Creativity as a tool for prospective use analysis in the design of innovative products

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RESUME

La participation des ergonomes aux projets de conception de produits innovants a fait l'objet de plusieurs évolutions majeures au cours des dernières années. Il en résulte un changement de statut de l'ergonome qui, de diagnosticien de l'activité existante, est aujourd'hui amené à analyser de manière prospective les *potentialités d'usage* associées à un produit, avec pour conséquence l'émergence de nouveaux besoins en méthodes et outils de travail. Nous proposons une approche pour répondre à ce besoin des concepteurs en général et des ergonomes en particulier. Nous présentons d'abord une revue de question sur l'intégration de l'ergonomie dans les projets de CPN. Nous situons ensuite les méthodes de la *créativité industrielle* comme réponse aux difficultés rencontrées par l'ergonome dans ce type de projets. Enfin, nous décrivons un protocole pour vérifier cette hypothèse, évaluant l'apport de deux méthodes de créativité – le *brainwriting* et la matrice de découvertes – à l'analyse prospective des usages dans deux types de projets : la conception d'un produit exploitant une technologie émergente, et la conception d'un système de sécurité.

Mots clés

Analyse des usages ; ergonomie prospective ; processus d'innovation ; créativité.

ABSTRACT

Ergonomists' participation to New Product Development (NPD) projects has undergone major evolutions in recent years. One consequence is the changing status of the ergonomist, from an expert in diagnosing existing activities, to an expert in identifying *opportunities* in the use of a new product, with a need for new methods and tools to assist prospective analysis of future use. We propose an original approach to address this need of designers in general and ergonomists in particular. We first present a survey of issues regarding ergonomics involvement in NPD projects. We then argue that creativity methods may be used to address some of these issues. Lastly, we describe a protocol to test this claim, assessing the benefits of two creativity methods – brainwriting and discovery matrices – for prospective use analysis, with two different applications: the design of products based on emerging technologies, and that of safety systems.

Categories and Subject Descriptors

H.5.2 [**User interfaces**]: *User-centered design.*

General Terms

Human Factors

Keywords

Use analysis; prospective ergonomics; innovation processes; creativity

1. INTRODUCTION

The official definition of ergonomics according to IEA suggests it may assist design in many fields, the most commonly cited of which are work system design and product design [15]. It has been suggested that these two fields rest on different epistemological and ethical bases [12]. Indeed, the role ascribed to the human factor is not the same in either case: for worksystem design, ergonomics aims to help improve the contribution of *operators* to company development through their work activity; in consumer product design ergonomics aims to raise a product's use value over competing products, while *users* contribute to economic development by purchasing the product. This paper deals with the latter, *i.e.* the contribution of ergonomics to New Product Development (NPD). Veryzer and Borja de Mozota [43] point out that NPD is characterized by a "fundamental tension between a technology-driven and a user-centered focus" and that "product applications are often, formulated with only a partial sense of the market". Given this state of affairs, ergonomic interventions in NPD projects may lack a clear definition of what constitutes "user activity" or "future product use". Over the past fifteen to twenty years, much work [38, 45] has stressed the importance of foreseeing the effects of introducing new technologies and systems in human activity, leading to a need for "prospective ergonomics" *i.e.* ergonomics focused on anticipating future user activity as opposed to designing or correcting products for existing activities.

In the first part of the paper, we content that current demands in the field of NPD place a strain on traditional ergonomic methods of activity analysis. We then suggest that another approach, based on the paradigm of *creative design*, may serve as a basis for prospective use analysis. In the third part, we describe an experimental protocol aiming to assess the benefits of using two staple methods of creative design – brainwriting and discovery matrices – to this end. Finally, we describe some early results of this experiment and discuss them in the light of current models of ergonomic intervention.

2. ERGONOMICS INVOLVEMENT IN NPD PROJECTS

Current practice in the design of innovative products is highly dependent upon technical and economic criteria. This has led to new practices in collaborative design and a growing need to optimize costs, quality, and time [35]. To this end, several authors have proposed a model of the NPD process with emphasis on creative design [24]. Our own reference in this paper will be the model put forth by Aoussat *et al.* [3]. This model provides a longitudinal view of the NPD process "from an idea to a finished product, and divides this process into 4 stages: (1) translation of a company's needs based on knowledge of this company, of its competitors, and of the target market end-users; (2) interpretation of these needs and production of innovative product concepts; (3) definition of the product, *i.e.* of its various design specifications; and (4) product validation, often based on iterative prototyping and user tests. Within the NPD process, ensuring early and continuous involvement of users and ergonomists is an enduring challenge [18, 21, 26]. There are several reasons for this.

First, demands for ergonomic interventions increasingly focus on *disruptive innovations.* Innovations are said to be *disruptive* if technology characteristics allow the product to stand out from the competition in one aspect, find a new market, and gradually penetrate the mainstream market as R&D allows it to catch up with widespread competing products. This disrupts current social patterns of use by introducing new artifacts and values within society [27] *e.g.* the "encroachment" of the market of landline phones by mobile phones. Faced with company need for disruptive innovation, ergonomists are very strongly confronted to the "paradox of design ergonomics" [41]: on the one hand, ergonomics relies on the analysis of existing activities to assist the design of new tools and products; on the other, these are likely to alter users' "courses of action". Therefore, ergonomists may often base their analyses on situations that are openly different from future use, acknowledging that it is precisely *departures from existing practices* that offer the most interesting prospects for innovation. For example, when assessing the usefulness of an interactive tabletop interface to assist designers in creative design sessions, ergonomists can analyze situations where users accomplish the same task using existing tools, *i.e.* pen and paper or a whiteboard, to compare them with the activity of users on a prototype [9].

Second, the need for earlier involvement of ergonomists derives from the fact that many decisions determining project costs are made in the "fuzzy front-end*"* of innovation [37]. Although this term highlights the enigmatic stage of *generating* product concepts and *selecting* the more promising concepts for further development, some authors point out that decisions at this point are also driven by multiple impulses, the best known of which are *market characteristics* and *technical know-how*. This leads to a classic distinction between technology-push and market-pull processes [7]. These two drives are rarely exclusive, and ergonomists must increasingly deal with projects where product, technology, and end users are all ill-defined. In such cases, the ergonomist's role remains to ensure a focus on users throughout the NPD process, but it also implies higher-level goals [4]: (1) saving development costs by identifying and solving design problems early on, (2) anticipating and avoiding problems related to use and all other stages of the product's lifecycle following its launch, and (3) identifying opportunities for further innovation.

Third, early involvement of ergonomists in NPD also implies that discussions of future use are likely to permeate the whole design process and involve people from many fields of design, whether they are involved in collecting and analyzing use-related data (*e.g.* ergonomics, sociology, marketing, etc.) or in using the conclusions of data analysis to make design decisions (*e.g.* engineering, design, etc.). All in all, design practice mostly relies on simple representations of future use to foster communication between practitioners, such as scenarios of use [10], but complexity may arise from the coexistence of multiple points of view on the same situations of use [13, 44]. In addition, scenarios are intended as a tool to elicit representations of future use in designers, but not necessarily to guide the *construction* of such representations.

3. COUNTERING BIASES THROUGH THE USE OF CREATIVE DESIGN METHODS

3.1 Biases in the anticipation of future use

The characteristics of NPD processes outlined above highlight the need for ergonomists to assist the anticipation of future product use in design teams from the early, concept-definition stages of the NPD process, by helping designers identify prospects and issues related to future use to develop new products. Such anticipation is a part of design work [45] but has been mostly approached in the literature through the biases which surround it. The most often-cited bias of this kind is *I-methodology* [2] whereby users believe themselves to be representative of future users and infuse these representations within the "script" of the artifact being designed. Furthermore, each designer can provide input to the team's shared representations of future use, but the more input is provided, the more time it will take to formulate consistent representations for design. This results in two sources of bias.

Firstly, the NPD process is characterized by *limited resources* (time, money, knowledge of users, etc.) and designers define the set of scenarios to be taken into account using a "satisficing" principle [39]. However, this approach has been described as ill-suited to the requirements of NPD, which rests on *conceptual expansion* [20] *e.g.* of what constitutes "product use". For example, in the design of a device to prevent drowning in swimming pools, user needs analysis may lead designers to widen the scope of use to other areas such as "by the sea", or further specify the concept of "swimming pool" to include public pools, private pools, etc., each helping define new "characteristic situations of use" [12] for the future product.

Secondly, *social interaction* has been said to act as a resource for this conceptual expansion [20]. In ergonomic interventions, however, the complexity of reaching a consensus is in part due to the complex social structure of the design team. A key role for ergonomists is then to produce data from real-world situations of use to foster consensus [19]. Simulation methods are often used to approach future use in this spirit, *e.g.* to test a prototype before it is deployed and assess the relevance of design choices. But a simulation implies a product concept has been clearly defined, which is not always the case in NPD: instead, as long as the product concept is ill-defined, use is approached through general concepts, defining the team's view of what constitutes "desirable" or “undesirable” characteristics of product use for the product: it should be safe, fun to use, usable “on the move”, etc. The biases outlined above suggest that, when attempting to substantiate these concepts with concrete situations of use, designers can be confined to their own past experiences and constraints as workers. Some authors have termed *requisite imagination* the ideal state where designers would escape these biases to improve user-centered design [1]. This concept, originally related to the design of safer systems, can be widened to accommodate other concerns of designers related to future use, notably a positive experience to users [28].

3.2 Creative design methods to counter biases in anticipation

Our contention in this paper is that adopting the methodological framework of *creative design* may help designers develop this “requisite imagination”. Creative design refers to a set of methods and models to assist the early stages of NPD. *Idea production* is the main goal at this stage of designer activity, and is described as having two components: divergent thinking, *i.e.* producing multiple answers to a design problem based on available information, and convergent thinking, *i.e.* selecting the most relevant answers to solve the problem at hand [11]. Since the 1950s, several methods and tools have been devised to assist creative production in designers [e.g. 25, 42], although some point out that many such methods and tools were developed with no scientific backing on the mechanisms of creativity [see for example 40].

Brainstorming is an example of this. Originally developed as a pragmatic tool by Osborn [32], it uses a set of four simple rules (*e.g.* “Withhold criticism” and “Welcome unusual ideas”) to facilitate idea generation. Since then, it has been the object of extensive scientific inquiry, which suggests that complex cognitive and social effects are at work in team brainstorming. For example, on the one hand, ideas produced by other participants can stimulate other concepts in long-term memory and lead to associational chains of ideas [14, 31]; on the other hand, numerous social factors have been shown to limit the scope of ideas explored by the team, *e.g.* evaluation apprehension, production blocking (“traffic jams” in oral communication), and “social loafing”, *i.e.* the emergence of “leaders” and “followers” in the collective, hindering the benefits of collaborative work through lack of equity in idea production [8]. Many alterations have been made to Osborn’s method in attempts to reap the benefits of collaborative idea generation, e.*g.* by adding new rules to the original four [36] or by experimenting with new input devices and modalities [9, 33].

Brainwriting [22, 33], used in this paper, aims to avoid production blocking by allowing participants to communicate in writing only. Some variants of this have been used to assist participatory design. For example, Boy’s GEM method [6] uses brainwriting as a means to elicit expert knowledge and identify issues in the use of future systems. This includes 6 stages : (1) issue statement formulation and choice of participants; (2) viewpoints generation; (3) reformulation of these statements into more elaborate concepts; (4) generation of relations between these concepts; (5) derivation of a consensus; (6) critical analysis of the results. The main drawback of this approach, however, is that it still implies that a product concept and population of future users have been defined, which is not always the case in NPD.

To circumvent this issue, we chose units of idea generation that were even more elementary than Boy’s “issues” and “situations”, drawing inspiration from Flichy’s [17]concept of “use frame” as being defined by several categories of elements, such as populations of future users, and possible locations of future use. We implemented a four-stage approach intended to mimic two cycles of creative divergence-convergence (Figure 1):

1. Based on a design brief describing the future product’s intended expected capabilities, participants take part in a brainwriting session to generate a list of possible user populations and use locations;
2. Answers thus produced to these questions are selected based on designers’ discretion, taking into account project goals;
3. User populations and use locations are combined within a discovery matrix to generate viewpoints on future use. This is reminiscent of Boy’s [6] “concept creation” stage, but should allow a greater creative divergence and more concrete output for designers;
4. Viewpoints serve an input to hazard/opportunity tables. This method is adapted from Preliminary Hazard Analysis or PHA [16], but has been adapted to allow exploration of *opportunities* in future use as well; the ease of use of PHA thus responds to Boy’s [6] remark that defining design issues to explore is the most difficult part of his GEM method.

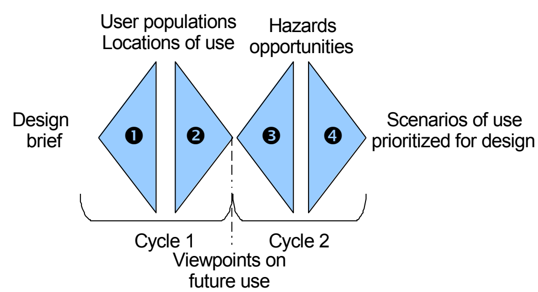

Figure 1 - Overview of the creative production process

4. METHOD

4.1 Participants

Forty-eight people (16 men and 32 women) were requested to take part in work sessions to anticipate the future uses of an innovative product. These participants were recruited from the staff and students of our lab and from our social network. Participants were 33.0 years old on average (σ=13.7) and had an average experience of 7.0 years in their respective fields (σ=10.5). They were recruited according to their professional background: the sample included 12 engineers, 12 ergonomists, 12 designers and 12 people with no prior experience of design (termed “naïve” in the rest of the paper. They were divided into 12 teams, each including one member of each group. Each team took part in one session.

4.2 Materials

The experiment took place in a meeting-room. Teams were provided with a brief, describing the intended technical capabilities of the product they were to design, as well as design roughs of the product and/or visual representations of analogous, existing products. Teams worked on either of two projects: the design of “an inflatable necklace to prevent drowning in infants”

[29, 30] and "an interactive tabletop interface to assist collaborative activities" [9]. In stage 1, they were also given blank post-its for brainwriting and sheets of paper to record their ideas. In stage 2, they were provided with the idea sheets produced during stage 1, as well as blank tables for hazard and opportunity analysis and blank sheets in case further new ideas should be produced. The tables included 3 columns: in the first, participants noted the viewpoint (*i.e.* idea-sheet) they were referring to; in the second, why they viewed this particular use as dangerous or interesting; in the third, they graded the entry on a 5-point Likert scale to prioritize taking these items into account in the NPD process.

In both stages, different-colored pens were used to record authorship of written productions: engineers used the blue pen, ergonomists green, designers, red and naive participants, black. Work sessions were recorded, with participant approval, using a camera focused on the team's work area. Finally, in both stages, participants were asked, at the end of the session, to fill in a questionnaire to assess their subjective impression on the methods used.

4.3 Procedure

The sessions included up to 2 stages (Figure 2). Eight teams took part only in the first stage of the experiment (Blocks A and B). For the second stage, eight teams took part, including four which had already taken part in stage 1 (Block B) and four teams of newcomers to the design projects (Block C).

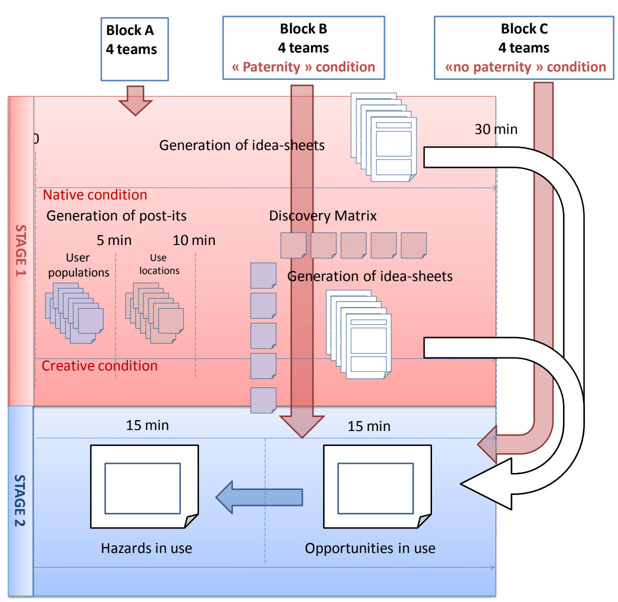

Figure 2 - Overview of the experimental protocol

In the first stage, participants were asked to "anticipate as many uses as possible" for the product they were working on, working as a team and using the sheets provided to record their ideas. Participants were also instructed not to restrict their exploration to situations where "everything went right", but to also include situations that presented a hazard to the user, product, society, etc.

Two conditions were used in this stage. In the *native* condition, which served as a control condition, teams were given no other instructions. In the *creative* condition, they were read aloud the rules of brainwriting devised by Paulus and Yang [33], and were instructed to answer the following questions, using post-its to facilitate work in the rest of the session: 1) "Who might the future users of this product be?" Followed by (2) "Where might this product be used?" They were then requested to select the five answers they thought most relevant to each question, and to use the post-its to construct a 5-by-5 discovery matrix. Finally, they were asked to use the idea sheets to record their ideas regarding future product use by using the matrix as a guide. Teams worked successively on both conditions: a counterbalanced design was used to control the effects of order and project. In both conditions, the time limit for task completion was 30 minutes.

In the second stage, participants were provided the creative output from stage 1 (idea sheets) and asked to fill the tables for hazard and opportunity analysis. Again, two conditions were used. The *paternity* condition refers to block B of Figure 2: participants had already taken part in stage 1 and reprised their own creative productions. The *non-paternity* condition refers to block C: participants were unfamiliar with the design projects and were provided with the creative production of the teams from block B as well as the relevant brief. A counterbalanced design was used to control the effects of paternity and project type: each team from block C was assigned to a "mirror" team in block B, who had worked on the same project.

Different independent variables were chosen for each stage. For stage 1, the condition (native or creative) project (inflatable necklace or tabletop interface) and role (engineer, ergonomist, designer, or naïve) were used. For stage 2, the variables were project, role and paternity of idea sheets (yes *vs.* no). As for dependent variables, we chose to conform to some well-defined criteria in creativity research: *fluency* (the number of ideas produced), flexibility (the variety of these ideas) originality (how unusual these responses are) and elaboration (how detailed each response is) [34] as well as participants' subjective impressions of the effects of introducing new methods in their working practices. Here, we will present only the methodological aspects of measuring *idea fluency*, and *subjective evaluations of work*.

Written productions (post-its and idea-sheets) were analyzed thus: each block of text and/or drawing pertaining to a situation of use was coded as a single viewpoint. In stage 2, a viewpoint was defined as a single graded item in the hazard/opportunity tables. The term viewpoint is taken here in Boy's sense of *assertion related to future* use. The number of mentions to *locations*, user *activity* (*i.e.* action verbs) and to the *system being designed* served as dependent variables, as well as the number of viewpoints generated. Mentions to users based on first- or second-person speech (*e.g.* "I'd love to be able to do CAD using that table") were deemed openly indicative of I-methodology, and viewed as a separate variable from users mentioned in the third person.

Finally, the questionnaire – filled at the end of each condition of part 1 and at the end of part 2 – graded several dimensions of subjective experience of work from 1 to 100: perceived *ability to anticipate* future use, to *assist* future designers, to design a safe product, to design an interesting product, ease in *carrying out the task*, in *applying the proposed methods*, usefulness of group work, and conviviality, amounting to six metrics for performance and eight for subjective experience.

We hypothesize the following:

H1. Creative design should promote idea fluency regarding future use, *i.e.* increase the number of viewpoints generated as well as references (1) to users in the third person, (2) to locations and (3) to user activity, in the creative *vs.* in the native condition;
H2. Creative design decreases the I-methodology bias; first- and second-person references to users should be rarer, and third-person references more frequent, in the creative *vs.* native conditions;
H3. Studies have shown that designing safety systems is prone to biases other than those outlined in section 3.1 [29]. The existence of specific biases suggests that the *condition* and *project* variables may interact with each other, although it is unclear how;
H4. Professional background is claimed to play a part in defining viewpoints at work [13]. On the one hand, certain roles are expected to focus on specific dimensions (*i.e.* an attraction of *ergonomists* to references to *users* and user *activity*, and of *engineers* to references to the system). On the other, creative design strives to erase roles [32]. Thus, one should find the "condition" and "role" variables to interact, so that topic-role attractions disappear in the creative *vs.* native condition;
H5. In stage 2, participants should encounter difficulties when working on a project they are unfamiliar with. Performance metrics (viewpoints generated, references to users, locations, activities and system) and subjective experience metrics are expected to decrease in the non-paternity *vs.* paternity conditions;
H6. Creative design methods are expected to promote a more positive experience for designers (vs. the native condition) for all 8 chosen metrics.

5. EARLY RESULTS

To date, design meetings have been held and data has been collected for all twelve teams of blocks A, B and C. are currently being analyzed to test all six hypotheses outlined above.

5.1 Subjective evaluations of the effect of creativity methods on work performance

ANOVA was carried out on all 8 metrics of subjective evaluation using the Condition (native *vs.* creative) as a between-group factor and the Project (inflatable necklace *vs.* tabletop interface) as a within-group factor. In contrast to our H6 hypothesis which posited that the creative condition would yield significantly higher ratings for all subjective variables, only three results were statistically significant.

In stage 1, analysis showed that the *condition* and *project* factors interacted significantly in participants' perceived of ability to *design an interesting product* (F(1/30)=3.19, p=0.084, see Figure 3), although neither factor exerted a main effect.

The Condition exerted a main effect on the perceived "ease of use in applying the method". This was rated significantly higher (F(1/30)=4.03, p=0.054) in the creative *vs.* the native condition, suggesting that participants found the "brainwriting - discovery matrix" association easier than open exploration of future use with pen and paper. Additionally, the project was also found to exert a main effect on the same variable (F(1/30)=5.01, p=0.033): participants found the "tabletop interface" project easier to work on than the "inflatable necklace" project.

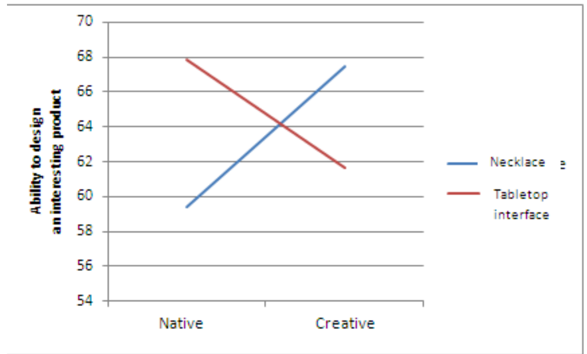

Figure 3 - ANOVA results on "ability to design an interesting product" (/100)

A second ANOVA was carried out on the results collected in stage 2, using paternity (yes *vs.* no) and Project (inflatable necklace *vs.* tabletop interface) as between-group factors. Again, only few statistically significant effects were observed. Paternity exerted a main effect on participants' evaluations of their *ability to anticipate future use* (F(1/28)=10.36, p=0.003): they felt they were more able to anticipate both the dangerous and interesting uses of the product when they had already worked on the project, than when they had not.

Finally, the *Paternity* and *Project* factors were found to interact on four aspects of subjective evaluation of work performance, partially verifying H5:

- *Ability to anticipate future use (F(1/28)=9.22, p=0.005)*: this was virtually identical for groups working on the necklace (regardless of paternity, i.e. of prior experience on the project). However, H5 was verified for groups working on the tabletop: newcomers rated their ability to anticipate future use significantly lower than "old-timers" did;
- *Ability to assist designers (F(1/28)=8.34, p=0.007)*: Again, H5 was verified for groups working on the tabletop, with higher confidence ratings for participants with prior experience on the project; interestingly, however, this was not the case for groups working on the safety necklace: those with prior experience on the project felt their contributions were *less* relevant to designers.
- *Ability to design a safe product (F(1/28)=7.43, p=0.011)* and *ability to design an interesting product (F(1/28)=3.73, p=0.064)*: again, H5 was verified for groups working on the tabletop interface (significantly higher ratings for participants with prior experience), but not for those working on the necklace: more experienced groups felt less confident that they could design an interesting product, as well as a safer one.

These results are admittedly early explorations and need to be interpreted in light of performance data (see H1). However, some points of discussion can already be put forth based on these findings

6. DISCUSSION

6.1 The impact of creativity and project stakes on anticipation of future use

Creativity methods are viewed as something of a “magic bullet” in NPD, and it is tempting to think of them as such in prospective ergonomics. Nevertheless, our early results regarding subjective ratings made by our participants yield some thought-provoking conclusions.

The first interesting result is the effect of the “project” interacting with other variables, on participants’ subjective evaluations. In our work, we chose two very different projects: a safety product for infants with a relatively well-defined “use frame” [17] (swimming), and a product based on disruptive technology with a less well-defined use frame (collaborative activities). Yet participants found the tabletop interface project easier to “handle” than the “inflatable necklace”. Participants claimed that the tabletop interface “felt more open” as a product, whereas the safety necklace was viewed as ”shut”, i.e. leaving little freedom to define situations of use: discussions often “stuck” to a handful of stereotypical “situations” [12], *e.g.* “the infant crawls out of the house, escapes supervision, and drowns”. This, we feel, demonstrates the potency of biases surrounding designers’ preconceptions of future use in such projects.

In prior work, we advocated the view that ergonomics should help designers not just to apprehend the variability of user activity; but also to introduce a variety of stakes in user-centered design [29, 30]. In this particular case, *product acceptance* by both infants and their caregivers seemed like a crucial condition for user safety, since the necklace would be useless if it was not worn. When using creativity methods on the necklace, participants felt they could design not just a safer, but a *more interesting* product as well. The term was left intentionally vague in the questionnaire, but the common denominator in participant responses to stage 2 is “interesting ways to improve user experience”.

These results suggest that creativity methods may help designers “think out of the box” by enriching the stakes of user-centered design in projects it UCD is dominated by a clearly defined stake. Such “dominance” of a single, safety-centric view on UCD, led to surprising results in stage 2, with participants feeling *less confident* that their work would be useful to designers and would lead to designing a safer product, when they had worked on the project in stage 1, than when they had not. Here, the most frequently-touted argument is that anticipation of possible accidents should be comprehensive for the product to be as safe as possible. This is an example of what Béguin describes as “crystallization" [5]: the device embodies design assumptions regarding future use and users, and every possible contingency needs to be accounted for, in order for safety to be flawless. These very high expectations are often seen as unrealistic, and other design approaches have appeared based for example on developing *system resilience* [23] *i.e.* ability to recover from hazardous situations once they have occurred, rather than to attempt to anticipate and prevent all possible risks through design. We do feel, however, that the unacceptability of failure in the design of safety systems (such as the device to prevent drowning in this paper) may cause biases when anticipating future use: future work should therefore focus on better identifying and countering these biases. Creativity methods are a first step towards this since they advocate a neutral point of view on ideas generated, but they pose interesting questions regarding evolutions of the ergonomist’s role in NPD projects.

6.2 An extended role for ergonomists in NPD projects?

Creativity methods are based upon a strong paradigm of freewheeling and lack of censorship in idea production [32]. In a brainstorming (or, in the case described in this contribution, brainwriting) collective, participants are expected to forfeit any considerations relating to social (particularly hierarchical) roles, even if this is often difficult to achieve (see for example [14, 31] for evidence of “evaluation apprehension” in brainstorming). Ergonomists should have a role no different from other participants when generating ideas. One key objection to this neutrality paradigm is that previous work has shown ergonomic expertise to focus on human activity in a vast “library of situations” [e.g. 12]. As such, we expect to find ergonomist contributions to creative production to be influenced by prior knowledge of existing activities, common usability issues, user characteristics, etc. Given the unfamiliar aspect of some user activities encountered in NPD, this also stresses the need for ergonomists to further develop a strong culture in innovative technologies. Furthermore, this expertise may also help him identify more easily the hazards and opportunities in the future uses of a product generated from the use of creativity methods.

7. CONCLUSION

In this paper we have described the main characteristics of NPD projects as they influence the practice of ergonomics. We have described the basics of a creativity-based paradigm to assist the first stage of an intervention in prospective ergonomics, as well as an experimental protocol to assess the effects of simple methods and tools derived from this paradigm. Our short term work will involve verifying each of the hypotheses listed in the paper, expanding the corpus of results on the way. In the long run, we aim to extend our investigations of prospective analysis to later stages of opportunity and hazard analysis, where ergonomists are led to collaborate with fields such as marketing and management [38], in order to assess how the early creative productions studied here may benefit the later stages of NPD.

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