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FIRST STEPS OF THE AUGMENTED DESIGN STUDIO

The interconnected Hybrid Ideation Space and the CI Loop

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Abstract. Professional or school design studios are essential environments for design supporting free exploration of materials and representations, analogue or digital. New technologies have moved into the studio with mixed results. Paradoxically, the use of portable computers, using Internet as collaboration channel, has actually *individualized* the design work and limited the support to co-creation, reinforcing individual work. The Augmented Design Studio argues for the implementation of hybrid technology, such as the Hybrid Ideation Space (HIS), in the design studio to compensate for the absence of collective local or remote efficient ideation space. This paper presents a case study showing the primary results of distant synchronous and asynchronous design collaboration supported by the interconnected HIS during an ad-hoc project and assessed by the improved Collaborative Ideation Loop (CI Loop) methodology. The HIS was installed in two universities located in different countries. We ran a research protocol in the format of a design *charrette* where two teams (team a: two architecture students, team b: two industrial design students) participated in the ideation of a bus shelter. This case study shows that teams were able to co-design while they were virtually "teleported" into each other's representations.

Keywords. Design studio; hybrid approach; Collaborative Ideation Loop; telepresence; Hybrid Ideation Space.

1. Introduction

The design studio is key for all design disciplines supporting free exploration of materials and representations, analogue or digital, without constraining interfaces, and within the strict constraints of the project. The physical (sensual) character of this exploration and the collaborative nature of the studio are the levers of creativity in this environment. New technologies using Internet as collaboration channel, have actually limited co-creation and individualized the design work. We are focusing here on simultaneous co-creation, or co-design, as opposed to cooperation where teammates work individually at *exteriorizing ambiguous concepts*, then regroup as a team to *communicate* their concept to each other and analyse it together. The Augmented Design Studio implemented the Hybrid Ideation Space (HIS) in the design studio as collective local or remote design space. This augmented approach keeps the user ahead of a fully digital approach. The goal is to serve the designers as they are, augmenting their acquired capabilities while recognising their cognitive limits. The HIS was developed in 2007 (Dorta, 2007) as a hybrid technology (analogue and digital) to allow designers to be *inside* their representations. In previous studies (Dorta et al, 2009; 2010) the HIS appeared to enhance the collaborative ideation process in face-to-face situations. This paper presents a case study showing the primary results of distant collaboration supported for the first time by two interconnected HIS installed in two distant universities. We ran a research protocol in the format of a design *charrette* where two teams of two students, from two disciplines (architecture and industrial design), participated in the ideation (conceptual design) of a bus shelter. They worked synchronously and asynchronously in different time zones. To assess the collaborative ideation (CI) we used a methodological and theoretical framework we previously developed, but improved further in this study: the Collaborative Ideation Loop, or CI Loop (Dorta et al, 2010). This case study shows that teams were able to co-design while they were virtually *teleported* in their shared representations. The co-creation was effective enough to achieve special moments of silent co-design, designers communicating graphically through the representation, each following and reacting to the other' suggestions. The CI Loop could provide better understanding of the collaborative ideation process.

2. Design studio issues

Graphic ideation should not be confused with graphic communication. Ideation is an active formative process related to idea generation and maturation, usually considered as visually *talking to oneself*. Graphic communication is a

passive explanatory process that presents fully formed ideas as visually *talking to others* (Marshall, 1992). In the context of CI, ideation conversation is collective and can be synchronous (considered co-design: doing simultaneously the task), or asynchronous (considered cooperation: putting together individual tasks) (Achten, 2002). Passive communication in the context of collaboration is reduced to presentations, done locally or remotely. These distinctions are important to better appreciate the CI exchanges. With the arrival of computers in design practices and the replacement of physical representations (sketches and physical models) by digital files, design studios have lost much of their ability to act as collective incubators. Two people sharing individual representation from a laptop does not replace the design studio's collective exchanges over simultaneously viewed multiple representations, and its group synergy.

For ideation purposes, traditional and digital media used in the studio can be considered in essence inadequate for ideation (and CI) because of basic problems: for the former, proportion issues of traditional sketches and models and workload of working with technical documents (plans); and for the latter, the need of a *digital know-how* (commands and interaction) and precise instructions delivering precise representations (finish and photorealistic), which is premature at the ideation stage. Designers are not able to be *inside* their sketches and models mastering scale and proportions during individual or collective ideation, while plans require information coding and decoding, hindering mental images and personal interpretation. Computers demand specialization to face the needed *digital thinking* or *digital logic* (Dorta, 2007) in addition to the design thinking. Even with a title like "Against ambiguity", Stacey and Eckert (2003) recognize that the computer offers a limited, narrow perceptual space ill-suited to ideation (*exteriorising ambiguous concepts*), which calls for inaccuracy, ambiguity and abstraction in order to foster reflexive conversation with the representations.

2.1. INDIVIDUAL VS. COLLECTIVE IDEATION

Designers frequently switch between moments of individual and collective ideation, focusing on their own or jointly resolving specific project issues. Because of the studio configuration, they can isolate from the group to converse with themselves through traditional representations (sketches and models), moving to the computer to further this individual *reflective conversation* (Schön, 1983). In addition to these media, they can do CI through real or virtual meetings. Talking is considered the first design tool (Jonson, 2005). Kvan and Gao (2004) have found that remote collaboration through chat lines, because it keeps traces, supports higher quality of design framing (addressing problem and context) than verbal communication. They can do CI locally or

remotely by phone, by chat and videoconference (e.g. Skype™), by shared online digital sketching (whiteboard) or through virtual worlds. Following up on contributions, cooperation is possible by exchanging physical information and annotations, digital files or models through electronic messages, in the local network or remotely in virtual worlds by Internet.

2.2. VIRTUAL DESIGN STUDIOS

Virtual design studios are computer-mediated environments, from simple email to collaborative virtual worlds. They adopt different metaphors, from a *desktop* to a *virtual place*. They can be centralised or distributed depending on file transfer and storage (Maher and Simoff, 2004). Originally developed on VRML, virtual environments allow collective 3D modelling and visualisation (e.g. Second Life™). This media is particularly relevant to CAD since digital models can be shared and explored through their worlds. As they are accessed through computer screens and avatar projections, the immersion felt in these virtual environments is disembodied (loss of awareness of physical self) and they do not provide the same kinds of explorations a real, physical, fully sensorial immersion can. There, avatars are used to evaluate proportions and, according to some authors (Abdellatif and Calderon, 2007), offer high perceptual and spatial qualities, and presence. They can also allow verbal and chat line exchanges. However, these environments suffer basic problems when it comes to ideation. Most of the models are made outside the world (e.g. Autodesk 3ds Max), because of 3D modelling limitations (complex shapes) and system's performance in terms of real-time rendering and interaction (Heidrich et al, 2007) to accelerate navigation and visualization. Furthermore, the real design studio exchange is imitated in a virtual world, down to reproducing the participants, bringing fundamental technical problems such as heavy calculations involved in getting an avatar to properly imitate human gestures, to moderating the collaboration, to making annotations or to sketch asynchronously only (e.g. Jung et al, 2001). In the Renaissance, once geometry was mastered, *architects* moved from the construction site to the studio, keeping crucial proximity to the project's context. Current technology allows virtual visits (Google Street View™) but without the telepresence of life size proportions (Porter, 1979), which is important to achieve a more effective ideation. Finally, the design project involves many disciplines requiring, during synchronous exchanges, representations that do not demand particular specialisation. Basic annotations through sketches combined with gestures and explanations are fundamental to sustain ideation and have been least supported by 3D modellers as seen in previous comparative studies with the HIS and traditional sketch and physical models (Dorta et al, 2009). In the

HIS, the sense of presence is maintained by real-time direct interaction with the graphical representation (sketch) supported by voice conversation. The life-size scale of the shared immersive space reinforces this sense of presence.

3. The Augmented Design Studio and the interconnected HIS

The Augmented Design Studio is based on a hybrid technology, such as the Hybrid Ideation Space (HIS), that combines the advantages of traditional CI tools augmented with the capability of technology, without reproducing or imitating them. The HIS allows co-located or remote co-design and cooperation through a media that displays the work to all, teleporting the designers in each other's representations.

Implemented in 2007 (Dorta, 2007) and assessed and compared as ideation and co-located collaboration tool (Dorta et al, 2009), the HIS permits freehand *sketching* and *physical model making* layered over in-context images, in immersion (life sized and real-time). It is a low-tech system: a tablet PC (Modbook™), a projector, an HD IP camera and a 360º immersive projection system based on spherical panoramas. The user sketches on the tablet or makes a rough scale model (in the model station) while spherical images are projected upward to a semi-spherical mirror on the ceiling and then reflected on the ceiling-mounted semi-spherical 16' diameter fabric screen. The user sketches in a normal perspective while the HIS software distorts the sketch in a spherical panorama. The tablet PC is mounted on a rotating device that allows users to always sketch in front of them inside a drawing area while they look all-around at a normal (undistorted) life-size 360º degrees perspective on the screen, thanks to the *trompe l'oeil* effect (from inside, users feel inside a 3D environment). Based in the same optical distortion, the model station uses the IP camera combined with a tiny semi-spherical mirror to capture in real-time (low fps for better transfer rates) the rough scale model while projected at life-size on the semi-spherical screen, avoiding the *Gulliver effect* (Porter, 1979), (Figure 1).

The HIS can receive up to four people for co-located synchronous collaboration under a new metaphor, the *hybrid place,* combining real and digital tools, interactions (acquired skills) and data. In order to address real practice requirement for remote collaboration, we networked two HIS. The sketch and the immersive real-time video of the model can be shared symmetrically (between two HIS) or asymmetrical (HIS and tablet, which was not used in this study). In this distributed setting, sketch data is relayed to a server that sends the information to the other HIS software while the video is accessed directly from the IP camera. Moreover, the drawing area tells *who's online* (or *presence*), knowing continuously where the partner is looking and sketch-

ing. The two HIS were installed in two distant universities (UC. Berkeley, School of Architecture and the School of Industrial Design at the Université de Montréal) (Figure 1). This setting engaged all remote collaboration issues, such as multidisciplinarity, differences in time, language and culture. Verbal exchanges were made possible by a commercial voice-over-IP system. This paper describes the HIS as used in the first steps of the Augmented Design Studio; see Dorta (2007) for the original HIS description.

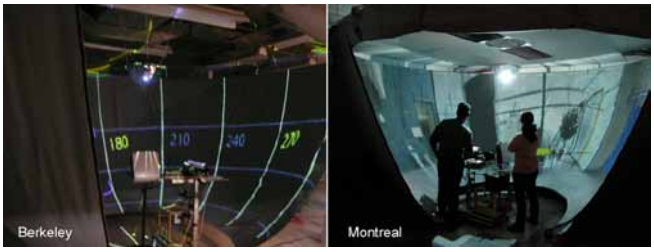

Figure 1. The first interconnected HIS, here with part of the spherical screen open

4. CI Loop

In order to measure the collaborative design, Kvan and Geo (2004) have proposed the use of design framing, as stated by Minsky's four-level frames: synthetic and narrative as *depicting* frames and semantic and thematic as *descriptive* ones, but aspects related to negotiation and moving during ideation are not considered. Previously developed, but improved further in this study, the CI Loop is a methodological compound instrument grounded in Bucciarelli's (1988) *design as social process*, Schön's (1983) *reflective conversation* and Goldschmidt's (1990) *graphical representation of concepts and actions*. The CI Loop is based on five elements common in the analysis of the design conversation and design process among those three authors: *naming, constraining, negotiating, decision making* and *moving*, with sub-elements for each one and their relationship with gestures (Dorta et al, 2010). Designers will be *naming* the object being discussed, *constraining* the project through its requirements and boundaries (time, budget and other constraints). The *negotiating* was, in this study, expanded to three subcategories: *proposing*, verbally making a design proposal, *explaining*, substantiating, and *questioning*, raising issues about or giving a rebuttal to a given proposal. *Making decisions* is specifically agreeing or disagreeing on a proposal, thus marking the end of the negotiation. *Moving* is adding to the representation and making pointing and sketching gestures. The first four actions are usually in the form of verbal exchange, while the moving is an act, which transforms the design situation (Goldschmidt, 1990).

We called this CI pattern a loop because it repeats itself, and it seems to spring from one to the next, often creating sequences of loops. A CI Loop (1) has to involve more than one participant; (2) starts with a naming; (3) ends with a decision-making (agreement or disagreement); (4) has to have an exchange, so at least one constraining, proposing, explaining or questioning (and a "dis"-agreement); and (5) has to have at least one occurrence of moving or proposing, or both.

5. Experiment

Two teams of two students, architecture (Berkeley - team a) and industrial design (Montreal - team b), participated in the ideation of a bus shelter as ad-hoc project for about 6 hours over 3 days in the following sequence: On the first day, after introduction and training, the 4 participants launched in a first ideation of 50 minutes. On the second day, Montreal worked in the HIS with a rough physical model for 38 minutes (time spent making the model outside the HIS is not accounted). Then the two Berkeley architects joined them for a 50-minute work session starting with the presentation of Montreal's three design proposals, interspersed with discussions about relevant supporting concepts, leading to some co-design. The Montreal team retired, leaving Berkeley to continue for an 80-minute session. The last day, both teams worked together at all times. First Berkeley presented their work (60 minutes), and then they co-designed together to complete the concept (75 minutes). The teams had to work in a suggested timeframe, which was adapted to come to a natural stop at the transition times. The CI Loop was used to code all 6 hours of video recordings in 10-second increments, noting all actions occurring in each increment. If an action lasted longer than 10 seconds (e.g. a particularly long explanation) it has been accounted for multiple times, marking its importance in time.

6. Results

In this study, we have observed that there are 2 different types of CI Loops, (1 and 2), corresponding to the different lengths of loop observed in a previous study (Dorta et al, 2010). CI Loop 1 (Figure 2) focuses on securing larger design *concepts*, which invites wider verbal exchange (more negotiations than moving). CI Loop 2 focuses on giving *form* to the previously agreed general concepts and is involved with specific issues that can be resolved in and by the representation. These exchange are usually shorter, having less negotiations and more moving, since they are confined to a specific issue present in the representation.

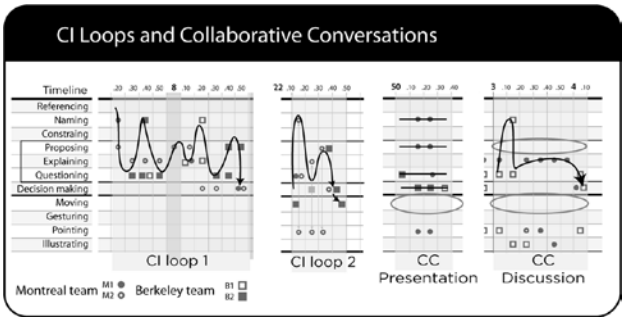

Figure 2: CI Loops (1 for **concepts** *and 2 for the* **form***) and CC (Presentation and Discussion)*

6.1. COLLABORATIVE CONVERSATIONS

If only four out of five requirements of a CI Loop are met, the exchange was a Collaborative Conversation (CC) indirectly involved in the ideation. CCs, observed for the first time in this study, have a predictable pattern (Figure 2), but are neither a loop (no springing in the argumentation from one pattern to the next), nor do they directly move the design forward. They are either *presentations* of previously agreed design, or *discussions* about concepts indirectly related to the design. The two CCs share an absence of moving. *Presentations* have a lot of proposing, as speakers present and explain their proposals, without negotiations between participants. *Discussion* about indirectly related topics have much back and forth between explaining and questioning but no proposing or moving.

6.2. LENGTH OF EXCHANGES

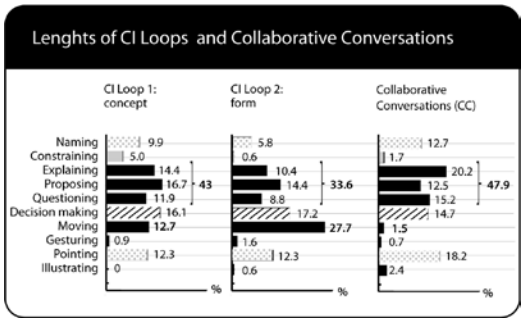

Figure 3: Time spent in collaborative exchanges

In CI Loop 1 more time is spent talking and deciding, then moving: 43% is devoted to the negotiation triad and 12.7% for moving (Figure 3). These loops average 68 seconds, whereas CI Loop 2 averages 24 seconds. In CI Loop 2, the time spent negotiating (explaining, proposing and questioning) was 33.6% versus 27.7% moving. This is almost one to one negotiating to moving, compared to CI Loop 1, where there are 3 negotiations for 1 moving. The CCs (all together) hold the most explaining and questioning of all, spending 47.9% in negotiation and only 1.5% moving. In CCs, *presenting* differs from *discussing* in that a lot of design proposals are stated when presenting and nearly none are when discussing a concept.

7. Conclusions

The interconnected HIS seems to support remote co-design and cooperation proving itself as a distributed computer-mediated CI system based on a hybrid place metaphor. Participants appear to have felt teleported in each other's representations, experiencing telepresence and understanding the project in spite of differences: in languages and accents (none of the participants were native English speakers); in professional culture (industrial design / architecture); in time zone; in seeing the other participant (locally) and not seeing them at a distance (which lead us to add a participants' video window, and consider more closely the importance of gesture in the design communication, as well as in the confident collaboration). Yet, in spite of the differences, we have seen in the last co-design session (last 75 min) many quiet drawing moments where collaboration happened across the distance: with participants in each location drawing together the same object in silence (very much in synch with each other); or with one participant from Montreal guiding a participant from Berkeley in his drawing.

The CI Loop, compared to Minsky's framing, shows in more detail the collaborative exchanges, although there is a general correspondence between CI Loop 1 and the high design descriptive frames, addressing problem and contexts, and CI Loop 2 and the depicting frames repeating instructions and creating scenarios from the design brief (Kvan and Gao, 2004). This study saw the first steps of the Augmented Design Studio with only two interconnected HIS (only 4 participants). We envision the Actual Design Studio as a network of HIS all interconnected symmetrically and asymmetrically (laptop and HIS) enhancing multidisciplinary Collaborative Ideation in professional and educational design studios. In a subsequent study (Lesage and Dorta, 2011), we compared the HIS to an Internet-based whiteboard software. Those results favour the HIS because of the immersive experience.

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