

# Collaboration and Design Education through the Interconnected HIS

## *Immature vs. Mature CI Loops observed through Ethnography by Telepresence*

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**Abstract.** *This paper documents the very first use of the interconnected HIS in a pedagogical setting. For this Augmented Design Studio, where three interconnected HIS were set up, the aim was to foster collaboration and co-design between the project participants as a new approach to teach the virtual design studio and to study the collaborative ideation process. The HIS (Hybrid Ideation Space) is an immersive system that uses freehand sketches and models to exteriorize conceptual ideas. Two innovative research methods have been used to assess this studio: the Collaborative Conversation framework that analyses the design discourse and the Ethnography by Telepresence, a non-intrusive observation method through an unused HIS. The Augmented Design Studio has been observed to help the design students push their project from abstract concepts to formalised concepts because in a pedagogical setting, it fosters collaboration over traditional top-down teacher-student interactions.*

**Keywords.** *Design collaboration; Augmented Design Studio; Design Conversations; Ethnography by Telepresence; Hybrid Ideation Space.*

## INTRODUCTION

What would you think of a music class where students sent in recordings of their performance and got feedback by email? It may be appropriate between performers and music critics, but learning to play an instrument will involve being corrected and shown *how* to play by master musicians. The digital tools flooding design studios put teachers and mentors in the position of the critic, depriving them of means to teach by doing, to engage in design thinking activities during their short encounter

with students. New technologies using Internet as collaboration tool have in fact limited co-design and individualized the design work and the learning process.

The Augmented Design Studio, as implemented with the interconnected HIS (Dorta et al. 2011a), fosters a collective local and remote design space where students, professor, designers and clients meet inside the shared representation, partaking and moving the design forward, leaving personal

computers out of any collaborative endeavors. The studio course reported here was collaboration-driven, echoing the way a professional studio operates. The collaboration occurred not between two groups of students, but between an array of designers of varying hierarchical positions: students and teachers, senior designers, art director, and client representatives from Milan responding together to a project brief from an Italian client. This studio not only echoed the design practice involving clients and other stakeholders, but it also put the interconnected HIS, to the test of a real pedagogical setting, bringing in major improvements in the studio behavior.

We observed that in the HIS the teacher-student design dynamics evolved from presentation-and-critique—supported by drawings (sketches or final representations) or computer imaging, where the student presents and the teacher responds, each locked in their respective roles—to a real collaborative stance. This shift from hierarchical to collaborative learning model was observed through the variations in types of Design Conversations, a framework to analyze the design discourse (Dorta et al. 2011b).

Furthermore, we have observed that, over the course of the work-sessions, the students have moved their project forward from the initial presentation of a potential concept (CCs-Presentation), to series of Immature CI Loops—concerned with identifying a suitable concept for the function they chose to tackle—to shorter series of Mature CI Loops—aimed at materialising their concept. Each student went about this process at his/her rhythm, some lingering for a long time in Immature CI Loops. Whereas no one dragged Mature CI Loops for more than two work-sessions in the HIS, Immature CI Loops seemed to have potentially endless cycles. The challenge: effectively move students from the abstract Immature CI Loops to the grounded Mature CI Loops, where the concept meets reality.

The current dominant teaching style is driven by the verbal exchange over students' work-in-progress. This exchange is often a rich blend of analysis and advice issued by the teacher, in a generally

friendly yet one-sided and hierarchical relationship. As the design studio currently stands, there are few opportunities for the teacher to do otherwise and physically engage as a designer with the student's work. There is a need to counter the strong leaning towards the verbal and abstract embedded in both hierarchical teaching style and Immature CI Loops. For one thing, it restricts the sharing of design know-how. And it may encourage some students to linger in the dreamy limbo of big ideas, delaying their landing in Mature CI Loops, too late to inject their project with much concrete design smarts. In pedagogical setting, the Augmented Design Studio has been observed to help design students push their project from abstract concept (Immature CI Loop) to formalized concepts (Mature CI Loop) because it fosters collaboration over traditional top-down teacher-student interactions.

This paper reports on a semester long design studio where each student has worked in the HIS for 30 min on different occasions, each of which was actually an ideation learning session: How to get an idea, how should a designer go about to develop a fruitful concept, how to exteriorize and share ideas so other colleagues can react to them and help improve upon them. The teacher's role in this case was to help each student to deliver the best possible concept to the professional client, by hands-on teaching.

## THE DESIGN STUDIO

The design studio has a central place in design education. In the last 15 years, technology, particularly the personal computer (first welcomed with hope, then assumed inevitable) has transformed teaching in the design studio. In our own studio classes, most notably, the type of representations students bring to the weekly one-on-one meetings are so inflexible, hard to intuitively alter in response to the flow of teacher-student discussion that most teaching occurs through conversation, analysis and advice. Goldschmidt et al. (2010) also describes the studio 'crit' (critique) in terms of this type of verbal exchange.

### **Collaborative design studio**

Cooperative learning has been originally approached by Piaget and Vygotski (Baudrit 2005). Among the cooperative learning attributes that Baudrit identifies, “measured heterogeneity” and “equal status” are relevant in the collaborative design studio. The former boosts the group reflection, preventing the reach of easy consensus; agreements are obtained following exchanges and discussions once pertinent ideas have been confronted. The latter warrants a minimum of participation and engagement in collective activities, avoiding experts/novices relationships.

Few studies actually look at the role of the teacher and the dynamics of the group. Della Vecchia (2009) emphasizes the communication in the interactions between studio teachers and students, appreciating that the Virtual Design Studio (VDS) increases the (asynchronous) time for reflection therefore delivering more thoughtful feedback. Shao et al. (2009) reports on the quality and quantity of communication. It isn't clear if this emphasis on communication is a result of technical issues in VDS. By not sitting adjacent to a tutor, Kvan (2001) noted that the VDS required adjustments in the communication channels:

*“The VDS (...) imposes a greater responsibility on the student to control their work. Communication between the teacher and the student has to be more structured than the more casual interaction that can occur when face-to-face. For example, seeing discarded alternatives, which lie nearby when carrying out a desk ‘crit’, the teacher can draw this additional work in to the discussion (...). In on-line communication, the student has more consciously to present work for review (...) even during the desk ‘crit.’” (Kvan 2001).*

He further described the design studio culture and processes using Schön's (1983) notion of ‘knowing-in-action’ (tacit knowledge) and ‘reflection-in-action’:

*“(...) we engage the students in conversation about their design intentions and decisions so far. Exploring their ideas, the teacher helps them to unravel their intentions from decisions that thwart the intentions.*

*Using words and drawings, we explore the implications of decisions and demonstrate alternative means of achieving various ends. In these interactions, we are showing the students how we reflect-in-action and we convey some of the tacit knowledge which is essential to the architectural profession itself.” (Kvan 2001).*

Goffin and Koners (2011) emphasize the non-verbal, less explicit quality of tacit knowledge transfer, not easily shared by formal instruction. It is often described as ‘know-how’, or work related practical knowledge. The key to acquiring tacit knowledge is shared experience (e.g. observation, imitation and practice). The concept of design studio formalized at Gropius' Bauhaus, supported the transfer of tacit knowledge within design education by having “Workshop Masters” instruct “Apprentice / Students”.

### **Cooperation and co-design**

*“Design collaboration requires a higher sense of working together in order to achieve a holistic creative result. It is a far more demanding activity, than simply completing a project as a team. I suspect that we collaborate far less often than we pretend to. (...) most of the time when people think they are working collaboratively they are actually co-operating and, even more important, compromising.” (Kvan 2000)*

In the context of design education, collaboration comes in different shapes: *Cooperation* is putting together design solutions (or part of design solution) that have been done individually, often asynchronously; *Co-Design* is when all participants are actively involved in furthering the design simultaneously (synchronously), which best suits the needs of tacit knowledge transfer.

### **Co-design, negotiation and co-evolution**

Bucciarelli (1988) posits that developing a design solution is a social process involving a variety of participants with different skills, responsibilities and interests, who see the object of design differently. Discussions and negotiations are held between the participants who do not share the same mental representations of the design; although their views are not aligned, they manage to maintain a design con-

versation between them while maintaining the ambiguity. Achten (2002) suggests that collaborative design is about collective sense building; their interaction is not only the sum of effective work, but reciprocal incentives to contribute to the design task, sharing information in an environment that encourages communication. Rittel (1973) reminds us that at the heart of design are 'ill-defined' problems. The key to tackling a design project should be based on negotiation between different stakeholders, since in the process of negotiation, the design team defines and redefines the problem. This back and forth negotiation and redefinition of the design problem in relationship to a potential design solution is what Dorst and Cross (2001) call the 'co-evolution' of the problem-solution.

## DESIGN CONVERSATIONS

Design Conversations is a methodological framework we developed (Dorta et al. 2011b) grounded in Bucciarelli's 'design as social process' (1988), Schön's 'reflective conversations' (1983) and Goldschmidt's 'graphical representation of concepts and actions' (1990). They combine to form different types of Design Conversations: Collaborative Conversations (CC), Collaborative Ideation Loop (CI Loop) and Collaborative Moving (CM), each having recognizable patterns, and appearing to follow a progression that matches the CI process development. They are based on five main elements common in the analysis of the conversation of designers and the design process among those three authors: *naming, constraining, negotiating (proposing, explaining, and questioning), decision making and moving*, with their relationship with gestures namely *pointing and gesturing*.

### Collaborative conversations (CCs)

CCs are either a **discussion** about concepts indirectly related to the design, or the **presentation** of a resolved design solution. CCs have a predictable pattern where *negotiation* and *moving* actions do not combine. **Discussions** are dialogues and have much back and forth between *explaining* and *questioning*

but significantly no *proposing* nor *moving*. **Presentations** are not dialogues, in the sense that there is no *negotiation*; they have a lot of *proposing*, as the speaker presents and explains the proposal, with the listeners stating their agreement punctually after each *naming, proposing* and *explaining* sequence. *Questioning*, if it is to demand clarifications, is part of the CC; but if it questions the presented concept, will lead to a CI Loop (Dorta et al. 2011b).

### Collaborative ideation loop (CI Loop)

The most recognizable element of Design Conversation, the CI Loop pattern is called a *loop* because it repeats itself, and it seems to spring from one to the next, often creating sequences of loops. Frequently, the participant who sealed a loop with a *decision-making* will initiate the next loop. To be considered a CI Loop, a collaborative exchange has to involve two or more participants; to start with a *naming*; to have a verbal exchange, with at least one *constraining, proposing* or *questioning* before a *decision* is made; to end with a *decision making* (agreeing or disagreeing); to have at least one occurrence of *moving* or *proposing*, or both. We have observed that there are 2 different types of CI Loops (Dorta et al. 2011b): **Immature CI Loop** (referred previously as *CI Loop 1*) focuses on securing design concepts, which invites wider verbal exchange (more *negotiations* than *moving*). It answers to: **What** are we going to design? **What** is the best solution for this problem? At this level, the objects are considered in their functionality; to serve a given function, designers may consider in the same breadth some wildly different solutions. **Mature CI Loop** (old *CI Loop 2*) focuses on giving form to previously agreed general concepts and is involved with specific issues that can be resolved in and by the representation. These exchanges are usually shorter, having less *negotiation* and more *moving*. They answer to: **How** are we going to design it, the 'how' having implications on the 'what' i.e. the material reality of an initial concept may push the designer to modify or reconsider this concept. Design materializes where 'the rubber meets the road'; the concern of Mature CI Loops is to give form

to an idea. There is a back and forth adjustment between the two levels of CI Loops (analogous to Dorst and Cross's co-evolution model, 2001).

### **Collaborative moving (CMs)**

CMs happen once the concept is secured, usually following Mature CI Loops. It is a bout of rapid ideation where a number of small decisions are being made on the sketch as it progresses. This kind of conversation accompanies the last stage of ideation before switching to another kind of design tool, which is different from illustrating a concept to better communicate it to a third party. As its name states, CM is collaborative. On its own, an individual reflective conversation with the representation does not constitute a CM (Dorta et al. 2011b). No CMs were observed in this study because students were responsible for their individual project, representing the latest evolution of the concept individually between each collective work-session.

### **THE INTERCONNECTED HIS**

Implemented in 2010 (Dorta et al. 2011a), the interconnected HIS permits collaborative freehand sketching and physical model making layered with in-context images, in immersion (life size and real-time). It is a low-tech system: a tablet display (12" Wacom Cintiq™) combined to a small computer Apple Mac Mini™, a HD projector, 2 HD IP cameras and a 360° immersive projection system based on spher-

ical panoramas. The user sketches on the tablet or makes a rough scale model (in the model station) while a single spherical image is projected upwards to a semi-spherical mirror on the ceiling and then reflected on the ceiling-mounted semi-spherical 5m-diameter fabric screen. The user sketches in a normal perspective while the HIS software distorts the sketch in a spherical panorama. The tablet 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 360° perspective on the screen, thanks to the *trompe l'oeil* effect (from inside the space, users feel inside a 3D environment). Moreover, the drawing area tells who is online (or presence), knowing continuously where the partner is looking and sketching. Based in the same optical distortion, the model station uses an IP camera combined with a tiny semi-spherical mirror to capture in real-time (low fps for better transfer rates between distant locations) the rough scale model while projected at life-size on the semi-spherical screen. The sketch and the immersive real-time video of the model can be shared symmetrically (between up to 4 HIS). In this distributed setting, sketch data is relayed to a server that sends the information to the other HIS software while the participants' video is accessed directly from the other IP camera. A commercial VoIP made verbal exchanges possible (Figure 1).

Figure 1  
The Interconnected HIS,  
students in the Hybridlab HIS  
and designers in the Milan HIS.



## METHODOLOGY

We used the Design Conversations framework to follow the development of the design dynamics during the work-sessions. Over a semester, participants met for six sessions in the three HIS (2 in Montreal, 1 in Milan), two of which were presentations to the art director and client representative for mid-terms and finals. The students were paired in fixed working teams where each student was responsible for her/his project as well as for feedback and support to their teammate's project. Each project was allocated 30 minutes in the HIS per work-session. After the project kick-off from Milan, the first two work-sessions took place in a single Montreal HIS (in co-location) with no Italian involvement. During the last 2 work-sessions, a Milan senior designer met with the student teams who were distributed over both Montreal HIS. The two presentation-sessions were conducted between one Montreal HIS where all students and professor gathered, and the Milan HIS.

### *Ethnography by telepresence*

In this research, we called upon two sources for our observations: the video recording of all activities in each of the HIS, usually from a camera placed on the top rim of the semi-spherical screen (god's eye view), that captures 60% of the immersive representation as well as the designers as they interact with the digital tablet, the projected representation and each other. The video recordings allow us to pursue the detailed analysis required to identify the Design Conversations. These constitute the bulk of our data collection.

We were able to add a significant first hand 'live' observation through *Ethnography by Telepresence*. As supported by the HIS, Ethnography by Telepresence allows the research team to observe the evolution of the ideation process from within, standing at the center of the shared representation, from the same vantage point all participants share, without disturbing them. Thus the researchers are invisibly teleported 'among' the participants. These real-time observations had the same quality as watching a live event, not knowing how it would unfold, with

the added advantage of actually be among the participants instead of the spectators.

We observed the first two work-sessions (12 hours in all) through the unused second Montreal HIS (in another building), and the last two (also 12 hours) from the side-line (as before), just outside the HIS, listening in and looking at the video-feed the participants use to see each other while in the HIS (a frontal view of the participants in each station). From the side-line, we can hear what they say, see what they do, see they are stressed or relieved, yet we feel we do not get a fully coherent picture of their experience.

## RESULTS

We observed that the design dynamics between parties evolved from a static presentation-and-critique supported by paper sketches and 3D models where the student presents and the teacher reacts, to a co-design stance. The initial dynamics was in part tributary to the teaching tradition and in part to the limited input a teacher can have on the representation in its fixed presentation form caught on paper or PC screen, thus reinforcing the hierarchical relationship between them. In the Augmented Design Studio, the work-sessions started, as would a regular studio encounter, with the student presenting their work-in-progress and the teacher and senior designer giving feedback. Whereas paper sketches or 3D models leave little room for teachers' input beyond constructive criticism, in the HIS, the feedback often migrated to a productive co-design about what the next step could be.

It seems that this migration was made possible by the ability of the HIS to bridge the expertise gap between teacher, senior and student designers. In the HIS, all participants have access to a shared representation supporting ambiguous, imprecise and abstract representations, blurring ownership, thus empowering all team members into action. Furthermore, the scale of the representation and the fact that designers work standing up added another channel of communication through body gestures, pointing, drawing in the air with hands or with the

laser pointer. The multiple exteriorisation channels (permanent and ephemeral representation, verbal and non-verbal communications) aimed at a single shared representation in effect facilitated a fluid distribution the various roles among the participants (mainly analysing out loud and recording concept progression), allowing a more even participation all around.

### From hierarchical to collaborative

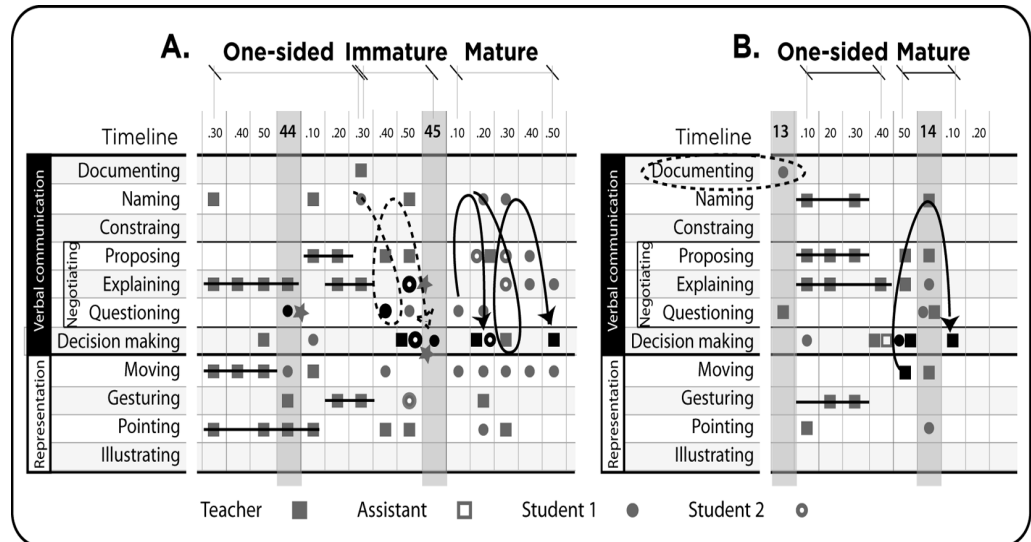
Figure 2 shows two examples of the transition from a one-sided CC, where the teacher proposes a concept, to CI Loops with negotiations between students and teacher. A one-sided exchange is a pattern closely related to a CC-Presentation: no negotiation between parties, a steady suite of naming and proposing with the added series of moving actions (recorded representations) with arm gestures and pointing (ephemeral representations), as the professor presents his suggestion. The students give their agreement (decision making) without any question or counter-proposal until the shift to CI occurs.

In example A (Figure 2), Student 1 had doubts (skeptical questions, star point), until the teammate

volunteered an explanation (star also), setting in motion an initial negotiation, that led to an Immature CI Loop, with the primary student honing in on a first concept. The Immature CI Loop (dotted) is followed by two Mature CI Loops before this conversation found a satisfying end point. In example B, the dotted oval around the documenting action records the primary student backing herself out of the CI for fear of lacking the electrical expertise to keep going with the ideation. This left the teacher undeterred, as he moved the ideation back in the field of expertise of industrial design. The teacher pursues the ideation on his own for half a minute or so before the student jumped back in again, with negotiations about materials that resolved this conversation.

Figure 3 presents two sections of what turned out to be a long design conversation in Mature CI Loops about how to give form to a specific solution. In the first section, the CI Loop, had some *negotiation* and little *moving* leading to an unconvincing agreement (*decision making*). In the second section, the client representative wraps up what has been discussed with generous *proposal, explanations and moving*.

Figure 2  
Two examples (A and B) of transition from hierarchical to collaborative teaching dynamics.



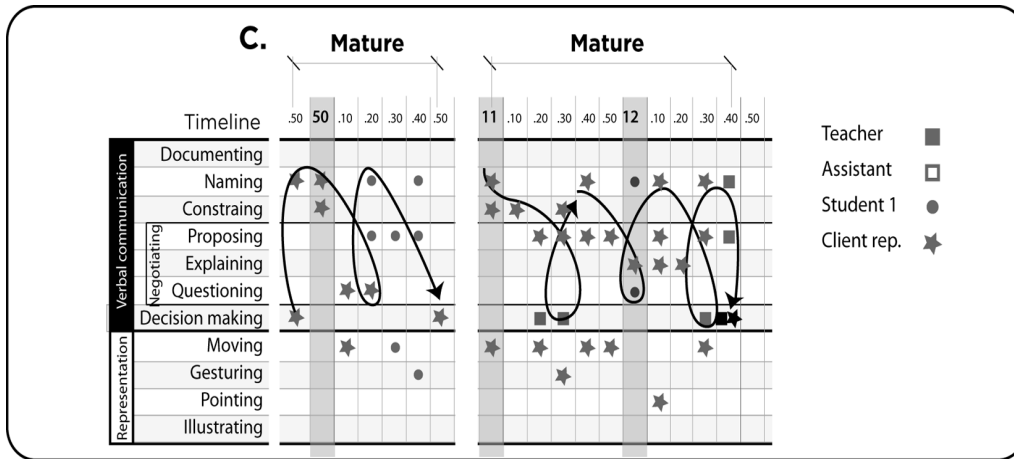


Figure 3  
Mature CI Loop with the client representative.

## DISCUSSION

### The shift

This shift from hierarchical to collaborative teaching/learning model was observed through the variations in types of design conversations. The beginning of the work-sessions was dominated by CCs, where each participant stated their position. In most work-sessions, the design conversation then shifted to CI Loops. Here, a combination of negotiating and moving actions came out as important differentiators: from none at first in CCs, they became dominant in the CI Loops. As soon as these appear in the conversation the design teaching dynamics toppled toward collaborative ideation, setting in motion CI Loop sequences. Negotiation crucially engages all parties, while moving actions help feed the CI Loops. When a participant draws an idea, the others are able to engage further in an even back and forth; if it is verbally expressed only, the exchange will likely orient itself toward analysis and advice, and top-down teaching dynamics.

### Beyond the looking glass: ethnography by telepresence

Our observation of the first two work-sessions through Ethnography by Telepresence revealed that the HIS provoked a shift in teaching dynamics. We think this observation was made possible because we were able to process at once multiple layers of information: we could see what they were looking at on the immersive representation, the digital tablet and when and how they looked at each other. The sense of presence was strong (between participants and with the immersive representation). For the researchers inside the HIS, that shift was perceived as a sea change: tone of conversation changed, the ease of student, their involvement with the representation, the questions asked and the real negotiations. From these first 12 hours of Ethnography by Telepresence, we can only say that this observation method has great potential. Although there is nothing new in observing actions, discourse, context and psychological states, observing them all at once in the coherence of the moment seemed to make visible the subtler shift in emphasis. In this way, Ethnography by Telepresence in the HIS is closer to on-site ethnography than *Cyber Ethnography* (Akturan 2009), in that it is immersive and participants



are not shielded by an avatar or an Id. Ethnography by Telepresence helped us see things the god's eye camera had not revealed, missing out on the sense of the whole experience.

## CONCLUSION

The Augmented Design Studio appears to push the model of individualized studio courses yielding top-down dynamics for lack of means of supporting active negotiations and moving actions over relevant representations at the pace of a real-time conversation, to a collaborative model closer to the *modus operandi* of professional design studios and of the traditional master/apprentice learning model of the design disciplines.

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