

An Observational Analysis of Collaborative Actions in the Design Industry

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Abstract

As Human Computer Interaction (HCI) is developing in order to introduce information technology (IT) in a more natural way, the need emerge to study the different settings in which it is going to be used to inform design. Where IT strategies are used to subdue the work-frame in which they were introduced, it now aims to complement the existing structure and ease the task of the workers. The design industry and particularly the architect industry is one of many that could benefit from development of this different kind of approach in computer system design.

The virtual collaborative environment is one of the centres of interest in HCI and this paper intends to provide insights and information to guide the design of such applications directed toward the design industry and particularly architectural practice.

1. Introduction

The observational study undertaken was aimed at exploring the nature of design collaboration in the design industry. The study explores the occurrences of physical collaborative design in comparison to the virtual. This approach attempts to gauge the key aspects of design, through exploring the aspects of design in architectural firms. Through viewing the interactions of designers, workplace settings and styles, this study reveals the nature of communication, considering issues of sketching, creativity gesture and movement across mediums. Through this study and analysis, collaborative design can be more informed about the driving elements which control its process.

2. Observational Study

The study treated in this document took place in summer 2002-2003 in two different architecture offices. The aim was to bring some insight on the physical design collaboration taking place in those places to help

the creation of principles and guides for the development of collaborative virtual design environments. It is important to remember that this initial study aim to be a base for further study on virtual collaborative design.

2.1. Background

The main methods on which our fieldwork observation was based are: ethnography, ethnomethodology and phenomenology.

Ethnography is described as a movement between anthropology and sociology that focus on observing people in their “natural” environment. It is considered as a “long term involvement”, a “real immersion” (Dourish, 2001) where the researcher tries to avoid preconceptions in the way he perceives his observations.

“Ethnography was viewed as a way of gaining insights into the nature of human activity that could provide the grounds for the design of new technologies.” (Blomberg 1995)

Ethnography has over the past ten years become a very popular method for collecting insight in HCI due to its efficiency to capture user’s requirement. It is especially efficient in capturing the insight inherent to the interconnection of the activities and social environments. It was therefore obvious that this approach would inform the development of our research, understanding that such insights were a very important part of what we were seeking to capture. However this method also has its limitations. It is not rare to see ethnographical analysis last months or even years. The time required by such method is always a very critical factor when deciding to conduct a user’s requirement capture. In our case the time allocated didn’t allow us for such a method, however the principles of the study where still applied as strongly as possible.¹

Ethomethodology is another method applied to observational studies. It is very close to ethnography and even often confused with it. However it has its own

¹ Phenomenology is a side issue, which is not associated with this paper. For further information in this area can be found in the work of Merleau Ponty.

identity and perspective. Where ethnography concentrates on observing people and their behaviour within their physical and social environment, ethnomethodology focuses more on the reasons making sense of our actions.

“The term ‘ethnomethodology’ thus refers to the study of a particular subject matter: the body of common-sense knowledge and the range of procedures and considerations by means of which the ordinary members of society make sense of, find their way about in, and act on the circumstances in which they find themselves.” (Heritage (1984:4))

Phenomenology adheres to the same point of view, trying to look at what makes sense of what we are doing. It also state that the world is what brings meaning to our actions. That’s why we tried to capture as much data about the settings of the office as possible.

2.2. Settings – Work, Practice & Social

This research was conducted in two Brisbane architectural firms during two days each over December-January 2002 - 2003. During this period we were able to capture very important data about the process and practice of those firms as well as their work settings. We decided to use a video-camera to be able to review our observations after the study. This idea is inspired from the more typical observational studies and informance design techniques. It has proven to be very helpful to review details of an action or a conversation during our observation as well as help us to understand the reasons behind actions and helped us to capture and review the very complicated interaction that took place and refine details of an interview. It was especially useful during the meeting allowing us to capture very dense insights. The use of videotaping is also supported by Suchman and Trigg (1991) and Jordan and Henderson (1995).

As previously explained, ethnographical and ethnomethodological, but also phenomenological studies give a great importance to not only what is happening, but the context in which it is happening. Therefore it is really important to describe the different firms in their physical as well as their organisational aspect.

Firm A is formed by 15 people; the repartition between the different professions is given on Figure 1. The landscape architects have a very separate role to the architects, they are often working on totally different project that have no connection. The project architects are in charge for guiding the design and dealing with the client. The student architects are expected to work in an architecture office to complete their theoretical formation with some experience in the industry. They are required to assist the project architect in their work, providing helpful support in CAD, research and documentation. The two Managers/Project architects have a key role in the organisation, being present in every important decision made in a project. They organise the workflow within the company and also ensure the coherence of the design within the firm’s view.

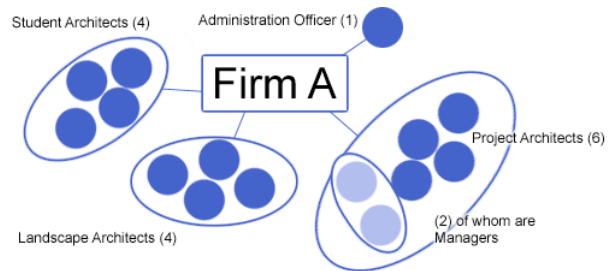


Figure 1. Firm A Organisation overview

The second company, called firm B for convenience, is composed of 18 persons. The repartition of the staff within the different categories is given Figure 2. We can observe a very similar structure. The project architects are only rarely involved with computer drawing as they mainly manage projects and direct the student architect’s work. The two managers are responsible to ensure that projects’ coherence with the firm’s design identity. The role of the student architects is initially the same as in first A, providing helpful support in CAD.

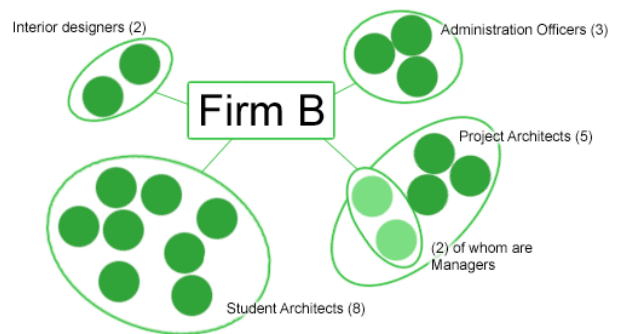


Figure 2. Firm B Organisation Overview

Both firms have a profusion of books, samples, magazines of architecture lying on shelves or desks all throughout the office. These documents are therefore available for consultation at any time. They are used to inform the design using catalogues to choose a material or a product for a particular work as well as staying up-to-date with what is going on in the architecture industry. It also contains the rules, norms and regulations relative to architecture in order for the designer to refer to them if necessary.

The office layout of the firm A is fairly open, with no high wall blocking the view and the workstations facing the rest of the room as much as possible. The desks are fairly busy with many documents apparently ready for quick consultation. Those documents include plans printouts, catalogues, samples of material or item, magazines. Each desk is also equipped with a phone and every computer is Internet and email capable. The back of the office contain a shared kitchen area that permits coffee breaks as well as the extensive library updated and maintained by one of the student architect. This is also the location of the plotters

On the other hand, the firm B has a more enclosed space with three main zones: the project architects (PA), the “CAD pit” where the student architects (SA) are and the managers-partners who are isolated from the rest of the office by two big shelves.

2.3. Work styles

The work is conducted following a series of actions describe Figure 3. The first idea is sketched on paper in group from the information gathered by the project architect (PA) in charge. Those come from the survey operated by the PA on site as well as the specifications and preferences given by the client.

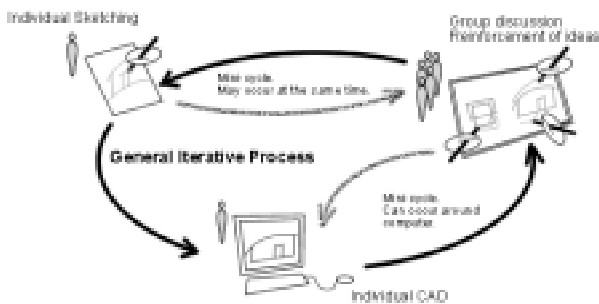


Figure 3. Iterative tasks for design

From this initial sketch, a first design is implemented either on computer or as a 3D physical model. The 3D physical model aims at seeing the nature of the building as a volume, for itself or its surroundings. The Computer generated drawing allows more precise details. This implementation is then reviewed and refined or completed by further details until the final plans are achieved. This process is described on Figure 4.



Figure 4. Design iterations

3. Outcomes and analysis

Interactions in both firms were, at a physical level, remarkably similar despite differences in work styles. There was a separation of individual and teamwork, where people would complete specific tasks on their own to then discuss these, either formally or informally, with their colleagues. People would collaborate by discussing and sketching over paper based plans/drawings and printouts of CAD drawings, which allowed a clearer overall view than onscreen. The ability also for all

participants to be able to alter the drawings at once allowed for far more efficient discussion than when a computer was used, both in the amount of people who could access the plan at a simultaneous moment and the time taken for sketching on paper versus the time taken to ‘sketch’ on computer. In this section, we look at key factors that enabled effective collaboration and the issues that arise when attempting to translate this style of collaborative work into the virtual.

3.1. Communication and social environment

Through the use of interviews, participants were asked what they felt the major issues would be if they were to work away from the office and forced to interact with colleagues via electronic means. The most common responses were that there would be no one to talk to, access to colleagues and resources would be restricted, and communication would be hindered. The ability to communicate effectively and efficiency through a common set of values creates an atmosphere/ambience where people are comfortable with each other. Solid working relationships are established and from this a mini society is born that manifests itself through language, common symbolism and design identity. The societal aspects of the office, together with a saturation of contextual information, provide ambience, which creates common focus and generates inspiration. It goes without saying that communication is a key part of collaborative design and the ability to effectively convey ideas through verbal and visual means is essential in all staff. Factors that greatly enhance communication include:

3.1.1. Proximity, Communication and Society

“Its all about me being next to this person and that person ... It’s all about the team.” [Manager of Firm A]

The creation of strong working relationships is reliant on trust and commitment and essential for successful collaboration. In face-to-face situations people instinctively ‘read’ others, assessing body language and attitude to determine credibility, as the old adage goes, first impressions last. Proximity to colleagues provides security, generates atmosphere and fosters collaboration and discussion. By being centrally located, staff are immersed in a working environment that encourages design and this saturation of work style and influences gives context to communication. Proximity to colleagues allows for quick access to implicit knowledge, and extended personal networks and promotes an awareness of projects around which allows knowledge sharing despite not being directly involved. It encourages spontaneity and informality in interactions, creating an atmosphere where people feel comfortable about expressing ideas and asking for criticism.

Staff, at both firms, felt that if they were remotely located, they would be unable to have the impromptu interaction that they were used to. All felt their work would suffer if they were unable to talk to any member

of the office at any one time, especially for quick discussion and feedback. It was commented that, technologically, it would be possible to work remotely, but team-wise the company would suffer if members were remotely located. This is echoed in a study by Bellotti and Bly (Bellotti, 1996) that looked at mobility within a product design firm, which had offices in different geographic locations and the impact this had on design teams. It was found, that while colleagues situated in one office communicated more effectively and had a greater awareness of projects conducted within that office, communication and awareness between geographically separate offices suffered. As reflected below,

“Informal and frequent interactions seem to be critical to the way the organisation conducts its work as a whole.”(Bellotti, 1996)

In relation to remote collaboration, the little questions would be the hardest to support, requiring the facilitation of real time, synchronous communication of a visual nature. Being able to quickly consult colleagues greatly shortens the design process, and maintains an idea, whereas, if forced to do so through asynchronous means, such as email, waiting for a reply even for a simple question, wastes time and disrupts the work flow. One participant stated when asked about working remotely and not having face-to-face contact with colleagues: “...you couldn't share a coffee with them” Proximity also facilitates awareness of body language and physical cues when communicating with colleagues.

3.1.2. Gesture in communication.

The use of gestures, in communication, to explain concepts and ideas is a natural and instinctive response and body language provides physical clues as to person's state of mind. Much of the problem with current distributed collaboration is that people are unsure of the headspace or mood of the person they are trying to communicate with as there are no visual clues (Bellotti, 1996) (Bekker, 1995). Gesture as a communication tool has a number of characteristics and uses as described by Bekker et al., through the outcomes of their study into face-to-face gestures and their use in design situations. Four major categories of gesture were defined, these being: spatial, where movement indicates distance, location or size; kinetic, describing actions or series of actions; points, pointing with a finger usually at an artefact or person; and other, describing all gestures which do not fall into the previous categories (Bekker, 1995). All of these types of gestures were observed in the collaborative interactions of the architects, as a tool for explanation and reinforcement of design. Instinctive and sometimes unconsciously made, gestures synchronise with speech and often occur in a spatial context to surrounding artefacts, people and activities. Many gestures can convey complex messages in a single hand movement, such as action, three-dimensional objects and to describe past events (Bekker, 1995).

The rapidity, flexibility and essentially visual nature of gestures is difficult to replicate in a software program as, in contrast to the common language, gestures are

malleable and adaptable and thus extremely difficult to give exact meaning to. Even the most literal collaborative systems fail in capturing gesture sufficiently, video conferencing, even when we get past the expense and technical constraints, has a narrow field of view which restricts effective use of gesture. One method, using multiple cameras and windows, manages to display the speaker, gesture, and artefacts of the discussion, but by separating these areas manages to destroy the context of gesture to speech and artefact. Sketching and gesture provide visual context for subjects being discussed, a quick and effective method of conveying ideas of a visual nature, that when described verbally, is a lengthy process and open to interpretation as there are no visual cues to provide reinforcement.

3.2. Creativity and sketching

Sketches are an essential function of a design process. It is a very powerful tool that helps communication, structure the design process and most of all enhance creativity. It is taught in every design practice from architecture to multimedia design and is even considered within the architectural practice as a quasi social requirement (Elliot, 1997). Its free form as well as its ease of use makes it unavoidable throughout the process. It is present in every stage of the design, from the initial idea to the refinements. Preponderance of sketches in design is also reflected in similar studies within design environments (Bellotti, 1996) (Bekker, 1995).

3.2.1. Sketches as communication medium

Sketches are first a very intense and sophisticated communication medium, allowing a very dense level of data to be transmitted in a very efficient way. It is by nature a quick drawing, rough and unfinished that allows expression of visual thoughts. It happens in the initial stage of design during the brainstorming to help providing a large volume of ideas for discussions. Sketching develops style, refines ideas to produce a plan, and encourages exploration and communication. (Elliot, 1997)

“I do sketch a lot, Everybody has his own way, his own notations for keeping in touch with idea...” (Jorge Silveti in Elliot, 1997, p.105)

Sketching is also very personal, tinted by the paradigms inherent in the author's view. It is often a lot more meaningful to the author than the person looking at it as it is sometimes not intended to be seen by anybody else. That is why it is often used in collaboration with gesture to explain concepts.

The sketches also allow the architect to quickly re-evaluate a design or modify or refine an existing plan printed on paper by sketching over it. This process as explained before occurs very intensively throughout the different stages to evolve the design. They are one of the key aspects of the whole design.

3.2.2. Sketches and virtual environment

The issue raised by the replacement of paper based drawing by a hardware and software system is intensively discussed by Ame Eliott (Elliott, 2002). We have tried to extend these points by our observations.

The sketching method is very difficult to translate into a virtual environment. It could be suggested to instead of replacing the sketch just to translate it digitally using scanners as it is done in firm B for getting form on version of the design to another. However we believe one of the key aspects of the usability of sketches has to be fluentness and ease of use. The use of scanners doesn't allow such fluentness.

The total replacement of sketching by a computer is also an unsolved problem at this time, as Ame Eliott shows in her study (Elliott, 2002) and the use of CAD even in free form mode doesn't replace the sketches and this for a few reasons: You can sketch on many supports and therefore almost anywhere assuming that you have a pen. More, sketches are rough and fast, where the computer tends to reinforce precision and order, its capabilities influence the user to perfect its drawing to scale them properly and use proper dimensions. A landscape architect in firm A once explained to us that he only used the computer for the end implementation because it would take him five minute to draw it by hand and an half hour by computer because he doesn't feel the need for neat drawing when using hand drawing.

More it often occurs that a misplaced line in a sketch appears to become the design, influencing the rest of the development in a way the architect didn't plan, it brings the touch of chaos that every artist use to forge art.

3.2.3. Sketches and physical dimension

Physical dimension is another point raised by the virtual environment. Two points need to be addressed, the first one is the use of paper over the on-screen display and the second is the use of 3D physical model over its digital analogue.

3.2.4. Physical artefacts in sketching

"...what you see on screen is not necessarily what you get on hard copy..." [Participant from Firm A]

The above comment was made by a participant when asked why printouts were needed for discussion of plans rather than referring to what's on screen. With paper plans, when looking at details, there is a peripheral awareness of the whole, providing a constant reminder of the big picture. It is easier to look at the overall plan and then focus on any number of zones quickly and efficiently. This is done without complicated manipulation and without changing the document. Paper plans are also much easier to manipulate, allowing people to easily flip through and reference a number of different plans. As paper is available in a wide range of sizes, it offers a flexibility of viewing space and size that is not available in current technology.

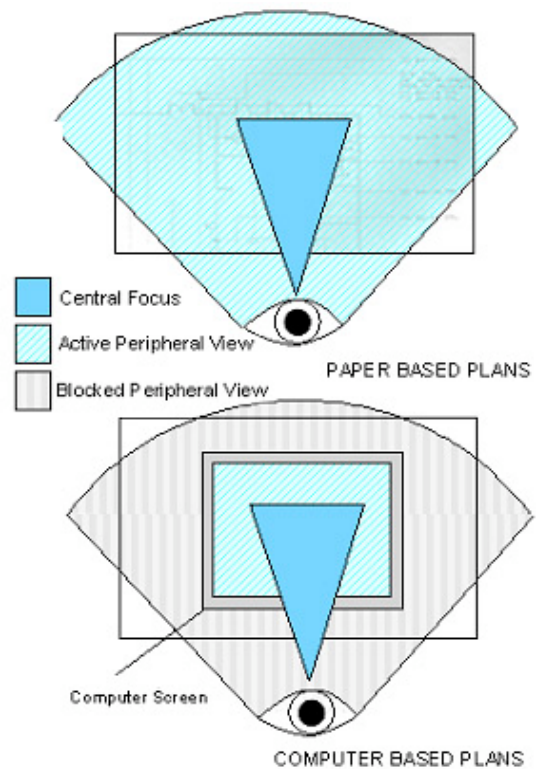


Figure 5 – Comparison of peripheral view between paper and on screen plans

Effective comparison of two or more sets of plans at once is difficult to do on computer due to issues with screen space and size, computer memory and speed. While the computer is extremely powerful in terms of accuracy and modelling capacity, finite screen space causes the loss of peripheral awareness and there is a tendency for people to get lost in the details. Technicality of computer affects perception of drawing, when a drawing is viewed on computer there is an assumption that it is accurate, whereas a hand-drawn sketch is seen as just that, a quick and inaccurate impression of shape and form [see Figure 5]. Also the technicality of the software's drawing tools restricts freedom and rapidity in expressing ideas, the ability to convey meaning through sketching a few lines, creating a suggestion of shape, is far more powerful and efficient than trying the same on computer. The physical actions involved in sketching by hand and sketching by mouse are different and the tools supplied by software don't support the freedom of movement required for natural sketching. Also there is a certain fluidity and aesthetic appeal in hand drawn lines that is difficult to replicate with current pixelated imagery.

3.3. Transforming between mediums

The process of discussion during a design process by partners, clients, consultants or other parties is quite involved. Throughout the process the design production

has occurred on an individual basis either through CAD or by forwarding the file onto relevant team members and in their elements. At the point discussion occurs files are taken from the virtual environment and printed in a traditional orthogonal layout to act as a catalyst for discussion in the meeting. This change in medium is shown in figure 6 below.

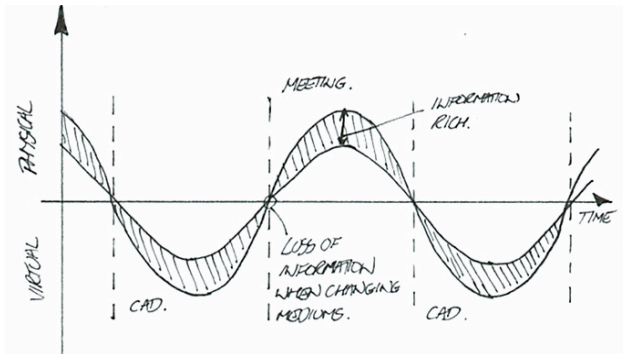


Figure 6: Changes in design medium during design process.

The medium tends to be directly related to the nature of communication required. When changing the number of participants involved in a meeting and moving from asynchronous to synchronous interaction, the change in medium required, to sustain efficient collaboration (refer to earlier section 3.2.1) Figure 7 shows the type of interaction that occurs over printed drawings in a typical meeting. Figure 8 shows some of the resulting sketches that can accompany this process. The continuous interaction by participants can be clearly seen, as they annotate the drawings to explain and portray ideas.

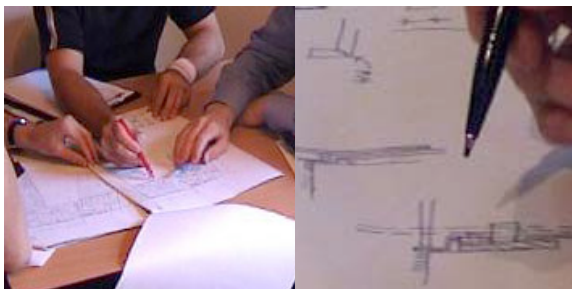


Figure7: Design meeting interaction.

Figure 8: Detail of annotated meeting discussion.

It is changing of mediums that can quite often be the issue. At these points when data must be transferred especially when travelling from the free form environment of the physical world to the virtual some of

that information is often lost. This is related to different constraints imposed by the tools in the different mediums. This inefficiency can result in lost time and design intentions. The levels of quality in the two mediums is often an issue with the parameters of physical sketching resulting in different outcomes and interactions in comparison to digital CAD documenting. (see section 3.2.4) Both mediums have clear affordances for their prescribed purpose and do lack common ground.

It becomes clear from this diagram (Figure 6) that there is a need for this efficiency to be improved. Several approaches are evident including the transferring of collaborative actions in the meeting scenario to the virtual world. Many researchers have worked to achieve this technological application but unfortunately many still miss the main point. While programs such as ArchiSketch, for example, do work in the virtual world to create a link between designing, documenting and discussion they lack one important aspect. These programs are designed for virtual collaboration on virtual techniques and approaches. They tend to be poor at supporting the physical collaborative elements that drive the nature of co-operative design in the physical world. Elements such as continuity in discussion, context of design discussion, especially at a latter date for reference, spontaneous ability to alter designs and overlay drawings easily.

According to Dourish, when discussing the important aspects of frameworks in embodied interaction, it is essential for users to manage the couplings of actions, in the program through which they engage and interact.

“The need to manage their own action arises, from the fact that those actions take on meaning for the users, as part of ... practice arising around the work being done. Meaning, and its coupling to the features and representations the system offers, emerge from the actions of users, not designers.” (Dourish, 2001, p.177)

To explain this point further, users should not be controlled by the limitations of the interactions in the software they use can achieve. The flexibility in physical collaborative design referred to above, can help achieve this end. After all, software applications should be created for the users to engage and manipulate, not just navigate, where the program sees fit

3.4. Continuity of the design process.

The process of delivering the ideas which were communicated in the meeting to the parties who are responsible for making the changes does appear to have inefficiencies. But the process of architecture is a long standing one, a traditional practice developed over many years of crafting to achieve this process.

Thus the question arises, does the process need changing? Some would argue it is inefficient, others would say that it is part of being an architect.

Dana Cuff has shown through her observational analyses of the architectural profession in America that there is inefficiency in the nature of practice, particularly the lack of continuity of the design process versus

practice in reality. "In practice, design hangs 'in the balance', because placing a high priority on design requires tradeoffs in other domains." "An office without good business practice will not survive, but ... can discourage good design." (Cuff, 1993, p.69) Scarce resources inside the firms ultimately drive many of these tradeoffs.

One key aspect to this argument is the sketching of design ideas, which alter an existing project. As each group member has bought their own notepads to the meeting it is quite common for a member to show their ideas to the group through their own pad. At the end of the meeting, individuals take their notepads away.

This results in the associate member often being responsible with writing up the alterations to the documented project, having to remember the design ideas portrayed in the meeting. But is it more important that the idea was portrayed rather than the associate actually receiving a copy of the design sketch used to explain that idea? If the important aspect is the communication of the idea then the process is successful.

This ability to interpret meaning through discussion around a design sketch then taking away the essence of this idea to place in documentation could be considered part of the training of becoming an architect-understanding, interpreting and applying to context. One could assume as the architectural profession has been working this way quite effectively that this is the case. Either way the ability to recall this information would be potentially beneficial to the profession.

4. Conclusion

Through the course of this paper we have discussed the observations from typical architectural design practices. Through these studies the nature of design has been explored, showing the interactions involved in the process. The importance of setting, practice and style revealed in regards to the communication in both the physical and virtual worlds and in sketching gesture and verbal communication. It has been shown that the process of design is intricate and that the practice is as individual as the participants involved. Through exploring these interactions, the inefficiencies in design are shown while revealing the fundamentals, which can be used to make the integration of the physical and virtual more suitable for those who matter – the designers who used them.

5. Future Work

Through this study we begin to get closer to the essence of what drive design, not just in architecture, but all professions. The final aim is to develop a foundation to which users and designers alike of collaborative design software can work in a virtual space embodies all the ease of use, spontaneity and freedom that the physical world offers, while integrating the practice with the modern design world's techniques.

To do this it is necessary to develop a framework for design collaboration in the virtual world, which can consider not only the intricacies of the physical and virtual interaction, but also the nature of situated actions which affect the flexibility of day to day design firms process. Through studies and analyses such as these, this end can be achieved.

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