The Dimensions of Positive and Negative User Experiences with Interactive Products

Gabrielle Provost and Jean-Marc Robert

École Polytechnique de Montréal
Department of Mathematics and Industrial Engineering
P.O. 6079, St. Centre-Ville, Montréal, Québec, H3C 3A7
{gabrielle.provost,jean-marc.robert}@polymtl.ca

Abstract. This study aims to identify and define the dimensions of User Experience (UX) with interactive products, measure the frequency of their presence and their strength. We conducted an empirical study with 25 subjects who were asked to describe a positive and a negative experience with an interactive product, and explain why it was positive or negative. Then, they had to complete an evaluation grid about the dimensions. Three judges listened to the UX stories in order to extract the dimensions and point out those that were the most important. Results show that 10 dimensions can account for any UX. The psychological, functional and usability dimensions are present in a large number of UXs (90%, 88%, 88%), followed by the cognitive, informational and perceptual dimensions (74%, 70%, 66%). Results also show that the same dimensions can be used to describe positive and negative UXs and that positive UXs include a larger number of dimensions than the negative UXs.

Keywords: User Experience, Interactive products, UX Dimensions, UX Evaluation.

1 Introduction

Despite the conceptual complexity of User Experience (UX), there is a craze for the subject among researchers and practitioners in the HCI and interaction design communities. This enthusiasm can be explained by the fact that UX refers to a rich, broad and inclusive reality that focuses on the end of an interaction with a product rather than the means to get there [8]. "UX has emerged as an umbrella phrase for new ways of understanding and studying the quality-in-use of interactive products." [1] However, it is generally accepted that UX is an extension of the concept of usability, implying the existence of additional dimensions to be considered for its modeling and evaluation [5]. Since UX is an end, the challenge for researchers and practitioners is to understand how to create a positive experience among users of interactive products. To face this challenge, we need to be able to evaluate it. Thus, this study aims to identify and define the dimensions of UX with interactive products, to measure the frequency of their presence, and to assess their strength in order to lay the ground for

the construction of a UX evaluation tool. UX dimensions can be defined as categories of elements that have an impact on a user when this user interacts with a product to do an activity in a given context.

2   Definition and Characteristics of UX

ISO9241-210 [6] defines UX as "a person's perceptions and responses that result from the use and/or anticipated use of a product, system or service." UX includes all the users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors and accomplishments that occur before, during and after use and that is influenced by the interactive system, the user and the context of use. Robert & Lesage [10] add that UX is also influenced by the activity. Indeed, since there is an interaction with a system, there must be an activity that involves a place, a time, inputs/outputs, etc. If the activity is poorly understood or considered out of context, the system, however effective, would not ensure a positive UX.

Based on a literature review and their own work, Robert & Lesage [12] extracted the following characteristics of UX: it is concerned with every aspect of the interaction with a system, related artifacts, the services, and the company; it is subjective; it is multidimensional and holistic; it is an overall effect on the user (it cumulates the effects experienced at each point of contact with the artifacts); it spans in and over time (it is not static); it depends on four basic elements: the *User* interacting with a *System* for doing an *Activity* in a *Context*; it is situated in a context (or is context-dependent); it can be considered at different granularity levels; it applies to an individual as well as to a team.

3   UX Dimensions

Since UX is not fully understood yet, it is a challenge to look into UX dimensions. UX models are not well established scientifically and do not all have the same level of granularity. Moreover, authors use different terms to refer to things about UX that are similar, close or different from each other, for instance: attributes [3], levels [2], components [12], aspects [7], elements [13] and dimensions [10] [11]. Dimension is the term that is preferred by [1] to incorporate the views on more than fifty studies on the dimensions of UX and it is the one we adopt in this work. In this study, we briefly discuss different models of UX and highlight the dimensions identified by various authors:

- Thüring & Mahlke [12] present a model according to which the user perceives two components: instrumental qualities and non-instrumental qualities. These two components influence a third one, i.e. the emotional reactions. The three components of UX lead to the establishment of an overall assessment of the quality of the system.
- Kort et al. [7] base their model on three aspects: composition (usability and pragmatic/behavioral characteristics), aesthetics and meaning. Each aspect is expressed through a set of design elements and combined to create the UX that evolves through a process of sense formation. The three UX aspects lead to emotions.

- Hassenzahl [3] believes that when a user comes into contact with a product, s/he perceives its characteristics and constructs a personal version of the product character. This character consists of pragmatic and hedonic attributes and leads to a judgment on the product's appeal and to emotional and behavioral reactions. Hedonic attributes are divided into two categories: stimulation and identification.
- Roto & Rautava [13] argue that a company can define a unique set of UX elements (between four and eight) that reflects its mission and objectives. There can be high-level elements for all products and lower-level elements for sub-categories of products. For Nokia, four elements were divided into two groups: utility and usability in the pragmatic group; and social value and pleasure in the emotional group.
- According to Garrett [4], the secret to designing a positive UX lays in a fundamental duality of the product, that is to say, the functional and informational aspects.
- Robert & Lesage [11] argue that UX is formed by one or more dimensions whose relative weight varies depending on the user's perceptions. They suggest six dimensions: functional, physical, perceptual, cognitive, social, psychological and two meta-levels: sense-making and aesthetics. Sense-making is a basic requirement for every other dimension because users give meaning to everything they do and aesthetics acts as higher octave of one or several dimensions at a time as some users refer to it as an expression of their overall UX.

In light of the literature, it is possible to describe a UX through a small number of dimensions that would apply to the vast majority of products. The dimensions of Robert & Lesage [10] [11] represent a good starting point.

3.1   Two Empirical / Analytical Studies of UX Dimensions

Robert & Lesage [10] [11] observed (and interviewed in two cases) six individual users or groups of users who had been using different systems in various contexts. Their goal was to better understand the characteristics of UX and their effects on users, and to identify UX dimensions. They reported results of their interviews and observations in the form of short stories. They extracted six UX dimensions: functional, psychological, cognitive, perceptual, physical, and social.

Robert & Larouche [9] brought the project one step further: and conducted a questionnaire-based survey on UX with 52 respondents. Their results confirm that all of the UX dimensions below, with the exception of the cultural dimension, can capture the characteristics of UX with interactive systems.

1. **Functional:** the respondent discusses the importance of the product's capacity (or power), robustness, rapidity, reliability, usefulness, accessibility, usability, etc. S/he talks of the functionalities, novelty, type of technology, and of their impact on the realization of his/her activities. S/he also talks of duration of batteries.
2. **Perceptual:** the respondent talks of the importance of his/her perceptual contact with the object, through vision, audition, smell, or touch. S/he talks of the aura of the product, of its aesthetics.

3. **Physical:** the respondent talks of the product's weight, size and noise, of the physical effort s/he must make and of the fatigue or pain s/he might feel.
4. **Cognitive:** the respondent talks of the cognitive load related to the interaction with the product. S/he talks of learning, understanding, decision-making, development of his/her abilities, competence, and situation awareness.
5. **Psychological:** the respondent talks of the emotions generated by the interaction with the product, of the impact of the product on his/her attitudes, opinions, motivations, identity, satisfaction. S/he discusses the underlying values of the product in relation with his/her own emotions.
6. **Social**: the respondent talks of the importance of others (e.g., parents, friends, work colleagues, etc.) and his/her relations with them when s/he uses the product. S/he talks of the impact of different representatives of enterprises on his/her relation with the product (e.g., customer service).
7. **Informational:** the respondent talks of the quantity, quality, reliability, completeness, precision, and up-to-date of the information provided by a product (e.g., Web site). S/he talks of the quality of writing, spelling, and syntax.
8. **Contextual:** the respondent talks of elements which are outside the usage of the product but determinant for his/her global satisfaction: for instance, publicity, documentation, quality-price relation, his/her experiences with other products, etc. S/he also talks of different points of contact with the enterprise and their impacts on the appreciation of the product usage.
9. **Cultural:** the respondent talks of the way the product contributes to defining and reinforcing his/her cultural identity: for instance, language, culture, music, food.
10. **Temporal:** the respondent discusses the time spent doing the activity and the impact of the frequency of use of the product. S/he also talks of his/her perception of time s/he saves or looses when using the product.

In Robert & Larouche's study [9], the functional and psychological dimensions are present in almost all UX stories (96% and 90%), followed by the cognitive (80%), contextual (79%), and informational dimensions (74%). There are no differences between positive and negative UX stories when one looks at the dimensions that are present in them. There are no differences between the three groups of respondents (different ages) when one looks at the presence of dimensions in their UX stories.

4   Methodology

This section describes the methodology of the empirical study we conducted on UX. It includes a description of the subjects and the procedure with them, of the judges and the procedure with them, and of the analysis grid that was used to identify the UX dimensions.

Subjects. Twenty-five (N=25) subjects participated in a semi-structured telephone interview. Subjects were recruited from the personal contacts of the researcher. Of the 25 subjects, 12 (48%) are men and 13 (52%) are women. The distribution of subjects according to age goes as follows: 18-29 years (N = 8; 32%), 30-39 years (N = 6; 24%), 40-49 years (N = 6; 16%), 50 years and over (N = 6; 24%). The occupations

are highly diversified among subjects. Participation was voluntary and the subjects were not paid.

Procedure for the Subjects. Interviews were conducted between July and August 2012. Interviews lasted approximately 30 minutes, were conducted with Skype and recorded. The subject's participation consisted of the following activities: read and sign the "Information and Consent Form"; provide demographic information; describe a positive and a negative experience with an interactive product; complete a UX evaluation grid

- **UX Description.** The subjects were asked to describe their positive experience with an interactive product and explain why it was positive. The exercise was then repeated with the negative experience. No other instructions were given to minimize the influence on their responses.
- **UX Evaluation Grid.** Subjects first had to read the grid that included a short definition of the nine following dimensions: functional, informational, perceptual, physical, cognitive, psychological, social, contextual, and temporal. Subject had to indicate on a scale of 0 to 5 if each of the dimensions had contributed to make his/her experience positive (0= no contribution; 5= great contribution). The exercise was repeated for the negative experience using a scale of 0 to -5. For each rating, subjects were encouraged to briefly justify the scores. All answers were given orally.

Judges. Three independent judges listened to the UX stories and evaluated them. Their qualifications were as follows: a woman with a bachelor's degree in mechanical engineering and a master's degree in ergonomics; a man with a bachelor's degree in computer science, a master's degree in software ergonomics and one year of experience as an interface ergonomist; a woman (the first author of this paper) with a bachelor's degree in marketing communications and a master degree in ergonomics in progress.

Analysis Grid. The analysis grid is a modified version of the UX evaluation grid described above, and aimed to facilitate judges' work. Dimensions were classified into two poles: the product pole (including the following dimensions: functional, usability, informational, physical characteristics, external characteristics, other) and the user pole (including the following dimensions: perceptual, cognitive, psychological, social, physical, other). Indeed, for some aspects of the UX, subjects mainly describe the qualities of the product and use objective terms, whereas for other aspects of the UX, they describe how they lived the experience and use personal terms. This classification of the dimensions has strong face validity and goes in the same direction as the distinction between the dimensions that relate to pragmatism and those that goes beyond it. Moreover, "other" was added to the user pole and the product pole to write down users' statements not belonging to any dimension identified so far; usability was added to separate it from the functional dimension; the physical dimension was split in two; the contextual dimension was renamed to avoid any confusion with "context of use"; the temporal dimension was removed because it overlapped with the notion of efficiency in the usability dimension.

Procedure for the Judges. The judges systematically extracted subjects' statements corresponding to the UX dimensions: they listened to the interviews, wrote down subjects' statements and associated them with one of the 10 UX dimensions (or "other") in the analysis grid. Then, judges' notes were pooled and transcribed into a new grid that the three judges agreed on. Finally, the judges had to determine the most important dimensions in each UX story in order to calculate the strength of the dimensions. The selection was based on the number of statements contained in a dimension, the frequency of each statement or synonyms, the time spent discussing a statement, and the expressions or the tone of subject's voice.

5   Results

Frequency corresponds to the percentage of times (on a total of 50) a dimension is considered present in a UX and strength corresponds to the percentage of times a dimension is considered important in a UX.

Interviews. On average, an interview with a subject lasted 29.3 min (SD = 7.4 min; Min = 19 min ; Max = 53 min). Skype turned out to be an excellent method for collecting data because participants far away could easily be reached, they did not have to write or travel, we could ask questions of clarification, and we could collect the voice tone.

Products. Products chosen by the subjects can be grouped in seven main categories: Web sites (8); smartphones, tablets and their applications (10); computers and software (9); small electronic devices (10); cars, motorbikes and their components (6); furniture (3); and Bixi, a public bike service in Montreal. The participants had used most products quite recently: 92% (N = 23) of positive UXs and 68% (N = 17) of negative UXs had occurred during the week preceding the meeting.

Number of Dimensions Per UX. On average, positive UXs contain 8.8 dimensions (SD=1.5) and negative UXs contain 6.7 dimensions (SD=2.0) out of a total of 12 dimensions. Therefore, a positive UX contains on average 2.1 more dimensions than a negative UX. Because positive UXs are characterized by a greater number of dimensions, it leads us to believe they are richer and complete. It is also possible that several positive elements are needed to form a positive UX, while only one or a few negative elements are sufficient to form a negative UX.

Frequency of UX Dimensions. When all UX are combined, the three most frequent dimensions are psychological (90%), functional (88%) and usability (88%) (see Table 1). These three dimensions are also more frequent when positive UXs and negative UXs are taken separately. Since they are part of a greater number of UXs, it is possible that these three dimensions are more universal than the others. This result is consistent with those of Robert & Larouche [9], which is not surprising since the functionality is the reason why a person uses a product, the usability makes the interaction possible, and the psychological dimension, which includes fun, emotions, attitudes, values, is the user's response towards a product.

On average, dimensions are present in 73.7% of the positive UXs and in 56% of negative UXs (see Table 1). So positive UXs tend to be characterized by a greater number of dimensions than negative UXs. This difference is particularly marked for the perceptual, social, and external characteristics dimensions: they contribute more often to make a UX positive than to make it negative.

Table 1. Frequency of UX dimensions

Dimensions	Positive UXs	Negative UXs	Difference	Total of UXs
Product Pole				
Functional	92%	84%	8%	88%
Usability	100%	76%	24%	88%
Informational	84%	56%	28%	70%
Physical characteristics	48%	36%	12%	42%
External characteristics	72%	40%	32%	56%
Other	56%	40%	16%	48%
Mean	**75.3%**	**55.3%**	**n.a.**	**65.3%**
User Pole				
Perceptual	92%	40%	52%	66%
Cognitive	76%	72%	4%	74%
Psychological	88%	92%	-4%	90%
Social	76%	32%	44%	54%
Physical	40%	40%	0%	40%
Other	60%	64%	-4%	62%
Mean (User Pole)	**72.0%**	**56.7%**	**n.a.**	**64.3%**
Total				
Mean	**73.7%**	**56.0%**	**17.7%**	**64.8%**
Total	**N=25**	**N=25**	**n.a.**	**N=50**

Contribution of the UX Evaluation Grid. The results show that the UX evaluation grid leads subjects to discuss their UX with a larger number of dimensions. The dimensions that are most often forgotten by the subjects are the cognitive and the psychological. They are both related to the user pole. In fact, people forget to mention dimensions at the user pole three times more often than dimensions at the product pole. The reason might be that people have more difficulty talking about subjective dimensions (e.g., thoughts, emotions, perceptions, etc.) than about objective dimensions. The UX evaluation tool we are constructing will have an advantage over interviews or observations, since it will directly ask questions about all the dimensions.

Strength of the Dimensions. Four dimensions get higher scores than the others: usability (60%), psychological (44%), informational (38%) and functional (34%). Dimensions at the product pole are considered important almost two times more often than dimensions at the user pole. Moreover, there seems to be a relationship between the frequency of a dimension and its strength since the psychological, the functional and the usability dimensions emerge in both cases.

Table 2. Strength of UX dimensions

(N.B.: the percentage represents the number of times, out of a total of 50, a dimension is considered important in the UX stories)

Dimensions	Positive UXs	Negative UXs	Total of UXs
Product Pole			
Functional	40%	28%	34%
Usability	60%	60%	60%
Informational	44%	32%	38%
Physical characteristics	12%	20%	16%
External characteristics	12%	4%	8%
Other	16%	12%	14%
Mean	**30.7%**	**26.0%**	**28.3%**
User Pole			
Perceptual	12%	8%	10%
Cognitive	12%	16%	14%
Psychological	36%	52%	44%
Social	8%	4%	6%
Physical	20%	20%	20%
Other	0%	0%	0%
Mean	**14.7%**	**16.7%**	**15.7%**
Total			
Mean	**n=25**	**n=25**	**n=50**
Total	**22.7%**	**21.3%**	**22.0%**

Composition of UX Dimensions. Data analysis has allowed us to make a list of all users' statements related to each dimension. Subjects often used a variety of words to express the same thing, for example, "beautiful appearance", "beautiful object", "pretty", "visually appealing", "enhanced visual" "cute", "wow", etc. In such cases, words were grouped under a single term and only the most frequent words were reported. Moreover, some statements were grouped under a single label: for example, when subjects outlined a series of product features, it was summed up by "Includes many features." Because of space constraints, the complete lists of users' statements are not presented in this paper; we rather present a summary (Table 3). These words and statements can be considered as sub-dimensions and will be useful when building a subjective evaluation tool of UX.

Table 3. Users' statements for each dimension

Product Pole	User Pole
Functional: Utility and needs' satisfaction; Functionnalities and options	**Perceptual:** Aesthetic; Presence and quality of multimedia; Stimulation of the five senses
Usability: Simplicity and ease of use; Speed and efficiency	**Cognitive:** Comprehension; Concentration and reflection; Attention and memory; Stimulation, discovery and learning
Physical characteristics: Weight, size and dimension; Adjustments (including dis/assembly)	**Psychological:** Fun / Frustration; Motivation; Expectations (satisfaction and disappointment); Values, meaning and evocation
Informational: Presence and relevance of information; Quality of information	**Social:** Presence of others and quality of interactions; In/dependence on other; Obtaining information about others
External characteristics: Product ecosystem (products complementing each other); Customer service and brand	**Physical:** Physical activity; Transportation, movements and gestures; Dis/comfort
Other: Accessibility and availability; Reliability and durability; Security	**Other:** Productivity (time); Profitability (money)

6   Conclusion

This study showed that the 10 dimensions presented in this paper can be used to characterize UX with a large number of products. The same dimensions can be used to describe positive and negative UXs. However, results indicate that positive UXs tend to be characterized by a larger number of dimensions than negative UXs. The psychological, functional, and usability dimensions seem to play the most decisive role in the evaluation of UX by the subjects. There seems to be a relationship between the frequency of the dimensions and their strength as the most frequent dimensions are usually strong. Finally, the study has made possible to extract sub-dimensions of each dimension.

Next steps of our research will consist in doing the following activities: evaluate the independence or interdependence of the dimensions with statistical analysis to see if some can be merged together; confirm the validity of grouping the dimensions around the product pole and the user pole; refine the analysis of the UX sub-dimensions in order to have the most representative ones for each dimension; build, test and validate the prototype of a new UX subjective evaluation tool.

References

1. Bargas-Avila, J.A., Hornbæk, K.: Old wine in new bottles or novel challenges: a critical analysis of empirical studies of user experience. In: Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems, pp. 268–2698. ACM, New York (2011)
2. Desmet, P., Hekkert, P.: Framework of product experience. International Journal of Design 1(1), 57–66 (2007)

3. Hassenzahl, M.: The thing and I: understanding the relationship between user and product. In: Blythe, M., Overbeeke, C., Monk, A.F., Wright, P.C. (eds.) Funology: From Usability to Enjoyment, pp. 31–42. Kluwer Academic Publishers, MDordrecht (2003)
4. Garrett, J.J.: Customer Loyalty and the Elements of User Experience. Design Management Review 17(1), 34–39 (2006)
5. Hassenzahl, M., Tractinsky, N.: User Experience – a Research Agenda. Behaviour and Information Technology 25(2), 91–97 (2006)
6. ISO 9241-210.: 2008. Ergonomics of Human System Interaction– Part 210: Human-centered design for interactive systems (formerly known as 13407). International Organization for Standardization (ISO), Switzerland (2010)
7. Kort, J., Vermeeren, A.P.O.S., Fokker, J.E.: Conceptualizing and Measuring User eXperience. In: Law, E., Vermeeren, A., Hassenzahl, M., Blythe, M. (eds.) Towards a UX Manifesto, COST294-MAUSE Affiliated Workshop, pp. 57–64. COST, Lancaster (2007)
8. Robert, J.-M.: Vers la plénitude de l'expérienceutilisateur. In: Proceedings of the 20th International Conference of the Association Francophone d'Interaction Homme-Machine, pp. 3–10. ACM, New York (2008)
9. Robert, J.M., Larouche, A.: The dimensions of user experience with interactive systems. In: Proceedings of IADIS International Conference - Interfaces and Human Computer Interaction 2012, pp. 89–96 (2012)
10. Robert, J.-M., Lesage, A.: Designing and evaluating user experience. In: Boy, G.A. (ed.) Handbook of Human-Computer Interaction: A Human-Centered Design Approach, Ashgate, U.K, pp. 321–338 (2011a)
11. Robert, J.-M., Lesage, A.: From usability to user experience with user interfaces. In: Boy, G.A. (ed.) Handbook of Human-Computer Interaction: A Human-Centered Design Approach, Ashgate, U.K, pp. 303–332 (2011b)
12. Thüring, M., Mahlke, S.: Usability, aesthetics and emotions in human-technology interaction. International Journal of Psychology 42(4), 253–264 (2007)
13. Roto, V., Rautava, M.: User experience elements and brand promise. In: International Engagability & Design Conference, in Conjunction with NordiCHI, Lund, Sweden (2008)