THE EFFECT OF THE DESIGNER'S APPROACH ON THE PERCEIVED PRODUCT QUALITY: AN EXPLORATORY CASE STUDY OF TANGIBLE PRODUCTS

THE VALUE OF DESIGN RESEARCH

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ABSTRACT

Nowadays people tend to value attachment, meaning and experience more than owning even more products. This challenges designers to create products that incorporate more meaning and experience. These kind of products could create a better attachment between user and product, longer use of products and as a consequence less waste. Knowing which steps, methods and tools and other 'components in the design process' have an effect on the user experience of the product could help the designer to create such products through implementing these components more into their design process. This paper describes the study in which the correlations between the components of the design process and the user experience by means of three exploratory case studies. Positive correlations were found between the components in the design process and the perceived product quality for components of the categories 'design shaping methods', 'ergonomic and functional study' and the category 'user involvement'.

Keywords: user experience, design process, product quality, design methods, human-centred design

1 INTRODUCTION

Today's society is rapidly changing into a society in which people prefer attachment, meaning and experience rather than owning even more products (van Dijck, 2007). More and more, people tend to live by the philosophy "less is more". Parts of society no longer want more products, but better products (Rams, 2013). Designers could respond to this societal change by designing from the philosophy of "more for less": products that incorporate more meaning and experience will create better attachment between users and products (van Dijck, 2007). Such attachment could, in theory, lead to prolonged use of products and, consequentially, to less waste. In order to create attachment between users and products, designers should understand the users of their products, as well as their context and activities, by following a disciplined design process inspired by user research (Norman, 2008). Veryzer and Borja de Mozota (2005) showed the value of User-Oriented Design for companies. It can help in addressing the realities of application (e.g., customer product use/needs) as well as the realities of the market. Several tools and methods, mostly originating from ergonomics, usability or user-centred design, are available for designers to ensure a good match between their product and the users' needs, resulting in better user experience. These are available on websites or in guidelines (such as www.designandemotion.org, www.usewell.be, design guide book design methods 1 & 2, Curedale, 2012; universal methods of design, Martin and

Hanington, 2012; etc.). Therefore, one might expect that designers commonly apply such tools and methods and succeed in creating usable, useful and desirable products. Unfortunately, many products still don't fulfill the users' needs and expectations (den Ouden, 2006, Norman, 2010, Nielsen, 2012, van Kuijk, et al.,2009). For instance, the research of Van Kuijk et al. (2009) showed a gap between expected and experienced usability. Customers have certain expectations of the usability of products. However, once customers use products, their assumptions often turn out to be wrong. Some products are so hard to use that consumers need assistance to use them, or even return or abandon the product (Den Ouden, 2006; Steger et al., 2007). To understand the causes of this gap between what users expect from products and the user experience of these products, it is interesting to study whether the designers approach influences the user experience. The different the steps methods, actions, etc. in the design process could play a role in arriving at user focused products. In order to determine the steps methods, actions, etc. in the design process that are critical for positive perceived quality of the product, we examined how design students applied the design process in projects undertaken as part of their studies in this research. In this research all the steps methods, actions, etc. performed during the design process were defined as 'components of the design process'. The components studied here were divided into five categories based on previous study (Kok et al., 2011).

The categories were categorised as follows:

1. 'State of the art': Mapping existing related and non-related products (with similar functionality). The question related to this issue are: Was technology, science and material research conducted?
2. 'Design shaping methods': Use of sketching techniques, computer rendering, 3D prototypes and/or working models.
3. 'Ergonomic and functional study': Study of ergonomic guidelines. Did the designer perform an analysis of the product's functions and the user's tasks? Was an analysis carried out of the risks and of the mistakes and errors that users can make while using the product? Did she/he test similar products her/himself? Was the designed product itself tested with respect to these aspects?
4. 'User involvement': Users involvement in the design process by observation questioning or user tests? How were users involved? Were they questioned, observed or asked for feedback about concepts and models?
5. 'Design research tools': in this category the use of design research tools used (such as cultural probes, ethnographic research…) which the student designers learned to use in the three bachelor years.

When the components of the design process that have a positive effect on the perceived product quality are identified, their influence on users' experience can be estimated and possibilities for improvement can be postulated. This is interesting for several reasons: for design research and education: Design research can then focus on how the components, which have positive effects on the perceived product quality can more easily applied. Education can be adapted so that flaws in the design process can be reduced or eliminated. Finally it is interesting to know how the design process is applied in practice.

The study described in this paper explores the components of the design processes of design students. More specifically, it is focused on the effect of these components on the perceived quality of the resulting products. Identifying which of these components elicit a positive effect on the perceived product quality may help designers to improve their products. In this research three exploratory case studies are studied: a 'mobile toy cabinet' for hospitalized children, a 'washbasin for nursing home hairdressers' and the design of a 'personal aid'.

2 RESEARCH GOAL

The goal of this study was to analyse the effect of the components (steps, tools & methods and others) in the design process on the perceived product quality of the resulting products. The components are classified in to five categories (described in the methods section). A positive effect on the perceived product quality was expected for the category 'state of the art', performing a state of the art analysis of (non) similar products, technology and materials analysis gives designers information about the possibilities and limitations, of the technologies, science, materials etc., and give, amongst others, an idea of the line of thought other designers had concerning similar design problems. Ideas and solutions created by others can inspires people to find new ideas and solutions (Belliston and Belliston, 2000), Similarly the category of 'ergonomic and functional study' is expected to have a positive effect. 'Ergonomic and functional study' increase the usability (Dirken, 1997, Daams, 2011), which often leads to better user experience. Several methods exist to visualise and shape the product during the design process. These methods not only serve to visualise and communicate about the product, but they also are part of the creative process of the designer. Shaping the design, for example by sketching or by making tangible models, stimulates the designer's creativity, (Kuyper, 2005, Cattanach, 1999, Cross, 2006), consequently positive effects on perceived product quality are expected Several researchers (Nielsen, 2010; Sanders, 2006) have stated that user involvement in the design process has a positive effect on the perceived product experience. Therefore user involvement throughout the design process was expected to have a positive effect on the user experience of the designed product. Finally the use of design research tools was expected to have a positive effect on the perceived product quality. Using 'design research tools' can for example stimulate the designers' creativity in finding new strategies etc. to tackle the design challenge or it can enable the designer to gain a better understanding of, for example, how users experience products or certain aspects of products, of the context of the users, of their lifestyle, or of the circumstances in which the users experience certain products useful (Dirken, 1997; Daams, 2011; Curedale, 2012).

3 METHODS

3.1 DATA SET

All three case studies, 'mobile toy cabinet' for hospitalized children, 'washbasin for nursing home hairdressers' and 'personal aid' were assignments carried out by bachelor students in Product Design, at the Luca School of Arts, Belgium.

3.1.1 *Mobile toy cabinet for hospitalized children*

In the case study of the 'mobile toy cabinet' for hospitalized children (five to nine years of age) the design processes of five products, created by second year bachelor design students were studied. The final result that the students had to deliver was a scale model of the designed product that demonstrated each of the functionalities of the design. Features that the students could not implement in the model (for example image projections) were illustrated by means of PowerPoint or Prezi presentations .The designs were assessed by two juries of end-users. One jury consisted of hospital staff (five members of the pedagogical staff, a nurse and two doctors), who would be using the mobile toy cabinet in their daily work. The second jury consisted of 20 children, six to eight years old. The data of both juries were used in the analysis.

3.1.2 *Washbasin for nursing home hairdressers*

Third year bachelor design students created six designs for a 'washbasin for nursing home hairdressers'. The end result had to be a working prototype. The assessment was done by a jury of four hairdressers and one occupational therapist, who all work in a residence for elderly people. First the design students presented the washbasin design and its features (Prezi or PowerPoint). Secondly, the prototypes were tested by the jury members. Afterwards each jury member individually assessed (on paper) each washbasin design by giving a score between 1 and 20.

3.1.1 *Personal aid*

In this cases study eight 'personal aid' products were created for a chosen target group. The student designers (all third bachelor year) chose, in consultation with the coaching teacher, a target group with a very specific need for which she/he would create a personal aid (such as for example a product which enables persons with reduced arm and hand force to work with a lathe). The assessment was done by two or three users (of the target group).

3.1.2 *The jury assessment*

To ensure that each jury (of the three cases) would assess the same characteristics of the designed product, the jury members were asked to pay special attention to the functionality (i.e. ease of use, adjustability to each individual user, the extent to which needs and wishes concerning this product were fulfilled), the design(i.e. color, shape, texture,…), and ease of maintenance. The jury of children, in the case study of the 'mobile toy cabinet for hospitalized children', were only asked to assess functionality and design. All jury members individually scored (on paper) each design on a scale from 1 to 20. Initially the juries were asked to give a score the functionality, the design and the maintenance separately as well as a score for the product in general, only two jury members gave scores for the individual aspect, therefore only the general score is used in the analysis. The evaluation by the children(mobile toy cabinet) was done slightly differently. The children were first asked to indicate for each mobile toy cabinet whether it was good enough to be used in a hospital or not, (This was done as a warming up exercise, as advised by the teacher, because the children do not often give scores). Secondly they were asked to assign a score on a scale from 1 to 20 for each designed product, and only this second score was used in the analysis. A scale of 20 was used because a part of the data of this study is also used in another study in which the ability of designer teacher to estimate the user product experience. In Belgian University Colleges the students (where this study was conducted) assignments are usually scored on a scale of 20.

3.2 STUDY DESIGN

Two type of data were collected, the components of the design processes of the students and the assessments of the designed products by the jury members.

3.2.1 ***Data collection of components in the design process***

Based on the categories, described in the introduction, a survey was created that the design students in the three case studies had to complete after the presentation of their designed product. Based on the data collected with this survey, the components of each design process were mapped and scored, ('0' when the component was not applied and '1' when it was applied by the participant). Figure 1 shows some examples of the components in the design process.

Figure 1- left side: examples of UI: feedback on 2D models, right side examples of the FT- RM-A by self-testing

3.3 STATISTIC ANALYSIS

The data were analysed in SPSS. First a Kruskal-Wallis exact test was executed to find possible significant differences in the scores for the designed product the three cases 'mobile toy cabinet', 'washbasin' and 'personal aid', (independent variable: type of design case, dependent variable the score). Also a Mann-Withney exact two sample test was executed to find possible significant differences in scores between the second bachelor and third bachelor year students designs processes (independent variable: study level student designer, dependent variable the score). Because a relatively small number of design processes was studied and the data consisted of dependent variables, nominal level, (the components) and dependent variable of interval (the score for perceived product quality) a Mann-Withney two sample test exact was done, to analyse which components in the design process had an effect on the scores of the jury.

4 **RESULTS**

4.1 ANALISIS OF THE INDEPENDENT VARIABLES

The mean score for the perceived product quality in the 'mobile toy cabinet' case was 13.40 (SD = 2.302), in the 'washbasin for nursing home hairdressers' case was 14.00 (SD = 3.225) and in the 'personal aid' case was 10.88 (SD = 3.227), (see Table 1). In the comparison of the 3 cases no significant differences were found (χ^2= 4.024, p = 0.134, see Table 2), as a consequence the three case studies are considered as one single case study.

case	**n**	**mean**	**standard deviation**
mobile toy cabined	5	13.40	2302
washbasin for hairdressers	6	14.00	3225
personal aid	8	10.88	3227

Table 1 – means and standard deviations per case

case	**n**	**Mean Rank**
mobile toy cabined	5	7.00
washbasin for hairdressers	6	11.90
personal aid	8	12.42
Kruskal-Wallis K-sample test exact		
chi-Square	4.024	
df	2	
exact significance	0.134	

Table 2 – Kruskal-Wallis K-sample of the three test cases

The mean score for the perceived product quality for the products designed by second bachelor year students was 13.40, (SD= 2.302), in the third bachelor year was 12.21, (SD= 3.490), (see Table 3). In the comparison of the two bachelor years no significant differences were found (U= 25.500, p= 0.402, see

Table 4). Therefore in this study there is no distinction made in the design processes of the second bachelor year and third bachelor year students.

case	n	mean	standard deviation
second bachelor year	5	13.40	2302
third bachelor year	14	12.21	3490

Table 3 –means and standard deviations per bachelor year

case	n	Mean Rank
second bachelor year	5	11.90
third bachelor year	14	9.32
Mann-Withney 2 sample test exact		
Mann-Withney- U	25.500	
exact significance	0.402	

Table 4– Mann-Withney two independent sample test study level

4.2 FREQUENCIES OF APPLICATION OF THE COMPONENTS IN THE DESIGN PROCESS

Except for some components in the category 'ergonomic and functional study' and the categories 'user involvement' and 'design research tools' the components were widely applied (in more than 3/5 of all design processes, see Table 1). The components of the category 'state of the art' one component in the category 'design shaping methods' (2D shaping) and some of the components in the category 'ergonomic and functional study' ('consulting guidelines' and function and task analysis') were applied in almost every design process. From the category 'ergonomic and functional study', the components 'functional, task, risk and mistake analysis self-testing' and 'functional, task, risk and mistake analysis of the designed product' were only applied in less than half of the design processes. Similarly in the category 'user involvement', the components 'Feedback on 2D, 3D and working models' were applied in less than half of the design processes. The 'design research tools' were applied the least, only in one fifth of all processes.

Component in the design process	frequency	
State of the art (STA)		
state of the art of similar products	18	(95%)
state of the art of non-relating products	19	(100%)
Technology, materials, etc. research	19	(100%)
Design shaping methods (DSM)		
2D (sketching/rendering)	18	(95%)
tangible models	15	(79%)
Working model	13	(68%)
Ergonomic & functional study (EFS)		
consulting ergonomic guidelines	17	(90%)
product function and task analysis (FTA)	17	(90%)
product risk and mistake analysis (RMA)	15	(79%)
FTA & RMA by self-testing	9	(47%)
FTA & RMA designed product	8	(42%)
Users involvement (UI)		
questioning users	15	(79%)
observation	13	(68%)
feedback on concepts and/or models		
feedback on concepts (2D)	7	(37%)
feedback on models (3D)	8	(42%)
feedback on working models	9	(47%)
Design research tools (DRT)		
design research tools	4	(21%)

Table 5– Components in the design process: frequencies

4.3 CORRELATIONS BETWEEN THE COMPONENTS AND THE PERCEIVED PRODUCT QUALITY

The average score was 10.9 on a scale of 1-20. Significant positive correlations, between the application of the components and the perceived product quality, were found for components of the categories 'design shaping methods', 'ergonomic and functional study' and 'user involvement'. (see Table 6) In the category 'design shaping methods' a significant correlation was found for the 'design shaping by making tangible (3D) models', (U=0.500, p=0.001). Moderate correlations were found for 'design shaping by making working models', (U=14.000, p=0.029). In the category 'ergonomic and functional study' significant correlations, between the components and the perceived product quality were found for 'product function task, risk and mistake analysis by self-testing', (U=13.000, p=0.008), and for 'product function task, risk and mistake analysis of the designed product' (U=6.000, ρ=0.001). Significant correlations between the components and the perceived product quality was found in the category 'user involvement' for 'feedback on 2D concepts', (U=5.500, p= 0.001) and moderate correlations were found for 'feedback on tangible (3D) models', (U=19.000, p=0.041) and for 'feedback on tangible (3D) models', (U=18.000, p=0.028). For some components interferences can be suspected: to be able to receive feedback about 3D and working models one needs to create 3D models and working models. Therefore we suspected correlations between the application of the components 'design shaping by making 3D models' and 'feedback on 3D models'; and 'design shaping by making working models' and 'feedback on working models'. To get an indication of possible interferences the correlation between these components was analysed by means of crosstabs: no significant correlation was found between 'design shaping by making 3D models' and 'feedback on 3D models' (α = 0.103) and a strong positive correlation was found for 'design shaping by making working models' and 'feedback on working models' (α=0.011, ρ=0.645).

Component in the design process	**frequency**		**mean sore**		**Mann-Withney U**	**p**
	applied	not applied	applied	not applied		
State of the art (STA)						
state of the art of similar products	1	18	10,00	10,00	9.000	0.526
state of the art of non-relating products	0	19	0,00	10,00	/	/
Technology, materials, etc. research	1	19	0,00	10,00	/	/
Design shaping methods (DSM)						
2D (sketching/rendering)	1	18	10,00	10,00	28.000	0.182
tangible models	4	15	2.63	11.97	0.500	0.001
Working model	6	13	5.83	11.96	14.000	0.029
Ergonomic & functional study (EFS)						
consulting ergonomic guidelines	2	17	12.25	9.73	12.500	0.573
product function and task analysis (FTA)	2	17	10.15	9.91	15.500	0.842
product risk and mistake analysis (RMA)	4	15	6.38	10.97	6.000	0.001
FTA & RMA by self-testing	10	9	6.55	13.56	13.000	0.008
FTA & RMA designed product	11	8	6.55	14.75	6.000	0.001
Users involvement (UI)						
questioning users	4	15	11.5	9.60	22.500	0;067
observation	6	13	8.33	10.77	29.000	0.405
feedback on concepts and/or models						
feedback on concepts (2D)	12	7	6.96	15.21	5.500	0.001
feedback on models (3D)	11	8	7.73	13.13	19.000	0.041
feedback on working models	10	9	7.35	12.94	18.500	0.028
Design research tools (DRT)						
design research tools	15	4	9.20	19.00	18.000	0.121

Table 6– Components in the design process: correlations

4.4 DISCUSSION AND CONCLUSION

4.4.1 ***correlations between the components in the design process and the perceived quality***

The main goal of the study described in this paper was to determine which components in the design processes of design students' assignments were critical for the perceived product quality.

4.4.2 *Design shaping methods*

As expected, positive correlations between the components and the perceived product quality were found in the category 'design shaping methods'. Making tangible models can stimulate the designer's creativity and can therefore effect the user's experience, as mentioned in the hypothesises. Another explanation could be that making tangible and working models enables the designer to detect possible limitations and opportunities of the design that are not always visible in 2D concepts. The strong correlation between the components 'design shaping methods by making working models' and 'user feedback on working models' could indicate that there were interference between these two components. In order to get more information about the interferences between the components a study with a larger amount of design processes should be conducted.

4.4.3 *Ergonomic and functional study*

For some of the components strong correlations were found between the components and the perceived product quality. The positive effect on the perceived product quality, found for the component 'functional, task, risk and mistake analysis (FTRMA) by self-testing' was expected. Conducting a 'TFRMA by self-testing', rather than using results of tests done by others, enables the (student) designers to better understand their product's functions. It enables the (student) designer to experience the possibilities and limitations of the products and the possible difficulties to perform certain actions. It could also inspire the student designers to find new possibilities, in simplifying certain actions or in creating new functions for the product. Being creative is not only a mental process but also a (psycho)motor process (Kuyper, 2005; Cattanach, 1999), using the product may have stimulated the creative process. The positive correlation between the component 'functional and task analysis & risk and mistake analysis of the designed product' (FTRMA designed product) was expected as well. When creating new features that solve certain problems one could create new problems which did not occur when the product did not have these features. For the components 'using guidelines' and 'functional and task analysis' no conclusions can be made because they were applied in almost every design process studied. Remarkably the components which have a positive effect on the perceived product quality are conducted the least, (in less than 50%). Further research about how education can encourage designer students to apply more 'FTRMA by self-testing' and 'FTRMA designed product' is needed.

4.4.4 *User Involvement*

In this category several positive correlations were found, between the components and the perceived product quality, as expected. The strongest correlation was for the component 'user feedback on 2D concepts. This could be explained by the fact that 2D concepts are made in the early phases of the design process and adapting 2D concepts is relatively easy and can be done

relatively quickly, compared to adaptations of 3D and working models. Applying user feedback 'on tangible models' and 'on working models' had moderate positive effect on the perceived product quality. Which is in line with what Daams (2011) and Dirken (1997) stated: users often have different product images than designers which can result in different and even wrong interpretations of features and functions. Using 3D models and working models for feedback also enables the designers to analyse how users interpret the product and its features and to adapt the product and its features in order to reduce miss-interpretations.
Similar to the category 'ergonomic and functional study' the components which have a positive effect are applied the least (less than 50%). Further research about how education can encourage designer students to apply more user involvement is needed.

4.4.5 *Design research tools*

When looking at the category design research tools two things stand out: no correlations between the 'Design research tools' and the perceived product quality were found and the 'design research tools' were the least applied of all components analysed in the design processes. Lack of time is one possible explanation, applying design research tools often require effort and time. Students often complained about the limited time for their assignments (this was often mentioned when submitting the assignment). The low application of 'design research tools is consistent with Kujala's (2003) findings. She concluded, from a review of the literature about design research tools for user involvement, that these tools have generally positive effects, especially on user satisfaction, but that they are costly processes and they require time and effort. More research about the reasons for the low application of design research tools in the design process is necessary.

For the components for which no effect was found in this study at least three explanations can be given: (1) the components really had no effect, (2) no correlations could be detected because the component was used in (almost) every case (such as 'state of the art of non-similar products'), and did not differentiate between outcomes, (3) the single component had no effect but certain combinations of components together could effect the results by interference. To analyse such interferences a study with a larger number of design processes should be conducted.

4.4.6 *Study design*

This study was not an in-depth study, but an exploratory case study. Further research with a larger amount of data is needed to analysis whether these results are still valid. The product assessment is conducted only in an early stage (the products are not (yet) on the market). The results give an indication of how users experience these products, but to come to more solid conclusions further research is needed. Secondly this study was executed with student designers, which makes generalisation to the complete designer group difficult. However, since it is difficult to obtain extensive reports about the design processes used by professional designers, analysing these cases could generate knowledge on the components applied in the design process. Analyses of professional design processes of designers of different schools should be

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conducted in order to generalise the results. Additionally the design processes and its effect on the perceived product quality of different kind of products are studied. Different products could have different benefits of the components in the design process. Finally the number of users in the jury was also rather small. The scores used in the analysis were for the designed product in general, this could have biased the results, different jury member might value different aspects, of the design as more important. For example if a product which is easy in us and has a good design but is difficult to maintain might have a different general score if the jury member considered maintenance important or if she/he doesn't.

The results should be interpreted as a first indication of the effect of the design process on the user experience. In order to get a better view on the effect of the components of the design process on the user experience further research with larger sample and a larger jury is required.

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