How do we sketch with someone 1000 miles away?: distance collaboration for designers

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Abstract: This paper frames preliminary explorations in the process of connecting new designers in an online, distance learning environment, developing strategies for distance education and collaboration. The research seeks to better understand the multifaceted issues developed by the loss of in-class face time in relation to growing global communities and education systems. The involved authors have begun to explore the complexities of not only communicating technical knowhow as it relates to design (both in terms of building systems and software instruction) but also at engaging the loss of the physical studio interactions. There has been substantial study regarding the efficacy of online instruction as it pertains to general subject matter, however, study into specific relationships and interactions in the design process remain fertile ground for research (Harrison, 2015). The authors are exploring remote technological solutions to support the behavioural dimension that in-class interactions provide (desk critique with trace paper, group critique, peer teaching, etc.). This paper discusses the implementation of an online instruction methodology while additionally exploring its efficacy in getting students to explore tools, ideas and concepts beyond simply following instruction. This seeks to engage the question – How do we sketch with someone 1000 miles away?

Keywords: Design; education; pedagogy; technology.

1. Introduction

This paper describes the initial steps that the authors have taken to develop a strategy that overcomes the challenges that conducting “real time” and interactive design crits with geographically separated participants presents.

This paper emerges from a project that began as a conversation between two people who were physically present in the same space at the same time. The participants, Ben Slee, an Architect, and Mark Olweny, Dean of Architecture at Uganda Martyrs University outside Kampala, identified the challenge of finding appropriately qualified teaching staff to deliver an Architecture degree of
international stature in Uganda. Through discussion, it was determined that it would be possible to connect collaborators from around the world to teach students in Uganda through a virtual communication array.

Subsequently, a series of corporeal and virtual conversations identifying challenges specific to teaching design and architecture took place and expanded the conversation beyond the preliminary team. There is no doubt that it has been tried, notably however, it is difficult to find a description of a framework that has been shown to be successful. There is also no doubt that many tools for enabling virtual conversations and sharing information in real time across the globe have been developed and are often available at no financial cost. However it is also clear that these are tools that we must learn to use, in the same way we learn to draw and share ideas, and that these tools do not facilitate the multiple and simultaneous communication methods that are present in the traditional design discussion or studio crit. Hence the question: How do we sketch with someone 1000 miles away?

2. Methodology and structure

The structure and methodology of this initial study follows the following format: The first part of this paper reviews existing practice and theory that explores interactions between people in the same physical space and in cyberspace. The second section describes a case study that used an online asynchronous instruction system to teach design. The third part of the paper reviews the technological hardware available to enable sketching in cyberspace. The fourth part of the paper describes and tests a two tablet system developed by the authors to enable synchronous sketching in cyberspace between people who are separated geographically. The fifth part of the paper sets out how this system can be used to deliver a unit of study to architecture students in Uganda and how the authors propose to evaluate the efficacy of the system.

3. Existing practice and theory

Mitchell (Mitchell, 1995) explores the implications of the emergence of cyberspace on how people interact with one another and therefore our conception of and creation of space (architecture). One of the themes that emerges is the significance of corporeal presence in our interactions and the opportunities and challenges that “dissolving the proscenium between the real world and the virtual” presents. The design crit is an excellent example of the challenges presented in mediating traditionally physical synchronous interactions into the virtual world.

The traditional studio based design crit involves a group discussion where each member and the tutor are physically present in the same space at the same time. Verbal communication is only one dimension of interaction and, as in all conversations, body language and eye contact are important for coordinating discussion. However, significantly, the design crit involves shared sketching in real time on paper where members of the group contribute to the same drawing, the manipulation and observation of physical models and physical gestures. It is this shared, multimodal experience that differentiates the design studio from other types of conversation. The act of sketching or drawing often elaborates on a reality and happens intuitively (Phillips, 2013). Sketching is to capture an animate thought, and is thus beyond perception (Fisher and Santacatterina, 2011). This action is completely transparent from brain to pencil (Lawson, 2014). Schon calls this "tacit knowledge" (Schön, 1983). The educational process simultaneously embeds several types of quale (a quality or property as perceived or experienced individually by a person).
Existing online teaching methods, which celebrate the monologue, are ineffective instruments in developing discussion beyond fact uploading and technical instruction. Within the literature review, online teaching is often engaged in lecture format; students review an online lecture, and are subsequently tested on that lecture material. These formats are monologues and discussion is limited to what can be articulated on online forums, an action that arguably eliminates the animate thought; the technology presents a sense of isolation within the digital environment (Carroll, 2013). The act of compression revokes the gestural thinking and the dialogue never evolves within a humanistic framework. These developing models are asynchronous and lose emotive engagement between participants. The design studio is a complex space where learning relationships and processes are constantly shifting between participants (Mewburn, 2012).

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3.1. Research framework – emotional response theory

This research operates from an Emotional Response Theory (ERT) framework. ERT as described by Mottet, Frymier and Beebe (2006) acknowledges the importance of implicit communication systems that are articulated through a system of various biologically shared signals (use of personal space, facial expressions, body posture, as well as paralinguistic features of communication such as tone, rate, pitch and volume (Mottet et al, 2006)). Under ERT, we see a constructed relationship in which the professor’s interactions with the student directly inform their emotional responses to content. While these messages are often unintentional expressions of underlying emotions (Mead, 1934), their impact plays a profound role in the design studio setting. ERT posits that the emotional state of the subject predicts whether they will approach or avoid places, ideas, etc, including how subjects approach or avoid learning (Mottet et al, 2006; Mehrabian, 1981; Russell and Barrett, 1999; Vinson and Biggers, 1993) and is supported by Biggers and Rankis (1983) who reported that emotions account for a large percentage of variation in research studies predicting behavior. Stated simply, ERT “predicts people will pursue what they like, people like what they feel positive emotions for, and people’s emotions are influenced by the implicit messages they received from others (Mottet et al, 2006).”

Within online learning environments, students may have issues establishing positive emotional experiences due, in part, to the lack of implicit messages being received from professor to student (Brooks and Young, 2015). Titsworth et al (2010) examined classroom emotion as influenced by three communication behaviors: non-verbal immediacy, clarity and communication competence. Brooks and Young (2015) observe that while clarity and communication competence might be transferable to online environments, non-verbal communication and immediacy, which play a foundational role in design studio crits, remain difficult to translate.

3.2. Historic and present technical limits of technology

Architects use sketching and diagramming in their design process to perform functional reasoning, formal arrangements, analogy transfer, structure mapping, and knowledge acquisition (Do, 2002). In recent years, the architectural design practice has witnessed a change in the use of technology, from the
imported yet tedious Computer Aided Design (CAD) drafting of construction documents, to using digital tools to explore new design possibilities. Some of the changes in technology usage include: parametric interfaces to create and control 3D models, rapid prototyping, and virtual communication and collaboration. With regard to sketching, Lawson (1994) depicts the relevance of the ‘unique’ hand-brain connection and how it affects the design process. A technology has not yet been developed to remotely streamline the cognitive processes involved in sketching and diagramming.

In their research Broll et al. (2004) introduced ARTHUR as their solution to the limitations of paper-based sketches in collaborative architectural design. The ARTHUR system is an Augmented Reality (AR) enhanced round table that supports complex design and planning decisions for architects. As an approach to capture a designer’s thought process in sketches, Do (2002) proposes a framework for reasoning that is represented with drawing marks, acts, and reacts. This study illustrates the possibility of developing design support tools based on these concepts.

Van Dam (1997) wrote,

“Raster graphics-based networked workstations and ‘point and click’ GUI WIMP s (Graphical User Interfaces based on Windows, Icons, Menus, and Pointing devices) are the legacy of Xerox PARC that we’re still using today”.

However, the dawning of ubiquitous computing is transforming and moving beyond Xerox PARC’s legacy. In 2010 George and Blake (2010) introduced Objects, Containers, Gestures, and Manipulations (OCGM) as the “universal foundational metaphors of Natural User Interfaces (NUI) paradigm”. If the next generation of design-related software and digital tools is going to fully integrate with the designers’ sketching and multimodal interactions, then these new human-computer interaction paradigms and NUIs will need to be developed around these intentions.

4. **Online asynchronous Q&A instruction: case study 1**

As a case study for online tutorial instruction, Professors Dustin Headley and Allan Hastings of Kansas State University engaged in the incorporation of online video instruction to resolve a lack of capacity in facilities. The studio environment included 27 second year undergraduate students that were subsequently spatially divided between two spaces, the design studio and the computer lab, to accomplish the design of prosthetic skins for 3D printing. All students had no prior knowledge in the computer and during the three week project were transient between the two spaces. Given the sheer number of students involved, it was impossible for each studio professor to effectively communicate with all students at both a technical and conceptual level within the scheduled timeframe (Monday, Wednesday and Friday from 130P-530P). As such, alternative methods of communication were engaged in an attempt to offset these issues. Students were charged with developing questions, both design and technically related, to communicate with the studio professors. The questions were then answered and shared through video conversation and demonstration through open discourse on Facebook.

As observed by the authors, the lack of one-on-one interaction had dramatic effects on how the students used the video feedback. Students consistently skimmed the conceptual discussion embedded in the video content to extract the more tangible instructional (how-to) content. The lack of implicit communication and immediacy cues projected to the students made the process of evaluating the value of different components of the content next to impossible. The students simply could not ascertain what was important for professional discourse and development beyond accomplishing the task at hand.
5. Review of the hardware: on the ground with the technology

Before thinking about developing an innovative system, the authors tested existing technology, specifically tablets. To achieve this, the authors developed an experiment to test three different tablets, comparing each for the participant’s functional preference.

The experiment methodology was simple: two video cameras were used to film the participants, each of which was given a simple sketching task to be completed using one tablet at a time (see figure 1). Later on, the participants filled out an Attrakdiff questionnaire (Hassenzahl et al., 2003) rating the tablet they had just used. There were small differences in the tasks with every iteration; this counterbalanced the order of the tablets and the task variation to help avoid bias. The three tablets used were: iPad air, Microsoft Surface, and Wacom CINTIQ. The task was to draw a simple floor plan for an apartment or small house.

![Figure 1: Participants creating their sketches.](image)

<table>
<thead>
<tr>
<th>Device</th>
<th>PQ</th>
<th>HQ-S</th>
<th>HQ-I</th>
<th>ATT</th>
<th>( HQ-S ) = Hedonic quality - Stimulation</th>
<th>( HQ-I ) = Hedonic quality - Identity</th>
<th>ATT = Attractiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPad</td>
<td>5.142857</td>
<td>4.52381</td>
<td>4.352381</td>
<td>4.695238</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CINTIQ</td>
<td>4.961905</td>
<td>4.447619</td>
<td>4.180952</td>
<td>4.704762</td>
<td></td>
<td></td>
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<tr>
<td>Surface</td>
<td>5.219048</td>
<td>4.695238</td>
<td>4.4</td>
<td>4.980952</td>
<td></td>
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</tbody>
</table>
Initially, the authors hypothesized that the majority of participants would be familiar with iPads, which would be a major influencing factor. It was also thought that the high-end capabilities of the Wacom CINTIQ would be another major influence. Despite being right about participants’ previous tablet experience (12 out of 15 had previously used iPads) the Microsoft Surface was the tablet with the highest score across the four different products dimensions measured by the Attrakdiff questionnaire (see Table 1). The more expensive and arguably more capable Wacom CINTIQ was previously used by only one of our participants, who picked the Wacom as their preferred tablet. The main issue for the participants with the Wacom CINTIQ was the pen hovering feature (there is no contact with the surface of the tablet required to direct the pointer on the screen).

All the sketches created by the participants (See figure 3) where created using an HTML 5 online interface called A Web Whiteboard (https://awwapp.com/). During the first dry run for the experiment the authors realized that using a desktop based application, such as Autodesk Sketchbook, had one particular problem: The interface, while similar in icons, was different across the different tablets. This meant that in some of our first tests the participants ended up evaluating the graphical user interface (GUI) instead of the actual tablet. To avoid this, we moved to use the online software, which remained the same across all 3 devices.

Figure 2: Means chart of answers to questionnaire.

Figure 3: Participants sketches created with a web whiteboard.
6. Proposition: working synchronously while remote

There is no silver bullet. Based on our previous research into preferred interfaces, the Microsoft Surface Pro was selected as an ideal base technology to utilize in the development of an ERT driven critique rig that simultaneously embedded effective drawing tools and options in the coordination of the communication technology. The technology also lends the advantage of a full operating system.

A two tablet system was developed to enable remote communication within the student-teacher relationship. One tablet was designated for video conferencing while the other was oriented towards drawing and review. The tablets operate independently of each other. This enables the user the freedom to assume whatever body posture is comfortable with the drawing tablet without adjusting the video interaction (Figure 4).

To engage the multimodal dimensions involved in ERT, Zoom, a video conferencing and recording software was engaged. This engaged dimensions of facial expressions, body posture (environment dependent), as well as paralinguistic features of communication such as tone, rate, pitch and volume.

![Figure 4: Shows the collaborative drawing on the tablet with the student at home on the other side of the work space.](image)

Notably, while similar to tools like Skype, this software afforded more consistent audio and video quality. This software enables the consistent logging in and out of participants for a single user (the instructor sets up a nine to eleven digit conference code and the students join for their appropriate time, or multiple students join for discussion). Participants can record their crits, enabling the revisiting of content from the discussion, and thus expanding the potential value of the interaction, extending into theological dialogues that can be revisited. Further, recording enables the analysis of the interaction itself.

For drawing tablet, a combination of the online resource “A Web White Board” (http://awwapp.com) was embedded in Windows Surface App “Screenshot” by Wild Lion Software while also connected to Microsoft OneDrive. The resulting combination enables students and instructors to take pictures of their trace paper drawings for collaborative review sessions or google search images and load them in the drawing space, subsequently this enables the saving of images at any moment during process from either side of the conversation. With added features of OneDrive, previously...
scanned trace drawings or computer renderings can also be at the fingertips of both the reviewer and the reviewed (Figure 5).

The resulting process embeds the advantages afforded by the technology (remote collaboration, synchronous engagement, extravagant documentation, etc.) with emotional response and interaction through drawing and the pen.

Figure 5: LEFT, Shows first year design student receiving crit from remote reviewer. RIGHT, The resulting drawing for the collaborative discussion.

7. Implementation: Uganda and beyond

This project was initiated by a desire to find a way of teaching Architecture students at the Uganda Martyrs University, Kampala. This final part of the paper addresses how this proposal can be implemented in that context and how we might assess its efficacy.

7.1. The course

It is proposed that we develop and teach an undergraduate unit called “Design and Construction Technologies”. This course is intended to convey technical knowledge primarily through lectures and an understanding of “design”, or the ability to assimilate and synthesize that knowledge in the context of a site and a brief through a practical exercise taught through tutorials. The technical knowledge covers structures (beams, bending moments etc.), material properties and construction systems. The practical exercise covers the synthesis of that knowledge through the designing a simple structure with a particular brief on a particular site to create delight; the Vitruvian ideals of strength, utility and beauty.

7.2. Practical arrangements

It is proposed that this will be achieved by developing a course where the lectures are delivered through video link. The opportunity for a question and answer session will be desirable but not necessarily required. The tutorials can be delivered using the tablet sketching system combined with the video conferencing system. This platform may be augmented by social network chat forums (e.g. Facebook) (Schnabel and Ham, 2014). The tutors will be drawn from leading practitioners around the world who are also experienced teachers. They will take charge of small tutorial groups, which is 3 – 5 students. It is anticipated that these students will, as a group, receive between 1 and 2 hours tutorial time each week. Coordinating international time zones may be a challenge however the platform allows student groups and tutors considerable flexibility in arranging and attending tutorials. There is, for instance, no need for
the tutor to be in any particular place for the tutorial they must simply have set aside the time and have an adequate internet connection.

7.3. Assessing the efficacy

The quality of the course and the delivery of the course will need to be assessed. It is anticipated that this will be done through quantitative and qualitative feedback systems:

Qualitative student and tutor feedback

A questionnaire will be developed asking students and tutors to score the following four aspects of the course on a 5 point scale (1 – poor, 3 – neutral, 5 – excellent) augmented by more detailed written feedback.

- Ease of use
- Ability to interact with the students
- Ability to interact with the tutor (or other tutors)
- Simplicity of timetabling tutorials

Marks from the final assessments of student projects will also be used as an assessment tool. It is proposed that these marks are validated using an external moderation process with a group of tutors from a leading school of architecture outside of Uganda.

8. Discussion and conclusion

In this paper the authors have tackled the problem of delivering a studio based design course to architecture students in Uganda using tutors who are dispersed around the world. In particular the challenge of creating a "virtual" studio environment has been identified. A virtual environment that facilitates the exchange of ideas through shared sketching, physical gestures and emotional cues. A system using existing and readily available technology has been proposed. Finally a framework for implementing and evaluating the system has been proposed.

The system combines the advantages of web based video communication with a web based sketching tool to allow students and teachers to sketch with, speak to and see each other simultaneously. Combined with cloud based file storage it allows participants access to a record of previous ideas that are often lost in the real studio. Compared to existing on-line teaching systems the proposition prioritizes the synchronous engagement of the participants.

The project is at an early stage and it is clear that while the proposition offers enormous opportunities there are limitations. The complexity of the studio environment and the process of sketching has been identified by Mewham (2009) and Phillips (2013) where multiple methods of communication and thinking are applied simultaneously and the roles of teachers and students are often exchanged. The authors do not pretend that this proposition can replace or replicate that experience. Bandwidth, screen size and camera angle are obvious technological limitations. The emotional experience of video conferencing is very different from a conversation between people in the same physical space. Skills with the technologies, particularly the social/emotional skills for virtual communication along with the sketching and rendering skills appropriate for the tablet interface need to be developed by participants. This does represent a real hump for those participating, however, the benefits greatly outweigh the costs.
The final part of the paper set out a framework for implementing this system and the technology to deliver a course in Uganda and evaluate its efficacy. The next stage of this project is to develop and test that framework. This system creates vast opportunities for global collaboration between students, teachers, schools and professionals. Significantly it can allow those with significant expertise in designing and creating sustainable built environments to teach in cities and countries that are developing rapidly and who need to rapidly expand their indigenous professional knowledge base without being physically present. As this system develops it will allow all of us the opportunity to sketch with people thousands of miles away.

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