Ideation and Design Flow through the Hybrid Ideation Space

Tomás Dorta / *School of Industrial Design, University of Montreal, Quebec-Canada* / ***tomas.dorta@umontreal.ca***

Abstract *This study assesses an innovative immersive* ***sketching*** *and model making system: the Hybrid* ***Ideation*** *Space (HIS). The system enables designers to sketch and make* ***models*** *all around them in real-time and real scale using a digital tablet (sketches), image capture (physical models) and a spherical projection device* ***(immersion)****. We carried out an experiment to evaluate this system using the concept of Design* ***Flow*** *and workload with industrial design students working in teams during the ideation stage of the design of a car. The HIS was compared to analog tools and hybrid techniques.*

Ideate, then represent?

The design process is an evolution of different kinds of representations, as stated by Goel (1995). For each step, a specific type of representation is used for specific tasks. During the ideation stage, the first kind of representation (e.g., freehand sketches and rough physical models) serves designers, individually or synchronously within a team, to exteriorize and visualize their design intentions, or communicate them with themselves. Later on during the process, designers employ a second type of representation (e.g., digital 3D models, drawings and images) to better communicate asynchronously to colleagues and clients already designed proposals. At the end of the process, a third kind of representation is reached (e.g., detailed technical drawings and rapid prototyping models) to communicate exact and definitive information to build the artifact.

The problem here is that ideation is still done as it has been since the Renaissance, by traditional analog manual tools, like sketches and physical models, without real support from current digital tools. Ideation often happens near an idled computer by sketches on paper or mock-ups using malleable materials, steering away from the exactness of digital representations and the inconsistencies of interfaces. Therefore, computers are limited to represent anew already designed ideas. To allow the designer to exteriorize and visualize internal mental images, external representations must be fluid, abstract, ambiguous and imprecise (Goel, 1995). However, studies opposed to ambiguity and imprecision argue that designers need to communicate with colleagues exactly what they mean, as clearly as possible (Stacy and Eckert, 2003). For asynchronous communication, computers have revealed their capacities to communicate using the above mentioned second kind of representation. Abstraction and imprecision are important during ideation, while the ideas are emerging, whether working alone or in synchronous collaborative settings. This process is set in a specific context, with plenty of gestures and verbal expressions, allowing for good communication of intentions and permitting a reflective conversation with the representation.

For each observer, a sketch has a perceptual interpretation space (Stacy and Eckert, 2003). The main problem of current digital ideation tools is that digital wire-frame or shaded models appear exact, so their perceptual interpretation space is very narrow (Stacy and Eckert, 2003). Furthermore, even with generative parametric solutions (e.g. Serrato-Combe, 2005), designers are not expressing their actual intentions but are inspired by digital propositions that always require computer savvy users to drive them.

Representational conversations

A designer needs qualitative and imprecise mental images and external visualizations, in a continuous interaction between the two types of representations (Visser, 2006). Making sketches and physical models is an interaction, a conversation. Designers see more in these representations than they put in when they make them (Schön, 1983). Designers work with incomplete information, making assumptions and provisional decisions that need to be revisited and reviewed. Imprecision (flexibility), ambiguity (alternative meanings), and abstraction (simplification), characterize the relationship between the actual and the possible solutions (Stacy and Eckert, 2003).

In these reflective representational conversations, designers frame and reframe problems. In such conversations, designers' effort to solve the reframe problem produce new discoveries which call for new reflection-in-action. The process goes through appreciation, action, and re-appreciation. In addition, designers' actions also produce unexpected consequences bringing new meanings. During these talk-backs, designers perceive and reframe the situation once again (Schön, 1983).

Design Flow The notion of flow has been used to describe a perceived optimal experience when people are engaged in an activity with high involvement, concentration, enjoyment and intrinsic motivation (Csikszentmihalyi, 1990). It is a state of mind that has been observed in other activities such as web navigation, surgery, composing, and painting, but not yet in digital design. It is characterized by clear goals and quick feedback, focused attention, loss of self-consciousness, altered sense of time, a sense of control, a merging of action and awareness, a match between participants skills and the activity's challenges, and an experience which is autotelic. To reach the flow state requires a balance between the challenges perceived in a given situation and the person's skills. If the challenge's level changes, it produces anxiety or boredom (Csikszentmihalyi, 1990).

Current approaches of human computer interfaces evaluating digital design tools are based on usability tests of task execution. However, the flow of creativity and inspiration during the design process, especially during ideation, has not been considered as a relevant cognitive aspect in this evaluation. The activity of design, in particular during the ideation process, may be evaluated using this notion of flow that we call the Design Flow.

The Hybrid Ideation Space (HIS) Intended as a cognitive artifact for ideation (Dorta, 2007) and stemming from hybrid techniques we developed earlier (Dorta, 2005; Dorta and Pérez, 2006) in order to put the user inside real sketches, and mix manual actions with digital ones using rapid prototyping and 3D modeling, the HIS allows the designer to use traditional techniques augmented by the advantages of a virtual environment.

Immersive Sketching A spherical graphical template constructed using a reflective sphere in a basic 3D model, serves as reference for sketching. This template is used with a painter software (e.g. Corel Painter™) via a digital tablet (Wacom Interactive Pen Display™) as an input device connected to a laptop. The computer simultaneously uses the tablet and a projector displaying the image over a semi-spherical mirror mounted on the ceiling. This projected image is reflected over a semi-spherical screen. The projected spherical template is then corrected, and users can see all around them in a normal perspective, in real-time *(Figure 1)*.

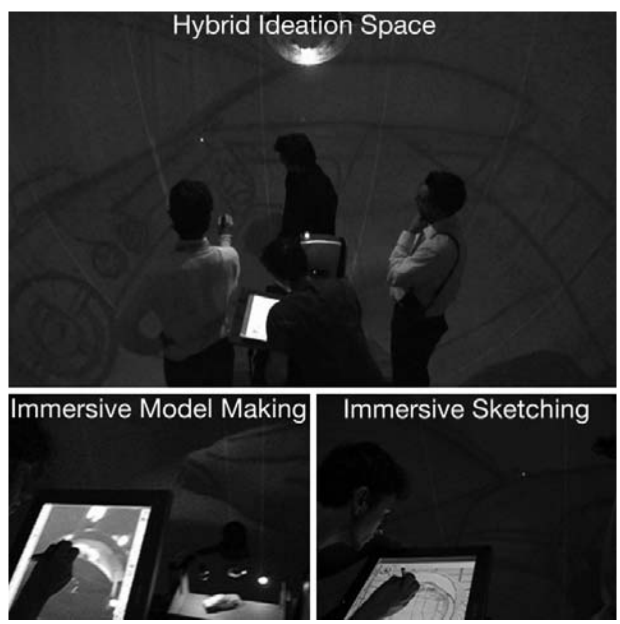

Figure 1 The Hybrid Ideation Space.

Hybrid Modeling to Immersive Model Making We proposed a Hybrid Modeling (HM) technique to work with physical models (Dorta, 2005). This technique lets the user go back and forth between manual and digital models using Rapid Prototyping (RP) and a 3D scanner. Starting from rough hand-made physical models, the designer can create shapes quickly using malleable materials. Then, the model is digitalized and used as a template for 3D modeling. Later, this digital model is printed using RP, becoming a matrix used to continue design explorations manually.

In order to improve this technique and combine it with sketches, we use a HD video camera and a small mirror-ball as input. The camera captures a deformed spherical image reflected by the mirror-ball placed at eye level of the scaled physical or RP model. In this way, as users modify the scaled model, they can see an immersive normal scale projection of the (physical or RP) model around them. The real-time monitored HD image is also displayed as a background layer in the painter software *(Figure 1)*.

Methodology

Twenty pairs of second year Industrial Design students participated in this study during the ideation stage of the design of a car (exterior and interior) as an exercise for a Computer Graphics class. They started with the HM technique making an initial rough model (up to 3 hours). Then, the models were digitalized and the digital geometry was given to assist the 3D digital modeling process (1 week). Next, these models were printed with RP and used on the HIS during 20 minutes for each team, because of schedule limitations. After that, a spherical graphical template was built from the interior of each digital geometry using the exterior shape and some basic forms as references to the seats and steering wheel. Then the teams returned to the HIS to design the interior of the car (20 minutes). We applied the Design Flow based on eight dimensions (anxiety, arousal, control, worry, apathy, boredom, relaxation, flow) (Csikszentmihalyi, 1990). We also used a questionnaire with twelve questions related to how they experienced the ideation working with the physical mock-up (the Model), the HM technique and the HIS (Immersive Sketching and Immersive Model Making). The last part was ranking eight components that can start or sustain the flow. A final question was related to the talk-backs of these representations and the development of concepts.

In order to evaluate the cognitive aspects of the HIS as an interface, we also used the NASA Task Load Index (TLX) (Vidulich and Tsang, 1985). TLX is a multi-dimensional rating procedure that provides an overall workload score based on a weighted average of ratings on six subscales: three dimensions relate to the demands imposed on the subject (mental, temporal, and physical demands) and three to the interactions of the subject with the task (performance, effort and frustration).

Results

Design Flow For the evaluation of the Design Flow the students put a dot in a circle divided in eight dimensions (Figure 2). These dots were placed according to how they felt at the beginning (time 1), the middle (time 2) and the end (time 3) of the task. The Model was not demanding or laborious. The HM was more precise and complex, and the performance of the students depended on how well they knew the technique. The task was least demanding and more forgiving in the HIS. Even with the time pressure and being first-time users, the students reported being in the state of flow more often in the HIS.

In another questionnaire on the Design Flow, the students indicated that there was anxiety in the HIS due to first-time use, yet at a lower rate than the anxiety reported in the HM, a technique they already knew (3D modeling). The level of boredom was higher when working with the Model and in the HM. The complexity of the task and interface in the HM required more concentration from the students. They lost track of time similarly in the HIS and the HM, even if the HIS was used only for 20 minutes and the HM for one week. Also there was a clear preference for re-doing the experience for its own sake in the HIS.

The students have considered eight components that can start the flow or support it during the ideation. They classified these components in order of importance. When the students felt more comfortable with the HIS, they were able to perform without problem. The performance in the HM depended on how the students knew. The technique while the intrinsic motivation was more important in the Model and HM.

Talk-backs They ranked the representations according to the feedback they got from them. It seems that the traditional techniques such as the Model and HIS provide enough information for the ideation process without the need of complicated interfaces.

Workload Even with the time limitation in the HIS, the students were able to achieve most of their design goals. The mental demand was similar in the HM but since the frustration was greater for the HM, this technique proved more demanding, stressful and complex. The effort was low when intuitive interfaces were used (Model and HIS).

The overall workload shows that for the Model the students achieved more design goals but it required additional effort. The design goals that the students achieved with the HM required more effort which causes frustration. For the HIS, even with the temporal demand and effort from the new interface, the students achieved their design goals.

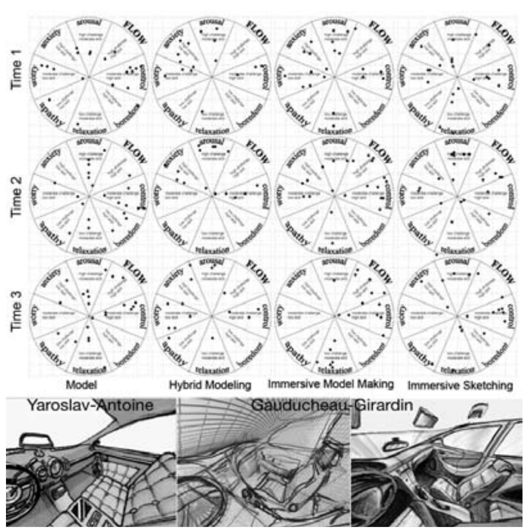

Figure 2 Design Flow evaluation.

Conclusions

Some students needed to adapt to the hand-eye coordination to work in the HIS (5 to 10 minutes); Immersive Sketching was easier when they felt more comfortable. The real scale in the HIS allowed the students to understand their concept and see errors more easily, triggering a better feedback loop. Students improved communication by using a laser pointer, one moving it over the projected sketch, the other following it with the pen, as if they were sketching at the same time. The students made observations about their design and the feedback between them was constant and efficient. Sketching and talking at the same time was significant in the HIS. The design decisions improved in quality as the sketch evolved.

The use of intuitive interfaces with physical Models and the HIS allowed the students to ideate more easily, based on factors such as time spent, concept produced and success rate. The design collaboration among students was very important in the HIS. The students with high intrinsic motivation often outperformed students with low motivation. When students worked together they enhanced the ideation process, particularly in an environment like the HIS where the main focus is active design.

Future work

Several experiments are in progress concerning learning processes, working with professional practitioners from different design fields responding to real needs, and design work in individual and team settings.

Acknowledgments

I acknowledge the research grants of the FQRSC and Hexagram which made this research possible. I thank the Industrial Design students, persons and organisms who participated in this project, in particular: Ignacio Calvo, Ludovic Merigot, Annemarie Lesage, Edgar Pérez, MATI-Montréal and Formlab.

References

Csikszentmihalyi, M. (ed.):1990, ***Flow-the Psychology of optimal Experience.*** / Harper & Row, New York. Dorta, T.: 2005, ***Hybrid Modeling:*** Manual and digital media in the first steps of the design process in J. Duarte /

G. Ducla-Soares and Z. Sampaïo, (eds.) ***Proceedings of the eCAADe Conference,*** Digital Design: The Quest for New Paradigms, Lisbon pp. 819-827. **/** Dorta, T., and Pérez, E.: 2006. ***Immersive Drafted Virtual Reality:*** a new approach for ideation within virtual reality in G. Luhan, P. Anzalone, M. Cabrinha and C. Clarke (eds.) Proceedings of the ACADIA Conference, Synthetic Landscapes – Digital Exchange, Louisville, pp. 392-402. **/** Dorta, T.: 2007. ***Augmented Sketches and Models:*** The Hybrid Ideation Space as a Cognitive Artifact for Conceptual Design in G. De Paoli and K. Zreik (eds.) Proceedings of EuropIA conference Digital Thinking: Finding the Ways 2007, Montreal, (in press). **/** Goel, V. (ed.): 1995. ***Sketches of thought***. MIT Press, Cambridge, MA. **/** Serrato-Combe, A.: 2005. ***Lindebmayer Systems*** – Experimenting with Software String Rewriting as an Assist to the Study and Generation of Architectural Form in J. Duarte; G. Ducla-Soares and Z. Sampaïo, (eds.) Proceedings of the eCAADe Conference, Digital Design: The Quest for New Paradigms, Lisbon, pp. 615-621. **/** Schön, D. A. (ed.): 1983. ***The reflective practitioner:*** How professionals think in action. Basic Books, New York. **/** Vidulich, M. A. and Tsang. P. S.: 1985. ***Assessing subjective workload assessment:*** A comparison of SWAT and the NASA-Bipolar methods in Proceedings of the Human Factors Society 29th Annual Meeting, Santa Monica, pp. 71-75. **/** Visser, W. (ed.): 2006. ***The Cognitive Artifacts of Designing.*** Lawrence Erlbaum Associates, Mahwah. **/** Stacey, M. and Eckert, C.: 2003. ***Against ambiguity, Computer Supported Cooperative Work***. 12:2, pp. 153-183.

Keywords: *Ideation, Flow, Sketches, Models, Immersion.*