AUGMENTED REALITY AND DESIGN PROCESS:
THE NEW ROLE OF AUGMENTED REALITY IN DESIGN PROCESS

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INTRODUCTION

In Industrial Design, the development of a three-dimensional physical model has typically been viewed as a critical part of the design process. Current computer technology has the potential to change the traditional modeling methodologies and to provide new ways to deliver digital 3D models and data. The paper will explore these potential modeling methodologies and propose a specific use of computer based 3D modeling for the design development process. The authors posit that the use of Augmented Reality technology, to create virtual product models, addresses the inherent difficulties with the delivery of physical models and also facilitates sharing feedback with all constituents involved in the design process. Integrating the emerging Augmented Reality technology into the product design process may offer a viable solution for working in the globalized, data driven design environment. The authors would also suggest that interactive media production, including feedback derived from user experience and usability testing is an essential part of the iterative design process for products. Therefore, the paper will explore the potential to link usability data to these virtual product models, allow for feedback to be collected during the viewing of these models and the archiving of this data for each revision in the iterative design process.

TYPICAL DESIGN PROCESS

Almost all manufacturing and design firms, have their own design development process. Some of them have more complicated processes than others, and some of them focus more on functional side rather than aesthetic and vice versa.

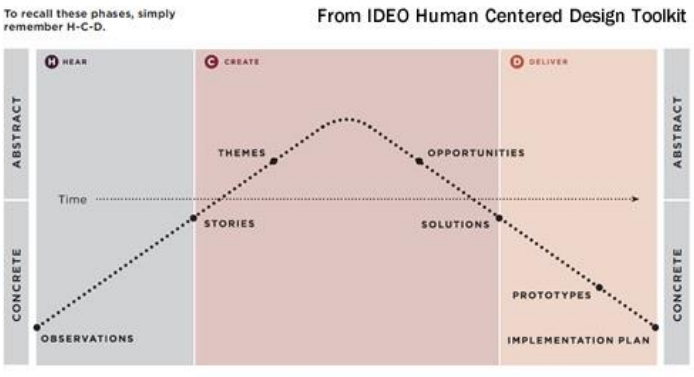

Figure 1. IDEO Human Centered Design (2012)

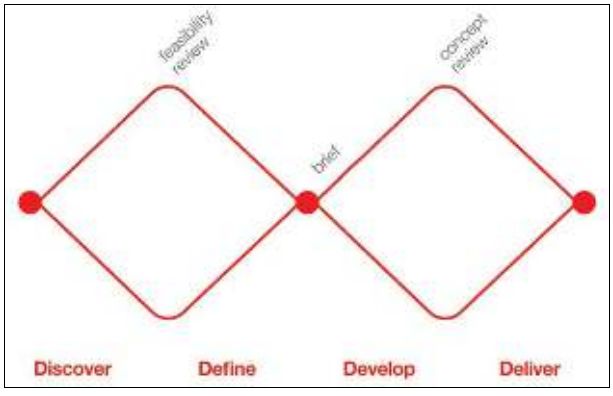

Figure 2. UK Design council double diamond design process

But there are few common stages that everyone has in their process: 2D and/or 3D visualization and validation. In recent years, with integration of a powerful computing technology in design development process, the border between 2D and 3D became very blurry and designers used more and more 2.5 D (3D computer model in 2D display) visualization approaches to validate ideas. With these various reasons, you see less and less physical model building in design process. To enhance the design process, the roles of 3D models and ability to provide feedback can be integrated into the Augmented and Virtual Reality technology currently available.

ROLES AND TYPES OF MODELS IN INDUSTRIAL DESIGN

Figure 3. Various stages of study mock-ups by hand

When industrial designers work on a design project they often build 3D models, also known as “Mock-ups” during various stages of their development process, either to validate their ideas and/or to clarify their 2D ideas in their mind into 3D forms. These mock-up, full size or scaled size of design are used for demonstration, promotion, and design evaluation. It provides complete or at least part of the functionality of a design and enables testing of it (Vieru, 2009). Mock-ups address the idea captured in a popular engineering one-liner: You can fix it now on the drafting board with an eraser or you can fix it later on the construction site with a sledge hammer (Soegaard, 2010).

In the early stage of development a designer might want to quickly build a rough model to study basic forms of ideas and study them. Usually, the quality of the model is not an issue; it is mostly used to get a “sense” of proportion and characteristics of the model. Later in the process, the design might want to build a structural functioning model to test and study a simple usability of designs. As the project progresses further into validation stage the designer might need to make a computer model to work on the aesthetics of the design. A final presentation model will be developed by hand or machine as the last stage of modeling process. The model has to be a realistic and close to the real product. In most cases, professional model makers will develop a high quality model based on a technical drawing or a computer model that they received from designers. Building a realistic model can be a very time consuming and expensive. However, reviewing those models will be the last chance to check on every single detail before company invests tons of money to mass produce the product. Most of time there is a mock-up review stage toward to the end of product development process, but due to some unavoidable reasons (i.e. tight budget and time, distance or location, limited access to resources…) designers or

companies will occasionally substitute this physical model building stage with computer-generated images. This similar to skipping a proper mock-up review and can cause a huge problem later, especially if a company needs to communicate with manufacturers in the other side of the world to discuss any design changes or updates.

TECHNOLOGY IN MODEL BUILDING: PROBLEMS WITH DIGITAL GENERATED AND 3D PRINTED MODEL

Figure 4. 3D printed Car (image credit: zcorp)

As technology grows exponentially; new ways of visually validating ideas other than through hand drawn 2D drawings or hand carved 3D foam models became available. These computer added modeling methods are much faster, more realistic, and much cheaper than traditional 2D renderings or hand carved foam models. Especially "Additive Modeling Technology," also known as Rapid Prototyping (RP), became an important part of the design process nowadays. It allows people test not only aesthetics of a device but also actual function of certain devices. Additionally, designers can use this RP method to build a physical model remotely, even from the other side of the world. Rapid prototyping machines and 3D printers are now becoming an essential tool to create a quality final presentation model.

As Industrial Designers, we are making a tangible object for users. Although current interactive technology became a big part of all digital devices, Industrial Designers still design for physical objects which people will have tangible interactions. This is where digitally generated 3D model's limitation comes into consideration. It doesn't matter how advanced the technology used in the design, the rendering of the design is still trapped inside of a flat screen. It only shows one view at a time, and a true 3D effect cannot be "felt." When a 3D printer is used, one can pick up a model, turn it around and have full access from all different angles. However, it takes anywhere from just couple hours to few days to build, and it is not cheap. When a small part of the model needs to be modified, Industrial Designers still need to spend the same amount of time and effort until the differences can be seen. Most recent years, Industrial Designers began using VR (Virtual Reality) and AR (Augmented Reality) as alternative ways to test a design and acquire benefits of both physical and digital methods of feedback.

INTERACTIVE MEDIA DESIGN

Interactive media development has been evolving since the mid 1990's and there are many different methodologies introduced in the industry. These methodologies borrow techniques from other media and technology fields that intersect with interactive media products. For example, storyboarding and audience analysis methods are inherited from the motion picture industry and video production for pre-production purposes. Similarly, the Spiral System Development Life Cycle is brought in from software development to illustrate the iterative process of developing versions of an interactive media product. Despite differences in terminology, interactive media development has a five stage process:

---Audience and Technology Analysis

---Design

---Develop

---Authoring

---Evaluation - QA/Usability

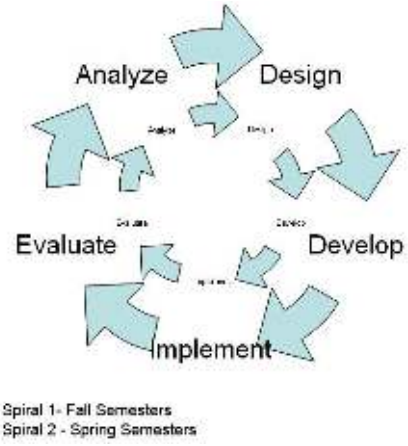

Figure 5. Interactive Media Development Stages in a Spiral Development Lifecycle (Jennings, 2010)

These steps are similar to many fields such and instructional design, but are also similar to those discussed earlier for Industrial Design. In fact, in both cases the next version of a product takes the evaluation data from the last phase and uses the data to create the next version. However, that is not the only time feedback is essential in the process.

As mentioned earlier, an iterative process guides these phase in such a way that client feedback and usability testing data are provided throughout the various phases of the project. This is what iterative process is all about – collecting feedback and data throughout the phases to improve the product and eliminate errors before the product is released to the audience.

This translates to a highly documented and managed process when done appropriately. What the proposed design app defined in this paper intends to do is cut down the amount of paperwork and allow for instant feedback from clients and testers that will be captured in sessions that provide access to the anatomy of a product's design. Any session can be accessed, at any time, to implement changes or go back to for reference. To do this, we propose adding input fields to current Augmented Reality apps, running on both android and iOS tablets, and

Virtual Reality environments that allow clients to view drafts, models or prototypes. These fields will allow clients and usability testers to instantly enter feedback during various phases of the development process.

VIRTUAL AND AUGMENTED REALITY MODELS

Both Virtual and Augmented Reality Technologies have provided new environments to build and share information. Virtual Reality was the first of the two to provide testing or mock-up environments that allowed for clients or observers the opportunity to interact with products or objects they would be able to otherwise in real life situations. Around 2006, Second Life slowly became such an environment where nuclear reactors and atoms were created and shared with the community of “avatars,” or digital representations of individual users (Brown & Adler, 2008). Interestingly the logo, or symbol, of Second Life is the eye-in-hand, which many cultures embrace as a symbol of creation that springs from knowledge. The symbol is fitting, as collaborative creativity is one of the single values that Second Life was designed to promote (Malaby, 2009). Although this symbolism supports the current “open-source” ideology that may in technology welcome; this approach has also created a plethora of technologies that are great ideas, but never seem to answer the question in the back of minds of early adaptors, “why is this Meaningful?”

For example, there were designers and developers from both the corporate world and in academia who would create their own virtual inventions or environments without any institutional support or methodologies that would support or standardize development in a virtual environment (Confetti-Higgins, 2009).

Similar paths are currently the case with the number of Augmented Reality applications available for computers and tablet devices. The term “Augmented Reality” is first used by Professor Tom Caudell during his project with Boeing to describe a digital display used by aircraft electricians that blended virtual graphics onto a physical reality (Caudell & Mizell 1992). From then, the technology has slowly begun to migrate from research laboratories to the market, from marketing to entertainment, to enhanced visualization, publishing, and design. The term “Augmented Reality” can be better understood when you compare to the more familiar concept of "Virtual Reality.” In Virtual Reality a user is completely surrounded in a virtual environment that completely created by the computer, in comparison to that Augmented Reality overlaying layers of virtual elements to the physical space as if they actually part of the real physical space.

There are so many possibilities out there with these technologies that they are accomplishing half of their potential before having the opportunity to answer for the early adaptors, “this product is Meaningful because….”

Our proposed structure, design and process for virtual and augmented reality product feedback defines why this is meaningful to the designers, developers, clients and users of a product.

Figure 6. AR marker in use (image credit: http://blog.inner-active.com)

PROPOSED STRUCTURE, DESIGN AND PROCESS

As it was mentioned earlier and despite some problems, utilizing digital technology to build models is unavoidable, and there are some distinctive great benefits we can't just ignore. But we need to find a best way to utilize and even create more benefits of using technology. The proposing solution will be adopting AR to enhance modeling and decision making experience by using AR to replace current presentation quality 3D physical modeling phase. The authors used following program and device to test his argument: a laptop computer, an e-book reader, 3D modeling programs - Rhino 3D, Solidworks, and SketchUp with a head mounted display, and an AR program - AR Media. Through this configuration the authors were able to create a computer model using a 3D modeling program and convert that into an AR compatible format. Then the file was sent to other place via email and displayed on an e-book. The pattern, an AR marker was viewed by a person with a head mounted display to see a complete computer model in real world as a full scale model. Through this process there was no physical distance barrier nor delayed communication between two parties. The same model can be sent to as many different places or countries as needed.

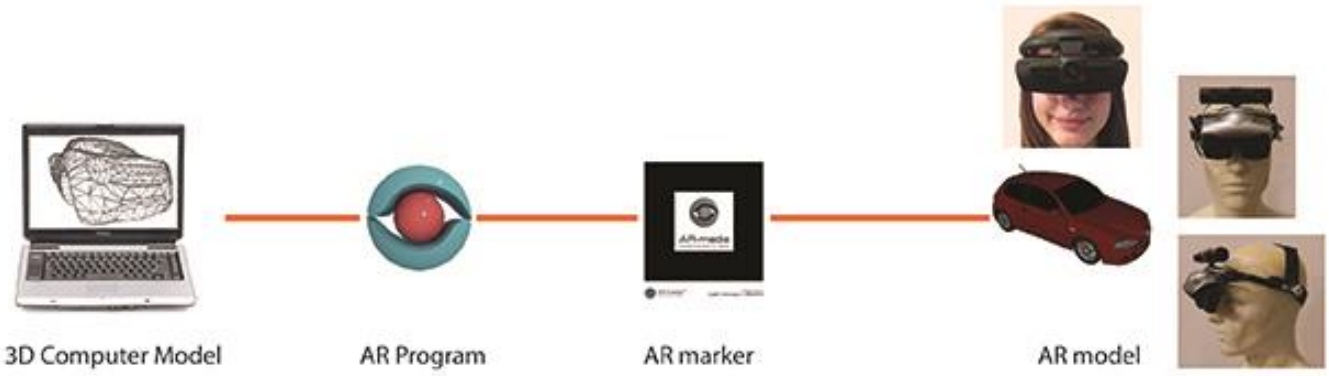

Figure 7. Work process

The DNA Model (Design Notify Analyze) defines the process to include iteration of feedback at every phase of the process. Successful completion and approval of each phase moves the process to the next phase. Remediation for any stage will see the phase revised (Red DNA Strain). While successful completion of a phase moves the project towards the next phase (Black DNA Strain):

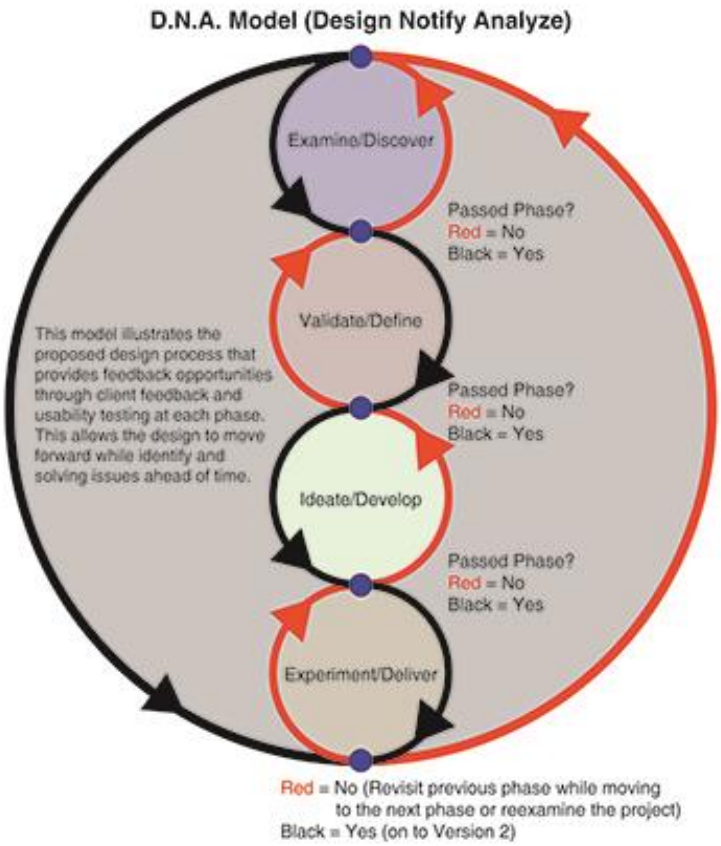

Figure 8. DNA Model for Industrial Design Process in AR Application

The proposed Structure, Design and Process using the DNA Model and proposed App follow both the industrial and interactive media design processes with a usability testing (UX) iterative design philosophy:

- Examine/Discover (Audience and Technology Analysis for Interactive Media Production) -Approved by client through 3D drafts and Storyboards.
- Validate/Define (Design for Interactive Media Production) - 1st Session sent to client for feedback with Prototype Usability Testing Feedback.
- Ideate/Develop (Develop for Interactive Media Production) - 1st session feedback incorporated. 2nd session sent to client with Usability Testing feedback.
- Re-Design/Develop (2nd session feedback incorporated…3rd session sent out and a pilot test for usability is conducted, if needed).
- Experiment/Deliver (Evaluate for Interactive Media Production) - QA/Usability Testing (3rd session feedback is incorporated. The 4th session focuses only on Usability Testing)
- Recommendations through Scope and Severity determine the movement between phases, with some happening simultaneously. After the last phase, these recommendations will be considered in the next version of the product.

Figure 9. AR Head Mounted, Current AR App Image, and Prototype Image of Proposed App Interface

Augmented Reality Apps and Virtual Reality Environments offer opportunities to display Industrial Designs and Interactive Media Productions. None of them provide the opportunity to document the DNA Model and processes of acquiring feedback from clients and usability testing. Our prototype design for such an App will combine all of these into a valuable tool for both Industrial Designers and Interactive Media Producers.

CONCLUSION

As Rapid Prototyping opened up a new opportunity for model building process and even manufacturing process, AR technology has a great potential that can extend its role of the design model and solve some of the problems we are facing in current modeling and validating process. The DNA Model will help define the process and fields needed to improve AR technology to allow feedback to be incorporated.

Further research will be required to gather more meaningful data and functionality before such AR technology is released. In addition, research will need to be conducted on the AR technology once it is release. Thus, the technology will go through the DNA model itself.

REFERENCES

Brown, J., Adler, R. (2008). Minds on Fire: Open Education, the Long Tail, and Learning 2.0. EDUCAUSE Review; January/February 2008.

Au, W. J. (2008). The Making of Second Life: Notes from the New World (1st ed.). New York, NY: Collins.

Confetti-Higgins, C. (2009). Sun Microsystems – Second Life: An Introduction. Retrieved May 21, 2009, from http://sla-divisions.typepad.com/rocky_mountain_chapter_sl/CCH_RMSLA_May192009.pdf

Caudell, P., Mizell, W., "Augmented reality: an application of heads-up display technology to manual manufacturing processes" in System Sciences, 2:659-69, 1992.

Soegaard, M (2010). Mock-ups, Interaction-design.org. 16 February 2010, from http://www.interaction-design.org/encyclopedia/mock-ups.html

Jennings, C. (2010). Educational Virtual Environment Methodologies: Using Second Life as an Instructional Tool. University of Wyoming. Sage Publications.

Ma, Z. (Ed.). (2006) Web-Based Intelligent E-Learning Systems: Technologies and Applications. Hershey, PA: Information Science Publishing.

Malaby, T. (2009). Making Virtual Worlds: Linden Lab and Second Life. Ithaca, NY. Cornell University Press.

Rogers, E. M. (2003). Diffusion of Innovations. Free Press, a division of Simon & Schuster, Inc. New York, NY.

Vieru, T (2009). KSC Gets Orion Mock-Up for Testing. News.softpedia.com. from http://news.softpedia.com/news/KSC-Gets-Orion-Mock-Up-for-Testing-103300.shtml