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Exploring virtual representations of physical artefacts on collaboration in the clothing industry

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ABSTRACT

This paper explores the issues and potential future directions of remote collaboration within the field of clothing design and manufacturing. We examine the potential of developing a computer system that supports multiple levels of virtual representation (textual, visual and tangible). We first identified the methods and processes of collaboration within the manufacturing and design industries, and evaluate current methods of remote collaboration designed for these environments. From this we conducted an ethnographic study with fashion design students, to examine what forms of collaboration are important when discussing design and manufacturing techniques. From these findings, we have designed, developed and performed a pilot study with a multi-touch interface, utilizing a gestural interface (rather than a traditional GUI), to explore whether collocated natural interactions can be extended remotely via technology.

Author Keywords

User-centred design, collaboration, tangible interface, gestural interface, multi-touch, observation,

ACM Classification Keywords

H.5.2 User Interfaces (D.2.2, H.1.2, I.3.6): Evaluation/methodology, Graphical user interfaces, Input devices and strategies, Interaction styles, Prototyping, Screen design, User-centered design

INTRODUCTION

This paper describes the findings of an ongoing research project that has been running since 2005. This project explores the problems encountered in the current shared workspace system in distributed manufacturing processes with remotely located facilities. Preliminary interviews at a children's clothing company revealed that the designers have to pass intermediate products back and forth between departments in the remote locations in order to make sure designers and manufacturers agree on expectations. These workspace systems do not involve high-tech computerised programs, but instead rely on calendar or diary based scheduling systems for each department.

The goal of this project is to explore, design and evaluate digital or hybrid solutions that increase the efficiency of the shared workspace system to function as effectively and efficiently as if they were collocated. A user-centred design (UCD) approach is utilised to better understand the requirements and design choices when designing such a system, which utilises a combination of textual, visual and tangible interface elements that support interaction in a physical workspace context. The project follows a highly iterative process of data collection from field studies, device design, prototyping and evaluation.

The project faces challenges in the area of understanding how the clothing industry operates, understanding how designers work and collaborate between various associated departments in the remote locations, and also logistical timeframe issues with regards to a full ethnographic study at a local clothing design teaching space.

THE PROBLEM

We are exploring issues with regards to the representation and manipulation of physical artefacts, specifically:

- Different users' modes of interaction.
- Information representation as opposed to visual or tangible encoded representation and the progression from information representation to visual or tangible presentation. (Ishi et al., 1997)
- Issues in fashion, in terms of classification of context in a fashion design environment.

It is important to consider the implications of technology and design methods within the clothing design environment. We were required to identify what the various processes within the industry are, and from that determine which processes can (and cannot) be enhanced or augmented with technology. This is done by reflecting on a series of observational studies, identifying any design directions that industry workers might or should follow, examining what (if any) suitable technologies currently exist, and how they may support problems encountered in the current design process when dealing with physical artefacts.

COLLABORATION IN CLOTHING DESIGN

The fashion industry may have a glamorous and trendy façade, but behind the scenes the technology used in the clothing industry has not kept pace with recent trends in Information and Communication Technologies (ICT). Competition forces all firms to transform and, as Sheehan discusses, the new ICT and the processes of globalization have already changed the face of manufacturing (Sheehan, 2000).

In order to better understand how a distributed manufacturing process operates, several interviews were carried out at a children's clothing company in Taiwan. Due to high labour costs, the company stopped manufacturing clothing locally during 2003. The company changed its strategy and contracted the manufacturing of the clothing to manufacturers in China. The design of the clothing is still carried out in Taiwan.

Figure 1 shows the breakdown of the typical steps taken, from resource gathering to putting the design into production, and delivery of the final product.

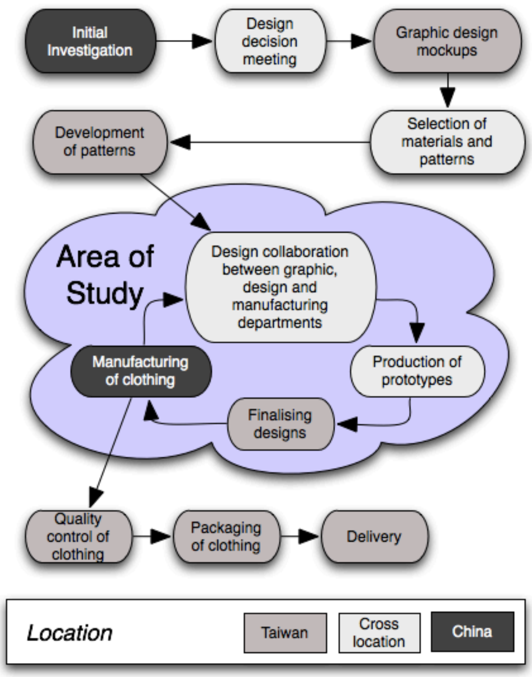

Figure 1. Overview of a typical clothing design and manufacturing process

Our area of study focuses on the iterative collaboration between the design department and the manufacturing department shown highlighted in Figure 1.

From an interview conducted with the head of the design department at the company, their designers have to give clear and concise instructions, and pass prototypes back and forth between factories to ensure designers and manufacturers have common expectations of the final product. During this development cycle, manufacturing issues and miscommunication between the design department and the manufacturer frequently arise as the manufacturer implements the design concepts to produce the prototype garment.

From interviews conducted with the designers, they often need to use physical manipulation to resolve prototyping or manufacturing issues, such as combining different fabrics and colours, or referring to an earlier or similar design. It is therefore important not to alter the way they do their design work. By creating a shared workspace collaborative design tool that can draw upon a database of design information from various departments (such as graphics, fabrics, costs, colours, and templates of past design tools), together with product life cycle management software, it may be possible to cut down the production cycle time, while keeping interaction and manipulation methods with which designers are already familiar.

It is expected that the level of expertise of the designer may also have an impact on the amount of physicality required in representation. This may imply that richer interfaces can improve usability for less experienced or less computer literate designers, and have a greater impact in the fashion design process.

Computing power has increased dramatically over the last few years and this has given rise to new computing technologies. Users now have the option to utilise a variety of new tools such as tangible or gesture input to navigate, access and manipulate data displayed on the computer. A primary example is multi-touch screen technology, which allows users to use complex gestures to operate a computer by simply touching the screen. It is therefore important to examine and understand these new technologies, and how they may be adopted by the fashion industry.

OBSERVATIONAL STUDY

In order to get a deeper understanding of how designers work, a preliminary ethnographic study was carried out with a group of fashion school students preparing for their fashion parade project. Early observation was focused on gestures used during their design phase.

During the early observation, the triangulation method (constructive methodology) (Cohen et al., 2000) was utilised.

Example of two students working together: Kate (student): *"I am having trouble with the size of this one, Ashley what do you think?"* Ashley (student): *"Let me have a look"*. Kate and Ashley were discussing a particular size problem with one of Kate's paper templates. Kate used her thumb and index fingers to measure the top and bottom of the template she was working on.

During one of the observation sessions a master and apprentice method (contextual enquiries) (Beyer et al., 1995) was carried out, where the TAFE students (the master) instructed me (the apprentice) how they do their design work. It proved effective in understanding the work practices and why certain tasks are performed, and what elements would be needed in any digital interface.

INTERFACE DESIGN PROCESS

Our initial concept is to design, develop and evaluate a digital interface that uses direct manipulation through multi-touch technologies. The device will be designed and implemented to enhance and augment the current working environment, and be embedded within the current environment (a physical table where designers can still work). The aim of the prototype is to explore and evaluate all three virtual representation interfaces: textual, visual and direct manipulation. Reflecting the interviews conducted at the clothing company and our observational study at a local clothing design college, it was determined that the key features of the prototype need to be:

- Database of design assets: Users will be able to search or browse all previous designs (including all design notes and sewing instructions), standard basic patterns, and samples of fabrics. Data can be efficiently brought into the system by copying files into a directory, photographing or scanning. All data is saved digitally and can be printed, should a hard copy be required.
- Textual/Visual/Direct manipulation: Users will be able to switch between different interfaces according to their need for design work; each level having unique tools such as instant fabric stencilling tool, virtual cutting and measuring tools etc.

The user will be able to view the effects of any design change instantly through a virtual "finished" garment using RFID tagged symbolic physical objects to perform navigation in the interface.

DEVELOPMENT

Based on the initial investigation of collaboration in the clothing system and current systems, we have developed a horizontal prototype to investigate how a multi-touch interface may help in the collaborative process. The aim of the prototype was to investigate the three types of interaction (Textual/Visual/Tangible), and to determine whether multi-touch interactions which better represent physical artefacts would better fit within the clothing design environment than a traditional digital interface would.

The multi-touch technology we are using is based on an optical multi-touch methodology called Frustrated Total Internal Reflection (FTIR) (Han, 2005) developed by Jeff Han. Our multi-touch technology uses a revised and updated version of this technology known as Diffused Surface Illumination (NUI, 2009), made possible by the development of new acrylic materials. It consists of a special acrylic called Plexiglas Endlighten to distribute the infrared light evenly across the surface. The composition of this type of acrylic contains very small mirror-liked particles throughout the acrylic. When the infrared light is shone on to the edges of this material, the light gets redirected and spread to the entire surface of the acrylic. When a finger touches the surface of the acrylic, the infrared light brightly illuminates the area of the finger in contact with the acrylic, which is detected by a camera with an infrared band pass filter. Community Core Vision (CCV, 2009) multi-touch software resolves the images from the camera to a series of blobs, each corresponding to the finger tips in contact with the acrylic. The coordinates of the detected blobs are passed to the user interface via the TUIO /Open Sound Control (OSC) protocol (Kaltenbrunner et al., 2005). The interface was developed using Adobe Air, a platform agnostic software platform built upon the Flash / Actionscript language. These technologies were chosen due to their flexibility, open source and modular nature.

The interface of the prototype consists of a main stage area and a two level navigation interface. The main stage area allows for a workspace where objects can be added, manipulated and collaborated on. Objects brought into this area allow for traditional multi-touch gestures, including scaling, panning and rotating (Wigdor et al., 2009). The navigation interface consists of two tiers. The main navigation allows the user to switch modes based on the task that needs to be performed, e.g. object manipulation, communication, design management and "helper tools" such as scissors or a ruler. The second level navigation provided direct access to actions related to the specific mode.

From initial investigations, there were potential concerns that the traditional navigation interface that was implemented would hinder the users experience and efficiency at using the interface. From this, Radio Frequency Identification (RFID) tags were attached to physical objects within the design environment. As these tagged objects were positioned near the prototype, a digital representation within the workspace would appear.

EVALUATION AND DISCUSSION

The project follows a highly iterative process, and as such ongoing informal evaluation has been conducted with relation to the concept presented in the developed prototype. A pilot study was conducted, where 10 participants from media-disciplinary design backgrounds were tested using a collaborative and ludic activity, which was built upon the concept of Charades (to encourage participants to explore the concepts presented in the design). The aim of the pilot study was to explore which forms of interaction (textual, visual, gesture/tangible) were relevant when collaborating remotely through a multi-touch screen based interface.

Two areas were set up within a meeting room, a small area that contained the multi-touch prototype, and a larger area (to represent a remote location) that contained a monitor displaying a copy of the display from the multi-touch interface. Participants within the large room also had the ability to interact with the interface remotely through a traditional mouse. A series of tasks were developed, each designed to encourage a specific style of collaboration (similar to a sentence in Charades). Each task was "acted out", where one participant would perform the task and, without verbal communication, attempt to communicate what they were trying to get across to the rest of the participants in the larger area. The reasoning behind this activity was to examine which tools and forms of interaction users felt best portrayed their task, and how combinations of these forms could be brought together to better explain a design. Activities were described on sheets of paper (two copies of each activity), and randomly chosen by the participant in the small area.

We found that the participants watching the interactive feed of the multi-touch interactions successfully guessed 8 out of 10 activities. Each activity required around ten minutes to be performed, however the prototype interface was a contributing factor in this. The key findings from the pilot study was that participants did not choose a single type of interaction to perform an activity, rather a combination of textual, graphical and direct manipulation (motion) actions were performed:

- Textual forms of interaction, typing using an on screen keyboard or writing with a pen interface, were used to portray factual information, such as measurements and descriptions
- Graphical forms of interaction, designs as well as annotations, were done using graphical forms of interactions, for example circling a specific aspect of a design or overlaying a pattern on top of a design
- Tangible / Direct manipulation forms of interaction, activities such as questioning the position of a pattern on a design, were portrayed by scaling, rotating and moving around patterns, to show motion and better describe how different designs, assets and materials would work together. It could be seen that this real time motion was very effective in communicating ideas to the other participants.

Participants playing the guessing role of the activity discussed that they would have liked to be able to interact and communicate back to the main actor through the interface. While this was possible using the mouse provided in the larger area, they stated that having the multi-touch abilities to better interact would have helped in the communication. Another finding was that participants had issues when transitioning between navigating the interface, and performing direct manipulation of objects on the stage. The RFID aspects of the prototype were not included in the study due to a lack of space. We feel that removing as many traditional interface elements as possible, and replacing them with a more gestural navigation would help reduce these issues. It was also noted that objects (such as a keyboard or ruler), which replicated the attributes of their physical counterparts, were less useful than the more abstract interactions such as the scaling of patterns.

It is important to note that issues were encountered during the pilot study, due to the implementation of the prototype. In later discussions with participants, we found that the software was a contributing factor in issues when communicating encountered by the participants. This was alleviated somewhat in the evaluation of the pilot study from informal interviews discussing their thinking process throughout each activity.

FUTURE WORK

Based on our observations in the pilot study, there is a clear direction to move towards a more natural interface, where gestural interactions are used, rather than using a digital representation of physical objects (for instance being able to "scrunch" together a design to delete it, rather than dragging it to a bin). Based on our findings, we are going to redesign the interface, and deploy it within a clothing design learning environment, and use observation methods to examine in detail the interactions with the system over a longer period of time.

Another future direction that we are looking to explore is the use of haptic technology and augmented reality to promote tangible interactions, rather than a flat digital surface. Due to the nature of design of working with physical fabrics, allowing users to get a better sense of the material, such as feel and touch, as well as being able to use physical fabric on the surface, would help with the more gestural nature of collaboration. We are also looking at introducing video conferencing elements into the interactions, to better support awareness between locations (Dourish et al., 1992)

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