

Chapter

An Analysis of Design Communication with and Without Computer Mediation

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.1 Introduction

With recent developments in CAD and communication technologies, the way we visualise and communicate design representations is changing. A matter of great interest to architects, practitioners and researchers alike, is how computer technology might affect the way they think and work. The concern is not about the notion of 'support' alone, but about ensuring that computers do not disrupt the design process and collaborative activity already going on (Bannon and Schmidt, 1991). Designing new collaborative tools will then have to be guided by a better understanding of how collaborative work is accomplished and by understanding what resources the collaborators use and what hindrances they encounter in their work (Finholt et al., 1990).

Designing, as a more abstract notion, is different than having a business meeting using video conferencing. In design it is more important to 'see' what is being discussed rather than 'watch' the other person(s) involved in the discussion. In other words the data being conveyed might be of more importance than the method with which it is communicated (See Kvan, 1994). Similarly, we believe that by using text instead of audio as a medium for verbal communication, verbal representations can then be recorded alongside graphical representations for later retrieval and use. In this paper we present the results of a study on collaborative design in three different environments: face-to-face (FTF), computer-mediated using video conferencing (CMCD-a), and computer-mediated using "talk by typing" (CMCD-b). The underlying aim is to establish a clearer notion of the collaborative needs of architects using computer-mediation. In turn this has the potential in assisting developers when designing new collaborative tools and in assisting designers when selecting an environment for a collaborative session.

.2 Computer Mediated Collaborative Design

In order to compare CMCD and FTF collaborative sessions between architects, we first need to look at how architects collaborate in FTF environments, the media they employ and the communication channels they utilize in order to convey design representations to their partner(s). When working FTF, architects have been observed to hold certain preferences for the way they set their design and creative environments and what 'traditional' tools they choose to use whether designing alone or collaborating with colleagues (Carter, 1993). Some architects might prefer to work with thick pencils scribbling 2D sketches on butter paper (Gross, 1994, Kvan, 1994). Others might sketch as well as start working with 3D volumetry. Sometimes they hastily proceed to build 3D massing models, made of polystyrene or cardboard (Visser, 1993). This enables them to acquire an enriched 'experience' of the space they are working with and makes it easier to communicate their 'idea' to other parties involved in the design.

However the continuous development of computer and telecommunication technologies, has seen architects increasingly using these mediums for communication as well as work. Hence architecture as a profession is becoming dependent on computers not only in ways of documenting designs, but also in the form of representing and communicating design ideas between various parties, from colleagues to clients to the general public.

Research into communication channels used in CMCD environments has shown that there is little agreement on whether audio and video channels are essential in such ventures as well as what constituted the appropriate channels (Maziloglou et al., 1996, Olson et al., 1997, Vera et al., 1998). A popular view held by some researchers is that adding audio, video and graphics is somehow expected to make the medium more "real" (Sudweeks and Rafaeli, 1995). According to Greenberg et al (1992) some researchers maintain *tele-presence* as being the alternative to FTF collaboration, where distributed participants in a collaborative venture are given the feeling that they are present in the same meeting room. Whether or not seeing one's partner has an effect on performance seems to be highly dependent on the type of performed task (Olson et al., 1997). On the other hand, Vera et al (1998) observed a slight decrease in low-level design as opposed to high-level design in text-based computer-mediated experiments compared to audio and video computer mediated experiments.

.3 The Study

In our study we investigate collaborative communication in a design session with two architects. We use a method similar to a protocol analysis in which we collect and transcribe the utterances of the designers during the design session and analyse the *design communication protocol* using a coding scheme. Protocol studies on design activity date back to that of Eastman (1970) where he studied architects in

the late 1960s. The protocol analysis method continues to be an accepted way to study design, although most of the studies look at single designers (Akin, 1986, Goldschmidt, 1991). Recently, the conventional, single-subject, method of protocol analysis has been used to analyse team design activity, (Cross et al., 1996, Vera et al., 1998).

We conducted twenty-six one-hour experiments using fifty-two 5th and 6th year architecture students. The participants were paired and each pair participated in only one experiment from any of the three categories using the same brief. We conducted eight experiments in each of the FTF and CMCD-a categories and ten in the CMCD-b category. One brief was designed for all three categories in order to reduce the variables.

The eight FTF sessions were carried out in a room containing a central table with participants sitting on either side. Each pair was given four A1 tracing sheets with a pair of black and blue felt pens in order to account for the sketches. They were each given a copy of the brief as well as extra A4 copies of the site plan and section, which can be used to trace over. A Sony Hi-8 CamCorder connected to VHS in the same room, was placed at an angle to capture both verbal and graphical interaction between the participants. Two rooms separated by a third larger one were used for the eighteen CMCD sessions. Each room was equipped with a Silicon Graphics O2 (SG) Unix workstation. The two SGs were connected along with the observer's terminal (in the central room) by a high speed Local Area Network (LAN). The CMCD-a sessions used computer-mediated audio and video with a shared electronic whiteboard (they used the Inperson). The CMCD-b sessions used a chat-like environment to talk to each other by typing messages, and a shared electronic whiteboard (also using Inperson) without the video channel.

.3.1 The Design Brief

In each experiment the two designers were given the same brief, as shown in Figures 1 and 2. All the experiments were 1 hour long. All experiments were both audio and video taped to help in the transcribing and in later analysis stages.

A City based painter recently acquired a site on top of a cliff in an inner-west suburb of the city. He stumbled across the location by taking the wrong turn one-day and ending up in a cul-de-sac, on top of a boulder with breath taking views, figure 2. To the owner, a dwelling represents more than a shelter or a place to live in. He prefers to think of it as a space comprising certain functions, some of which are living, working and entertaining. Far from being a novel idea, the house as a shelter that combines the working and living environments dates back a few centuries. Numerous contemporary architects have relished such unique opportunities to investigate and develop their own architectural theories.

The brief set out by the owners along with their teenage son (19), and daughter (17), was a simple list. Functions such as an entertaining area, a decent sized naturally lit workshop and Roof terrace overlooking the cliff were among the items included. The owners require that the design be unique while reflecting and enhancing the natural attributes of the site.

Figure 1. The text of the design brief

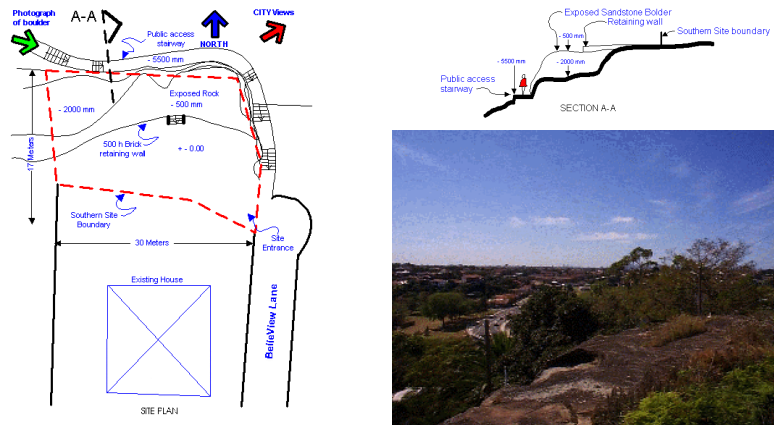


Figure 2. The brief site plan, section (NTS) and photograph (taken from site)

.3.2 The Coding Scheme

We considered four different coding schemes from separate research projects. The first, (See Sudweeks and Albritton, 1996) categorises communication types as follows: *Informal control of communication*, *formal control of communication*, *socio-emotional communication*, *conceptual communication*, *task communication*. The second coding scheme investigates the amount of time spent in computer mediated collaborative sessions 'introducing *new ideas and clarifying those ideas*' (See Olson et al., 1997). The third coding scheme on the other hand classifies interaction between FTF and Video-conferencing technologies by investigating '*Interruptions, overlaps, hand-overs and dominance*' (See O'Connail and Whittaker, 1997). Part of the fourth coding scheme investigated '*low level design*' versus '*high level design*' in computer mediated design sessions with full and limited communication channels (For more details see Vera et al., 1998).

Our coding scheme is formed of four major classifications and in turn some of these are further broken down into sub-categories, illustrated in Figure 3. These classifications are:

1. '*Communication control*', a theoretically and externally derived structure which would help identify possible differences, advantages and disadvantages between the three design communication mediums (FTF, CMCD-a and

CMCD-b. Communication control includes statements made by the designers to hold the floor, to interrupt, to acknowledge presence, and to hand over communication to the other person.

2. ‘*Communication technology*’ a data derived structure, looks at discussions held between participants related to the use of the tools and the collaborative environment.
3. ‘*Social communication*’, a data and externally derived structure, looks at the amount of time spent on social talk in the three collaborative mediums. Examples of social talk are: making a personal statement about the person running the experiment, commenting on the way a person looks in the video window, talking about what the other person is wearing.
4. ‘*Design communication*’, a data, theoretically and externally derived structure distinguishing between ‘design ideas’, ‘design scope’ and ‘design task’. This category helps investigate whether there were any variations in the way the design itself was discussed between the 3 different mediums (for a more detailed account see Gabriel and Maher, 1999).

These categories are not intended to be exhaustive, but to indicate, through analysis, the relative amounts of communication in each category when comparing FTF and computer-mediated collaborative design. We are particularly interested in whether computer-mediation affects the ability to discuss design issues (that is, whether we would see less design communication), and whether there are significant differences in the way communication control occurs in the different collaborative environments.

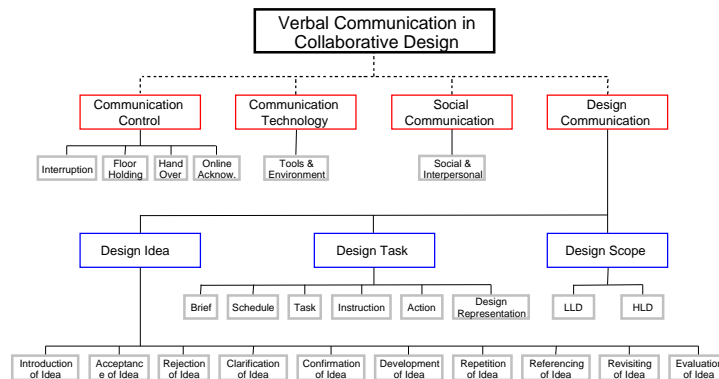


Figure 3. A hierarchical tree of the coding scheme

.4 Results and Discussion

All 26 experiments were transcribed so that each utterance by a single designer was considered as a single ‘text unit’. Each utterance was coded by two independent coders. One or more types of communication were assigned to each

text unit. An arbitration process followed resulting in single unified coded transcripts.

Figure 4 shows the average distribution of the percentage¹ of the coded text units, across the 4 primary coding categories in all 3 categories of experiments, revealing some important variations. For example, in the CMCD-b sessions (no audio or video) there were fewer text units dealing with communication control and more text units concerned with design communication than in FTF or CMCD-a. However, to further measure these differences and assess the impact of the different communication channels, we briefly characterise our observations and analysis of the coded sessions into 2 principal classifications. These are differences in *communication* and differences in *verbal design representation*. To begin with, we compare differences in communication across the 3 categories of experiments through the first 3 primary categories of the coding scheme: *communication control*, *communication technology* and *social communication*.

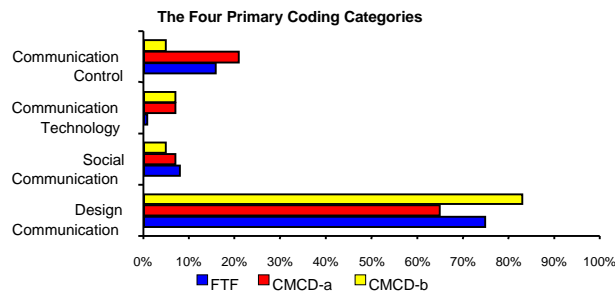


Figure 4. Mean percentage of the 4 primary coding categories across the 3 categories of experiments.

Communication Control varied markedly between the 3 categories of experiments. We were expecting differences mainly between FTF and CMCD sessions. We expected that the participants in CMCD sessions would have higher levels of interruptions in an attempt to overcome the novel collaborative environment and the remoteness created by the communication medium. However, in both FTF and CMCD-a the verbal (audio) communication was ‘spontaneous’ and at times participants were observed competing for the ‘conversational floor’ which resulted in higher levels of interruptions thereby obstructing the flow of communication. However contrary to our expectations there were fewer interruptions in the CMCD-a category compared to FTF since the mean percentage of utterances coded under the interruption sub-category was 41% FTF to 31% CMCD-a. Communication was less spontaneous in CMCD-b with participants

¹ We show the results as an average of the percentage of text units in each category in order to normalise the values. Some sessions had a large number of text units and others had a relatively small number, even though each session was one hour long.

getting straight to the point with shorter and clearer utterances, and essentially no interruptions or floor holding.

Discussions about *communication technology* did not vary much between the CMCD categories, where the designers experienced similar difficulties, mainly with the tools of the shared whiteboard. However *social communication* presented us with an unexpected result since despite the removal of the audio-video channels, CMCD-b users had similar levels of social interaction compared to the other 2 categories (8% FTF and 7% CMCD-a vs 5% CMCD-b).

Differences in *Verbal design representation* are directly linked to the *design communication* principal coding category. Figure 4 indicates that CMCD-b had the highest percentage of text units coded as *design communication*. Figure 5 shows the differences in how *design ideas* were discussed in the different categories of collaboration. There are nearly twice the amount of text units concerned with *introduction of idea* in CMCD-b compared to the other 2 categories (10% FTF and 9% CMCD-a vs 28% CMCD-b, out of total text units coded under design idea).

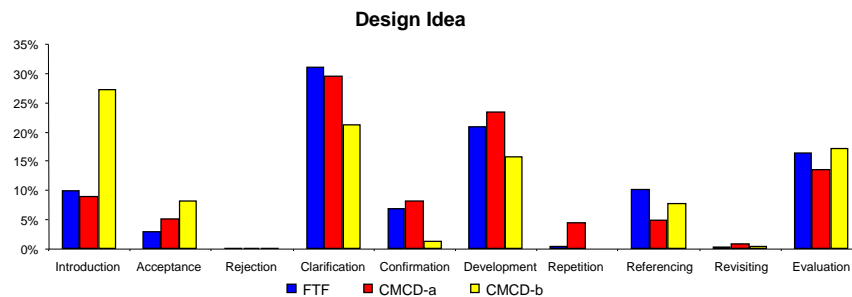


Figure 5. Mean percentage of design idea across the 3 categories of experiments.

With no interruptions participants in CMCD-b appeared to communicate their ideas as if they were designing by themselves. That is they kept introducing new ideas, whether they had a response or not, as if they were “thinking aloud”. Therefore rather than stopping at the first idea coming to mind, participants continued to introduce new ideas recording them in writing. However, the high percentage of new ideas being introduced means that there was a lower percentage of text units in confirmation of ideas, rejection of ideas, and revisiting ideas.

In summary, our expectations were that the major differences in collaborative communication would occur between the FTF sessions and the CMCD sessions. Our results show that in many ways, there is a strong similarity between FTF and CMCD-a and major differences between CMCD-b and the other two types of collaboration. This implies that a significant factor in the way designers communicate is whether the designers are talking by speaking or talking by typing, not whether the designers are physically present in the same room or using computer-mediation. The results do not imply that one way of communicating is better than another, only that the differences are significant.

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