HOW DESIGNERS CONCEIVE UTILITY, USEFULNESS AND NEEDS CONSTRUCTION IN DESIGN: AN EXPLORATORY STUDY WITH THREE CONTRASTED DESIGNERS' PROFILES

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ABSTRACT (250 WORDS MAX)
Usefulness is considered as a major criterion in ergonomics design. Our objective is to show that heterogeneity and diversity of designers' profiles could lead to a partially shared representation of the utility and usefulness, methods and tools. To do this, we explore the representations of engineers, graphic designers and ergonomists on the utility, usefulness and needs construction in the design. The methodology developed for studying these representations is a categorical analysis of verbalisations produced during semi-structured interviews. We provide elements of understanding on the relationship between the designer's profiles and the representations on the definitions of utility and usefulness, and on the needs construction process (design phases, methods, tools and stakeholders involved).

Keywords: Usefulness, Design cognition, Reflective practice, Interdisciplinarity

1 INTRODUCTION

Usefulness has been considered as a major criterion in ergonomics design [1] together with other important criteria such as usability, accessibility or acceptability. Usefulness refers to the artefact's quality of providing supports to actual users' goals, and specifically those required and (spontaneously) expected. Empirical studies, theoretical frameworks, methods and recommendations regarding usability and accessibility have been widely disseminated in the communities involved in the design of innovative artefacts (*eg* ISO 9241-11). Contrarily, usefulness and utility have not received as much attention and there are far less related theoretical or methodological framework which could help to define the objectives and to guide the design for the usefulness criterion. We have to understand the real running of design in order to improve the consideration of the usefulness in the design process of emerging technologies artefacts, characterized by an innovative concept, uses unclear, limitations that slow down the massive application and a promise of changing economic and social context [2]. This involves exploring how the usefulness and the "needs construction" process (*ie*, phases, methods and tools which aid needs production process) are currently considered by the different design stakeholders.

The aim of this study is to examine designers' representations about processes as well as concepts related to usefulness, with a specific focus on how they define it, the elements which facilitate needs construction process as the phases, the methods and tools they mobilize and the way they represent the users. We have contrasted three profiles of designers in this study: engineers, graphic designers and ergonomists.

The article is organised as follows. In the next section, we describe the related works on representations and viewpoints on usefulness and needs satisfaction in design. The third section describes our methodology based on the categorical content analysis of verbal material from semi-

structured interviews with three different profiles of designers. The fourth section presents the results, and the paper concludes with the limitations and perspectives for future research.

2 RELATED WORKS

2.1 Heterogeneity and specificity of disciplinary viewpoints about usefulness based on the analysis of prescribed methods and tools; a brief overview

Utility and usefulness can be defined in different ways [3]: utility-purpose of an artefact (*eg*, its functionalities and properties), usefulness-value for the end-user (*eg*, benefits and advantages of the use of the artefact for the users) and response to a need (*eg*, expectation, requirement). Design frameworks, methods and tools recommended in the literature are heterogeneous. Depending on the discipline and author, there are specific emphases on some issues related to usefulness as well as it appears specific failures in covering some other issues. For example, the literatures in engineering and in ergonomics deal with the issue of needs production more largely than the literature in industrial design. The key actor related to the production of needs also depends on the discipline. In engineering, needs identification is usually based on the silent partner‘s requirements (*eg*, [4]). This is in contrast with ergonomics approaches, where needs identification is based on task and activity analysis of (real/future) end-users [5]. In industrial design, some needs which are “unexpressed” by users are anticipated with specific methods and tools which allow to extend the field of the possibilities and even to be creative (*eg*, [6], [7]). Such a creative dimension of design has been far less seriously considered in ergonomics and user-centred design (but see [8]).

Prioritisation and selection of needs in design are only addressed in engineering and ergonomics literatures. These two disciplines differ mainly about the user involvement in this selection process: when engineering recommends the selection and prioritisation of needs by the designers themselves [9], ergonomics recommends the contribution of users to the decision phase (*eg*, [10]).

Finally, there are a variety of methods to assess the usefulness in the literatures of engineering, industrial design and ergonomics. In engineering, functionalities of concurrent software are evaluated to judge those that can be reused for the design of a future software. In industrial design, evaluation is usually realised by the graphic designers themselves, who play the role of users. To a lesser extent, designers (graphic designers) ask real end users to assess non-functional prototypes; but this evaluation comes down to “it’s well” or “it isn’t well” [11]. In ergonomics, evaluation of prototypes is made by end users who can propose new functionalities and measure the benefits of the software in comparison with the reference situation [12]. The huge variety of these definitions, frameworks, methods and tools suggests different mental representations of the utility, usefulness and needs construction among designers having different disciplinary backgrounds.

2.2 Empirical studies of designers’ representation about usefulness and the best way to satisfy users’ needs

Few studies deal explicitly with viewpoints or representations concerning usefulness and the best way to satisfy users’ needs. “Representations” refers here to as the “networks of properties, concepts, knowledge, know-how, beliefs and experienced sensations during the person's history, his experience and the needs of the action” [13].

As far as we know, two studies have focused on designers’ representations on the users’ needs [14; 15]. A third study [4] has been focused on how the designers understand their own contribution to the process of needs construction. These three studies show that designers have a partial and variable representation of the users’ needs according to their profession, role in design and background. However, they do not explicitly deal with the usefulness of the artefact and they give no information about the means used to take into account the needs and usefulness in the design. Another limitation is that only one engineer’s profile is involved in these studies, whereas other stakeholders (*eg*, users) and design disciplines are also involved in the consideration of the needs through design models and processes. For example, in their study concerning the design of a virtual reality software, Loup-Escande and al. describe the acts of construction of needs, the dynamics of construction of needs and the contribution of each stakeholder to these processes [16]. The methodology was based on the participant observation in a longitudinal study. The results show that users contribute more than designers and silent partners to the needs design process, in particular during the production and

evaluation phases. The degree of user involvement in the process is both a factor and a consequence of the representation that the designers have about the design and usefulness of an artefact.
The study presented in this paper is original because it provides a first exploration of representations of different designers' profiles about the usefulness and needs construction trough along the design process. In particular, we focused our study on the representation of the utility, the usefulness and the representations on the stakeholders (*eg* users, silent partners) to involve in design process, on the tools and design phases associated with the needs construction. Three profiles of designers have been comparatively studied: engineers, graphic designers and ergonomists.

3 METHODS

3.1 Participants

Ten designers participated: two graphic designers, four engineers and four human factors experts (ergonomists). Participants were aged between 27 and 53 years (mean=39 years; median=35.5 years; S.D.=10 years). The two graphic designers are teachers in a High School of Design. Parallel or prior to their activity of teaching, they have practised an industrial design activity in agency. Among the four engineers, three are associate professors in computer science, while the fourth one was "practitioner" and worked on internal projects of his company. Among the four ergonomists, two are full-time researchers, one is associate professor and works on research projects, and the last is "practitioner" in a company.

3.2 Semi-structured interviews

Semi-structured interviews were conducted individually by the first author. After having collected biographical data about the interviewees (current position, past positions and past experiences, background, age), the interviewer asked the designers to focus on their past projects and to explain and illustrate how they processed in order to take into account the needs and the criterion of usefulness at different moments of the design project. A list of specific topics were briefly reported to the participant in order to ensure that all interviewees were initially aware that our interest was focused on issues related to the needs collection, the role of creativity, the way needs have been formalised, the conversion of needs into specifications and / or functionalities, the usefulness evaluation, etc.

3.3 Collected data

The interviews lasted 40 minutes in average. The total duration represented 6 hours and 50 minutes. All interviews were transcribed verbatim. After having deleted interviewer's questions and optional interventions, we obtained a corpus of 34 923 words representing 2344 lines of text.

3.4 Verbal data analysis

The method to analyze the recorded interviews was twofold. Firstly, we carried out a categorical content analysis, whose basic principle is the grouping of similar objects under a common category [17]. For that purpose, we use the TROPES software[1] in a roundabout way (*ie*, not in order to make a cognitive analysis of the discourse like in [18; 19]) for its ability to recognise conjugated forms of verbs and plural forms of nouns. We prepared the scenario "manually" (*ie*, composed of themes, subthemes and semantic equivalents) used for the analysis, according to the objectives of the study. Secondly, we went back to the corpus in order to extract verbal excerpts specifically associated to main categories and observed associations between categories and profiles. Furthermore, it enables us to clarify and illustrate the results based on projects and situations elicited by participants during the interviews. These two methods enable us to complement the quantitative analysis of the discourse of designers with a qualitative analysis.

Definition of the scenario used in our analysis

The scenario for analysis has been elaborated to observe the main themes (Table 1) related to the several dimensions of usefulness and needs processing in the participants' discourse. These themes have been selected on the basis of our framework (see sections 2.1 and 2.2), because there are four

[1] http://www.semantic-knowledge.com/tropes.htm.

issues associated with usefulness in design and can explain heterogeneity and specificity of disciplinary viewpoints: definitions of usefulness, needs construction phases, tools of the needs construction process and finally stakeholders explicitly associated with the needs construction process. These four themes are decomposed in thirteen subthemes associated to our scenario. These subthemes have semantic equivalents which correspond to the sense units directly associated with a subtheme (eg, “benefit”, “advantage” and “activity” for the subtheme “usefulness-value”). Themes, subthemes and their semantic equivalents represent a hierarchical decomposition which corresponds to an increasing level of detail in our analysis. This hierarchical decomposition is presented in Table 1.

Table 1. Main themes, subthemes and semantic equivalents.

Theme	Subtheme	Semantic equivalent
Definition of usefulness	Utility-purpose	Function, functionality, concept, service, specification, recommendation, solution
	Usefulness-value	Activity, advantage, benefit
	Need	Request, lack, need, expectation, requirement, constraint
Phases of needs construction process	Prospective phase	Collect, emerge, expression, express, inference, infer, collection, imagine, anticipate, guess, ideation, imagination, exploration
	Needs formalization phase	Reword, transform, reformulation, transformation, formalize, model, formalization, modeling
	Needs selection phase	Choose, select, choice, decision, selection, priorize, priorization
	Evaluation phase	Reuse, correct, modify, improve, improvement, correction, modification, evaluate, adequacy
Tools and methods	Needs production tools	Interview, classical analysis of work, activity analysis, self-confrontation, theoretical model, ergonomic models, observation, appointments, meeting, actor schema, brainstorming, focus group, persona, creativity, scenario, script
	Needs formalization tools	Task models, activity models, specifications report, task model in computer, production tools of needs
	Needs evaluation tools	Prototype, model, drawing, draw, prototype, prototyping, usability testing, longitudinal study, logbook, movie, feedback, video
Stakeholders	Designers	Software developer, ergonomist, graphic designer, engineer, designers, team, ergo, student, graphic designer, computer, information system division, specializing in human computer interaction
	Silent partners	Director, representative, association, customer, backer, company, association, steering committee, decision maker, industrial organization, partner, non-disabled person, person without disabilities, work division, responsible, contractor
	End-users	User, operator, blind, business, community, consultant, child, expert, people with low vision, business, parent, senior citizen, disabled person, salesperson

Statistical analysis

The statistical analysis is based on the counting of the frequencies of coded themes in individual discourses. These frequencies are calculated directly by TROPES software. We obtained a total of 1732 units for all participants. The units have been counted by theme for each participant.

In order to know the importance that each designer’s profile assigned to each theme and each subtheme, mono and bivariate descriptive statistical analyses were carried out. Since our data were essentially categories, bivariate analyses were based on contingency tables analyzed with two main

indicators. Cramer's V^2 estimates the magnitude of the association between two categorical variables [20; 21]. The association is conventionally considered as strong when $V^2 > .16$ and as weak when $V^2 < .04$ [22].
Relative deviations (RD) measure the association between modalities of two nominal variables [23], e.g. needs elicitation by designers in analysis phase. They are calculated on the basis of a comparison between observed and expected frequencies. There is attraction when the RD is positive, and repulsion when negative. By convention, we retain only RD with absolute terms > .25.

Qualitative analysis

For a more detailed analysis (*eg*, the distinction between "collection acts" and "imagination acts" in phase "prospective universe"), we performed a qualitative analysis in order to clarify and to explain the use by an interviewee of special attributes related to a category or a subcategory. This qualitative analysis is illustrated with examples of sense units extracted from the analyzed corpus.

4 RESULTS

4.1 Contrasted definitions of utility/usefulness according to the designers' profile

Ergonomists and engineers have produced the most units related to the purpose of the artefact, the artefact value for user and the usefulness as a response to a need (resp. 257/560; *ie* 46%; 254/560; *ie*, 45%) followed by graphic designers (49/560; *ie* 9%). The trend is similar if we compare these numbers to the size of each designer's group. Ergonomists enounced the most units (43%) followed by engineers (39.5%) and by graphic designers (17.5%).
Moreover, we observe that the usefulness as a response to needs is mostly present in designers' representations (347/560) compared to the utility-purpose (186/560) and the usefulness-value (27/560).
The analysis of data shows an intermediate global link between the definition of utility/usefulness and the designer's profile (Cramer's $V^2 = 0.04$). The analysis of RD shows that the usefulness-value strongly characterises the ergonomists' discourse (RD = +.86), while this notion is less evoked by engineers (RD = -.84). The analysis of RD shows that the graphic designers evoked mainly the utility-purpose (RD=+.97) and less "usefulness as a response to needs" (RD=-.51).
We performed a qualitative analysis of the utility-purpose attributes (*eg*, function, concept, service, and specification), the usefulness-value attributes (*eg*, benefit, advantage, activity) and the usefulness as a response to needs (*eg*, need, requirement, request, and expectation). This analysis shows that the utility-purpose category is mainly evoked through references to "specifications" and "functions" whatever the profile. Graphic designers mainly use the term "concept" in the sense of "*a concept, it is a promise of the future product*" or "*the concept, it is like initiating a unique response to a need*".
About the usefulness-value, our analysis shows that the attribute "activity" is mostly cited. One use of this term extracted from the corpus is: "*we will describe this activity in order to try to identify [...] what we could change or add to help it. It is from this point that we can make this evocation of need*" (ergonomist).
Concerning the usefulness as a response to needs, the attribute "need" is the most expressed in the speeches by the different profiles (215/347). For engineers and for graphic designers, the need comes from the field or from the silent partner ("*it is often the client who comes or I will say it's a commercial approach which means that it comes a time when he has a need*"), while the engineers think that the need is "*a vague notion [...] which is not clearly formalised on paper*" and ergonomists evoked also a second category of needs ("*there's two kinds of needs, those which arrive from the field and those that we will emerge*". Another common term is "requirements" (83/347), as illustrated by the following example: "*there are requirements that can be grouped, others being mutually exclusive*" (engineer).
Other words are less frequently used: "request" (28/347), "constraint" (13/347), "expectation" and "lack" (respectively 4/347). The term "constraint" means "*technical constraints or very strong constraints related to a brand"* (graphic designer), and may also reflect the silent partner's constraints. Indeed, one participant explained that "*what we have to do at the beginning is to tell him [the silent partner]: give me all your constraints, all the ones you think, then those that you don't dare to think or imagine*" (graphic designer). The term "request" was strongly used by ergonomists while it was lowly evoked by engineers: "*the principle with a needs expression is that at a moment, there is a request*"

(ergonomist). The word "lack" is characterised by a strong attraction with the ergonomists' group, while repulsion is observed with the engineers' group: "*Lacks, so things that are not made*" (ergonomist).
We find a strong attraction between the term "expectation" and the ergonomists' group: "*when someone says 'oh the system could do that', I have the expectation evocation*" (ergonomist).

4.2 The representations of the process of needs construction are different according to the designers' profiles

Phases of the needs construction process

Representations of different designers' profiles have also been studied in terms of phases of the needs construction process. Engineers and ergonomists employ more terms for phases of needs construction process (respectively, 115/245; *ie* 47% and 114/245; 47%), than graphic designers (16/245; *ie* 7%). The trend is similar if we compare these numbers to the size of each designer's group. Ergonomists and engineers have evoked the most units (44%), followed by graphic designers (12%). The prospective phase (*ie* which corresponds to the needs production) was largely present in the analyzed speeches (92/245; *ie* 38%), followed by the artefact evaluation phase (66/245; *ie* 27%) and needs selection phase (50/245; *ie* 20%). The phase of needs formalisation was the less evoked by the participants (37/245; *ie* 15%).
The analysis of data shows an intermediate global link between the phases of the needs construction process and the designer's profile (Cramer's $V^2 = 0.06$). The analysis of RD shows that the prospective phase is characterised by a strong attraction with ergonomists and graphic designers (respectively, RD = +.40; RD = +.33), while engineers less evoked it (RD = -.44).
A more detailed analysis shows that the attribute "collection and identification of needs" has been mostly evoked by engineers and ergonomists: "*Infer needs and thus define the basis for a usefulness*" (ergonomist). The graphic designers have essentially evoked references to the imagination such as: "*we prefer to guess what they will do in a real situation, rather than create false situations*". One graphic designer explains that "*(...) prospective surveys among the general public are not working very well. Because they cannot immediately say: what we would like to see that or that inside. Once that is thought and when we put the two products side by side, there is no problem and it's pretty accurate. They can tell you: I prefer this one for some reasons*". This confirms the interest, for ergonomists and graphic designers, of the evaluation of an artefact being designed to anticipate new uses.
There is a strong evocation of the needs selection phase by engineers (RD = + .53), unlike ergonomists who made much less to this phase (RD = -. 53). This was reflected in the engineers' discourse by verbalisations such as: "*prioritise goals*" or "*every time we have alternatives, [...] we must make a decision and do a choice*". In their discourses, we observe that engineers tend to integrate the usefulness in design process from a silent partner (*eg*, "*The needs collection is generally done during a formal or informal meeting*, *during the discussions with the companies in which needs exists and become clearer in the course of time*") and by imagining the functions of the artefact in function of the technical constraints (*eg*, "*I just try to imagine the product functionalities that could meet these specifications, these formalized requirements, by taking into account the technical possibilities*").
When they refer to the retrospective phase, engineers use the terms "correction" and "test" referring to actions of system debugging which are linked to iterative and incremental models of software engineering (*eg*, *"validation cycles with corrections"*), while graphic designers and ergonomists evaluate a prototype in order to identify needs and design an artefact that adds a purpose or a value to the end user (*eg*, *"evaluation of prototype with building of scenario"*).

Tools and methods used in the needs construction process

Participants evoked more units related to needs production tools and methods (168/283; *ie* 59%), than units related to needs formalisation methods (62/283; ie 22%) and units linked to needs selection methods (62/283; *ie* 19%). We observe that the ergonomists have much evoked tools and methods of needs construction (166/283; *ie* 59%), followed by engineers and graphic designers (respectively, 59/283; *ie* 21% and 58/283; *ie* 20%). The trend is different if we compare these numbers to the size of each designer's group: ergonomists are those who have evoked the most units (49%) but are followed by designers (34%) and engineers (17%).

The analysis of data shows an intermediate global link between the tools and methods of the needs construction process and the designer's profile (Cramer's $V^2 = 0.14$). The analysis of RD shows that the graphic designers and engineers strongly evoked needs formalisation tools (respectively, RD = +1.44; RD = +.55): "*after the selection of a concept, we wrote a prospective specifications report*" (graphic designer). For some engineers (*ie*, those have worked in project teams involved ergonomists), making choices involves a description of the activity with the meaning of a task which can be formalized (*eg*, "*a hyper detailed process model which describes a range of activities*"). Evaluation tools are characterised by a strong attraction with graphic designers' group (RD = +.47), who referred to evaluation support (*eg*, prototype, model, drawing), while a repulsion is observed with engineers' group (RD = -.73).

Another interesting result elicited from the qualitative analysis of verbalisations is that an engineer who used the term "*ecological evaluation*". He explained that he was trying to "*do user-centered design*" and "*regularly assess either concepts or parts of the system [...] and then regularly [...] with people*".

An ergonomist has explicitly linked the evaluation supports or acts with the production of new needs: "*it is expected that new data emerge during the product evaluation*" (ergonomist).

The qualitative analysis also shows that the terms referring to the needs production tools are mainly tools for collecting and identifying needs like "*it's really by successive interviews and meeting that needs are clarified and confirmed, and that others disappear*" (engineer); Among these ones, tools very specific to ergonomist's profile have been cited by other designer's profiles. This is the case of self-confrontation usually used by ergonomists and yet evoked by an engineer: *"it was a first phase where [...] we also made a self-confrontation at home with a voluntary person*". We also note that all ergonomists cited interviews, analysis of activity and observation as tools for collecting and selecting needs. These last two tools are specific to them.

Stakeholders involved in the needs construction process

We also wanted to identify the designers' representations on the privileged stakeholders' profile that are associated with needs construction. Ergonomists have evoked the most units related to stakeholders involved in needs construction (316/644; *ie* 49%). Engineers (183/644; *ie* 28%) and graphic designers (145/644; *ie* 23%) evoked less units. The trend is different if we compare these numbers to the size of each designer's group: Ergonomists and graphic designers are those who tend to be more talkative about the stakeholders involved (respectively, 79/197.3; *ie* 23%).

Interviewees expressed more units related to the end user (330/644; *ie* 51%), than units referring to designers (157/644; *ie* 24%) and silent partners (157/644; *ie* 24%). The analysis of data shows an intermediate global link between the stakeholders involved and the designer's profile (Cramer's V2 = 0.09). The analysis of RD shows that, in their discourses, graphic designers (RD = +.98) paid more attention to designers than engineers (RD = -.26) and ergonomists (RD = -.30): "*to consult an industrial designer, a graphic designer, an engineer for some elements to help to transcribe the specifications report*" (graphic designer). Similarly, graphic designers evoke mostly the silent partners (RD = +.50), contrary to ergonomists (RD = -. 36). These last ones strongly include end users in their discourse (RD = + .32), which is not true for graphic designers (RD = -. 70): "*showing different versions of prototypes to users to help them to elicit their needs*" (ergonomist).

6 CONCLUSIONS: LIMITS AND FUTURE WORK

This paper confirms the results deduced from the literature: there is a link between the designer's profiles and the representations of usefulness and needs construction (phases, tools and stakeholders involved). However, the data which confirm this link are trends that we have to confirm and further study in future research. Indeed, a limitation of our study concerns the sample size of professionals and the small representation of the graphic designer's profile. A larger sample for each profile would allow to study the intra-group variability and to assess to what extent the experience in former projects module theirs representations of utility, usefulness and needs construction. This assessment could be done through interviews: a first series of interviews with designers who have never worked in multidisciplinary teams and a second series with designers who worked on multidisciplinary projects.

The data collected allow us to improve the design process by providing recommendations on when (*ie*, design phases) and how (*ie*, kinds of tools and methods) integrate these designers regarding their profile and their degree of experience.

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