

# Creative Collaboration with Representations: A Case Study of Interaction Design in an Interactive Space

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## Abstract

This paper focuses on the concepts of creativity and representations produced in the context of collaborative design. More specifically, on the interplay between collaborative creation of sketches (design proposals), and argumentation and negotiation processes taking place in the design activity. The question raised in this paper is how sketches produced during a design session reflect and mediate dialogues and argumentation in the design activity and how the sketches feed into new ones. We are also interested in finding out how the characteristics presented by the artefacts in use permit coming to creative interactions. The concepts of “action context”- and “target context representations” are introduced and used to illustrate shifts of focus during a design session. We have studied a group of students working on a design task in an interactive space for two weeks. The purpose of the study was to investigate how an environment meant to support collaborative work and learning support collaborative and creative learning of interaction design. The results obtained indicate that students attending a course on interaction design often ignored, forgot or at least did not pay enough attention to target representations. Furthermore the results suggest that “action context representations” to a large extent occupy student activities as a result of either complex technology or as a result of the students thrust to do something instrumental. We suggest that technological support for collaborative learning of design should have some kind of reminder of the mapping, or interplay, of design proposals and the target context representation.

## 1. Representations and artefacts as resources for action

Collaborative design can be viewed as an activity driven by communicative practices and representations for mediating ideas. The way representations that surround us and in many senses also construct us, our thinking and our actions has been reported in the literature (Hutchins, 1990, 1995; Weill-Fassina, 1993; Rabardel and Dubois, 1993). Artefacts can be viewed as intermediators of human action (Vygotsky, 1978; Wertsch, 1991). The nature of an artefact in an activity can be understood by identifying the ways people use it, the needs it serves, the history of its development, and the ways in which artefacts shape and change practices, facilitating and/or constraining particular actions. In the study of complex situations the concept of *representations for action* has been suggested (Weill-Fassina, Rabardel and Dubois, 1993). Representations for action refer to the representations that people have of the situation they are a part of and focuses on people’s actions, how people act in relation to what others’ do and say with or without artefacts. By situation, we here refer to complex, dynamic and uncertain activities that are difficult to predict in advance.

In domains such as design, and interaction design in particular, the learning goals are often difficult (if not impossible) to define in a precise manner. In this sense, design, interaction design and learning of these domains is often ambiguous. The need to propose, discuss and evaluate different ideas, design proposals, etc. is therefore crucial to learning and practice of design. In professional design, negotiation is a crucial part of the design situation and the student has to appropriate such knowledge to be prepared for this. Designers must learn not only the skill to design visual design, and design that is in line with some general nice

appearance, but also to learn how to negotiate the relation or the interplay between some actual system design and design of use (Arvola & Larsson 2004). Especially, in the conceptual stages of design, negotiations between different designers (system architecture, database, interaction design) are important. But also when integrating designs it is important, particularly if the general design concept has not been agreed upon or not been dealt with thoroughly. Interaction designers must have some understanding or representation if you like, of the interactions that the users will do. Thus the problem a team of designers who design a common object face is on the one hand to coordinate a common representation of the future use situation, and on the other hand a smooth mapping of mediated representations for actions within the context of design activities. We call these contexts *target context* and *action context* respectively.

One problem with supportive representational environments is that each and every representation on their own may be supportive but when something goes wrong, or when the different representations are not mapped, much of the users work is to match the representations by handling the mismatch manually. Another is that each designer may be immersed in *action context representations*. Such immersion may result in that the team members fall in love with the design proposal and cannot see beyond it and its effects on actual use and correspondingly the user (Engeström & Escalante, 1996). Another apparent situation is that if the supportive systems, and their systems image, is not mapped the designers have to work out the mapping manually, or which is more likely just drop the effort with the consequences that the design suffers, i.e. that the users are immersed in action context representations due to lack of understanding of the system and experience from using it. These problems are well-known in the field of Computer Supported Cooperative Work especially within situations of cooperation within control rooms where operators at times must handle mismatched representations or are focused on action context representations resulting in that *target context representations* are suppressed, forgotten or just do not come into mind (Garbis & Artman, 2004).

### **1.1. Supporting learning and practice of interaction design**

Sketching, drawing, i.e. representing design ideas and learning to represent ideas have been found to be crucial to the design process and also to development of design ability (Löwgren & Stolterman, 1998). Further, in studies of students representing scientific phenomena, a meta-representational-competence has been suggested to lie behind student's abilities to create, critique and adapt a variety of different scientific representations (diSessa & Cobb, 2004). Without getting involved in a discussion of whether this ability should be regarded as an individual trait or as stemming from the individual-environment transaction, investigations into this phenomenon is called for and it can be hypothesized that this phenomenon is also crucial to less well defined domains, such as interaction design. The field of interaction design is a young and therefore conceptually undeveloped field (Löwgren, 2002; Reimann, 2001). An established language, terminology, or conceptual framework shared by practitioners, do not exist. There is also a lack of software tools to support the designing of interaction.

It can be hypothesized that inexperienced designers, due to their lack of experience of previous design projects and skills of using artefacts in the process, attend to and focus more on action context representations than on target context representations. Environments and tools that are developed are of course meant to support design activities. Ideally, these tools should support designers and design activities to focus on target context representations. However, these tools are often very complex and their functionality not enough fine tuned, for instance in terms of their flexibility and how well these can be customized to meet user needs.

Eventually, this ends up in that even experienced designers may subsequently be forced to attend to and focus too much on the action context. The goal however should be to provide with tools supporting activities that allow both inexperienced and experienced designers to focus on target context representations.

The general design research has focussed on what we call action context representations, i.e. the use of supportive tools within the design environment and those skills a designer must have in order to make good design proposals (Gedenryd, 1998; Lawson, 1997; disessa & Cobb, 2004). Generally, the arguments are focused on the solitaire designer with much creativity and talent, rather than collaborative efforts and accomplishments within designer teams. We will instead focus on communicative practices which designers use in order to convey ideas and make design. This means that we are not focused on some general mental mechanism, talent or other trait, but rather in how team members communicate and negotiate different solutions. We are in this paper especially interested in describing how design can be viewed upon as an oscillation between different forms of contexts, and how different forms of representations support or undermine collaborative design activities. This motivates a focus on the interplay between collaborative creation of sketches (design proposals), argumentation and negotiation and how sketches that are created mediate discussions and argumentation and feed into new ones, and to what degree characteristics of artefacts in the environment that are used in the process permit coming to creative interactions.

## **2. Creativity and learning in technology supported environments**

As proposed by Barab & Plucker (2002), traditional conceptions of cognition and intelligence should be re-examined (Barab & Plucker, 2002) if cognitive, social, cultural and historical external processes are to be treated as integral parts of competent action. This has been argued for by several researchers, for instance Pea (1993). In focusing on the concepts of ability and talent (or creativity, authors' remark) Barab and Plucker (2002) theoretically ground these in situated action, activity theory, distributed cognition and legitimate peripheral participation. The authors suggest that instead of looking upon these concepts as properties of an individual, these should be looked upon as "*...a set of functional relations distributed across person and context, and through which the person-in-situation appears knowledgeably skilful*" (ibid pp. 174). I.e. in the dynamic transaction among the individual, the physical environment and the socio-cultural context, ability and talent arise. In this view ability and talent are part of the individual-environment transaction and as such an opportunity that is available to all, but it may be actualized more often by some. Part of the individual-environment transaction is of course various artefacts (papers, pencils, computers etc.) that are there to support an activity. Thus, an important goal for educators, designers, etc., should be to provide with environments and contexts through which talented and creative interactions can emerge. Research into these issues of course already exist, however the need for research into representations and learning as related to immersive technologies has been called upon. Both within research on representations in multimedia learning (Reiman, 2003) and in design based research (Collins et. al. 2004). This is especially the case in technology rich environments that have been developed to support collaboration in and learning of various target domains.

Within the domain of interaction design for instance, environments and tools in the environments should support the process in which designers and learners can negotiate and agree on target context representations. I.e. the tools should support activities that can result in creation of target context representations. But the question however remains as to whether the tools and their functionalities are enough fine tuned to allow for this. Important to note here is that *we are not* claiming that creative expressions and solutions can only be made in attending

to and creating target context representations. Equally creative expressions and solutions can be made in attending to and creating action context representations. However, the creative solutions in the action context should not lie in trying to understand how a supposedly supportive artefact can or should be used or merely focussing on instrumental aspects of the artefact being designed.

## 2.1. iLounge – an interactive space

At the Royal Institute of Technology in Kista, Sweden, there is an interactive space called the iLounge designed and built with the purpose to support collaborative work and learning:

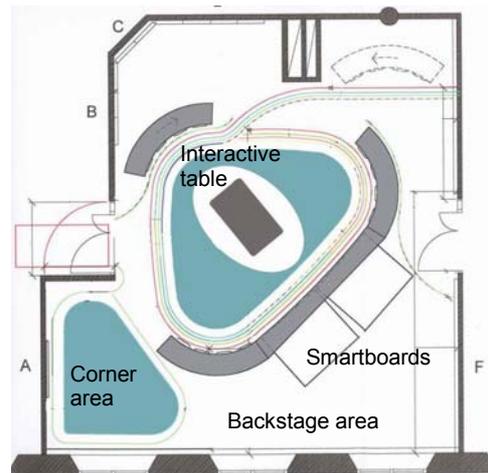
- *Large* screens that can show material that can be viewed and discussed by a whole group of people.
- The contents of the screens can be *shared* by the participants – documents can be edited by the participants.
- The screens are *interactive* – the participants can edit material on the shared screens through their own keyboards or directly using the touch screens.
- *Multiple screens*: several wall screens and a large horizontally embedded plasma screen (a table) are used instead of just one permitting the participants to work in more flexible ways, e.g., the participants can easily shift between working in groups or working individually on a subtask.
- Multiple computers: apart from the computers in the room, people can also bring their lap-tops and connect to a LAN. This allows for flexibility (bringing documents and other work related information) and the possibility to work on a familiar platform. Also, more people can actively contribute to the ongoing work rather than having one person taking control of events.

To facilitate and support work in the iLounge, services that help and support the user to move data between the devices present in the room have been developed:

- One with which one can open any file on any other computer that runs the service (Tipple).
- One that allows the user to move web content between displays in the room (Multibrowse).
- One that makes it possible to use the same pointing device or keyboard on more than one computer in the room (PointRight).

PointRight together with iClipboard makes it possible for the user to cut or copy text between computers in the space. The text is placed on a clipboard that is shared by the computers running the service.

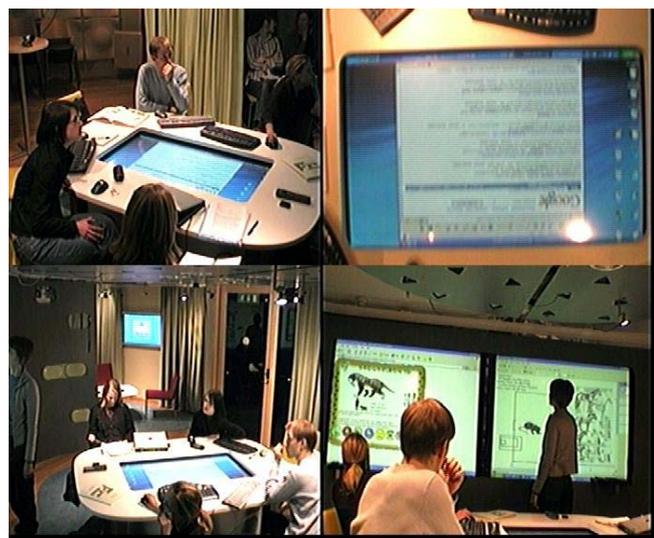
Figure 1 shows a plan of the room. The room has a wireless network and keyboards and mice in the room are also wireless, using Bluetooth technique. Finally, the iLounge contains high quality audio and video equipment that for instance can be used when having videoconferences, or during user studies.



**Figure 1.** Plan of the room. The working areas are shadowed.

### **3. Method and data collection**

Five female and four male students in the ages of 21 to 45, divided in two groups, participated in the study. One group consisted of three men and one woman, and the other group of one man and four women. Some of the students in the groups knew each other from before. The students attended a course in design of interactive systems. The students' task was to design a digital, multimedia guide for an exhibition "4, 5 Billion Years - The History of Earth and Life" at the Swedish Museum of Natural History. The two groups were responsible for designing the multimedia guide describing "from Big bang to first life", and "pre-historical mammals". The target group was children about twelve years old. We followed the students during the conceptual design phase of their assignment. The conceptual design phase lasted two weeks and consisted of brainstorming, sketching of scenarios and the multimedia product, and information search. During this time the groups had four and five sessions, respectively, in the iLounge. Prior to this, they received an introduction to the environment and the specific services introduced in the section "2.1. iLounge" above.



**Figure 2.** The view of the video recordings with four angles

Data were collected through observations, pre- and post-study questionnaires, and ended with semi structured group interviews. Results from the study are also accounted for in (Sundholm et. al. 2004a and 2004b). Both the work sessions and the interviews were video taped. The

recordings consist of four angles to cover the whole workspace (see figure 2 above), and one channel for sound. Altogether the data material consists of 21, 5 hours of video data. As a tool for our analysis we have used interaction analysis (Jordan & Henderson, 1995), and more specifically, certain foci for analysis, namely spatial organization of activity, participation structures, artefacts and documents, turn-taking, and trouble and repair.

## 4. Results

### 4.1. How embarrassing, do you really want *me* to draw?

As pointed out by Löwgren & Stolterman (1998), representing design ideas and learning to represent ideas through sketching and drawing have been found to be crucial to the design process and also to development of design ability. In the case accounted for here however, instead of using paper and pencil to sketch the participants worked on one of the two interactive screens for making sketches or for showing information found at the Internet to each other. While producing a sketch, one of the group members usually stood in front of the screen, and the other participants were sitting around the table. The person in charge of drawing the sketches alternated. For instance, one participant would be using the touch functionality of one of the screens, another using the keyboard and mouse working on the same document, and the third using PointRight and iClipboard to insert a piece of text, and together they created a sketch.

Excerpt 1 illustrates that although the group had become acquainted with and used the interactive screens during the first session they still felt somewhat uncomfortable in using these during the second session.

**Excerpt 1.** Group 2, session 2. Using the interactive screens to sketch<sup>1</sup>

Time 0.12.55	Person	Transcript of interaction	Characteristic of action
1	#3	“We can also put some pictures here [in the Notebook]”.	Sits down. Looks at the right interactive screen
2	#1	“You mean, when we draw the proposals we can do it with the interacti...”	Looks at #3 sitting next to #1.
3	#3	“Mmm, but we can draw now. We have written down some things about what we want. I don’t know exactly what we are going to do now.”	Looks at the right interactive screen
4	#1	“Mmm... We can do that.”	Looks at #3.

An obvious drawback in using the interactive screens to sketch is that the interactive screens and the tools that support sketching and drawing makes for very raw and clumsy sketches as compared to using paper and pencil. Nevertheless, ideas are represented and the process can go on. The positive side is that discussing around the interactive table is a collective act directed towards the team and put issues up front.

In the above excerpt, line 1, person #3, starts the episode with drawing attention to the use of pictures in order to start the design, which person #1 quickly follows with a question of how to use the interactive screens. Then in line 3 he is referring to a target representation of the use situation, but at the same time he is articulating his hesitation towards how clear this representation is for making a design proposal. Person #1 is focused on doing something and uses the representational means i.e. the interactive screens. The two team members seem not

<sup>1</sup> The transcriptions below are divided with resemblance to the work of Pomerantz & Fehr (1997). But in our case “Characteristic of action” describes the actor’s action, not the abstraction of the utterances.

to be synchronised in their endeavour to articulate visions and means. This kind of discussion is of course to be expected and in a sense constitutes a fruitful oscillation between the different forms of constraints to the design proposal. At the same time it may not be fruitful since the unfocussed discussion might stand for an anxiety of articulating either means or goals. However, the communication serves as a driving force for the team – each communicative initiative directs the team to consider new aspects of the design.

Interesting to note is also the transition between private and public, where drawing and sketching on a piece of paper followed by an attempt to translate or copy that onto the interactive screens allow the rest of the group members to see and react on the design ideas. In “excerpt 2”, the continuation of the previous excerpt, we will see how going public and exposing ones sketches to the rest of the group produces dissatisfaction. This directs the communication and the actions towards the appearance of action context representations.

**Excerpt 2.** Group 2. Direct continuation of excerpt 1. The embarrassment of going public with ones drawings.

Time 0.21.05	Person	Transcript of interaction	Characteristic of action
5	#3	“But if one draws something under here [shows with the pointer]. Or to make some more space.”	Points with the pointer in the Notebook, on the right interactive screen.
6	#4	“Hm...”	Looks at the right interactive screen.
7	#3	“Some screens or something or... [refers to the design of the multimedia guide]”	Looks at the Notebook.
8	#4	“Yes. Is anybody good at this, to draw?”	Looks at #3.
9	#3	“I am very bad...”	Works with the Notebook.
10	#5	“So am I.”	Looks at a Word document on the left interactive screen.
11	#4	“There are others...”	Looks at #3.
12	#1	“On where? There? [points to the right interactive screen] It is just to go there and draw with the hand.”	Points at the right interactive screen.
13	#4	“Yeah, right! If... Is there anybody with some talent of drawing?”	Looks at #3.
14	#5	“We don’t care about how the animals look.”	Looks first at #3, then at the left interactive screen. Talks simultaneously to #1, line 12.
15	#5	“What are we supposed to draw?”	Looks at #2 and #3. Talks simultaneously to #3, line 13.
16	#2	“Draw pictures of a screen with all the animals, maybe. It is just to make some dots.”	Looks at #5.
17	#4	“Someone with some talent of drawing?”	Talks at the same time as #2, line 16. Talks to #1.

Here the interactive screens seem to be more inhibiting, than supporting coming to creative expressions. One interpretation of this could be that the students felt embarrassed in making sketches in public on the interactive screens in front of the rest of the group. Another interpretation more in line with the argument above would be that the drawing program was too unsophisticated to meet the requirements the students had. I.e. the translation or copying of sketches made on paper onto the interactive screens did not well enough account for, or well enough capture the idea represented potentially resulting in too much of interpretation and explanation of the proposed idea.

In line 14 person #5 tries to redirect the discussion away from the appearance of the design proposal that they are to create, but the team is stuck on the appearance and holds on to the discussion. We interpret this as person #5 trying to include the issue that the appearance is mainly of interest when they have an idea of the use of the system. That is, person #5 tries to direct the issue of target context- rather than the action context representation. In line 16 person #2 seems to adhere to this shift in focus in pointing out that they simply have to “make some dots”. Still, as the target context representation is not clearly articulated and shared the issue is dragged back to an issue of the here and now of making design sketches, where the focus is shifted again towards a more instrumental perspective. Although it seems that no one is willing to take on this instrumental perspective and actually do something.

#### 4.2. Why embarrass ourselves, let’s make use of artefact characteristics

The problem was resolved by ripping pictures from the Internet and by using simple representations such as squares and circles, to signify animals. This was done using two interactive screens in parallel, one for using the Internet and one for using the drawing program. This is interesting since it illustrates the interdependence of two seemingly independent processes, and the relation of how the workspace layout is supporting creative solutions and creative use of representations in collaborative activities.

Excerpt 3 illustrates how their ideas about how the animals in their multimedia guide should be represented, and how the documentation from an earlier work session becomes the entrance for them how to solve the problem.

**Excerpt 3.** Continuation of Excerpt 2.

Time cont	Person	Transcript of interaction	Characteristic of action
6	#2	“Hm... But it is a bit like... in pasting, in pasting such pictures and stuff, and you want it to look good, you have to spend a lot of time to...”	Looks at #3, and shortly at #4.
7	#3	“Yes, but...”	Looks at #2.
8	#2	“...edit them. I think we might as well draw: or like this, to pretty much do like this...”	Looks at #3.
9	#1	“Here one can see mammoths that look like mammoths in the surroundings.”	Looks at a web page on the table computer with pictures of animals.
10	#3	“I think... I think one could cut and paste a bit...”	Looks at the other team members. Talks simultaneously to #1, line 9.
11	#4	”Can’t we just find some pictures with a lot of animals...”	Looks at the other team members.
12	#2	“Mm...”	Looks at #4.
13	#3	”Yeah...”	Looks at #4.
14	#4	“...and paste it for the time being?”	Looks at the laptop.
15	#3	”Yes.”	Looks at #4.
16	#4	“...so that it looks like a	Looks first at the team members, then at the laptop.

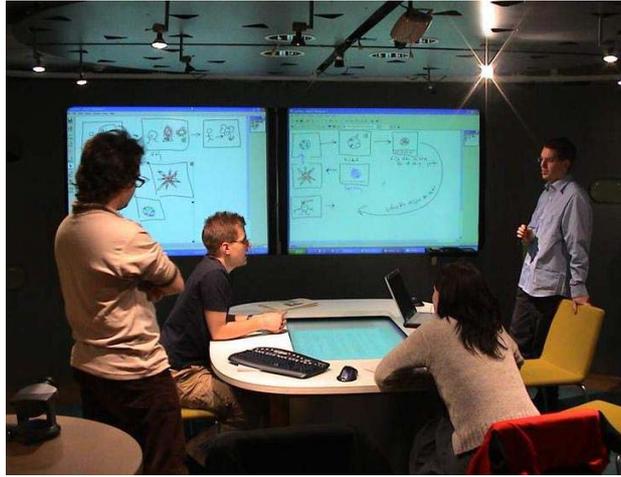
		landscape with animals and everything.”	
17	#3	“Exactly.”	Looks down.
18	#2	”Yeah, right. Do you remember that first page that we... it was something about games for children...it was one of those...”	Looks at #4.
19	#3	”Yeah.”	Looks at #2
20	#4	”Mm...”	Looks down.
21	#2	”...with different animals.”	Looks at #4.
22	#4	”...but can’t we...?”	Looks at #2.
23	#2	“And then it will be sorted under our...”	Looks at the left interactive screen.
24	#3	”Our pictures, right?” [compare this to the folder “My Pictures” in Windows]	Looks at the left interactive screen.
25	#2	”No...”	Opens “My Computer” on the left interactive screen. #2 opens a word document, where they have a link to a picture, which he opens in a web browser, and they discuss the picture.

Here we can see how the document serves as a collective memory of earlier discussions and negotiations, which they all previously have agreed upon and now have access to. It becomes an important source for them not to get stuck in the design process. And also, the digital representations give the users the chance to re-negotiate and re-represent the design proposals. This discussion is facilitated by an easy access to the Internet, digital representations of animals as well as a shared surface for projection.

The excerpt also illustrates how the team resolves the tension of drawing by snatching pictures from the Internet. This creative use of the artifacts gives an opportunity for the team members to re-focus on the use of the multimedia guide. The excerpt is a good example of the oscillation between action context discussions and target context discussions as well as of how technology can and should support these oscillations. More experienced designers often have learned different repertoires of design solutions to test and choose among that can help accomplish smooth oscillation, while inexperienced designers seem to need transparent and ready-to-hand support to be able to do this. However, as Lawson (1997) has shown, such design repertoires are very fragile and may easily break down when facing new design situations. Therefore we think that design studios should be designed with both action context- and target context representations in mind.

### 4.3. How shall we go about creating design proposals?

The interactive screens were mainly used in two different ways. Mostly to present rudimentary sketches, often visual, to other team members as illustrated in figure 2. Individual sketches on paper sometimes preceded this. The other way to use the screens was to present web pages from the Internet, in order to discuss the information that was found, design or other issues coupled to the project. In both cases the goal was to make information available to others in order to discuss (which makes it open for re-interpretation or disputing of the idea). In this way the team gets the “raw” information, rather than some pre-processed summary prepared by another team member.



**Figure 3.** A group discussion regarding design sketches

Excerpt 4 shows how the interactive screen is used to present an idea. The excerpt is taken from an early part of session 3, where the group still has not decided or agreed on the concept of the multimedia guide. Before the excerpt below begins the members of the group have discussed what children would like to know, and how deeply they should go in to particular details. While other group members tries to solve some practical issues, #1 stands up, and starts to make a sketch of a proposal of a game on the left screen. The theme is a competition, “like a boxing game”, between animals.

**Excerpt 4.** Group 2, session 3. Presentation of ideas

Time 0.23.07	Person	Transcript of interaction	Characteristic of action
1	#2	“As one of the games, or...?”	Sits down. Looks at #1.
2	#1	“Yes, but you can..., like this [pointing]... eh, I mean to eat or to be eaten, but you can choose, so you in one way or another, or maybe not like this. But you present the information about them, and then you can... or even if one might go here. But maybe also like this. “	Stands in front of the left interactive screen. First looks and points at the sketch, then looks at the group around the table, and finally points at the sketch again.
3	#1	“You might go like this in the forest somewhere. Here you have...”	Opens a new page in the Notebook and starts to visualize how #1 thinks by drawing with the finger.
4	#3	“But if you think we are going to do this in a real way, then we need to know what they sound like, and how they use their body, and knock, and...”	Sits down. Looks at #1 and #5. #3 sits on the opposite side around the table.
5	#1	[Mumbles something inaudible]	Sketches in the Notebook. Nobody pays attention.
6	#5	“It is built upon research [inaudible]...”	Sits down. Looks at #3
7	#1	“Then you can have different animals.”	Looks at the interactive screen, and start to draw with the finger in the Notebook. Nobody listens.
8	#3	“Watch Jurassic Park [the movie].”	Looks at #5.
9	#1	[Mumbles something about “a cave”]	Sketches first, then turns around and looks at the group.
10	#5	“Mm...”	Looks at #3

As we can see the idea is forming as it is successively formulated and represented. The team members are partly open to the idea, partly developing the idea but also tend to take the idea to a practical level of implementing it. This is one of the few instances where we have found the team formulating and pursuing ideas about the target context, that is, where the discussion in the group is more about the use of the multimedia guide than of the technology and the representations surrounding them. It seems as if having come to the solution of ripping pictures from the Internet relieves the group from having to focus on graphical details but can concentrate on the use of the guide. This gives witness to the group having found a meaningful use of the interactive screens and their functionality resulting in a stronger focus on target context representations. Learners of interaction design need support that facilitates and highlights the important relation between immediate actions carried out in the environment and a vision of actions and use in the target environment. I.e., a support that helps learners shift between action- and target context representations, respectively.

#### 4.4. Let's make use of another characteristic in recapitulating what we did the last time

The interactive screens were also used as an entrance to the history of the design and the process of idea generation and in this way served as a collective or shared memory. Design proposals in different phases of the design process could easily be revisited and the development of a design concept could thus be traced. Further, arguments rejecting or highlighting a certain proposal, as well as chains of arguments leading to deciding to go for a certain design proposal could be accessed through the notebook.

Excerpt 5 illustrates how the digital whiteboard is used for creating a common understanding of the design proposal. In the previous session, #2 was not there, this session he arrived a couple of minutes before the others. While waiting for the others he is looking through some documents created during the previous session.

**Excerpt 5.** Group 2, session 5. Catching up the ideas from last work session.

Time	Person	Transcript of interaction	Characteristic of action
0.04.12			
1	#1	"Have you had time to check what we have been doing?"	#1 looks shortly at #2.
2	#2	"Yes. It was..."	#2 looks and opens the shared folder on the left interactive screen.
3	#1	"Wow! Good. How good. Ambitious."	Sits down.
4	#4	[clears her throat]	Opens a can of coke, and looks at the left interactive screen.
5	#2	"You could explain as well, if you want."	Opens the Notebook document that the others created last time.
6	#3	"Well, it might be necessary with some explanations."	Looks at #2, than on the left interactive screen.
7	#1	"Do you mean... Do you mean that? (laughing) Aren't they self explainable?"	Looks at #2, and laughs friendly.
8	#2	"Well, they are that, but just some details..."	Looks first at #2, than back on the left interactive screen.
9	#2	"What is meant by, in this part, [points with the mouse] 'if someone is getting closer to subject	Uses the mouse to point at an inserted text piece in the storyboard, and follows the quote with the pointer.

		picture...’?”	
10	#4	“If someone is, well... If you think someone is standing on a screen. Well, we haven’t solved that yet...”	Looks at #2.

The notebook document here supports and facilitates discussing the work the group did during the previous session, and also of creating a common understanding and building a shared picture of the work. Not only #2, who was not there during the last session, asks for further explanations. Also, #3’s confession about the need for explanations (line 6) and #1’s laugh and question about the meaning of the drawings (line 7) gives witness to this. For those who were there the last time it is also a catch up to get back to the discussion that was held during that occasion. They spend the following ten minutes explaining the storyboard for #2. #2 is the one asking questions, and the one in charge of the Notebook document. He goes through all the pages in the Notebook to get the whole picture of the story for the multimedia guide. During the session they continue to work on the storyboard, and the design of the multimedia guide to specify it even more, with pictures, and pieces of text.

Mediating and explaining earlier accomplishments to members who have not been involved during earlier sessions here provides with obvious learning benefits. Also, this example can be viewed upon as a repository of earlier arguments and design decisions. Having to recapitulate the discussions and decisions made during the previous session provides with an opportunity to practice on arguing for choices and decisions that have been made – these decisions and choices must be argued for from a target context representation perspective, else they would make no sense. Of course these decisions are not carved in stone but can be re-negotiated when new interpretations, design considerations and ideas become evident. As such the interactive screens and the public notations seem to be a very important and effective tool. Interesting to note is that the drawings call for further explanations, i.e. the drawings are in no way self-explanatory, but they do however make sense to those that took part in the process of making them. Those who took part seem to be very clear about the choices and decisions that have been made and are easily able to recapitulate the chain of arguments leading to the proposed drawings.

## 5. Discussion

If tools are not appropriated both to individual and team needs these tools will rather be a nuisance than support. The nuisance steals attention, concentration and energy from the individual and in turn from the team. The tools become present-at-hand rather than ready-at-hand. This may sound like a renaissance cognitive idea of a given mental capacity, but our argument is rather that the communication among the team members is directed away from target context representations to action context representations. We certainly see that students of Human-Computer Interaction in general and interaction design in particular, must have some training in attending to and creating target context representations, be visionary if you like, in order to proceed with becoming skilled designers.

As mentioned in the introduction one known problem with supportive representational environments is that each and every representation on their own may be supportive but when something goes wrong, or when the different representations are not mapped, much of the users work is to match the representations by handling the mismatch manually. Another is that each designer may be immersed in *action context representations* resulting in that *target context representations* are easily not attended to or even forgotten. Actually these problems are in coherence with situations of another complex and highly representational domain, the control of dynamic systems such as aviation, emergency management, underground

management etc. These domains are defined by that the systems change both autonomously and as a consequence of the actions of a management group and are often characterized as consisting of open-ended problems as there is no way of knowing the exact development (see Garbis & Artman, 2004; Artman & Persson, 2000). In many of these situations operators lack first hand perception and subsequently much of the operators' interpretation is dependent on mediated information (Artman & Garbis, 1998; Johansson, Artman, Waern, 2001). They are to control a dynamic system (target context) although their knowledge of this context is mediated and defined by the information and the representations that are mediated to them (action context representations). In these domains the mismatch between different action context representations forces the operators to put much effort into resolving the mismatching (Garbis & Artman, 2004; Artman & Persson, 2000). As we have found in this study the designers get so immersed in action context representations that the target context is not enough accounted for in the design discussions. This is very problematic if one considers interaction design to be the design of use, rather than product design. The problem is equivalent to an emergency management operator only reacting on presented information, and forgetting to foresee future possible events in the target context. An emergency management operator must at all times try to have his/her mind one step before the actual happening in the target context even if acting on information represented in the action context. Of course there are large differences between emergency management and collaborative design, for instance in terms of time pressure, the seriousness of the situation, and routines in the practice carried out, but both situations must handle action context representations and both should try to have an imaginative target context representation. One crucial problem in both domains appear to be how to share and communicate ones, often in the process not yet uttered, idea of the target context as well as to keep it alive while attempting to formulate and represent the idea in the action context. As mentioned, in emergency management much is handled by routine or procedure, routines that often account for common or normal situations even if the variability is infinite (Perrow, 1984). When learning to be an emergency- or underground operator, one is not only formally trained in educative settings but also trained through work carried out in parallel as an apprentice. By following an experienced operator, handling of information within the action context is learned, also to vividly present and discuss information with colleagues who all contribute not only to the handling of the case but to expressing and painting a picture of the possible target context is practiced. The operators are continuously learning a repertoire of possible situations and possible actions coupled with these situations.

In this study we have observed students performing a task in collaboration but without any larger chunks, or vivid discussions about the context of the future use of the artefact being designed. In spite of this, students managed to come to creative solutions in handling artefacts in the action context subsequently resulting in the students being able to focus more on target context representations. However, the observations also illustrate the need to provide learners of interaction design with transparent and ready-to-hand support allowing them to smoothly shift between action context- and target context representations. Learning the practice of interaction design includes much more than only making an appropriated design. It also involves practicing to make vivid presentations of the future use of the interactive system, thus training in attending to and creating target context representations. It is the use that should direct the design rather than design directing use, or is it not?

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