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THE CONFLUENCE OF THE REAL AND THE VIRTUAL

Anthony Williams[1], Ning Gu[1], Willy Sher[1] and Leman Figen Gül[1]

[1]School of Architecture and Built Environments, The University of Newcastle, Callaghan, Australia, ning.gu, tony.williams, leman.gul@newcastle.edu.au

ABSTRACT:

There has been considerable work done in the support of the collaborative design activity. Technology has provided a diverse range of support systems to support designers as they conduct their design activity. Concurrent with this has been the research activity which has been focusing on the attributes of the designer and the qualities necessary to be an effective contributor to the process of collaborative design.

This paper considers the outcomes of research projects undertaken to both evaluate and contribute to the design of virtual design environments. The collaborative design potential of such virtual design domains as "DesignWorld" (Maher et al, 2006) and the less design specific, "Second Life"[1] has been recorded in a range of papers. These systems provide a significant platform for development and future research in them but they also provide a broader range of research scenarios for the future when considered with the research being conducted on the "human skills" or the "Core Skills" which are being concurrently researched.

This paper will discuss the issues posed by the findings of these two research domains and explores the opportunities they provide for further research and development. The need to better

[1] http://www.secondlife.com

understand the designer and the knowledge, skills and attitudes they require to be effective in the collaborative design context when considered in tandem to the opportunities that technology provide in the potential of the virtual collaborative domain are significant and will be pervasive for future designers.

1. INTRODUCTION

Technological innovation has had a major impact on the world of design, it is not only an outcome of the design process, but also provides opportunities and options for designers. Technology has not only provided opportunities but it has also contributed to the complexity of many design processes. In the Industrial world there often exists the need for large teams of designers to work collaboratively in the production of large or complex projects. In such situations Multi Disciplinary Design Teams (MDDTs) are formed. The complexity of the problem demands that the team comprise individuals who have training and experience in a variety of design disciplines. These discipline areas, depending on the design project, could include designers from a range of design fields, e.g. electrical engineering, industrial design, architecture etc. Reasons for working collaboratively in the design process are;

- ☐ The complexity of designing a major item, e.g. large building, requires specialists from a diverse range of disciplines, including architects, quantity surveyors, structural and service engineers.
- ☐ The group's effectiveness in reaching a successful outcome is greater than the effectiveness of an individual designer undertaking the same problem [Peng, 1991].

Lawson, using the example of architects, demonstrated the importance of collaboration to their role as designers:

> An examination of professional diaries is likely to show that most architects spend more time interacting with other specialist consultants and with fellow architects than working in isolation.....[1990, p.184].

2. THE NATURE OF THE PROBLEM

2. 1. VIRTUAL ORGANISATIONS

After the fear engendered by the September 11 attacks and the questions surrounding the value of centralised business districts (such as downtown Manhattan[2]), experts from the domains of sociology, business and design have been seeking alternatives to such central business districts and considering the question: Will virtual organisations be "the next big thing"?

The development of organisations used to mean its physical expansion - larger space, new branches and more employees. With the evolution of technologies as well as the booming of online community and activities: e-business, e-learning and e-entertainment, we are witnessing an increasing use of virtual environments as an important extension of our physical world allowing people to communicate and collaborate without physically being there. One famous commercial example is the virtual trading floor for the New York Stock Exchange (NYSE). Hani Rashid's[3] design incorporates and visualises the virtual booths as well as interactive graphs within the virtual trading floor, which simulates but, more importantly, extends, the physical trading floor.

One important characteristic of the contemporary world is the ability to be distributed. Societies, corporations and individuals are remotely linked together with the support of communication and network technologies. While the use of teleconferencing and videoconferencing facilities allow you to reach for collaborators in different geographical locations, 3D virtual worlds as the latest forms of virtual organisations extend our physical organistions into the virtual realm with augmented place and augmented presence.

In design, researchers at the University of Newcastle, University of Sydney and architects at Woods Bagot[4], have looked at the prospects of using 3D virtual worlds to enhance remote team collaboration in global design offices (Rosenman et al, 2005). Figure 1 shows examples of architects working in a range of remote collaborative situations in a 3D virtual world powered by "Active Worlds"[5]. Designers are represented as "avatars" (animated characters) and immerse in the digital design, which is characterised as "designing within the design" (Maher and Simoff, 1999)

[2] http://www.evolvenewyork.org
[3] http://www.asymptote.net
[4] http://www.woodsbagot.com.au
[5] http://www.activeworlds.com

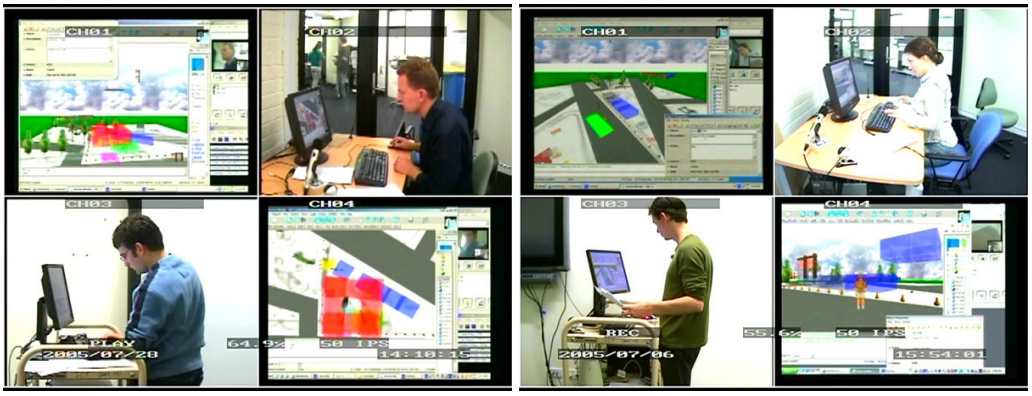

Figure 1 Remote design collaboration in Active Worlds.

The places in virtual worlds may be virtual, but the community and the economy there are real and are growing rapidly. Examples such as "Second Life" (Figures 2) have attracted millions of members. The virtual organisations range from real estates, travel agencies, entertainment industries to academic and research institutes. Communities in Second Life even develop their own currency, which is exchangeable with US dollars, and maintains their own stock market.

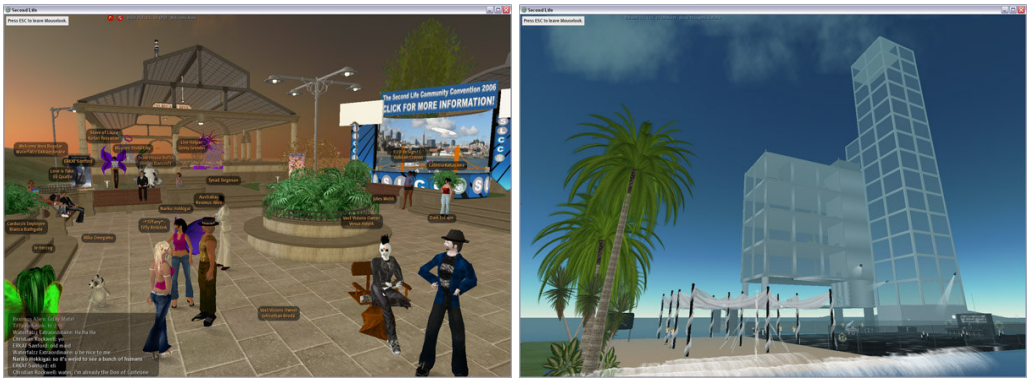

Figure 2 Virtual community members (L) and a virtual office building (R) in "Second Life".[6]

To better support activities in virtual organisations, more cutting-edge technologies are being developed, for example, the concept of 3D electronic institutions (Bogdanovych et al, 2007). The key advantage of 3D electronic institutions is the incorporation of a 3D virtual world with an underlying intelligent computational framework that ensures secure online activities and reinforces organisational structures. The 3D virtual world is automatically designed and redesigned, as needed, using a design grammar (Gu and Maher, 2005), providing an adaptable virtual world for the electronic institution.

[6] Virtual world designs by "Second Life" virtual community designers, powered by Linden Research, Inc.

2. 2. MULTI DISCIPLINARY DESIGN TEAM

An important consideration in the organisation of an MDDT is the process of re-organisation of knowledge, attributable to participation in these teams. The re-organisation of design knowledge most frequently occurs at design team meetings where designing involves interaction between the team members. It is in the activities of these meetings that ideas of individuals become shared understanding of the team. Consequently as a result of a team's design meetings it would be expected that an individual's knowledge, established prior to the meeting, would change and be augmented as a result of the interactions and experiences of participation in the meeting. Dunbar [1995] in research relating to scientific research groups, established that individuals were more likely to change their thinking about a problem as a result of comments from a team discussion than would be evident in a person working individually.

The move towards a virtual world is becoming ever more relevant in today's unstable world environment. The extent to which a team becomes virtual can be affected by a number of variables including the extent of the distance between members, the number of organisations the members represent, the length of time the team has functioned together (Ratcheva and Vyakaram, 2001), and the experience (i.e. technical skills) of the team members. The extent of a team's virtuality can also be affected by world instability, such as the events of September 11, so that as distance increases, and people are reluctant to leave home due to international issues, the degree of a team's virtuality increases (Kirkman et al., 2002).

With fast development of and changes in technology in most fields it is not inconceivable that virtual teams may soon exhibit the same generic attributes as co-located teams. However, there are other issues to consider, such as:

- Time differences between members.

- Whether the technology is available to all members of the team (Williams, 2004), and whether they are trained in the use of the technology (Lahti et al., 2004).

- Loss of contextual cues, such as body language (Riedlinger et al., 2004; Jaafari and Tooher, 2002).

- A lack of leadership hierarchy within the remote groups (Jaafari and Tooher, 2002)

- The members are at the mercy of technology. Communication channels could be severed by a fault in the system (Jaafari and Tooher, 2002).

- Different managerial styles between different organisations (Gameson and Sher, 2002a).

Whilst there are some challenges faced by those working in virtual teams, the benefits seem to be a selling point. In the long run virtual teams are less expensive and more time efficient, as well as increasing the amount of knowledge and skills within these teams.

3. THE IMPLICATIONS OF RESEARCH ON THE TECHNOLOGY AND OUR UNDERSTANDING OF THE VIRTUAL TEAM ACTIVITY

Virtual teams are increasing both in number and approaches to their management and implementation. The study of the virtual design worlds has provided a better understanding of the design activity conducted in virtuality as well as the identification of technological advancements which will enhance the environment itself. Section 3.2 reports the outcomes of our generic skills research project which inform the understanding of the virtual design activity. A behavioural markers scheme (Bellamy, Williams, Sher, Sherratt, & Gameson, 2005) is applied based on the categories proposed by Salas et al (2000) as listed in section 3.1, to measure the participants' generic skills during design collaboration.

3.1. GENERIC SKILLS CATEGORIES

In Human Factors research conducted by Salas et al into teams, generic skills have been defined as those that influence both individuals and teams (Salas et al., 2000). They are skills which are '…transportable and applicable across teams' (Salas et al., 2000).

Human Factors research is based in understanding the human side of organisational and team operation, the non-technical or generic aspects. This area has amassed a large amount or literature regarding generic skills within teams, as has research into successful computer mediated communication. The list below describes those generic skills which, have been suggested, significantly contribute to successful collaborative activities:

- ☐ Adaptability

- ☐ Shared Situational Awareness
- ☐ Performance Monitoring and Feedback
- ☐ Leadership/Team Management
- ☐ Interpersonal Relations
- ☐ Co-ordination
- ☐ Communication
- ☐ Decision Making

3.2. GENERIC SKILLS RESEARCH PROJECT

This project involved the study of design teams involved in the design activity in three different design contexts ranging from face to face through to designing in the virtual world. Video data of participants collaborating in two person design teams was collected for three differing levels of virtual technology. This allowed observation of any differences in generic skills used between the three conditions. The three experimental conditions are described below:

- ☐ Traditional Collaborative Design (face-to-face) – This included simple face-to-face interactions such as talking and sketching.
- ☐ Shared Electronic Whiteboard - Facilitated shared drawing, images and text. Also included were synchronous speech and visual communication via a web camera.
- ☐ High Bandwidth Multi-user 3D Virtual Worlds - Team members manipulate a 3D representation of a design using computer based tools, communicating through 'chat', video and synchronous speech facilities.

To provide an overview of these results the team's design activity was combined to establish if there was an overall significance for generic skills of total design activity analysed. The chi square analysis of total design activity indicated that this was also significant $\chi^2(6, N = 2010) = 65.89$, $p = .000$ with similar percentages seen in Teams 1 and 2 (Figure 3). Once again, according to the ASR table (Table 1), the significance was not driven by the group board condition but the face-to-

face and 3D virtual world conditions. For the generic skills analysis it appears that there is a consistent increase or decrease in each of the skills as the participants moved from face-to-face to group board to the 3D virtual world condition. Both the task management and decision making skills decreased as virtuality increases, while the opposite is true for team working and situational awareness.

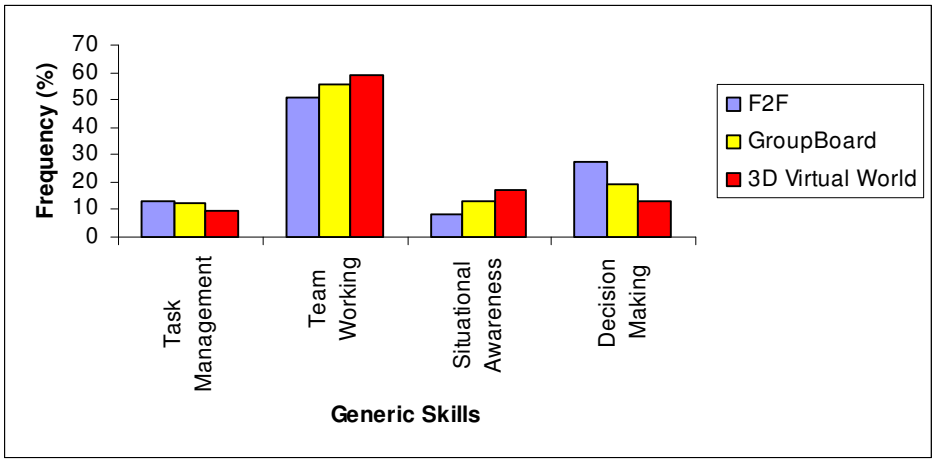

Figure 3 Graph indicating the percentages of observations for each category of the Generic Skills Analysis for the face-to-face, group board, and virtual world.

	Task Mngt	Team Working	Situational Awareness	Decision Making
ASR F2F	1.5	**-3.0**	**-4.4**	**6.1**
ASR GroupBoard	0.3	0.2	0.03	-0.5
ASR 3D Virtual World	-1.8	**2.8**	**4.4**	**-5.7**

Table1: Adjusted Standardised Residuals for Total of Team 1 and 2 generic skills combined, which indicates drivers of overall significance.

The results of the chi square analysis and the graph of generic skills frequency for, total design team activity, indicate that:

There is a significant and consistent increase in the frequency of team working and situational awareness as team members moved from low to high bandwidth conditions.

The is a significant and consistent decrease in the frequency of decision making as team members moved from low to high bandwidth conditions.

Overall the results from the analysis of the collaborative design indicate that the method of collaboration does appear to have an impact on the frequency of generic skills and interactions. Team 1 and Team 2 had similar results in terms of the profiles, for both generic skills.

There was a significant and consistent increase in the frequency of the team working generic skill as the design collaborators moved from face-to-face to group board to 3D virtual world. This increase indicates that designers have employed this generic skill increasingly as virtuality has increased. Team working observable behaviours which were commonly seen during the coding of the video data were ‘confirming shared understanding’, ‘communication design plans’ and ‘reassuring and encouraging’.

- ☐ Confirming shared understanding involves asking for confirmation on something another designer has drawn, said or written. It is a question for which the ‘enquirer’ may already know or have access to the answer. A rise in this behaviour indicates an increased need for checking and accuracy, also a lack of confidence in making decision with apparent data must be considered.

- ☐ Communicating design plans involves one designer describing what they can see on the design plans i.e. drawings. This includes details such as lengths and area. An increase in this activity indicates a greater need for co-ordination and shared understanding. So as the designers are less able to communicate using non-verbal cues they become more reliant on the ability to describe (verbally) the area to which they attending.

- ☐ Reassuring and encouraging involves one participant praising or agreeing with another’s idea or point of view in a positive manner. An increase in this behaviour may indicate that there is a need for greater positive reinforcement in the virtual conditions. So as virtuality increases and becomes less familiar there is a greater need to support each other in actions and ideas as they use the unfamiliar technology.

There was a significant and consistent increase in the frequency of situational awareness generic skills application as designers moved from low to high bandwidth. The overriding behaviour which was scored for this generic skill was ‘gathering information’. Gathering information involves one designer asking another a question regarding the design, the site, an idea or even artefacts. An increase in the frequency of this behaviour indicates simply an increase in the amount of questions asked by the designers of each other, which may indicate escalating levels of uncertainty.

There was a significant and consistent decrease in the frequency of decision making generic skill usage as designers moved from low to high bandwidth. The observable behaviour which was scored most frequently for this generic skill was ‘discusses design options’. Discusses design

options involved one designer suggesting an idea for a design to another. Therefore a decrease in this activity would indicate that the designer spent a significantly less amount of time suggesting possible solutions to the design problem as they moved from low to high bandwidth conditions.

The findings of this study provide a clearer understanding of the implications for working collaboratively in the team context in the virtual design context. Cognizance of the skills and strategies to improve performance of designers will in turn improve the performance of teams as they participate in the virtual design team.

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