Principled Ways of Finding, Analysing and Planning for Communicative Overhead in Interaction Technology for Fashion Industry

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Abstract. In this paper, we identify and analyse the problems associated with communicative overheads of a fashion design and manufacturing workflow. We conduct a multi-stage qualitative study to investigate where the rich multiple channels of communication afford and constrain the workflow during remote collaboration. From this study, we define what communication channels we have in our system. We then use the video data that we had collected through user testing, together with the feedback from the video-assisted stimulated recall interviews, to identify three kinds of communicative overheads in our system: novelty of technology, ongoing constraints and operational problems. We analyse each communicative overhead with examples from our video data, and conclude that there are various overheads, some that participants may overcome through learning and familiarity with the system, some that may not be easily overcome, and some that may not even be unique to a remote collaborative environment, as they also occur in a face-to-face collaborative environment. We believe that offering richer communication channels does not necessarily equate to greater efficiency in the collaborative process, and that designers and developers of collaborative systems need to investigate the effect of communicative overheads before introducing new channels to their system, as these overheads may decrease the efficiency of any collaborative experiences.

Keywords: Coordination, workflow, communicative overhead, channel, remote collaboration, mash-up technologies, qualitative study.

1 Introduction

As communication technology advances, new communication channels emerge. These channels can assist coordinating activities, joint problem solving and sharing artefacts of work, but they also raise the potential for new communicative overheads. Communicative overhead is anything that participants could account for as extra communicative work, such as taking more time explain something, increased incidence of repair, or increased levels of meta-communication. In this paper we explore three sources of communicative overheads: novelty of the technology, ongoing constraints, and operational problems.

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2 Related Work

The choice of communication channel can be determined by both social presence theory and media richness theory. Short, Williams and Christie first used the term 'social presence' [1] to describe the absence of nonverbal communication which reduced social presence in mediated communication. As computer-mediated communication (CMC) has evolved, the social presence is said to become a way for the individuals to represent themselves and exchange messages, and how those messages are interpreted by others in an online environment [2]. Media richness theory suggests that the effectiveness of the communication is dependent on the selection of an appropriate medium [3], based on the degree of ambiguity users are willing to accept in any given communication situation [4]. It is a channel-based approach to the selection of an appropriate technology for a given situation.

Burgoon proposed the principle of interactivity framework that offers understanding of the interrelationships of verbal and nonverbal cues within CMC [5]. The principle of interactivity assumes that the degree of interdependent, contingent, participative, and synchronous interaction provided by a communication interface or experienced by interlocutors, or both, will affect the social judgments and task performance. [5] [6].

According to the 3C collaboration model (communication, coordination and cooperation) [7], individuals need to communicate and negotiate with others in order to make decisions and exchange information. They also need to minimise conflict to prevent loss of communication while they are coordinating and organising themselves to work together. "The need for renegotiating and for making decisions about unexpected situations that appear during cooperation may demand a new round of communication, which will require coordination to reorganize the tasks to be executed during cooperation." [8]. Neale and Carroll interpreted that coordination can sometimes be viewed as overhead or operating cost while completing interactive group activities [3].

The challenge of supporting effective collaborative group work in a distributed context depends on the level of communicative overheads that are embedded within each communication channel. Communicative overheads have an impact upon interactivity, especially when they are seen as getting in the way of the task. That being said, it is overly simplistic to equate communicative overheads with a negatively valanced sense of trouble or that they are necessarily show-stoppers to adoption [9].

In this paper, we are focused on finding, analysing and planning for communicative overheads within a Textual Visual Tangible Multi-touch (TVTM) system [10] in a remote collaboration setting. The TVTM system consists of two networked multi-touch tables that present users with a shared common workspace. Each table offers an array of simple design editing tools, a basic pen tool for writing and annotating, and a live webcam for demonstrating physical artefacts.

3 Previous Study

We previously identified different modes of interaction, such as the manipulation of physical artefacts, as opposed to textual, visual or tangible encoded virtual representation of these artefacts. We also identified collaboration issues in the textile industry through interviews and observational studies, in terms of classification of context in a fashion design environment [11].

Based on our pilot studies of collaboration, and the use of currently available technologies such as natural user interface (NUI) technology [12] and tangible user interface (TUI) technology [13] [14] in a fashion design environment, we have developed the TVTM system; a 'mash-up' system from a selection of currently available technologies that will allow us to utilise the multi-touch and tangible aspects of the technology, which is more effective than a single standalone technology such as video conferencing [15].

We have also conducted an experiment that required the solving of a design problem using a traditional fax machine versus our TVTM system between two remote locations. The results showed our TVTM system was significantly more efficient, and minimised communicative overheads.

4 Qualitative Study

We have conducted a multi-stage qualitative study to investigate and evaluate the use of the TVTM system and hardware for supporting remote interaction and collaboration in the fashion industry, and also to find and evaluate communicative overheads within communication channels. This study also explored the phenomenon of the gesture-based interaction around the multi-touch gesture technology. For our first stage, we were evaluating the TVTM software with pairs of design students undertaking collaborative tasks. Stage 2 of the study used the video recording from stage 1 to explore and review the interactions in more detail in terms of communicative overheads. Stage 3 of the study involved a game playing process to explore common interaction themes in the video data.

4.1 Methods and Settings

We conducted our user testing with a group of female students in their second and final years of a fashion design course at a local TAFE collage. There were eight participants in total and each user testing session was conducted in pairs, giving four groups in total.

The first stage of the study was to evaluate the participants undertaking a design critique collaborative task (which is a part of their course assessment). Each participant was assigned a TVTM system to complete the task. The participants were shown a short video clip detailing the functionality of the interface, and operating instructions prior to each user testing session.

The participants were encouraged to "think out loud" during the entire session, and the interaction between the participants was studied and captured by recording video during each testing session. At the conclusion of the first stage of the study, we reviewed our observation notes together with the recorded footage to create targeted sets of questions for the video-assisted stimulated recall interviews. This style of interview technique uses video footage to assist participants to recall their experience of user testing during post-event interviews.

We began conducting the second stage one week after we had completed our stage 1 study. We requested our participants come back for the interviews in the same pairs as in stage 1 of the study. The entire interview procedure was described to the participants, followed by their viewing a video clip of their specific user testing session.

While the participants were watching video footage of their participation in the first stage, we began a series of questions directly related to some of the interactions that were observed during their user testing session. The majority of these questions were related to why there were certain interactions with the system or with their partner during the user testing.

We asked questions related to the participants' thought processes at a specific moment during the user testing, to obtain a clear understanding of their design (thought) process while they were critiquing each other's work. We also asked the participants to describe their experience during the entire collaborative process, and obtained feedback regarding the usability of the TVTM system.

4.2 Defining Communication Channels

Our TVTM system offers a mash-up of multiple communication channels. These channels include an audio channel, a shared screen visual channel, a live webcam video feed channel, a multi-touch & gesture enabled visual interface channel, a virtual keyboard input channel and a hand writing/drawing input channel.

4.3 Results – Discovering Overheads

Through observation and analysis of the video data that was obtained, it was determined that there were three different kinds of overheads. They are the novelty of the technology, ongoing constraints, and operational problems. We will discuss each kind of overhead, and relate it to some specific events that were observed in the video data and the participants' responses from the video assisted stimulated recall interviews.

Novelty of the Technology

Example 1: Participant A was trying to convey to participant B a fabric image she wanted for her alternative swimwear design. Participant A was using her finger to tap on the image thinking it would bring up the image that she selected (Fig. 1), participant A said *"I don't think it is working"*. In the meantime, participant B did not know what was happening, so participant B asked participant A *"what is going on? what are you trying to do?"*.

It appeared as though Participant A was trying to select the image using the traditional 'point and click' method with which she was familiar. During this period, Participant B was unaware of the problem that Participant A was experiencing. The interviewer then encouraged Participant A to think out loud so that Participant B could be aware of the situation.

Participant A: *"I realised that I needed to drag the images out of the image selection panel in order to bring up the fabric image. I then explained my thought process to participant B while dragging the image out to the work area."*

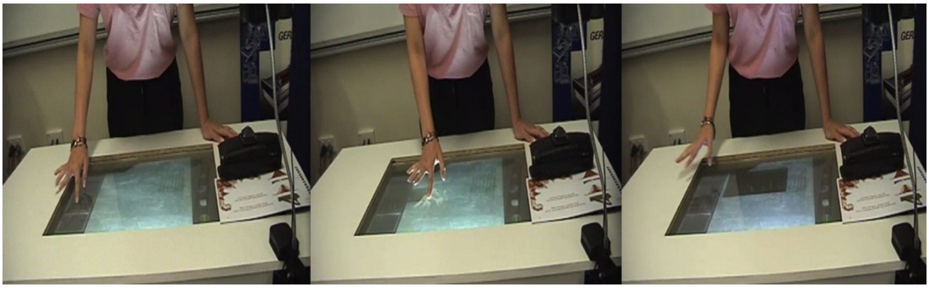

Fig. 1. Participants tapped on the screen first, but nothing happened, a few seconds later she realised she needed to drag the image out

Example 2: Participant C appeared to be exploring the functionality of the TVTM system as she was repeatedly tapping and browsing on the screen, working through the available tools to select the most appropriate.

The interviewer asked Participant C to confirm what she was trying to do at that time.

Participant C: *"I did not know which tools I needed so I was trying to find another way to show participant D my alternative design so she can understand it"*

In this particular example, participant C was unable to recall what design tools the TVTM system offered. Participant C had to click on each design tool in turn, to remember the function of each tool, so as to identify the best tool to illustrate the alternative design to participant D. While participants are exploring and trying to familiarise and learn the system, it causes communication delay/overhead.

Ongoing Constraints

Participant E was browsing through some images, she repeatedly browsing up and down using her finger on the screen.

Participant E: *"Can you see what I am doing?"*
Participant F: *"Yes I can but I have no idea what you are doing though."*
Participant E continued to browse the images.
Participant F: *"What are you doing (Participant E's name!)"*

In this example, participant F was watching participant E's interaction with the TVTM system through the shared screen ability of the system. Participant F did not know what participant E was trying to do, since participant E did not initially verbalise her thought process. There are many examples in our video data where similar situations occurred. This is due to the fact that if one of the participants worked 'individually' and 'silently' (for example searching an image) and did not "think out loud", then the other participant had no clue about what is happening. This particular type of overhead is not unique to this environment using the TVTM system however, it could also occur with participants in a face-to-face collaborative environment.

Operational Problems (Hardware & software)

Example: Participant I was showing an actual fabric sample over the webcam to participant J. The live webcam video feeds were transmitted over to the system. Participant J was having trouble seeing the live video feed (Fig 2) so she said, *"could you lift it up a bit?"*

Fig. 2. Participant I (left) raised the fabric samples up towards the webcam

The interviewer then asked Participant I to clarify the nature of the problem she was experiencing.

Participant J: *"the image on the screen is too small, so I asked participant I to lift it up so the camera can zoom in a bit"*

In this example, there was a hardware and software limitation, as the resolution of the webcam did not provide sufficient quality of live video feed. Participant J requested participant I to lift the fabric closer to the webcam, so the image would appear larger, with more fine detail visible. This lost time represents an overhead during the collaboration.

Novelty can potentially be overcome through training, experience and time. Ongoing constraints and operational problems, which can be either hardware or software related, can also introduce additional overheads.

5 Discussion

From our previous observational study on a clothing factory, we noticed clothing designers were still using both telephone and facsimile to communicate with their sub-contracted manufacturers in China.

Communication by telephone can be classified as 'mediated interaction' [5]. It is leaner than face-to-face communication as it removes all the visual information while maintaining verbal and audio cues to communication.

Facsimile can be classified as a written channel; for example, clothing designers were able to send out a design alteration specification quickly over to the overseas manufacturer, especially when there is a time difference between the two remote locations. However, the facsimile communication channel produces overheads. As we showed in our previous study, it was not efficient in a situation like collaborating on a problem-solving task in two remote locations.

The communicative overhead inherent with a facsimile communication channel is primarily due to asynchronous communication. Facsimile also lacks important properties, such as the ability to manipulate text and graphic images [16]. From our interview with the clothing designers, they usually received a facsimile response from the remote manufacturer within normal business hours. Sometimes they sent and received facsimiles that contained the same graphic images that had previously been facsimiled, along with additional hand written notes, or annotations around the images on the original facsimile.

In this study, we have attempted to identify the communicative overheads associated with the deployment of a mash-up of rich multiple channels within our TVTM system. This mash-up of multiple channels provides both affordance and constraint to the workflow. In this context, the richer communication channels afford greater efficiency and interactions for remote collaboration, whereas the communicative overhead is the constraint.

In real world settings, people who engage in collaboration apply various channels of interactions to cope with these complexities of workflow; in most cases, overhead or operating cost is involved [1, 3]. If the group collaboration suffers from a high level of overheads, it is possible that the time lost due to these overheads may not be regained by the use of the richer communication channels, leading to a potentially less efficient collaborative experience, and possible abandonment of the joint activities.

Designers and developers need to consider that the notion of overheads is related to the notion of cognitive overload, which can be identified by tracking participants' thought processes while they are completing a task.

New channels may not necessarily create overheads or eliminate existing overheads. From the results of our study, we identified an overhead not directly attributable to the use of any specific channel, which may equally occur during face-to-face or remote collaboration.

Designers and developers of CMC systems can bring new channels into use for particular tasks, however overheads have an influence on how effective new channels are for users working remotely. Therefore they should not necessarily expect an immediate improvement to workflow.

We conclude that our study has shown that offering richer communication channels does not necessarily equate to greater efficiency in the collaborative process.

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