Interaction Walkthroughs and Improvised Role Play

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Abstract. How do designers of interactive media work on the dynamic aspects of their designs? Previous research has emphasised the role of gestures to express what users and computers do. This paper contributes with a detailed analysis of interaction design master students' enactments. Two kinds of enactive means for expressing behaviour are identified: interaction walkthroughs and improvised role play.

Keywords: Sketching, models, design representations, gestures, enactment, interaction design.

1 Introduction

This paper investigates how interaction designers express and communicate the dynamic aspects of their design object using gestures, intertwined with talk and graphic representations. A key activity in interaction design is the exploration and communication of alternative design solutions. This makes it important to find adequate ways to describe the object being designed. It is well established that designers use models and sketches together with talk for this purpose. The problem for interaction design, however, is that its object of focus is dynamic: ways of interacting and using the system [2], [3]. Hence, the overarching question for this paper is how interaction designers work on the dynamic aspects of their design object.

The study points out the importance of designers seeing each other, as well as seeing the sketches and hearing verbal descriptions of the design. Indeed, as we will show, some design ideas are never presented verbally, but only through gestures and common understanding.

1.1 The Role of Making Models in Design

When designers perform acts on their models, including sketches, scenarios, storyboards, diagrams, physical models and computer prototypes, we say that they act in the *action context*; that is, here and now in the workplace activity [1], [31]. The models, however, are also representations of what will happen in the *target context*, in the virtual world of hypothetical user activity where a future design solution will be used [27], [32].

Models are also used to collaborate, communicate ideas and jointly understand the design situation [18], [21], [30]. The understanding emerges in quick loops of making explorative design moves in the model, seeing the effects, and assessing the holistic consequences [2].

As the designer sketches, the representation of a design idea creates further ideas, and helps the designers to reframe their design problem. In fact, the sketch can precede the thought and hence drive the cognitive process [10], [28]. Designers reflect on their sketches in both acts of "seeing as", which stimulate new ideas, and acts of "seeing that", which prompts assessment of consequences [12]. Furthermore, designers tend to talk and draw simultaneously, a phenomenon called spatial-action language [28].

1.2 Models in Interaction Design

Turning to the area of interaction design, the models and design representations employed there typically include lists of tasks and functions, user personas and scenarios, diagrams of structures and interactions, user interface sketches, paper prototypes, and computer prototypes. Sketching on paper is particularly important during early design explorations [5], [17], [18], [19]. The sketches tend to fall into two categories: user interface sketches and storyboards representing sequences of interactions. Diagrams are used to develop site maps to visualize site structure. Schematics of the types of information and the information groupings on individual pages are used (also called grey models or wire frames). In mock-ups, high-fidelity representations of web pages are often created in graphics applications like Adobe Photoshop. These mock-ups are often used in specifications. The term prototype often refers to computer prototypes made in HTML or Macromedia Director. Prototypes are typically used late in the design process. Collaborative work is often done on whiteboards, but computer tools such as Microsoft PowerPoint are also utilized. Written scenarios and personas are furthermore widely used [18], [23].

1.3 Expressing Interaction

Interaction designers need to represent ways for people to interact, they need to represent usage, and they need to represent user experiences. Sketching in interaction design differs from sketching in other domains since the designer focus explicitly on expressing kinaesthetic experience, interactivity, temporal aspects, tangibility,

immersion, sound, and haptics [11], [29]. Sketching in interaction design needs to be both static and temporal [20]. The problem is to express the dynamics of interaction.

To represent and communicate the dynamics of a working interactive system, computer prototypes are usually built. Before such prototypes can be built, however, the dynamics must be represented in other ways and state transition charts in the form of branching storyboards are one such way. A major drawback of these state charts is that they become very difficult to read and draw as the system becomes more complex [22].

1.4 Enactments

Synectics, a technique for developing creativity, builds on analogical thinking and humour as central ingredients of creativity. One of its key techniques is making personal analogies: participants are encouraged to imagine what it would be like to be the system or a component of the system [8]. For example, what would it feel like to be the garbage collector in the programming environment of LISP? By enacting this role, the designer can better figure out how the software should behave and appear to the user. Enactment, where a person acts out the performance of someone else or animates the behaviour of an object has been argued to be vital in design [24], [25], [31]. The enactment allows a designer to create and take part in a time-based representation of an activity, and others can join in this enactment.

Enactments can also be used to test how the user would behave. Jeff Hawkins, the inventor of PalmPilot, has been said to walk around with small pieces of wood in his pocket to prototype a PDA (personal digital assistant) and discover where and when he could make use of their product [26]. Buchenau and Suri describe this kind of prototyping as "experience prototyping"; they highlight "the experiential aspect of whatever representations are needed to successfully (re)live or convey an experience with a product, space or system" [7] (p. 424). If they are to experience the technology personally, designers must actively experience the subtle differences between design alternatives, and explore by doing. Buchenau and Sari argue that doing so will make it easier to grasp issues and feel empathy with stakeholders and their experiences. Thus, designers can explore by asking questions like "what would it feel like if…?"

In participatory design, developers sometimes engage users, employing staged and planned performances and role play in order to try out prototypes and mock-ups. The aim is to explore usage situations in a highly engaged way and to develop empathy. These performances can take the form of improvisational theatre or staged scenarios [9], [13], [15], [16].

The above techniques for acting out interaction are all planned and structured. Other enactments, however, are unplanned, situated, and taken for granted. These expressions of interaction and usage often take the form of gesture.

Designers frequently use hand gestures to make references [10]. This includes pointing to make references and gesturing to clarify or emphasize concepts (e.g. shrinking a square with the hands while asking "or can we scale the size down?"). Gestures form an important part of the spatial-action language of designers and making gestures is a convenient way to express the behaviour of both users and objects [4], [14], [24], [31]. These gestural enactments are sometimes made in

reference to a text or a sketch. In themselves, gestures and hypothetical user actions are ephemeral, and do not leave stable representations for future scrutiny [32].

Performing sequences of collaborative enactments is one way to explore ideas and share knowledge [6], [33]. They create a lived experience for the actor that also can be seen and assessed by others. This helps the design team focus on what the user is doing at all stages in the design [14].

Based on the observation that gesture and enactment play an important role in exploring how a product is used, we decided to analyse the spontaneous and unplanned enactments interaction designers do.

2   Method

This study reports a detailed analysis of a four-hour design workshop with four master's students in interaction design. This particular workshop is part of a series of workshops with students performing and learning interaction design. In total, the empirical material is encompassed by approximately 20 hours of video recordings made using multiple cameras.

Our studies took place at the Royal Institute of Technology in Kista where an interactive space called the iLounge was designed and built with the purpose of supporting co-located collaborative work. It is used both as a learning facility and as an experimental research facility. Two large touch-sensitive displays (smartboards) are built into a wall. In front of this wall is a table with a horizontally embedded plasma screen, also touch-sensitive. This interactive table is large enough for up to eight people to sit around it. In one corner of the room a smaller table and three chairs are placed in front of a wall-mounted plasma display, enabling a part of the group to work separately. The room has a wireless network and contains laptop computers with a wireless LAN card. The keyboards and mice in the room are also wireless, using Bluetooth. Finally, the iLounge contains high-quality audio and video equipment that can be used for videoconferences, or during user studies.

2.1 Procedure

Four master's students in interaction design, two male and two female, were invited to the iLounge. They all knew each other well, having taken the same courses for four years. The two female students were given a design brief asking them to design an interactive space to be used for studio classes. The two male students were given a brief asking them to design a drawing tool for an interactive digital whiteboard. The briefs thus pointed towards design solutions in the direction of the iLounge they were to visit and experience. Our idea was that they were to seriously consider how they would like such an environment to be structured, and thus come up with ideas about how iLounge could be improved.

The participants had worked individually on their designs before coming to iLounge. During the visit to iLounge they synthesized their individual design work with the work of the other design student who had been given the same brief. Then

presented their collective ideas to the two other students and ran a critique session. After these sessions we conducted an evaluation of the iLounge studio and what they thought about working there. During the first hour, an introduction to iLounge was given. Each group then used about thirty minutes each to synthesize their designs and about ten minutes to present their ideas; the critique session took about ten to fifteen minutes for each pair. The evaluation was performed during the following hour.

We recorded all sessions using both audio and video from multiple cameras. This video material formed the empirical material for this study. No interventions were made during the sessions, except during the evaluation, which was facilitated.

2.2 Analysis

After we gathered the data, we analyzed it together. The focus of our analysis was on the gestures and dramatizations (i.e. enactments) of their design proposals. During the analysis we interpreted the enactments and their performatives. We also traced our interpretations of events in the synthesis sessions to events in the presentation sessions. All verbal utterances and gestures were transcribed into a protocol in our native language (Swedish). We then analyzed the transcriptions further as we engaged with them theoretically using previous research, and only then did we translate them into English.

3 Results

In this section we describe how the designers enacted their design sketches using gestures to make them behave. Often they incorporated these enactments within acts of speech, but, as we will see, some enactments had no signifying word or verbal counterpart during the sessions. The enactments enhanced what the designers wanted to communicate, much in the same way that sketches provide simplified visualizations of a complex design proposal. In this section we present examples of how such communicative enactments were performed.

3.1 Without a Word for the Design

The two women, whom we will call Anna and Barbara, had the assignment of designing an interactive space using different digital resources. They started their synthesis session by quickly examining their sketches and summarizing their basic ideas about an interactive space. They had two basic ideas: that users needed plenty of space for sketches and that they needed space for both individual and collective activities. They were quite surprised that their sketches coincided. One of them, Anna, quickly took on the role of sketching on the smartboard and Barbara took on being the discussant: structuring the process of synthesizing the design by suggesting themes and discussing individual design proposals as well as documenting ideas. Anna generally expressed herself using many gestures, while Barbara was more modest with her gestures.

Barbara suggested that to structure the process they should start off by sketching things that would not need to be mobile, "like whiteboards etc." In Excerpt 1 we see how she was abruptly interrupted by Anna who vividly presented an idea about a mobile whiteboard.

Excerpt 1. Group 1, Synthesis. The tilting table.

1	Anna	Some of these come on small stands with wheels. (Barbara: OK) It depends on, I don't know, it depends on how the transmission works, but if there are many sockets then you can put it in different places… or at least slant ((stands up and vividly enacts a "tilting table" with her arms)) it so it depends on if they are permanent like these or not.
2	Barbara	For the whiteboard then..
3	Anna	Yes, like those old stands like those old rolling blackboards (Barbara: uh huh, OK) that you could move like a curtain ((walks like she is pulling the curtain)) at the theatre.
4	Barbara	Could you make them work that way too?
5	Anna	I don't know, but it would be cool.
6	Barbara	It would be cool ((writes)) I'll write work area
7	Anna	Write: for different purposes.

Although Barbara suggested starting off with non-mobile furniture the discussion then focused on Anna's idea of a mobile smartboard that can be tilted. By demonstrating how a smartboard can be slanted from a vertical to a horizontal position Anna enacted the interaction, which was closely connected to the purpose of their design concept. First, in turn 1, Anna waved her arms to act out how it should be possible to slant the smartboard, and in turn 3, she makes an act of seeing-as where the smartboards can be pulled along like a curtain. In turn 4, Barbara made a mirroring tilting gesture. In this gesture she both experienced the interaction of tilting the board, and affirmed that she understood the concept. They both found this idea very appealing.

About 15 minutes later, while they were discussing and summarizing their synthesized design proposal they returned to the enactment of the tilting table. During the process said had said that they should denote different aspects of the properties in the room using different colours: blue was to denote technology. Excerpt 2 presents what they said, and Fig. 1 depicts the enactments in a picture sequence.

Excerpt 2. Group 1, Synthesis. The tilting table, continued

1	Anna	Okay, but then I'll draw them in blue as they are technology.
2	Barbara	The tables? Are they technology?
3	Anna	Well…the… ((enacts the "tilting table" with the arms))
4	Barbara	Uhuh, ((mirrors the same enactment)) those ..yes

Fig. 1. Sequence showing the enactment of "the tilting table". Anna waves her arms to enact "the tilting table" and Barbara mirrors the enactment.

When Anna suggested that she draw the tables into their design sketch using the blue pen to denote technology, Barbara did not understand why the tables should be denoted with blue. This misunderstanding is reasonable, as they had been discussing both tables in the sense of ordinary designed tables and an enacted "tilting" smartboard. When Barbara asked whether the tables counted as technology, Anna answered by again enacting the tilting table; this helped Barbara understand, and she then mirrored the tilting with her arms. Still they had no word to denote the table/board. The tilting table existed only in the enactment that the two designers shared.

3.2 Interaction Walkthroughs

The two men, whom we will call Christian and Daniel, had the assignment of designing a drawing tool for a smartboard. Their synthesis session started directly, as they discussed differences between traditional whiteboards and a digital counterpart in terms of affordances. Christian went to the smartboard and started up the installed sketchpad, and then sat down to listen to Daniel. Daniel first explained his view of the differences in what it is possible to do with a traditional whiteboard. They both pointed to the object-centred character of the digital whiteboard (that the user works with drawn objects rather than with pen strokes). In excerpt 3, we see how Daniel goes to the smartboard and presented his idea about the differences (Fig. 2).

Their preliminary and quite spontaneous analysis of the differences between traditional and digital whiteboards was clearly connected to their enactment of interaction. In fact, the enactments drove the analysis, moving it from an abstract and analytical perspective on the differences in affordances, to the concrete and physical behavior of this actual digital whiteboard. By exploring this analysis of affordances at the same time that he explored the actual smartboard Daniel dramatized a type of user behaviour: a designer's think-aloud exploration. This enactment also took place on the presentation level, since the designers explored the feel of the smartboard. In this case it did not feel natural. Christian, who was sitting down, was more distant in his attempts to take the floor, but Daniel was so engaged in his explorative dramatization that he seemed to more or less ignore Christian's initiatives. When Christian prompted Daniel to think about whether he had an alternative idea about interacting, the discussion ended with a blunt no, with Daniel's extension that maybe it all could have been done with a mouse. The explorative dramatization might have made Daniel a bit disillusioned about how one can interact with the smartboard as he reverted to an almost mundane form of interaction.

Excerpt 3. Group 2, Synthesis. Naturally not natural

1	Daniel	Because when you…. When you draw then…you know, this is not natura...it's not natural. I must put this pen away then take my finger and drag this. You know, I do this only because I know I can put away the pen and use my finger as a mouse so to speak (Christian: yes)
2	Christian	But at the same time I think that it is like..
3	Daniel	But it's good that you can do that as if it is an object.
4	Christian	Did you have any alternative, or
5	Daniel	No, not really, I just thought that you might have a tool to use? as a mouse…

Fig. 2. Presents his argument by making a sketch of how one does not do it naturally

3.3 Improvised Role Play

In the following excerpt we exemplify how the two male designers explored the different uses of the actual smartboards in order to design them to be used for collaborative purposes. It is striking that the pair started to dramatize their work using other voices, as if to explicitly express that someone else (the user) would say and act out what they think. These forms of voice dramatization quickly turned into examples of what each speaker wanted to do. In turn, the two amplified and enhanced these examples as they engaged in enactments, trying to do what they anticipated the users doing; see Excerpt 4. Here Daniel concluded by describing the concept of the traditional whiteboard. Fig. 3 depicts the two designers taking on the role of the users.

Excerpt 4. Group 2, Synthesis. You sketch there and I sketch here

1	Daniel	But I think it's, what I think is a bit difficult about this is that we absolutely cannot work at the same time. Think of if I were to like "*But check this out, then we cannot have that there…*"
2	Christian	Exactly. If we do that then I would come and say, "*but this should be here*", but you will say "*no it should be here.*"
3	Daniel	"*But, we do like this*".. hang on… wait a moment..
4	Christian	Then I want to at the same time, and want to move these…
5	Daniel	Exactly…or you want to draw… Say you want to draw down in the corner…
6	Christian	There you have the advantage with the whiteboard. Okay, then you sketch there and I sketch here…

Fig. 3. Both designers are working together in vividly dramatizing the users' behaviours.

This episode of enactment is interesting in that both designers cooperated in the role play; Christian followed Daniel, playing along with his initiatives. In the earlier excerpts, we also saw that the female designers were playing along, but they mirrored each other's enactments rather than one taking a distinct lead. In this session the two designers cooperate and play along, using both gestures and voice in taking on the roles of users. These short role playing sessions evolve into a discussion of what target context the user would be in. They explore the concept of cooperative sketching by role playing.

4 Discussion

We began this paper with an overarching question: How do interaction designers work on the dynamic aspects of their design object? Looking at previous research as well as our results, we have seen that they create the dynamic aspects within a tight coupling of talk, graphical representations, and gestural enactments.

The sketches are important as tools for thought, but it is the enactments and dramatizations that make the sketches behave. Playing the role of a user, and exploring the potential technology with the intent of using it, helps designers explore the design and their design ideas, and also come up with new ideas.

The enactments help designers to focus and move themselves imaginatively into the target context where their design solution might be used. In the material, we saw how Anna and Barbara used their gestures as a shared reference to their design without even having a word for it. As such, gestures served as a powerful means to collaboratively assess the use of their design and engage in the situation of its use [24], [25], [32]. But not only do gestures help designers assume the role of the user. They also help them take on the role of the artefact-in-use. In the empirical material,

we saw how Christian and Daniel imagined and enacted what the computer should be doing, for example, how drawn objects should behave in contrast to pen strokes.

In the action context of the here and now, designers speak, gesture, and modify graphic representations. The graphic representations create a space, representing the target context, in which designers can perform design moves [1]. They do so by continuously modifying the graphic representations and by performing gestural enactments to communicate and explore the dynamics of interaction. This process supports the interaction designers in imagining themselves as part of the interaction processes of people and artefacts. Our observations support the work by Robertson, who describes how designers use enactments to create and take part in a time-based representation of process or activity that others can take part in [24], [25].

Sketches can be thought of as states in a state diagram; what the diagram lacks are the transitions. In order to represent the transitions between states, the designers make use of gestures. In fact, the tilting table has two states: horizontal and vertical. In between those states there is a transition, which the women designers represented by using arm movements. Similarly, as the Christian and Daniel dramatized the users' utterances and actions, they were representing transitions within and between functions, thus creating and experiencing structure and interaction. This can be seen as a form of experience prototyping [7]. The drama becomes a process of collaborative reasoning, firmly anchored in a situation of imagined use. Once again, this corroborates earlier research [24], [25], [31], [32].

4.1 Interaction Walkthroughs and Improvised Role Play

In our material, the participants performed enactments using gestures that mimic the actions of users in an *interaction walkthrough*. The interaction walkthrough is a gesture-driven enactment and it helps experiencing and figuring out the behaviour of the artefact-to-be-designed.

Christian and Daniel took on the role of two users and imagined themselves in a certain situation of use. This *improvised role play* is a scenario-driven enactment, and is used as a designer's think aloud exploration which contextualises the design solution in an imagined target situation.

Without these forms of expression, it would be difficult to express interaction and also the basic design concept behind their design solutions.

4.2 Future Research

The research presented here is conducted in workshops with interaction design master students. Further research conducted in cooperation with professional interaction designers will provide a more contextual insight into the expression of dynamics and behaviour in the practice of interaction design. Future research also needs to address what the influence of gestural enactment is on the product, and give a more detailed analysis of the functions of different kinds of gestures.

As Tuikka has noted, enactments are of an ephemeral nature [32]. This means that there are no stable traces of them. In order to make specifications for construction and

to support asynchronous communication it is however necessary to document the dynamics in some other way than gestures and role play. Hummels has provided examples of how arrows in sketches are used for that purpose [14]. Improvised role play can be documented in high-level storyboards, written scenarios, and video sketches. Interaction walkthroughs can be documented in storyboards, state transition charts, and simple animations. Building running prototypes is probably an even better specification. None of stable representations are however as swiftly used and convenient in collaborative design as enactments are, in the form of improvised role play and interaction walkthroughs.

4.3 Conclusions

In an analysis of gestures in interaction design we have identified two means for expression of the dynamic aspects of interaction design: Interaction walkthrough and improvised role play. Gestures drive the interaction walkthrough and scenarios created on the spot drives the improvised role play. These means for expression are two kinds of enactments. Given the ephemeral nature of enactments, the improvised role play and interaction walkthroughs still need to be documented in stable representations. Storyboards, scenarios, video, animations, and state transition charts are examples of stable representations that can be used.

References

1. Artman, H., Ramberg, R., Sundholm, H., Pargman, T.C.: Action Context and Target Context Representations: A Case Study on Collaborative Design Learning. In: Koschman, T., Suthers, D., Chan, T.W. (eds.): Computer Supported Collaborative Learning 2005: The Next 10 Years!, Lawrence Erlbaum Associates, Mahwah (2005)
2. Arvola, M.: Shades of Use: The Dynamics of Interaction Design for Sociable Use. Linköping Studies in Science and Technology Dissertation No. 900, Linköpings universitet, Linköping, Sweden, http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-5019 (2006-02-08) (electronic version 2005, printed version 2004)
3. Arvola, M.: Interaction Design Patterns for Computers in Sociable Use. International Journal of Computer Applications in Technology 25 (2/3) (2006) 128-139
4. Athavankar, U.: Gestures, mental imagery and spatial reasoning. In: Gero, J.S., Tversky, B. (eds.): Visual and Spatial Reasoning in Design. Key Centre of Design Computing and Cognition, University of Sydney (1999)
5. Bailey, P., Konstan, J.A., Carlis, J.V.: DEMAIS: Designing multimedia applications with interactive storyboards. In: Proceedings of MM '01. ACM Press, New York (2001)
6. Bekker, M., Olson, J.S., Olson G.M.: Analysis of gestures in face-to-face design teams provides guidance for how to use groupware in design. In: Proceedings of DIS '95. ACM Press, New York (1995)
7. Buchenau, M., Suri, J.F.: Experience prototyping. In: Proceedings of DIS '00. ACM Press, New York (2000)

8. Cross, N.: Engineering Design Methods: Strategies for Product Design, 3rd ed. John Wiley & Sons, Chichester (2000)

9. Eden, H., Scharff, E., Hornecker, E.: Multilevel design and role play: Experiences in assessing support for neighborhood participation in design. In: Proceedings of DIS '02. ACM Press, New York (2002)

10. Fleming, D.: Design talk: Constructing the object in studio conversations. Design Issues 14 (2) (1998) 41-62

11. Fällman, D. In romance with the materials of mobile interaction: A phenomenological approach to the design of mobile information technology. Dissertation, Umeå University, Sweden (2003)

12. Goldschmidt, G.: The dialectics of sketching. Creativity Research Journal 4 (2) (1991) 123-143

13. Howard, S., Carroll, J., Murphy, J., Peck, J.: Using 'endowed props' in scenario-based design. In: Proceedings of NordiCHI 2002. ACM Press, New York (2002)

14. Hummels. C.: Gestural design tools: Prototypes, experiments and scenarios. Dissertation, Technische Universiteit Delft (2000)

15. Iacucci, G., Iacucci, C., Kuutti, K.: Imagining and experiencing in design: The role of performances. In: Proceedings of NordiCHI 2002. ACM Press, New York (2002)

16. Iacucci, G., Kuutti, K., Ranta, M.: On the move with a magic thing: Role playing in concept design of mobile services and products. In: Proceedings of DIS '00. ACM Press, New York (2000)

17. Landay, J.A., Myers, B.A.: Interactive sketching for early stages of user interface design. In: Proceedings of CHI '95. ACM Press, New York (1995)

18. Lantz, A., Artman, H., Ramberg, R.: Interaction design as experienced by practitioners. In: Proceedings of the Nordic Design Research Conference 2005. http://www.tii.se/reform/inthemaking/proceedings.htm (2006-02-08) (2005)

19. Lin, J., Newman, M.W., Hong, J.I., Landay, J.A.: DENIM: Finding a tighter fit between tools and practice for web site design. In: Proceedings of CHI 2000. ACM Press, New York (2000)

20. Löwgren, J.: Animated use sketches as design representations. interactions November + December (2004) 22-27

21. Nelson, H., Stolterman, E.: The Design Way: Intentional Change in an Unpredictable World. Educational Technology Publications, Englewood Cliffs (2003)

22. Newman, W.M., Lamming, M.G.: Interactive System Design. Addison-Wesley, Harlow (1995)

23. Newman, W., Landay, J.A.: Sitemaps, storyboards, and specifications: A sketch of web site design practice. In: Proceedings of DIS '00. ACM Press, New York (2000)

24. Robertson, T.: Embodied Actions in Time and Place: The Design of a Multimedia, Educational Computer Game. Computer Supported Cooperative Work: The Journal of Collaborative Computing, 5 (4) (1996) 1-27

25. Robertson, T.: Cooperative Work and Lived Cognition: A Taxonomy of Embodied Actions. In: Proceedings of the Fifth European Conference on Computer-Supported Cooperative Work. Kluwer Academic Publishers, Dordrecht (1997)

26. Sato, S., Salvador, T.: Playacting and focus troupes: Theater techniques for creating quick, intense, immersive, and engaging focus group sessions. interactions September + October (1999) 35-41

27. Schön, D.: The Reflective Practitioner: How Professionals Think in Action. Basic Books, New York (1983)

28. Schön, D.: Educating the Reflective Practitioner. Jossey-Bass, San Francisco (1987)

29. Svanæs, D.: Understanding Interactivity: Steps to a Phenomenology of Human-Computer Interaction. Dissertation in Computer Science, NTNU, Trondheim (2000)

30. Sundholm, H., Ramberg, R., Artman, H.: Learning Conceptual Design: Activities with Electronic Whiteboards. In: Agger Eriksen, M., Malmborg, L., Nilsen, J. (eds.): CADE2004 Web Proceedings of Computers in Art and Design Education Conference, Copenhagen Business School and Malmö University. http://asp.cbs.dk/cade2004/proceedings/ (2006-02-08) (2004)
31. Tang, J.C.: Toward an Understanding of the Use of Shared Workspaces by Design Teams. Dissertation, Stanford University (1989)
32. Tuikka, T.: Remote Concept Design from an Activity Theory Perspective. In: CSCW '02, Proceedings of the 2002 ACM conference on Computer supported cooperative work. ACM Press, New York (2002)
33. Wulff, W., Evans, S., Rheinfrank, J.: Animating Interfaces. In: CSCW '90, Proceedings of the Conference on Computer-Supported Cooperative Work. New York: ACM Press (1990)