PATCHES IN SKETCHES: WHICH TYPE OF SKETCH IS MORE VALUABLE FOR THE END-USER IN THE EARLY PHASE OF NEW PRODUCT DEVELOPMENT

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Abstract

Involving end-users early in the process of New Product Development (NPD) has proven leading positive effects on further developments of the design and success of new products. In the early stages of NPD designers often use sketches to communicate their ideas, to get feedback to iterate and develop the design. While the relevance and value of sketching as part of the design process and the usability to communicate ideas more effectively have been investigated, little research has been conducted looking at the elements that support effective means of generating insights from end-users. Sketches are often used according to the appropriate purpose and context of the situation, different types of sketches can be used to convey their idea. It is important to understand what elements of the different types of sketches are that generate most valuable feedback from the user involved in the development process. Presenting end-users 5 types of frequently used sketches showed that the information sketch was most favorable, followed by the scenario sketch. The use of color, explanatory elements and context of the product were important factors for the preference of these types of sketches.

Keywords: Sketches, Early design phases, Evaluation, Communication

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1   INTRODUCTION

When companies want to maintain their competitive advantage, it is necessary to foster innovation and thus the development of new products (Junginger, 2008). This statement about important survival strategies of companies is widely shared in industry and academia. More detailed recommendations which also belong to the kind of simple truths – frequently shared and least doubtful – is the need of appropriate communication with the user at the very beginning of the design process (Brown, 2008; Creusen, 2013). Involving end-users at early stages in the product development process generates feedback and insights that are essential for the decision of how to further develop the design outcome (Steen, 2007). This communication is an essential part of a successful designer-user co-operation, because it can lead to products that better fit the end-user and therefore have an increased potential to be more successful on the market. Getting feedback from end-users early in new product development (NPD) process has great impact on the cost and speed to market (van Kleef, 2005) which are the main influencing factors of successful innovation. If a design has to be changed in a later stage of NPD, it is costly and time consuming to adjust the design while in the early stages the design is easier to modify and changes are still doable because an idea or certain elements of an idea are not fully designed, modelled and engineered yet (Smulders, 2014).

Sketches made by designers do not necessarily meet the understanding of the other stakeholders, especially when coming from different disciplines (Tversky, 2002). It is reasonable to argue that the drawings and the interpretation of a sketch by a designer is different from the understanding of a user or other stakeholders. Designers develop their own sketch style and their own preferred way of working, methods and preferred materials to work with. The designer, as the creator of the final product furthermore knows the full context of the solution while the end-user often has a better understanding of the problem (Smulders, 2008). Receiving feedback is therefore important for the designer and the ongoing design process. Finding a proper medium such as the type of sketch or prototype that helps end-users to generate valuable insights can contribute to the success of the product and innovation. In the early NPD stage designers often have the ability to envision products or elements of products as how they would look and function as a finalized product. For involved stakeholders as well as for the end-users the used sketches or prototypes might be less clear. The end-users' interpretation of different sketches can differ from the interpretation of the creator of the sketch, as they go through different thought processes and thus each person develops an own mental model and thus a different understanding of the problem and the solution (Smulders, 2008).

The research reported in this paper is confined to different types of sketches commonly used during this early phase of the NPD process, because the early stage of the NPD process crucial for the success of new products (Buchenau, 2000). This research compares selected types of sketches, to find out which type should be used in order to generate valuable insights from the end-user. The goal is not to evaluate which sketches are perceived as aesthetically most pleasing, but to define the type of sketch that supports the end-user involved in the design process to understand and contribute to a successful design output.

This paper is structured as follows; firstly, a summary of the role of sketches in the design process and the main theoretical assumptions are discussed, followed by the research propositions and hypotheses of the presented research study. Secondly, the research methods used in this study are described. Thirdly, our results and findings are presented, and finally the conclusion, recommendations and discussion will reflect on the relevance of the results.

2   THEORETICAL ASSUMPTIONS

Tim Brown (2011) claims that the key to success is to understand the needs of end-users, a statement that is supported by many other practitioners and researchers (Buchenau, 2000; Coughlan, 2002; Schutze, 2001; Ariff, 2012; Veryzer, 2005). How can we gain a better understanding of the end-users? The main assumption is that the early involvement of end-users in the design process will lead to a higher sense of acceptance of the final outcome, as the involved end-users become co-owners of the information (Sleeswijk 2007). Thus, involving end-users and other stakeholders early in the design process will lead to better design results.

The knowledge and the evaluation of ideas, the understanding and acceptance of information is different for designers and end-users. Sketches hold the design in view of the designer, freeing the mind to examine and evaluate (Tversky, 2003). The same sketch presented to an end-user is reviewed and

compared to their understanding of the problem and then assessed according to their perspective and envisioning capability. Several researchers have discussed the functions of sketching (see for example Ariff et al., 2012, Goldschmidt, 2002; Pipers, 2007; van der Lught, 2005) which can be summarised into the following five means of sketching.

1. Sketching is a means for externalizing and analyzing thoughts.
2. Sketching is a means for simplifying multi-faceted problems.
3. Sketching is a means of persuasion that sells ideas to clients.
4. Sketching is a means for communicating complete and less complete – even ambiguous information.
5. Sketching is a means for simulating if-then scenarios.

Ariff et al. (2012) analysed the basic elements of how sketches convey information. From that analysis the authors built a framework which was the source for the categorization system that has been applied. The framework categorizing all design-communication activities has been detailed into four main categories: drawing, detailing, explaining, and transferring. In this experiment all participants were assigned either to a silent or a non-silent condition, where the non-silent group was allowed to verbally communicate during their design process while the silent group was allowed to communicate only through sketching. The results show that the silent group performs better in conveying information through sketching.

Dorst (2010) also discusses the importance of sketching as part of the design and problem solving process, and as such he describes sketches as representatives of the thought process. Sketches support the creativity needed to solve wicked problems (Buchanan, 1992).

Pearse (2007) argues that the advantage of sketches lies in their openness to discussion as they are not intended to be final ideas, but work as catalyst to open up the discussion. End-users as well as also other non-designers might see and understand that sketches are not representing a definitive product. In the case of a presentation render for example, end-users might think the product portrayed by the sketch is already finished and that elements are not open for debate. When it comes to dealing with differences in perspective Carlile (2002, 2004) investigated in how far boundary objects reduce differences in perspective and create a common understanding and indeed Carlile could show that sketches can overcome differences in perspective. Lim (2008) did research on differences among prototypes that are considered in terms of 'filtering' or 'manifesting' prototypes. The focus in Lim's research was put on the differences among prototypes and not on the way prototypes convey information to end-users. Menezes (2006) looked at different types of sketches over different domains and the perception of sketches by designers. Different disciplines are considered, but the end-user is not taken into account. Veryzer (1998) showed the importance of unity and prototypicality on the aesthetic aspects of a design when visualizations were the sole basis of judgment. To create aesthetic coherence the sketches in this research were therefore made by a design professional. With a focus on design development within teams, Elsen (2012) suggests to start sketching as early as possible in the design process. Involving end-users in evaluating early sketches help designers in steering their designs in the right direction.

3 RESEARCH STUDY

Plenty of research has been done in order to understand the value of sketches and prototypes for transferring information (Dorst, 2010); the other important issue about the effectiveness of sketches is to overcome different perspectives within multidisciplinary teams (Carlile, 2004; Neumann, 2012). Schrage (2008) reports that every company has its own culture of sketching and its own way of prototyping. Despite the recognition of the value of sketches in the design process little research has been done to understand what kind of sketch is most successful in conveying information to the end-user or to other professionals involved in the early stage of the design process with the aim to generate insights from them.

The main research question for this research study is: 'What type of sketch should designers use to generate valuable insights from the end-user involved in the early stage of NPD?'.

Sub-questions to answer this question are related to basic features such as:

1. Colour: Are coloured sketches preferred over black & white sketches?
2. Representation: Are sketches with verbal explanatory elements preferred over sketches with visual elements?

3. Details: Are less detailed sketches preferred over sketches with more details?

Thus three elements of sketches have been investigated A distinction was made between coloured sketches and black and white sketches, different levels of detail and whether there were visual or textual elements of explanation. According to the laws of simplicity our hypotheses were as follows:

1. Coloured sketches are preferred over black & white sketches – information wins.
2. Less detailed sketches are preferred over detailed sketches – simplicity wins.
3. Sketches with more explanation are preferred over sketches without explanation – explanation supports framing of essential information.

Furthermore, it can be expected that there would be differences in the interpretation of designers and non-designers due to their educational and professional background.

This research focused on the generation of valuable insights from the end-user involved in the early stages of NPD. The hypothesis is that coloured sketches give a better understanding of what the product might look like in reality and will thus be easier to understand for the end-user. Another function of colour is that it can highlight elements in the sketch that are important and can therefore generate more valuable insights by directing the focus of the person that evaluates the sketch.

Less detailed sketches provide more thought space for end-users to contribute their opinions and thoughts on the design and will therefore generate more valuable insights than detailed sketches (Brown, 2008). A detailed sketch can be perceived as a 'finished' product and will therefore not stimulate the end-user to reflect on possible changes of the design outcome and the product. Designer professionals are more familiar with the process and will not quickly interpret a sketch as 'finished', but see it open for debate thus generating more insights.

It is reasonable to expect that sketches with more explanations will help to build a mental framework and provide a specific context of the product and will therefore be easier understood. This can stimulate to thinking within the framework, still providing opportunities to contribute with valuable insights and comments. Explanatory elements can be visual as well as textual and should explain the use, function or context of the presented element.

3.1 Research method

Before the initial research a pilot was done. The results of the pilot led to changes in the setup of the research. The number of sketches got reduced to 5, of which the prototypes were discarded. Sketches are more often used in the early stages in NPD and are therefore taken as main focus for this research. The characteristics of material and dimensions of prototypes are not properly translated by showing pictures of prototypes, therefore the decision was taken to only use frequently used types of sketches.

The type of sketches were chosen from a study of the most frequently used sketches in a study from Loughborough University. The choice of the 5 types of sketches was confirmed by four expert designers as being sketches that are often used in their design processes. For the measurement the 1 to 7 Likert scale was chosen and sketches got developed in a way that highlighted clear differences between the types. To reduce confusion for the participants in this research, the drawings for the final research were drawn by a design professional. The design professional was given the task to design a coffee machine that can be used on a camping ground. Using the same person for the drawings made the sketches more coherent from an aesthetic point of view. A second pilot was done to receive feedback on the clarity of the questions. Minor changes were made in the wording, so full comprehension of the questions would be ensured.

For the final research study an online questionnaire was compiled. The results are from a group of 40 participants, varying in age and professional background. From these results 38 were used. 5 types of sketches were presented, with 14 questions regarding the interpretation of the sketch, followed by 4 qualitative questions with a maximum of 140 words to elaborate on the sketches and preferences. The participants were asked to rate each of the drawings on the usefulness, understandability, attractiveness, purpose and triggering of thoughts. This was followed by 4 open questions per sketch: 'What do you like about the presented sketch?', 'What would you change?', 'What do you think is missing?' and 'Would you use this sketch'. The final questions participants were asked was to choose one sketch, that they thought would help them to generate the most insights from users. The answers to the questions

were coded and clustered according to topics. This was reviewed by a second, independent coder to reduce personal bias.

By using an online questionnaire it was ensured that answers were given to the same questions in a fixed format to ensure objective testing throughout the study. The coffee machine sketch types were: idea sketch, scenario sketch, information sketch, final render and a mind-map. The sketches were shown one after another before a comparison image was shown with all 5 sketches. The names of the sketch types were not shown to not influence the participants' perception on the sketches.

Sketch 1 is an idea sketch that was used by the design professional to help him find the proper direction for the design. It is made in black & white and shows drawings of differently directed concepts. In the corner it was noted that the design was for a coffee machine to be used in a camping context. Sketch 2 was a scenario sketch that showed 1 concept, used in different stages of the usage process. The sketch was also in black & white. The 3rd sketch was an information sketch, with one 1 concept, with a little colour, rough lines and description of the different parts of the coffee machine. The colour was used to highlight the different parts to direct the attention of the participant, but should not be interpreted as colours for the final design. The 4th sketch was a rendered drawing in colour. It showed 1 clear sketch in full colours with a lot of aesthetic detail and materiality on the proposed design. Sketch 5 was a mind-map, often used to group and categorize initial ideas and elements of the design. This was done in black and white. The different types of sketches are shown in Figure 1. The results and interpretations are discussed in the following part.
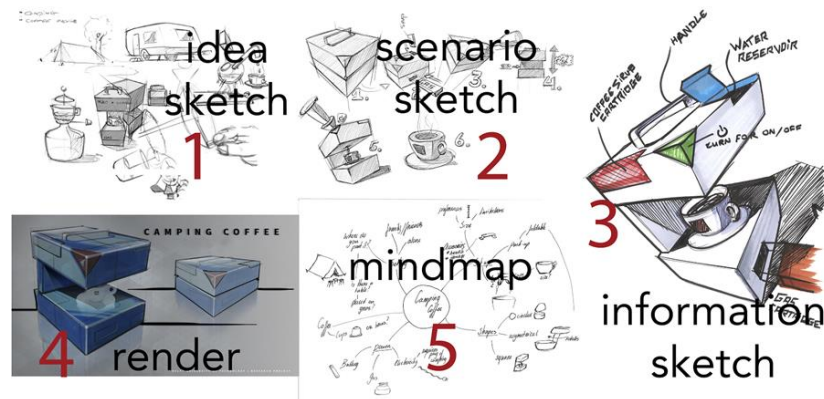

Figure 1. Different types of sketches presented in the questionnaire

4 RESULTS

The results of the questionnaire were analysed and the answers of the qualitative part were coded and grouped by two coders.

4.1 The Questionnaire

From the data that was gathered several graphs were made that show the preferences of the different types of sketches that were presented. The 5 topics were: usefulness, understandability, attractiveness, purpose and triggering of thoughts.

Table 1. Rating of the different sketch types on usefulness, understandability, attractiveness, trigger thoughts and purpose

	Idea sketch	Scenario sketch	Information sketch	Rendered sketch	Mind-map sketch
Usefulness	(n=39, mean=3.9, SD=1.861)	(n=39, mean=5.36, SD=1.367)	**(n=39, mean=5.46, SD=1.144)**	(n=39, mean=5.08, SD=1.345	(n=38, mean=3.71, SD=1.859)
Understandability	(n=39, mean=4.26, SD=1.464)	(n=39, mean=5.54, SD=1.861),	**(n=39, mean=5.92, SD=0.957)**	(n=39, mean=5.28, SD=1.431)	(n=38, mean=3.61, SD=1.824)
Attractiveness	(n=30, mean=5.31, SD=1,341)	**(n=39, mean=5.62, SD=1.31)**	(n=39, mean=5.59, SD=1.117)	(n=39, mean=5.38, SD=1.616)	(n=38, mean=2.32, SD=1.338)
Trigger thoughts	(n=39, mean=4.92, SD=1.01)	(n=39, mean=4.97, SD=1.423)	**(n=39, mean=5.15, SD=1.288)**	(n=39, mean=4.79, SD=1.559)	(n=38, mean=4.29, SD=1.916)
Purpose	(n=39, mean=3.56, SD=1.774)	(n=39, mean=5.51, SD=1.502)	**(n=39, mean=5.69, SD=1.104)**	(n=39, mean=4.79, SD=1.559)	(n=38, mean=4.13, SD=2.108)

Comparing the means of the different sketch types, the information sketch is rated highest on all variables, except on lower attractiveness. The means of the scenario sketch is rated second apart on attractiveness. The mind-map is rated low on all variables except for the purpose it serves. It should be noted that the standard deviation differs per sketch. The mind-map, which has a low mean on all elements, has a relatively high standard deviation. The highest values have been indicated with bold lettering in the table above.

4.2 The Questionnaire: qualitative analysis

The answers on the qualitative part of the questionnaire had a maximum of 140 words. The answers were in most cases not longer than one sentence. The answers were coded and then labelled in 3 categories; 0 - non-valuable insight, 1 - valuable insight regarding sketch, 2- valuable insight regarding product categories. The qualitative responses were initially coded and divided into 34 categories. In Figure 2 the 11 most frequent codes are presented. The 3 most frequently coded elements of the sketches has to do with colour, explanatory and structure. Many of the answers were combination codes of context and purpose, wherefore these are considered of more importance than the structure. The codes respond to the 'clarity' of the sketch, whether 'colour' is used, the 'context' relates to the environment the product is used in, 'explanatory' whether there are elements that explain the use, 'hierarchy' is related to the relative place of the objects in the drawing. 'Product' refers to a comment about the product itself, 'purpose' to the purpose of use, 'sketch style' about the way the drawing is made, 'structure' related to the structure of the sketch and objects drawn, 'text' refers to comments about the use of text and 'usage' about how the product is being used. Further analysis of the codes will be discussed below.
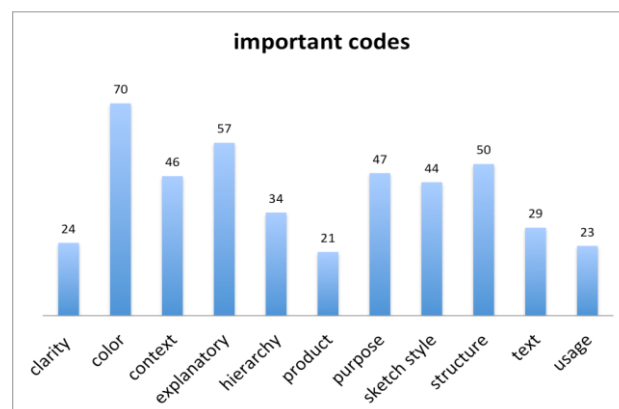

Figure 2. Most important codes

When asked to pick one sketch that makes them want to change the design the scenario sketch is picked first, followed by the information sketch.

From these insights a distinction was then made by dividing the participants in 4 groups: industrial designers (1), engineers (2), management (3) and others (4). Minor differences were found between groups. The mind-map was chosen twice, only by the industrial designers, and the idea sketch twice by industrial designers and the other group. The final render was never chosen by industrial designers, and only few times by others and engineers.

These results suggest slight differences between different educational backgrounds. It has to be noted that the frequency of 40 total participants is too low to draw definite conclusions. Every count is a separate person, the height differences are based on the group size and therefore might be misleading to an uninformed reader. The group 'other' is a rest group of participants that had filled in 'other creative' or 'other'. There were no significant differences between these combined groups. Further research should be done to explore the difference in preferences according to professions and educational background.

4.3 Analysis of the results

The results of the codes show the importance of colour as well as explanatory and contextual elements of sketches. 70 codes were about colour, 57 explanatory, 50 on structure and 47 and 46 on purpose and context. Answers to the questions could consist of multiple codes. Because purpose and context can be taken together and were combined in the comment they were deemed more important than structure. The codes can be either positive or negative comment. Figure 3 shows the amount of codes generated per drawing.
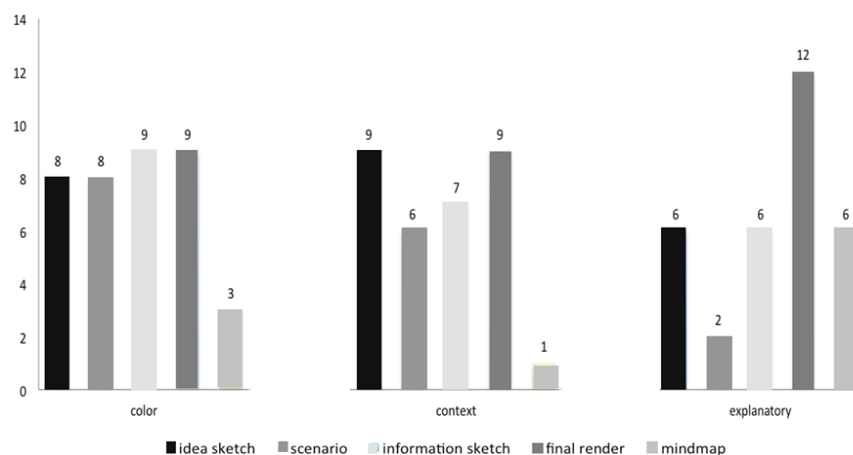

Figure 3. Frequency of codes per sketch type

Looking at the codes per sketch type, the colour is rated equally important for most sketch types - except for the mind-map. For the context there are more differences with regards to the frequencies of codes, with the mind-map being very low. Explanatory codes scores very high for the rendered sketch, while very low for the scenario sketch. Looking at the codes it shows that the scenario sketch was clear in purpose and the rendered sketch needed more information regarding the product.

The results show that the information sketch is rated highest on 4 out of 5 categories compared. The scenario sketch is rated second highest. Only in the case of attractiveness is the information sketch ranked 2nd and the scenario sketch first. The mind-map is rated lowest in all categories except for it being clear in its purpose, where it is ranked second to last.

The information sketch comes out second as most favourable, following the hypothesis. It has colour, is not very detailed compared to the other sketches and had several lines with explanation of the product. Though it comes out as most favourable sketch, only by looking at the codes what was liked best about the sketch it shows 19 out of 39 codes on colour.

The scenario sketch that was ranked first had rather low levels of detail, but no colour. There was visual explanation of the product and context. The codes indicate that colour is missing in the sketch.

The idea sketch and rendered sketch performed in the middle. The render was highly detailed and coloured but missed explanation on the product and the idea sketch missed all components. The mind-map came out last 4 out of 5 cases. It did not have colour, details and only explanation on elements of the design, lacking structural explanation on the product itself.

5   SUMMARY AND CONCLUSIONS

From the results we can conclude that sketches with colour, explanatory elements and context support a better understanding of the idea presented. These insights support the information sketch, followed by the scenario sketch, to be most preferred. The other sketches generated insights that supported the importance of the elements discussed above.

From the combination of quantitative and qualitative data the following is concluded:

Hypothesis 1. Coloured sketches are preferred over black & white sketches is supported. The information sketch is ranked highest in the elements of the sketches that make it understandable. The coding confirms the use of colour to be a positive element of the drawing and coding from other sketches comment negative on the lack of colour.

Hypothesis 2. Less detailed sketches are preferred over detailed sketches is supported. The most preferred sketches, the information sketch and scenario sketch are drawn with rough lines, unclear details that allow for interpretation. The most detailed sketch, the rendered sketch is never rated last, but more in the middle.

Hypothesis 3. Sketches with more explanation are preferred over sketches without explanation is supported. The information and scenario sketch both have explanatory elements. The information sketch indicated with words what the functions and elements of the product are and the scenario sketch visually explained the steps of using the product. Furthermore did the coding support indicate the importance of having explanatory elements. Many participants also commented on structure and hierarchy elements.

The codes that were created for the qualitative part of the research indicated the importance of colour, explanatory elements and purpose and context of the product. In the research the information sketch was the most preferred sketch, followed by the scenario sketch. The elements of these drawings contributed to the readability and understanding of the product and the usage within a context. This allows end-users to contribute their thoughts and provide feedback of their needs and wishes regarding the product. Least preferred was the mind-map sketch.

For design professionals this means that even though they might have a preferred type of sketch to work with, it should be considered that the most effective sketch to receive feedback should include colour, explanatory elements and context of the product.

6   RECOMMENDATIONS AND DISCUSSION

The presented research study focused on the question what type of sketch designers should use to increase the understanding of other professionals involved in the early stages of NPD process. The outcome of this research suggests that the best type of sketch to generate valuable insights from the end-user is firstly coloured, secondly not too detailed and thirdly entails verbal explanation. On a more general level it seems very important to place the product in a context which provides further understanding of the product. In this research the information sketch, followed by the scenario sketch, were most preferred by end-users.

The results suggest that for end-users and other professionals who are involved in the early stage of NPD, to understand and appreciate the sketches clarity and understanding of the product are important elements for end-users to understand the product sketch and comment on it to provide designers with valuable feedback. Using explanatory elements in the form of contrast, colour, white space, size, text, numbers can help end-users to better interpret the sketches in order to give valuable insights. Using colour and explanatory elements in the sketches creates a further understanding of what it might look like and how the product is used. It can be advisable to use multiple sketching types to convey ideas and concepts to end-users and other professionals in the process, what helps to broaden their perspective on the design solution. Sketches are used in context and should be presented with regard to the situation and people involved. While designers can be tempted to use the sketch type of their preference, this might not always be the best way to communicate their ideas. As shown in this paper, do elements

regarding colour, context and explanatory elements yield more valuable insights from end-users than sketches which do not have those elements.

The research is limited in that it focused on one specific product. This was done to limit variations in understanding when combining it with other products, but is therefore limiting when considering other more complicated products. Using more product categories would have extended the time significantly. The participants could be categorized into 4 categories; industrial designers, engineers, management and others. Other and management made up ⅓ of the participants and engineers and industrial designers both ⅓ of all participants. This research was too small to draw conclusion based on these categories. Expected is that engineers would favour more technical sketches, yet technical aspects were limited in these drawings as it was assumed these kind of drawings are not used in the very early design process but later during the details design process. Also, differences in preferences have not been taken into account. The personal preferences for a specific sketch might be influenced by the design style.

The aim of the authors was to find the type of sketch that generates most valuable insights. It has to be taken into account that there are many more different types of sketches, and that every designer has his or her own way of executing such drawings. Therefore, the outcome of this research should be interpreted as the best way to deal with end-users and with participating professionals. Though this research is in support for designers to get away from the methods they usually use, and incorporate end-user-centred design drawing, it is also recognized that designers get better by practice and hold onto their own signature. This is a friction which should be considered in the design process.

When using sketches to convey design ideas and concepts to end-users and other professionals it seems to be helpful using more than one type of sketch. The different sketches used all serve different purposes, and for conveying the ideas to end-users and other people involved we recommend to use a variety of sketches. Further research should be conducted to find out which combinations of types of sketches result in more valuable insights from end-users during the design process.

Another limitation of this research is the amount of sketches. The 5 sketches were chosen through the judgment of 4 designers as being most commonly used in the early stages of NPD. A sketch and prototype template from Loughborough University was used to determine the sketches most suitable for the context of the early stage in NPD. There are many different types of drawings that could be considered. These complex interactions could be further investigated in future research.

In addition, we suggest for future research to further analyse the elements of preferred sketches. The results of the open-ended questions suggest that certain drawings are preferred because of specific elements in the drawing. Elements like colour, thickness of lines, roughness, texture, sharpness, clarity and dimension could be chosen for further research.

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