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A HOLISTIC VIEW ON IDEATION AND VISUALISATION TOOLS

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ABSTRACT
With the enormous development in digital aids for the designer, a key question emerging is which tool to use in which design stage and for what in order to keep momentum in the design process, in particular related to more traditional tools like sketching and physical models. Based on literature review and practical student experience, this paper identifies and categorises a range of visualisation tools, related to the design process, and, since such an overview is missing in literature, collects, reviews and reflects on opinions on when to apply which tool. The findings suggest that one tool should be decisive in each phase of the design process, with the other two supporting the decisive tool.

Keywords: Sketching, CAD, physical models, visualisation tools, design process

1 INTRODUCTION

When someone comes up with a new idea for a new product, they also come up with problems that need to be solved. The products ability to prevail depends on factors like dimensions, material properties, ergonomics, technologies used, and costs. This is a lot of information to process, and that is exactly what the designer does. The designer is trained in techniques and processes of organizing information [1]. A way of processing the information that is used by almost all designers today is visualisation. Sketching, CAD-drawings and physical models can organize information and be used as "visual reasoning". The result is often so simple and understandable that outsiders can also get an overall understanding of the problem, which normally would be too complex to fully grasp. By using illustrations throughout the process, the designer can make sure that he understands the consequences of the decisions made.

1.1 Aim of the paper

A wide body of literature exists on visualisation tools, and on how to use them. However, the authors have experienced a lack of guidance in directing designers in their choice of visualisation method depending on the design phase they are in, and depending on the context, goal, audience and available resources related to a particular design task. This provides the rationale for the paper: to review existing literature in order to explore whether this perception of lack of guidance when to use (a combination of) visualisation tools can be substantiated. Moreover, if such a gap exists, the paper aims to suggest a timeline when and to what end to use appropriate visualisation tools which could be useful for educational purposes as well. Visualisation tools are hereby understood as means to (support) physical, digital or mental idea generation related to physical product design, and which are therefore valuable in maintaining a certain momentum and progression in a design process. When to use which tool may seem obvious, but is it really?

1.2 Research method

The literature review conducted resulted in an article base of 20+ publications related to design process, sketching, CAD and physical modelling. A condition for inclusion in the article base was that literature should be dated no earlier than 2008 as these subjects are very time sensitive. The rest of our referenced publications such as books date back to no earlier than 2005. By exclusion of earlier work we do not claim that visualisation is getting more important in design work, rather that in this period CAD tools have become as common tools for designers as the pencil and cardboard models.

2 THE DESIGN PROCESS

The design process itself is also a powerful tool. By going through certain phases, the designer ensures that unforeseen problems do not appear at the end of the project, and he can therefore avoid any need of redesign. Phase models like those of French [2] and Pahl and Beitz [3] have been used since the 1960s, and they mainly agree on the overall phases of the process to be analysis, ideation/conceptualisation and detailing. All the phases have to be done at least once, but iterations are likely to be necessary [1,4].

The analysis phase, also often referred to as "the fuzzy front end" is the phase where the brief is received, client meetings are held and research is done. A lot of information is handled and organized; the structure, progression and limitations of the project become gradually understood. This "fuzzy" phase of the process will result in a set of design criteria that are then used throughout the rest of the process.

In the ideation phase, the designer produces large amounts of ideas, both for the whole product, but also on sub-system level [1]. By parting into sub-systems it is easier both for the designer and for outsiders to get a good overview of the problems addressed. Ideas are later combined into different concepts that are evaluated and weighted. In the end, most likely after many iterations of the stage, one concept is chosen and detailed as a final product. It is said that it is only at this stage the designer actually fully understands the problem addressed [5].

3 SKETCHING, CAD AND PHYSICAL MODELS AS VISUALISATION TOOLS

Much of the literature on this subject is based on experiments and tests verifying hypotheses on whether one or another ideation tool is superior to another. Some publications are related, and cite literature that is over a decade old, although CAD-software development is expanding rapidly every year and designers need to adapt accordingly.

The remainder of this chapter aims to present a categorisation of existing visualisation tools that was made based on the literature review, in order to facilitate the discussion on when various tools are most relevant to use in the design process. Because of space restrictions it is not possible to provide an extensive description of all visualisation tools, hence Table 1 provides keywords and key purposes only. In the table, a distinction is made between sketching, CAD and physical modelling tools, which are briefly introduced below:

- *Sketching*: A designer unable or unwilling to take advantage of the versatile tool that sketching is, may come out as an incomplete designer [6]. Sketching theory makes up everything from the relevant medium to the suitable technique for shading, colouring or perspective. The tools, techniques and time applied to a sketch or a set of sketches are chosen based on what the designer seeks to communicate. Olofsson [7] makes a distinction between Investigative and Exploratory sketches, Explanatory sketches and Persuasive sketches which has been used in the table.
- *Computer-aided design*: The use of CAD (Computer-aided design) tools in the design process has increased drastically in recent years. Less expensive CAD software such as Solidworks and Rhino has become available to the public and can today be run efficiently on standard laptops. Traditionally these tools have been used later, or in the end of the design process, but because of large improvements in user-interface and functionality, it can now be used also in a more creative way. This might be beneficial for the process, but may as well reduce the performance of the designer and the team around him because of the dangers of design fixation [8]. Today mainly two different methods of CAD modelling are used; surface and solid modelling, which both can be practiced in almost all popular software [9]. Based on literature [1,8,10-12] we suggestion a division of models into five categories as done in Table 1.
- *Physical modelling*: A vast number of variations in degrees of detailing, materials, testing abilities and surface and detailing-finish exists when making physical models, which should be adjusted to the stage in the process and the time and financial resources available [13,14]. The categorisation proposed in Table 1 is loosely based on Kristiansen's categories [13], but also inspired by other guidelines [14-16]. As with the rest of the article the categorization of physical models is related to product design, and the use of these visualisation tools, rather than representational tools.