HOW PRODUCT REPRESENTATION TYPES ARE PERCEIVED AT THE CLIENT'S END TO FACILITATE COMMUNICATION AND DECISION MAKING

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ABSTRACT
The ability to communicate effectively, honestly and convincingly to design clients with good technical background and middle management experience is important to facilitate decision making in the designing process in a cost responsible manner.
This article shows that these design clients' assessment of representation type according to level of detailing and completeness of communicated information reversibly complements the room for design changes. "Presentation Drawings" communicate a high level of completeness, which is almost equal to "High Quality Presentations in CAD" and "Quality Design Models. As expected, interaction with the tactile volume creates a "near completion" assumption among design clients. A dualistic attitude can be observed among clients, when dealing with CAD models. Due to the incompleteness, but also viewing capabilities of initial CAD-models, clients were averagely neutral in their opinions concerning the level of design information provided by it. However, the representation quality of "Detailed Design Models" are being perceived similar to "Presentation Drawings", because of their high level of detailing, realism and "frozen" mode of presentation.

Keywords: Product Representation, Design Client, Design Process

1. INTRODUCTION
Many articles and books have been written on the topic of representation techniques throughout the design process as a means to facilitate, creativity, idea and concept development, collaboration and communication.
Designers often place great emphasis on sketches, because they are thought to be associated with creativity [1]. In terms of human cognition, sketches promote the dialectical process between a sufficiently specified and coherent physical form, and abstract, conceptual, propositional knowledge [2, 3]. It also allows new ways of seeing and reinterpreting sketches that could provide new forms and abstract concepts [4, 5, 6]. According to Suwa and Tversky [7], the use of sketches does not only aid to memory, but also in perceiving visuo-spatial relationships and reasoning about functional issues and goal-setting. Sketches are representations of the results of thinking process, decreasing the cognitive load of designers, while provoking creativity during designing [8].
One of the most influential views is that sketching is a dialogue between the designer and what the drawings suggest [2, 9]. Some studies proposed that ambiguity is one of the key factors, because it allows the seeing of new possibilities in the representations, in other words re-interpretations [8, 9, 10]. Sketches also seem to be essential for revising and refining ideas, generating concepts and facilitating problem solving [11]. The convenience and speed of using sketches enable designers to generate and represent ideas easily and quickly [12].
Besides traditional tools of representation, such as sketching and physical model building, Computer Aided Design (CAD) tools are currently widely used as a generative and communicative tool in design practice. For example, digital visual representations can be used for better understanding of the form, thus as a support for visual thinking [13]. This idea is supported by pointing out that intensive visualization and immediate feedback in computer media influenced the designer to generate images more frequently in his/her mind, compared to conventional media [14, 15].However, some regard computer-aided design as an inappropriate mean for conceptualization [16, 17].
According to Bødker, design crosses boundaries between work activities [18]. Therefore, representations play an important role in design because designers, in various ways, need to externalize design proposals and present them to others, fellow designers, users, or managers.

All these tools have their own special characteristics making them communicate differently. By being more conscious concerning the perception and acceptance of various product representations, the designer may be able to improve the communication between himself and the client throughout the design process.
Complementary to visual representations, physical models provide tactile information and more easily reveal flaws than drawings or 2-D representations do for the same product. Besides this, physical models were reported to be less frequently used than sketches or CAD, probably because designers tend to avoid the effort of building a model except where it is absolutely necessary [19].

The objective of this study is to investigate how designers should communicate and present their work to the client at different stages of the design process. As not much is known on how different representation techniques are mentally perceived and understood by the client, investigations entails how designers can be more conscious concerning the use of 2-D and 3-D product representations, such as sketches, drawings, CAD, physical models, to achieve improved communication and decision making between design clients and themselves. It is therefore essential to create an understanding among designers and design clients concerning the relationship between design output and representation at various stages of the design process. In addition it is important to know the limitations and possibilities for allowing design changes at each stage of the design process.

2. INTERACTIONS IN DESIGN PRACTICE

There has been increasing acknowledgement that design is a social process [20, 21]. Related studies documenting in detail the real world work conducted within design and technology organisations have built and elaborated on aspects of designer's social practice; a cursory survey of such work would include practices such as designers' varied, coordinated and ‘political’ uses of prototypes and representations [22].
The design profession is built on personal relationships. As such, this profession parallels that of management consultancy. Research of client’s reasons for choosing management consultants showed that the three most important ‘choice criteria’ were: the consultancy’s ‘reputation’, its reputation within its specialist area, and knowing the consultant who works on the project [23]. In addition, the importance of on-going relationships was highlighted. An earlier study, identified ‘personality’ as one of the most commonly cited criteria client’s consider when choosing a design consultant [24]. According to Jevenaker, mutual trust and respect between the client and designer are fundamental for the evolution of long-term relationships [25]. As the client and designer get to know each other, over time, mutual trust and respect may be built into the relationship, which is an integral and critical part of ‘inaugurate learning’ between designer and client.

In real-life practice, the client will brief the designer, and give a project audit, clarifying the task, requirements and constraints of the project. Throughout the process, the designer and client, usually meet several times to clarify certain aspects, make decision and in general keep each other up to date on the project.
The designer’s role in product development projects often differs. In one project, the designer could be involved in the early stages to assist defining the direction and develop initial concepts, whereas in another project, a designer could be engaged for “styling” purposes. However, the industrial designer often prefers to be part of a team from initial stages of the design process, enabling to apply not only elements of aesthetics, but also create product meaning and function. According to Tovey, the designer calls upon particular skills such as drawing and presentation techniques, and has to have sufficient understanding of engineering and market requirements to ensure that the integrated product design is ergonomically, technically and commercially feasible [26]. When working across various disciplines, it is not always easy to communicate the design explicitly to other partakers in the project.
To create a communicative platform for interaction calls for that on one hand the designer has to understand the client’s concerns and needs in the project and on the other hand the client has to convey his/her needs in a way that the designer can appreciate. Thereafter, the designer has to interpret the client’s needs in a visual form – a two-dimensional or three-dimensional form, enabling the client to make responsible and well thought out design decisions [27].

3. PRODUCT REPRESENTATION AND COMMUNICATION WITHIN THE DESIGN PROCESS

For many years, psychologists and engineering design methodologists have investigated engineering design processes with a focus on the designer's individual mental and manual processes. This effort was aimed at analysing the different individual procedures used by each designer and finding ways of supporting them by the performance of these procedures [28, 29, 30, 31]. Most empirical studies of design problem solving have been based on an examination of design protocols emphasizing the verbal content sometimes with an analysis of the drawings as well [32, 33, 34].

According to Romer et al., communication is the most decisive, but also most difficult activity for task clarification, either with colleagues or clients [19]. Visual representations are omnipresent throughout the New Product Development (NPD) process, from early sketches to CAD-rendered general arrangement drawings. Usually, as the design progresses, the drawings illustrate increasing degrees of concretization and detailing [35]. In other words, as the project evolves from abstract to concrete, the degree of realism of the representation also increases. However, how a project is being presented, could be just as important for the client decision, as what is being presented.

3.1 The Influence of Representation on the Design Process

German engineering designers have been the main contributors to the development of the consensus model, which has been described in VDI publications and in slightly different versions in several textbooks [28, 29, 36, 37]. The consensus model portrays the engineering design process as a recommended sequence of activities, leading to certain typical intermediate results: performance specification, function structure, principal solution, modular structure (concept), preliminary layout, definitive layout, documentation. The activities are grouped into four phases: clarification of the task, conceptual design, embodiment design and detail design [38].

The early phases of the product development process, which are clarification of the task and conceptual design, will have the highest impact on quality and on the manufacturing costs of the future product. It is assumed that 70% of the product costs are determined within the first fifth of the development process. Therefore, decisions made within the early phases are most decisive for the product costs, although the effects of these decisions are only vaguely calculable at this stage of the development process. The further the product development process proceeds, the more calculable the product costs become, but the higher the effort is in cost and time, to change wrong decisions which were made during the early phases. Figure 1 illustrates this correlation.

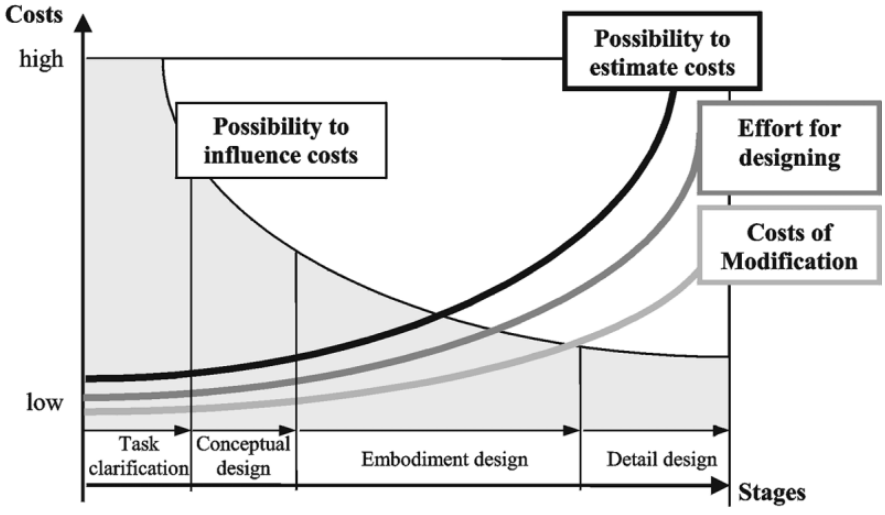

Figure 1: Stages of and costs within the product development process [41].

As the product designing progresses, more integrated solutions are developed. Drawings and pictures demonstrated the essence of the solution, with one or more of the original ideas being elaborated, combined and tested. Some ideas can be tested on paper by construction and calculation; others need to be physically tested in order to see if the assumptions made are right or even feasible. This is usually done through functional models and CAD.

It can be seen that designers apply specific external representations to fulfil specific functions, for example, sketches for solution development, CAD for documentation or complex models for checking requirements. However, all kinds of representations seem to support communication and, to a slightly lesser extent, solution development and testing. Physical models, in particular, were employed for a variety of different functions.

3.2 Sketching as a Representation Tool in the Early Stages of the Design Process

Sketches can provide insight into and trace the designer's mode of thinking at any particular point in the design process [42]. One of the most detailed studies of the act of sketching was conducted by Goel [10]. He identified two types of operation occurring between successive sketches in the early stages of design, namely *lateral* transformations and *vertical* transformations. In a *lateral* transformation, movement is from one idea to a slightly different idea. In a *vertical* transformation, movement is from one idea to a more detailed and exacting version of the same idea. Goel concludes that freehand sketches, by virtue of being syntactically and/or semantically dense and/or ambiguous, play an important role in the creative, explorative, open-ended phase of problem solving. He believes that the properties of the freehand sketch facilitate lateral transformations and prevent early fixations.

Olofssen et al. identified 4 types of sketches, each with its purpose, strengths and weaknesses. These are ”Investigative Sketches”, ”Explorative Sketches”, ”Explanatory sketches” and ”Persuasive sketches (renderings)” [43].

In terms of communication and external representation, 'explanatory sketches' and 'persuasive sketches' are most relevant. However, persuasive renderings might not communicate adequately to all external partakers of a project. For example they may appeal to someone in marketing because of its appearance and artistic flair, but will probably fail when shown to product engineers as they seek different and more accurate information. According to Lawson, an additional problem with sketches is their propagandistic intention to convince the client that the design is at least satisfactory or excellent, while concealing weakness as much as conveying strengths in the design [44]. Things that would not work in real life, can be tweaked in a drawing, misleading the client to accept a flawed design, which again can prove to be a very costly mistake. This is supported by Errington-Evans, underlining that drawing is such a powerful means of communication that it can become an end in itself. This can trap the designer into the designing the drawing rather than the product.” [45].

In short, for the final representations and realisation, hand drawings are not accurate enough and need to be complemented by CAD models

3.3. CAD as a Representation Tool in the Design Process

From a digital model, one is able to extract either perfectly machined models, or even stunningly realistic illustrations, at a pace and precision that not even the best illustrator or model maker could ever achieve. However, because of the inherent parts definition, geometric specification and level of precision, it does not allow the designer to make lateral interpretations.

When it comes to using CAD as a sketching tool in the early stages of the design process, such as task clarification and conceptual design, interaction with non-digital representation media, such as sketches are the most common. With respect to the simultaneous use of these tools, it has been shown that most of the designers used sketches to prepare and support CAD-work, whereas the CAD is probably used as a media to avoid troublesome changes to the product definition [19].

However, a basic requirement for using CAD are that the efforts of using certain functions needs to be as low as possible, in order to balance with the expected benefit to be gained from using them.

In terms of external representation, several designers stresses the importance of not showing their client a CAD-generated image of the project too soon in the project based on the assumption that the level of commitment increases correspondingly to the precision of the applied tool. For example, if a designer shows a precise computer rendered image of a potential solution early in the process chances are that the product is being conceived by the client as being further developed and detailed than as actually shown in the image.

3.4 Physical models as a Representation Tool in the Design Process

Although designers are aware of the 'multi-functionality' and effectiveness of physical models, it seems that the effort necessary for making physical models of a certain finishing quality, requires skills, time and accessibility to precision tools, which is much larger than the effort necessary for

developing sketches. This is one of the reasons for their less frequent use. However, low-fidelity models are used relatively often in the early stages of the design process to complement sketches in a fast and economical way in the exploration of ideas and concepts. Unfortunately, disadvantages of fast and low-fidelity of for example cardboard models can have a negative impact on communication, if it *has too many 'loose' elements causing unwanted noise. The result may be that the most ingenious solution could be rejected, because of presentation."* (Interview with Solstad, J., Kadabra design, 13.02.2007)
On the advanced end of 3-D representation, a Rapid Prototyped model as a result of CAD input, allows the designer to present a perfectly machined product, which may unrealistically represent the "to be manufactured product" as well as entice the client with premature design solution, given them a pre-conception that the product development has reached a more advanced stage than actually the case is.

4. COMMUNICATION THROUGH PRODUCT REPRESENTATION

Nowadays, product development is a team process and therefore, it has often been supposed and shown that communication is one of the most decisive factors for successful product development [46]. Therefore, the process of creating a common platform for communication between the designer and design client is important and should take place in the beginning of the project to improve communication between the two parties.
Within the social context of engineering design, the degree of success when co-operating with a client on a design project is often a matter of good or bad communication. Hereby, communication is defined as the sharing and exchange of information or experiences in a way that relates one party to another, based on the transmission of stimuli and the evocation of responses' [47].
Many of the decisions are made by the designer himself simply because he is the one coming up with the ideas to begin with, however it is usual that the opinion of the client is sought after several stages of the process, depending on the nature of the project.
Until now, the client is referred to as a single entity; however this entity comprises of various stakeholders, such as management, R&D or marketing, with different focus and interests. Therefore, it is important that the designer adapts his communication respective to the different participants to gain suitable feedback on ideas, concepts and products. According to Harold Lasswell's comment on communication: *"Who says What to Whom in What Channel with What Effect"* may be applicable for a collaborative design project, where designer and client communicate, the *Who, What, Whom, What Channel, What Effect* would be [48].

The two most important types of communication for the designer are visual and verbal. The relative strength of verbalisation, are based on the assumption that words are the most common means of human communication, both in face-to-face and computer-mediated environments, as experienced by many designers in conceptualising designs [49]. According to Menezes and Lawson, advanced architecture students used more verbal cognitive actions per minute than novices while describing the same images [50]. Additionally, words are fundamental not just to communication but to the process of thought itself, although this observation may be overlooked or underestimated [50]. Furthermore, verbalisation emphasised the social and collaborative aspects of designing [52]. However, the disadvantage of verbal communication is that the partakers of the conversation need to share a common language in order to fully understand each other. The terminologies of the specialized field, in this case Industrial Design is not necessarily shared and commonly understood among designers, the design clients and end-users of the product.
Designers in all disciplines are sensitive to the appearance of artefacts and environments. Their aim is to achieve a *"speak for itself"* representation at all stages of the project through a wide variety of visual communication tools. The visual qualities of their design products are of great importance to them, as well as to their clients. According to Crilly et al., visual appearances of products play a significant role in determining consumer response [53]. Product form may provide for unarticulated consumer requirements and suggest product qualities that are otherwise difficult to ascertain.
A debate concerning the mode of such representations addresses the use of imagery as the prime generator of visual thinking in designing, where external representations, in the form of drawings of all sorts and other two- and three-dimensional representations, are considered indispensable to design thinking [54].

5. EXPERIMENT

The experiment was undertaken to determine how decision makers in product manufacturing companies understand and interpret different types of product representations at different stages of the product design process.

A total of 14 engineering professionals with good technical background and middle management experience equipped with a certain amount of decision making authority, were involved in this experiment. All professionals were employed in Norwegian companies, however, their type of product development activities varied significantly. They were volunteers invited upon the criteria that they are familiar with (industrial) design processes but did not undergo formal Industrial Design training. The experiment was divided into a quantitative and qualitative section.

5.1 Quantitative Evaluation of Representations (Section 1)

In this section of the experiment, participants were subjected to a wide range of visualisations of four concepts of handheld vacuum cleaners presented through different media. The choice and presentation of the seven (7) different media has been associated to selected stages of the design process (see figure 2).

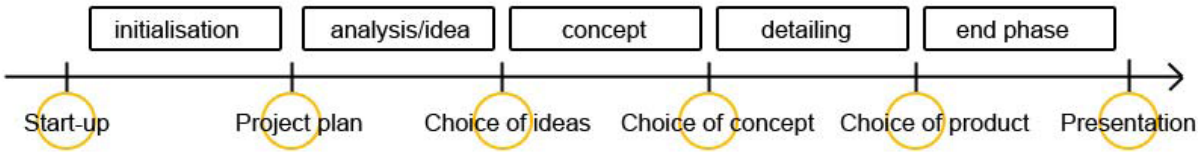

Figure 2: Milestones, where meetings with clients are supposed to take place according to an explicit formalised design process

The objective of this experiment was:

- To find out what type of representations are necessary for design clients to make design decisions at which stage of the design process.
- To determine if there is a correlation between how far the design has been developed and how much room participants believe there is for design change based on the selected method of representation.

A quantitative evaluation of the presented visualisations was required from each participant based on the following two questions:

Question 1: *How would you place and rate the following representations, based on level of detailing and completeness according to the design process on a scale from 1 – 10, whereby "1 = preliminary" and "10 = detailed / near completion"*

Question 2: *How would you place and rate the following representations based on "room for design change according to the design process" on a scale from 1 – 10, whereby "1 = little room" and "10 = much room"*

For each of the four concepts, a series of representations, comprising of sketches, drawings, CAD and physical models of different levels of detailing, were randomly presented and compared. To minimise errors and increase the validity, repetitions of representations were incorporated in the experiment. The representations belonging to the same stage were presented in the detail and style which is of the same quality across the four different hand-held vacuum cleaner concepts. The product representations for the 7 stages were:

5.1.1 Stage 1: Idea Sketch / Thumbnail Drawing

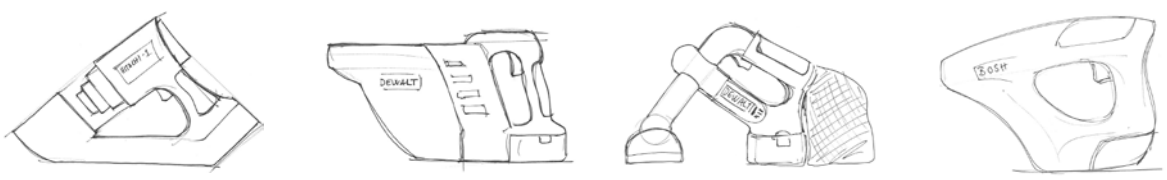

Figure 3: Examples of simple and rough thumbnail sketches using free hand.

5.1.2 Stage 2: Line Drawings

These are black and white drawings, executed with grey or black fine liner. The lines are precisely drawn, avoiding overlapping strokes. This is made possible through tracing of previously generated rough sketches on a light-table.

Figure 4: Examples of accurate line drawings.

5.1.3 Stage 3: Marker Rendered Concept Drawings

Roughly markered rendered concept drawings based on the outlines generated in stage 2. Indications of lights and shadows have been incorporated.

Figure 5: Examples of markered rendered concept drawings.

5.1.4 Stage 4: Presentation Drawings

High quality presentation rendering, generated with the help of a 2-D computer aided drawing program, Photoshop.

Figure 6: Examples of Photoshop rendered presentation drawings

5.1.5 Stage 5: Initial CAD Models

Representations of initial CAD models, modelled in low resolution and with relatively limited detailing, but with the correct colours, using Autodesk Inventor.

Figure 7: Examples of initial CAD models

5.1.6 Stage 6: High Quality Presentations in CAD

Rendered representations of high quality CAD models. Materials and level of detailing are realistically represented in 3-D Studio Max.

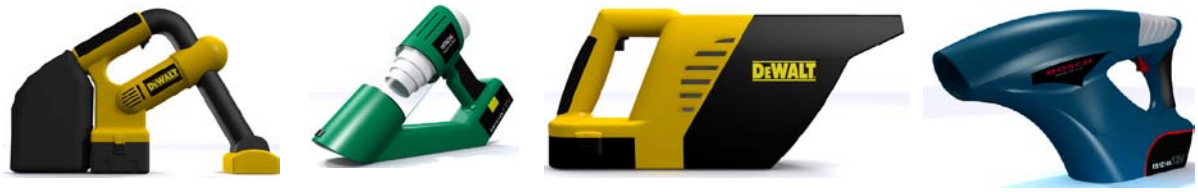

Figure 8: Examples of high quality detailed CAD models

5.1.7 Stage 7: Presentation Quality Design Models

Design models were physically presented to the client

Figure 9: Examples of design models

Results from the quantitative experiment are summarised in the following 2 tables. Table 1 refers to question 1 and attempts to map out level of information perceived by the design clients for the different representations. Table 2 refers to question 2 and provides an indication how much room for design change is available based on the impression each representation communicates to the design client. Values were derived from averaging client's responses in terms of "level of design completion" and "level of room for design change" of the repetitive images of the same type of representation. Scores, which have been highlighted in both table 1 and 2, indicate opposite but complementary trends in terms of how representations have been perceived by the client in terms of level of completeness and room for design change. For example, "Quality Design Models" shows a very detailed level of completion, but suggests little room for design improvement.

Table 1: Design clients' assessment of representation type according to level of detailing and completeness of communicated information. (Values were derived from averaging repetitive images within the same type of representation).

	Level of detailing and completeness on a scale from 1 – 10: "1 = preliminary" and "10 = detailed / near completion"									
Type of Representation	1	2	3	4	5	6	7	8	9	10
Idea / Thumbnail Sketches	5,25	5,5	1,5	1,25	0	0,5	0	0	0	0
Line Drawings	1,5	3,38	3	3,13	0,88	1	0,13	0	0,38	0
Marker Rendered Concept Drawings	0,5	1,25	**2,88**	**1,75**	**3.13**	**1,88**	**1.88**	0,38	0	0,38
Presentation Drawings	0,2	0,2	0,6	2,8	1,4	1,2	1,8	0,6	3,8	1,8
Initial CAD Models	0,38	0,25	1,75	2,88	2,13	2,75	1,63	1,63	0,25	0,38
High Quality Presentations in CAD	0,13	0	0,75	1,5	1,88	1	**1,38**	**1,88**	**3,38**	**2,13**
Quality Design Models	0	0,25	0,63	0,38	1,5	1,63	1,75	1,63	3,25	3

Table 2: Design clients' assessment of representation type according to allowance for design changes (Values were derived from averaging repetitive images within the same type of representation).

	Room for design change on a scale from 1 – 10: "1 = little room" and "10 = much room"									
Type of Representation	1	2	3	4	5	6	7	8	9	10
Idea / Thumbnail Sketches	0	0	0,25	0	0,5	0,75	0,75	2,5	4	5,25
Line Drawings	0	0	0	0,75	1	1,75	1,75	4	3,63	1,13
Marker Rendered Concept Drawings	0	0	1,25	**1,88**	**2**	**2,25**	**2,13**	**2,5**	1,5	0
Presentation Drawings	2,2	3,2	1,8	2,4	1,6	1,2	0,6	1	0	0
Initial CAD Models	0	0,13	1,25	2,5	2,88	3,75	1,38	1,88	0,25	0
High Quality Presentations in CAD	**1,75**	**2,88**	**2,88**	**1,88**	1	1,63	1,38	0,38	0,25	0
Quality Design Models	2,38	2,88	3	2,25	1,25	0,75	1,25	0,25	0,25	0

5.2 Qualitative Evaluation of Representations (Section 2)

Representations as shown in figures ***6*** *(Photoshop rendered presentation drawings)*, ***7*** *(Initial CAD model)*, ***8*** *(Detailed CAD model)* and ***9*** *(Physical design model)* were subjected to qualitative evaluation among the interview subjects.

Regarding the Photoshop rendered representations *(see figure 6)*, many concerns were addressed on the constructive and manufacturing uncertainties of the designs. Also ergonomic aspects, though positively viewed were approached with some scepticism. For example, weight and size is not clearly communicated in the renderings.

Mainly positive comments were related to the product's form and expression. However, it is surprising that the subjects commented on aspects such as production costs, quality, etc without having gained a deeper and more detailed understanding of the designs.

Overall, the initial CAD models *(see figure 7)* seems to communicate a certain level of concreteness in terms ergonomic and technological product information. This is because of the flexibility which CAD provides in terms of viewing modes, such as rotation and zoom in / out. However, considering subjective responses directed towards the form and intended use of the product, subjects were averagely neutral in their opinions. Lack of detailing and product graphics were the reason of this.

Referenced to the detailed CAD models *(see figure 8)*, comments related to construction and manufacturing addressed mainly the identification and functioning of parts. Although, subjects were generally neutral and did not share their likes or dislikes about the way the products have been constructively modelled, negative comments pointed out the ambiguity of how for example, the suction and dust collection parts coherently and technically function. Different opinions were given about the appearance of the designs, but in general comments were positive. Minor comments were that glass components gave a weak and vulnerable impression, and that wall-thicknesses were not clearly represented in the CAD models.

Similar to the Photoshop rendered presentations, and because at this stage CAD models were frozen in presentation mode, information concerning weight and size are sought after from an ergonomic perspective.

Generally, physical design models *(see figure 9)* as a form of presentation were well received among the interview subjects, as it provided a good feeling of weight and volume. Design discussions took place mainly around form and ergonomics. The reasons were that once an opportunity occurred to physically hold a model, ergonomic issues become a natural topic for discussion. Seduced by the almost realistic external presentation of the physical model and expectations of a finalised product, it is not surprising that design clients are extra critical about its ergonomics. A majority of the subjects formed clear opinions about the form and expressions of the products. However, not many comments were made on how the products were principally structured, constructed and expected to function.

The most likely reason is that the presentation of a reasonable tactile volume creates a positive assumption among design clients, reassuring that the technological functionality has been addressed from a constructive as well as a spatial perspective. A minor comment however, is that size of the product is bigger than is perceived on 2-D representations.

6. DISCUSSION

One of the most powerful skills the designer possesses is the ability to communicate visually, through sketches, drawings, CAD representations and physical models. Hereby, the designer should be able to communicate his work to the client in a manner that facilitates decision making. How the designer chooses to present the various ideas and concepts to the client should not be left to chance as different representations are conceived and perceived very differently. The ultimate goal of effective communication is to ensure that clients perceive the same meaning of the represented product according to the designer's communicative intensions [55].

The qualitative section of the experiment shows that the Design clients' assessment of representation type according to level of detailing and completeness of communicated information reversibly complements the room for design changes. For example, "Idea / Thumbnail Sketches" scored very high as a preliminary expression of design but at the same time, it provides much room for design interpretation by the client.

Surprisingly, "Presentation Drawings" (see figure 6), communicates a high level of completeness, which is almost equal to "High Quality Presentations in CAD" and "Quality Design Models". Speculatively explained, technically versed design clients may be positively influenced by the high level of presentation on form and expression, such that confidence on realisation is being boosted.

As expected, tactile interaction between design client and the physical design model, enhances the perception of "near completion" of the design. The tactile volume creates a positive assumption among design clients, reassuring that the technological functionality has been addressed from a constructive as well as a spatial perspective.

A dualistic attitude can be observed among clients, when dealing with CAD models. Due to the incompleteness, but also viewing flexibilities which "Initial CAD models" provide in terms of viewing modes, such as rotation and zoom in / out, of initial CAD-models, clients were averagely neutral in their opinions concerning level of design completeness. However, the representation quality of "Detailed Design Models" are being perceived similar to "Presentation Drawings", because of their high level of detailing, realism and "frozen" mode of presentation.

7. CONCLUSION AND FUTURE WORK

Being able to communicate effectively and convincingly to design clients, according to the level of understanding required is important to facilitate decision making in the designing process in a cost responsible manner. Hereby, the designer should be aware of which representation strategies are powerful and effective to communicate essential information in a specific as well as suggestive way for selected target groups. As the pool of subjects was mainly confined to professionals, who are technically well-versed, future researches should target professionals with a business and marketing background. It may be possible that these group seeks more techno-functional assurance in the alignment with "near completeness" representations.

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