The Diversity of Non-instrumental Qualities in Human-Technology Interaction

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Abstract

Quality aspects that go beyond the instrumental value of an interactive system are one area of research in the field of user experience. In this paper we describe an approach to the measurement of non-instrumental qualities that defines aesthetic and symbolic aspects as main sub-categories and discuss further relevant sub-dimensions. An exemplary study on three mobile phones is presented that used the discussed assumptions as theoretical basis and applied various questionnaire dimensions from the literature. The results demonstrate the usefulness of the approach and show that a consideration of diverse aspects of non-instrumental qualities makes it possible to better explain users' overall judgments. Implications for the evaluation and design of interactive systems and ideas for future work are discussed.

1. Introduction

In their introduction to the special issue of Behaviour & Information Technology on 'Empirical studies of the user experience' Hassenzahl & Tractinsky (2006) mention three important areas for user experience research: non-instrumental quality aspects, the role of emotions and the experiential character of the user experience. In this paper, we will focus on non-instrumental qualities as one important aspect of the user experience. Non-instrumental qualities can be described as quality aspects of an interactive system that address user needs that go beyond tasks, goals and their efficient achievement.

1.1 Dimensions of non-instrumental quality

In recent years, the importance of various dimensions of non-instrumental quality aspects has been discussed for the area of human-technology interaction. Contributions range from very broad models that consider various aspects of non-instrumental quality, but are not tested empirically, to more focused approaches that are based on empirical results, but consider only selected aspects.

Jordan (2000) argued for a hierarchical organization of user needs and claimed that along with the functionality and usability of the product, different aspects of pleasure, i.e. physio-, psycho-, socio- and ideo-pleasure are important to enhance the user's interaction with it.

Rafaeli & Vilnai-Yavetz (2004) presented a model that suggests that artifacts need to be analyzed according to three conceptually distinct aspects: instrumentality, aesthetics and symbolism. Aesthetics and symbolism represent two categories of non-instrumental quality. Aesthetics refer to the sensual experience a product elicits, and the extent to which this experience fits individual goals and spirits. On the other hand, symbolism refers to the meanings and associations that are evoked by the products.

Further interesting approaches exist in the area of product design. Veryzer (2000) outlined the broad literature on visual aspects of product design and their influence on consumer behavior. He compared different models concerning the processing of product design and how users respond to it. Creusen & Schoormans (2005) claim several roles of product appearance. Next to the functional and ergonomic product values that are described as instrumental quality aspects, they discuss the aesthetic and symbolic product value as important quality dimensions. They define aesthetic value as pertained to the pleasure derived from seeing the product, without consideration of utility. Symbolic value can be described as the ability of a product's appearance to communicate messages, e.g. it may look cheerful, boring, friendly, expensive, rude, or childish.

Crilly, Moultrie & Clarkson (2004) present an integrative approach to qualities of product design and summarized various aspects in three categories: semantic interpretation, aesthetic impression and symbolic association. This distinction relates to the aspects of instrumentality, aesthetics and symbolism introduced by Rafaeli & Vilnai-Yavetz (2004) in some way, but they are described in more detail and are connected to product design features. Semantic interpretation describes the proportion of the product's value that is attributed to its utility. Contrast, novelty and order as well as subjective concinnity that may be regarded as the extent to which the design appears to make sense to the viewer in respect to the consumer's personal, cultural and visual experience are aspects of aesthetic impression. Furthermore, two categories of symbolic association are described. Self-expressive symbolism is described as associated with products that allow the expression of unique aspects of one's personality. Categorical symbolism is associated with products that allow the expression of group membership, including social position and status.

To recapitulate, in most of these approaches two distinct categories of non-instrumental qualities are differentiated. On the one hand, aesthetic aspects are discussed. These aspects mostly concentrate on visual aspects of product appearance. However, other sensual experiences like haptic or auditory aspects of product use are

also concerned as for example discussed by Jordan (2000) in his definition of physio-pleasure. Another category refers to the symbolic value of a product. Aspects like meaning and associations generated by the product are summarized in this category. The concepts of socio- and ideo-pleasure introduced by Jordan (2000) are reflected by this category.

Other contributions focus on selected aspects of non-instrumental qualities and are supported by empirical results. For example, Lavie & Tractinsky (2004) focused on visual aesthetics of websites. They found that users' perceptions consist of two main dimensions, which they termed ''classical aesthetics'' and ''expressive aesthetics''. The classical aesthetics dimension pertains to aesthetic notions that emphasize orderly and clear design and are closely related to many of the design rules advocated by usability experts. The expressive aesthetics dimension is manifested by the designers' creativity and originality and by their ability to break design conventions.

Furthermore, Hassenzahl (2004) introduced the concept of hedonic quality and focused on symbolic aspect of non-instrumental quality. He assumes that two distinct attribute groups, namely pragmatic and hedonic attributes, can describe product character. Accordingly, a product can be perceived as pragmatic if it provides effective and efficient ways to achieve behavioral goals. On the other hand, it can be perceived as hedonic if it provides stimulation by its challenging and novel character or identification by communicating important personal values to relevant others. Summarizing, he subdivides hedonic qualities into the two dimensions of stimulation and identification.

Although non-instrumental quality aspects and their application to design are widely discussed, only a few validated approaches exist for quantitatively measuring them (Hassenzahl 2004; Lavie & Tractinsky 2004). This fact complicates further research on their importance and interplay with other aspects of the user experience. Therefore, the aim of our approach is to take the broadness of the more theoretical models and combine it with the empirical basis given by the more focused contributions (Mahlke 2006).

1.2 An integrative model of non-instrumental qualities in human-technology interaction

We propose a hierarchical model of non-instrumental qualities (Figure 1). Aesthetic and symbolic qualities are two of the main categories in this approach like proposed by most other models discussed before (Rafaeli & Vilnai-Yavetz 2004; Crilly et al. 2004).

Aesthetic aspects of non-instrumental qualities are divided in various dimensions related to the human senses. Visual, haptic and acoustic perceptions are most relevant in human-technology interaction. We distinguish two dimensions of symbolic quality. Communicative aspects are related to the messages a product communicates. They can relate to the expression of unique aspects of one's personality or group membership as described in Crilly, Moultrie & Clarkson (2004) or Cresuen & Schoorman's (2004) concept of symbolic value. Associative aspects on the other hand are concerned with personal memories like described by Norman (2004) on his reflective level of product perception.

A third category integrates so called motivational aspects. It includes non-instrumental qualities like described in Hassenzahl's (2004) concept of stimulation. This main category is not considered in the empirical part of this paper because most of the broad approaches described earlier do not consider these aspects. However, if further empirical research demonstrates the importance of this category, future studies should also incorporate motivational aspects

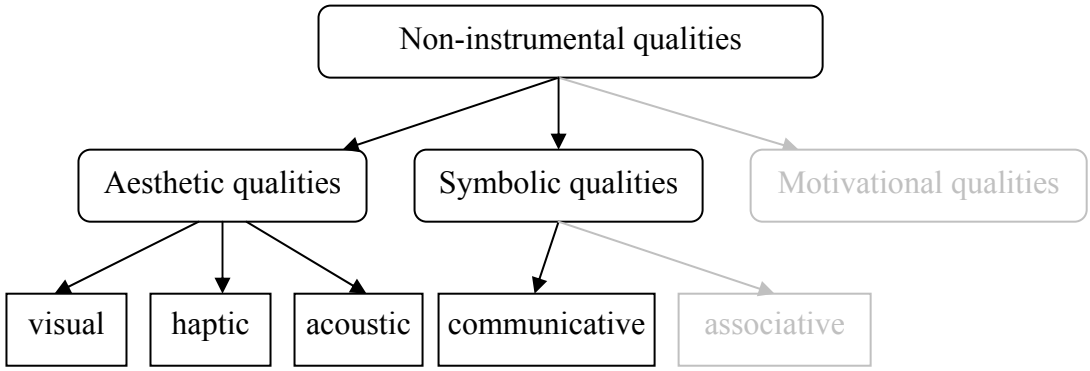

Figure 1: Model of non-instrumental qualities (black concepts used in the study in section 2)

Based on this model of non-instrumental qualities existing detailed approaches can be used to measure the particular dimensions empirically like for example Lavie & Tracinsky's (2004) work on visual aesthetics.

1.3 Non-instrumental qualities and overall judgments

Several empirical studies relate overall judgments to quality aspects of interactive products. Mahlke (2002) studied the influence of user's perceived usefulness, ease of use, hedonic quality and visual aesthetics on the intention to use specific websites. He found that the instrumental quality aspects, i.e. usefulness and of use, show a main contribution to the overall judgment, but that also the non-instrumental qualities of the system, i.e. hedonic quality and visual aesthetics, play an important role. Hassenzahl (2004) studied the interplay between usability and hedonic quality in forming overall judgments. He used two overall judgments, i.e. beauty and goodness. He found that judgments of beauty are more influenced by user's perception of hedonic quality, while judgments of goodness - as a more general evaluative construct - are affected by both hedonic quality and usability. The importance of various dimensions of non-instrumental qualities and the sensibility of our model can be evaluated studying the explanation of overall judgments.

1.4 Research questions

In conclusion, the following research questions arise from these theoretical considerations:

- Which dimensions of non-instrumental qualities are important for interactive product experiences?
- What is their influence on overall judgments of interactive products?
- Does our diversity approach explain more variance than other approaches to non-instrumental qualities (like e.g. Hassenzahl, 2004).

We assume that various sub-dimensions of aesthetic and symbolic quality represent independent and relevant factors for the perception of non-instrumental aspects of product quality. Furthermore, the consideration of aesthetics and symbolic quality aspects should lead to better results predicting overall judgments than focusing on specific aspects of non-instrumental qualities.

2. Method

Three mobile phones were incorporated into a study to investigate the relations of various dimensions of non-instrumental qualities and their influence on overall judgments.

2.1 Participants

Sixty individuals (35 women, 25 men) participated in the study. They were between 17 and 44 years old (28.5 years on average). Most of the participants (n = 57) used a mobile phone regularly and experience with mobile phone usage was 6.1 years on average. Six of the participants used a mobile phone from the same brand at the time the experiment was conducted and another eleven had used one before.

2.2 Stimuli

Three mobile phones were used as stimuli. All were from the same manufacturer, so the influence of brand did not have to be considered. Furthermore, the three products were similar with respect to instrumental qualities. However, the three mobile phones differed regarding non-instrumental quality aspects. Differences with respect to aesthetic and symbolic qualities were assured in a pretest with seven experts of usability and product design. The experts got a description of all non-instrumental quality dimensions and gave a rating for each dimension. Furthermore, the experts confirmed that the differences regarding instrumental qualities were only minor.

Figure 1: Mobile phones used in the study (from the left Motorola PEBL, RAZR V3 & T191, in the following they are referred to as Product A, B & C)

2.3 Design

The factor 'product' was the only independent variable in the study. Each of the three mobile phones represented one condition. The independent variable 'product' was a between-subjects factor. So each condition was completed by twenty participants.

2.4 Dependent Variables

Aesthetics aspects were measured with the following questionnaire dimensions: classical visual aesthetics (Cronbach's alpha .70) as recommended by Lavie & Tractinsky (2004) to assess visual aesthetics, a scale based on Jordan (2000) to measure haptic quality (Cronbach's alpha .82) and five items taken from Farina (2001) to measure acoustic quality (Cronbach's alpha .90). Symbolic aspects were surveyed using a scale that focused on the communicative sub-dimension (Cronbach's alpha .82). Each of the scales consists of five items and ratings ranged from 0 to 6 (low to high).

To compare our model with a more focused approach to non-instrumental qualities we measured Hassenzahl's (2004) dimensions of identification and stimulation (Cronbach's alpha .77 and .90, respectively). The scales consist of seven items each and ratings ranged from 0 to 6 (low to high).

Overall judgments were assessed using a one-item scale that ranged from 0 to 6 (low to high). Furthermore, we surveyed pragmatic quality (Hassenzahl 2004) to verify that the products did not differ with respect to instrumental qualities.

2.5 Procedure

The study was conducted in the UseLab at the Center of Human-Machine-Systems at Berlin University of Technology. At the beginning of the experiment participants received a description of the study. Afterwards participants were assigned to one of the three conditions. To experience the interaction with the products seven typical tasks were given to the participants for each product (tasks ranged from turning on the phone to changing date and time or saving a phone book entry). Participants had ten minutes for the tasks. After accomplishing all the tasks, participants filled out the questionnaire that assessed their ratings regarding the different quality dimensions and the overall judgment.

3. Results

After giving an overview of the average ratings for the three mobile phones on each of the assessed quality dimensions, results on the correlations of the various quality dimensions are described. Furthermore, results on the influence of the quality dimensions on participants' overall judgments are presented.

3.1 Quality Perceptions for the Three Products

An overview of the data for all dependent variables for the three conditions of the factor 'product' is given in Table 1. Overall, Product A and B were rated similarly high, while Product C received lower ratings ($F(3,57)=6.6$, $p<.01$). Accordingly, Product C received the lowest ratings on all four dimensions of non-instrumental

quality proposed in our model, although differences in haptic quality were not significantly different ($F(3,57)=0.7$, $p=.50$). Product B was rated high with respect to visual aesthetics ($F(3,57)=2.7$, $p<.05$) while the evaluations regarding haptic and acoustic quality ($F(3,57)=3.2$, $p<.05$) were lower in comparison to Product A. On the other hand, Product A received lower ratings regarding the symbolic quality ($F(3,57)=3.6$, $p<.05$).

Table 1: Mean Scores and Standard Deviations on All Dependent Variables for the Three Products

dependent variable	Product A		Product B		Product C	
	M	SD	M	SD	M	SD
overall rating	3.3	1.6	3.1	1.4	1.9	1.1
visual aesthetics	3.7	1.2	3.8	1.1	3.1	0.8
haptic quality	3.7	1.5	3.2	1.5	3.2	1.2
acoustic quality	3.2	1.3	2.8	1.2	2.1	1.3
symbolic quality	2.4	1.5	3.0	1.1	2.2	0.8
identification	3.8	1.1	3.7	0.7	3.5	0.6
stimulation	3.8	0.8	3.8	0.8	1.9	1.2
pragmatic quality	3.0	1.3	2.8	1.2	2.9	1.1

Regarding the dimensions proposed by Hassenzahl (2004) the results showed that all three products were rated almost alike for identification ($F=(3,57)=0.9$, $p=.41$) and Product C had a lower rating for stimulation in comparison to the two other products ($F=(3,57)=24.6$, $p<.001$). The pragmatic quality was rated similar for all products. Thus, no significant differences between the three products were found with respect to pragmatic quality, $F(3,57)=0.2$, $p=.80$.

3.2 Correlations between Quality Dimensions

The relationships between the assessed dimensions of non-instrumental quality are reported in Table 2. Noticeable is that there is no significant correlation between the three dimension that focus on aesthetic aspects. Symbolic quality on the other hand is correlated significantly with all aesthetic scales.

Table 2: Correlations between the dimensions of non-instrumental quality

dependent variable	stimulation	identification	symbolic quality	acoustic quality	haptic quality
visual aesthetics	0.40**	0.48**	0.54**	0.21	0.25
haptic quality	0.18	0.28*	0.36**	0.25	1
acoustic quality	0.45**	0.52**	0.41**	1	
symbolic quality	0.47**	0.61**	1		
identification	0.47**	1			
stimulation	1				

* p < .05; ** p < .01

The two dimension identification and stimulation are correlated with each other and almost all of the other non-instrumental quality dimensions.

3.3 Regression of Overall Judgments

Regression analyses were performed to better understand the influence of the various dimensions of non-instrumental quality on overall judgments. First, we applied the model on non-instrumental qualities presented in Section 1.2 and incorporated the dimensions of visual aesthetics as well as haptic and acoustic quality as aesthetic aspects and the dimension of symbolic quality to predict participants' overall judgments. Table 3 reports the results of the analysis. All four dimensions contribute significantly to participants overall ratings. Overall 72% of the variance of the overall judgments can be explained using the four dimensions of non-instrumental quality.

*Table 3: Regression of Overall judgment with our model (Beta values and significances *** p < 0.01; * p > 0.05)*

Predictors	Beta	Std. Error
visual aesthetics	0.22*	0.13
haptic quality	0.33***	0.09
acoustic quality	0.31***	0.09
symbolic quality	0.32**	0.12
R^2	.72	
* p < .05; ** p < .01		

In another regression analysis we applied the model proposed by Hassenzahl (2003) using the two dimensions identification and stimulation. The results are presented in Table 4. Both concepts contribute significantly to the overall rating. Overall 38% of the variance of the overall judgments can be explained using the four dimensions of non-instrumental quality.

*Table 4: Regression of Overall judgment with the model Hassenzahl (Beta values and significances ** p < 0.01; * p > 0.05)*

Predictor	Beta	Std. Error
Identification	0.43**	0.21
Stimulation	0.31*	0.13
R^2	.38	
* p < .05; ** p < .01		

4. Discussion

Based on the structural model of non-instrumental quality aspects the study focused on the relationship of the proposed dimensions of non-instrumental quality and their importance for overall judgments. Four dimensions of non-instrumental quality were incorporated in the study: three aspects of aesthetic quality and one dimension to measure symbolic aspects of product quality.

The descriptive results show that each of the three products incorporated in the study led to different profiles of non-instrumental quality perceptions. Similar to the results from a study on portable audio players in Mahlke (2006) these results give hints that the consideration of diverse dimensions of non-instrumental quality can enrich the view on users' product evaluations. Interestingly, we did not find significant correla-

tions between the three quality dimensions focusing on aesthetic aspects. Thus, aesthetic dimensions of product quality seem to be perceived independently. However, the aesthetic scales were all related to the symbolic quality dimension. Therefore, a relationship between aesthetic and symbolic quality perceptions is assumable.

The comparison to another model of non-instrumental qualities in human-technology interaction (Hassenzahl 2004) demonstrated that the consideration of diverse dimensions of non-instrumental qualities like proposed in our model can better explain overall judgments. However, it has to be considered that we used more variables to predict overall ratings than the compared approach. Nonetheless, this extension increased the variance of overall judgments that could be explained.

Some limitations remain in the study. Using real products that differ on various design dimensions made it impossible to identify which system attributes influence non-instrumental quality perceptions. A more detailed approach is necessary to answer this question. Furthermore, only one dimension of symbolic quality was incorporated into the study, although we discussed further aspects in the model. At last, the relationship of aesthetics and symbolic aspects has to be clarified further. However, the results of this study give first hints regarding the connection of these two categories of non-instrumental qualities.

5. Conclusions

We proposed a model of non-instrumental qualities that aimed at combining the advantages of more focused contributions (Hassenzahl 2004; Lavie & Tractinsky 2004) and broader, conceptual approaches (Creusen & Schoormans 2005; Crilly, Moultrie & Clarkson 2004). The results of a study on mobile phones demonstrated that it is reasonable to integrate divers dimensions of non-instrumental quality to evaluate interactive products and that our approach has a prognostic advantage for the users' overall judgments over more focused approaches.

Therefore, the evaluation of interactive systems should incorporate a diversity of non-instrumental quality aspect to better understand users' perception of qualities that go beyond the instrumental value. We demonstrated how existing questionnaires can be combined to achieve a measurement of various non-instrumental quality aspects. This approach to the evaluation of interactive products can also be deployed in applied projects. Furthermore, the proposed model can be used by designers to guide their thinking about users' needs during the design process.

To better understand the user experience as a whole and the relevance of non-instrumental qualities in particular more research is needed that focuses on the interplay of non-instrumental quality aspects with instrumental qualities and emotional user reactions. We proposed an approach to the experimental study of these three main aspects of the user experience (Mahlke & Thüring 2007) and will continue to deliver more empirical contributions (Mahlke & Lindgaard 2007) that support the design and evaluation of future user experiences.

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