

Picture from SU-Nytt, Nr2, 1 mars 1984.

<sup>2</sup> One example of this was the informaticians at DSV involvement in the parliamentary pre-work of the ‘Data Law’ – the first national law on privacy enacted in 1973, where we also met with the liberal politician Kerstin Anér who minted the ‘computer shadow’ - the traces of people’s actions left in IT systems.

<sup>3</sup> For instance an educational project with University College Visby developed the technique of lecturing via teleconferencing with students placed either in Visby or Stockholm. Further developments were driven within the ‘MIT’ unit headed by Eduardo Pérez adding international sites as nodes as well as developing and managing the educational program for PostHögskolan.

courseware for inquisitive and, frequently, mature students from various areas. Usually courses were on 5 credits, each centered round research oriented reports and textbooks with many international and national specialists as guest lectures. Lectures, seminars and exercises offered ample opportunities for discussions and field trips; the program in total was 40 credits – one full year of studies.

Originally the following courses were offered: IS-1 Informatics with General Systems and Cybernetics, IS-2 Information Systems with Scientific and Technical Communication, IS-3 Teleinformatics with Networks and Communication Systems, IS-4 Computer-based Information Retrieval and Management, IS-5 Informatics with Systems in Industry and Organisations, IS-6 Communication in Interactive Human Information Systems, IS-7 International Informatics Systems, IS-8 Security and Integrity for Information Systems, Nets and Data

Among researchers providing texts and reports for courses but also visiting the department can be mentioned James Grier Miller (Living Systems), Russel L. Ackoff and Fred E Emery (On Purposeful Systems), W. Ross Ashby (Introduction to Cybernetics) Stafford Beer (Brain of the Firm), West Churchman (System and Management), Gordon B. Davies (Management Information Systems. Conceptual Foundations, Structures and Development), A. Debons (Information Science, Search for Identity), L.B. Doyle (Information Retrieval and Processing), C.T. Meadows (The Analysis of Information Systems), W. H Newman (Constructive Control, Design and Use of Control Systems), J.P. van Gigh (Applied Systems Theory), B.C. Vickery (Information Systems), G. M. Weinburg (Introduction to General Systems Thinking), B. Langefors (Thais), Joel de Rosnay (The Macroscopic. A New World Scientific System), Barrington Nevitt (The Communication Ecology).

During mid 1970'ies and '80'ies the Informatics program was extended into advanced level (called C and D-courses, 40 credits) and into a separate management oriented 40 credit program (called SAPL – Systemanalytisk

påbygggnadslinje) both aiming for future research. Within these extensions were 5-10 credit courses such as IS-9 Human Information processing in Systems, IS-10 InformatiCom , IS-11 Decision Methodology and Consequence Analysis, IS-13 Informatics System Methodology, IS-15 System theory, IS-16 Legal Informatics (taught jointly with Juridicum at Stockholm University), IS-17 Applied System Analysis, IS-21 Living Systems with Bionics and Natural Design, IS-24 Satellite Communications, IS-26 System, Planning and Prospecting, IS-27 System and Automation, IS-29 System Testing, Trust and Fault Tolerance, IS-36 C3I-systems, amongst others; creating in total almost 40 courses.

However, towards the end of the 1980'ies two important course of events occurred: the research activities including research-oriented courses in Informatics with Systems was moved from DSV in the fall 1988 and the Security Informatics program started in 1985. Since Security Informatics was much influenced by Informatics, including planned cooperation for courses between the two programs, the remaining joint parts continued the scientific tradition during the end of the 1980'ies into the SATS program.

### **Systems Analysis and applied Systems Theory 1989 - 1995**

The one-year study program in Systems Analysis and Applied Systems Theory (SATS-program) built on the Informatics program focussing the management perspective. It was developed by a team of informaticians to jointly utilize existing Informatics courses for SATS as well as for Security Informatics. Eventually also SATS/ Informatics was used as one elective on the 3rd year of the ASY-line. Thus SATS together with Informatics with System became the management-oriented part of Informatics at DSV while Security Informatics became the IS/IT security-oriented part. Between Security Informatics and SATS/Informatics initially 25 credits out of 40 were taught jointly. R&D activities including various educational efforts made the two parts become independent in 1992 with Eduardo Pérez heading SATS/Informatics and Louise Yngström Security Informatics.

Today (2006), looking back at almost 35 years of R&D including educational efforts based on the Informatics paradigm, we can be grateful to the numerous scholars and fascinating people who contributed to creating and maintaining an action-oriented research and learning environ-

ment characterized by feed-back and feed-forward; something that never ends, ever changes - "Cybernetic Living". Many of us - learners, teachers, researchers - marvelled and still marvel what the future within the paradigm can be made to bring to mankind.

## Courses and Programs in Security Informatics

Information Security, Computer Security, ICT Security – and lately Information Assurance – are names of the complex and dynamic area which in DSV became Security Informatics. Security Informatics has been offered as a one-year program since 1985. Initially, its prerequisites were two academic years including at least one year of CSS. A prototype version of an internationalised Master Program called Information Security in Information Technology Environments started in 1992. Students were mostly professionals within security and/or IT security, but successively young university students chose the programs as a part of their first academic degree, and Security Informatics became one of the specializations of the DSV 4 year master program (DSVL) in 1996/97. In parallel during the 1990's ICT security courses were offered to KTH students as a specialisation on the M Sc D-line.

By 1994 250 persons had successfully finished the first year (Security Informatics), and a further 200 persons part of the second year (Information Security in Information Technology Environments), most of them active in working life. Evaluations were favourable related to former students' appreciation of actual practical use of course knowledge (on positions such as Corporate security directors, Corporate IT security directors, IT security specialist, IT security auditors, teachers and researchers). More extensive descriptions of the education are found in the DSV/SU PhD thesis 96-021.

### Contents of courses and programs

Focus is on Information Security, which includes concepts such as IT security, computer security,

communication security, etc., paying attention to national and international security developments of importance to create robust IT societies. In Europe and North America, great changes in approaches to IT oriented security occurred from 1985 and on; trends were towards harmonisation of national and international activities. Models and methods for analyses of risks, threats, security specifications, evaluations, standards, definitions, protocols, etc were developed, tested and evaluated. Activities in workshops and conferences were many and diverse; the ambition of course developers is that all programs will – in depth as well as in width – reflect existing and on-going research and developments within the area. Course material is constantly being updated with textbooks, reports, proceedings etc. and visiting researchers in ICT security ordinarily lecture on new topics. Security Informatics treats security and IT security interdisciplinary and holistically, encompassing theories and methods for security in organisations as well as in technical systems and IT used as security measures for social, socio-technical and technical environments.

Many people have contributed to content specification; the earliest, most concrete and wide perspective was given by the first chairman of International Federation for Information Processing, IFIP's, Technical Committee no 11 – Computer Security, Kristian Beckman, who was also heavily engaged in the educational work of the Vulnerability Board.

Awareness of the importance of well integrated, organisationally optimally located and executed information security functionality exists in Sweden today. However, difficulties

are obvious when it comes to division of responsibilities, work descriptions, cost benefit estimates, etc. The systemic-holistic approach – based on system's theories – has shown to be profitable and useful for dealing with complex problems in dynamic environments – for the whole as well as in details.

In the 20th century many argued that the background of a corporate security director was rather dependent on personal qualifications and the scope of the organisation than on formal qualifications. However, for other professionals such as doctors, lawyers, auditors, programmers, system analysts, engineers, etc. there exists different, usually academic, required degrees and diplomas. Security Informatics and IS in IT environments were initially suggestions for such degrees, and within Europe similar thoughts were developing within the ERASMUS project, where the department took part in curricula developments and exchange of teachers, students, and course material.

Today, Security Informatics is taught regularly as courses and programs for degrees at Stockholm University and KTH; the original interdisciplinary Security Informatics Program at the DSV/SU master program, a disciplinary program for students on the KTH M. Sc. Computer Science program, a comprehensive (mix of both) International Master Program at KTH and an integrated program (between software engineering and IT security) for students on the KTH M Sc IT program.

## International cooperation

IS in IT Environments was, as the Security Informatics Program, originally developed based on industrial demands and also in cooperation with other international scientific departments. It aimed for an internationally accepted Master of Information Security.

Within the SOKRATES/ERASMUS, ICP during the 1990's developed possibilities to offer courses exchangeable between international departments; teachers and students became mobile. International cooperation manifested itself mostly through international guest lectures, but some 50 Swedes have been exchange students in Hamburg, Gratz, Brisbane, Perth, Vienna and various universities in the US. Some courses use English as a common language.

## Target groups and approach

To design, build, manage, evaluate and maintain IT systems robust, safe and secure was initially specified to be the most important activities within IT from the last decade of the 20th century. Sweden was one of the first countries to engage practically in this on the level of society. The 1973 Data Act was the first national act focusing privacy, the 1977 SARK-report from the Vulnerability Board concentrated on society's vulnerabilities owing to computerization, the 1978 Security By Analysis method advised methods for dealing with EDP safety and security problems within organizations, the 1991



The very first meeting of the ERASMUS ICP for developing a postgraduate program (syllabus) in the area of Information Security, Dependability and Safety in 1994. The following universities are represented in the picture taken outside the university library in Samos, Greece:  
Athens University of Economics and Business, Lund University, University of Peireus, University of the Aegean, Stockholm University, Aston University, University of Plymouth, University of Vienna.

All-terminal project aimed for keeping, processing and communicating data securely in government agencies, just to mention some well known historical activities. Most Swedish projects were founded on a consensus basis characterized by a holistic approach, where interactions between techniques, organizations, legal practices and social factors were mediated into one whole.

Courses are intended for designers, developers, managers, and evaluators of secure ICT systems in organizational environments. The target group includes third and fourth year students in a computer and system science program and M Sc engineering students, but also security and ICT security professionals.

### Prerequisites

In order to increase possibilities of academic studies in information security, prerequisites were changed to one year of academic studies including at least half a year of computer science for the starting course. However, in practice it is more appropriate to have two – three years including at least one and a half year of computer science.

### Courses 1985 - 2005

Tables below present initial courses as well as an overview of existing courses in programs.

In 1985, 40 credits were offered to ca 20 full-time students yearly, 2005/06 80 + credits are offered to ca 120 full-time students yearly (of which ca 40 on the SU DSVL or SU Master degrees, ca 60 on the KTH International Master Program, ca 20 on either of KTH M Sc D- or IT-program). In addition, ca 200 students yearly take courses complementary to other specializations (for instance the KTH International Master Program EMIS, DSVL students in Information Systems, Software Engineering and Interactive Systems). Further, but not included in the list of courses in the second table are, specialized security courses targeting other groups of students are offered to Medical Informatics/KTH, 2IT/KTH and ITK/SU.

The second table gives an overview of the four main streams of ICT security education; specializations within the 4 year master DSV line

(DSVL), the M Sc in Computer Science (MSc CS), the M Sc in IT (MSc IT) and the Master of Science in Information and Communication Systems Security (ICSS). In order to be regarded as specialized in security, students' master theses needs to be in the area; the compulsory courses for each specialization indicate the differences even though there is a smorgasbord of additional choices possible. The DSVL graduate is able to work or do research within contemporary ICT security problems including organizational issues. The MSc CS graduate will be specialized on technical issues related to current R&D within distributed systems. The MSc IT will be specialized on technical issues related to R&D within software engineering and security (courses from software engineering are also compulsory). Graduates from the KTH International Master Program will have a comprehensive knowledge of the field useful for management as well as for technical expertise, for working life as well as for research activities.

Courses taught jointly for more than one group of students provide variety in depth and practical applications to fit varying prerequisites and levels.

**Table showing the initial 1985 Security Informatics Program**

- Informatics with General Systems and Cybernetics, 5 credits
- Information Networks, 5 credits
- Computer-Based Information Retrieval and Management, 5 credits
- Informatics and Systems in Industry and Organizations, 5 credits
- Security and Integrity of Information Systems, Networks and Data, 5 credits
- Legal Informatics, 5 credits (taught jointly with the Dept of Law)
- System Testing, Reliability and Fault Tolerance, 5 credits
- Advanced studies chosen in accordance with the field of specialization, 5 credits

Table showing 2005/2006 Compulsory (C) and Optional (O) courses for specializations within the 4 year master DSV line (DSVL), the M Sc in Computer Science (MSc CS), the M Sc in IT (MSc IT) and the Master of Science in Information and Communication Systems Security (ICSS).

Courses taught jointly for more than one group of students provide variety in depth and practical applications to fit varying prerequisites and levels.

|                                                     | DSVL/SU | MSc<br>CS/KTH | MSc<br>IT/KTH | ICSS/KTH |
|-----------------------------------------------------|---------|---------------|---------------|----------|
| General Systems Theories with Cybernetics, 5 cr     | C       |               |               | C        |
| Computer Security, 5cr                              | C       | C             | C             | C        |
| Cryptography, 5 cr                                  | O       |               | O             | C        |
| Network Security, 5 cr                              | C       | C             | C             | C        |
| Software Engineering and Security Architecture, 5cr | O       | O             | O             | C        |
| IT Security and the Law, 5 cr                       | O       | O             | O             | C        |
| Security Management, 10 cr                          | O       |               |               | C        |
| Security Management, 5 cr                           | C       | O             | O             |          |
| Security in Open Distributed Systems, 4 cr          | O       | C             | O             | O        |
| Security in Mobile and Wireless Networks, 4 cr      | O       | C             | O             | O        |
| Java and e-Commerce Security , 4 cr                 | O       | C             | O             | O        |
| Value Based Security Management, 5 cr               | O       | O             | O             | O        |
| Contemporary ICT security problems, 2 cr            | C       |               |               |          |
| Master thesis, 10 or 20 cr                          | C       | C             | C             | C        |

## Courses in IT-management and Management with technology

Development of courses in IT-management and Management with Technology began at DSV at the end of the eighties. Four basic ideas were considered.

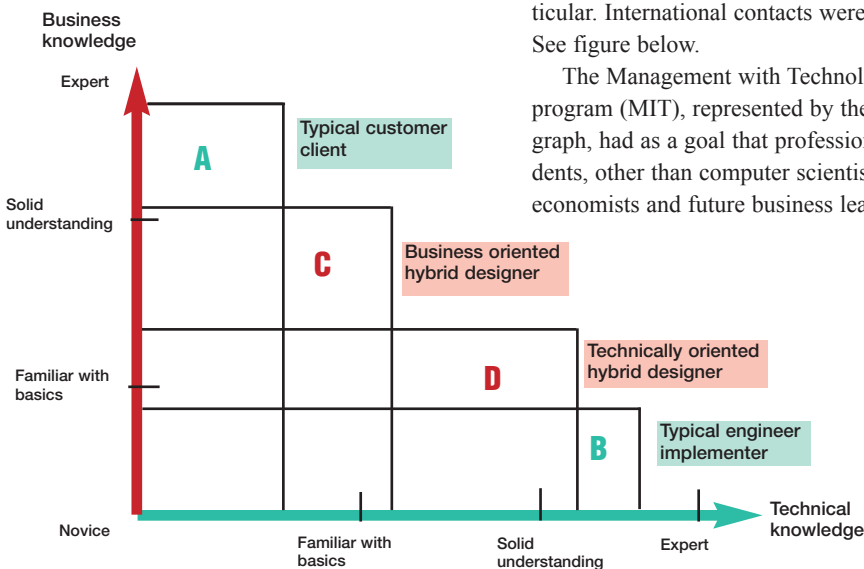
In the first place, the understanding that since information technology (IT) was influencing all aspects of human life, professionals other than computer scientists needed a solid knowledge of IT in order to influence, manage and transform their own business and careers. In the second place, the understanding that most engineers needed to complement their computer science or other technical knowledge with a business and organizational perspective. In the third place, the understanding that computer scientists, as well as other professionals, needed a systemic-holistic perspective on technology and the world. The analytic and rationalistic view needed to be complemented with a Systems view. As Aristotle once remarked; it is as difficult to understand the parts without seeing the whole as to understand the whole without seeing the parts. Last but not least, the development of the area was based on the idea of education as action, i.e., students

needed to learn with technology if they were to understand how to use technology to modify their future jobs, careers and organizations.

The vision was transformed into two main course programmes, a number of executive courses and a technological platform supporting the pedagogical approach to learning on technology with technology. The course programs were Management with Technology (MIT), and Information Technology Management (ITM). Executive courses were given to the Swedish Post (described in the section for Commissioned education), Cell Networks, Mandator and Aros Securities. Many national and international universities became interested in the course programmes, the technology and pedagogics. Ad hoc versions of the digital environment were designed to every student in the educational programs.

The seminal ideas behind the creation of the area of Business Technology at DSV reflected concerns at national and international levels. Many academics and scientists had envisioned the need of transforming education in general and computer science and business education in particular. International contacts were taken.<sup>1</sup> See figure below.

The Management with Technology course program (MIT), represented by the area C in the graph, had as a goal that professionals and students, other than computer scientists, primarily economists and future business leaders, should



<sup>1</sup> Peter G.W. Keen and J Michael Cummings: Networks in Action, Wadsworth Publishing Company, Belmont, California 1994.

become familiar with the basics and reach a good understanding of information technology. The courses within this area were developed through the transformation, extension and the new profile given to the SATS program created in 1988.

MIT was developed in collaboration with the Business School and other departments from the Stockholm University with which DSV reached an agreement to give a new BA in Economics in the island of Gotland. The course program was transformed and officially accepted as an MBA program by the Stockholm University in 1993. Later on (in 1998), the educational activities in Gotland were transformed to what is today The Gotland College of higher education, and the MIT program became one of its main educational programs. Research groups and specialization areas of DSV were invited and many did participate in the MIT program.

New methods and new technology for learning and communication was used. In parallel with development of the course program in Gotland where the MIT program was offered since 1989, a technical platform was developed. The platform allowed DSV and its partners to share educational programs, lectures and teacher resources in real time. Later, in 1998, The Södertörn College of Higher Education began to share the MIT programme with DSV students in Gotland and Kista. In 2002, Söderhamn and Santiago de Chile were also incorporated with the same programme.

The goal of the second course program, in Information Technology Management (ITM), represented by the letter D in fig. 1, was that students with engineering or other technical background reached the level of "solid understanding" in the area of business knowledge and organizational experiences. ITM was formally initiated in 1995 as one of five specializations for DSV's four-year master programme. The ITM-specialization consisted of two interdependent blocks of courses of 20 credits each plus a Master's thesis (Swedish "magister").

The areas A and B in the figure represent traditionally high levels of expertise in Business and Engineering and were not intentionally pursued by course programs at DSV.

All educational programs, the technical

development and the pedagogical approach are based on a holistic and innovative perspective on IT and IT-platforms. A perspective aimed to give students the necessary competences to participate in and the design of; processes, new working models, new products and services, new businesses and new ways of creating value in a networked economy.

In summary, the main goals with the creation of the area of Business Technology were to give knowledge and insight on information technology to business and other non-technical students/professionals and, to give a business- and organizational perspective to information technology students. A goal on its own and a prerequisite for learning on technology with technology was the development of a technical and progressively digitalized learning environment. The general idea was to learn and teach about the relationship between information technology, business, work, learning and innovation in all types of organizations.

The regular and executive courses, the pedagogical approach and the technological platform were thoroughly and constantly evaluated and the results well documented during the sixteen years of experience with shared and distributed education. In general terms, it can be concluded that the students reached a high level of satisfaction.

### **The MIT course program**

The courses in MIT were structured as a group of interdependent course modules, MIT 1-IV, which for students fulfilling all other requisites could be completed with a master thesis (20 points/credits) leading, in this way, to a MSc at DSV. The program was based on the use of new technologies and new methods for learning. It was given as a real-time combination of near and distance education.

#### ***Top-down approach to IT and business education***

The MIT program began by presenting a basic and systemic understanding of IT and a holistic vision of organisations and the new economy. Progressively, specialist competences may be developed, in different areas of IT and its intersection with individuals, organisations, businesses and society.

**MIT I Management with IT I, 20 points/credits**

*Systems theory, IT Management and basic computer science*

MIT I is a combination of theoretical and practical courses. The purpose of the MIT I block was to give the students basic competences in system theory, computer science as well as IT management in the digital economy.

*MIT I consisted of the following courses:*

Systems theory and IT, 5p/credits  
Computer architecture, 3p/credits  
Basic programming methodology, 4p/credits  
IT-Management I, 5p/credits  
IT-supported Human to Human Interaction, 3p/credits

**MIT II Management with IT II, 20 points/credits**

*Systems and organizational development, Telecommunications and computers and information technology*

The purpose of MIT II was to widen and complete the basic, technical skills by extending the technical courses from MIT I to areas such as communications, databases and systems development, connecting these skills to system theories and businesses.

*MIT II consisted of the following courses:*

System development, 4p/credits  
Systemic development on organizational level, I, 4p/credits  
Database methodology, 4p/credits  
Basic programming methodology, II, 5p/credits  
Telecommunication, I, 3p/credits

**MIT III/ ITM II Management with IT III, 20 points/credits**

*Leadership, Computer science, IT-platforms, value networks and networked economy*

This block is a common block for students that have previously taken MIT and ITM course programmes. For this reason, the description of this block is done within the description of the ITM program below.

**MIT IV Specialization modules**

MIT IV contains a set of modules where each module (approximately 10 points) corresponds to a specialization or in-depth studies/activities in a current and relevant area of research at DSV. The course normally consists of two freely chosen modules. Examples of modules are: Knowledge Management, Process work, Agent- and Internet

programming, Electronic commerce, Inter-organizational Information Systems, Internet Marketing and business activities, Databases, System security, System development for complex systems etc. The modules were formed out of the existing offer of pool courses at DSV. The students were allowed to choose more than two modules.

**The ITM course program**

The ITM-course program educates students and experts in computer sciences and other technical and IT-related professions so that they can connect and adapt the IT-development to business development, to new ways of working and to business and organizational management. ITM illustrates the business possibilities that ICT offer to people, organizations, companies, the economy and society.

The ITM specialization consists of two blocks/modules of courses of 20 points/credits each. These are called ITM I, and ITM II, respectively. The ITM II program is a joint program for students coming from a business background and students coming from a technical background.

**ITM I Information Technology management I:**

*IT, Systems, IT-platforms from a business perspective and The Digital economy*

The purpose of the ITM I block is to present a business and a system-theoretical perspective to Information and Communication Technologies. The course focuses on the use, management and architectural design of technical platforms to intra- and intercommunicate individuals, organizations and companies. The understanding of the business possibilities will allow computer scientists to make effective contributions to the realization of the company business strategy and will increase the effectiveness and efficiency of companies and organizations.

*The ITM I specialization program consists of the following courses:*

Systems Theory, 3 points/credits  
Organization, IT-Systems and Management, 7 points/credits  
IT-Architecture, Strategy and Design, 5 points/credits  
IT-Management, 5 points/credits

**ITM II/MIT III Information Technology Management II  
(or MIT III)**

*Systems development at the organizational level, project management, security, wired and wireless telecommunication in value networks or intra and inter-enterprise systems*

The purpose of ITM II/MITIII is to further explore the connection between business and IT, introducing new approaches to organisation and systems development and still other aspects of technology. The students will complete their tools-kit and develop more practical experience, to analyse and change organisations based on information technology. The students should deepen their understanding on how to integrate organization and companies into value networks and the global economy.

*ITM II or MIT III contains the following courses:*

System development on organizational level, II, 5points/credits

Project management, 3points/credits

Information security, 3points/credits

Telecommunication, II, 4points/credits

IT-Management, II, 5points/credits

## Courses specialized in games

### Background

The tradition of games within the area of IT is long, and has developed through many stages. Already in the late sixties, when data terminals were introduced more commonly, there were games of varying nature. Often, they were entertaining strategy games, but there were also games within more advanced environments such as Computer-Assisted Learning, for example the Plato-system, which has influenced DSV's early research a lot.

The hardware and software development has offered new possibilities for game design and introduced new research domains, particularly in the area of advanced human-machine interaction, but also in the software engineering area, etc. Games have become one of Sweden's export articles, and the importance of the area is also pinpointed by an extensive EU-research effort, with Dr. Annika Waern, SICS, as coordinator.

### Games education development at DSV

During autumn 2002 and spring 2003, professor Love Ekenberg and the university subject teacher and doctoral candidate Mats Wiklund started to discuss computer games development from an academic point of view. Ekenberg, who at this time had acquired empirical experience of several computer games (and later on was to reach the desirable and almost mythical level 60 in the

huge online game World of Warcraft) attended to the particular possibilities in the media of computer games both technically and content-wise. Wiklund, with a background as computer games critic in the leading newspaper Dagens Nyheter, shared Ekenberg's fascination for the subject of games.

After having secured that courses in game development could be guaranteed a sufficiently high academic level, if designed in an appropriate way, the plans were intensified. Doctoral candidate Kjell Näckros, whose research has connected to the area of games, joined the group and the two first course elements of five credits were developed and offered for the first time at

Mats Wiklund to the left and Love Ekenberg, the initiators of game education at DSV



DSV in the autumn of 2003. 119 students registered to this first embryo of the games education, and to the general course taught in the evenings and also open for students outside the computer area, 107 students appeared.

Not only students showed great interest, but also mass media, who gave much attention to Stockholm's first education in game development at university level. During an intensive period, several students were interviewed and DSV appeared frequently in media.

The computer games education was rapidly extended to 20 credits in the autumn of 2004. Doctoral candidate Tony Lindgren was engaged for a course element about AI (Artificial Intelligence) in games, and Wiklund developed a new course element about 3D graphics for computer games development. During the academic year of 2005/2006, DSV's commitment on an 80-credit education in computer games development was launched, in which pure course elements in computer games are varied with other contiguous elements useful in game development, for example programming, databases and multimedia for Internet specialized in game development.

Simultaneously, course elements on virtual worlds in online games were added together with elements on advertising in the media of computer games, as well as increased possibilities to carry out degree projects within the area of computer games. Through cooperation within the area of multimedia education, further competence in game development could later on be added to DSV. With its new, large volume, the study program needed a person responsible for the program as a whole. In the autumn of 2005, Kjell Näckros was appointed to the post.

In 2006 it is possible to enter the programme directly from upper secondary school, or include courses from 10 to 40 credits in game development in the last two years of the DSV-programme. Those who wish can also expand the 80-credit program with a complementary course element, and a package of 40 credits in game development courses can also function as a master's course (corr. Swedish "magisterkurs") for students who want to continue from 120 to

160 credits points. For the first time, a summer course in 3D games development has also been offered in 2006.

Since the start after three years, over 500 students have completed one or several courses in game development at DSV, the autumn of 2006 being uncounted. This has been noticeable in student life in various ways; enterprising students in the 80-credit program have arranged a very much acclaimed computer games' tournament in the student's pub, among other things. Phenomena related to computer games also leave marks on research to a larger extent than before, and Wiklund as well as other doctoral candidates at DSV are now deepening studies of the area of computer games. This, together with a strengthening of resources through which persons with special competence, such as Dr. Daniel Pargman, have been connected with DSV for particular efforts, indicates that the game development is heading for a exciting future.

### **Range of courses in 2006**

Games education within DSV fulfil the normal standards for academic education.

There are three tracks in the range of courses:

#### **1 Computer games development, 80 credits.**

Entry requirements for this education are general eligibility with special qualifications in mathematics C, "passed" being the lowest acceptable grade. In total, approximately 50% of the course elements focus entirely on game development, the remaining 50% are selected part-courses from the available range of other DSV-courses. (See range of courses below.)

#### **2 Computer games development I, II, III, Bachelor theses work**

Specializations in computer games on 10 credits each, which can be selected separately. The 10-credit modules consist solely of courses specialized in computer games, consequently a total number of 40 credits can be studied in 10-credit stages from 10 up to 40 credits. Prerequisites for these course modules are a minimum of 40 credits in Computer and Systems Sciences or corresponding qualifications.

This track is mostly selected by the students at the four-year program at DSV, within the scope of the optional range of courses, but students who wish to extend their Bachelor's Degree (corr. Swedish "Fil. Kand") with 40 credits to achieve a Master's Degree (corr. Swedish "magisterexamen") also apply to these courses.

**3** General course in game development, a 5-credit evening course, suitable for students who want deeper knowledge in the subject of computer games, but who do not want to take a whole educational program. General eligibility is required to enter this course.

**Disposition of the 80-credit educational program at the time for the admission in 2005**

Approximately one half of the courses are specialized in computer games, the remaining half aim at providing requisite competence in other areas within Computer and Systems Sciences.

The courses focused on computer games have been marked out. Combinations of these courses are included in Track 2.

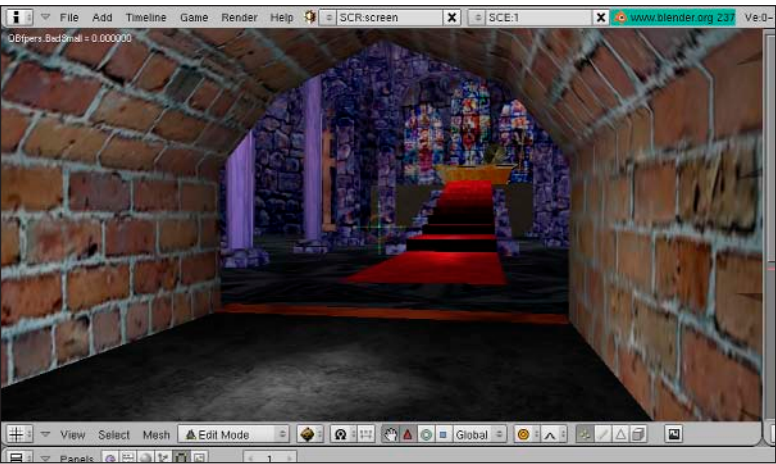
**Computer games development, 80 credits**

**Year 1, 40 credits**

- Introduction to Design and Development of Games, 5 credits
- Computer Systems I, 4 credits
- Assignment in Games Development, 1 credit
- Object Oriented Systems Design and Development, 4 credits
- Object Oriented Programming, 6 credits
- Models and Data Bases, 5 credits
- Media Technology for the Internet and Game Development, 5 credits
- Scientific Communication, 4 credits
- Object Oriented Programming II, 6 credits

**Year 2, 40 credits**

- C programming, 5 credits
- Game Development, 5 credits
- 3D Graphics for Game Development, 5 credits
- Artificial Intelligence (AI) in Games, 5 credits
- Online games, game communities and advertising games, 5 credits
- Game programming for 3D-API:s, 5 credits
- Thesis, 10 credits



Project assignments are included in most of the courses. The picture is from a students' project for construction of a three dimensional game world in an illuminated cathedral.

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Undergraduate education:

*Programmes and courses  
at Royal Institute  
of Technology*

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## CONTRIBUTIONS TO THE PROGRAMME IN TECHNICAL COMPUTER SCIENCES, 180 CREDITS

The Technical Computer Science programme (D-line) is a well established (20 years) programme within the IT field leading to a Master of Science in Engineering. DSV has contributed both to the creation of this programme and its continuous development. DSV has been responsible for a small number of mandatory basic courses (primarily Information systems and Database technology) and a number of specializations. DSV has also kept up a high popularity among KTH students with respect to diploma works and subsequently masters theses. In the nineties DSV was co-responsible for the popular cognitive engineering track.

Currently DSV is responsible for the following three specializations:

### **Computer security**

This specialization covers comprehensively the complete area of computer security. It will give a detailed overview of various principles, security mechanisms, and security services. The specialization covers user authentication, communication, message and files security, and access control together with the most popular secure network environments. Security Architectures for Open Distributed Systems, gives advanced aspects of computer security in client/ server environments, and in electronic commerce.

### **Information systems and database technology**

This specialization prepares the students to take responsibility for information systems and databases in companies and other organizations but also for work with end users of database technology (today dominated by intranet and internet technology). Courses cover topics like Datawarehousing, Enterprise resource management systems, Knowledge networks, Interoperability, Information and Business modelling as well as knowledge and software reuse.

### **Intelligent interactive systems**

Intelligent interactive systems (IIS) are systems which proactively and rationally can interact with users in order to simplify and support their work. Examples on relevant IIS applications are systems for support for datamining in databases, information filtering, group communication and personal communication, decisionmaking in large organizations, navigation in public information systems, interactive entertainment, personally adapted education and home services.

# CONTRIBUTIONS TO THE PROGRAMME IN INFORMATION TECHNOLOGY, 180 CREDITS

In the year 2000, a new 4.5 year KTH Master of Science programme in Information Technology was launched in Kista. DSV contributed a lot to the planning and initial administration of this programme.

The initial design of the programme was based on three more specialized programs, one of which had a focus on computer and systems sciences. The program has been organically changed over the years, but the details given below reflect the content and organization in 2001.

The Information Technology programme has a hierarchical structure, with two mandatory years, a choice of track in the third year and a specialization in the fourth year.

## Mandatory courses (2001)

### Year 1:

- Introduction to IT, 5cr
- Mathematics I, 6cr
- Mathematics II, 6cr
- Discrete mathematics, 5cr
- Computer science, basic course, 6cr
- Digital electronics, 6cr
- Communication systems, basic course, 6cr

### Year 2:

- Mathematical statistics, 6cr
- Computer engineering, 4cr
- Physics, basic course, 4cr
- Physics, advanced course, 4cr

### Year 3:

- Oral and written communication, 4c
- IT project, 5cr

### Year 4:

Environmental engineering, 4 cr

### Optional tracks year 3

*In the third year the students were provided with a choice of four tracks*

- Information Systems
- Communication Systems
- Electronics and Computer Systems
- Microelectronics

## Contributions by DSV

DSV was responsible both for the mandatory courses in Introduction to IT course and the Computer Science, basic course.

DSV was responsible for the track one in Information systems on the third year with the following mandatory courses:

- Computer science advanced course, 6cr
- Logic, 4cr
- Human computer interaction, 4cr
- Principles for computer security, 4cr
- Software engineering, 4cr
- Computer science III, 4cr
- Artificial intelligence, 6cr
- IT in organisations and database technology, 8cr.

In the fourth year, 12 specializations were provided, where DSV was responsible for three:

- Software engineering and computer security (IS-PS)
- Management of IT and IS (IS-MI)
- Interactive systems (IS-IS).

Examples of courses from the specialization in Software engineering and computer security are:

- Introduction to software engineering and computer security, 4cr
- Software metrics 4cr
- Qualitymodels and standards, 4cr
- Computer security I, 4cr
- Computer security II, 4cr
- Safety issues in organization and risk management, 4cr
- Fault tolerant and robust systems, 4cr

Examples of courses from the specialization in Management of IT and IS are:

- Datawarehousing, 4cr
- IT-management, 5r
- Information system theory, 5cr
- IT-plattform: Strategy, architecture and design 5cr
- Knowledge networks, 4cr
- Organizations, IT-systems and management, 7cr
- Strategical information systems, 4cr.

Examples of courses from the specialization in Interactive systems are

- Methodology for design of interactive systems, 4cr
- Design and construction of interactive systems, 5cr
- Theory of knowledge and philosophy of science, 4cr
- Cognitive psychology, 4rc
- Cognitive science, 4cr
- Agent programming, 4cr
- Intelligent interfaces, 4cr.

Over the years several diploma works on the Information Technology programme have been supervised and examined by DSV.

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# CONTRIBUTIONS TO THE PROGRAMME IN MEDICAL INFORMATICS, 160 CREDITS

The Programme in Medical Informatics at Karolinska Institutet was established in 2001, as a result of a period of investigation. It has been developed by and is run in collaboration between KTH and KI.

The programme has been designed accordingly to a proposal from a common working team in 2001. The team was lead by Jan-Olof Höög, KI, and Kristina Grönberg from KI acted as secretary. Other members from KI were Lene Martin, Rolf Bergin, Uno Fors and Gunnar Klein. Members from KTH were Gunnar Landgren, Björn Pehrsson and Torleif Olhede.

The collaboration between the seats of learning is regulated through a common programme committee, which is lead by programme director Ingvar Krakau, KI. At KTH, DSV has so far been responsible for development and implementation of the major part of the courses. Various persons at DSV have had the main responsibility, since 2003 Henrik Boström.

Each autumn, nominally 30 students are accepted for the programme, which has KI as responsible authority. The ambition was to increase this number to 50 students, but so far this goal has not been reached. The programme is given at three campuses; KI Campus Solna, KI Campus Huddinge and KTH-Kista/IT-University.

The first class of students graduated in the spring term of 2005. The programme will be revised as a consequence of the 2007 reform of higher education.

The aim and general direction of the programme has not been altered since 2001. However, evaluations and revisions of courses have in some cases led to extensive alterations of those courses and to changes in the range of courses.

## Aim

Graduates in Medical Informatics work with medical and technical aspects of all forms of documentation and communication within health

and medical care, and within medical research and education. In this way, the medical informatician thus plays a key role in the development and maintenance of the systems required for knowledge-based health care, including clinical information systems and medical decision-support systems; web portals for health personnel, patients and the general public; medical imaging systems; and telemedicine.

Persons working within the health care sector with practical experience of developing IT systems from the health sector or from industry are employed as supervisors. A major part of the teaching takes place in the form of problem-based studies. It is natural that there is close contact with hospitals and the primary health care system during the teaching. It is also natural with use of a great deal of IT in the actual teaching process. Central principles include the performance of tasks in groups and access to international information over the Internet.

In the programme, students learn how to:

- Develop web portals for staff and patients
- Assist in developing medical information systems
- Assist in developing medical decision support systems
- Recognise the basics of medical image analysis systems
- Design systems for telemedical applications
- Recognise and manage security problems that arise when handling sensitive medical information (technical, legal and ethical aspects)
- Manage large development projects.

## Programme Design

The programme includes three blocks of subjects: medicine, computer science, including applied system science and medical informatics. The medical block provides students with basic subject knowledge relating to medicine and biomedicine. This knowledge will enable stu-

dents to become skilled in medical informatics on a professional level. It is also intended that a common knowledge base will facilitate communication between technicians and other professional groups active in healthcare and nursing.

The computer science and applied system science block is aimed at providing the technical competence required to attain the general goals of the programme. Courses in computer science and applied system science provide the theoretical basis.

Within the medical informatics block, students are introduced to computer use within medical research, industry, healthcare and nursing. The courses include administrative aspects such as

laws, regulations and ordinances within the medical field, and applications for supporting healthcare processes, as well as more technical applications, such as image analysis or other biological measurement data. During this block, students have the opportunity to establish research links if they wish.

The final year consists of a degree project and optional courses, where students may choose among courses within the areas clinical informatics, medical management and advanced study in computer science. The programme requires full time studies (equivalent to 40 hours/week). An exam follows each course, but there is no final examination after the completed programme, besides the degree project.

## Courses in Medical Informatics programme

courses at KI ►

courses at KTH ►

### Term 1

|                                                          |                          |                                             |
|----------------------------------------------------------|--------------------------|---------------------------------------------|
| Introduction to Medical Informatics and Health Care, 4cr | Computer Systems 1, 4 cr | Physiology, Anatomy, and Cell Biology, 12cr |
|----------------------------------------------------------|--------------------------|---------------------------------------------|

### Term 2

|                                                             |                              |                                                   |                                                             |                                         |                                         |
|-------------------------------------------------------------|------------------------------|---------------------------------------------------|-------------------------------------------------------------|-----------------------------------------|-----------------------------------------|
| Medical Informatics, Human Biology and Health Care 1cr of 2 | Histology and pathology, 2cr | Medical Microbiology and Laboratory medicine, 6cr | Medical Informatics, Human Biology and Health Care 2cr of 2 | Logics and Discrete Mathematics I, 4 cr | Basic Course in Medical Statistics, 4cr |
|-------------------------------------------------------------|------------------------------|---------------------------------------------------|-------------------------------------------------------------|-----------------------------------------|-----------------------------------------|

### Term 3

|                                  |                                             |                                      |                                         |                                          |
|----------------------------------|---------------------------------------------|--------------------------------------|-----------------------------------------|------------------------------------------|
| Human-Computer Interaction, 4 cr | Project Management and Group Dynamics, 3 cr | Logics and Discrete Mathematics, 3cr | Introduction to Software Engineering, 4 | Pharmacology and pharmacotherapy/B, 5 cr |
|----------------------------------|---------------------------------------------|--------------------------------------|-----------------------------------------|------------------------------------------|

### Term 4

|                                                |                           |                 |                                  |                 |
|------------------------------------------------|---------------------------|-----------------|----------------------------------|-----------------|
| Data Communication and Computer Networks, 4 cr | Systems Development, 4 cr | Databases, 4 cr | Objektoriented Development, 4 cr | Webdesign, 5 cr |
|------------------------------------------------|---------------------------|-----------------|----------------------------------|-----------------|

### Term 5

|                                                                 |                             |                                               |                                 |                                                |
|-----------------------------------------------------------------|-----------------------------|-----------------------------------------------|---------------------------------|------------------------------------------------|
| Health Care Organization and Economics from IT-perspective, 4cr | Medical Image Analysis, 4cr | Philosophy of Science and Medical Ethics, 2cr | Relational Database Design, 3cr | Medical Documentation and Process Support, 6cr |
|-----------------------------------------------------------------|-----------------------------|-----------------------------------------------|---------------------------------|------------------------------------------------|

### Term 6

|                           |                                   |                    |                                                               |                                             |
|---------------------------|-----------------------------------|--------------------|---------------------------------------------------------------|---------------------------------------------|
| Biomedical Databases, 2cr | Medical Security Informatics, 4cr | Telemedicine, 4 cr | Medical Web Applications and Computer Supported Learning, 5cr | Medical Analysis- and Decision Support, 5cr |
|---------------------------|-----------------------------------|--------------------|---------------------------------------------------------------|---------------------------------------------|

### Term 7

Optional courses of totally 20 credits. Courses can be selected from the range of courses provided by KTH, by KI or by other seats of learning, provided that the Programme Responsible gives approval.

### Term 8

Degree thesis, D-level, 20 credits, alternatively degree thesis, C-level 10 credits and degree thesis D-level 10 credits

There is also a possible continuation to reach Bachelor's degree.

## MASTER OF SCIENCE PROGRAMME IN ENGINEERING AND MANAGEMENT OF INFORMATION SYSTEMS, 60 CREDITS

Information technology is rapidly becoming a key enabler in the evolution and transformation of organizations and society. As a consequence of this development, there is an increased demand for skilled engineers that can take on the role as tomorrow's information leaders.

The aim of the programme is to educate students that can manage and participate in the design, development, establishment, usage, management and administration of large IT systems that support organizations on the operational, tactical as well as strategic levels.

### Vision

The programme will give the students advanced knowledge in systems design including requirements engineering, software maintenance, and software metrics. The programme will provide the students with a strong background in project management for the design and operation of IT systems, including process management, leadership, and economy. The programme will also give a firm understanding of the opportunities and limitations of IT in supporting and transforming organizational activities, including business models, business processes, decision support, and knowledge management.

The IT-university's strategic location offers the opportunity of interaction between education, research and industry in a unique way.

### Courses and thesis

The first semester offers both compulsory and elective courses focussing on Enterprise Systems, Knowledge Management, Software Reuse, Model Driven IT Architectures, Software Processes, and Leadership in Project Management. The second semester offers a large number of elective courses in which the students can go deeper into areas like Security, Data Warehousing, Business Models for Internet, Software Maintenance, Data and Information Management, and others. During the first and second semesters, the students also carry out a

large project. In the third semester, the students will write their master thesis.

A student can always design his/her own individual study plan, which has to be approved by the director of the program.

The third semester is devoted to the Final Degree Project/Master's Thesis, which is focused on the solving of a problem within the scope of the programme. The project may originate from an industrial problem or be suggested by one of the research groups at the IT University. The results are presented in a report – the Master's Thesis – and in a seminar.

Examples of courses in the program are the following:

- Enterprise Systems and Modelling
- Project Management for IT systems
- Internet and Business Models
- Internet Search Techniques and Business Intelligence
- Global IT Management
- Models and Languages for Object and Web Databases
- Knowledge Management
- Model-driven Development of Components

The master theses written in the program range from more technical ones on database and search techniques to more management-oriented theses on Internet business models and globalization. Some representative examples of theses are:

- A comparison of Web languages in the context of Knowledge Representation
- Business Process Improvement Framework
- Empirical study of the changing of successful factors of e-business in developing countries

The program has been very popular and has attracted around 400 applicants each year since its beginning in 2003, and about 70 students have started the program each year. These students bring fresh knowledge, different perspectives and new ways of working to the department, benefiting their co-students as well as the staff.

## MASTER OF SCIENCE PROGRAMME IN INFORMATION AND COMMUNICATION SYSTEMS SECURITY, 60 CREDITS

This is a KTH Master of Science programme with a major in Information Technology with a specialization in Information and communication systems security. The programme comprises 60 credits of which 40 credits correspond to courses and 20 credits concern diploma work (master

thesis). The programme is given entirely in English. It was given for the first time in 2003.

The programme is further described in another chapter in the book, under Courses and programmes in Security informatics

## MASTER OF SCIENCE PROGRAMME IN INTERACTIVE SYSTEMS ENGINEERING, 60 CREDITS

This is a Master of Science program with a major in Information Technology and a specialization in Interactive Systems Engineering. The program comprises 60 credits of which 40 credits correspond to courses and 20 credits are a diploma work (master thesis). The program is given entirely in English.

The field of Human-Computer interaction is rapidly changing from scenarios characterised by single modality interactions based on the PC paradigm towards highly collaborative scenarios where groups of people interact within environments with many devices and services, typically utilising many modalities. Another tendency is the shift of focus from entirely co-located, static and homogeneous work settings to distributed, mobile and heterogeneous (physically and socially) work settings.

The Interactive Systems Engineering Master programme provides a unique combination of courses, which targets these tendencies. On a basis of modelling, programming, design and theory building, the program specialises on collaborative computing, ubiquitous computing, adaptive interfaces and affective interactions.

The programme has both an interdisciplinary breadth and a depth in these specific areas.

The first term provides basic courses in human-machine-interaction and artificial intelligence and a theoretical, methodological and programming background for the spring term.

- Human-Computer Interaction: Principles and Design (HCI)
- Artificial Intelligence Principles and Techniques (AI)
- Methodology for Interaction Design
- Programming of Interactive Systems
- Cognitive and Social Science Theories and Concepts for Interactive Systems

If the student already has a background in HMI and AI and regards these introductory courses as unnecessary duplicates, these two courses can be substituted. The second term provides an opportunity for specialisation in areas where K2LAB has specific competence:

- Modelling and analysis of complex systems
- Collaborative computing
- Ubiquitous computing
- Affective interaction.

The third term is dedicated entirely to the master thesis work. The K2 unit at DSV has active research groups which can support thesis supervision in the following areas:

- Ubiquitous computing
- Collaborative computing
- Affective interaction
- Complex systems and
- Interactive systems for particular user groups such as kids.

The basic skills taught on this program also constitute a good basis for masters thesis work focussed on particular application areas such as:

- Computer games
- E-applications
- E-learning applications
- Mobile services in general.

Topics for thesis work could either be provided within K2 research groups or through our industrial partners.

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# *Students' involvement*

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# STUDENTS AND DSV

## The main formal channels

Good relations and cooperation between the department and students is fundamental for quality development in a wide sense, in education as well as for student environments.

Regulations prescribe that students – undergraduate and graduate – shall be represented in the Board, and also participate in preparation of educational changes.

At DSV, students are organized in departmental student committees, one each for undergraduate students (Ämnesrådet – ÄR) and for graduate students (Doktorandrådet, DR). The mission for ÄR and DR is to be the students' voice in all aspects of the education. Their normal primary contacts in these matters are the study rectors for undergraduate and for graduate education. It has not always been easy to recruit members to these committees, so various joint efforts have been made to facilitate the recruitments. For instance, both DSV and members of the committees stress to new students the importance of student engagements in the early introduction.

Undergraduate students at DSV formed D.I.S.K. in February 1990, meaning Students' Union of the Department for Computer and Systems Sciences ("Data- och Systemvetenskapliga Institutionens Studerandes Kårförening"). DISK's contributions to the students' environment at DSV are extremely valuable. DISK organizes a lot of activities for the students, including their own pub with a limited economic support from DSV. DISK is presented more in detail later by the present chairperson. Engagement in DISK is certainly also important for the individuals. See for instance the memories of Lars Gunnarsson in this book, where he claims that the merits from DISK was one reason for his employment.

In the beginning of the 1990's, the Student Counseling Committee (Studentrådet) was established with representatives from ÄR, from DISK and from DSV. DSV is represented by the head of department, the study rector, student counselors and responsible administrators.

In Studentrådet, matters at all levels are discussed, from four-year plans to details in the physical environment.

Students at KTH are organized separately, and in relation to the programmes. So far no formal separate channels have been established for the international master students.

## Processes important

Planning processes at DSV follow two main cycles, one annual and one every fourth year. Via the Studentrådet and DR, students are involved early in these processes, and in all stages. Development starts with a request for proposals of goals, new activities, improvements to be included in the plan, which are considered in a first draft of a plan. Normally there are at least two revisions with intermediate referral in the student groups.

Annual and long-range plans are of course to be decided by the Board as the last stage, and final changes are possible. Through this process, students at DSV can, if they want to, have a real possibility to influence.

## Student course councils

For the majority of undergraduate students the processes around courses are more important. Course evaluations are of course compulsory, mostly made through questionnaires, since 2000 supported by the Daisy-systems, with the possibility for students to anonymously edit the form and submit it to the teacher normally after the course is finished.

In order to simplify for students to influence during a course, DSV decided to implement so-called Course Councils ("Momentråd"), which in principle should be appointed for all courses. A "Momentråd" is a forum for discussions during the course, where student opinions, questions and requests can be put forward during the course, so that eventual adaptation can be made in the course without delay. "Momentrådet" should at least include two students and the course responsible teacher. The councils are supposed to

present a written report where the outcome and future revisions of the course should be included and published in Daisy. Both students and teachers appreciate the course councils, but there has been a certain inertia at implementation.

### **Physical Spaces**

As presented in the introduction, DSV has changed address four times during the last 40 years. Anxiety for moving to Kista in 1990, turned out to be unjustified. Increased space was allocated to students, space for group work as well as a PUB of their own. As group activities represent almost 50% of students' work, requirement for additional group spaces when planning for the move to the Forum building were high on the students' list. This was taken into consideration. Compared to the situation for other students at SU and KTH, DSV students must be considered privileged.

All graduate students employed at DSV have their own office space.

Initially, there was no possibility of housing a PUB, but thanks to student initiative and own work they since 2003 also have a pub in FORUM. For more details, see below. Students also run their own cafeteria in connection to lecture rooms.

### **Final comments**

To conclude this text on students' contributions at DSV, we have to mention the important welcoming activities for beginners, organized by the students. Regularly, they also publish the magazine "Systembladet", another appreciated piece of work.

DSV has been honoured and grateful for the students' nomination to the prize for best undergraduate education at SU, which DSV received in 1997.

Both students and DSV have gained from the positive atmosphere and collaboration, and the aim is certainly to preserve this in the years to come.

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## HISTORY OF DISK

The history of DISK begins when the Department for Computer and Systems Sciences (DSV) moved from Frescati to Electrum in Kista. At this time, there were only two active student organizations within DSV, the Departemental Student Committee (“Ämnesrådet”) and the Section for arranging social activities, “Klubbmästeriet”. Being concerned over the risk that the good spirit and influence of the students should decline after the move, SUS was asked what could be done. The advice was for DSV to constitute a students' union of its own, and SUS gave two reasons for this suggestion. As a separate students' union, students would have a better position in the cooperation with the institution, as well as better support from SUS.

Against this background, D.I.S.K. was formed in February 1990, D.I.S.K. meaning Students' Union of the Department for Computer and Systems Sciences (“Data- och Systemvetenskapliga Institutionens Studerandes Kårförening”).

This name was in 2002 to be changed simply to DISK. During the first year, the union consisted of the following five sections; the Subject Council, Klubbmästeriet, the Sport Section, the Comfort Section (“Trivselsektionen”) and The Culture Section. In 1991, the Senior Section and the student magazine “Systembladet” were added, and in 1993 a computer section was added. During this time, the Subject Council became a separate organization under the Subject Council of SUS. In 1993/1994, the Comfort Section was shut down and the Section of Trade and Industry (Näringslivssektionen) was formed in 1995. Due to low interest, the Culture Section and the Computer Section were shut down in 2005, and the new section “Särimners Kultingar” was created.

In the first term, approximately eighty members were recruited, next term the number had increased to nearly 100. In 1995, the system for how the students pay their member's fee was simplified, and as a result of this improvement the number of members increased considerably.

Today, the union has approximately 1600 members.

DISK's labour market's day, “Systemvetardagen”, has since it first took place in 1996, been not only one of DISK's most visited arrangements, but also an important source of income. The first year, the labour market's day was organized in collaboration with the institution. The number of companies represented has varied during the years, but in the peak year of 2001, as many as 53 companies participated.

DISK's café at Forum was inaugurated in 2002 by Minister of Defense Björn von Sydow, with pomp and splendour. Until 2005, the café was run by the students, but as a result of irregular opening hours, DISK decided to employ someone to work in the café.

Today, the pub is a central part of DISK's activities, but how has it all evolved during the years? Initially, pub activities arranged by Klubbmästeriet were modest: a crate of beer in a classroom and something to collect the money in. In 1994, the pub (provided that that the previous activities can be called a pub), moved in at the then *Mats Café* at Electrum, a tiny space of approximately 20 square meters. Already at this time, certain lecturers stood out through their presence, and one of them even had a chair reserved in a corner every Wednesday. One year later, the wall to the adjacent DISK room was torn down, and “*Foo Bar*” expanded. Beer was now served in bottles, and if the bar was well-attended, the beer was guaranteed to keep room temperature after seven o'clock in the evening.

Two years later, in 1997, someone came with the idea to tear down another wall, the one facing the adjacent computer hall. The idea was first met with skepticism, yet it remained in everyone's minds, and through significant support from the DSV staff among others, Foo Bar was closed for the massive reconstruction during spring term of 1998. This happened during the heydays of IT, and the café was rebuilt to become a glamorous place with wood paneling on the

walls and oak parquet floor.

The money came partly from external sponsors, but mostly from Stockholm University. Three happy years followed in the new room with parties, students' farces and lots of fun. No one even considered the possibility of running out of money. But the IT industry expanded and DSV did not want to be left behind. Moreover, the staff was cramped for space due to lack of more offices. The move was initiated already during spring 2001, by all major lectures now being held in the Forum building, which was to become the new home of the institution. But when the move was eventually completed, there was no new room available for Foo Bar. After the move to Forum, DISK had no bar for two years. During spring 2003, rooms on the 4th floor at Forum became vacant, and in the summer of 2003 the new Foo Bar was built by active DISK members. Two of those were paid to manage the project. The oak parquet floor was saved in the very last minute from the old pub at Electrum, which had been deserted during this time. The beer fridges were fetched from a storehouse and all things belonging to the bar were dug out from the corners where they had been hidden. The inauguration on August, 29, was a grand party with the Minister of Industry and Commerce Leif Pagrotsky being present.

*Elin Carlsson*

Chairperson 2006

**DISK's Chairpersons ►**



|      |                                                                                       |
|------|---------------------------------------------------------------------------------------|
| 2006 | Elin Carlsson (spring term)                                                           |
| 2005 | Pär Johansson                                                                         |
| 2004 | Emily Rosenqvist                                                                      |
| 2003 | Lars Gunnarsson                                                                       |
| 2002 | Lars Gunnarsson<br>Ida Bohman (Wellner) (autumn term)<br>Camilla Lindström (Jun-Sept) |
| 2001 | Magnus Joelsson (numera Svan) (spring term),                                          |
| 2000 | Anna Kjellgren                                                                        |
| 1999 | Liselotte Kihlstedt                                                                   |
| 1998 | Lisa Leffler-Peura                                                                    |
| 1997 | Johanna Alm                                                                           |
| 1996 | Johanna Alm                                                                           |
| 1995 | Henrik Wiren-Hagelbeck<br>Gunilla Andersson (autumn term)                             |
| 1994 | Jens Johanneson (spring term)<br>Jens Johanneson (autumn term)                        |
| 1993 | Fredrik Svensson (spring term)<br>Fredrik Svensson (autumn term)                      |
| 1992 | Per Ivarsson (spring term)                                                            |
| 1991 | Per Ivarsson                                                                          |
| 1990 | Eva Rosenberg (Öhlén)                                                                 |

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# *Commissioned education*

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At numerous occasions over the years, DSV has been approached with external proposals for educational cooperation. There has been requests from other universities, from organizations, from private and public companies, and many others.

At the Department, there is a defined policy that external and commissioned education may not interfere with basic educational demands. Private and public companies have approached DSV with tempting offers. These possibilities are generally “qualitatively profitable”. DSV is of the opinion that contacts with external partners always are fruitful. Educational cooperation with companies and organizations point at new educational possibilities, and refer to new application areas.

Young universities in less central parts of the country have asked for support, and DSV has been happy to provide such support in numerous educational situations, on graduate as well as undergraduate levels.

In this section it is provided examples of different types of such commissioned education.

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## COMMISSION FROM THE SWEDISH POST – INFORMATICS PROGRAMME

Within the scope of internal education within the Swedish Post, the Post College “Posthögskolan” (Phs), the Swedish Post engaged six colleges of higher learning/universities to compete for a commission as collaboration partner for a new education programme in Informatics.

The tendering procedure was based on the requirements from the Swedish Post, but it was also open for the participants to modify and improve organizing of the Swedish Post. DSV was commissioned to develop and implement the education, which was pursued for six years during the period 1994-1999. During these years, approximately 200 persons were educated. The education commission was connected to the KTH part of DSV, and was the largest one at KTH at the time.

The education included one year of studies, and was equivalent to 50 academic credit points, which meant a higher study pace than regular educations. Studies were pursued at full-time, and participants were free from their regular work tasks during the whole study year.

The participants came from all over the country, and had generally been employed at The Swedish Post for several years. They were qualified students, some of them had a complete academic exam. Irrespective of their formal merits, applicants underwent a selection procedure that included tests as well as interviews, performed by a committee made up of an all-round group of people.

Responsible for development and implementation of the education at DSV was Eduardo Pérez. The education was continually controlled and revised by a management group, consisting of Head of Department Tord Dahl, DSV, Head of PHS Anders Isberg, Gert Persson, The Swedish Post and Eduardo Pérez, DSV. Revision was based on the evaluations submitted by the participants every week, among other things.

### **Purpose and design of the education**

The purpose of the education was to increase competence within the area of informatics for

those who, in their leadership or work role, were affected by and dependent of the development within the IT area. The programme in informatics aimed at developing and preparing the participants for various work tasks as manager, project-, system- or marketing manager, for instance.

PHS-IT discussed the relation between organization, business strategy and information technology. On the basis of an overall perspective on informatics, participants were expected to increase efficiency within administration and production, as well as to connect informatics and the IT-systems to the Swedish Post's goals and business strategies. The goals were:

- to increase knowledge and awareness of IT among participants
- to increase the participant's knowledge of IT and its importance for how the Swedish Post's business and business development could increase, and as a consequence, acquire understanding of the possibilities and difficulties this implies
- for participants to learn how to transfer theory and methods to practical use in current or future work tasks
- that participants, after their examination, should do a better job, be able to take better decisions, and to a larger extent contribute to a more efficient use of IT and IT development within the Swedish Post.

The education was developed in collaboration between DSV and the Swedish Post. Premier international expertise within the areas Work Flow Analysis, IT-Management and Business Process Reengineering was consulted, for example Fernando Flores, Peter Denning and Peter Keen.

Basic goals of the education was to provide knowledge and understanding of

- General and applied systems theory
- Strategic use of IT
- Management and IT-economics
- Post-related topics and project work
- Business- and work processes

- High level systems development
- Communication
- Group communication, IT architecture and decision support
- Modern computer systems architecture
- Information administration, databases
- Human-Computer Interaction, AI, design and cognition
- Security and legal aspects
- Open distributed systems

By using their competence within IT and business activity, participants were expected to act as bridge-builders between purely technical experts, business executives and economists.

The picture below illustrates which courses were part of the education, their scope and their place in time.

**The Swedish Post Informatics Programme**

**T 1**

|   |                                                             |      |
|---|-------------------------------------------------------------|------|
| ① | IT-system, Systems Theory and Cybernetics                   | 3 cr |
| ② | Models and Architectures for Computer and Operating systems | 2 cr |
| ③ | Programming Methodology and Software engineering            | 2 cr |
| ④ | Systems Development and Administration                      | 4 cr |
| ⑤ | Legal Informatics                                           | 2 cr |

**T 2**

|   |                                                        |      |
|---|--------------------------------------------------------|------|
| ① | IT-Management                                          | 4 cr |
| ② | Human-Computer Interaction                             | 4 cr |
| ③ | Project Management                                     |      |
| ④ | Databases, Modelling and Administration of Information | 4 cr |
| ⑤ | Tele Communications                                    | 3 cr |

**T 3**

|   |                                                                   |      |
|---|-------------------------------------------------------------------|------|
| ① | IT - Economy                                                      | 2 cr |
| ② | Information Security                                              | 2 cr |
| ③ | Contracts and Licences, Laws                                      | 2 c  |
| ④ | Group Communication, IT-Architecture and Decision Support Systems | 4 cr |

Project work

Project work, 10 cr

T1 was run from Jan -April, T2 April-September, T3 September - December. The course numbering refers to the course order, after the course name the number of credit points per course is printed. The project work was pursued over the entire year. In connection with the different courses, Postal issues were discussed.

## Planning and implementation of the education

DSV engaged experienced teachers, among those several professors and researchers, for example Peter Seipel, Thomas Falk and Dag Ericsson. International guests such as Peter Denning, Peter Keen and Stafford Beer also contributed, as well as representatives from trade and industry as guest lecturers.

The education was organized and planned so that the participants got a practical experience from "living with advanced IT", thereby learning advantages and disadvantages. This was a project within the project - to study integrated use of different types of IT. As part of the education was also included further development of ideas around regular- and distance education using IT, which lead to the IT platform described in a separate section. The project work of the course participants also aimed at contributing practically to the Swedish Post's reengineering.

Students had access to laptop computers, they became acquainted with and used different types of software such as tools for personal computer

processing, for example word processing, calculating, database management and tools for computer-supported presentations. Lotus Notes was used for communication, The Analyst for systems development, etc. During their period of study they visited different research environments, for example virtual reality environments, and paid educational visits to different companies.

About 60 theses (10 credits) were examined in many different areas, examples are (titles are translated from Swedish):

- The Post Office from a new perspective – A study of workflow methodology
- "Torget" and other players in the World Wide Web
- The Swedish Post in the Internet – the future Customer meeting
- eLetter – a changing service
- Logistic processes in the medicine production industry – a business opportunity for the Post.



The 1997 student group, together for a rowing competition. Eduardo Pérez, responsible for the Informatics program, is second in the first row, seen from the right.

**A few comments from students and assigners:**

*From an interview with Anders Isberg, Swedish Post:*

“Those who take this educational programme shall function as translators in the gap between operational managers and technicians. We are not training technicians, but translators – ‘hybrid managers’.”

*From an interview with Ylva Folin (student):*

“Ylva Folin says she has acquired an entirely new view of life, and broadened her perspective to see possibilities ... ‘You could actually say I see the world with new eyes. This education has certainly stirred my thoughts’.”

*Tatiana Steén (student):*

With her past in the area of systems development projects, Tatiana Steén was one of those who already had some experience from the subject.

“To a large extent, I was self-taught. The Post University gave me the necessary ‘putty’ to join my previous knowledge and experience together.”

“In addition to purely theoretical knowledge, the Post University also gave me a wider perspective and an ability to see things with new eyes.”

**Epilogue**

The education has given DSV good PR, through the attention it has received in media from departments and company managements but also internationally. In many cases, this led to a development of course contents, and to pedagogic ideas through a stimulating dialogue with the Swedish Post's representatives and with the course participants.

The assigners were pleased with the education. In addition to the Informatics Programme, DSV received other commissions from the Swedish Post. Among the two most extensive and most interesting ones was a group of specialist courses and a project to transform the alumni of the Informatics Programme to a competence network. Some of the specialist courses were intensified studies in technical subjects such as Security and Telecommunication, others such as Process Innovation and Business Perspectives on Telecommunication, which were repeated several times, focused on business development.

The commission has also contributed to the development of our education programmes within the MIT/ITM area. This gave DSV the right conditions for the development of an IT platform, which is now installed in two of our lecture rooms at Forum, and which has been used in other commissions and in our regular education.

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## THE GOTLAND PROJECT

In 1989, the SATS program (30 credits plus 10 points of a C-level thesis) was incorporated at the BA in economics program given by different departments of the Stockholm University in Gotland. It became the third and final year of the BA program. The peculiarity of the DSV involvement, mainly due to the scarcity of lecturers and time resources, was that the educational program was given simultaneously to the DSV students in Kista and the Gotland students in Visby. The first year, this was done through the use of an off-the-shelf video conferencing system (GPT). Already in the second year, the video conferencing system and the room design were radically transformed.

The program began as a biannual program enrolling 30 students. However, more than one thousand students postulated to thirty places in the second year. This led the authorities to run

the program annually. At the same time, the number of students was augmented to fifty. The success of the program led the authorities of the Stockholm University to accept this BA as an official program of the University.

The number of students enrolled was successively increased to 60 and finally 80 students in the program. However, from 1995 onwards two programs were given simultaneously. Out of a total of about 600, the average number of annual students in the DSV programs was about one hundred and twenty five (125). The students were satisfied with the content, the pedagogy and the technology.

In 1998, the university studies given at Gotland were transformed to *The Gotland College of Higher Education*. The collaboration between DSV and Gotland around this program finished in 2002.

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## THE SÖDERTÖRN PROJECT

In 1997, the Swedish Parliament decided to create a third university (in Södertörn) in the Great Stockholm area and asked for collaboration with the other Universities in the region. Due to the pedagogical concept (shared and distributed education), the experiences of almost 10 years with Gotland and the level of development of the technical platform, DSV was able to offer Södertörn the possibility of sharing the IT-Management education with our own students in Kista and the students in Gotland.

Södertörn decided to combine the DSV course with courses from their own business school, to offer the courses Management with IT (MIT) with an annual enrollment of 80 students.

In this way, the same educational program was shared by about 200 students at the same time. The collaboration with Södertörn allowed them, using own and other's resources, to start a new career immediately, as soon as the technology was deployed.

This allowed, for the first time, to test the model and the prototype with three groups in the network. The program worked and the students were satisfied. The contents, the pedagogy and the technology were, like in Gotland, also accepted.

This collaboration was finished in 2004.

## SECURITY INFORMATICS COURSE FOR THE COUNTY LABOUR BOARD

In 2003, a group of 20 unemployed academics, mostly engineers and software developers, were offered a course including project work of 30 weeks' duration, organized by the Department on behalf of the County's Labour Board, through Success AB (Stockholm University Centre for Continuing Education and Study Services). 20 weeks were used for course work in Security Informatics, while 10 weeks were conducted as individual industrial projects. Apart from participating in the general undergraduate

education, members of the group were also provided with one course solely for them, special seminars preparing them for the industrial projects, their own laptops to be used during the full 30 weeks of courses and work and a project advisor at DSV. Software for security experts was provided by Symantec. After the course, several members of the group were re-employed, some within their own previous fields and some within information security.

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## MASTERS DEGREE IN INFORMATION AND COMMUNICATION SYSTEMS SECURITY

**at the University College Gjøvik, Norway.**

In May 2002, DSV was commissioned by KTH to aid the University College Gjøvik in Norway in their efforts to obtain the full rights of a research-oriented higher education department in ICT security. KTH had taken on to aid the Norwegian College in research areas already existing at KTH; the DSV part contained quality assurance of a two-year Master Program, its content, courses and theses work. An almost identical study plan for a Master Program at KTH was developed by Louise Yngström, inspired by the Norwegian study plan and DSV's own educational experiences including the collaborations within the SOKRATES / ERASMUS ICP's in Information Security during the 1990s.

Students from Gjøvik and KTH would be able to exchange courses and collaborate within projects, but mainly the courses at the first year would be taken at the home university. All master thesis projects were examined by KTH personnel – Louise Yngström – and the students' final degrees were issued by KTH. The agreement between Gjøvik and KTH was finished when Gjøvik reached the goal of getting their own rights to issue master degrees in information security. The two year Master Program became the template of the international KTH master program in Information and Communication Systems Security, ICSS, 60 credits starting in 2003/04, and from 2006/07 extended into a full 80 credits Master.

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# *Adult education*

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## ADULT EDUCATION – Flexible availability

Already one year after the academic education had started, demands arrived from active professionals to be able to pursue their studies in parallel to their work. To comply with this demand in the Stockholm area, a basic course for 20 credits was offered in the evenings. The evening courses are still running, and the number of students who have completed this course can now be counted in thousands.

By the end of the 1960s and the beginning of the 1970s, the Department was the only one in the country to offer academic education in what was then called Information Processing – Administrative Data Processing. Requests and demands for in-service training and continued education poured in from Kiruna in the north to Växjö in the south. Professor Langefors considered that these needs should be satisfied if possible. As the only academic department in the country there was need to take social and national responsibilities to ensure that education was offered wherever the local conditions were satisfactory. The director of studies at that time, Tord Dahl, was commissioned to organize and administrate the "national" in-service training and continued education, under condition that the regular education at KTH and SU was not disturbed. The target group for the education was active professionals in the business world and in the public sector. Many companies wanted the education to be exclusive, with themselves as assigners. However, there were also many employees who realized that such education could become important knowledge in their professional work. Their employers was of a different opinion, but the employees still wanted to participate and were willing to pay for the education with their own private money. To provide an opportunity to participate also for these people, the education was implemented in co-operation with the national adult educational associations TBV, ABF and a few others.

The adult educational associations had a lot of experience from previous work in administrating academic courses. Moreover, and equally

important, they had government subsidies for these courses, which resulted in a reasonable course fee for those who financed their studies with their own money. Due to the lack of qualified teachers, and the demand not to disturb the regular education, courses were taught on Friday evenings, on Saturdays and on Sundays, by teachers at the department who regularly were responsible for the particular course module. In that way, the education was guaranteed the same quality as the regular education at the department.

The first course started in 1968 in Kiruna, with most participants coming from LKAB. Shortly thereafter other places in the country followed, for example Linköping, Västerås, Borlänge, Eskilstuna, Umeå, Visby and Gävle, as well as several municipalities within the county of Stockholm. Between two and four courses of 20 credits were carried out each year, until it all ceased in the middle of the 80s. More than a thousand people were trained in Information Processing – Administrative Data Processing as a result of this work. These activities ceased for several reasons. Most important was probably the fact that the government subsidies for academic education to the adult educational associations stopped, and that new universities and colleges of higher learning which could take over responsibility for the education had been established.

Normally, a study group consisted of 25-30 participants. Teaching usually took place during 8-12 hours every second weekend, and a course of 20 credits took one year to complete. It is no exaggeration to say that the study group in most cases was heterogeneous, seen from all perspectives. There were people from all levels, economists, technicians, programmers and system developers. Their educational background varied from academic undergraduate degrees to nine-year compulsory school. Many of them were experienced programmers and system designers, others had no experience at all from using computers.

The teachers often faced a great pedagogical challenge in manoeuvring the discussions that came up as a result of these differences among the course participants. But most problems found their solution in one way or another, and as the course progressed, the differing previous knowledge of the participants proved to be an advantage when solving programming- and systems tasks, for example. Economists, programmers and systems designers learned to benefit from each other's competences in their learning. Even teachers, who sometimes had not seen much of the so-called reality, got a good insight in what was going on out there.

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Teachers as well as the Department made many friends through these educational activities, friends who later reached prominent positions in society, and who have expressed their gratitude for the efforts in various ways.

Those engaged in these educational activities consider them as an important effort in academic adult education, an effort that lasted for more than fifteen years, while the subject field was still young. The teachers involved still take a certain pride for the efforts, even though more than twenty years have passed since the programme ceased, and more than forty years since it started.

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## **The distributed course in Computing knowledge**

Utbildningsradion/Liber and teachers from five other universities developed the university course Computing Knowledge ("Datakunskap"), 10 credits. To this course, textbooks and laboratory experiments were developed. The course was offered as a distributed course on radio and TV, while laboratory experiments and examination were carried out locally at the respective seats of learning. 30 000 persons registered for the course, which was offered during the period 1985-1990.



The first of the 16 textbooks in Datakunskap.

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# *Graduate education*

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# GRADUATE EDUCATION

## Background and historical setting

Being a young department in a new scientific area, there were no research traditions to fall back upon. Nor was there a clear view on research and graduate education. During the 1960's these issues were debated in society to finally end up in the reform of 1969. Before that, rules and regulations were mostly from the 19th century and even when the new reform was passed in 1969 <sup>1</sup> it took some time for academic institutions to follow in practise. The Licentiate degree (also from the 19th century) was for a long time argued to be a middle examination – and in the 60's it still took around four years. The Doctorate following was the project of your lifetime. The Licentiate was formally taken away in 1973, to re-appear as a possibility during the 1980's <sup>2</sup> but then only as a first part of the graduate program to be followed by or included in a PhD within the same scientific area.

Qualifications for the PhD degree were at the same time moving towards a less lifetime project. In 1998, the latest Act influencing the graduate program came. All throughout, changes in the scientific area and Acts directing the process, study plans at KTH and Stockholm University developed. <sup>3</sup> Typically, the Faculties involved <sup>4</sup> directed the budget allocated for graduate studies including professors and decided on issues such as study plans, admittance, examination, etc according to legal regulations. The following text interprets our work following these changes in the department.

## Graduate education in the 70's

During the late sixties “the old graduate education system” was effective. It contained two academic degrees: the Licentiate degree and the

Doctors degree. Both degrees were suffixed by the topic area of the degree, e.g. Licentiate of Technology, Doctor of Philosophy, Doctor of Economy, etc.

The Licentiate degree studies lasted approximately two to four years <sup>5</sup>. It included a major and a minor part. The major part was producing and defending the licentiate thesis. The defending was done in a licentiate seminar, where an external examiner acted as the opponent. The major part could also include examination of a literature course, typically a number of books to read and to report about. The minor part was studies in another, related discipline. It could be a literature course or it could be writing of a report about a delimited problem that implied literature search and reporting. The licentiate degree examination could be given the “grade” pass or fail or it could be given a number up to seven (typically in technical universities). The grade was determined by the main examiner, normally the professor of the department.

The Doctor's degree in the old system was quite another matter. Unlike the more well-structured, disciplined and delimited 4-5 year PhD educational processes of today, writing a doctors thesis in the old system was “the individual work of your life-time”. The quality requirement was that a scientific thesis should report original and significant new knowledge, not published before. The time to produce a doctoral thesis could take many years. A thesis in our topic was, typically, a thick book of many hundreds of pages. It was not unusual that thesis defenders at dissertations were middle-aged, most often, men <sup>6</sup>. Most often, a PhD degree examination consisted only of the dissertation, no other course examinations were needed.

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<sup>1</sup> Prop 1969:31 om forskarutbildning och forskarkarriär mm

<sup>2</sup> The Andrén'ska utredningen 1979, followed by several propositions regarding the graduate education, here Prop 1981/82:106 Utbildningsutskottets betänkande 1981/82:UbU37 om forskning mm.

<sup>3</sup> An overview of changes in graduate programs due to Society's increased interest, directions and acts are found in SOU 2004:27 Bilaga 5 “Forskarutbildningens förändring - en översikt”.

<sup>4</sup> For Stockholm University the Faculty of Social Sciences, for KTH the Section for Technical Physics.

<sup>5</sup> Therefore and “old” Licentiate degree is often interpreted as being equal to a “new” PhD degree.

<sup>6</sup> The first woman to be awarded a doctorate in our topic was Eva Lindencrona. She defended her in 1979 at Chalmers University of Technology.

The dissertation itself was a very formal event. The respondent as well as the three (sic!) opponents all wore black ties.

When our department started to become interested in graduate education, around 1969/70, also the requirements for a PhD degree were changed and the whole process was made considerably less complex. A “new system” was introduced. A PhD thesis should no longer be “the work of your lifetime”, but rather the first milestone in a researcher’s career. Much less thick “theses books” were now anticipated. The quality requirement of a thesis was expressed as – it should have the quality that it could be the basis of a paper acceptable in an international journal of good reputation. There were no longer three opponents but only one. The dissertations became much less formal. In the beginning <sup>7</sup>, the grade, pass or fail, was decided by the examiner, normally the professor of the department, after consultations with the opponent. The dress code was not black ties any longer.

### **Early supervision and PhD courses**

Graduate education at our department started during the very late 60’s by a number of higher D-level courses. We did not have a system of a number of course credits to be included in your PhD exam. The courses were provided mainly to extend your knowledge and horizon and to help students to find a feasible topic for their thesis work.

Who were presenting these courses? It was first of all Langefors, who was lecturing on topics related to control of businesses and organisations by the use of information and information systems. But courses were offered also by young teachers at DSV who, at this stage, had no PhD degree. Mats Lundeberg was lecturing on the ISAC approach, Tomas Ohlin and Janis Bubenko lecturing on Operating Systems, Bubenko lecturing on Modelling and Associative Data Bases, Performance analysis by simulation, Markov processes, etc. At the same time, these young teachers were working towards their own PhD theses. They all had one and the

same thesis advisor: Börje Langefors. None of them had any PhD scholarship. The thesis production had to be done in their “free time”, normally during nights. This was a very hectic and turbulent period. The graduate education did not follow any particular system or procedure, but all candidates were enthusiastic about their work. Nothing could stop them.

Some of the early PhD’s were Kristo Ivanov, Janis Bubenko, Bo Sundgren, Mats Lundeberg, and Rolf Høyer. Their thesis supervisor had been Börje Langefors. Bubenko and Lundeberg remained at the department and became active in the role of supervising new PhD candidates. Ivanov and Høyer moved to other universities and continued supervision there. Sundgren, working at SCB, stimulated his colleagues to take part in DSV’s graduate education.

### **Financing**

No PhD grants or PhD “tenures” (doktorandtjänster) existed for financing the graduate studies at this time. If there were no research project grants available that could be used for the topic of the thesis, the thesis production had to be done in the students’ available free time. On the other hand, most PhD candidates at this time were employed as teaching assistants. As the teaching workload was, most often, not very large, the remaining time could be used for PhD studies.

### **Graduate education during the 80’s and the early 90’s**

At the end of the seventies, 67 students were enrolled as PhD or Licentiate candidates. 18 of them were registered at KTH, and 49 at Stockholm University. Quite a few of them, perhaps about 50%, later got jobs in business, industry or in the official sector, and left the department. Their intention were to continue to pursue an academic degree, but very few managed to manage both a job and academic studies at the same time.

The process of graduate education during the eighties followed the same pattern as during the

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<sup>7</sup> Several years later the graduation committee of three or five examiners was introduced. All members of this committee should have the academic degree of Docent or Professor.

seventies. By this we mean that

- Supervision was still a problem, a few advisors had too many students each to supervise
- Completing a doctoral thesis was a very individual matter. Financing was a problem and thesis work had in many cases to be done after working hours
- The graduate level courses offered by the department were scarce. Much of the “collective” teaching was organised by the students themselves, e.g. by forming special study groups and “circles”.

The following table shows the total number of Licentiates and the total number of doctorates awarded in a period until 1999 at KTH and at Stockholm University (SU); the number of women indicated within brackets.

| Type of degree   | Until 1979 | 1980-1989 | 1990-1999 |
|------------------|------------|-----------|-----------|
| Doctorates, KTH  | 7          | 9         | 16 (3)    |
| Doctorates, SU   | 5          | 3         | 23 (4)    |
| Licentiates, KTH | 3          | 1         | 13 (3)    |
| Licentiates, SU  | 5 (1)      | 2         | 40 (5)    |

Emanating from DSV, the first female licentiate was Anita Kollerbaure (1973), and the first female PhD was Eva Lindencrona (1979).

We can see that the “production rate” of doctorates was slightly more than one per year until the nineties. During the nineties the rate grew to about four per year. This can be attributed not only to the increase of the number of supervisors widening the research areas possible for PhD candidates, but also to increased attention and focus on the processes involved in a “PhD education” leading gradually to a more formalised and organised approach.

The process of pursuing a doctoral degree got a firmer structure at the end of the 1980s. A PhD degree was “designed” as a four-year education plan consisting of 160 credits, i.e. 40 credits per year. At our department a thesis was assigned 100 credits and individual courses at the graduate level were assigned 60 credits. 15 out of the 60 course credits were mandatory courses in general scientific method and communication topics that

all candidates had to pass. Towards the end of this period also the financial side of PhD studies improved. A (very) limited number of “scholarships” became available and assigned to students of the department by the university authorities. The assigned scholarships were re-evaluated each year, and students with an unsatisfactory performance were stopped. It should be added that PhD studies for several candidates were partly financed by them being members of some of the research laboratories SYSLAB, PRINCESS/CLEA, K2LAB or SECLab at the department, or employees of the newly formed research institutes SICS or SISU in Kista. On the whole, the relationship between DSV and the above research institutes developed well and produced a considerable number of degrees.

### **Towards a more formal structure of the graduate program**

Before 1997, all matters of the graduate education were formally dealt with at the DSV Board, implemented by supervisors. The research labs included researchers, supervisors and eventually also PhD candidates. In order to stimulate and improve the whole graduate program including linking the PhD students’ research closer to research in the laboratories, a Research Education Committee consisting of all supervisors was established in the department, and a study director of PhD programme was initiated during 1995-97. Roles and responsibilities between the Committee, the Chair of the Committee, the Heads of the research laboratories, Supervisors, the Study director, the Research secretary, the Dean and the Board were defined. In particular, the important tasks in reference to research and the graduate education of the Committee were expressed as to

- Suggest formulation of policies of more general implications
- Formulate policies for admittance and exclusion of candidates
- Evaluate and suggest admittance of new candidates
- Establish an annual budget for courses on suggestions from the study director
- Take charge of quality assurance of theses

including forming models for quality assurance of the program

- Suggest how to use the so-called “non-fixed part”<sup>8</sup> of the graduate budget
- Decide on revision of DSV’s graduate programs<sup>9</sup>
- Deal with overall problems to ensure similar treatments over the department

Members of the Committee were all supervisors and secondary supervisors. In addition the Dean, the Study director and the Research secretary were allowed to participate in the three annual meetings stipulated.

In 1997, this model was formalised; the Board for Graduate Education, FUN, and the Research Collegium, FUK, were established by the Board of DSV, with FUN being the decision body<sup>10</sup> while FUK discussed and prepared the issues. FUK consisted of all DSV employed and appointed supervisors and secondary supervisors; FUN consisted of three members of FUK together with the Dean and the PhD candidate elected for the Board. Members of FUK and FUN’s chair were elected by the Board for two years on suggestion from FUK.

FUN was stipulated to deal and decide in all matters concerning the graduate education. In particular important issues were

- Admittance and exclusion of candidates
- Establishment of the budget for research and graduate programme
- Take charge of quality assurance of theses and develop quality assurance procedures for the graduate program
- Work for refinements, changes and extensions in plans for the graduate program

At annual Committee, later FUK, meetings the graduate program including issues such as courses, supervision, research directions, admittance, financing, etc were thoroughly debated and discussed, leading to much wider attention, interest and knowledge of processes involved in the graduate education. Somewhat

later also the PhD students formed their own body, Doktorandrådet, DR, which involved the PhD candidates into all processes of the program, including planning for the future. An annual ‘doctoral candidate day’ was introduced in 1997 as a forum focussing in particular the students’ view – the day included presentations and discussions between candidates and supervisors on matters such as “how to succeed with a licentiate/PhD final seminar”, “criteria for a good supervisor”, “hidden cultural rules in academic environments”, “one-year after dissertation – what could the degree be used for?”, “evaluations of the education”, “post-doc possibilities”, etc.

### **Graduate education after 1998**

On April 1, 1998 the new PhD education Act was enforced stating in principle that each PhD candidate/student should be fully funded to pursue a PhD education. In total, the education should be finished after four years of full-time studies, but it was also allowed to do teaching or other departmental duties on 20% time, extending the time for a PhD up to five years. Minimum time should be eight years, i.e. a 50% study time. Funding was mainly provided through the Faculty Research budget – stipulating certain percentages solely to be used for PhD grants or PhD “tenures” (doktorandtjänst) – but also external research funds were used for tenuring PhD students.

The study plans for DSV’s graduate program were from the beginning specified for a Doctorate (and a Licentiate) in Computer and Systems Sciences either at KTH or SU. In 2000, the graduate program was amended with a study plan for the research area Man Machine Interaction at Stockholm University, facilitating also for candidates with backgrounds such as humanities, cognitive sciences, medicine or communication sciences to enter the PhD program at DSV. All three programs include the mandatory courses Theory of Science,

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<sup>8</sup> The budget from the Faculties, Stockholm University Social Science Faculty as well as KTH ? Faculty, stipulated fixed parts for funding Professors and PhD students, but the remaining part was freely allocatable within research and graduate program.

<sup>9</sup> At the time two: one in Computer and Systems Sciences at KTH, one in Computer and Systems Sciences at SU.

<sup>10</sup> Delegated from the DSV Board.

Research Methodology and Scientific Communication, while further courses are chosen within a wide range of D-level or PhD specific courses to support the specific area of research the candidate is pursuing. Courses are offered by the department, by arrangements between various Research Schools and Consortia including also other national and international research collaborations .

In addition to “regular PhD students” being admitted to the program, DSV has commitments with other universities in Sweden whose teachers through grants for PhD studies pursue their education with DSV, as well as SIDA promoting developing countries’ selected university teachers to do the same . In addition, DSV has a few industrial PhD candidates where their companies fund the studies. The ca 70-90 active PhD students each has a main supervisor and belongs to one of the laboratories/units. Each unit has a local graduate program coordinator to aid the supervisors; this way the Study director and the Research secretary can support and supervise the program processes more generally than before . In addition, the roles of FUK is today filled by the group of Senior Researchers.

PhD theses and degrees today (2006) are no longer the end of a career but rather indications that the awardee is competent of doing research in a modern environment. Naturally, this has changed a lot of the processes and assessments involved in the graduate program; most PhD theses are compiled from published papers at conferences and journals, often with additional authors such as the supervisor and fellow research candidates – this way preparing the candidate for contemporary ways of collaborative research. Prior to the final examination seminar various forms of internal DSV seminars have scrutinized the Thesis for quality assurance.

The supervisor is no longer the examiner; rules for the formal examination include one opponent, a distinguished external academic within the field of the Thesis, and a Grading Committee consisting of three to five Professors or Docents. The final grade is still Pass or Fail.

The following table shows the number of Licentiates and Doctorates awarded during 2000 – 2005; the number of women indicated within brackets.

| Type of degree | 2000 - 2005 |        |
|----------------|-------------|--------|
| Doctorates,    | KTH         | 11(2)  |
| Doctorates,    | SE          | 16(9)  |
| Licentiates,   | KTH         | 6(2)   |
| Licentiates,   | SU          | 31(15) |

As communicated through above table, women now constitute a more significant part of the PhD awardees. As compared to the numbers of awarded PhD and Licentiate degrees 1971- 1999, during the past six years, 2000 -2005, 32% of all DSV PhD degrees and 40% of all DSV Licentiate degrees were passed. When it comes to the female part, 61% of all women being awarded PhD degrees and 65% of all women being awarded Licentiate degrees happened during the last six years.

Within the Bologna process there are bound to be changes and future challenges for the PhD education in order to keep up with DSV’s goals as specified as Demands and Indications for: *recruitment, theses, supervisors, financing, courses, quality assurance, post-doc activities, equal opportunities and internationalisation* in the Long-term Development Plan, Utvecklingsplan för DSV 2006-2010, Prefektens samrådsgrupp, Fastställt av styrelsen 2006-03-07.



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## *International contacts and cooperation*

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# INTERNATIONAL CONTACTS AND COOPERATION

## Background

During the seventies, international cooperation<sup>1</sup> was limited and consisted mainly of visits to DSV by recognised scientists and of visits made by DSV personnel to international conferences and centres. For instance, Börje Langefors spent half a year at Purdue University, USA, while Janis Bubenko jr, Stig Berild and Lars Kahn each spent one year at IBM Research in the USA. Anita Kollerbaur spent a period at Xerox Parc. We should also mention international collaboration within the sphere of IFIP's Technical committees TC2 (WG 2.6, 2.9), TC3 (WG 3.2), TC8 (WG 8.1, 8.3) and TC9 (WG 9.7) where DSV's personnel have been, and normally still are active. In fact, the first chair of TC8 was Börje Langefors. A number of working conferences were arranged by IFIP Working Groups WG2.6, WG3.2, WG8.1, and WG8.3 where DSV personnel played significant roles. DSV personnel also participated in a project run by TC3, WG 3.2 and developed a comprehensive curriculum for system analysts and designers (edited by R. Buckingham in 1974).

Below we enlight such international relations and contacts that have not been enlightened earlier in this book.

## EU-projects

Collaboration with international partners and with an objective to produce concrete research results, started first in the middle/late eighties when Swedish groups were permitted to take part in larger international research programs<sup>2</sup> supported by the European Union. Sweden belonged then to the European Economic Area (EEA). Other countries in EEA were, among

others, Norway and Austria. Starting with the 2nd Framework Programme research groups and companies from EEA could participate, at their own expense, in EU-supported projects. In Sweden, the cost of this participation was supported also by NUTEK (formerly STU).

In the beginning, i.e. around 1986, knowledge in Sweden about the possibility to take part in an EU-supported research project was almost non-existent. Janis Bubenko<sup>3</sup> still remembers that he and two other Swedes, one from Ericsson, the other being Dan André, later a coordinator of Swedish activities in the EU Framework programmes, were the only Swedish participants in a "proposer's day"<sup>4</sup> in Brussels in 1997. Brussels was full of Englishmen, Germans, Dutch, and Frenchmen looking for international partners in project consortia. Very few Scandinavians were at hand.

These meetings in Brussels resulted in a number of project consortia and proposals where SISU/DSV was a partner. Initially, about less than half of the proposals became accepted for funding. An EU Framework project consists typically of 4 - 10 partners. Partners from business and industry were mandatory. One of the industry partners normally became the "contractor" while university partners played roles as associated partners to some of the business and industry partners. In the beginning of the Framework programmes, the size of a project could be quite large - 50 to 150 person years during a period of 3 to 5 years. Later, in the nineties, the projects became not only smaller and shorter (20 - 30 person years during 18 - 24 months) but also significantly more oriented towards practical, exploitable results.

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<sup>1</sup> Nordic cooperation is described in a special section.

<sup>2</sup> Some projects where DSV and SISU personnel participated are also described in Benkt Wanglers paper "Some EU projects at DSV and SISU".

<sup>3</sup> Bubenko then represented mainly SISU, but the projects were later staffed with researchers both from DSV and from SISU. SISU, being a research institute, was normally a more accepted participant in a consortium, otherwise flooded with many university partners. The EC was not too fond of having more university than business and industry partners in a consortium.

<sup>4</sup> At a proposers day the European Commission presented research themes of the next framework programme and there was a possibility to meet possible partners and to start forming of project consortia for preparation of project proposals.

In any case, the time after 1987 and during the nineties became quite EU-project “intense” for many researchers both at DSV and at SISU. A considerable number of projects were launched with participation from SISU and/or DSV. KIWIS, TEMPORA, NATURE, ORES, ELEKTRA, HYPERBANK, HYPERKNOWLEDGE, Asia eBIT, HUCE, HUMAINE (NoE), Web4Groups, SELECT, SeniorOnline, SALUT, and Web4Health/KOM2002 are some projects in which personnel from DSV has taken part.

Participation in these projects gave Swedish researchers as well as people from business and industry invaluable experience, theoretically, technically as well as socially. Most European Union countries were visited. The cooperation resulted not only in tangible product prototypes, but also in a large number of co-authored research papers in journals and conferences, as well as in licentiate and doctoral theses. Also new companies were formed.

### Projects with developing countries

ICT is by many considered to offer developing countries to shorten or even to skip many development phases towards a richer and more just society. Since 1998 has DSV had a considerable engagement in different projects in the third world, primarily in Mozambique, Tanzania, Uganda, Sri Lanka, Ethiopia, Burkina Faso and Vietnam. These projects are and have been financed by SIDA (Sweden) as well as by the European Union. The purpose of these projects has been to support and further develop their infrastructure as well as to increase the competence in IT-departments and centres. Many universities have been supplied with new and modern computer systems and networks. About fifty PhD candidates are pursuing their degrees within these projects.



DSV together with Vattenfall (VF) in a workshop of the ELEKTRA project, 1998. From left: Per Burman VF, Christer Nellborn DSV, Janis Stirna DSV, Danny Brash DSV, Kurt Wedin VF, and Annika Bergenheim, VF.

## NORDIC COOPERATION

Over the years, the Department has been happy to be able to stay in close contact with many scientific representatives from the Nordic countries. There has been connections on numerous scientific projects and organizational events. A few examples are given below.

### **SCIP – Scandinavian Information Processing project.**

Thanks to an initiative by Börje Langefors and Arne Sølvberg, and a grant from NORDFORSK (Scandinavian Council for Applied Research), the first Nordic cooperative project in the field of information systems started in 1969. The idea was to bring together groups that already were doing research in the topic area of Information Systems, and to enhance this work by frequent meetings and exchange of results. The initiative was named SCIP – Scandinavian Information Processing project. Groups and persons that participated in SCIP were (ref. (Lindgreen 2003) ):

**SYSKON** – a project concerning System Development, headed by Christian Andersen, Institute of Management, University of Århus. Participants: Fritz Krogh-Jespersen and Anders Petersen.

**Project NO**, Participants: Ole Øhlenschläger Madsen and Niels Jørgen Relsted, both from Institute of Management, University of Århus.

**DATAMATICS and INFORMATICS**: Poul Sveistrup, University of Copenhagen.

**Exact Description of DATamatic Problems (EDDAP)**: Paul Lindgreen and Flemming Sylvest Pedersen, both from A/S Regnecentralen Copenhagen

**DIFO - Design of Information systems, especially File Organization**: Pertti Järvinen and Hannu Kangassalo, Department of Computer Science, University of Tampere.

**CASCADE**: Headed by Arne Sølvberg. Participants Per Aanstad and Geir Skylstad all from Computing Center, NTH, Trondheim.

### **CADIS - Computer-Aided Design of Information Systems.**

Headed by Janis Bubenko jr.  
Participants: Stig Berild, Olle Källhammer, Eva Lindencrona and Jompa Johansson, all from Dep. of Information Processing, Royal Institute of Technology, Stockholm.

**The specification of formal information systems for administrative control**: E. Torsten Lundquist, Departement of Development, KemaData AB, Stockholm.

### **The development of a computerized real-time documentation system applying computer graphics as a means for interaction:**

headed by Hans E. Andersin. Participants: Kristel Siro and Markku Syrjänen, all from Institutionen för Informationsbehandlingslära, Tekniska Högskolan, Helsinki.

It should also be mentioned that fil.cand.

Ann-Kristin Wentzel from NORDFORSK served as a perfect host for most of the SCIP-sessions at the different sites in Scandinavia where there were meetings and seminars. The most significant meeting was a conference held in SCANTICON, Aarhus, Denmark, 1971, SCIP as well as non-SCIP, attending. This event also produced a book (Bubenko jr., Langefors et al. 1971) published by Studentlitteratur, Sweden.

### **Life after SCIP**

Limited Nordic projects in the area of Information Systems followed after SCIP. A few workshops were financed by Nordforsk, however. In any case, it seems safe to say that SCIP was indeed instrumental concerning development of approaches, methods and tools for business and information system development in the Nordic countries. Practically all of the individual projects listed above continued growing. They developed and published many new ideas, methods, and tools. Additional groups and research directions came into being. Consulting companies adopted some of the ideas and methods as well. Internationally this “movement” is called the Scandinavian School of systems development (see also a description of this school

in (Iivari 2003)). Much of the results were presented at the annual Nordic conferences NordSAM and NordDATA, as well as at international conferences and journals.

Later, during the eighties, Nordic cooperation on research in information systems gradually faded out. This was primarily to, we think, the establishment of the European Union and its research funding program ESPRIT. The Danes became early members of EU and, consequently, directed most of their research activities towards the other early members of the union. The Nordic conferences NordSAM and NordDATA did not continue in the late eighties. At the same time, however, Swedish partners, as Sweden was a member of EFTA, were permitted to join EU-based research projects at their own cost (then sponsored by NUTEK). DSV and SISU were some of the first in Sweden to exploit this new possibility.

### **The new century**

The closest collaboration among Nordic partners is nowadays done within projects supported by the European Union. However, DSV does participate in a Nordic project with the name TvärSök. The objective of the project is to design an inter-lingual search engine, to be used on web

sites that comprise information in all the Nordic languages. The team includes scholars from Stockholm University and KTH, together with colleagues from the universities of Oslo, Bergen, Copenhagen, Helsinki and Reykjavik (Iceland). The project will be running during 2005-2006.

The project aims to facilitate facts finding in the neighbour idioms among Nordic citizens. Here, language and conceptual problems are addressed.

### **References**

- Bubenko jr., J. A., B. Langefors and A. Sölvberg, Eds. (1971). Computer Aided Information Systems Analysis and Design. Lund, Sweden, Studentlitteratur.
- Iivari, J. (2003). Is Scandinavian information systems development becoming passé? History of Nordic Computing (IFIP WG 9.7 First Working Conference on the History of Nordic Computing (HiNC-1), June 16 - 18, Trondheim, Norway. J. A. Bubenko jr., J. Impagliazzo and A. Sölvberg, Springer: 339 - 356.
- Lindgreen, P. (2003). SCIP: A Scandinavian project on systems analysis and design. History of Nordic Computing (IFIP WG 9.7 First Working Conference on the History of Nordic Computing (HiNC-1), June 16 - 18, Trondheim, Norway. J. A. Bubenko jr., J. Impagliazzo and A. Sölvberg, Springer: 327 - 338.
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## CONFERENCES AND WORKSHOPS

where DSV has played a significant role in starting and/or arranging them

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### Nordic conferences and workshops during the seventies

The main event of the NORDFORSK-sponsored SCIP project took place in 1971 in Scanticon, Aarhus, Denmark. 11 papers were presented and discussed in a three-day workshop, attended by about 60 persons, many from business and industry. The workshop papers are collected in a book, "Computer Aided Information Systems Analysis and Design", published by Studentlitteratur. Each paper is concluded by a documented question – answer section.

In 1975, NORDFORSK sponsored a Scandinavian Workshop on Data Base Schema Design and Evaluation in Røros, Norway.

Proceedings were edited by Janis Bubenko Jr and Arne Sölvberg. The workshop was attended by about thirty researchers. Professor Daniel Teichroew, University of Michigan, Ann-Arbot, showed how his doctoral student Jay Nunamaker had exploited Langefors' ideas about construction of information systems (elementary messages, file consolidation and process grouping), and developed one of the first computer based tools to support the construction process. DSV was represented in this activity primarily by the CADIS group.

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### The SPOT conference series (1982, -83, -84)

The Systems Development Laboratory (SYSLAB) launched three annual conferences named SPOT (Systemutveckling i Praktik Och Teori) with a number of invited speakers both from Swedish business and industry as well as from international research centres. Peder Brandt of SYSLAB acted as the main organising chair. The SPOT conferences were attended by more than 150 delegates. International speakers at the SPOT conferences included Gordon B. Davis,

USA, Enid Mumford, Manchester, UK, Hans-Jochen Schneider, Technical University of Berlin, West Germany, Raymond Yeh, USA, S. Bing Yao, USA, and Michael Brodie, USA. The conference series provided DSV with a good network of contacts with business and industry as well as with internationally well reputed scientists in the area of data bases and information systems.

## Very Large Data Bases 1985

The VLDB series of conferences was started 1975 in Framingham, Massachusetts. The main motivation for having a special conference for “very large” data bases was the introduction of powerful disk-based storage devices for direct access. The capacity of one such device was about 25 Megabytes. This created a need to develop technology and methods how to structure, store, access, and manipulate large amounts of data. Consequently, many of the papers presented at VLDB dealt with data modelling, structuring, and access, as well as with performance issues such as access technology and query processing. VLDB was held annually in the months of August - September. Later VLDB formed an Endowment, consisting of 21 trustees. The Endowment was responsible for the financial continuity of VLDB and for selecting sites for future conferences. The number of attendees of a VLDB conference was about 600 - 800. The proceedings were initially published by Morgan Kaufmann. Typically about 35 - 45 papers were accepted. The acceptance ratio was about 20%. Janis Bubenko Jr.<sup>1</sup> was appointed co-program

chair for VLDB’78 in Berlin (together with S. Bing Yao). Perhaps this led to that later SYSLAB proposed to arrange the conference in 1985 in Stockholm. The proposal was accepted by the Endowment. Alain Pirotte and Yannis Vassiliou were appointed program co-chairs. Lars Söderlund acted as the organising chair. The key-note speech was given by Gösta Lindberg, Director of technology at Ericsson Telecom. Most SYSLAB members and many DSV students took part in carrying through all administrative matters such as registration, running sessions, etc. It should be fair to say that VLDB significantly stimulated data base research within SYSLAB and SISU. Data modelling, conceptual modelling, object oriented approaches, as well as distributed database systems were important research topics in the 80ies at SYSLAB and at SISU. The VLDB conference in Stockholm, held in the Grand Hotel, was a great success. It did attract a record attendance of more than 800 delegates. Many people from business and industry attended the conference.

### VLDB’85 dinner banquet at Grand Hotel, Stockholm.

On stage, the organising chair Lars Söderlund, SYSLAB, and the balalaika orchestra “Kazbek”.



<sup>1</sup> Janis Bubenko Jr was elected vice-chair of the VLDB Endowment 1986 - 1989, and chair of the Endowment during 1990 - 1993.

## The CAiSE conference series

The first Conference on Advanced information Systems Engineering, CAiSE'89, was arranged in end of May, 1989 by SISU, supported by SYSLAB and DSV. The aim of CAiSE'89 was to bridge the gap between theory and practice in systems development. Consequently, CAiSE'89 was organised in two parallel streams, one theoretical and one practical. The theoretical track was traditionally organised by submitted, reviewed, and accepted papers, primarily from researchers. The practical track consisted mainly of invited talks from business, industry and the public sector. General conference chairpersons were Agneta Qwerin, Swedish Society for Information Processing, and Janis Bubenko jr, SISU & DSV. The executive Program Committee consisted of Björn Nilsson, chairman, Håkan Dahl, Christer Dahlgren, Kurt Gladh, Lars Swärd, and Örjan Odelhög. The Organising Committee was chaired by Lars Bergman, SISU. CAiSE'89 turned out to be a great success, in particular to the participants of the theoretical track. A large number of submitted papers and international delegates could be noted. This gave us the idea to continue the CAiSE conference in a more international setting. Also CAiSE'90 was arranged at Electrum, Kista, by SISU and supported by DSV. The general chair was Arne Sølvberg, the program chair Bo Steinholtz, and the organising chair was Lars Bergman. All three were also editors of this first Springer Verlag (Lecture Notes in Computer Science) publication.

CAiSE'90 was attended by about 200 delegates from more than 20 countries. Considerable interest was expressed by European colleagues to continue CAiSE on a European scale. Janis Bubenko jr and Arne Sølvberg decided to support this challenge and worked out a few simple rules for CAiSE. Simply speaking, CAiSE is a conference with almost no rules. It has a steering committee which essentially consists of chairs of earlier organised conferences. Each year the organising body of CAiSE is responsible for the finances, profits as well as losses. About every fifth year it is expected that CAiSE returns to a Nordic country. CAiSE is guided by an advisory committee consisting of Colette Rolland, Janis Bubenko jr, and Arne Sølvberg.

Since its start in 1989 and 1990, CAiSE has been hosted in Norway, France, U.K., the Netherlands, Finland, Greece, Catalonia, Italy, Germany, Sweden, Switzerland, Canada, Austria, Latvia, Portugal and Luxembourg. The 19th event of CAiSE will be held in Trondheim, Norway, 2007. All CAiSE proceedings, since 1990, have been published by Springer Verlag, Lecture Notes in Computer Science.

Another interesting effect of CAiSE is its regular set about ten tutorials and workshops, normally arranged during two days preceding the conference itself. Some well known workshops, such as EMMSAD and REFSQ, are arranged here. The URL of CAiSE'06 is <http://www.tudor.lu/caise06>.

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## **The Baltic DB&IS Conference series, 1994**

The Baltic states regained their independence in August, 1991. Contacts and exchange with these states were immediately intensified. Based on an initiative by Arne Sølvyberg, NTNU, Trondheim, and Janis Bubenko Jr, DSV, KTH/SU, it was decided to arrange a first “all-Baltic” workshop in Trakai, near Vilnius, Lithuania in 1994. The theme of this workshop was to be “National Infrastructure Databases”. The conference was supported by the Swedish Institute. A considerable number of international guest speakers were invited. The main local actors were Antanas Baskas, Albertas Caplinskas, and Saulius Maskeliunas. The main aim of the workshop was to strengthen the Baltic computer science and data base community and to improve their cooperation and international exchange. The 1994 workshop became a success. It was decided to run the workshop every second year and to

alternate it between the three Baltic states Estonia, Latvia, and Lithuania. The scope of the workshop was broadened to “Baltic Conference of Data bases and Information Systems” (Baltic DB&IS). The Baltic DB&IS in 1996 and in 2002 were held in Tallin, Estonia (main organisers were Hele-Mai Haav and Ahto Kalja), in 1998 and in 2004 in Riga, Latvia (main organisers were Janis Barzdins and Juris Borzovs), and in 2000 and in 2006 in Lithuania. Swedish participation in these conferences has been considerable. The main organisers in 2006 is Albertas Caplinskas, Johann Eder, and Olegas Vasilecas. The URL of Baltic DB&IS’2006 is <http://isl.vtu.lt/dbis2006/> The programme committee of Baltic DB&IS’2006 has a strong Swedish representation. Bubenko and Sølvyberg are permanent members of the Baltic DB&IS advisory committee.

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## IJCAI'99

The International Joint Conference on Artificial Intelligence (IJCAI), the most prestigious conference in the area of Artificial Intelligence (AI) is held biennially since 1969. IJCAI Conferences are sponsored by the International Joint Conferences on Artificial Intelligence Inc., an independent organization whose purpose is to maintain the high standards of the IJCAI conferences both with respect to the planning and the execution of each conference. IJCAI are supposed to be held at different site spread all over the world according to a fair scheme. The Swedish and Scandinavian Societies (SAIS) for Artificial Intelligence worked hard to attract major AI conferences to Scandinavia. In the mid 90ies Carl Gustaf Jansson as Chairman for SAIS had the main responsibility for coordinating the Scandinavian efforts on making a bid for IJCAI. Eventually the Scandinavian effort was successful and in hard competition IJCAI-99 was decided to be held in Stockholm, hosted by the four Scandinavian societies. Gratitude has been expressed to Scandinavian and Swedish colleagues (foremost professor Erik Sandewall for his support).

DSV got the responsibility for organizing IJCAI - 99 with Anita Kollerbaur as Conference Arrangements Chair and Carl Gustaf Jansson as Local Arrangements Chair. Conference chair for IJCAI-99 was Prof. Luigia Carlucci Aiello, Dipartimento di Informatica e Sistemistica of Università di Roma and Program Chair was Prof. Thomas Dean at the Department of Computer Science dept. of Brown University.

In conjunction with IJCAI- 99, RoboCup (The Robot World Cup Soccer Games and Conference) was arranged. RoboCup aimed at fostering AI and intelligent robotics research by providing a standard problem, a soccer game, in which a wide range of technologies can be integrated and examined. DSV was also responsible for this event, with Magnus Boman as coordinator.

IJCAI'99 contained workshops, exhibition and technical sessions from August 31- August 6. The conference was held at City Conference

IJCAI 99 was hosted by the four Scandinavian societies.



Centre in the centre of Stockholm. With 20 workshops, 12 invited speakers, 195 papers and 1406 participants from 42 countries the conference was a huge undertaking. Responsibility for conference arrangements included economical matters, sponsoring, information on the Web, all printed information such as registration and program brochures, organization of social events and all other administration for local part of the conference.

IJCAI-99 offered spectacular events for the participants. The opening ceremony took place at the Stockholm City Hall, and the conference dinner was arranged at Vaxholm Fortress from the 16th century. Conference arrangements at IJCAI-99 were appreciated by participants, organizing committees as well as IJCAI Inc.

### Reference

IJCAI-99 Proceedings of the Sixteenth International Joint Conference on Artificial Intelligence, Volume 1 and 2, editor Thomas Dean, Morgan Kaufmann Publishers, Inc., California 1999.

## Conferences in the area of Computers in Education

As part of the extensive research program in the area of computers as tools for learning, the department was responsible for three major conferences. The common mission for these was to promote the communication between academia, industry and educational professionals. These three are regarded as part of the so-called third mission for the department.

### Computers as tools in education, 1973

“Computer systems for educational support”, a two-day event in October 1973. This was the first conference in the area in Sweden arranged on behalf of the Swedish National Board for Technical Development (STU). The PRINCESS group was responsible for the arrangement together with the Swedish Company, STAANSAAB and it was held in the premises of the Swedish Parliament Building.

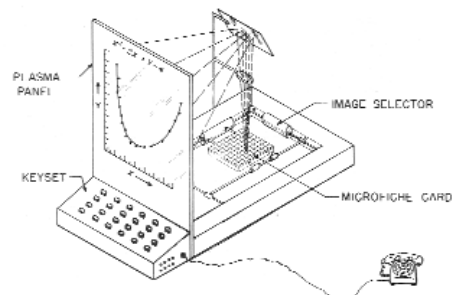
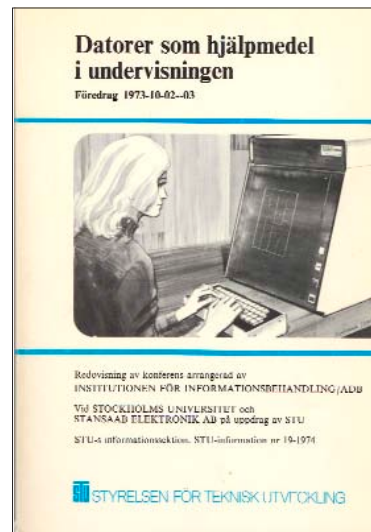
Researchers, teachers representing different levels and technicians from industry were among the contributors. A spectacular talk was given by professor Donald Bitzer, Computerbased Education Research Laboratory, University of Illinois, Urbana/Champaign. Prof Bitzer presented the Plato System with an online demonstration - technically advanced at that time. The Plato terminal, a multimedia full graphic plasma terminal, designed by prof. Bitzer.

### Datalär- 84 and Datalär- 87

Datalär might be translated to CompuLearn. Both conferences presented research, development and methodology in the area of computing primarily for teachers in secondary and adult education.

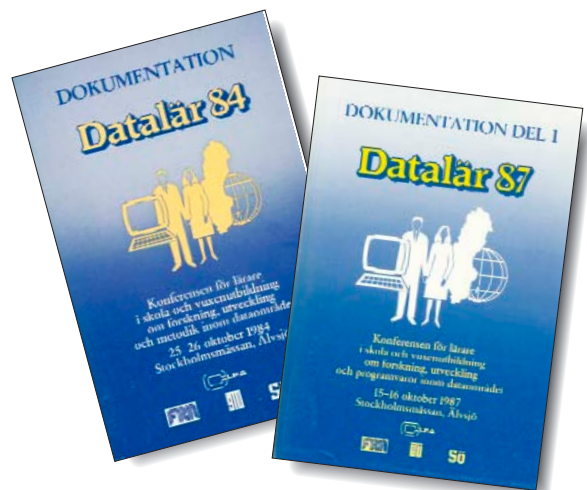
Datalär conferences were initiated by Anita Kollerbaur as part of the research within CLEA, with financial support from National Council for Planning and Coordination of Research, the Swedish National Board for Education and the Swedish National Board for Technical Development. Both conferences were held as 2-day events and located at the Stockholm International Fairs.

Datalär-84 was organized in three main sections. One section was dedicated to visions



The Plato terminal

Schematic Diagram of Student Console



of the future from different perspectives, the second presented research about data processing, humans and society, the third research about application areas.

Among the speakers from the Department were Istvan Orci, Eva Lindencrona and Anita Kollerbaur, from KTH Prof. Lars Erik Thorelli, who gave a talk on the technical perspective, ass. prof. Gunilla Bradley from Stockholm University talked about human-machine aspects.

Research and development in the area grew rapidly, influencing the size of the Datalär-87. It was organized in 9 plenary and 24 parallel sessions, involving 100 speakers. An exhibition was added.

Examples of contributions by representatives from the department were:

- Vulnerability session was chaired by Louise Yngström
- Mikael Kindborg contribution on Human-Computer Interaction

- Artificial Intelligence session was chaired by Carl Gustaf Jansson
- Janis Bubenko addressed Research on Systems Development
- Rune Petterson analyzed Electronic Publishing.

## References

Computers as Tools in Education, Conf. Proceedings 1973-10-02-03, STU information nr 19-1974 (In Swedish).

Datalär-84, Proceedings from a Conference about IT for learning for Teachers about Research, Development and Methods, ISBN 91-970520-1-9, Stockholm 1984 (In Swedish)

Kollerbaur A., (ed) Datalär-87 Proceedings, part I from a Conference about IT for learning for Teachers about Research, Development and Methods, ISBN 91-970520-2-7 (In Swedish).

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## Conferences in the Information Systems, Modelling and Software Engineering

Many other international workshops and conferences have been held at DSV in the areas Information Systems, Modelling and Software Engineering, e.g.

- The 4th European-Japanese Seminar on Information Modelling and Knowledge Bases (1994), chaired by Benkt Wangler, H. Kangassalo, and S. Oshuga
- Workshop on Futures in Information Systems and Software Engineering Research (1999), chaired by Bengt G. Lundberg
- IFIP TC8/WG8.3 International Conference on Decision Support through Knowledge Management (2000), chaired by Bengt G. Lundberg, Sven Carlsson, and Björn Thodenius
- The 7th International Workshop on Applications of Natural Language to Information Systems (2002), chaired by Reind van de Riet, Paul Johannesson, Birger Andersson, and Maria Bergholtz.
- The 2nd International Workshop on Software Methodologies, Tools and Techniques (2003), chaired by Fumio Negoro, Hamido Fujita, Paul Johannesson, Birger Andersson, and Maria Bergholtz.

## Conferences in the area of Information Systems Security

The following international workshops and conferences have been held at DSV in the area of Information Systems Security/Security Informatics:

- Security and control of information technology in society, IFIP TC9/WG9.6 working conference (1993), chaired by Dr Richard Sizer, UK, Martin Wasik, UK, and Louise Yngström, DSV.
- IFIP Joint WG9.6/11.7 Seminar (and WG meeting) on IT misuse and the Law (1998) chaired by Dr Richard Sizer, UK, Simone Fischer-Hubner, and Louise Yngström, DSV.
- IFIP TC11/ /WG11.8 First World Conference in Information Security Education, WISE1(1999) chaired by Louise Yngström and Simone Fisher-Hubner , DSV.
- Joint IFIP WG 8.5 and WG9.6 working conference on User Identification & Privacy Protection – applications in public administration & electronic commerce (1999) chaired by G. Quirchmayr, S. Fischer-Hubner, and L. Yngström.
- NORDSEC'99, The fourth Nordic Workshop on Secure IT systems – Encouraging Co-operation (1999) chaired by Louise Yngström, DSV and Thomas Svensson, FMV.
- Swedish day 1995 at the IFIP TC11 conference in Cape town (RSA) on Information Security - the next decade. Security on the electronic highways in Sweden (1994) chaired by Louise Yngström.

IFIP TC11 conference in Cape town 1995 featuring the Swedish group presenting Security on the electronic highways in Sweden.



## VISITING RESEARCHERS AT DSV

During the years since its formation in 1966, DSV has had more than 150 visiting scholars and researchers, both international and Nordic. Visits have ranged from shorter meetings, talks, and seminars to longer stays and presentation of advanced courses at the graduate level.

The interest to visit DSV was, in the beginning, mainly due to the international reputation and recognition of Börje Langefors and his work. Later, during the seventies, other researchers at DSV introduced themselves on the international stage with presentations at conferences and publications in scientific journals.

Main themes addressed by researchers at DSV were Information Systems Development and Engineering, Data Base technology, Conceptual Modelling, Artificial Intelligence and Logic Programming, Business and Object System Analysis, Change Analysis, Computer Aided Instruction and Learning, Information Systems Security, and Computer System Performance Analysis.

This gave the department an international recognition and reputation, which made it attractive for visitors. In the following we present a naturally incomplete survey over some have honoured our Department with a visit.

### Visitors first from the Nordic countries

Visitors in the forming stage of the Department were mainly from neighbouring Departments in the Nordic countries in connection with the SCIP project, e.g. Hans Andersin, Arne Sølvsberg, Rolf Høyer, Pertti Järvinen, Kalle Lyytinen, Paul Lindgreen, and many other Nordic colleagues. At this time we were also visited by Daniel Teichroew, University of Michigan, Ann Arbor, interested in CASE technology for IS design, and Adèle Goldberg, Xerox PARC, working on computer aided instruction. Also Ronald Stamper and Colin Tulley, UK, found the Scandinavian School interesting to study it further.

Visitors during the seventies include Kristen Nygaard, one of the fathers of the “object-orient-

ed” language Simula’67 and the language DELTA, David Parnas on structured programming, Peter Naur on software development and engineering, Dennis Tsichritzis, then on operating systems, Michael Senko on data bases and conceptual modelling, Gordon B Davis on Information Management Systems, John McCarthy on AI, Robert Kowalski on logic programming, Niklaus Wirth on programming languages, Kenneth Kahn on AI, and many others.

### Extended research – contacts with SYSLAB and CLEA

International visits during the eighties intensified due to extended research activities and international cooperation of SYSLAB and CLEA. One of the visitors, Alfs Berztiss, Univ. of Pittsburgh, visited SYSLAB for fifteen consecutive years between 1985 and 2000. He has presented a number of courses in Information Systems and Software Engineering, primarily at the graduate level, as well as given supervision to graduate students. Other visitors during the eighties and nineties include Michael Brodie on Knowledge Base Management, Antoni Olivé on Conceptual Modelling, John F. Sowa on Conceptual Structures, John Mylopoulos, Colette Rolland, Barbara Pernici, Peter Lockemann, Matthias Jarke, Yannis Vassiliou, Peri Loucopoulos, all on Conceptual Modelling and Information Systems Engineering, Anthony Wasserman on software engineering, Sjaak Brinkkemper on method engineering, Stafford Beer and Peter Keen on IT and organisations, and many others.

### Many visitors in the area of systems security

The area of information systems security has in the last 20 years been honoured by many visiting scholars, among them Dorothy Denning on Crypto Politics, Bill Caelli on ICT Security, Simone Fischer-Hübner on Privacy Enhanced Technologies, Wilhelm Steinmüller on Information Technologies and Public Administration, John P Van Gigh on Applied General Systems Theory, James Grier Miller on

Living Systems, Richard Baskerville on Risk analysis and management, and many others.

### **New contacts in EU-supported projects**

Starting from the early nineties, DSV became engaged in a considerable number of EU-supported projects. This resulted in a large number of new contacts, collaborative activities and visits. It is beyond the scope of this section to list names of all researchers involved in these activities. Some of the activities are further described in the section on international cooperation.

### **Baltic scholars to DSV**

The political changes in the Sovjet Union in 1991 created freedom to a number of eastern states in Europe. In particular, research institutions in the

Baltic countries took this opportunity to initiate contacts and collaboration with western counterparts. This initiative was supported by the Swedish Institute. As a result, DSV opened its premises, for shorter or longer time periods, for Baltic scholars who wished to learn more about the advances in computer and systems sciences in the western countries. In addition, several MSc theses were completed at DSV by Baltic students. Two Ph.D. degrees have been awarded to Baltic students. Visits to DSV, in order to study DSV's curricula and way of teaching, have been paid by scholars from leading universities in the Baltics.

Naturally, the Department also is proud to have recieved a number of distinguished guest professors.

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## *Contacts and cooperation on the national level*

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## INFORMATION SOCIETY CONTACTS AND SUPPORT FROM INDUSTRY

Through the years, from early times in the sixties and seventies and onwards, the Department has benefited from exceptionally good external contacts. Especially so, industrial cooperation has been fundamental for much of the applied idea development at the Department. In numerous cases, this has been instrumental for the possibility to build and establish research and development of value for all concerned parties.

In this book, we have chosen not to identify this contact surface in detail in all the cases that this might have been possible. We could have mentioned a number of exciting private companies that have been important as application and idea support. We could also have listed a number of important public committees and organizations, which have formed a strong basis for applied information systems thinking at the Department. But we choose not to. It would lead to long descriptions and discussions, related not only to industrial and public networks but also to persons who have played important roles for project development and support.

Instead we choose here to formulate a collective and maximally strong statement about the type of industrial and public support from which the Department has been lucky to have benefited. We feel we cannot overdo this, these contacts have been of great importance for close to all research projects at the Department.

Let us repeat. Through the years, the Department has been lucky to find itself in fundamental contact with private companies as well as public organizations. The support from these sources has covered important financial resources, but has – primarily – also contained personal engagement from leading personalities in almost all information systems application areas where educators and researchers at the Department have been active.

For this support, the Department is extremely grateful. Without it, it would not have been possible to reach the research and application success that we are happy to be able to show today.

## CONTACTS WITH ORGANIZATIONS

In the late 1960s and beginning of the 1970s, a systems shift took place. No longer would pure technology – hardware and software development – form the sole focus for computer systems concern. No longer would monopolistic forces dominate as strongly. Rather, market competition and user concern attracted increased importance. Concern expanded outwards. Computer related organizations naturally expanded with this in focus.

But the organizational development had started earlier. And university activities were open for cooperation.

In Sweden, the “Punched Card Club” was created in 1953, an organization that focused on sharing of experiences concerning offline equipment. In 1959 the name was changed to the Association for Rational Computing. Again, in 1963, the name was changed to the Swedish Data Association (SDF). Contacts with the universities were limited during the early times. Content focus for SDF was placed on sharing of experiences concerning administrative systems, that at the time were pragmatic and mostly did not lend themselves to analytical investigations.

At the end of the 1950s, Börje Langefors took active part in forming SSI (Svenska Samfundet för Informationsbehandling). He became its first chairman, for the years 1959 - 67. The organization related itself to systems development and cooperation concerning early research in mainly technical areas. It had academic contact. An important mission for SSI was to represent Sweden in IFIP (International Federation for Information Processing). SSI was also very active in Nordic cooperation, including organizing a number of the NordData conferences.

The number of SSI members increased successively, and in 1989 the number of members was 3500. Many of these had university origin.

In 1974, Riksdataböndet (RDF) was formed, a user oriented organization that had members from different parts of the computer system industry as well as from public sector users. A service company was created as a complement, attached to RDF, called Servi-Data.

In the lead of RDF from the end of the 1970s and into the 1980s was Nils-Göran Svensson, an able organizational leader who sadly died in an airplane crash at the end of the 80s.

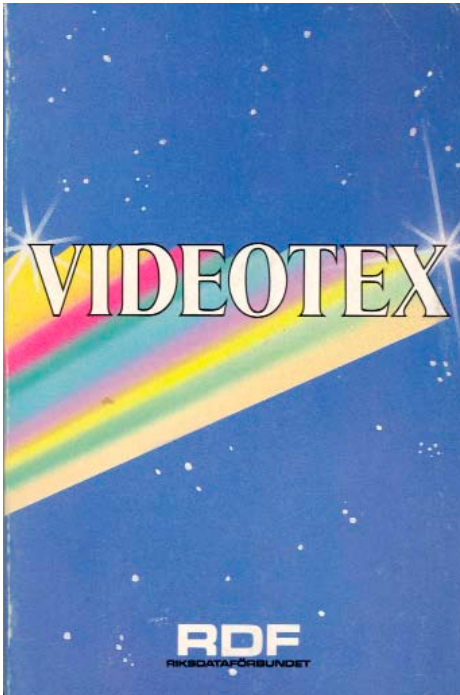
Focus of the work inside RDF was placed on education and exchange of user experiences. It was formed groups of concern that supported publishing of a large number of books of educational nature, arranged seminars and took the responsibility to represent “the computer user” in the beginning public as well as private concern for increased efficiency and competition to the mainstream industrial lines. Many of the books produced had origin from DSV authors.

RDF also arranged conferences, took responsibility for computer systems development standards, published educational pamphlets, organized qualified reference groups, and found itself in an active market role as a representative for computer system users. There was a clear line of connection between the university (and DSV) and RDF. RDF representatives took part in university seminars. Experts were chosen from the academic side for RDF presentations and as authors. Early authors included Janis Bubenko, Rune Engman and Mats Lundeberg, who published systems descriptive texts, and Tomas Ohlin (who in 1986 in the RDF book series published “Videotex”, describing the fore-runners to the Internet).

In 1968, a new organization SystemUtveck-larnas Riksförbund, SUR, was formed, with the aim to increase concern and observation about the roles for programmers and systems analysts. In the beginning of the 1970s, SUR and SSI merged.

In the 1980s, there were three organizations:

- SSI (Svenska Samfundet för Informationsbehandling) – that had many academicians as members
- SDF (Svenska Dataföreningen) – that mainly organized computer industry members, focusing on administrative applications
- Riksdataböndet – that organized users with education in focus



The RDF-book on Videotex.

In 1989, these three merged into Dataföreningen i Sverige. This strong organization supported and supports education, important conferences and seminars on many increasingly important computing issues.

Having been very active in contacts with the early organizations, naturally, DSV was in good contact also with this new organization. Together, it was recruited qualified personnel to seminars, discussions, and authoring projects. The expansive contacts have continued over the years into the new century.

## SPINOFF COMPANIES AND INSTITUTES

Over the years, a number of research projects at the Department DSV have expanded and ultimately found the university costume too narrow. It has become natural to define a wider and more commercial costume. At this time, after the copyright problems have been solved, companies have been formed, and marketing of product results have been initiated.

This has been fully supported by the Department DSV. In fact, it has been supported not only morally, but also to some extent with more practical resources, at transition times.

In some cases, the transition from a university project to a commercial company has passed via an interim form, a research institute. Ultimately, however, a number of fully commercial companies have been defined. Several of these have become commercially competitive.

Here, we give a few examples of some of these spinoff organizations.

Naturally the text below does not mirror a complete selection of spinoff companies and institutes from the Department. The texts below have mainly been provided by representatives of the companies and institutes.

### **SISU (Svenska Institutet för Systemutveckling)**

An important impact of SYSLAB (the SYStems development LABoratory at the department) was the formation of SISU (the Swedish Institute for Systems Development). Instrumental in this process was the SYSLAB's industrial advisory group<sup>1</sup> headed by Rune Brandinger, then CEO of Valand Insurance Co. Persons from the department, in particular Janis Bubenko and Tord Dahl,

together with the advisory group, in 1984 contacted a large number of Swedish organisations in order to obtain financial support for forming of a research foundation. A considerable support was obtained. A "supporting user- and partner organisation" called ISVI<sup>2</sup> (Intressent-föreningen för SVensk nformationssystemutveckling) was established. SISU's research plans for the first three years, 1985 - 87, were worked out and documented in a "Framework Program" (ramprogram). All members of ISVI guaranteed to support SISU's research according to the Framework Program.

SISU was initially financed by STU and 21 organisations and companies. The Swedish government decided in the autumn of 1984 to establish the operation of the industry research institute SISU starting January 1st, 1985. The 1985 budget of SISU was about 8 MSEK. Thirteen researchers<sup>3</sup> were transferred from SYSLAB to SISU in January 1985.

The main goal of the SISU institute was to act as a bridge between practice and academia. SISU's main areas of activity were:

The Information Center (information dissemination, education), Management of Information and Data Resources, Methods and Tools for Problem-oriented Systems Development, and Interactive Systems – Office Information Systems.

Consequently, SISU took some results of SYSLAB and tried to develop them into "products" which could be applied in practice.

Two of these were OPAL and RAMATIC.

OPAL was a prototype system for distributed object management. The OPAL group later formed the consulting company NeoTech.

RAMATIC was a meta-CASE tool, i.e. a tool

<sup>1</sup> Members of the group were Krister Gustavsson, Statskontoret, Gunnar Holmdahl, ASEA Information Systems, Göran Kling, Volvo-Data, Sten Martin, Swedish Defence, Per-Olov Persson, Riksdataböndet, Sven-Erik Wallin, Esselte Datacenter, and Kurt Wedin, Vattenfall.

<sup>2</sup> ISVI members in 1984 were: ASEA, Datalogic, DBK, ENEA, Ericson, Försvarsstaben, Göteborgen, IBM, Infologics, Kommundata, Programmator, Saab-Scania, SE-Banken, SKANDIA, Statskonsult, Statskontoret, Televerket, Valand, Vattenfall, Volvo-Data, and Volvo-PV.

<sup>3</sup> These researchers were Matts Ahlsén, Peder Brandt, Stefan Britts, Janis Bubenko, Roland Dahl, Tord Dahl, Mats-Roger Gustavsson, Christer Hultén, Lars-Åke Johansson, Eva Lindencrona, Stefan Paulsson, Lars Söderlund, and Håkan Torbjär. SISU's first secretary was Marianne Sindler.

to build CASE-tools for particular methods and description techniques. RAMATIC was later used for building system modelling tools in several Swedish organisations as well as in several projects financed by the European Union's Framework programmes. Another heritage from SYSLAB was the conceptual information modelling knowledge and tradition. It later contributed to developing strongly participatory business and enterprise modelling approaches as well as computer supported modelling tools within SISU.

In its "peak era" (1990 - 1993) SISU had an annual turnover of about 35 million Swedish crowns and about 40 employees. The institute generated and carried out a large number of national collaborative projects<sup>4</sup>, where the supporting organisations from ISVI took an active part. One such project was TRIAD that generated a vast amount of knowledge in business modelling in organisations. SISU realised early the scientific, technological, and the economic importance of joining the ESPRIT programme. Work on forming of consortia and on preparing project proposals started in 1987. SISU managed to be accepted as partner in a considerable number of EU-projects. This collaborative work gave later openings for forming spinoff companies such as CNet, Projektplatsen, and ALKIT.

SISU continued its operations until 2000, during the last two years as part of a research company Framkom. SISU's Managing Directors were Janis Bubenko (1985 - 1992), Thomas Falk (1992 - 1994), Eva Lindencrona (1994 - 1998) and Mikael von Otter (1998 - 2000).

## ENEA

Today ENEA is a world leader regarding the development of operating systems for mobile telephones with a market share of almost 60%. The company is also selling tool boxes for the development of all kinds of embedded online computer systems. How could all that start within a Department for Data Processing at the Royal Institute of Technology in Sweden?

It was started by an obedient son fulfilling his fathers wishes to create a prosperous company. With such ideas in mind Rune Engman started after finishing schools (ME and MBA) a company called Engmans Elektronik AB. Later it became known as ENEA. In the beginning the company worked with printed circuits. It had its production in Helsinki and sales in Sweden. It was never a success. Soon after the introduction of the company the demand fell sharply and the company was made resting. The creator had to go back to work as an assistant, and later as a lecturer, at the Department for Data Processing, especially with assembler programming.

Meanwhile a Swedish based ITT company had started to develop computers without support from their HQ in Brussels. They needed back up and asked Börje Langefors (with an industrial background at SAAB) for help. After a personal recommendation, this developed into assembler programming teaching, and later consulting. The first project was to develop a program for "Garbage collection". The work was big, so Ingrid Karlmar, Karl Erik Ericsson and Olof Björner were invited. The problem was however that none in this group had any deeper experience of that type of programming. The answer was Göran Sundström, a guy from outside the Department with good knowledge of basic computer programming and with a degree in technical physics. The work was done to the satisfaction of the client who started to ask for more and more work.

The company expanded into production of all kinds of basic software, but also application software, for i.e. Air Traffic Control, and (for other clients) distribution of electrical power. Soon, many relevant Swedish industries were clients. Sister companies were started in Denmark, to help Radio Denmark with the distribution of video signals, in France, to help Eurocontrol with air traffic control, and in Germany, to help Facit AB with their small computer system for Business Administration.

Two projects ought here to be mentioned. The first was a compiler for the Swedish Defense

<sup>4</sup> Additional information about SISU's results [http://roxy.cnet.se/vnapps/SISUWeb/Frontpage\\_default.vns](http://roxy.cnet.se/vnapps/SISUWeb/Frontpage_default.vns)

Research FOA of the Simula language, a project that occupied 10 people for 2 years. The second was the development of an Operating System for Censor computers (made by ITT Sweden). The later project was the embryo to the work nowadays done by the company.

After 13 years of continuous success and with the staff increased to 85 members, the employees were affected by hybris and demanded that the Swedish company should take a “Great Leap Forward” in order to conquer the world.

The demand was way out of what was financially possible for a Swedish family entrepreneur. So the Swedish company was sold, while the remaining ones were kept. The new owners took the jump. What then happened to them is another story.

### CNet

CNet was established in 1995 by a research group within SISU (including Matts Alsén and Stefan Paulsson) and became a separate company in 1998 to commercialise results from the EU-projects Intuitive and Multimedia Broker, who had developed graphic search interfaces for multimedia databases and multimedia services intended for electronic publishing. The separation resulted in a software product, which in 2006 is still an important part of the company's business. It was also an early application of XML technology.

CNet's clients were companies and organizations within media and industry who needed to manage various information products in their business, and to deliver and publish these products using different channels and media in parallel.

During the hectic heydays of Internet around the turn of the millennium, CNet managed to successfully play the role of a small but fast provider of XML technology. Through a continued focus on technical and methodological competence, and through a more long-term investment in FoU-specialized EU-projects, the company has survived the burst of the IT bubble without major problems.

The company's core business is their own portfolio of products, together with a solid

knowledge in information systems development with Internet technology. During the years, the company has developed a number of products focused on semantic knowledge-techniques.

The development platform *Visual Net Server* offers possibilities to automatically analyse and extract information from websites, documents and databases using a self-developed semantic marking technique. *NewsToBuy* is a system for content management that offers small and medium-sized companies an efficient tool for information publishing and knowledge sharing. *Termado* is a terminology server, which functions as a complete tool for creation and publishing of terminology catalogues, concept definitions, lexicons and dictionaries. *AdETransact* automates advertising management within the media industry. The product *WebHybris* is a Semantic Web Server, which enables accessibility to complicated quantities of data to end-users through the Web, using graphic, semantic maps.

During the past few years, the company has deliberately invested in FoU-project within EU's scope of programs, including consultant services for the EU Commission and other companies in development of project proposals.

The projects mentioned above, which constituted the start of CNet, were based on competence and results from DSV/SYSLAB, and SISU (see above) had offered the opportunity to apply this knowledge within the scope of the growing Internet infrastructure.

CNet is still a technology company owned by its staff. The co-workers are in different ways linked to DSV, SU and KTH.

### Compumine

Compumine develops and sells software for data mining. Data mining is a process for identifying useful and valuable knowledge from existing data. The process is general and looks the same independently of the area of application.

It typically starts with a need of improving some process for which data has been collected, one or several questions that one wants an answer to, and a collection of data. Based on the questions, the data is organized in such a way that it may be analyzed in order to allow for extracting valuable

information. Particular software is used to analyze the data, and any findings are carefully validated before the results may be moved into the organization.

Compumine's product, *Rule Discovery System*<sup>TM</sup> (RDS<sup>TM</sup>), is a software that is used in the most important steps in the data mining process, namely to go from well-organized data with a particular question in mind to new insights and even deployment of the results. With RDS<sup>TM</sup> Modeling Edition, a customer may easily and with no prior knowledge, analyze data in order to discover new potentially valuable patterns and also develop very accurate and sophisticated prediction models. These models may then be used in the daily work within an organization by using RDS<sup>TM</sup> Deployment Edition, which allows for a smooth integration with existing infrastructure, such as a web portal.

RDS<sup>TM</sup> is a general product that is not bound to some particular type of data. Currently, Compumine focuses on providing RDS<sup>TM</sup> to customers in the pharmaceutical industry, including AstraZeneca and Biovitrum, where the product is used for analyzing experimental data. However, since the product is general, it could equally well be used for analyzing data in e.g. direct marketing, credit card fraud detection or mine prospecting.

Compumine was founded in 2002 by two researchers at DSV, Henrik Boström and Lars Asker, and Per Lidén, CEO. The company currently has three employees and has its headquarter in Uppsala. For more information, please visit [www.compumine.com](http://www.compumine.com).

### **Databaskonsult DBK AB och Infocon Data AB**

During the 1970s, the Cadis project developed a prototype for an associative database manager in several prototype versions (Cadis System 1-4 or to put it briefly, CS1-4). By the end of the 1970s, the idea to create a company was born, and Databaskonsult DBK saw the light of the day. The initial stage was tough, with testing of products in all parts.

By means of continued support from The National Swedish Board for Technical Development ("Styrelsen för Teknisk

Utveckling") and Swedish Defense ("Försvaret"), CS4 evolved into a complete product after intensive work. At least a number of defence applications were developed. A contributory factor to the interest shown by the Swedish Defence, was CS4's elegant possibility to manage advanced data structures, that there was a coherence between information model and implemented model, and that the database manager was integrated with a specifically adapted programming language. Courses were given, a CS4 user association was formed, new functions were developed. CS4 became Dream/CS5, to emphasize an upgrading that included a form manager and an inquiry language.

The specialization towards defence applications and the plans for expansion, demanded a major cooperation partner. The plans were realized in 1985, when Philips Electronic Industries ("Philips Elektronikindustrier") bought DBK. Infocon Data AB was then established, designated to function as a main developer of Dream/CS5 as well as of applications. Cooperation was smooth, but in 1989 Philips Electronic Industries were forced to terminate their engagement in the product. Infocon faced a difficult choice: either reorient Infocon into general consulting business, or shut down.

The employees took a joint decision; Infocon and Dream/CS5 were intimately linked to each other and the unique spirit of engagement, fellowship and friendship that had been built over the years was to become a sweet memory. Infocon was calmly liquidated after all employees had found new positions.

The two most competent in Dream/CS5 then took on the responsibility for continued development and maintenance. Infocon Program Design AB was established. The company is still active in further development of both Dream/CS5 as well as old and new applications. Dream/CS5 is still, in 2006, a stable and efficient product, highly competitive compared to other database management products.

### **MAD Preference**

The spinoff company MAD Preference AB was established 2003 by Mats Danielson and Love

Ekenberg, together with the PhD students Jim Idefeldt and Aron Larsson. The main activities are to provide decision aid and education to companies, authorities and other organizations.

The methodologies used are direct outcomes of the initiators' research in fast algorithms which enable the modeling and evaluation of very complex decision situations, even in cases where there is a high uncertainty in the information regarding how probable possible outcomes are or how valuable the different outcomes may be. Since this is the case in most real-life decisions, it is seldom the case that a decision maker reasonably can make precise estimates of probabilities and forecasted payoffs. Consequently, the initiators believed that their results, except for having beautiful geometrical properties, might be of some practical use as well.

This seems so since the methods and tools based upon these have been applied on numerous real-world problems in various industries and authorities: on problems from 6 to 1800 consequences in projects lasting from 1 day to 40 man-months and with costs from USD 10,000 to 1 billion.

### **NeoTech**

Christer Hultén, Lars Söderlund and Stefan Britts are three NeoTech consultants who are proud to work for a company that is a spinoff from the Department at the Royal Institute of Technology and the University of Stockholm. In this department they all received their PhDs in relational and object database technology. They had the privilege of spending fifteen years in database research under the leadership of Professor Janis Bubenko – first in the CADIS group, later in SYSLAB and finally in SISU.

In the eighties – almost two decades after the relational model's breakthrough in the database research field – commercial relational database systems were rapidly increasing their market shares. It was decided that the time had come to take relational database design methodology to the business scene in Sweden. So, in 1987, Christer and Lars founded NeoTech and Stefan joined a year later.

At this time, the father of the relational model

– Ted Codd – was broadcasting the relational message over the world, supported by Chris Date, whose textbooks on relational databases now have been the standard textbooks for decades in many universities around the world. There were good contacts since long time with Chris Date, and a joint venture was established between NeoTech and the company Codd & Date International. Conferences and seminars were organized by NeoTech in Scandinavia, with the intent to escalate the interest in the relational model and its formal fundament – something the DBMS vendors neglected, at that time as well as today.

Over the years, the NeoTech group expanded its perspective on methodology to include many more models used in systems development. Its focus gradually shifted to also include analysis of business processes and design of information systems. The view is that information is the most important resource in any organization, and NeoTech can by now be said to have acquired a leading edge in "information management".

Information management, according to NeoTech views, includes issues around information and data management on several levels of abstraction, such as:

- Tactical issues concerning business information requirements and the use and refinement of this information
- Methodology issues of classification, structuring and description of business information
- Technical issues in database organization and in retrieval and communication of data in networks

### **Projectplace**

Projectplace International AB was founded in January, 1998, as a company separated from SISU, Swedish Institute for Systems Development ("Svenska Institutet för Systemutveckling") and was based on ideas developed within the European research project BSCW (Basic Support for Cooperative Work). Projectplace International develops and provides web services for those working in projects together with colleagues, customers and partners.

The business concept is to improve efficiency and quality in project-oriented organizations by providing a web service that simplifies planning, implementation and follow-up of projects.

The clients are project managers, IT departments and project-intensive organizations in private and public sector. The company has subsidiaries in Norway, Holland, Great Britain and Germany, language-specific versions of the web service and locally adapted service.

Projectplace was founded in January, 1998, by Mattias Hällström, Magnus Ingvarsson and Peter Engstedt (prev. Johansson). The web site Projektplatsen.se was launched in September. The company's first client discovered the website on the very same day, and sales had started.

The internationalisation of the company was initiated in 1999 through the launch of the English website Projectplace.com, and Prosjektplassen.no in Norway during the autumn. Meanwhile, the Swedish version had soon been established as a project-managing tool in Sweden.

In 2000, Projectplace implemented a new share issue, which gave the company approximately 24 MSEK after emission costs had been subtracted.

During the autumn, Projectplace.nl and Projectplace.co.uk were launched. Sales offices were opened in the Netherlands and in Great Britain. In spring 2001, the website was launched in German, via Projectplace.de. Sales offices were established in Germany.

In 2002, new tools and modules were added to the website, to make the projects of a whole organization more efficient, for example through project portfolio management and support for knowledge recycling in projects. Partner cooperation was initiated in 2003, in order to offer clients a more complete solution. After a number of years during which the company was built up, a solid annual profit was presented.

In August 2004, the product portfolio increased through two separate products focusing on the project manager, as well as two company solutions to satisfy organizational demands. In 2005, the company has a turnover at ca 60 MSEK and is profitable. Since then, the company is expanding on the European market.

### **The Institute for Business Process Development (Institute V)**

The Institute for Business Process Development is a research foundation working in the area of business transformation and business performance improvement. The Institute is called Institute V for short. V stands for "Verksamhetsutveckling," the Swedish word for business process development. Institute V was founded in 1981. The founding of the institute built on the positive experiences of cooperation between business firms and researchers that had taken place in research group ISAC at the University of Stockholm during the 1970s.

The research group ISAC cooperated during its existence with a group of approximately twelve Swedish business firms and government authorities. The ISAC group members participated in a number of action research projects together with these organizations. Part of the work in the ISAC group was also financed by this group of organizations, many of which became founding members when the Institute started its work. Among the founding members of the Institute were: ASEA AB, Mjölkcenralen Arla ekonomisk förening, Scandinavian Airlines Systems, Skandinaviska Enskilda Banken, Svenska Personal-Pensionskassan, Telefon AB LM Ericsson and AB Volvo. Many of these organizations have since changed names and/or organizational affiliation; a reflection of the fact that it is now 25 years since Institute V was founded.

A leading idea at the start of Institute V was the transition from Systems Development to Business Process Development. This idea was also manifested in the name of the institute. We had the idea that there would be a change in emphasis from an information systems orientation to a business process focus. The relationship between information systems and business processes would still be vital. At the time the word "Verksamhetsutveckling" was a new word. Today this word is widely used.

One of the first projects of the new institute in 1981 was to interview the founding members about their perceived needs for new research. Two areas that came out as a result were methods

for high-level organizational analysis and methods for selection and adaptation of standard application packages.

The purpose of Institute V is to develop, use and disseminate knowledge about how individuals in businesses can use information, information systems and information technology in order to achieve sustainable business results. In that way, Institute V wants to contribute to the advancement of business in Sweden as well as internationally.

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The work at Institute V includes research and development projects, application projects, as well as longer educational programs and seminars. The institute is associated with the Stockholm School of Economics. Professor Mats Lundeberg from Stockholm School of Economics is the leader of the institute. Chairman of the Board is Professor Rolf Høyer, Norwegian School of Management.

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# *Computing facilities*

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## THE A-COMPUTER SYSTEM CONFLICT

In the 1960s and beginning of the 1970s, the concept “Information society” was often considered to represent something futuristic. Public discussion was limited. Instead, the most natural ICT-related general discussions concerned computer systems, their type of use, and their industrial backgrounds. The IBM practical monopoly and its consequences were discussed. Should small countries like Sweden allocate development resources to inhouse manufacturing of computers, or rely on internationally available industrial sources? Possible industrial dependencies were discussed.

In the early years, the public sector was slow in applying computerized systems. Sequential file systems were developed, but databases and distributed access was tried only to a limited extent. Legally, ICT relations concentrated on personal integrity problems. This was a legal area where Sweden – with its integrity legislation of 1963 – was a pioneer, especially owing to the work by Parliament member Kerstin Anér, documented in the book “Datamakt” (Data Power).

With this background, the few computer affairs that reached the press were uncommon and somewhat exotic. One of them, which turned out to grow to an affair of some magnitude, was the change of central computer systems within the Stockholm University area. The organization of university computing in the 1960-70s was centralized. Direct government influence was substantial, resources for acquisition of university computer equipment were controlled very severely. In the center of the decision making was Statskontoret, a central public rationalization authority. There were close links between this authority and the Ministry of Finance.

Statskontoret went as far as to defining an own currency for guiding and controlling the different university computing centers around the university areas. Statskontoret formally bought the central computers, placed them at certain computer centers, and handed out virtual “usage coins” according to a home created policy. To receive such coins for a university institution,

you had to gear your computer usage pattern according to a model that appealed to Statskontoret. The result was an extremely centralized system of computer use.

Since there was no organizational competition, the students and researchers felt chained.

The advisory group, that Statskontoret used, was Stockholms Databehandlingsdelegation, an expert body of administrators, politicians and researchers. The majority here was compact, and opposition was unusual. Administrators and politicians were in majority, and researchers were in minority.

Central computer systems in this case were classified according to size. Small machines, with market price (at the time) of around 10 000 Euro, were named C-machines. Medium sized machines for up to 100 000 Euro were B-machines, and the very few A-machines were quite expensive.

Around 1965, Stockholm University needed a new family of computers. A demand analysis was defined which stressed the outer environment and manufacturer concerns. This demand analysis for the A-machine project was centrally carried out in a way that seemed biased, and that would likely benefit IBM, who was the market leader at the time. IBM’s market influence was of a magnitude that was unprecedented. (It could only be compared with that of Microsoft today).

The main public Statistical Authority (SCB) also needed new equipment, and it was decided that a new IBM 360 model 50 should be installed there. This series of new machines was at the time quite unproven, and the main software was untested in several respects. However, SCB, that had been using IBM for some time, chose to continue to follow the IBM line, a choice that turned out to lead to waiting time for tested software. But in this case certain delays in this case were accepted.

For the university area, the choice of manufacturer would mean an enlarged influence for this manufacturer, through all student and research users. Therefore, several vendors made

priority for this project. Central administrators with purchasing influence were courted more or less openly.

The A-machine project contained several machines, a big system in the middle and a number of smaller machines in the periphery. And perhaps even more important, its “cultural” user influence would spread, and have substantial indirect market effects in wide areas.

The first A-machine requirements analysis outline, defined by Statskontoret, reached the Stockholm University department for Information Processing in 1967. Some teachers and researchers there were astonished by the uniformity and passive content of the analysis outline. In beforehand, it gave the impression that the project already was decided. IBM would be the winner. Although it was a fact that the full 360 series at the time was unfinished at the manufacturer, and that main software not yet existed, IBM vendors succeeded in convincing the main authority Statskontoret, that these products would be delivered in time. To university people, this seemed like a completed run already from the beginning.

At that time, in late 1967, two teacher/researchers at the University department decided to show their interest. Janis Bubenko and Tomas Ohlin, with the support of Börje Langefors, managed to place themselves as university representatives in the Advisory expert commission that would suggest to Statskontoret which computer system to choose. In spring 1968, when system decision time approached, IBM was in the lead concerning the type of evaluation efforts that Statskontoret had defined. However, for a number of experts, it turned out that system evaluation and comparing efforts were unsatisfactory.

Bubenko and Ohlin then decided to define a more thorough evaluating effort by themselves. A number of measurements were carried out, based on certain families of different “test jobs”. Theoretical comparisons and practical measurements were made about the efficiency of different machines for these test jobs, systems from Control Data, General Electric, IBM, ICT and Univac.

The result from these measurements showed firstly that small to medium-sized machines would be recommendable for “smaller” jobs, and secondly that for the very A-machine, IBM placed itself quite low in processing efficiency. This was the case especially for “heavier” jobs. The efficiency difference was as large as close to a factor 2.

Part of the discrepancy relied on main software differences. Univac and GE had developed existing operating systems that could handle multiprogramming dynamically, something that IBM at the time could not. IBM could only deliver “Multiprogramming with a fixed number of tasks”, MFT, and not “Multiprogramming with a variable number of tasks”, MVT. Also, there were heavy differences concerning usage concerns, especially job control and network capacities.

Bubenko’s and Ohlin’s report was naturally criticized by those who felt that IBM ought to be the winner. The report was said to have measured less important system matters.

Although the Stockholm University and the Royal Institute of Technology formally backed up Bubenko and Ohlin, the final system decision by Statskontoret was not supportive to their evaluation work. The autumn 1968 decision to choose IBM 360/75, with 360/30 as additional support machines, gave the impression to be a “political” one. IBM representatives were very competent in convincing the Ministry politicians that their system was what Swedish universities needed.

During the year when this “computer battle” took place, newspapers covered the affair quite closely. At times, even a weekly comment was given in the Dagens Nyheter. What was the latest news? Would the researchers win? Therefore, the defeat of the researchers and student users, who had preferred another manufacturer, was given thick newspaper headlines. “Bureaucracy wins over university research!” Newspapers were emotional.

This was one of the few moments where computer system concerns reached the newspaper headlines in the late 1960s.

Afterwards, it turned out that there were

heavy delivery delays regarding main IBM systems software, and that systems efficiency turned out to be quite close to Bubenko's and Ohlin's measurements. In that respect, although users for some time had to suffer because of low system efficiency, theoretically the two university researchers were successful.

The lessons from the A-machine affair turned out to be a motive for Bubenko and Ohlin to summarize a number of the theoretical findings and experiences in two 1971 books, "Introduction to Operating Systems" (unfortu-

nately only in Swedish language). These books were used in university education in Sweden for many years during the 1970- and 80s. They were probably among the first university texts in the world that analyzed operating system qualities theoretically.

## References

Anér Kerstin, Datamakt, Gummesons Boktryckeri, Falköping 1975, ISBN 91-7070-421-X.

Annerstedt m. fl. Datorer och politik, Studier i en ny tekniks politiska effekter på det svenska samhället, Civiltryckeret, Kristianstad.

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## THE ICT ENVIRONMENT AT THE DEPARTMENT

### History of ICT access

In Sweden, provision of ICT services for universities for long times has been highly centralized, as described in the text “The A-computer system conflict”. In the 1960s, ICT access for students, teachers and researchers was considered as a specialized service of exclusive nature. Decisions about the general organization for and provision of such services was concentrated to a central public authority, Statskontoret, that was directly connected to the Ministry of Finance. It was formed an advice giving expert group with researchers and representatives from authorities, but in effect this group at times felt like hostages. Decisions about university procurements were taken elsewhere and higher up in the Swedish public bureaucracy.

The Department had to accept this principle. The central authority even invented a special currency, “computing coins”, that were handed out to departments on a yearly basis. These virtual coins could be converted into computing resources, hours and minutes of runtime on different mostly central computing facilities.

Naturally such a centralized organization created discontent from users. There were battles between different teacher and research groups from different departments, all of them competing for more computing coins.

The central authority at times had to function like an umpire on the football arena.

For years this was the system that Swedish Universities had to accept, and use. Centrally procured computer systems were put on a “market” where the different university departments could buy access – if they had coins left.

Those who did not were left to use other methods or means for computing, at times manual.

For universities in the Stockholm area, a central computing centre, called QZ, combined university computing with defense research computing needs. Here, for long times IBM 360 systems were chosen.

Naturally the Department DSV worked hard

to make available as large amounts of computing coins as possible. When access was insufficient, alternatives were analyzed. The Department was one of the first to try decentralized computing, when technical development made such resources possible and ultimately available.

In the beginning of the 1970s, timesharing systems were introduced. Terminal access to computing resources (this was long before the PC) meant a tremendous increase in systems availability. Although the terminals at the time were somewhat awkward to handle practically, and naturally were completely “unintelligent”, this type of access meant a revolution to students and teachers.

Through completely own efforts, the Department turned to the computing industry, and ultimately was given the chance to try out a local small HP system, with the agreement that usage experiences would be collected and made available to HP. The system in the beginning supported 8 teletype terminals. At the Department, a specialized “terminal room” was set up, available around the clock.



The Teletype terminal

This meant a fantastic increase in access possibilities for students. No longer were they left to leave their punched cards piles to a centralized reception, and hopefully receive the results the morning after. Instead, compilations and test runs could be made on the spot, and access times were counted in minutes instead of hours. Interactive programming was first introduced using the BASIC language.

The HP system itself was physically placed at the Department, and was kept under control by a sole systems expert. The bureaucracy was minimal.

The central public authority was puzzled. Ought this to be allowed? Such local computer access disturbed the whole central “coin balance” system. What would happen if others followed? Could the use of the central computers decrease so that central “profitability” would sink? What would happen with the central “coin power”?

Naturally this decentralization continued quite fast, and after time, the centralized system proprietors had to give up, although not without concern.

For research, a DECsystem -10 system at Stockholm University Computing Center (QZ) later came to be used for a number of years.

In the PRINCESS project, Plato terminals were adapted to the DEC-10 environment, and were used at the end of the 1970s. The Plato system was introduced at visits by the pioneer Donald Bitzer. His system of principally hundreds of terminals was aimed to be built on centralized system software with decentralized access principles. However, procurement of a large computing system (Control Data 6000) for this use was at that time not made possible in Sweden.

Many other types of dedicated computer systems were tried out at the Department, by different research groups. Two examples are described below:

- the Ilounge a prototype for an interactive workspace
- the IT platform for distributed and shared education

The policy at DSV to provide modern, up to date ICT environments for students and personnel was



#### **Macintosh 1984**

the first reasonably affordable system with a graphical user interface. It had keyboard and a one button mouse for interactions, for storing data and programs, 128 kB RAM Memory, and one floppy drive for 3.5" 400 kB discs.

introduced with the HP system. During the years, users there have naturally seen several shifts in DSVs computing environment. The HP system was to be followed by several other computer systems that were placed at the department with own support organization. Different versions of DEC – including systems 2020 and 2060 were used since 1981.

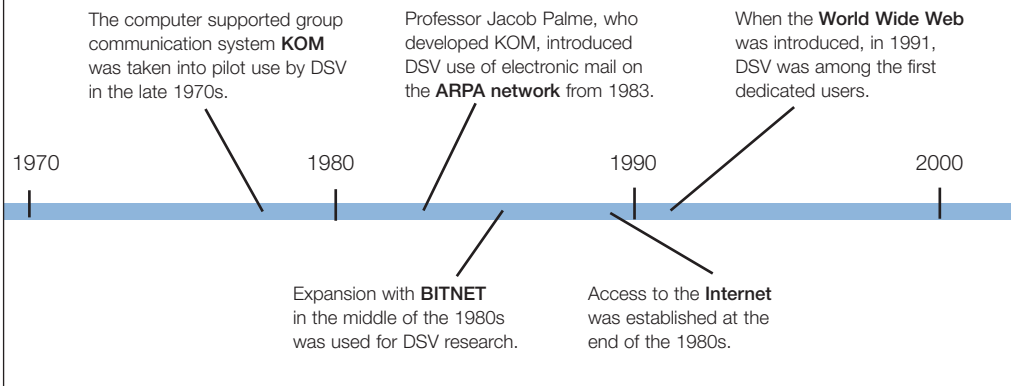
At the time the general opinion at DSV was that personal computers could not be a complete computing alternative for education and research at the university level.

However, a few researchers started early to use personal computers, and developed a system GLAS- Graphic Low cost Advanced System for used in the schools. Each GLAS computer then had more computing capacity than the HP-system, and had better functionality and technical performance than the first IBM PC. 15 GLAS computers were assembled from standardized components around 1981.

With the first Macintosh system 1984, the attitudes started to change.

In 1990 DSV had an environment with 30 PCs with MS-DOS, 24 Macintosh systems and 32 “dumb” terminals connected to the local DEC system.

## DSV – an early participant in widely distributed access



At that time, the DEC systems were to be phased out. A strategy for a new computer environment based on open systems architecture and standards was developed. This led to a change to a Digital Ultrix environment with 90 workstations used in parallel with personal computers, from 1991 - 2000. Also a few SUN Solaris systems were available.

During the 1990s there naturally was an increasing use of personal computers both for employees and for students, and since 2001 when DSV moved to the new premises in the Forum building, the workstation environment was substituted with advanced personal computers.

From 1998, DSV has introduced compulsory use of the group communication system First Class.

In 2006 DSV totally around 500 computer systems (including 50 servers) are available, stationary as well as portable, in a uniform Windows/Linux environment. Students have access to more than 200 stationary computer systems, and they can also use their own portables. A wireless network is accessible in most of the IT-university campus area, support for home use is naturally also available.

### iLounge

The iLounge is a prototype of an interactive workspace, established at the KTH Kista Campus in the beginning of the new century.

It is designed and built by the research group FUSE at DSV, with support from the architects Gullström Architects AB. The intention with this interactive space is to offer an environment that supports collaborative work, especially collaborative design work. Apart from being a research environment, it is gradually used more often for everyday work by student groups on project-oriented courses at the KTH Kista Campus.

The iLounge consists of two heart shaped areas and a corner for audience and side activities. It is constructed as a room within a room. The two main areas are framed by curved mobile walls and curtain rails with several levels of curtains of different character, partly motor driven. Behind the curved inner wall is the "back stage" area for technicians and researchers.

The atmosphere in the iLounge is meant to be more studio- or theatre- like than office-like. High quality wooden floor, choice of wall fabrics and textiles in combination with flexible light setting should contribute to this effect. Light could contribute by varying in the intensity to adapt to different tasks. Both lights and curtains are computer controlled.

There is high quality audio and video equipment that serves several purposes for both input and output. User studies make use of recording of speech, e.g. for voice recognition, loudspeakers playing background sounds and sound cues and high quality of video communication for



The iLounge interactive wall and the interactive table.

distributed work. A standard videoconference system is used as the basis for communication between interactive rooms.

### **IT-platform developed for Shared and real-time Distributed interactive Education**

#### **SHADE**

During 16 years, courses in the IT-Management area were designed, adjusted and delivered, simultaneously, to several groups of students and universities at different locations.

The educational model developed and used was called SHADE: Shared and real-time Distributed interactive Education. The model is based on the transforming and enriching traditional face-to-face education and distributing it, in real-time, to geographically scattered student groups. Off-line, this platform provides access to course materials and interaction with all the actors involved, before, during and after the real-time encounters.

In terms of content and structure, the courses consisted of a theoretical philosophical part, a methodological part and a practical/technical part. Courses combine lectures and practice.

#### **INCA: The technical platform**

The multimedia platform INCA (Interactive Networks for Collaborative Action) was designed to allow real-time, two-way video- audio- and data communication. The platform was, and still is, a dynamic combination of analogue and digital technologies.

The platform consists of a number of key components: access tools, information and knowledge repositories, applications and communication links. The networks used have guaranteed, from the very beginning (1990), the TV quality of the transmissions and a minimum level of interruptions.

#### **The digital classrooms**

Technically, the digital classrooms are the result of the integration, re-design and automation of videoconferencing systems, computer conferencing systems and new pedagogical tools – or audio-visual (AV) technologies (picture: see next page).

Experience showed that only a part of the platform became a visible and an attractive part of the platform. Classrooms of the same type as those in Kista, with the same purpose of sharing and distributing education with DSV or other partners, were built in Gotland, Södertörn and Söderhamn. For several educational activities, the communication worked well. Beyond DSV, the military schools of Sweden adopted the same pedagogical idea and built three rooms in Östersund, Karlberg and Halmstad. Internationally, similar rooms have been built in Saint Petersburg, Santiago de Chile, and in Spain.

#### **DAISY**

##### **DSV Administrative Information SYSTEM**

DAISY was designed to deliver increasing quality of service, and increased quality of information. Daisy has brought about the possibility to simplify managing of education, automatic handling of routine tasks, and manual handling with

system support for individual matters, for high volumes of education.

Daisy is process oriented and supports:

- personnel administration, handling of basic data for faculty
- student administration, all data needed for handling students, from application to graduation, including alumni
- course administration, from overall planning, scheduling and syllabi to managing of faculty, managing of students and evaluation
- examination administration, including planning, managing and support for grading, as well as publishing of grading and follow up on production
- evaluations on line, support for reuse of evaluations for new groups of students, anonymous answers, simple tabulation of results and support for publication of evaluation report

- timetable administration, support for the whole process of scheduling, planning and publication of information

- resource administration, managing of any type of resources needed for class, computers and projectors
- administration of projects, for keeping track of all data from application, manning and financial plan to reports and publications

Basic design principles include specialized views for different user groups.

The system was developed as an in-house project with participation of students, using user centered iterative design.

For students, Daisy means a considerable improvement in terms of quality and access to relevant information. Results are reported electronically, timetables are personalized, descriptions of all passed courses is possible

### The digital classroom

One of the digital classrooms in Kista 2006. The left screen is a digital interactive writing board, on both screens pictures can be shown from different sources in the classroom. This is teacher controlled via a panel. As a part of the concept all lectures were videotaped made available for students rehearsal.



(“course CV”), result summaries and reminders of examination dates are given. For teachers and administrators, the system provides support for all central work processes.

It was introduced in 2000 at DSV and from the autumn of 2006 and on, Daisy will be used at all KTH programmes given in the Kista University area.

#### Example from the main student view in Daisy

The screenshot shows the Daisy student interface with a navigation bar at the top containing: **Current studies**, **Personal**, **Search**, **Select/Register**, **Timetable**, and **Study results**.

**Current studies startpage for student with all ongoing activities.** (Callout pointing to the 'Current studies' tab)

**Ongoing**

**Design theory and creative methods (ITK3:DK), 5p**  
 Course segment of Advanced course in it and communication sciences, 30p  
 2006-08-28 to 2006-10-06  
 Written exam, 2p    Final exam, 2006-10-07 ☒ **Enrollment to written exams.** (Callout pointing to the checkbox)

**Projectwork (ITK3:PA), 6p**  
 Course segment of Advanced course in it and communication sciences, 30p  
 2006-08-28 to 2007-06-08  
 Project work 1, 3 p  
 Project work 2, 3 p

**Unfinished**

**Practical project management (IB9400), 5p**  
 Course segment of Project management, 5p  
 2006-03-06 to 2006-06-10  
 Assignment 1, 3 p  
 Assignment 2, 1 p  
 Assignment 3, 1 p  
**Course area with course-name and links to information page, list of students, courseschedule and exams.** (Callout pointing to the course area)

**Communication science (ITK1:KV), 5p**  
 Course segment of Basic course in IT and communication sciences, 40p  
 2005-01-17 to 2005-06-04

**Timetable, the personal schedule for the semester can be exported to online calendar.** (Callout pointing to the 'Timetable' tab)

**Short schedule this and next week, basic information and links to literaturelist and study CV.** (Callout pointing to the 'Study results' tab)

**Timetable**

| Må | Ti | On | To | Fr | Lö | Sö |
|----|----|----|----|----|----|----|
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |

**2006-09-12**  
 13-14:45 Sal C  
 ITK3:DK Föreläsning 6

**Registrations HT2006**

**First time registration**  
 Advanced course in it and communication sciences, 30p

**Re-registration**  
 Project management, 5p  
 Basic course in IT and communication sciences, 40p  
 Register

**Study information**  
 Study list (pdf)  
 Literature list HT2006



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*Visions for a university  
department in the future  
information society*

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# VISIONS FOR A UNIVERSITY DEPARTMENT IN THE FUTURE INFORMATION SOCIETY

## The direction

Computerized systems will penetrate more and more into peoples lives, in contrast to being available only in specialized professional settings. Computational resources will be available virtually everywhere, in homes, in cars, in public transportation vehicles and in public environments. Computers will no longer be easily distinguishable special artefacts, but embedded in everyday things. The traditional industrial sectors of computer manufacturing, software development, telecommunications, media, and entertainment will merge.

Having supported mainly individual users, computerized systems will come into play in our collaborative and social processes both privately, professionally and on the society level. Large corporations and organizations will become increasingly more dependent on these systems, not only for basic administration, economy and logistics, but also for knowledge management of organizational competence and decisionmaking both on management and grass root level. As the interplay between different kinds of companies and organizations will increase, aspects such as interoperability and reuse will grow in importance.

We will see an increased growth of the use of technology in particular areas such as healthcare and medicine both in homes, work places and in hospitals. Support for people with special needs will be further enhanced. A huge field of expansion is the growing utilization of technology in developing countries, to educate and to counteract health and food problems.

Systems will monotonically grow in size, complexity and heterogeneity. The amounts of digitally stored information will grow rapidly, and the need for competences about refined methods for retrieval and storage will increase. The need for sophisticated analysis of the behaviour of these systems, involving both technology and people, will be ever-increasing.

A consequence of the above tendencies is that the issues of security, privacy and integrity will become of utmost concern. Human - computer guided systems will truly be utilized both for business and pleasure and personal life, with care taken about the potentials and dangers this can mean.

Computerized services for knowledge distribution and dialogue will enhance participation for large groups of citizens. The reason is that the knowledge based networks and technology support decentralized access. However, there will be access borders between certain citizen groups in society.

Computerized systems will increasingly be used to monitor and support democratic contacts and communication between citizens and decision makers. The distance to the citizen will decrease. No part of this will happen in conflict to the will of increasingly educated citizens.

## Actions

In the light of these tendencies, DSV's traditional areas of strength both in education and in research will grow even more in importance. The following important areas are envisioned:

- The integration of information systems deeper into our society will need increased analysis and concern.
- Human machine interaction focused on the interplay between people, devices and services, ubiquitous and mobile computing and support for collaborative work processes
- Information and computer security focused both on algorithms, platforms, standards and on organizational, social and human situations
- Systems analysis focused on modelling, simulation, visualization, data mining, decision support and risk analysis.

- Systems development and software engineering focused on knowledge management, reuse, interoperability and management of large software systems.

The information society changes more and more rapidly. University research and education should always have a long outlook, but must on a 3-5 year timeframe be able to dynamically refocus well established areas, and gracefully phase out established areas whose importance is weakening, and provide rational growing ground for new promising areas of high industrial relevance and importance for society at large.

Starting from the base of the highly relevant priority areas mentioned above, and maintaining the flexibility for reorientation, DSV must be able to maintain a high and stable level of funding both from national and international sources of scientific as well as industrial character.

The ambition is to maintain attractiveness in education and research nationally and internationally, being able to recruit highly competent faculty members, and to attract motivated students on a global scale. These educated people will then become highly attractive in industry and government, continuously improving working environments and pedagogical practises.

They will have good partnerships both in academia and industry.

Apart from keeping up excellence in the traditional academic respect it is an aim for DSV to increase the methodological influence on practises in business, industry, and in governmental agencies, as well as to support development of systems for participation in decision making. It is desirable to increase the two-way flow of competent personnel between DSV and business, industry and government, as well as with other users, increasing the rate of generating patents and spinoff companies.

DSV aims to be an active part in the forming of a Centre for Digital Culture, where education and research that reaches over conventional borders will be carried out. This Centre will work to expand the concept of culture, to include new commons, integration, inclusion, sensualism, new social patterns, multiplicity, social games, public services and electronic democracy.

The visibility of the Department in media and public debate is planned to increase.

30 years ago, a new Nobel Prize was defined in Economics. DSV supports discussions about creating a Nobel Prize in the area of Information and Communication Technologies.

# LICENTIATE THESES 1996 - JULY 2006

| Year | Author                     | Title                                                                                                                                             | University |
|------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1971 | Gunnar Lemon               | Informationsanalys inom det teknisk-administrativa området<br>(Tillämpning och studium av prededens- och komponentanalys)                         | SU         |
| 1971 | Tomas Ohlin                | Utvärdering av databehandlingssystem                                                                                                              | SU         |
| 1972 | Kristo Ivanov              | Quality-control of information: on the concept of accuracy of<br>information in data-banks and in management information systems                  | KTH        |
| 1972 | Gunnar Rodin               | Metoder för kryptering av datorlagrade data                                                                                                       | KTH        |
| 1973 | Ulf Gars                   | Styrning av datakommunikation med utgångspunkt från<br>svarstidskrav                                                                              | KTH        |
| 1973 | Sten-Åke<br>Tärnlund       | On computation of the unification algorithm in a resolution based<br>deduction                                                                    | SU         |
| 1973 | Christer Arvas             | Planering av databasorienterad statistisk informationsbehandling                                                                                  | SU         |
| 1973 | Anita Kollerbaur           | Analys av system för interaktiv datorstödd undervisning och en<br>första analys till hypotesformuleringar                                         | SU         |
| 1989 | Erik Malmberg              | On the use of Semantic Models for Specifying Information Needs                                                                                    | KTH        |
| 1989 | Benkt Wangler              | On the use of Abstractions in Database Modeling<br>- Propagation of Mapping Constraints under Attribute Abstraction                               | SU         |
| 1989 | Erik Knudsen               | Grammars, Parsing and Logic Programming                                                                                                           | SU         |
| 1990 | Gunnar Holm                | Kvalitativa aspekter hos systemeringsmetoder: En metodologisk diskussion<br>av frågan Vad gör systemutveckling mänsklig och kompetensutvecklande? | SU         |
| 1990 | Henrik Boström             | Generalizing Goal Orders as an Approach to Generalizing Number                                                                                    | SU         |
| 1990 | Harald Kjellin             | Improving Partial Matching by Assigning Weights to Attributes                                                                                     | SU         |
| 1990 | Peter Idestam-<br>Almquist | Demand Networks: An alternative Representation of Version Spaces                                                                                  | SU         |
| 1990 | Lars Asker                 | Approaches to the Imperfect Theory Problem in Explanation-Based Learning                                                                          | SU         |
| 1990 | Anders<br>Björnerstedt     | Secondary Storage Garbage Collection for Decentralized Object-Based<br>Systems                                                                    | SU         |
| 1990 | Peter Nilsson              | Information Quality - An analysis of quality aspects of information used in<br>problem solving                                                    | SU         |
| 1990 | Guillermo<br>Lois de Silva | CIME: An Application-Oriented conceptual Modeling Language                                                                                        | SU         |
| 1991 | Christer<br>Samuelsson     | Using explanation-based learning to speed up natural language<br>systems                                                                          | KTH        |
| 1991 | Mikael Kindborg            | Visual Techniques for Orientation in Hypermedia Structures                                                                                        | SU         |
| 1991 | Bassam Michel<br>El-Khouri | A Methodology for Preparing Data for Cluster Analysis                                                                                             | SU         |
| 1991 | Paul<br>Johannesson        | On Negotiations, Schema translation, and Schema Integration in<br>Federated Information Systems                                                   | SU         |
| 1991 | Magnus Boman               | Axiomatic Propositional Epistemic Logic Systems as a<br>Framework for Federated Information Systems                                               | SU         |
| 1991 | Kristina Höök              | An Approach to a Route guidance Interface                                                                                                         | SU         |
| 1992 | Hercules Dalianis          | User adapted natural language discourse generation for<br>validation of conceptual models                                                         | KTH        |
| 1992 | Annika Waern               | Planning and Reasoning Strategies for Human-Machine<br>Interaction in Route Guidance                                                              | KTH        |
| 1992 | Per Lindevall              | A Geometric Approach to Reactive Planning in a Route Guidance<br>System for Automobiles                                                           | KTH        |
| 1992 | Peder Brandt               | Using Explanation-Based Learning to speed up<br>Natural language Systems                                                                          | SU         |
| 1992 | Fredrik Kilander           | COBBIT - Improving COBWEB's performance in an evolving domain                                                                                     | SU         |
| 1992 | Jussi Karlgren             | The Interaction of Discourse Modality and User Expectations in<br>Human-Computer Dialog                                                           | SU         |
| 1992 | Eduardo Pérez              | Information Security Management in IT Systems and Organizations.<br>A conceptual Model                                                            | SU         |
| 1992 | Love Ekenberg              | Mechanization of a Theory for Decision Analysis                                                                                                   | SU         |

| Year | Author                | Title                                                                                                                           | University |
|------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------|------------|
| 1992 | Louise Yngström       | Towards a Systemic-Holistic Approach to Academic Programs in the Area of IT Security                                            | SU         |
| 1993 | Peter Holm            | A Social and Organisational Perspective on Computerisation, Competence, and Standardisation                                     | SU         |
| 1993 | Åke Malmberg          | Systemic Grammar Network as a Knowledge Representation Language                                                                 | SU         |
| 1993 | Björn Rosengren       | När- och distansutbildning med dubbelriktad bild- och ljudkommunikation - en fallbeskrivning                                    | SU         |
| 1994 | Jari Koistinen        | Large-Grained Modularization of Object-Oriented Software                                                                        | KTH        |
| 1995 | Xiaohong Jin          | Authentication in Open Distributed Systems                                                                                      | KTH        |
| 1995 | Mats Danielson        | Computing Best Choices Using Imprecise Information                                                                              | KTH        |
| 1995 | Ivan Bretan           | Natural Language in Model World Interfaces                                                                                      | KTH        |
| 1995 | Peter Rosengren       | Visual Query Systems - Architecture and Usability                                                                               | KTH        |
| 1995 | Åsa Rudström          | Applications of Machine Learning                                                                                                | SU         |
| 1995 | Matts Ahlsén          | The Federation as a Model for Information Systems Architecture                                                                  | SU         |
| 1996 | Mats Waltré           | Scenario Analysis - An Approach to Organisational Learning                                                                      | KTH        |
| 1996 | Peter Hökenhammar     | Beställarkompetens vid Datasystemutveckling                                                                                     | SU         |
| 1996 | Gunnar Wahlgren       | A proposal for a computer aided IT risk management system - an object-oriented approach                                         | SU         |
| 1997 | Yi Cheng              | A Comprehensive Security Infrastructure for Mobile Agents                                                                       | KTH        |
| 1997 | Petia Wohed           | Formalism and Schema Evolution                                                                                                  | SU         |
| 1997 | Fredrik Holmgren      | A Grammar-Based Approach to Design and its Application to Electronics and Logic Programming                                     | SU         |
| 1997 | Sven-Erik Öhlund      | Utveckling av ett utvärderingsinstrument - PRODEVO - ett hjälpmedel för att utvärdera IT-baserad tjänste- och produktutveckling | SU         |
| 1998 | Mira Kajko-Mattsson   | Conceptual Model of Software Maintenance - A First Step Towards a Framework for Software Maintenance                            | SU         |
| 1998 | Henricus Verhagen     | Agents and Sociality                                                                                                            | SU         |
| 1998 | Klas Karlgren         | Refining Language Games and Fostering Superficiality in Learning                                                                | SU         |
| 1998 | Fredrik Espinoza      | sicsDAIS: Managing User Interaction with Multiple Agents                                                                        | SU         |
| 1998 | Jan Aidemark          | Planning Information Systems for Organisational Flexibility                                                                     | SU         |
| 1999 | Eriks Sneiders        | Automnated FAQ Ansering on WWW Using Shallow Language Understanding                                                             | KTH        |
| 1999 | Janis Stirna          | Choosing Strategy for Enterprise Modelling Tools Acquisition                                                                    | KTH        |
| 1999 | Anne Persson          | An Empirical Assessment of the "From Fuzzy to Formal" Approach to Enterprise Modelling                                          | SU         |
| 1999 | Mats Wiklund          | Datorförmedlad kommunikation via Bulletin Board Systems (BBS:er)                                                                | SU         |
| 1999 | Alan Davidson         | Availability, Integrity and Consistency in Certificate Management                                                               | SU         |
| 1999 | Danny Brash           | Participation in Enterprise Modeling                                                                                            | SU         |
| 1999 | Niclas Eberhagen      | An Investigation of Emerging Knowledge Distribution Means and their Characterization                                            | SU         |
| 1999 | Guy Davies            | Formally Mapping Dynamics: From Process Transitions to Schema Events                                                            | SU         |
| 2000 | Stefan Zemke          | Machine Learning for Index Prediction                                                                                           | KTH        |
| 2000 | Eva Rydberg-Fåhræus   | Growing Knowledge How to Support Collaborative Learning e-Discussions in Forum Systems                                          | KTH        |
| 2000 | Matei Ciobanu Morogan | Generic Security Objects a Comprehensive Java Security System for Open Networks                                                 | KTH        |
| 2000 | Mark Tierney          | Concall: An Exercise in Designing Open Service Architectures                                                                    | SU         |
| 2000 | Martin Svensson       | Defining and Designing Social Navigation                                                                                        | SU         |
| 2000 | Håkan Sterner         | Knowledge Management Methodologies - Contributions from Systems Thinking, Decision Making and Organisational Learning           | SU         |
| 2000 | Nandika Kasun         | The Concept of A Security WWW System Based on Smart Cards and Certification Technologies                                        | SU         |
|      | De Zoysa              |                                                                                                                                 |            |

| Year | Author                  | Title                                                                                                                                  | University |
|------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------------|
| 2001 | Johan Kummeneje         | RoboCup as a Means to Research, Education, and Dissemination                                                                           | SU         |
| 2001 | Jakob Tholander         | Designing for Cognitive Apprenticeship: A Learning Environment for Object-Oriented Modeling                                            | SU         |
| 2001 | Åsa Smedberg            | An Approach to Working and Learning in Combination Using IT - a Systemic-based Approach with Focus on Human and Technological Networks | SU         |
| 2001 | Fredrik Björck          | Security Scandinavian Style                                                                                                            | SU         |
| 2001 | Kjell Näckros           | Game-Based Instruction within IT Security Education                                                                                    | SU         |
| 2001 | Anette Hulth            | The Gist of Written Documents: Automatic Derivation and Evaluation of Content Descriptors                                              | SU         |
| 2002 | Harald Svensson         | Work Conducted On and With the Personal Software Process                                                                               | KTH        |
| 2002 | Jeffy Mwakalinga        | Security Management of Global and Integrated Security System                                                                           | KTH        |
| 2002 | Anna-Maria Kessler      | Value at Risk (VaR): Usability and Reliability in the Short and Long Run                                                               | SU         |
| 2002 | Prasad Jayaweera        | A Methodology to Generate e-Commerce Systems: A Process Pattern Perspective (P3)                                                       | SU         |
| 2002 | Lisa Brouwers           | Flood Risk Management Policy from an Insurance Perspective                                                                             | SU         |
| 2002 | Roger Holmberg          | An Architecture for Large Scale Similarity Based Retrieval of Complex Objects                                                          | SU         |
| 2002 | Fredrik Rutz            | Trust in Assistants                                                                                                                    | SU         |
| 2002 | Karin Hansson           | Managing Natural Catastrophe Loss; Simulation of Policy Strategies                                                                     | SU         |
| 2002 | Henrik Bergström        | Investigating the Concept of CBR for Software Cost Estimation                                                                          | SU         |
| 2002 | Sebamalai J Paheerathan | Repository Support to Enterprise Application Integration Based on Business Scenarios, Contracts and Commitments                        | SU         |
| 2002 | Rickard Cöster          | Learning and Scalability in Personalized Information Retrieval and Filtering                                                           | SU         |
| 2002 | Maria Bergholtz         | Creating Conceptual Model Interpretations                                                                                              | SU         |
| 2003 | Martin Jonsson          | Supporting Context Awareness in Ubiquitous Service Environments                                                                        | KTH        |
| 2003 | Vandana Kabilan         | Using Multi Tier Contract Ontology to Model Contract Workflow Models                                                                   | KTH        |
| 2003 | Mats Skoglund           | Investigating Object-Oriented Encapsulation in Theory and Practice                                                                     | SU         |
| 2003 | Per Backlund            | Knowledge Transfer in Information Systems Engineering                                                                                  | SU         |
| 2003 | Theresia Olsson Neve    | A Cognitive Narrative Approach to Individual Learning and Personal Development within Organisations                                    | SU         |
| 2003 | Respickius Casmir       | An Approach to IT Security Education for Developing Countries                                                                          | SU         |
| 2003 | Jarmo Laaksolahti       | Towards Socio-Emotionally Rich Interactive Narrative                                                                                   | SU         |
| 2003 | Tony Lindgren           | Rule Conflicts<br>- New Methods of Resolution                                                                                          | SU         |
| 2003 | Rika Manka Tesha        | A First Order Framework for the Analysis of Conceptual Schemas                                                                         | SU         |
| 2003 | Benedict Amon           | Defining User Requirements for Automating Software Development:<br>- A LYEE Case Study                                                 | SU         |
| 2003 | Job A Chaula            | Security Metrics and Public key Infrastructure Interoperability Testing                                                                | SU         |
| 2003 | Charles N Tarimo        | Towards a generic framework for Implementation and Use of Intrusion Detection Systems                                                  | SU         |
| 2004 | Dickson M Rugaimukamu   | Unified Contract and Process Design                                                                                                    | SU         |
| 2004 | Lourino Alberto Chemane | ICT Platforms Integration - A Framework for Value Networks                                                                             | SU         |
| 2004 | Carina Helmersson       | Informationshantering i småföretag - ett verktyg med ett holistiskt perspektiv                                                         | SU         |
| 2004 | Upendo Eneah Njabili    | Empirical Test of the AOR Approach                                                                                                     | SU         |
| 2004 | Marcelo V Munguanace    | Applying Analysis Pattern and Components to Improve the Agent-Object-Relationship Modelling Technique                                  | SU         |
| 2004 | Ewa Zimmerman           | Guidelines for Enhanced Intranet Use<br>- A Study of Dissemination of Information to Field Workers Within Municipalities               | SU         |

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| Year | Author                     | Title                                                                                                                                            | University |
|------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 2004 | Tobias Wrigstad            | External Uniqueness<br>- A Theory of Aggregate Uniqueness for Object-Oriented Programming                                                        | SU         |
| 2004 | Åsa Grehag<br>Dahlstedt    | Requirements Interdependencies<br>- Towards an Understanding of their Nature and Context of Use                                                  | SU         |
| 2004 | Alexander<br>Backlund      | Making Sense of Complexity in the Context of Information Systems                                                                                 | SU         |
| 2005 | Johan Mattsson             | Interaction through Spells<br>- Establishing traces of Invisible Connections                                                                     | KTH        |
| 2005 | Petra Sundström            | Exploring the Affective Loop                                                                                                                     | SU         |
| 2005 | Orlando Pedro<br>Zacarias  | A Bayesian Approach to Malaria Modelling in Maputo Province<br>- Mozambique                                                                      | SU         |
| 2005 | Avelino Isaias<br>Mondlane | Natural Disasters Risk Management and Financial Disaster Hedging in<br>Developing Countries An Ex-Ante Approach Toward Financial Risk Mitigation | SU         |
| 2005 | Terese<br>Stenfors-Hayes   | Implementing Knowledge Management Principles in Higher Education                                                                                 | SU         |
| 2005 | Jabiri Kuwe<br>Bakari      | Towards a Holistic Approach for Managing ICT Security in Developing<br>Countries: A case study of Tanzania                                       | SU         |
| 2005 | Eva Sjöqvist               | Epostens Roll i Organisationen<br>En studie om att använda eller inte använda epost                                                              | SU         |
| 2005 | Andrea Andrenucci          | Using Web Portals for Medical Information Mediation                                                                                              | SU         |
| 2006 | Wei Li                     | Toward A Person-Centric Context Aware System                                                                                                     | KTH        |
| 2006 | Gustav Boström             | Simplifying development of secure software - Aspects and<br>Agile methods                                                                        | KTH        |
| 2006 | Gustaf<br>Juell-Skielse    | ERP Adoption in Small and Medium Sized Enterprises                                                                                               | KTH        |
| 2006 | Nguyen Hong Van            | Mobile Agent Approach to Congestion Control                                                                                                      | SU         |
| 2006 | Mona Pålman                | Communication of Decision Tool Data                                                                                                              | SU         |
| 2006 | Rose-Mharie<br>Åhlfeldt    | Information Security in a Distributed Healthcare Domain<br>Exploring the Problems and Needs of Different Healthcare Providers                    | SU         |
| 2006 | Maria Croné                | Interactive Workspaces as Support for Collaborative Work                                                                                         | SU         |
| 2006 | Fatima Jonsson             | Youth Selves in Game Play - How Young People Use Computers<br>to Express Themselves                                                              | SU         |

# DOCTORIAL THESES 1996 - JULY 2006

| Year | Author                       | Title                                                                                                                                     | University |
|------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1973 | Bo Sundgren                  | An Infological Approach to Data Bases                                                                                                     | SU         |
| 1973 | Janis Bubenko                | Contributions to formal description, analysis and design of data processing systems TRITA-IBADB-1010                                      | KTH        |
| 1973 | Kristo Ivanov                | Quality-Control of Information on the Concept of Accuracy of Information in the data-Banks and in Management                              | KTH        |
| 1974 | Rolf Høyer                   | Formelle og uformelle aspekter av administrativ styrning                                                                                  | KTH        |
| 1976 | Sten-Åke Tärnlun             | Logic Information Processing<br>TRITA-IBADB-1034                                                                                          | KTH        |
| 1976 | Mats Lundeborg               | Some Propositions Concerning Analysis and Design of Information Systems TRITA-IBADB-4080                                                  | KTH        |
| 1976 | Hans-Eric Nissen             | On interpreting services rendered by specific computer applications                                                                       | KTH        |
| 1977 | Peter Revay                  | RAS i teoretisk och praktisk belysning<br>TRITA-IBADB-1051                                                                                | SU         |
| 1978 | Kjell Samuelsson             | Informatics by General Systems and Cybernetics<br>TRITA-IBADB-5011                                                                        | KTH        |
| 1978 | Mats Lindquist               | The Dynamics of Information Search Services<br>TRITA-IBADB-6012                                                                           | SU         |
| 1978 | Lars Kahn                    | Design of abstract programs in an interactive environment<br>TRITA-IBADB-3106                                                             | SU         |
| 1979 | Björn Nilsson                | On Models and Mappings in a Data-Base Environment<br>ISBN 91-3805-221-0                                                                   | SU         |
| 1980 | Åke Hansson                  | A Formal Development of Programs                                                                                                          | KTH        |
| 1980 | Christer Hultén              | A Data Structure for Highly Skewed Access Patterns<br>ISBN 91-8521-256-3                                                                  | KTH        |
| 1980 | Lars Söderlund               | A Study on Concurrent Data Base Organization<br>ISBN 91-8521-257-1                                                                        | KTH        |
| 1980 | Göran Goldkuhl               | Framställning och användning av informationsmodeller<br>ISBN 91-7146-111-6                                                                | SU         |
| 1981 | Hans Köhler                  | Undervisningssystemering - Ett metodologiskt bidrag till kunskapsområdet datorstödd undervisning ISBN 91-7146-121-3                       | SU         |
| 1982 | Bengt G Lundberg             | Contributions to Information Modelling<br>ISBN 91-8521-284-9                                                                              | KTH        |
| 1983 | Istvan Orci                  | Contributions to Automatic Theory<br>ISBN 91-8521-297-0                                                                                   | KTH        |
| 1985 | Gregor Jonsson               | A Conceptual Schema Facility based on Conceptual Information and Logic Programming                                                        | KTH        |
| 1986 | Bo Steinholtz och Kim Waldén | Control of Evolving Software Systems<br>A Language-Independent Database Approach ISBN 91-7170-991-6                                       | KTH        |
| 1987 | Carl Gustaf Jansson          | Taxonomic Representation<br>ISBN 91-7170-991-6                                                                                            | KTH        |
| 1990 | John Arild Johannesson       | Organisatorisk systemutvikling og informasjonsledelse (organisatorisk design, informasjons- og arbeids-prosessanalyse) ISBN 91-7146-823-4 | SU         |
| 1991 | Jan Olsson                   | An Architecture for Diagnostic Reasoning Based on Causal Models ISBN 91-7146-823-4                                                        | SU         |
| 1991 | Per S Agrell                 | Systems Theory for Systems Practice<br>(A simple framework for complex studies) ISBN 91-7146-976-1                                        | SU         |
| 1992 | Sven Rasegård                | Informatics and Systems Science Applications for Analysis and Structural Improvement of a Municipal Organization ISBN 91-7146-973-7       | SU         |
| 1993 | Terttu Orci                  | Temporal Reasoning and Data Bases<br>ISBN 91-7153-100-9                                                                                   | KTH        |
| 1993 | Lars-Henrik Eriksson         | Finitary Partial Inductive Definitions and General Logic<br>ISBN 91-7153-105-X                                                            | KTH        |
| 1993 | Benkt Wangler                | Contributions to Functional Requirements Modelling<br>ISBN 91-7153-102-5                                                                  | KTH        |

| Year | Author                  | Title                                                                                                               | University |
|------|-------------------------|---------------------------------------------------------------------------------------------------------------------|------------|
| 1993 | Manny Rayner            | Abductive Equivalential Translation and its application to Natural Language Database Interfacing ISBN 91-7153-144-0 | KTH        |
| 1993 | Paul Johannesson        | Schema Integration, Schema Translation, and Interoperability in Federated Information Systems ISBN 91-7153-101-7    | SU         |
| 1993 | Magnus Boman            | A Logical Specification of Federated Information Systems ISBN 91-7153-103-3                                         | SU         |
| 1993 | Peter Idestam-Malmquist | Generalization of Clauses ISBN 91-7153-145-9                                                                        | SU         |
| 1993 | Martin Aronsson         | GCLA: The Design, Use, and Implementation of a Program Development ISBN 91-7153-148-3                               | SU         |
| 1993 | Henrik Boström          | Explanation-Based Transformation of Logic programs ISBN 91-7153-167-X                                               | SU         |
| 1993 | Christer Samuelsson     | Fast Natural-Language Parsing Using Explanation-Based Learning ISBN 91-7153-146-7                                   | KTH        |
| 1994 | Stewart Kowalski        | IT Security: A Multi-disciplinary Inquiry ISBN 91-7153-207-2                                                        | KTH        |
| 1994 | Love Ekenberg           | Decision Support in Numerically Imprecise Domains ISBN 91-7153-208-0                                                | SU         |
| 1994 | Lars Asker              | Partial Explanations as a Basis for Learning SU ISBN 91-7153-223-2                                                  | SU         |
| 1994 | Harald Kjellin          | A Method for Acquiring and Refining Knowledge in Weak Theory Domains ISBN 91-7153-225-0                             | SU         |
| 1994 | Stefan Britts           | Object Database Design ISBN 91-7153-221-8                                                                           | SU         |
| 1994 | Fredrik Kilander        | Incremental Conceptual Clustering in an On-Line Application ISBN 91-7153-224-2                                      | SU         |
| 1995 | Magnus Stensmo          | Adaptive Automated Diagnosis ISBN 91-7153-415-6                                                                     | KTH        |
| 1995 | Wei Song                | Schema Integration - Principles, Methods, and Applications ISBN 91-7153-362-1                                       | SU         |
| 1995 | Anna-Lena Johansson     | Logic Program Synthesis Using Schema Instantiation in an Interactive Environment ISBN 91-7153-414-8                 | SU         |
| 1996 | Annika Waern            | Recognising Human Plans: Issues for Plan Recognition in Human-Computer Interaction ISBN 91-7153-456-3               | KTH        |
| 1996 | Klas Orsvärn            | Knowledge Modelling with Libraries of Task Decomposition Methods ISBN 91-7153-471-7                                 | KTH        |
| 1996 | Hercules Dalianis       | Concise Natural Language Generation From Formal Specifications ISBN 91-7153-464-4                                   | KTH        |
| 1996 | Peter Holm              | On the Design and Usage of Information technology and the Structuring of Communications and Work ISBN 91-7153-474-1 | SU         |
| 1996 | Kristina Höök           | A Glass Box Approach to Adaptive Hypermedia ISBN 91-7153-510-1                                                      | SU         |
| 1996 | Louise Yngström         | A Systemic-Holistic Approach to Academic Programmes in IT Security ISBN 91-7153-521-7                               | SU         |
| 1997 | Rolf Wohed              | A Language for Enterprise and Information System Modelling ISBN 91-7153-588-8                                       | KTH        |
| 1997 | Rolf Gambäck            | Processing Swedish Sentences: A Unification-Based Grammar and Some Applications ISBN 91-7153-457-1                  | KTH        |
| 1997 | Nada Kapidzic Cicovic   | Extended Certificate management System: Design and Protocols ISBN 91-7153-617-5                                     | KTH        |
| 1997 | Mats Danielson          | Computational Decision Analysis ISBN 91-7153-613-2                                                                  | KTH        |
| 1997 | Ying Zhang              | Multi-Temporal Database Management with a Visual Query Interface ISBN 91-7153-670-1                                 | KTH        |
| 1997 | Pierre Wijkman          | Contributions to Evolutionary Computation                                                                           | SU         |

| Year | Author                   | Title                                                                                                                                           | University |
|------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 1998 | Jari Koistinen           | Contributions in Distributed Object Systems Engineering<br>ISBN 91-7153-588-8                                                                   | KTH        |
| 1998 | Ulf Essler               | Analyzing Groupware Adoption: A Framework and Three case studies in Lotus Notes Deployment ISBN 91-7153-700-7                                   | SU         |
| 1999 | Sari Hakkarainen         | Dynamic Aspects and Semantic Enrichment in Schema Comparison ISBN 91-7153-934-4                                                                 | SU         |
| 1999 | Christer Magnusson       | Hedging Shareholder Value in an IT Dependent Business Society the Framework BRITS ISBN 91-7265-011-7                                            | SU         |
| 2000 | Henricus Verhagen        | Norm Autonomous Agents<br>ISBN 91-7265-073-7                                                                                                    | SU         |
| 2000 | Petia Wohed              | Schema Quality, Schema Enrichment, and Reuse in Information Systems Analysis ISBN 91-7265-074-5                                                 | SU         |
| 2001 | Fabian von Schéele       | Controlling Time and Communication in Service Economy<br>ISBN 91-7265-300-0                                                                     | KTH        |
| 2001 | Janis Stirna             | The Influence of Intentional and Situational Factors on Enterprise Modelling Tool Acquisition in Organisations ISBN 91-7265-363-9               | KTH        |
| 2001 | Peter Hökenhammar        | Integrerad Beställningsprocess vid Datasystemutveckling - Om kravhantering i ett vidare perspektiv ISBN 91-7265-154-7                           | SU         |
| 2001 | Mira Kajko-Mattsson      | Corrective Maintenance Maturity Model: Problem Management<br>ISBN 91-7265-311-6                                                                 | SU         |
| 2001 | Anne Persson             | Enterprise Modelling in Practice: Situational Factors and their Influence on Adopting a Participative Approach ISBN 91-7265-361-2               | SU         |
| 2002 | Eriks Sneiders           | Automated Question Answering: Template-Based Approach<br>ISBN 91-7283-235-5                                                                     | KTH        |
| 2002 | Martin Eineborg          | Inductive Logic Programming for Part-of-Speech Tagging<br>ISBN 91-7283-274-6                                                                    | KTH        |
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The book gives an account of research and education at DSV, and of minor and major events occurring in a workplace. A number of professors who are active – or who have previously been active at DSV – give their appreciation of the development. In wide brush strokes, they paint a picture of the development of IT research and education during the past 40 years. In humorous or critical words, they give their view of life and of the development at the department.

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