Where All the Interaction Is

Sketching in Interaction Design as an Embodied Practice

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ABSTRACT

Sketching and design sketches are often recognized as key elements of successful interaction design practice and a central skill in interaction design expertise. Interaction design is a relatively young field without well-developed conventions, tools, and formalisms. We analyze the practical work and the conduct of interaction designers in how they express interaction and dynamics through white board drawings. We focus on how talk and action were used to shape the meaning of the drawings. The ways the designers imagined that users would interact with the system and how it would mediate communication between users became topical through a web of drawings, talk, and embodied action. Our analysis forefronts three aspects of interaction design: 1) the role of the design material 2) the role of embodied action in interaction design, and 3) talk and embodied action as central means of *doing design*. We argue that the qualities of a design material need to be understood in relation to the activity in which it is taken into use and through the kinds of actions that the participants engage in. This implies that design representations do not carry meaning in themselves but *are made* meaningful through design activity.

Categories and Subject Descriptors

H5.m Information Interfaces and Presentation

Keywords

Interaction Design, Interaction Analysis, Design Talk, Bodily action

1. INTRODUCTION

This research is concerned with understanding the practical work of interaction designers and the role played by representational artifacts and representational action in that work, in particular we focus on the activity of sketching. A sketch can generally be characterized as a not fully specified drawing often made as a brief preliminary account or outline of a design. Contrary to other design practices such as architecture and graphic design, interaction design is a relatively young field without well-developed conventions, tools, methods and formalisms that practitioners rely upon. Currently, there is a conceptual discussion in the field regarding how to understand the notion of design in interaction design and HCI [see e.g. [1], [2]. The present work contributes to this discussion by documenting some of the characteristics of the "professional vision" of interaction design practitioners. The challenging issues that we address here are concerned with understanding the practical means of expressing interaction and how static drawings and sketches actually become to be about the design of interaction. We argue that the drawings and sketches as such are not sketches of interaction, rather they become about interaction through the designers active engagement with these representations through talk and action. Our analysis shows what such a design process can be like.

Particularly challenging for interaction designers is to express design ideas so that they make the dynamic and interactive qualities salient to other participants in a design session such as peer designers or stakeholders. Interaction design representations are often produced through the use of static forms of expression, which makes interaction design largely about bridging static and dynamic forms of expression.

In this work we present an analysis that shows how interaction design largely is about joint creation of design ideas through collaborative and embodied action that rely upon semiotic resources such as sketching, talk, and gesturing. Thereby, we contribute to an understanding of the relationships between representational artifacts, embodied forms of expression, and communicative action in interaction design practice. These are central means of how interaction designers express dynamics and interaction.

In the particular case that we investigate in this paper, two interaction designers collaboratively work out an idea on a whiteboard using sketches and drawings as representational devices[1]. We analyze how they jointly develop design ideas and how sketches are made to work as representations of different aspects of the interactive system being designed. The use of the drawings shifted from being treated as information containers at a conceptual level to sketches of concrete interface elements. What one particular drawing represented at a specific stage in the design process was closely interweaved with and shaped by the designers' talk and action. We analyze the conduct of the designers in relation to the drawings and how talk and action were used to shape the meaning of the drawings. In line with

[1] In total, two pairs of interaction designers and two pairs of service designers were studied.

interaction and conversation analytic approaches [3] the analysis is descriptive in character with a focus on understanding the practical means people use in creating order in their everyday social endeavors.

2. SKETCHING AND INTERACTION DESIGN

The notion of interaction design has evolved out of work in HCI and areas such as user interface design. Whereas traditional user interface design is concerned with designing the particular interface elements that will be used to interact with a computational system, commonly through WIMP-interfaces, interaction design puts its emphasis on the design of the interaction between users and computational artifacts. Such work often includes design of user interfaces as an important element, but in line with e.g. [4] we argue that interaction design is about more than designing a user interface; it's about designing interaction between users and artifacts.

Studies of user interface design practice have emphasized the different representational resources that interface designers rely upon such as storyboards, sitemaps and sketches [5]. Such work has also led to the development of interface design tools to support the interface design process through systems such as Denim and Silk [6]. However, such work does not focus on interaction designers' practical means of conceptualizing interaction and how dynamics and interactivity is enacted. In line with some more recent studies of interaction design we are investigating the practical and representational means that interaction designers use to keep an imaginative and creative stance towards design challenges [7-9].

Sketching and design sketches are often recognized as the key elements of successful interaction design practice and a central skill in interaction design expertise [10]. Sketching have been documented to have functions including support for individual cognition, for collaboration and negotiation, as well as for producing artifacts to communicate and present ideas to stake holders. A recent study of communication between interaction designers and their clients [11], identifies the use of singular sketched objects as elastic components that dynamically may change purpose and meaning over time in the design process. The role of sketching is increasingly emphasized in interaction design practice [4, 12] often drawing on Schön's [13] classic work on how the design material works as a conversational partner that "talks back" to the designer. The qualities of the design material thus have consequences for how a design activity unfolds, and also the resulting design. Such analyses have lead to the development of ideas [14] for new design materials. Löwgren [14] discusses the need for design materials that capture the dynamic aspects of sketches, such as animated use sketches, especially when being presented to stakeholders. Sketches and different kinds of prototypes are frequently used as representations and tools for testing, evaluating and communicating ideas and concepts within HCI. Sketching plays a number of different roles in different stages of the design process, such as tools for supporting individuals' own creative design processes, and tools for communicating with stake holders regarding design proposals [10]. Representing design ideas thus serve several purposes for the individual designer, e.g. for reaching an understanding of the design problem, for getting enough material to work with, and for providing materials to be used to communicate with others. Within interaction design more particular roles of sketches have been proposed to include: 1) a way to structure thoughts and the forming of ideas, 2) as an instrument enabling designers to communicate with themselves, and enabling seeing and inspecting one's own thoughts more readily at hand by supplying something to react and reflect upon, and, 3) as a tool for communicating with others, enabling taking the next step based on something that exists [4].

However, sketching is not only designated for design activity. Tversky [15] for instance, has studied lay people's sketching as a general cognitive activity that support memory and perception. In Tversky's studies of the qualities and properties of sketches, aspects such as how sketches reflect the conceptual structures of an idea have been focused on. Similar work has analyzed the cognitive strategies used by designers arguing that sketching is used for externalization of ideas and as memory aids that reduce the cognitive burden of designers [8]. In the same spirit, Neiman, Gross, and Do [16] studied the function of sketches in early design phases by analyzing the characteristics of the sketches for a design case by classifying aspects such as types of drawings, relationships among drawings, and, principal elements contained in the drawings. Drawing on Schön one could define these expressions and representations as part of a designers repertoire. When studying actual design work the usage of the repertoire, irrespective of what the repertoire consists of, become central [11]. Studying the usage of a repertoire also emphasize the doing of design rather than idealized theories of design.

2.1 Moving towards a practice based view of interaction design

The role of external representations in mediated discourse has extensively been studied in a number of research areas such as CSCL, e.g. [17]; CSCW, e.g. [18]; and distributed cognition, e.g. [19, 20]. Of particular relevance for the study presented here is the ethnomethodological stance in which participants' practical means of establishing shared meaning is investigated. Our research draws on work that emphasizes the multimodal character of social interaction and how the character and properties of the material used in representational practices structures the unfolding of activity and discourse [21, 22]. In such work, the meaning of a representation is viewed as a joint achievement by participants' engaged actions upon, and interaction through, representational artifacts. Our work thereby relates to more general studies of creativity and imagination that attempt to challenge dualistic conceptions of knowledge and action – often called the "dual knowledge" thesis [23] – not only on a philosophical level but also through documentation and analysis of empirical cases [24].

2.1.1 Interaction design as performed and embodied action

Recent studies propose a perspective on how designers use conversational and material resources such as language and sketches for performative purposes in order to enact design solutions [1,4]. Thereby social and embodied action becomes a way of actually doing design [25]. Dong for instance uses speech-act theory to introduce a performance perspective of language use in design. Related studies for instance by [26, 27] use concepts of performance and enactments to emphasize how bodily action in combination with language are key elements in students' and children's construction of ideas in the design of interactive systems. These studies of design work of both students and children show how bodily action and enactments with representational artifacts are central aspects in the expression of dynamics and interactivity. The studies referenced above relate to current trends in HCI that emphasize embodied aspects of interaction and the role played by the concept of performance in interaction design [28, 29]. We attempt to extend and contribute to such work by analyzing what designers actually do to make sketches represent an idea.

In ethnomethodological terms we investigate the designers' practical work of jointly constructing ideas about interaction with a particular focus on the embodied forms of action used to make sense out of sketches. Rather than studying sketches as expressions of the ideas of individuals, such a perspective involves studying the in-situ interpretations through which sketches are given meaning in a process of collaborative production of ideas.

3. CASE STUDY: SKETCHING WORK BY INTERACTION DESIGNERS

We present an analysis of two interaction designers conducting an authentic design case at the Swedish Enforcement authority. The design activity was part of a process of building an interactive system for the handling of applications for debt restructuring. Debt restructuring allows Swedish citizens in economic jeopardy the possibility of avoiding personal bankruptcy. The process was previously completely manual and the task of the interaction designers was to design a system to support the work process. In the part studied here the interaction designers focused on the authority's process of receiving applications for debt restructuring and other related documents. Documents could be both in physical and digital form. Central to this part of the process was to map the new information towards other actors in the system.

We used interaction analysis as the primary method of analysis with particular focus on multi-modal aspects of interaction including talk, gaze, and bodily action in relation to the interpretation and production of artifacts and documents [3]. Content logs of the overall design process were created by characterizing how the activity developed. Detailed transcriptions and analysis were made of strips of interaction that were of particular interest. An overall theme that appeared from our initial analysis was that sketching was a highly complex activity. Besides the sketches themselves, a number of other communicative and expressive means were involved in the activity. As our analysis became more detailed we discovered that talk and bodily action including gesture about interaction and dynamics were intrinsically intertwined with the activity of sketching, and in negotiating the meaning of sketches. In the analysis we present here we go into detail into four different fragments that were selected to illustrate some of the means that the interaction designers used to engage with the dynamic and interactive aspects of the system they were designing. In the transcriptions we use a subset of Jeffersonian transcription conventions. The transcripts have been translated into English by the authors. M and E refers to the two designers and C refers to the stakeholder.

First we present an excerpt selected to illustrate the character of the overall design process. In the following sections we present a number of excerpts that go into detail into the designers' work.

3.1 The Overall Character of the Sketching Activity

In the work of the designers there was a distinctive difference in the way they discussed with the stakeholders and how they discussed among each other. The conversation between designers and stakeholders was clearly verbalized often with long descriptive explanations. This style of talk could be characterized as "information gathering" and often concerned testing of hypothesis regarding the information that should be represented in the system. In Excerpt 1 the interaction designers are in the initial phases of design and are in the process of defining the overall structure of the system to be designed.

1 M: You are drawing surfaces directly yes

2 E: I got an assign=

3 M: =you have a vis[ion here

4 E: [vision here (.) it could be: (.) completely different (.) but one has to start somewhere

5 M: Yeah

6 E: Really some one [must have some kind ((*walks up to left box on white board and lifts arms*))

7 M: [in (.) in the inbox has some form of document tha-

8 E: has arrived

9 M: has arrived (.) and then we have a number of questions ((*turns towards stake holder*)) (.) ehh more to check that the document is complete before we do anything to it right (.) these controls that you read

10 C: Ehh

11 M: Wh [why are we doing this control

12 C: [yeah: (.) we are doing this control because to eh: (.) partly it's about identifying that it's the correct case (M: yeah) but it's also to (.) be able to see if there is a case to which it is some kind of connection

13 M: okay yeah

14 E: connect (*looks at stake holder*) it with a case

15 C If there is a kalle johansson existing from before and then there is greta johansson

16 ME: Yeah

17 C: And then we have the connection registration that one notes then right

18 M: Right since otherwise there is only one live case for each debtor right

19 E: But this with the (*looks at stake holder*)

Excerpt 1

The focus on "information gathering" becomes clear about ten turns into the excerpt. Several times clarifications are asked for by the designers (turns 11, 15, 17) which are provided by the stake holders (turns 12, 16). When discussing with the stake holders, the issue of how users would interact with the system was, however, rarely an aspect that the designers explicitly brought to the fore.

Between designers, on the other hand, the conversation was mostly quite short and fragmented in character, including a lot of unfinished utterances and deictic phrases like "this" "that" "there", and with numerous references to drawings and sketches on the white board. This style of talk and action could be characterized as "enacting design representations", and worked

as a way of collectively conceptualizing ideas for how the future interaction would unfold.

Theory of design, is sometimes said to be composed of three generations each presenting different views of designers and design work [30]. The first generation emphasized designers as expert problem solvers. The second one viewed the interaction between design proposals and clients as central in a process through which requirements specified by users developed continuously together with the design proposals. The interaction designers in our study could initially be characterized as having the role of the negotiators who interpret the requirements of the stakeholders. This was mostly obvious during the first part of the design work as exemplified by the excerpt above. The third generation of design theories built on insights about design knowledge being partially tacit and contextual with an especial interest in what makes design knowledge specifically design oriented.

As the activity progressed, the activities and talk of the interaction designers displayed a change from the negotiator role to becoming designers with a specific design competence. This change was not always explicitly observable in the verbal interaction (see Excerpts 3 and 4). Different phases of the design work thus corresponded to the different metaphors of the three generations of design theories.

During the early phases, the stakeholders were the experts who provided the accurate information to the designers. Many terms from the stakeholders' domain were introduced and used, and the designers even picked up the specific pronunciation of some of these. Later in the process, the designers were more independent of the information gathering and engaged in drawing out possible new design proposals. When one of the designers' sketched a button in the incoming errands list, one of the stakeholders exclaimed: "*You have been around!*"

When discussing with the stakeholders the topic of the discussions centered around the structure of information and how it flowed in the organization and between people. Most of the discussion focused on what was the case at the time rather than envisioning new possibilities and new designs. The designers tried to make limitations explicit. The sketching was largely done to clarify general ideas and for establishing a common ground for the work to follow.

Further into the design process the interaction designers discussed less about information structures and were often involved in sketching on the whiteboard and became more oriented towards interaction oriented issues. The character and content of the discussions changed. They moved from discussing what is, to cautiously trying out design proposals and to get them validated. Having faced the stakeholders in the discussions they increasingly turned towards each other and towards the whiteboard or the computer. The designers started using specific terminology related to user interaction and even concrete interface elements such as "classic inbox", "to open messages", "message lists", "flagging" (of events), "filtering", "sorting", "clicking", "double-clicking", "opening windows", and "tabs" etc. The designers frequently pointed at things on the whiteboard to show where "in the system" they "were" as if they were simulating imaginary user interaction with the sketched system.

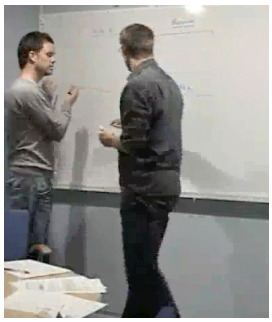
The shift from information gathering and negotiation about what is, to designing new interaction was not a definite shift in the activity; the designers returned to the stake holders later on as they got into more detail in their design proposals.

3.2 Sketching Work

Locating the exact passages where the designers actually designed the interaction was not always straightforward. The interaction was only partially represented in the whiteboard sketches. They also used other representational artifacts such as post-it notes, scenarios on sheets of paper. These together with talk, bodily movement including gestures formed the meaning making practice about interaction. All these forms of communication and expression served complementary purposes in the specification of the interaction between users and the systems being designed. The ways the designers imagined that users would interact with the system and how it would mediate communication between users thereby became topical through a web of sketches, talk, and embodied action.

Their professional discourse is essentially about issues concerned with "design of interaction" even though this was often expressed through not immediately observable conduct. Excerpt 2 serves to illustrate some of the initial details of this. The two designers were here in the process of sketching out the first few interaction elements of the system. When discussing this with the stakeholders that were present in the room they put much effort in verbally articulating the information and communication flows of the debt restructuring process. On the other hand, when talking to each other they were often quite brief in their talk, doing less conversational work to achieve a shared understanding with their design partner.

1. E: some kind of controls that you could have here ((*scribbles on the white board*))(1.0) or whatever those might be (.) does not matter
2. E: maybe because one can't read someone's writing
3. M: yeah just because ((*points at white board*))



4. E: yeah
5. M: so it's kind of a document window
6. E: yeah, right

Excerpt 2

The two designers are here engaged in discussing some scribbles on the white board by E (to the left). E seems to be explicitly vague in his formulations (some kind of controls …or whatever those might be) when describing his idea to M (on the right). Despite this, without much explicit effort M gives the impression of understanding E's idea by looking at the sketch on the white board and pointing (turn 3) to a particular area that E has turned his attention towards (turn 1) through scribbling on a specific spot on the white board. In turn 5 M proposes that what E drew was a kind of document window and points to the same

area that E shifted their attention towards. In this strip of interaction, they both seem to infer a lot of meaning in the use of the words 'control' and 'document window'. These are taken to involve a range of interface issues related to interaction and functionality, that they both are knowledgeable about. The drawing on the white board plays a key role for M's possibility of interpreting and contributing to the suggestion put forth by E. The white board drawing thereby works as a representational artifact that they both orient their actions towards and use in the shared construction of the meaning of the design sketches. The drawings become key elements for the unfolding of the social interaction, as well as in the representation of design solutions. The following excerpts serve to analyze how this is achieved in more detail.

3.2.1 Pointing as a representational device for design

The strip of interaction in the following excerpt occurred when the designers started to explore how to handle relations between different actors in the system and how such relations would be "registered" by the users of the system. As discussed previously, talk was here not very descriptive, instead it involved a lot of short and often deictic utterances such as "here", "there", etc referring to different aspects of the sketching activity. This was often combined with highly active pointing work. The designers here have started to outline their ideas on the whiteboard in the form of four squares, three of them named 'inbox', person view, case view respectively, and a fourth un-named square with the words relationship written inside of it.

1 E: and then these here maybe one should register them ((*points at*

white board))
here the connections like you say

2 M: yeah it's some control questions

3 E: Yeah then it's like you do it here in some way also

4 M: really it depends on what type of (.) I believe ((*points towards*

board))
the connections are very specific to the application (.) it's not a check that is done (.) really ((*gestures to the right side of the board*))

the connection lies in the actual case (.) or person (.) and it seems to show up on the application ((*open hand towards left side of the board*))

for example but for instance it is not any kind of action it is a control question you ask but it is [eh specific

5 E: [when a new one arrives ((*points at upper left square on board*))

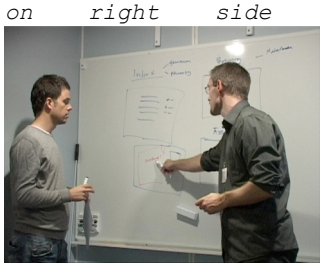
(.) if you think that it's only a letter coming in ((*gesture in front of body*)

6 M: Yes

7 E: then one at least has to say what(.)
[the case it belongs to

8 M: [what case this one belongs to

9 M: but this is ((*points to left side of board*) is a specific meaning for that ((*points to right part of board*)) there ((*points distinctly on right side of board*))



(.) it is kind of a forbidden word to use

10 E: Sure

Excerpt 3

In turn 3, E asks yeah then it's like you do it here in some way also. Note how this is vaguely formulated through the use of markers such as 'well' and 'in a way'. This is responded to by M in a verbally elaborate manner combined with a number of explicit pointing gestures (see Figures in turn 4) directed towards the squares on the white board. These gestures are not broad references toward the white board drawings. Rather, each pointing action is specifically timed with M's spoken explanations. Pointing action thereby works as a means of making particular aspects of the drawing salient to the other participant. "really it depends on what type of (.) I believe ((*points*))the relations are very specific for the application (.) it's not a check that is

done (.) really ((*points to the upper right square on the board*)) the relation is on the actual case (.) or person (.) and it seems to appear on the application ((*points to the lower left square on the board*)) for instance but it's not any kind of document it is a check you make it is really". The last two pointing gestures are synchronized with M saying 'relations', 'a check', and 'application'. The two objects pointed at are physically located in different places on the board. By pointing at each of these two squares while simultaneously talking about relations between them he is able to represent the relation between the two in a complementary representational space constructed through physical action.

The physical actions of pointing and gesturing contribute to creating a representation of how two of the drawn objects are to be connected. The representation of the design idea is thus not only what is drawn on the white board. The representation is constructed out of the combination of physical action, language and a white board drawing. Representing the relationship between two objects is interactively co-constructed through the combination of talk and gestural action closely interrelated with the physical manifestations on the white board. The designers are constructing a potential meaning for the handling of relationships between different objects and actors in the system. However, at the present point in the design process this suggested interpretation on how to represent these relationships only exists in the space of talk, physical action, and drawings as representational artifacts.

The white board drawings become anchors in the creative process of exploring different designs. The designers can experiment with and imaginatively alter the representations by *acting upon them* through physical and verbal action. But instead of physically manipulating the representations, they use them as resources that they can orient their creative actions towards. The white board representations thereby provide a point of stability that they can "return" to after having explored potential alternative designs. The meaning of the drawings are constructed through the designers talk and actions oriented towards them. In a sense, in combination with talk and embodied action the drawings are turned into "sketches of interaction".

3.2.2 Talking about the drawings

In the following excerpt the interaction designers have started to move from conceptual aspects of the new system and started to consider how these can be materialized through the interactive properties of the design. Figure 1 and 2 show the white board at the start of excerpt 4. In the following excerpt the issue of connecting the different actors involved in the system is further explored by the designers. At the start of the excerpt, the interaction designers focus their work on the box in the lower right corner of Figure 1. Figure 2 includes a number of GUI-elements and further into the excerpt they move to this part of the white board and focus their work on its right hand side where a document should be displayed.

Figure 1: Left part of white board

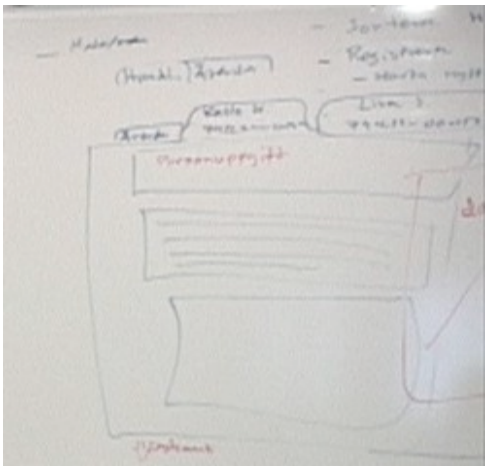


Figure 2: Right part of whiteboard

1 M: Okay so this was (1.0) and you had both inspect and connect here really

2 E: yeah

3 M: wonder if it is actually needed

4 E: Actually you only do one thing at a time but I was thinking (.) technically you reuse the same (.) but that one can uh yeah want to reconnect the case afterwards(.) maybe sometimes

5 M: Could be that maybe we introduce the possibility of making incorrect connections ((*points to right side of lower left square*))

(hhhh)[by giving that choice

6 E: [yeah

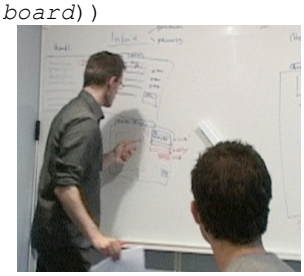
7 M: But I was thinking really when you are about to inspect the case the::n en (.) ((*points to left side of lower left square*))

and if we play with the idea that one can actually open the document ((*walks over to right side of board and points*))

and that it actually is fairly readable directly the case

8 E: Mmm

9 M: then ((*walks back to left side of board*))



this one is not needed ((*points to right side of board*))

window in case one is near sighted or so -

10 E: Yeah (.) right

11 M: or bad

12 E: Yeah (.) true

13 M: so it is some kind of special function[here

14 E: [exactly not used very often but actually it is just a maximize function really it is the same [information probably (.) like in the (.) or with controls and so

15 M: [yeah yeah (1.0) right

16 (3.0)

17 M: Eh because I mean there are a lot of other things ((*gesture over square on white board*)) that we are interested in in the document but it is the kind of stuff we enter when looking at the document ((*leans over to other side of board and points at square*)) and enter that information ((*taps board exactly when saying 'in'*)) in the actual case (.) I would believe

Excerpt 4

Here, we would like to focus on how talk work as a way of elaborating on and opening up different aspects of the design space that they are addressing and how the white board drawings can represent these. In the initial turns (1,3) of this excerpt both of the designers end their turns using phrases such as `really` and `maybe sometimes`. By ending their turns in this way an element of uncertainty regarding the current topic is introduced indicating that the discussion is still open and need to be elaborated further. In turn 5, M starts to explore how to treat the issue of connecting actors in the model. The uncertainty is sustained as he starts his turn by `it could be that we maybe introduce the possibility`. This shared expression of uncertainty provides a space for M to start experimenting with alternative ways of representing the problem of connecting the actors in the system. Similarly, starting in turn 9 a gradual refinement of the initially fairly vague reference `then this is not needed … window`, in turns 13 and 14, gets refined to refer first to a `special function` and next to a `maximize function`. By introducing the concept of a `maximize function`, E proposes a concept that summarizes what has been achieved through indexical conversational work in the previous sequence of interaction. The use of the concept of a `maximize function` does the imaginary work of manipulating the representation in order to further specify it's meaning. What they did not describe in their graphical representation, were instead expressed through the use of the proposed term.

This shows how sketching is not only an activity conducted through the construction of graphically represented sketches on the whiteboard, but also through the construction of a shared conceptual "sketch", produced through conversational work with language as a creative tool. Hence, by acting upon the graphical representation through language they refine their sketch and establish its meaning within this particular situation. Conversational action directed towards material objects thereby becomes a way of doing sketching.

3.2.3 Walking about the sketches to enact system interdependencies

The conversational work in the initial turns of excerpt 4 suggested how talk were used both to open up design issues that needed to be explored, as well as how talk could be used to create concepts with the power to summarize results of longer sequences of negotiation and discussion. While talk was one important resource for conducting design work, physical action and enactments oriented towards the white board drawing were another. In the following we will go further into how this was achieved

In turn 7, M started to elaborate on his idea his by saying `I am thinking` and `play with the idea`, suggesting that what he will start here is a suggestion rather than a ready made idea. When M says `open the document` he simultaneously walks over to the part of the white board where documents of a case is to be displayed and points to that part of the board. Walking, is thus used as a way of shifting focus to this particular aspect of the design and to get E to attend to this issue. After E's response in turn 8, M says that `then this one is not needed` (turn 9) while simultaneously walking back to the left side of the board and points to a drawing on the board. M is here proposing a change to the design that involves removing an element in the white board sketch. A key aspect in M's production of this proposal is the synchronization of talking about the objects, walking between, and pointing to the representations of objects on the white board.

Physical acts of walking and pointing work as means of putting focus on different objects and different aspects of the design. More importantly, it works as a means of creating and experimenting with imaginary connections between the objects, connections which at this point in the design process are not materialized in the physical representation. Dependencies between objects in the system that will rely on user actions and dynamics in the system are difficult to represent using the static white board only. Physical action and language explicitly directed towards the white board sketches thereby works as complimentary means for representing such dynamic and interactive aspects of design ideas.

4. DISCUSSION

We have attempted to extend the understanding of how interaction designers express dynamics and interaction by analyzing the work of a pair of interaction designers in jointly producing design sketches. A number of dimensions in the different modes of sketching were observed as well as changes in these dimensions during the design work. As discussed in the results, the overall character of the designing and talking of the designers changed as the work evolved. Of particular importance were the different ways sketches were made to represent aspects of the evolving design. Three aspects were identified as contributing to how they jointly produced the design idea; (1) the talk about and accompanying the sketching activity. (2) bodily movement and gestures of the designers oriented towards the white board drawings, and (3) the graphical drawings produced using the white board as design material.

4.1 Doing Design Through Talking

The design work started out with discussions between designers and case owners tailored at gathering information regarding the current manual information system for the designers to work on. At that point there was not much drawn on the white board. Their talk gradually became oriented towards use and interaction in the planned interactive system rather than describing the existing one and they would later use more interaction design terminology and jargon related to concrete interface elements and user interaction. The talk seemed early on to be intentionally vague to emphasize that the sketches were merely suggestions open for discussion. Later such under-specificity was reduced and more precise wordings and interaction design terminology was used. The interaction designers would give long indexical verbal descriptions of how the system could be used, which was accompanied by gesturing and pointing at the whiteboard. Later such descriptions were replaced by launching concepts or by referring to shared interaction design concepts. For instance, the designers proposed changes to a sketch through the imaginary act of moving a square to a new position on the board, an act achieved through conversational means.

Sketching is thus not an activity conducted through the construction of graphically represented sketches on the whiteboard only, but also a construction of a shared conceptual "sketch" through work with language as a creative tool. By proposing to view a drawing through a particular phrasing they were able to establish a shared concept for the drawing that worked as a summary of a number indexical descriptions and embodied references. A square not materialized in the graphical representation became part of their shared idea of the system through a proposed term. The drawings thereby provided points of stability for the designers' creative work. What was on the white board could be manipulated through language and physical action. Hence, by acting upon the graphical representation through their use of language they refined their sketch and thereby conversational action became a way of doing sketching.

4.2 Embodied Action in Sketching

The white board sketches were gradually developed throughout the design process to capture an increased number of aspects of the case. The sketches were in many ways specified and conceptualized through gestures and bodily action. Taken out of the context of the designers' talk and action, the sketches provided only a limited account of the system being designed. By gesturing and pointing, the designers illustrated imaginary use of, and interaction with, the sketched system. The designers pointed at drawings on the whiteboard to show "where in the system" they "were" as if simulating user interaction. Also, they would "click" in the air to visualize how users would interact. Gesturing and talk became more and more specific. Initially, large wavy motions were used to refer to broader areas in the information structure, while they later on pointed to and referred more specifically at specific elements of the system.

Whiteboards have a limited power to represent the dynamics and temporality of interaction and the designers used other means such as talking, moving around, pointing, and gesturing, to jointly build their design. They described relations in the system and imaginary interaction in the "system". Thereby, the static white board sketches supported considerations of dynamic design issues through the embodied actions of the interaction designers performed towards the sketches.

4.3 White Board Sketches as a Design Material

In all design activity, the character of the material that designers use in the design process shapes the outcome of the final design. For instance, letting an architect design with paper and pen rather than working with a computer-based design program supposedly have consequences for how the activity unfolds. In our case, the primary design materials used by the designers

were a white board and colored felt pens. A whiteboard drawing is a static representation, i.e., the drawing cannot fully include the dynamics of what it represents such as changes caused by user input or other external events. A drawing can of course be changed by the designers themselves, but there is nothing dynamic in the drawing itself.

In our study, the objective of sketching changed during the design process. The designers first focused on information gathering and sketching with the objective to clarify and to understand information structures and flows in the current organization. At these stages the sketches were tools for the designers to create a common understanding as well as communicating their understanding to the stakeholders, which offered them opportunities to react to possible misunderstandings. The sketches were *vague* for a long period of time, later became more *specific* as they were refined and detailed and different parts of the system were given dedicated functions and specific relations to other parts. The sketching evolved from being improvised, informal, descriptive and indexical to eventually becoming more conceptual and (perhaps) professional. Representing the planned interaction was primarily not done through the whiteboard drawings but achieved by how the designers moved around, gestured and talked about the interaction. Later, the sketches became more concrete addressing interface level issues with focus on possible future interaction with the planned system. They cautiously launched ideas and tried out the feasibility of these. Rather than using the sketches for *describing* information structures they were used for *simulating* interaction.

A potential problem is that there is a possible mismatch between the design material and the character of the system actually being designed. This, since the dynamic and interactive properties are lacking in the design material. However, static representations, such as white board drawings or scribbles on post-it notes, are commonly used by interaction designers. We have shown some of the means that designers use to express and represent dynamics and interactivity. In our case, talk in combination with bodily action such as gesture and walking around were used as complementary representational means.

5. FINAL REMARKS - SKETCHES AS ORDERING DEVICES

In their interaction design work, the different means of expression supported each other and had different strengths and weaknesses. Sometimes the designers would both gesture and talk to clarify or emphasize (e.g., say “double-click” while doing a clicking gesture). By pointing and gesturing they were able to illustrate interaction which would have been cumbersome to describe in verbal language alone and very difficult to draw. On the other hand, by using language they were able to describe interaction, which would otherwise have been difficult to draw. By giving a long, indexical description a name (e.g., “maximize function”) they created a shared shorthand way of referring to the described interaction and were no longer in need of the descriptions anymore. A strength of the whiteboard drawings is that they are persistent, in contrast to gestures and talk.

The role played by the whiteboard drawings in the work of the interaction designers can be understood through Suchman’s ground breaking analysis of the role of plans in human conduct. In her revised [31] analysis she extends her discussion of plans, scripts, maps etc through the general category of *ordering devices*, and how these work as resources for the carrying out of action, but never being determinants of action. A key characteristic of such ordering devices is that they are *inherently underspecified,* i.e., they only partially describe the character of a particular artifact or action. It is through interaction with and through these ordering devices that they are given their meaning. The white board sketches seem to work as ordering devices for the interaction designers. They leave a space for negotiation and interpretation in the process of working out a design solution. Hence, we argue that an understanding of how designer make sense out of sketches as representations of design ideas, requires an analysis of the sketches in the context of their production and use. This analytical perspective is in line with many studies in the tradition of ethnomethodology that have investigated how people make sense out of representations, e.g. through Goodwin’s [32] analysis of how scientists learn to distinguish between different nuances of the color black and Heath & Hindmarsh’s work [20] of embodied referencing in office work.

The general argument that we try to support through our empirical investigations is that a static design material such as a white board, actually can become highly dynamic in the hands of skilled interaction designers. The designers represent aspects of temporality, dynamics, and interaction by acting upon the drawings through talk and embodied action such as walking and gesturing. Hence, the qualities of the design material need to be understood in relation to the activity in which it is taken into use and the kinds of actions that the participants engage in. Thereby, design representations do not carry meaning in themselves but *are made* meaningful through design activity.

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