

How Do User Experience Experts Organize Their Knowledge of User Experience Criteria?

Josefina Isabel Gil Urrutia^{1,2,*}

Eric Brangier¹

¹Psychologie Ergonomique et Sociale de l'Expérience Utilisateurs (PErSEUs)

Université de Lorraine – UFR SHS
Metz, France

email: josefina.gil_urrutia@allianz.fr (*)

email: eric.brangier@univ-lorraine.fr

Laurent Cessat²

²Direction des Développements et de la Maintenance,

Département Digital & Mobile
Allianz France Solutions & Services
Paris La Défense, France

email: laurent.cessat_2@allianz.fr

Abstract— This paper presents a study where 17 User Experience professionals assessed and categorized a set of User Experience/Human-Computer Interaction criteria. We examined how they organize their cognitions around a suggested set of 58 criteria based on 7 significant theoretical dimensions: accessibility, usability/practicality, emotions & motivation, persuasion, cultural factors, management of the experience and socio-organizational factors. We aimed to determine whether the experts' cognitions would mirror these same theoretical considerations and, if so, to what extent. For this purpose, we analysed their classifications of the criteria during an open card-sorting task, limited to 7 groups. Results show a repartition of the criteria among the following standardized categories: (1) Utility & Usability; (2) Marketing Strategy; (3) Hedonism; (4) Organizational factors; (5) Emotional & Cognitive Stimulation; (6) Control & Personalization; and (7) System characteristics. We found that the groups created by the participants were conceptually rather similar throughout their categorizations and that they were rather close to the founding theoretical dimensions we had originally considered. Implications for our theoretical model's architecture are discussed.

Keywords-user experience; holistic criteria-based approach; card-sort; dimensions; multidimensional model.

I. INTRODUCTION

Throughout history, ever-changing consumer requirements, economic models and technology have had a determining role on the evolution of the field of Human-Computer Interaction (HCI)/User Experience (UX). This has resulted in different issues being addressed at given times, as well as in different recommendations being made. Consequently, we are currently confronted with an overflow of frameworks, approaches, concepts, recommendations -so called criteria- which results in an ever increasing complexity of our practice [17].

It is with this in mind that we have taken upon ourselves to propose a holistic criteria-based approach in the field of HCI/UX to aid in the process of designing and/or evaluating user interfaces/products/services and that would encompass all aspects relevant for its truly holistic comprehension and conceptualization [6].

However, we must now reflect upon a possible organization of the myriad of relevant principles. To do this, we opted to examine how UX professionals organize their cognitions regarding a proposed range of criteria.

Considering UX as a multi-dimensional system, and based on the definition of UX suggested by [17], we opted for a selection of criteria based on 7 dimensions that we consider paramount in UX. These dimensions cover different aspects of HCI, ranging from sensory-motor factors, to cultural aspects, as well as cognitive, emotional and persuasive elements, among others. Each dimension is represented by a subset of criteria: 5 are based on pre-existing sets of guidelines; the remaining 2, we created based on the literature. These are:

- Accessibility: Web Content Accessibility Guidelines [15];
- Usability: Bastien & Scapin ergonomic criteria [1];
- Emotions and Motivation: de Vicente & Pain emotions & motivation detection model traits and states [2];
- Persuasion: Nemery & Brangier persuasion criteria [9];
- Culture: Schwartz basic human values [14];
- Management of the experience: created based on the literature [7], [10]-[13];
- And socio-organizational factors: also based on the available literature [4], [5].

Given the substantial number of criteria (58; detailed presentation in [6]), along with their inherent redundancies and interdependencies [6], [17]-[18], it seems difficult to mentally organize them in a coherent and relevant manner. Therefore, in order to determine a viable architecture for our suggested model, it is necessary to study how UX experts would mentally represent and organize said lot of criteria.

How do UX experts organize their knowledge of UX criteria? Two research questions were addressed here:

- On one hand: whether or not UX experts - who regularly use these criteria - all have the same mental organization of the set.
- On the other hand: whether their cognitive organizations of the criteria are in line with that provided by the authors of the different theoretical criteria grids. Or, on the contrary, whether the organization of the criteria depends on other factors that need to be elucidated and interpreted.

This study aimed to determine how UX experts would envision, apprehend and structure the proposed set of UX criteria through a card-sort exercise: would the card sort reveal categories stable enough throughout the experts? Would the general classification of criteria produced by experts overlap itself or correspond with the original theoretical guidelines proposed by their original authors? and if so, to what extent?

This paper therefore focuses on an experiment -which was part of a broader research project- where UX experts had to classify 58 recognized criteria in strictly 7 groups. Section 2 presents the methodology used. Thereupon, the results will be summarized (in section 3) followed by their discussion (in section 4) and we will conclude with our future work in Section 5.

II. METHOD

A. Participants

17 HCI/UX Design experts (6 women, 11 men; mean age 44 (standard deviation (SD)=8.6)) took part in this experiment. Among them, 11 are specialized in Ergonomics/Cognitive Psychology, 4 in Computer Science and the remaining 2 in Communications and Media. Participants were required to have at least 10 years of experience in the field of HCI/UX in order to be eligible for this study (mean (\bar{x})=17.53; SD=6.05). 11 of them are academics, 4 are consultants and 2 are both. 10 have a PhD, and 7 have a Master’s degree. The experts received a small compensation for their participation.

B. Material

This study used the same deck of 58 cards described in [6], each containing the name and definition of a criterion from the set. A pen and extra plain 5x5cm cards were always at the participants’ disposal in case they wished to create (a) new card(s). Also, plain white 5x20cm index cards were made available to create the category name tags.

The researcher who conducted the experiment used a camera and a recorder to document the data.

C. Procedure

Sessions were un-moderated and carried out individually. No duration limit was imposed; they lasted 10 to 20 minutes.

Participants were presented with the card-deck. They were asked to do an open card-sort in strictly 7 groups (which corresponds to the number of theoretical sets of guidelines considered). They were asked to name the categories they had created and to explain the logic on which they had based their sortings. These debriefings were recorded and later transcribed for reference during the analysis and interpretation of the data.

Participants were allowed to exclude the criteria they considered irrelevant and/or to create (a) new card(s) indicating a name and definition when considered necessary.

III. RESULTS

Following [3], we analysed each participant’s classification to create standardized categories that would

sum up the range of classifications done by the experts. Furthermore, [3] automatically generated the items by standardized categories matrix.

Also, with an adapted version of [8], we generated the global distance matrix. Using R-3.3.2 [16], we carried out a Hierarchical Cluster Analysis (HCA) with Ward’s clustering method and a Multi-Dimensional Scaling (MDS) based on Kruskal’s non-metric MDS.

A. Standardized Categories for the Criterion Distribution

Table 1 recaps the 18 pertinent standardized categories we created for the analysis of the different participants’ categorizations (plus the “Excluded/Irrelevant” category).

TABLE I. STANDARDIZED CATEGORIES CREATED FOR THE ANALYSIS (GENERATED USING [3])

Standardized Categories	Sorters who used this	Total cards in this category	Unique cards	Agreement
Utility, task-system suitability, achieving the goal, efficacy	5	30	21	0.29
Usability/Pragmatism ergonomic criteria, efficiency	12	163	37	0.37
Utility & Usability / Efficacy & Efficiency	2	43	26	0.83
Hedonism, Pleasure, Emotions	14	138	41	0.24
Adaptability of the system	9	90	42	0.24
Organizational Factors	9	63	20	0.35
Socio-organizational factors	2	12	9	0.67
Persuasion, Incitement, Pervasive design	11	71	28	0.23
Marketing Strategy/ Customer Relationship Management	13	88	21	0.32
User Effort	1	6	6	1.00
Personalization/ Customization	4	23	15	0.38
Mastering/Control over the system	3	20	19	0.35
Security/Reliability- User’s Protection	8	53	26	0.25
User onboarding	4	43	28	0.38
Emotional & Cognitive Stimulation for self-development	7	48	24	0.29
Social, moral and/or cultural factors	5	21	12	0.35
Technical aspects/ Robustness	3	16	14	0.38
Others/Unknown	6	28	23	0.20
Excluded/Irrelevant	6	15	14	0.18

The agreement values found are rather low ($\bar{x}=0.38$; $SD=0.22$). However, the occurrence of the standardized categories is quite high ($\bar{x}=6.59$; $max=14$) By instance, as much as 14 participants created a category conceptually-linked to “Hedonism, Pleasure, Emotions”. So, though it remains questionable as to which criteria belong to which category, the fundamental categories underlying the organization seem to be of general-understanding among the participants.

B. Hierarchical categorization of the 58 criteria

Next, we performed a HCA on the overall distance matrix. By reading of the items by standardized categories matrix, we were able to interpret the resulting dendrogram, in order to identify and label the clusters of criteria found (Fig. 1).

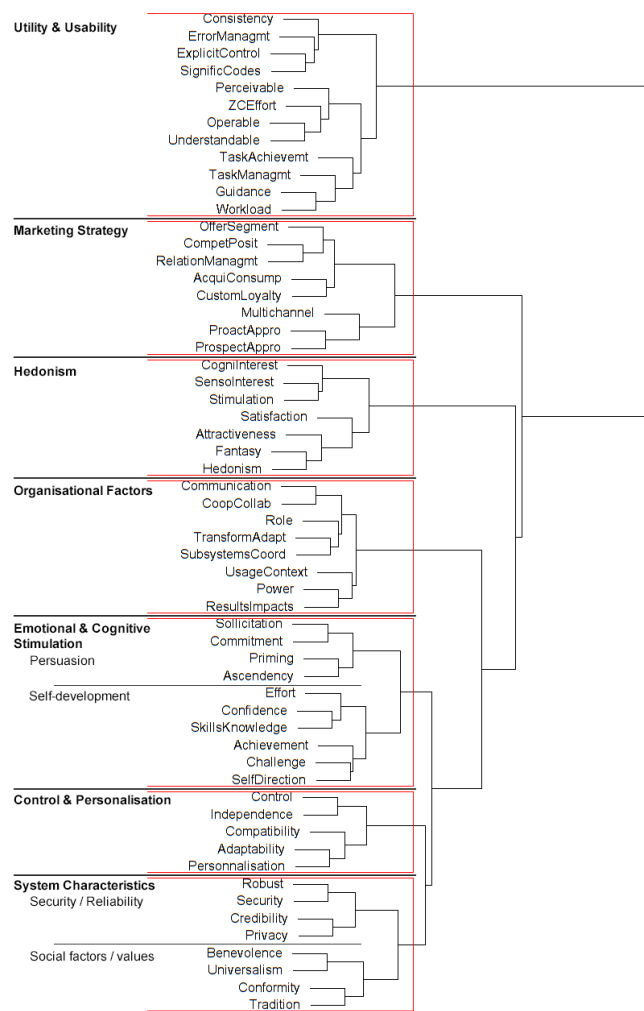


Figure 1. Dendrogram showing the 7 standardized categories retained and the classification of the 58 criteria

Indeed, the categories retained are (in order of appearance in the dendrogram; see Fig. 1):

1. Utility (task-system suitability, achieving the goal, efficacy) & Usability/Pragmatism (ergonomic criteria, efficiency) containing the items: Perceivable, Operable

- and Understandable from [15], Consistency, Error Management, Explicit Control, Significance of Codes, Guidance and Workload from [1], Zero Customer Effort from the management of the experience dimension, as well as Task Achievement and Task Management from the socio-organizational dimension;
2. Marketing Strategy/Customer Relationship Management encompassing 8 of the 9 elements created for the management of the experience dimension, namely: Offer Segmentation, Competitive Positioning, Relationship Management, Acquisition-Consumption, Customer Loyalty and Recommendation, Multichannel/Omni-channel, Proactive Approach and Prospective Approach;
3. Hedonism, Pleasure, Emotions comprising the criteria: Cognitive Interest, Sensory Interest, Satisfaction and Fantasy from [2], Stimulation and Hedonism from [14], and Attractiveness from [9];
4. Organisational Factors: including 7 of the 10 elements created for the socio-organisational dimension (Communication, Cooperation/Collaboration, Role, Transformation-Adaptation, Sub-systems coordination, Context of use, Results & Impacts) and Power, from [14];
5. Emotional & Cognitive Stimulation for self-development: structured around two subgroups - one containing elements in relation to “persuasion, incitement, pervasive design” (Solicitation, Commitment, Priming and Ascendancy, all from [9]), and the other to “self-development” (Effort, Confidence, Challenge from [2], Skills & Knowledge from the socio-organisational dimension, as well as Achievement and Self-direction from [14]);
6. Control & Personalization, a combination of two subgroups: “personalization/customization” and “mastering/control over the system” linked to user’s need and desire for self-expression and self-direction. The former is composed of the elements Control and Independence both from [2]; the latter is composed of Compatibility and Adaptability from [1] and Personalisation from [9]. These criteria were often linked to notions of Utility and/or Usability and of “Adaptability of the System”;
7. And, lastly, what we chose to name “System’s characteristics” based on the analysis of the debriefings, a category including the subgroups “Security/Reliability-User’s Protection” (Robust from [15], Security from [14], as well as Credibility and Privacy from [9]), and “Social Factors/Values” of the system (Benevolence, Universalism, Conformity and Tradition, all taken from [14]).

These results are very similar -as to the groupings and the naming of the groups- to those from our previous paper [6] where the participants were asked to do an open-card sort without a limited number categories. The results showed an average repartition in 7.71 groups ($SD=1.65$; $min=5$; $max=11$) and the categories retained were: 1) Utility & Usability; 2) Hedonism, Pleasure, Emotions; 3) Persuasion, Incitement, Pervasive design; 4) Emotional & Cognitive

Stimulation for self-development; 5) Marketing strategy/ Customer Relationship Management; 6) Security/Reliability-User's protection; 7) Organizational factors; and 8) Social, moral and/or cultural factors.

However, regardless of the similarity, three main findings are worth mentioning.

Firstly, this exercise yielded differences in the granularity of the classification: depending on whether the participant had previously done more or less than 7 groups, they would often either divide one (or more) in two, or, assemble two (or more). For example, this was the case for participants who had previously created a group for "Efficacy", another one for "Efficiency", and who assembled the two in order to create one named "Usability/Utility/Ergonomic Criteria" (or vice-versa). Likewise, the same phenomenon happened with the categories "Organizational factors" and "Social factors" – though only 2 participants assembled them together and thus this does not reflect in the categories retained. Moreover, however seldom, certain participants would pick-and-choose certain criteria in order to *extract* an entirely new category (e.g., "Marketing Strategy", by participant n°13).

Furthermore, compared to the groupings found in [6], only 3 *migrators* were found; while the rest remained pretty much the same ("migrators" being items that moved from one category to another):

- Compatibility (ergonomic criterion; [1]) moved from "Utility & Usability" to the group "Control & Personalization";
- Achievement (cultural criterion; [14]) moved from "Social factors" to the "Self-development" subgroup in the category "Emotional & Cognitive Stimulation for self-development";
- And, to a certain point, Self-Direction (cultural criterion; [14]) that moved from the subgroup "mastering/control over the system" to the "self-development" subgroup – which are subgroups of the "Emotional & Cognitive Stimulation for self-development" category.

This indicates a permeability/porosity of the frontiers and evidences certain variability in the interpretation of the criteria –like further discussed below.

Lastly, these results highlight the variability in the interpretation of the criteria and of the card-groupings, with regard to the criteria's attributes and their category affiliations. For example, the group of criteria labelled "Social Factors/Values" previously (in [6]) interpreted as characteristics of the user or of the context of use, is interpreted here as characteristics of/expected from the system (e.g., "a benevolent system", "a traditional system").

C. Categories' Relationships and Proximity

The dendrogram (Fig. 1) revealed a close link between the categories (7) "System characteristics" and (6) "Control & Personalization" which in turn revealed a link to the category (5) "Emotional & Cognitive Stimulation for self-development". The following group to link to the dendrogram is the (4) "Organizational Factors", next, the (3) "Hedonism, Pleasure, Emotions", then, the (2) "Marketing Strategy/Customer Relationship Management", and lastly, the (1) "Utility (task-system suitability, achieving the goal,

efficacy) & Usability/Pragmatism (ergonomic criteria, efficiency)".

This structure might be due to stronger cohesiveness values within the last 4 categories listed above. This is especially true for the category "Utility & Usability" given the importance of its perceived distance (graphically represented in the tree diagram).

D. Spatial Representation and Structure

The MDS required a three-factor analysis in order to obtain significant enough results (stress=17.06%). The spatial representation drawn from this analysis is presented in a two-dimensional plot in Figure 2.

The spatial representation and repartition of the criteria throughout the MDS showed a structural resemblance to that of our previous study [6]. Indeed, the results here allude to the same ternary structure with the three outermost groups (Utility & Usability, Organisational factors, Hedonism, Pleasure and Emotions; representing the functional, experiential and contextual pillars of UX) merging towards elements of technological persuasion and user stimulation.

Additionally, by graphical reading, the same two possible factors justifying the structure stand out:

- Along the x-axis, a first one seeming to correspond to the nature of the experience, ranging from the functional experience to the experiential experience;
- The other one along the y-axis seeming to be the level the criterion intervenes on: the user, the system or the context of use.

Further analyses are required to verify this and to identify the third factor.

However, three new findings stick out. First, the system is more visibly represented via the category "System characteristics" that occupies a significant area between the Organizational factors and the Utility & Usability categories. Second, the category "Control & Personalization" seems to bridge "Utility & Usability" and "System characteristics" as well as the former and "Emotional & Cognitive Stimulation for self-development". Lastly, in the same manner, the group "Marketing Strategy" seems to link the elements pertaining to organizational factors and social factors/values of the system to the remaining elements, serving as a sort of intermediary between the two.

E. Additional Elements of Analysis

Six participants excluded 13 unique cards from their sortings. Only the criterion "Challenge" was excluded by two participants – which has a negligible impact as to its perceived relevancy for our model.

No one suggested adding any new criteria.

IV. DISCUSSION

This paper presents a study where UX professionals assessed and categorized a suggested set of UX/HCI criteria in order to elucidate whether the basis for their categorizations would overlap with the original theoretical dimensions considered, if so, to what extent, or whether it would be based on other factors that would need to be revealed.

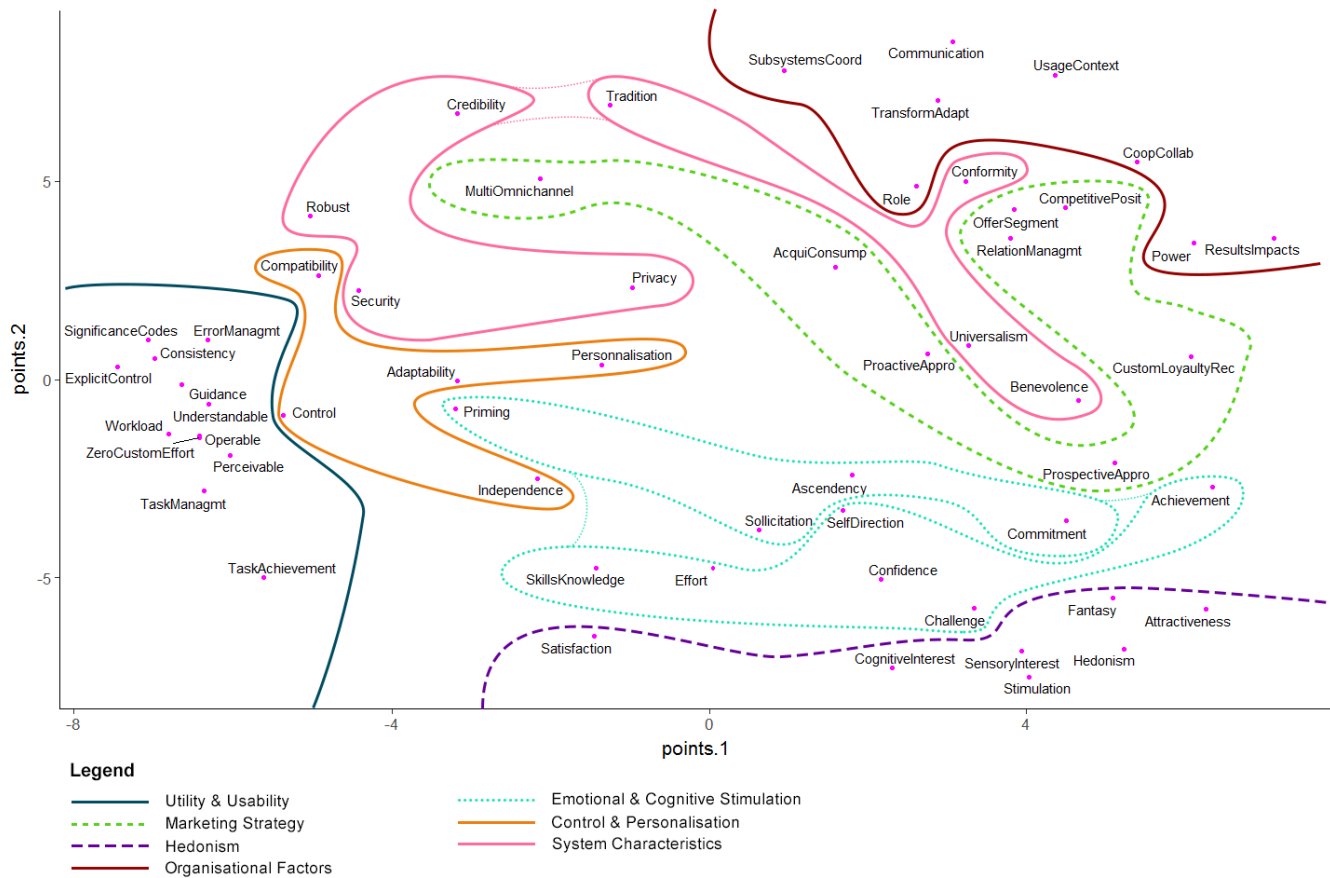


Figure 2. Multi-Dimensional Scaling plot using 3 factors (stress=17.06%) showing the overall categorization among 7 standardized categories.

Four/Five of the seven categories retained from the analysis indicate a relative correspondence to the initial theoretical dimensions. Besides from the categories “Utility & Usability”, “Marketing strategy/Customer Relationship Management” and “Organizational factors” being evidently analogous to the usability, management of the experience and socio-organizational factors dimensions, one/two more categories deserve further attention. Indeed, the categories “Hedonism, Pleasure, Emotions” and “Emotional & Cognitive Stimulation for self-development” are also related to our emotions & motivation dimension – even though a distinction was clearly made by the participants, who opted to make two separate categories. Similarly, the subgroup “persuasion, incitement, pervasive design”, contained within the “Emotional & Cognitive Stimulation for self-development” (though it was a category in and of itself in [6]) is in line with yet another one of our theoretical UX dimensions (Persuasion). Thus, despite the rather low agreement values, and though not entirely in line with the 7 dimensions considered, the participants’ resulting mean categorization is fundamentally quite close to our theoretical considerations.

Moreover, this study shed light as to differences in the granularity of the classifications. This shows that various possible levels of categorization of the criteria can be made which raises questions as to what the optimal architecture for a holistic criteria-based model of UX would look like;

between a high/macro-level or a low/micro-level (more detail-oriented) approach.

Results also revealed the porosity/permeability of the frontiers between the categories as well as a considerable variability as to the interpretation of the criteria and of the groupings. Indeed, certain criteria were attributed varying characteristics and, depending on this, were allocated to varying categories – evidencing a criterion’s multiple possible impacts on UX as well as the systemic nature of UX. Other than the three *migrators* identified and described above, this was particularly the case for Schwartz’s cultural values [14]. Undeniably, these elements were subject to the most varying interpretations possible; participants describing/manipulating them as social/cultural factors, as system characteristics expected by the user, as factors of motivation, etc.

The spatial representation reinforced the idea of a ternary structure built around the three basis of the experience (functional, experiential and contextual elements) merging towards technological persuasion and user stimulation. But this time the system is more markedly represented and, as supported by the proximity among the categories in the tree diagram, it is closely linked to elements of user control & personalization which in turn are strongly linked to emotional & cognitive stimulation for self-development.

Lastly, we found that three factors underlie the participants’ cognitive organizations reflected through this

sorting exercise; one being the nature of the experience, one seeming to be the level the criterion intervenes on; the last one remains to be clarified.

V. CONCLUSION AND FUTURE WORK

Generally speaking, human-machine interactions have been studied within the framework of research related to software ergonomics, which aims at adapting the software to the user as it deals with information. In other words, the goal is to adapt the computer's behaviour, i.e., its external manifestations, to the user's cognitive functioning seeking to offer the most efficient, pleasant, satisfactory and least restrictive assistance possible. By extension, software ergonomics also needs to produce knowledge about how users work, interact and think. This knowledge includes many criteria that we seek to better understand and organize in a relevant manner in order to propose a structured model.

When HCI experts are asked to categorize these criteria, it appears that:

- The criteria grids are mentally reassembled in a way that certain criteria are stable and invariant of their category, while others are not, so they *migrate* towards other categories;
- The criteria most stable and consistent with their category are those related to usability;
- The criteria are subject to varying interpretations and they might be attributed different characteristics leading to categorization differences;
- The standardized categories created and retained during the analysis of the data, are conceptually similar to a certain point to the initial theoretical considerations we chose for the suggestion of the 58 criteria;
- The two main factors justifying the categorization and its resulting spatial representation seem to be the nature of the experience (functional vs. experiential), and the level of impact of the criterion (user, system, context of use).

While research on UX factors and criteria is continuing, we think this research is necessary to summarize perception of UX criteria as assessed by UX experts.

Currently, two studies are underway in which we are evaluating the applicability of our holistic criteria-based approach, in both HCI design and evaluation practices. Our next task will be to define a generic toolkit to organize the criteria so that they can be used in interface design and evaluation.

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