

Can simple 3D modelling replace paper sketching in early ideation phases?

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ABSTRACT

Designers are thought to use sketching to visualize ideas and to map their minds. However, many designers chose to jump straight into 3D-modelling when engaging in new tasks. Increased demand of efficiency and lack of drawing skills tempt designers to start modelling straight away, as this is a task that can be very time consuming. The demand for quick and simple 3D ideation tools is increasing, and new software is becoming available. These tools allow designers to create rougher models that can be altered and iterated upon. This article will review literature on ideation, sketching and 3D-modelling, and look at some of the newer software available. The inspiration for this comes from both the possibility to alter and change designs underway, as well as the benefits of seeing objects in a 3D atmosphere when exploring shapes during ideation phases.

KEYWORDS: 3d-modelling, sketching, ideation, product design

1. INTRODUCTION

Sketching is an important part of design, especially in the early phases where it is often used as a tool for exploration and to visualize and test the ideas of the designer. Ideas often start as a thought in our mind, and from there sketching can be a tool to further explore that thought and cover inconsistencies or incompleteness. This can be very useful, as our brain may not have the capacity to evaluate, construct and hold designs. Sketches place the idea on paper, making it possible for our mind to evaluate and examine before further iteration. Sketches can also be used as public representation of our thoughts and be reviewed by others and collectively discussed. (Tversky, et al., 2003)

Sketching with light strokes or erasers can also help when the designer wants to iterate and explore shapes. It lets the designer see shapes

and decide on the go what works best. What then, if the designer wants to use sketching to explore complex shapes in three dimensions? Sketching complex shapes can be very difficult and time consuming for the average designer and with complex sketches you often lose the ability to easily make changes underway.

The intention of this article is to review research done on traditional sketching as an ideation tool, and to compare that to using 3D modelling software for the same purpose.

1.1 Article structure

The article will first introduce some definitions to explain terms used later. Then there will be an explanation of the method used followed by the three main themes; ideation, sketching and Computer aided design. After that there will be a discussion part, where the discoveries and

research will be discussed, followed by that; a conclusion of the article.

1.2 Definitions

Virtual Reality

Virtual Reality (VR) is a technology that is used to replicate an environment, either fictive or imagined, and simulates a user's presence and surroundings so that the user can interact with it. In simpler terms VR lets you see and interact with things around you that doesn't exist but looks real. (Dvergsdal, 2016)

Computer Aided Design

Computer Aided Design (CAD) is defined as the use of computer systems to assist in the creation, modification, analysis or optimization of a design. (Narayan, Rao, & Sarcar, 2008)

2D and 3D

Refers to two and three-dimensional drawings and environments.

2. METHODS

2.1 Literature Review

A literature review was used to gain theoretical insights in both CAD and traditional sketching. The timeframe on articles about traditional sketching is quite wide, as traditional sketching methods have remained quite stagnant over the past decades. The CAD-world, however, is in rapid development, and the available literature varies in relevancy. Some of the much-cited literature is quite outdated as it concerns outdated software that is no longer used commercially.

Most of the literature was found using the Oria portal provided by the NTNU library. ResearchGate, which is by many seen as a social network for scientific research, was also used to find and request articles from authors. As with

gold mining you can discover a vein of gold, a lot of the articles had good references, creating veins of good research to be read. A few books about design methodology and tools have also been assessed. This included primary sources that had direct descriptions of research done by the individual that performed the study, and also secondary sources that were written by authors who didn't observe the described events directly.

Keywords used during search were mainly 3D-modelling, sketching, conceptual design, ideation etc. This was combined with design to get articles mostly related to design and design methodology even though articles from other fields have also been taken into consideration. 3D-modelling and traditional sketching combined gave few relevant results, so the results from the two are presented and later combined to get a picture of the possibilities of using CAD software to create useful sketches.

3. IDEATION

Ideation is often defined as the process where the designer generates ideas and solutions through sketching, brainstorming, prototyping and many other ideation techniques. During ideation, the designers aim is to generate a lot of ideas that can later be cut down to the most practical or innovative to inspire better design solutions and products. (Dam & Siang, 2017)

"Ideation is where you start your conceptual design. This is a hugely creative and fun phase. Ideation is where you brainstorm to come up with ideas to solve design problems. Ideation is inseparable from sketching and evaluation aimed at exploration of design ideas." (Hartson & Pardha S, 2012)

Design ideation is often associated with sketching, and the story about how a rough sketch on a napkin landed a big client has been heard by many.

4. SKETCHING

4.1 The role of sketching in design

Hartson & Pardha (2012) defines sketching as rapid creation of free-hand drawings expressing preliminary design ideas, focusing on concepts rather than details. They also explain that a sketch is a conversation between the sketcher/designer and the artifact.

Designers today often prefer to use sketches in the early phases of conceptual design, because sketching can fulfil their intuitive and natural needs during their activity. Sketching can be very low-effort and allows the designer to focus on the creative side of conceptual design. (Bouchard, Aoussat, & Duchamp, 2006)

Even though traditional sketching is intuitive for many, it is a skill that needs training. Sketching complex organic shapes can be difficult and time-consuming and failed attempts may discourage and lead to insecurity about the design. Sjödel (2018) argues that people that fail to master a drawing technique may question their right to draw at all.

Ferguson likes to divide drawings in to three categories; prescriptive sketches – sketches used as direction in making a finished drawing, thinking sketches – used to guide and focus the non-verbal thinking and talking sketches – a communication tool in the development team, used to get consensus. (Ferguson, 1992)



Figure 1: Concept sketches (Istituto Europeo di Design, 2018)

Figure 1 shows what can be categorized as a thinking sketch, used to create a chair concept and explore different shapes.

4.2 Ambiguity

A low fidelity sketch can offer a range of advantages. They can be quick to make, and at the same time offer a form of ambiguity. Ambiguity can be beneficial in the early stages of a design process where it can lead to free interpretations from several parties and help to start discussions about the design. (Sjödel, 2018) Buxton (2007) states that: “If you want to get the most out of a sketch, you need to leave big enough holes. Ambiguity creates the holes. It is what enables a sketch to be interpreted in different ways, even by the person who created it.” The last part of the quote is very interesting, as ambiguity can help the designer in exploring further iterations of the design.

The famous picture “My wife and my Mother-in-Law” shows the power of ambiguity. See Figure 2.



Figure 2: My Wife and my Mother-in-Law (Wikipedia, 1888)

5. CAD

3D-model creation is a major bottleneck in production pipelines because it requires human effort to create diverse and complex shapes. (Olsen, Samavati, Sousa, & Jorge, 2009)

5.1 WIMP

The current high-end CAD software incorporate powerful tools for detailed and accurate construction and manipulation of geometric models. Systems like these typically use a WIMP(Window, Icon, Menu, Pointer) interface which is based on entering parameters in dialog boxes, adjusting control points, and floating palettes. (Olsen, Samavati, Sousa, & Jorge, 2009) Examples of WIMP software is SOLIDWORKS, Maya and Inventor.

5.2 SBIM

Sketch-based interfaces for modelling (SBIM) is a more natural and accessible interface. The goal with SBIM is to allow sketches to be used in the modelling process, from creation of rough models, to fine detail construction. SBIM is mostly still in research, as mapping 2D sketches to 3D modelling operations is very difficult. (Olsen, Samavati, Sousa, & Jorge, 2009)

5.3 Examples of existing software

Examples of relatively new existing CAD-software has been evaluated to establish an understanding of what types of software is available and the benefits they can provide.

Gravity Sketch

Gravity sketch is a VR-sketching tool that allows the user to sketch 3D models in real-time. By using a computer, VR headset and controllers, the user can sketch out and edit 3D-models. Gravity sketch is made to lower the barrier to digital 3D design for people that are not trained in traditional CAD. Gravity sketch are also working on reaching out to other platforms, like tablets and motion controllers. (Gravity Sketch, 2018)

With gravity sketch you can draw an object in the air in front of you and explore the shape by turning either your head or the object. This can be very helpful when designing things like car interiors, as you can sit down in a chair and sketch out the interior around you while getting a feel of dimensions and aesthetics. Gravity sketch also allows you to import models to use as either reference or to edit. Figure 3 gives an idea of what can be created relatively fast and easy in Gravity Sketch. Complex organic shapes can be manipulated to create sketches that can be experienced in three dimensions.



Figure 3: Nike Cloud 9 - Sketched in Gravity Sketch (Gravity Sketch, 2018)

SOLIDWORKS Industrial Designer

SOLIDWORKS Industrial Designer is created to simplify the process of conceptual design by removing the constraints of traditional design software to give a more intuitive, flexible and powerful modeling environment. It uses a combination of 2D drawing and 3D free-form

tools to create models that can be easily altered and iterated.

Figure 4 shows how SOLIDWORKS Industrial Designer can be used; here are 2D sketches used together with 3D-modelling to create a concept.

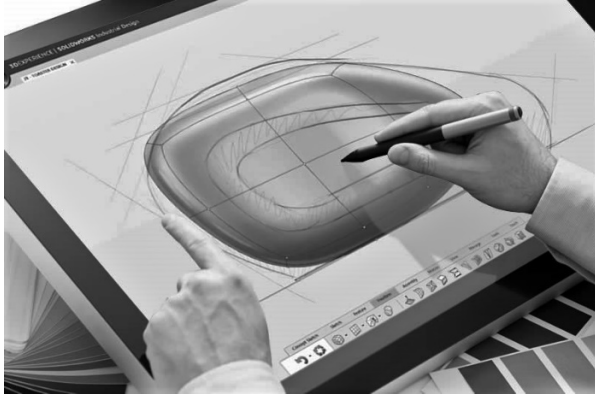


Figure 4: Concept sketch using SOLIDWORKS Industrial Designer (Javelin Tech, 2018)

SketchUp

SketchUp is a free 3D-modelling tool where you can draw in either 2D or 3D perspective. SketchUp is created to be intuitive, robust and user-friendly. SketchUp is known for its ease of use, and is used by architects, interior designers, engineers and video game designers. Sketchup lets you push and pull surfaces to create 3D forms, that later can be stretched, copied and rotated to extend your design.

6. DISCUSSION

This section seeks to discuss the insight gained through the literature review.

As also mentioned by Alcaide-Marzal et al. (2012) Previous work in the field of digital sketching agree that Paper and pencil are still more powerful than digital tools in producing conceptual solutions, in terms of efficiency. The participants in the tests conducted by Alcaide-Marzal et al. were more efficient using 2D sketching. Their work, however, show that by using tools that allow digital sculpting, where

tools and procedures are more artistic than in traditional CAD methods, test subjects performed better. (Alcaide-Marzal, Diego-Más, Asensio-Cuesta, & Piqueras-Fizman, 2012)

Another interesting observation by Alcaide-Marzal et al. (2012) was that the participants were more inclined to detailing their work in 3D sketches, and that they wanted to complete parts of their work that wouldn't even be visible in the result. This is interesting, as it shows the effect 3D visualization has on conceptual development. The possibility of navigating the object in 3D seemed to compel designers to work on unnecessary details and it is something that has also been documented in the work done by Bilda and Demirkan (2003).

Ambiguity is often lost in WIMP-based 3D-modelling, as the inputs need to be specific and detailed for the computer to calculate the different shapes, especially with more detailed products.

With more playful modelling tools, much like sculpting clay, 3D-modelling can help a designer find the perfect shape. Through adjusting and editing and letting forms emerge, the designer can work on getting the best result intuitively and the ambiguity that emerges can help in exploring new ideas.

3D modelling systems that are based on hand-drawn sketches have a reputation of only being suitable for "quick and dirty" modelling tasks. (Yang, Sharon, & van de Panne, 2005) However, the work done by L. Olsen et al. (2009) indicates that SBIM can have a tremendous diversity of applications and techniques, showing that it can have the potential to be utilized in a wide range of modelling tasks. L. Olsen et al. argue that the community should perhaps embrace the ambiguous nature of sketch-based systems. As argued by Nealen et al.: *"Though our capability to derive a mental model from everyday shapes around us is well developed, we fail to properly communicate this to a machine. This is why we*

have to model in a loop, constantly correcting the improper interpretation of our intentions. “

Another aspect to discuss is the need for additional equipment when using different modelling tools. As opposed traditional sketching with pen and paper, most of the available software requires some sort of computer, and while some software doesn't require a lot of processing power, most do, creating a need for expensive equipment. Virtual reality equipment has over the last years become commercially available, and prices have dropped, making this a more viable solution. Sculpting software like Geomagic Freeform, use haptic feedback devices to enhance the design experience. The availability of this equipment varies, and most designers won't be able to bring equipment where ideation is needed.

With emerging software and solutions, this field should still be researched, and tests should be performed on new software. There is no apparent research done on sketching in VR with tools like gravity sketch, and it should be interesting to see what capabilities it has as a replacement for regular pen and paper. Videos published of and by people using Gravity Sketch portray an incredibly intuitive and powerful sketching tool, however, research should be done to uncover its true capabilities.

A lot of the studies done in this field have very low sample sizes, and there is little qualitative feedback from the subjects. Also, more comparisons between and testing of different methods of producing sketches in 3D could be beneficial in finding the ultimate tool for design ideation.

7. CONCLUSION

There are a lot of tools for conceptual design that are already available, however, work show that it is difficult to use them properly. (Alcaide-Marzal, Diego-Más, Asensio-Cuesta, & Piqueras-Fizman, 2012) Researchers seem to agree that more comprehensive analysis of actions in 3D

sketching, and the connection they have with 2D sketching are needed to determine a correct approach to these new tools. It can seem that the feeling of sketching traditionally is difficult to replace.

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