MEANING MAKING IN THE INTERSECTION BETWEEN SKETCHES AND 3D MOCK-UP

Ali, Abu; Liem, Andre
Norwegian University of Science and Technology (NTNU), Norway

Abstract

This paper presents a report of a workshop held in Konfack, University College of Art, Craft and Design, Sweden. The objective is to investigate how designer creates the meaning in the intersection between sketches and 3D physical mock-up. The method of the study is using sketches to act as a medium to transmit the meaning to 3D physical mock-up (clay modeling) by designers to resolve the task " Object for seating". The authors analyze the data from the lines of sketching through comparisons of aspects such as variation, physical effects, and psychological effect. Meanwhile, the 3D physical mock-up shape is formalized according to principles of design. The reflection of the sketches and 3D physical mock-up shows that some meaning occur at the intersection between them. This study reveals that participants generate a variety of meaningful designs using sketches and mock-ups throughout the design process.

Keywords: Design process, Meaning Making, Formgiving

Contact:
Abu Ali
Norwegian University of Science and Technology (NTNU)
Institute of Product Design
Norway
abu.b.ali@ntnu.no

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1 INTRODUCTION

Sketching is a useful tool for creativity and problem-solving that traditionally plays a central role in the design-oriented disciplines of architecture, engineering, and visual communication. According to Tversky (2002), sketches are ways to express and record designers´ ideas and thoughts in a more visual and permanent way. Likewise, it is being a way of making the working memory content more reliable, which can alleviate the double burden of preserving and documenting content as well as acting on it (Tversky, 2002).
Sketches are tools to check the completeness and internal consistency of designer's idea. A sketch is embodiment of free idea generation to determine the existence of proof. Sketches are also sources idea development (Goel, 1995; Goldschmidt, 1991, 1994; Schon, 1983; Schon and Wiggs, 1992; Suwa, Tversky, Gero, and Purcell, 2001). Designers make sketches with individual ideas and gold in mind. Sketches are quickly done by hand in an informal way or rendered with computer-aided drawing tool. According to Schon (1983), the essence of using sketches in the design process is related to the aspects of the design they want to elaborate, explain and communicate. In other words, sketches act as a medium to communicate and trigger problem-solving. (Goldschmidt, 1991; Schon and Wiggins, 1992: Goldschmidt, 1994; Gero and McNeil,1998; Kavakli,et.al,1999;Suwa,et al,2000).
In designing the process of 3D from sketches and mockups, compromise the basic-level of the contact of meaning. Moreover, the physical 3-D form sketches and mock-ups created during the design process bring the concepts and meaning into reality. 3 -D forms embody experiences into a holistic expression. According to Suri, J. F. (2003), designer's concerns three-dimensional forms as testing ideas to persuading the clients. Meanwhile Monö, R. (1997), argues that, the form itself carries the pragmatic and semiotic signs as well as symbols of the product that generate the meaning. The authors carried out this study as part of the Ph.D. course in Form, Aesthetic, and Meaning Making in Kostfack, Sweden to generate meaning. The objective is to investigate how designer creates the meaning in the intersection between sketches and 3D mock-up. Sketches assist as an external memory to argue the limitation of human intellectual skills. The workshop, entitles "Object for Seating" was aimed at getting design practitioners to be engaged in a process of designing. The authors used certain aspects of the sketching process, and mock-up building to investigate "what meaning is". The workshop was built around a participative design process involving the creation of mock-ups in a `meaning-making` process. As there were, many design practitioners and researchers with different backgrounds involved in this workshop, cross-fertilisation of thoughts contributed to meaning making.
As the purpose of the workshop is to develop what meaning is about when undertaking design activities, the following research questions are presented:
RQ 1: How do participants generate meaning from sketches through mock-ups in design activity?
RQ 2: How collaborative should design processes be to facilitate meaning-making?
RQ 3: What is the value of the workshop from the perspective of meaning making by the researcher/ facilitator?
The focus of this study centers on the participative workshop. Chapters 2 – 5 provide the theoretical background for the experiment, where participants with different backgrounds took part in.

2 DESIGN AS MEANING MAKING

In design, cognitive interfaces enable reconstruction and meaning construction to explain the perceptual and cultural codes, which are involved in communication. In terms of presentation and representation, design is supported by diagrammatic reasoning and is regarded as a tool to communicate individual and collective cultures. In this case, the core conception or graphic presentation is not the individual data, but the information. The designer defines and interprets conceptual relations by the virtue of selecting and organizing data. This conceptual relation is called information. The role of the designer is to provide the form needed to make a predefined content/information/data/meaning, and message perceptually accessible.
John Deely (1986) argues that the entire human experience, without exception, is an interpretation structure mediated and sustained by a sign; a sign of cognitive interfaces. Design is an interface of meaning making or simply the design of meaning. Meaning stands for thought induced in the receiver that originated contact with the design. Designs can be simpler or complex in their material and conceptual structures, but as a whole, they are the interface. The receiver expects a pattern, which is

based on a reconstruction of meaning. It can be said that these patterns are relations in forming a "gestalt".
In the concept of visual thinking, visual apparently deals with a different type of thinking, based on perceptual and physical experience. Design concerns with the meaning and communication. It determines intended, constructed and reconstruction of the meaning. Design is defined as cognitive interfaces that enable reconstruction of intended meaning. As an approach to semiotic relations between perception and meaning construction, design is a medium to report on the perceptual and cultural codes involved in communications (Kazmierczak, 2003).
In the semiotic cognitive model, design represents communication and meaning. There are two reasons why cognitive semiotic is one of the best models; firstly, it focusses on the gap between form and meaning-making, and Secondly, it is compatible with the concern of design regarding the construction of communications. Cognitive semiotic is understood as a study of signs that is considered as perceptual activity of thought and meaning. In the process of meaning making, Löwgren, and Stolterman (2004) considered designing as a tool for creating a certain meaning through the development of systems and arrangements. From another perspective, Nelson & Stolerman (2003), described meaning-making in the contexts of thinking as a fundamental aspect of understanding the relationships between elements and entities within a systems perspective.

3 LINE, SHAPE, AND FORM

In the process of embodying meaning, lines, forms and shapes are essential building stones. A Line is defined as an extension of a point, elongated mark, and connection between two points, the effect of age and the object. The way of designers employ lines in the composition, is to make a shape, contour, define a boundary, and create a variety by using angular, broken, bent, thick or thin lines. Rhythm is created with curved or straight line, varied in length, stimulate texture, etc. Lines are analyzed according to nine aspects: path, thickness, evenness, continuity, sharpness of the edge, contour of the edge, consistency, length, and direction. Lines also act as design components such as a line of building, for example, a structure uses include column, trusses, rafters beam, planking, brick rows, line in clothing and line in lighting. However, there are physical and psychological effects of line that are represented in designs. The direction of the line is the strongest of the aspects because it leads the eye and create focus. A vertical line creates the meaning of awake, alert, defy gravity rigid, firm, stable and reliable. Horizontal lines signify restfulness, yields to gravity, creates quietness, response, passivity, calmness, or serenity. A diagonal line appears undecided, unstable, busy, active, dynamic, restless, dramatic, sporty, and lengthening and reduces horizontal or vertical shapes. Meanwhile, Horizontal lines combined with the vertical lines create illness, static, equilibrium. For example, the framework of a building, telephone poles, branches of a tree. The line can bring the expressive power including the manipulation of the audience. Aspects of use such as an assertive mood can be created with straight, solid, sharp, thick, even, smooth, bold, or even vertical lines. Kevinrigdon (2007).
Shape and form are lines surrounding space to create something that a line dividing space does not which in turn creates potential effects that nothing else can. As its definitions, shape is flat, lines enclose two-dimensional areas. However, form is a three-dimensional area enclosed by the surface. Thus, it can be identified that a hollow form had volumes, and solid form has mass shapes and forms compose variations of geometry shapes that are divided by; i) Equal sided, shapes encompass square, circle, equilateral, pentagon, hexagon, octagon, diamond, marquis, ogive, and star. Meanwhile, from composes all sphere and cube, ii) unequal sided, shapes encompass oval, scalene and isosceles triangle, rectangle, parallelogram, trapezoid, etc, whenever forms-tube, cylinder, cone, pyramid, rectangular, box, bell, etc. Shape and form project the moods of the type and directions of lines enclosing them and the space within them. Kevinrigdon, (2007). Examples are:

1. Stable and confident-rectangles, square
2. Less stable but more dynamic-triangles, pentagons, hexagons, octagons, trapezoids, parallelograms, cones, and pyramids.
3. Visually interesting-unequal proportions
4. Less visually interest-equal proportions, circle, square, sphere, cube
5. Security-shapes that fit together tightly, squares, hexagon, ogives, diamonds, triangles, paisleys, parallelograms, rectangles.
6. Variety-shapes that leave space, octagon, star, circle, etc.

The relationship between 2D shape and 3 D forms is closely related to the interplay of shape and form belongs to the world of sculptor, architect, scenic designer, interior designer, fashion designer, costume designer.

4 MOCK-UP

Designers in all disciplines make use of sketches and models to envision artifacts before they are constructed. In industrial design, designers often use mock-up and prototypes as a nature part of their work process. Mock-ups are objects that have the appearance but not the function of an individual artifact, constructing a simple object from readily available materials. The designer can often identify potential problems and explore alternative avenues early in the process. For industrial designers, this is a natural way of working since the functionalities of the object are usually already specified or known to be confined within certain parameters. According to Holmquist (2005), a mock-up is the embodiment of form. An artifact could manifest the real world, as tangible device or as buttons and widgets on the screen. As mentioned earlier, 3D physical mock-ups created during the design process bring the concept of reality.

5 REFLECTION - IN - ACTION CREATE MEANING

Schon`s theory is established within the constructive view of human perception and thought processes. Schon`s (1983) description of reflection-in-action is the way designers reflect in both situations: during and after the design process. Schon introduced the term `reflection-in-action`, describing a strategy that professional practitioners use in their everyday practices while working under situations of complexity, uncertainty, uniqueness, and value conflict. According to Schon, practitioners participate in reflective practice with others on their knowing and reflecting-in-action, which allow them to reconstruct their theories of action enabling their response strategies to be explicitly formulated. In the context of this research, the author investigates how designer generates meaning from the idea generating the mock-ups using a constructive reflection- action process.

6 WORKSHOP DESCRIPTION

The workshop session was presented by the design researcher/facilitator. A group of 8 participants attended this 2 – hour workshop. Participant was from various backgrounds: design practitioners, a professor, a post-doc, doctoral candidates and a master student coming from various design fields. There were five females, and three males are taking part in this workshop. The participants came from Chalmers University of Technology, Konstfack, University Collage of Art, Craft and Design, Linkoping University, Parsa Kamehkhosh Art & Design Studio, Swedish Institute for Computer Science (SIGS), and Lund, University, Sweden.

The workshop, which focused on design process, was structured in several parts, beginning with a short presentation by the researcher/ facilitator. Participants were tasked with specific and prescribed activities and divided into four groups. They used basic visualization and analytical tools, such as pencils (sketching) and clay (mock-up) to transmit and transform the idea, as well as video observations to record information. Participants were required to design and build the mock-up to complete three different objects within two hours. Proximity to each task took about thirty minutes, and the groups had to move to another task in order to achieve three different objects. The workshop focused on designing “objects for seating” based on four selected objects. The workshop was structured in four stages, starting with the participants observing and experiencing the object, followed by sketching and model making activities. In practice these activities alternate. The researcher/ facilitator recorded the experiences and observation about the design process.

Figure 1: Workshop setting and participants experience with the objects.

Figure 2: Participants involved with sketch and clay modeling activity.

7 RESEARCH METHOD

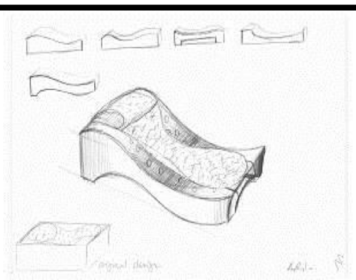
In this paper, the authors investigate the sketch-based interface development, particularly within the context of the design process. The authors first analyzed shape transformation performed through the analysis of sketches on paper and observations of videos. The meaning of lines strokes of sketching was analyzed using comparison of lines aspect, variation, physical effects and psychological effects. Meanwhile, the 3D physical mock-up shape was formalized according to the principles of design.
The analysis of the data collection in the workshop involved the following steps:

- Sketches analysis - Comparing and contrasting the finding
- Clay mockup analysis - principles of design
- Observation analysis – observation, video and pictures.

7.1 The analysis of Sketches - Comparing and contrasting the finding

Visual Reasoning Model was used to analyze and to understand sketching processes taking place in conceptual design. (Park, J. A et al., 2008). In addition, Aspect, Variation, Physical Effect and Psychological Effect are four elements in line proposed by Kevin Rigdon; (2007) were used in this study to interpret participants' sketches. According to these elements, the evaluation of participants' sketches are shown in Table 1 below.

Table 1: Sample analysis of sketches reflection on the final design for participant 1

sketches	Aspect	Variation	Physical effects	Psychological effect
	Path	Wavy	Emphasizes roundness	Feminine, soft
	Thickness	Thin	Minimizes weight	delicate
	Evenness	Even	Smooth lines	flowing
	Continuity	Solid	Advances boldly	strong
	Edge	Sharp	bumpy	hard
	Consistency	Solid	Advances boldly	strong
	Length	Long	Emphasizes of direction	Suggest continuity
	Direction	Long	Emphasizes of direction	Suggest continuity

According to the practice and teaching of form – giving typically takes the starting point in enhancing the intuitive and explorative approach to form giving rather than employing available structured methods for generating form. In this study, the 3D physical mock-ups are analyze by three principles, which are directional, highlighting and synthesizing as shown in Table 2.

Table 2: Sample analysis of mock-up's reflection on the final design for participant 1

Mock-up	directional principles		highlighting principles		synthesizing principles	
	Repetition	Repeat texture, hole	Concentricity		Proportion	Distances, sizes, amounts, degree or part in relation to each other
	Parallelism	Used with straight and curve form	(a)Effect		Scale	Size of texture should taken into consideration side of the object
	Sequence	No sequence	Visual	Focus point,	Ballance	Horizontal balance
	Alternation	Alternation with texture	psychological	casual	Harmony	Culturally subjective
	Gradation	Texture surface of successive layers of material suggests straightforwardness	(b)Practical uses include but are not limited to	Freeform shapes	Unity	Unity and harmony
	Transition	Emphasizes the direction in which it is going in the body	(c) Concentricity	Move the eye in the wave direction		
	Rhythm	Curve sea waves, swaying	Contrast			
			(a)Effect			
			Physical	Emphasizes the texture		
			Psychological	Dramatic, similarity,		
			(b)samples of contrast	Harsh, solid, square rounded		
			(c) emphasis			

8 REFLECTION OF THE RESULT ON HOW PARTICIPANTS GENERATED MEANING FROM SKETCHES THROUGH 3D PHYSICAL MOCK-UP

Participant 1 tends to sketch in 2D and 3D sketches. She manages to draw using sketchy lines. There are several lines aspect in her sketches such as wavy, thin, even, stable, edges, consistency, long and direction. She transmits the sketching to an organic and geometry shape of the object. As a final design, she transforms the idea sketches into 3D physical mock-up to objects for seating such as a reclining, zoomorphism, and a geometrical structure seating object. She uses the fundamental design principles (repetition) especially in the
3D physical mock-up of subject matter 1. Element of texture and robust shape of 3D mock-up represent the meaning of the comfortable. Indirectly, `reflection-in-action`, used in their everyday practices while her working background as a jewelry designer under situations of complexity,

uncertainty, uniqueness, and value conflicts perhaps may have influenced her ideas ways of visualisation using tactile elements. (see figure 3)

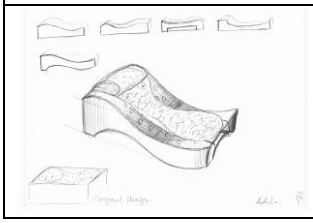
Sketches	Mock-up
	

Figure 3: Participant 1 final reflections

Participant 2 tends to sketch in 2D and 3D drawings and uses several aspect of lines. Similarly to Participant 1, Participant 2 translate her thought of meaning in several of 2D thumbnails in an organic shape. She transforms the meaning directly from the object that she observes. She transforms her design to clay mock-ups mimicking the microorganism reclining seating object. Apparently she manages to create a psychological effect on her 3D mock-up with an unequal sided shape that brings out the dynamic rhythm. As a Ph.D. student and professional musician, she transmits her artistic thoughts clearly in her design. She also manages to manipulate casual meaning of fun and joyful by adding a kid characteristic in the playground object. (see figure 4)

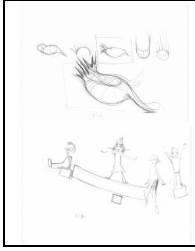
Sketches	Mock-up
	

Figure 4: Participant 2 final reflections

Participant 3 has a tendency to sketch in several aspect of lines including confidence threshold, shading, freedom, sketchy line, and shadow to establish a 3D object in sketching. She also uses the description in her sketches to present the function of definite objects. She transmits the meaning of 2D sketches into 3D physical mock-up by emphasizing the experiment with the material of the subject matter. In the intersection of 2D to 3D physical mock-up, she seems to have manipulated the meaning of an assertive mood by creating straight, solid, sharp, thick, uneven, sharp lines? Especially in creating her subject matter four into reality. As a result, the proportion of most of her 3D mock-up represents a strong sense of balance that give a feeling of security and stability. (see figure 5)

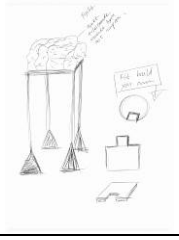
Sketches	Mock-up
	

Figure 5: Participant 3 final reflections

Participant 4 draws with thumbnail sketches. He emphasizes the variation his line aspects with straight, thin, even, continuity, sharp, and smooth lines merely to smooth, rounded, and combination of straight and curved effects. In the intersection between 2D sketches, Psychological effects of his lines drawing show that he emphasizes the meaning of his design with stiff, direct, rigid, masculine, gentle, passive, consistent, sporty,
Precise and calmness. He transmits his idea into sketches in practically and idealistic way. In 3D physical mock-up, he encapsulates the meaning of seating to shelter for living. In synthesizing principles, he manages to distribute a high sense of balance that gives a feeling of security and stability particularly in his igloo design. (see figure 6)

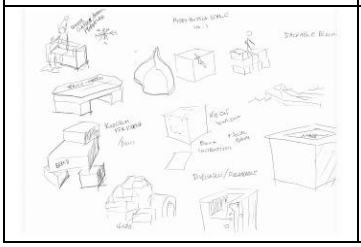
Sketches	Mock-up
	

Figure 6: Participant 4 final reflections

Participant 5 uses free stroke lines, bold line, thin line, shading, cross-hatching, and ellipse. He transmits the meaning of objects for seating with direct translation base from object that he observes and experience. He transforms his design to clay mock-up to unrecognizable object for seating and one of his designs were developed directly from his mental picture without sketches. Taking a reflection-in-action approach and understanding the background of participant 5, who is a problem-solving oriented industrial design practitioner, he may have adopted a pragmatic approach to the development of functional designs. Most of his 3D physical mock-up were directly transmitted from his 2D sketches. Except for subject matter 4, he constructs his idea sketch from his mental picture and transforms meaning directly to the 3D physical mock-up. (see figure 7)

Sketches	Mock-up
	

Figure 7: Participant 5 final reflections

Participant 6 tends to employ lines in creating a range by using angular, bent, thick and thin lines. Physical and psychological effects of his line are most reliable with the vertical, horizontal and diagonal lines. These particular lines distinguish the meaning of rigid, passivity, dramatic and horizontal line to create the sense of statics such as his object to lean. Moreover, his choices are made with respects of the lines in a design can provoke a mood with an assertive mood with solid, sharp and uneven shape. He uses parallelism principles transmitted from 2D sketches into 3D physical

mock-up. For example, one of his 3D physical mock-up applies lines, space, form, and the combination of the same pattern onto the form. He expresses his ideas in harmony whenever he transforms the 3D into culturally subjective objects. (see figure 8)

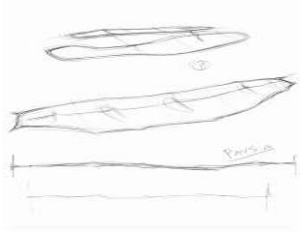
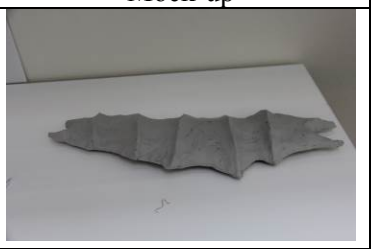
Sketches	Mock-up
	

Figure 8: Participant 6 final reflections

Participant 7 is a Ph.D. student. Similar to participant 5, as an industrial designer she employs lines composition to make the shape, create rhythm with curve or straight lines. She also uses the element of contrast with marker rendering and shading. With the explanation sketches, she uses an explanation for the function of one of her design to communicate with others. Physical and psychological effects her sketches of the object for seating creating the meaning of comfortable, safe, relax, resting concept. The transformation from 2D to the 3D physical mock-up, she applies the principles of balance with the asymmetrical of informal horizontal balance in her design of subject matter 1. The effect of balance will create the sense of security and stability. For example, the object for seating will bring an intense sense of informal balance in casual, dynamic, complex, and conducive to creativity. She transfers the ideas using a very exact translation of the theme using a proportional scale between human and object. (see figure 9)

Sketches	Mock-up
	

Figure 9 : Participant 7 final reflections

Participant 8 tends to draw in free line, fast stroke, thumbnails, shading and adds descriptions to describe her ideas. Similar to participant 4, she emphasizes her variation line aspects with straight, thin, even, continuity, sharp, rounded, and combination of straight and curved effects. She transmits her idea into sketches in practically and idealistic way. Most of the designs are more likely to conceptual and practical object. In 3D physical mock-up, she encapsulates the meaning of seating in geometry form and added a scale figure to express the funtion and the size of the object. She is an expert in forming esthetic and a Professor in Applied Industrial Design and Craft. She mostly communicates with participant 7 in making the design.

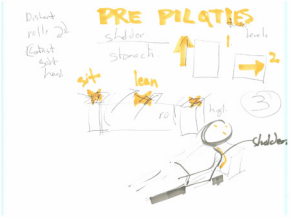
Sketches	Mock-up
	

Figure 10 : Participant 8 final reflections

9 DISCUSSION

Referring to the three main questions mentioned earlier (see research question) to answer RQ 1: How do participants generate meaning from sketches through mock-ups in design activity?, this study reveals that participants generate variety of meaningful design from sketches and mock-ups during the design process. It shows that participants used sketches and mock-ups as a form of communication to reflect their understanding, thought, experiences and clarify meaning. The final mock-up is a mere representation that help them identify potential problems and explore alternative avenues early in the design process. They generate meaning by being engaged in design thinking, role playing and being actively involved in discussing functional issues with respect to aesthetic aspects of the concept. With the assistance of sketches and mock-ups, participants will transform the meaning into the design based on their experiences and future predictions.

To answer RQ 2 : How collaborative should design processes be to facilitate meaning-making, the author comprehends that co-creation in a participatory design process is advantageous for creating new ideas in the design development process to create new meaning . Participatory design is a mindset that can be used in the fuzzy- front-end of the design process. During the workshop, participants became the at-once- users and designers to create their product. They used visual and verbal languages to discuss feedback and experiences. During the workshop, participants experienced design activities by trying to collaborate with each other rather than compete. The participants managed to create meaning using sketches and mock-ups through a collaboration process.

To answer RQ 3: What is the value of the workshop from the perspective of meaning making by the researcher/ facilitator? This workshop was a way to generate some ideas and theories about design thinking, collaborative meaning making, and esthetic meaning making. The author found out that, several concepts, which were developed in this workshop are attractive and focuses on the underlying logic of nature in creating forms. The author also realized that most of the designs were influenced by feature, elements and parts of the object that were observed and experienced earlier on. During the design process, communication is a fundamental way of understanding the need for people who will be the recipients of the design and real time experiences of dialogs that occurred, when transforming the design into reality.

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