DEPARTMENT OF COMPUTER AND SYSTEMS SCIENCES
STOCKHOLM UNIVERSITY
ROYAL INSTITUTE OF TECHNOLOGY

IS1/2I1228 ENTERPRISE SYSTEMS AND MODELLING

AUTUMN 2006
http://dsv.su.se/vle/course/view.php?id=7

COURSE NOTES

COURSE GOALS

The goal of the course is to familiarise the students with:

- research and trends in the enterprise modeling and enterprise systems area, in particular modeling languages, methods and systems architectures
- advanced concepts in enterprise modeling including business patterns, business models and ontologies, and process management
- the functionality and architecture of enterprise wide systems
- alignment of business and IT
- international research publications

SCHEDULED ACTIVITIES

LECTURE 1: Course overview and context. Goal models.

LECTURE 2: Logistics, in particular procurement and sales, introduction of modelling assignment.

LECTURE 3: Business models, REA (Resource – Event – Agent), an ontology for enterprise systems.

LECTURE 4: More on business models, *e³-value*.

LECTURE 5: Linguistic models for communication. Speech acts. A formal language for business communication (FLBC).

LECTURE 6: Process models, Petri Nets.

LECTURE 7: Guest lecture.

LESSON 1: Goal models and business models.

LESSON 2: REA ontology I.

LESSON 3: REA ontology II.

LESSON 4: Process models.

INITIAL PRESENTATION: Project assignment.

MODELLING SESSION: Project assignment.

FINAL PROJECT REVIEW: Project assignment.

LITERATURE

Pavel Hruby: *Model-Driven Design Using Business Patterns*, Springer, 2006

Collection of selected papers

TEACHERS

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EXAMINATION

The examination of the course consists of two parts:

- Written exam, see section written exam
- Project assignment, see section project assignment

WRITTEN EXAM

An example of a written exam can be found at the course web site and the First Class conference "gamla tentor" a sub-conference to the conference "Studentexpeditionen". The students are allowed to bring lecture notes, exercise notes and course literature to the written exam.

You can be awarded maximum one extra point for your written exam by attending the guest lecture and handing in a 1 – 2 pages written summary of the lecture. The summary must be handed in no later than the exam date. This opportunity is only available for the first written exam given directly after the course period in which the student participated.

You can be awarded maximum two extra points for your written exam by individually carrying out the Special Assignment, which is described on the home page of the course. The assignment must be completed before the exam. . This opportunity is only available for the first written exam given directly after the course period in which the student participated.

GRADING

The written exam contains questions for a total of 30 points. The grading will be as follows:

For students at SU, 22 points suffice for G, 27 points suffice for VG.

For students at KTH, 22 points suffice for 3, 26 points suffice for 4, and 29 points suffice for 5.

ENTERPRISE MODELLING

This assignment is to be carried out in groups of five students. Each such group is called a *project group*. The assignment is about a company, Design Computer AB, described in the text below (AS-IS). Your task is to investigate and document the future situation (TO-BE) in the company and relate it to the goals of the company. When you are describing the TO-BE situation of the company, you should think about such facts as best practice, effectiveness, productivity and liquidity. (Lecture 2 and other literature should be used as background information used for solving the assignment.)

In order to pass the project assignment, each project group has to

1. Participate in an *initial presentation*

2. Participate in an *early project review* and hand in the results of this review (see below for details), which must be completed before the fourth lesson

3. Participate in a *modelling session*

4. Construct and hand in a final solution, documented in the same way as done in the seminar groups; this is done in a joint group, see below

5. Participate in a *final project review*; this is done in a joint group, see below

Your documentation shall include:

- A text describing how the company plans to fulfil the strategic objectives of its business, which are described under the heading Design Computer AB below (around 1/2 page)

- A conceptual schema (expressed as UML class diagrams) using the REA ontology. All classes/entities including attributes must be named and the cardinality/multiplicity between the classes/entities must be expressed. Stereotypes for all classes shall be specified in accordance with REA

- A goal model based on BMM

- A list of company processes at a high level

- A number of scenarios (expressed as UML sequence diagrams) for the most important processes

- An *e³-value* business model

- A value process graph for the most important processes showing the resources produced and consumed

- A number of detailed process models expressed as Petri nets

- An explanation of the relationships between the models. The *e³-value* model shall be related to the process models and the goal model shall be related to the *e³-value* model. For relating the *e³-value* business model to the process model, you can use the phases from Open-edi (see "Useful resources" on the home page of the course). For relating the goal model to the *e³-value* business model, see the lecture notes.

The documentation shall also discuss the following questions:

- Which Action-Workflow loops exist? Are there open loops or closed loops? If there are open loops, should they be closed?

- Do the process scenarios adhere to FLBC?

- How should the processes be changed in order to better support the goals of the company?

- Which parts of the conceptual schema correspond to the REA ontology?

The documentation shall also contain a description of which changes the project group has made to its models after the modelling session, and a brief description (around one page) of the results from the early project review. Do not forget that all models should also be described and explained in plain text.

INITIAL PRESENTATION

Each project meets with a teacher for about 30 minutes and presents and discusses its solutions. The following models are to be presented:

- Goal model

- *e³-value* model

- Draft of the conceptual schema

EARLY PROJECT REVIEW

Before the modelling session, two project groups must meet and discuss and review each others models. It is up to the project groups to find another project group to perform the project review together with. The results from the review must be documented by each project group (according to the early project review template) and shall be handed in by FirstClass.

The review should focus on the model's syntax (does the project group use the correct UML and Petri net notation?), the scope (are all parts of the company modelled?) and the detail level of the models (are the models detailed enough?). The review should also check that all model types (conceptual schema, goal model, value process graph, and process scenarios) are included.

Each project group must hand in a review protocol, and the early review protocol template on the home page of the course shall be used for this purpose.

MODELLING SESSION

During the modelling session, which is a one day event, two project groups should together create a conceptual schema, a goal model, a scenario, *e³-value* business model, a value process graph, and a process model, based on the two project groups' models. The project groups will discuss and compromise to find common models. The modelling must be carried out using plastic sheets and post-it notes, which will be supplied by the teachers during the modelling session. After the modelling session, both groups will together join into a new group, called a *joint group*. This joint group will refine the models from the modelling session and hand in the final documentation. The final documentation must contain a description of which changes the joint group has made to the original models of the project groups.

FINAL PROJECT REVIEW

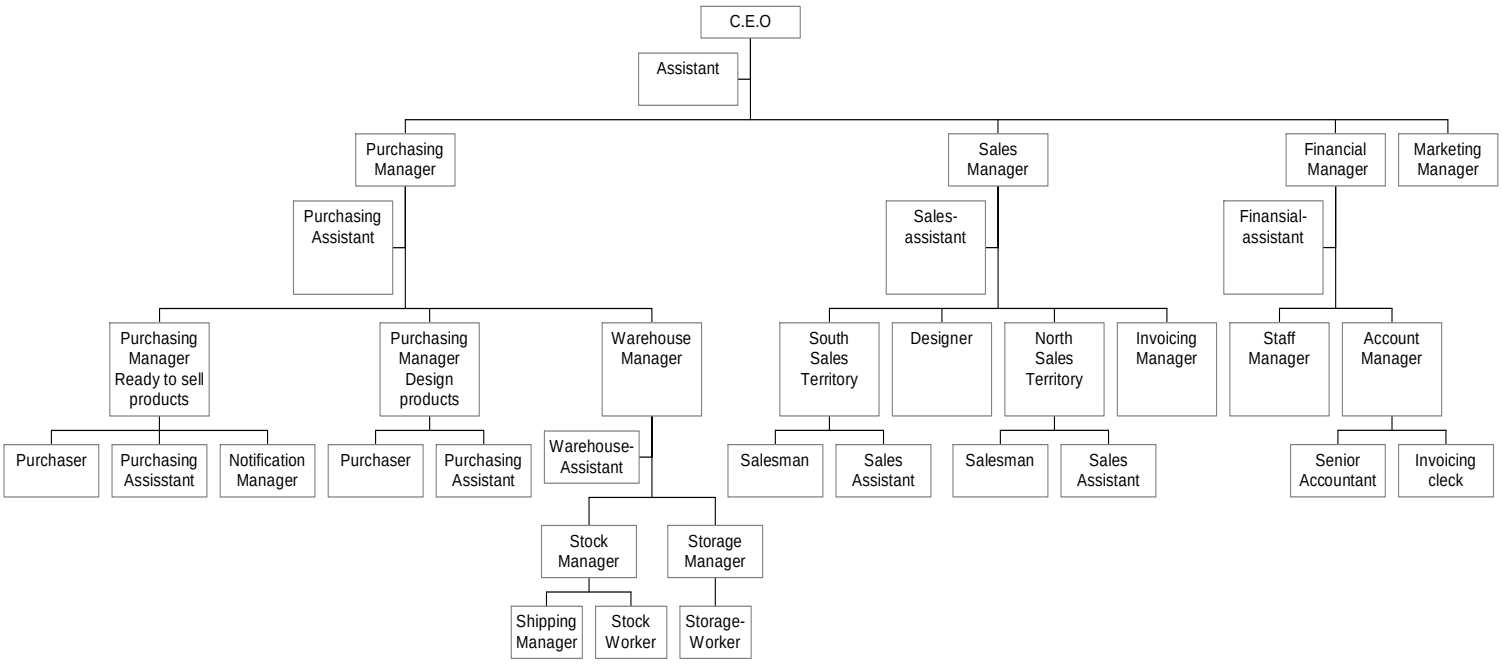
Two joint groups and a teacher meet for about 90 minutes. The joint groups shall exchange their documentation at least two days before the final project review. Each joint group shall read and criticise the work of the other joint group. During a review, an opponent group leads a discussion by first giving a short presentation of the other group's work (at most 15 minutes) and then giving detailed comments and questions that the other group shall answer (for about 30 minutes). The final review protocol template on the home page of the course shall be used.

DESIGN COMPUTER AB

Design Computer AB is a company situated in Stockholm. The company co-operates closely with its international counterparts. The company may in the future even join these counterparts and form a joined group of companies. The group has presence in several big cities across Europe such as London, Paris, Copenhagen, and Stockholm. The companies are interested in forming a group as they all market the same product lines. Furthermore, they all sell to the same categories of companies such as other companies, public authorities and in some occasions also to individual consumers. The companies believe that they as a group can minimise costs and stock, improve their purchasing position, etc. in order to increase their profit.

The company's executive board draws up common lines concerning organisation structure, strategic objectives, etc. However, in these matters the executive board has discussions with its counterparts so that the companies have similar organisations, strategic objectives etc when possible in order to facilitate a future merge.

Facts on Design Computer AB
As mentioned above the company is situated in Stockholm and its organisational structure follows.



The company sells a selection of different products and services such as:

Products:
- Standard products
- Spare parts
- Custom made products[1]

Services:
- Design of products
- Assembly

The company's executive board has formulated the following set of strategic objectives for the company's business:
- Products should allow flexible use
- Products and services shall be harmless to the environment
- Products and services shall be ergonomic
- Products and service shall have high quality
- Products and services shall have reasonable prices
- Customers should be satisfied
- An increase in profitability of 5 percent in a period of ten years
- Implement a new sales channel within two years

The company's principles for customer delivery concerning standard products and spare parts can be formulated as follows:

If products are in storage, they shall be shipped so that they arrive on the delivery date.
If products are not in storage, then they could be shipped directly to the customer by the supplier if the order-value allows the purchasing department to authorise it. Otherwise the customer should be asked if he wants to register a back order (meaning that the products will be delivered when they are in storage again) or if he wants to reorder at some later point in time.

Customers that order custom made products get a 10% reduction when assembly is not included in the order. Since the company's executive board wishes to reorganise the company in order to increase its profitability some employees have been interviewed about the as-is business processes.

BUSINESS PROCESS DESCRIPTIONS

Sales

Most customers are existing customers, but there are also many new customers. A new customer may have read about us in a magazine or he may have been contacted by a sales representative. When a customer approaches our company, the customer is allocated to one of our sales departments depending on his residential location. If all sales personnel at the customer's sales department are occupied, the customer is transferred to another sales department. This procedure often prolongs the time of delivery with one or two days. 70 percentages of orders are standard orders and they are delivered straight away to the customer according to agreed conditions. If the customer does not know exactly what kind of products he needs to purchase, he is transferred to the design department to discuss the matter with a designer. When the customer together with the designer has decided which products to purchase, the customer orders the product or makes an inquiry for quotation. In some cases, the sales department realizes that the inquiry is not appropriate for the customer or that it is incomplete. The customer is then contacted for further

[1] Custom made products are product that customers can customise using different components (e.g. spare parts) or parts with better quality etc.

discussions before the inquiry is answered. When the inquiry is complete, it is evaluated and a quotation is sent to the customer. The quotation may specify alternatives, e.g. products, prices, payment conditions and conditions of delivery, etc. The company's objectives for its sales are that 99 percentage of all orders should be delivered in time and that all customer-invoicing should be paid due day (maturity).

About 30 percentage of all quotations result in sales orders and one aim for the company is to increase this to 40 percentage in the next five years. A sales order may contain many different products and for each product the delivery time is specified, i.e. the delivery time may vary from product to product depending upon if the product is a standard product, a spare part or a custom made product. For standard products and spare parts, time of delivery is one week but for the custom made products it varies. If there exists a quotation, the sales department always checks that a sales order is consistent with the quotation it is based upon, if not the sales department sends an acknowledgement to the customer. If a customer has issued his sales order within the legally binding period of the quotation, the sales department accepts the sales order. If the sales order arrives later, terms may have to be renegotiated owing to possible changes in supplier conditions upon which the quotation was based. In case that the sales department cannot come to new terms the sales manager might have to cancel the order. In spite of this the sales manager often accepts the order due to other considerations, e.g. the sales department does not want to lose a big customer or it wants to gain an important new customer. However, lately one has the feeling that this happens too often, possibly because the sales personnel want to get their commissions.

Procurement

For each order the sales department must make sure if a standard product and/or spare parts are in stock, is ordered or has to be ordered before it can be delivered. For customers that have ordered other products than standard products, the purchasing department might have to order assembling or production. In some cases, the purchasing department may order products for two or more sales orders at the same time, but as their custom made products are much differentiated this is not frequent. Based on the bill of materials[2] (BOM), the purchasing department can compute the quantities the purchasing department needs to purchase in order to deliver its order in time. Based upon the sales order and the bill of materials (BOM), the purchasing department prepares and sends a purchase request to one or several different suppliers.

An important task for a purchasing department is to choose the optimal supplier for each standard product or spare part that the company has in stock. The choice depends on price, availability, time of delivery etc. Usually, there are more than one supplier for each article. Different purchasers use different purchasing methods. Some make use of special algorithms while others choose manually, although the company prefers that purchasers use the same purchasing method. When the purchase department has chosen suppliers for all items, they should send purchase orders to the suppliers within one hour. However, this time limit is respected in only 10% of all purchases. A purchase order may concern several articles, and for each article the purchase (delivery) conditions are specified. Usually, the total quantity ordered should be delivered at the same occasion. But in some cases, the delivery time varies (the delivery will be spread out over several occasions). The purchase order also specifies to which location the supplier is to send his articles. Sometimes, the purchasing department requests the supplier to confirm the purchase order or delivery dates. If he does not confirm immediately, one reminder will be sent. If he still does not confirm, the purchasing department will cancel the order. Unfortunately, it happens too often that orders have to be cancelled and another supplier has to be chosen. Since this makes it impossible for the sales department to keep promised delivery time to customers, the purchasing department should try to only use suppliers that confirm their purchasing requests in time.

When the purchasing order is issued an agreement concerning invoicing must be included. Either the company pays at each delivery or it pays when all the goods of a particular purchase order have been delivered. When the purchaser has authorised the invoice for payment it is returned to the senior accountant. Invoices are very often paid too late because authorising takes too long.

[2] A bill of material contains information about a product's components and their number etc.

The main goals of the company for handling purchasing invoices are to:

- get cash discount
- avoid penalty interest
- have effective cash flow

Goods-receipt

When goods are received from a supplier, it will be inspected by the goods-receipt before stocking in order to ensure that it is not damaged. If the goods are damaged, the purchasing department should make a complaint and in most cases also return all or parts of the goods, which they usually forget.

Delivery

Every morning each warehouse checks the orders that are due for shipment and which of these orders that can be shipped. All the products of the order are picked and loaded on a lorry, which delivers the goods to the customer. The stock manager determines which orders to ship in order to meet delivery times. This is especially important when there is not enough of lorries to carry out all orders that are due for shipments. Usually, the customer is satisfied with the delivered goods. However, sometimes there are complaints. The customer may claim that some or all goods are damaged and a customer might even claim that he got the wrong goods. It is the sales department that handles all complaints and who takes the appropriate action due to failing complaints instructions. In cases like this, the new delivery has the highest shipping priority. Some of the customers mention that they so often have to complain about damaged goods, missed delivery times, incorrect invoices, etc that they have considered changing to another supplier. The CEO is very concerned about the large amount of complaints since one of the companies goals are that only one percentage of orders should generate complaints from customers.

LESSON 1

GOAL MODELS AND BUSINESS MODELS

EXERCISE 1

Adam and Eve have built a new cottage. However, before they can move into their new home they must lay out a country garden. In some cases, Adam and Eve have different thoughts about how to plan their garden. Your task is to make a goal model for the garden planning. The model should include goals that if possible satisfy Adam's as well as Eve's wishes presented below:

1. Though a great deal of the ground is rocky they both wish to have a large sunny patio

2. Adam dreams about a great lawn, Eve on the other hand would like to have a large kitchen garden and a large rose garden

3. They also would like to have trees in their garden to cast shade on the lawn and on some parts of the patio.

4. Another dream that they have is that their garden should include either a pond or a waterfall

However, they must also consider the following facts below when planning their garden:

1. They have limited means but since Eve's father owns a garden center they hope to be able to but their plants, trees, etc. with discount

2. They have limited time to spend laying out their garden, but they have some neighbors that are senior citizens and who like something to do

3. Another matter that troubles Adam and Eve are that they are not allowed to blast away some of the rocks due to regulations

EXERCISE 2

A bakery produces hundreds of different sorts of plain bread, wheat bread, cakes, gateaux etc. to be delivered to different retails shops according to the bakery's orders. The bakery needs to keep track of all product descriptions that are needed to produce its selection of bread and cakes. The descriptions include facts such as ingredients, quantity, processing, rising time, baking time, baking temperature and production time. The production is carried out partly using machinery, partly

manually. Sometimes a production is a failure and then the bakery needs to know the name of the person responsible for the production and which oven that has been used. Furthermore the bakery needs to know the name of ingredient suppliers. The bakery usually purchases flour, sugar etc from one supplier and baking powder, marzipan etc from another supplier. Construct a conceptual schema for the business using REA.

LESSON 2

REA ONTOLOGY I

EXERCISE 1

There exists a number of Internet music stations, where a listener can choose what music he or she would like to listen to. The listener does not have to pay any fee, instead the Internet music stations get revenue from advertisers. Furthermore, the music stations have to pay for the music they are playing. This is done through two regulatory bodies, called RecitalRight and SongRight (fictitious names). RecitalRight gives rights to play music performed by certain artists and produced by producers and manages the reimbursement to these actors. SongRight does the same but for composers and textwriters.

a) Create an *e³-value* model for the above business case including actors, value objects, and value exchanges.

b) Complement the model from a) with a scenario path.

c) Suppose that there is a new actor, an advertisement broker, that helps advertisers to target the right listeners. The adveritsment broker gets information about the listeners from the Internet music stations and uses this information to match listeners with advertisements. In this way, listeners will be exposed to more relevant advertisements. Extend the model from a) to include this actor.

EXERCISE 2

In the text below, the business of a company is described. Solve the following tasks based on that description:

a) Construct a conceptual schema for the business using REA.

b) Assume that the company no more delivers the pictures with their own personnel and cars but outsources this activity to a distributor. How does the schema from a) change?

c) Construct a value process graph for the business that shows how the processes are interrelated based on the resources they produce and consume. Show how the processes relate to the conceptual schema from a).

A company manufactures and sells framed fossils. The company has a number of subunits that autonomously manage procurement and sales. However, some activities are managed centrally, see below. The subunits procure fossils and frames from their suppliers – note that no single supplier can provide both fossils and frames. The fossils to be framed are typically very expensive and are

procured one at a time, often after a complex negotiation. The frames, on the other hand, are fairly inexpensive and are ordered in large quantities in order to keep prices down.

The mounting of the frames is made by qualified personnel. When a picture is completed, it is inspected by an inspector in order to guarantee that it holds the highest standards before it is shipped to a customer.

The customers usually buy only one fossil at a time, but sometimes one customer orders several pictures simultaneously. In most cases, the customer specifies the kind of fossil desired, e.g. "tooth of Tyrannosaurus Rex", but sometimes a customer orders a specific fossil. Most pictures are expensive and fragile and they are, therefore, shipped directly to the customer by the company's own personnel who for this purpose use the company cars.

The company employs central personnel for mounting and delivery of pictures. Furthermore, the company centrally purchases the cars used at the deliveries.

A number of information requirements are the following:

1. Which customers have bought a picture costing more than 1000 euro?

2. Which customers have bought a picture but still not paid for it?

3. Which frame is the most popular for fossils costing more than 10,000 euro?

4. Which suppliers can deliver amber fossils?

5. Which employees have delivered a picture to the customer Anders Andersson?

LESSON 3

REA ONTOLOGY II

EXERCISE 1

CONSTRUCT exchange and conversion processes for explaining language training by means of the REA ontology. What resources are involved in language training and what actors? Which economic events are changing the resources? Take the perspective of an employee who acquires language training. Think about what resources the employee acquires and how she uses them. Document your answer using exchange as well as conversion processes. Include stereotypes for all classes introduced.

EXERCISE 2

CONSTRUCT exchange and conversion processes for explaining radio advertising by means of the REA ontology. What resources are involved in radio advertising and what actors? Which economic events are changing the resources? Take the perspective of a company that acquires radio advertising. Think about what resources the company acquires and how it uses them. Document your answer using exchange as well as conversion processes. Include stereotypes for all classes introduced.

EXERCISE 3

CONSTRUCT exchange and conversion processes for explaining garbage management by means of the REA ontology. The background is that a company that produces resources may also produce garbage (including toxic material) that has to be disposed. In other words, the company has to get rid of the garbage in an environmentally acceptable way. What resources are involved in garbage management and what actors? Which economic events are changing the resources? Take the perspective of a company that has to manage its garbage and does so by itself. Think about what resources the company acquires and how it uses them. Document your answer using exchange as well as conversion processes. Include stereotypes for all classes introduced.

Suppose that the company outsources the management of garbage to another company. How will the processes change?

LESSON 4

PROCESS MODELS

EXERCISE 1

Consider the following recipe:

Salmon with mashed potatoes is made in the following way. The salmon is cut into small pieces and salt and pepper is added. Thereafter, the salmon is put into a refrigerator for 20 minutes. In parallel, the potatoes can be prepared. 5 kilos of potatoes are boiled on the furnace for 15 minutes. Thereafter, butter and salt is added and everything is mixed in a mixing machine for 2 minutes. Finally, the mashed potatoes is sprinkled around the salmon and put into an oven for 35 minutes.

Use a Petri net with time to model this recipe. Make sure that all resources are modelled, ingredients as well as kitchen machines.

EXERCISE 2

AN OFFICE CHAIR CONSISTS OF TWO PARTS, a bottom part and a top part. The bottom part consists of one bottom frame and four wheels. The top part consists of one top frame, one seat, one back, and two arm rests. An office chair is assembled in the following way. The bottom frame and the four wheels are assembled to produce the bottom part. Doing this requires one machine of type A and takes 20 minutes. Independently of this, the top part is assembled. The back is painted, which takes one hour and requires one machine of type B. The top frame, the seat, and the two arm rests are also assembled. This requires one machine of type B and takes 40 minutes. Finally, the back is added to the top part, which takes 15 minutes and one machine of type B. When both the bottom part and the top part are completed, they are assembled into a chair – 20 minutes and one machine of type A.

Model the assembly of the office chair by means of a Petri net.

EXERCISE 3

SOME CONFERENCES INVITE AUTHORS TO SUBMIT PAPERS. The following text specifies a possible procedure for managing the invitation and the paper submission.

The conference chair sends a personal invitation to a possible author. If the author answers in the affirmative within seven days, she will get an instruction message describing the submission

procedure in detail. If the answer is negative, the author will get a polite acknowledgement message. The author should provide a full paper within 30 days of the instruction message. If the author has not submitted a paper before this deadline, she will get a notification. This notification will be repeated four times with two days between the notifications if there is no answer from the author. When the paper has been submitted, it is sent for a scientific review to a reviewer. The reviewer must answer within 10 days. If there is no answer from the reviewer, she will get exactly one notification. If the reviewer does not send in a review report within three days of the notification, the paper must be reviewed by another person. The conference chair selects another person and the paper is sent to this person with a request to review the paper within 3 days. If the new reviewer rejects the request or does not send a review on time, the procedure is repeated. There may be many failed repetitions, and if it turns out to be impossible to find a reviewer, the conference chair has to review the paper herself.

When the review has been completed, the conference chair will make a decision whether to accept the paper. If it is accepted, an acceptance letter is sent to the author, otherwise a rejection letter.

Model this process by means of a Petri net. Specify triggers for all tasks. Note that the description is incomplete and make appropriate assumptions.