"Show me, how does it look now": Remote Help-giving in Collaborative Design

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ABSTRACT

This paper examines the role of visual information in a remote help-giving situation involving the collaborative physical task of designing a prototype remote control. We analyze a set of video recordings captured within an experimental setting. Our analysis shows that using gestures and relevant artefacts and by projecting activities on the camera, participants were able to discuss several *design-related* issues. The results indicate that with a limited camera view (mainly faces and shoulders), participants' conversations were centered at the physical prototype that they were designing. The socially organized use of our experimental setting provides some key implications for designing future remote collaborative systems.

Keywords

Remote Help-giving, Awareness, Common-ground, Collaborative Physical Task, Design

1. INTRODUCTION

Computer-mediated communication (CMC) systems that involve *collaborative physical tasks*[1] should support coordination of participants' speech as well as their actions [2, 3, 6, 7]. Kraut et al. [7] suggest that in such a CMC system, supporting 'mutual awareness' and establishing 'common-ground' between participants are the two important issues. Here, visual information becomes a major resource of communication and a support to verbal exchanges between the participants. The visual information about the object in question and other relevant information (e.g. gestures) not only help participants maintain and gain up-to-date understanding about the current situation but also allow participants to establish a common-ground during task performance.

In our project we focus on understanding the nature and the role of visual information as a resource for conversations in remote collaborative physical task. In the current phase we consider the aspect of 'assisting' or 'help-giving', in a task of co-designing a prototype remote control. Here, one of the participants uses different types of clay to design a prototype remote-control. We refer to him/her as Industrial Designer (ID). The second participant, at a remote location, provides assistance and guidance during this process without having direct access to the design material. We refer to him/her as User Interface Designer (UID). Here ID has knowledge about product development, technology use and their integration, whereas UID can provide user-focused guidance. Hence, ID and UID have complementary expertise.

In our experimental setup (figure-1), both participants were equipped with high resolution cameras with adequate support of audio-video technologies. The cameras could show participants' heads and shoulders. Both participants could adjust their camera views, if needed. Both of them had the same documentation and specifications about the design of prototype remote control, but only ID had the design materials to develop a prototype.

Figure 1: Experimental setting of remote help-giving

In this paper we report an analysis of 9 design sessions with different IDs and UIDs captured on videos – approximately 40-60 minutes each. The videos show both participants interacting with each other in real-time. From the analysis, we show that by using gestures and showing relevant artefacts and by projecting activities to the camera, both participants established mutual awareness and common-ground.

In the following, first, we describe the results of our analysis using several examples. Next, we discuss some issues discovered and describe future work.

2. RESULTS

We found three types of visual information utilized by the participants for establishing awareness and common-ground: 1)

1. A 'collaborative physical task' involves two or more people working together on physical objects in the real-world. [3]

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use of gestures, 2) use of artefacts, and 3) projecting activities on camera. We will show how this visual information enabled adjustments in the design of the remote control prototype – allowing discussions of size, shape, interaction mechanisms and ways of using.

2.1 Use of Gestures

Participants used gestures to make each other aware of the situation as well as to provide instructions for specific actions. Their gestures were mainly *object-focused*, i.e. referring to the physical prototype. Both participants used head movements and facial expressions to convey agreement, confirmation or otherwise. This was a quick way to say 'yes' or 'no' to the other participant. We will describe some specific patterns that allowed more detailed communications.

2.1.1 Pointing to a specific part

On several occasions pointing to a particular part of the remote control was used to communicate ideas. For example, in figure-2, this ID used pointing gestures to locate specific parts of the prototype and to describe position of buttons and screen of the prototype remote control. This kind of gesture was mainly used by IDs as they had direct access to the prototype. In order to make relevant design decisions, IDs needed to point to a specific portion of the prototype to discuss details.

Figure 2: ID (left) points to a part of the prototype to communicate with UID.

2.1.2 Describing a specific shape

Since UIDs did not have direct access to the prototype, UIDs frequently used gestures to communicate shapes and size of the prototype, to describe interaction mechanisms and to explain ways of using the prototype. From the two examples shown in figure-3, (a) shows a UID explaining the size and shape of a button, and (b) shows a UID using a two-handed gesture to demonstrate a flap-like interaction mechanism for the prototype remote control. A fragment of the conversation from example (b) illustrates how participants were able to discuss different design possibilities through visual information.

ID : "The bottom of the remote control could have a slider"
UID : "Fantastic. Yeh, that's my idea"
UID : "I also like a flap window, like in the Motorola phones, you know" *(UID poses as shown in figure-3b)*

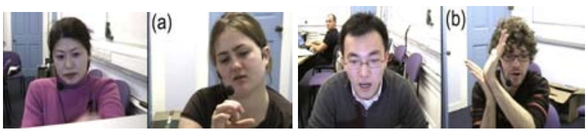

Figure 3: UID (right) describes specific shapes using gestures to communicate with ID (right).

2.1.3 Animated gestures

Some of the aspects related to the prototype remote control were not easily describable in words or through showing the prototype only. We observed that participants used animated gesture to explain their ideas clearly. Figure-4 shows an example when an ID is describing a 'sliding' behavior to confirm with UID's suggested mechanism. Here is a short excerpt of their conversation.

UID : "Do you think you can make a sliding mechanism for the prototype as we had discussed in the last meeting?"
ID : "You mean, like this…" *(ID uses an animated gesture as shown in figure-4 to demonstrate a sliding mechanism)*
UID : "Yeh, that way"

Figure 4: ID (left) uses animated gestures to make a design suggestion.

2.2 Use of Artefacts

We observed that in combination with speech different artefacts were used by the participants for aiding mutual awareness, for continuous coordination and for directing participants' focus of attention. These artefacts included the prototype remote control but also other artefacts like paper-based drawings and some hybrid coordination techniques – mixing gestures with artefacts.

2.2.1 The design object

As the remote control prototype is the main source of the discussion, IDs have to continuously update UIDs by positioning it close to the camera, whenever needed. Here the temporality of the design object becomes very important. This temporality helps establishing a common understanding of the process. If the camera focused on the faces of the participants, the remote UID had to request to see the current state of the prototype by asking "*show me, how does it look now?*", for example. Visual information related to the design object not only helped for establishing mutual awareness or common-ground, it also improved conversational efficiency. For example, when a UID could see what an ID had done, he/she would confirm or intervene appropriately.

Figure 5: Different stages (a, b & c) of the remote control projected by ID (left) to UID (right)

2.2.2 Related materials

We also observed that participants used other materials like paper based sketches and drawing diagrams in order to communicate ideas to each other. An example is illustrated in figure-6. Figure-6a and 6b point to different time-frames. In this particular case, using a sketch, remote a UID assists an ID throughout the design process. This can be seen in the figures where the UID works on her drawing while simultaneously explaining her drawings to the ID. Here, the development of the physical prototype of the remote control (accessible only by ID) and drawing sketches (used by UID) go hand in hand.

Figure 6: UID (right) continuously assists ID (left) using drawing sketch

2.2.3 Hybrid coordination

There were specific coordinative patterns where participants used a mix of gestures and artefacts in order to establish common-ground. We observed several instances of these types of hybrid coordinative patterns. As can be seen in figure-7, a UID (right) mimics the shape of the prototype remote control to be able to explain a specific position that needs to be re-adjusted. Both ID and UID play a role here in establishing a common-ground. A fragment of their conversation illustrates the importance of this.

UID : "I think you could put the volume control there"
ID : "Hum…?"
UID : "Where your thumb is… "
ID : "Here?"
UID : "No…here" *(UID poses as shown in figure-7)*
ID : "Here?" *(ID poses as shown in figure-7)*
UID : "Ya…ya"

Figure 7: An example of material common-ground established by participants.

2.3 Projecting Activities on Camera

We observed that projecting different activities towards the camera (i.e. showing actions in front of the camera) allowed participants to make each other aware of the start and the progress of a particular design activity. This was done only by the IDs since they had direct access to the prototype. Since both participants had a limited view of each other, at specific times an ID projects available clay materials, adjusts the camera view to focus on specific parts and also adjusts the position of the prototype remote control to keep UID aware and up-to-date about the ongoing activities. By projecting activities on the camera the information is intentionally made commonly visible which in turn makes the production and understanding of references (made during conversations) easier.

As it can be seen in figure-8, physical actions were projected so that the intended participant can see these actions and their meanings. Public visibility as a coordinative aspect has been echoed by many others [4, 8]. Especially, Robertson suggests that the public availability of different artefacts and embodied actions to be perceived by distributed participants in a cooperative process could enable their communicative functions.

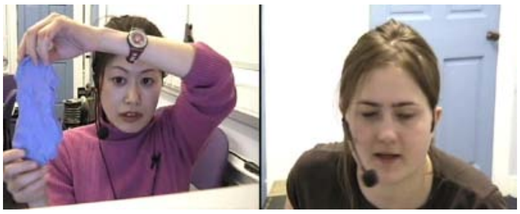

Figure 8: Projecting actions on the camera.

2.3.1 Available materials

We observed that in order to establish a common-ground, at the beginning of all design session ID shows all the materials available to him to UID. This enabled UID to better assist ID in the design process.

2.3.2 Adjusting camera

Both ID and UID were able to adjust the focus of their own cameras as they were able to see their own view in addition to each other's views. As shown in figure-9, an ID zooms in to the prototype to show details. This kind of activities occur either when requested by the UID or when they both finish an aspect of their specific phase of design activity. It was also seen that sometimes an ID forgot to adjust the focus of the camera, which did not provide sufficient information to UID.

Figure 9: ID (Left) adjusts camera to zoom in on the prototype.

3. DISCUSSION

In this paper, we examined how participants coordinated the design of a prototype remote control in an audio-video mediated environment. We have collected different patterns of establishing mutual awareness and of building common-ground between participants. Echoing others [6, 7], our results demonstrate that help-giving during remote collaborative physical tasks requires complex coordination between participants. Participants have to decide how and when to provide instructions and how to align these with their conversations.

We found that collaborative design activities were facilitated by three types of visual information: gestures, artefacts and projecting activities on camera. In table-1, we list design activities that our participants carried out using these categories of visual information. This list should not been seen as a complete taxonomy but it reflects the importance of visual information in a remote coordinative physical task. Importantly, we observed how participants integrate and align their activities using both behavior and speech.

Table 1: Different visual information and design- related activities they support.

Gestures	• Describing shape and size • Mimicking interaction mechanisms • Pointing and describing a position • Referring to actions required on a part of the object
Artefacts	• Transferring work-in-progress information • Showing shapes (using a drawing sheet) • Discussing planning mechanisms • Setting knowledge landmark for future actions
Projecting Activities on Camera	• Showing available materials • Status updates • Making information publicly visible • Directing co-worker's focus of attention

Why does Visual Information help in the domain of Cooperative Design?

Both participants had a different, geographically separated ecological setting. It has been shown that participants who share a common physical space can better coordinate each other's activities than when they collaborate from remote locations [1]. Our findings show that the three types of visual information that we identified help in building 'common spaces'. Participants have to rely on design object, paper drawings, and creating common-ground through gestures. These provide a common frame of reference that supports awareness between remote ecologies and enables participants to align and integrate their collaborative activities.

The richness of gestures, artefacts and projected activities allows participants to effortlessly make sense of the co-worker's actions, as these are really mundane and participants do not have to 'decode' any abstract representations. As shown in [5], the intersubjective intelligibility of the common spaces, which are built within two separate ecologies, help in establishing an efficient coordinative environment.

Design is an inherently 'visual' domain. Our previous study [10] shows that visual information like sketches, physical models and prototypes developed within different fields of design (e.g. industrial & product design, architecture) help in coordinating design activities. We were able to confirm this visual character of design.

4. FUTURE WORK

Our overall research goal is to develop technologies to support remote cooperative design. The experimental setting that is used in our study provides indications of how visual information could be critical in supporting awareness and establishing common-ground amongst remotely located participants. We intend to apply more reliable ways of registering and interpreting these coordinative processes and to identify patterns. We also plan to expand our analysis to more than two participants, where we intend to have the system to perform real-time pattern analysis in order to support multiparty collaboration.

A following step will be to study design practices in real world. It has been evident from the past experiences of media spaces [5, 9] that because of the impoverished understanding of 'collaborative work', media space-like environments have not been very successful. Clearly, real world practices of designers are needed for understanding real-life coordination mechanisms.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Clark, H. H., & Brennan, S. E. Grounding in communication. In L. B. Resnick, R. M. Levine, & S. D. Teasley (Eds.), Perspectives on socially shared cognition, 1991, American Psychological Association, 127–149.

[2] Fussell, S. R., Setlock, L. D., Parker, E. M., and Yang, J. Assessing the value of a cursor pointing device for remote collaboration on physical tasks. In CHI '03 Extended Abstracts. ACM: NY, (2003), 788-789.

[3] Fussell, S. R., Setlock, L. D., Yang, J., Ou, J., Mauer, E., and Kramer, A. D. Gestures over video streams to support remote collaboration on physical tasks. Hum.-Comput. Interact. 19:3, 2004, 273-309.

[4] Heath, C. and Luff, P. Collaboration and Control: Crisis Management and Multimedia Technology in London Underground Line Control Rooms. Computer Supported Cooperative Work, Vol. 1, No. 1, Kluwer Academic Publishers, the Netherlands, 1992, 24-48.

[5] Heath, C., Luff, P., and Sellen, A. Reconsidering the virtual workplace: flexible support for collaborative activity. In Proceedings of ECSCW'95. Kluwer Academic Publishers, Norwell, MA, (1995), 83-99.

[6] Kirk, D., Crabtree, A. & Rodden, T. Ways of the Hands. In Proceedings of ECSCW'05. Kluwer Academic Publishers, (2005), 1-20.

[7] Kraut, R., Fussell, S. and Siegel, J. Visual Information as a Conversational Resource in Collaborative Physical Tasks. Hum.-Comput. Interact. 18:1, 2003, 13–49.

[8] Robertson, T. Cooperative Work and Lived Cognition: A Taxonomy of Embodied Actions. In Proceedings of ECSCW'97, Kluwer Academic Publishers, (1997), 205-220.

[9] Schmidt, K. The problem with 'awareness': Introductory remarks on 'Awareness in CSCW'. Computer Supported Collaborative Work. 11: Springer Netherlands, 2002, 285-298.

[10] Vyas, D., Heylen, D., and Nijholt, A.: Physicality and Cooperative Design. In Proceedings of the 5th international Workshop on Machine Learning For Multimodal interaction. A. Popescu-Belis and R.