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ANALYSIS AND TRANSLATION OF USER NEEDS FOR ASSISTIVE TECHNOLOGY DESIGN

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ABSTRACT
Products specialised for disabled people, called technical aid or assistive technology, usually give poor satisfaction to users. We hypothesize that such failures are due both to a lack of understanding of users' needs, and to a difficulty to translate these needs into data usable by all members of the design team. In this paper, we present an original approach for needs analysis process, combining several complementary methods so that a multi-disciplinary design team could be aware of and account for a handicap situation.

Keywords: methods for needs analysis, product design process, handicap situation

1 INTRODUCTION
There are about 50 millions people with disabilities in Europe. The population as a whole is ageing and the probability of occurrence of disabilities is increasing. Changes in needs for care, combined with increasing expectations for new and improved services, result in additional pressures on health and social budgets [1]. Moreover, specialized products intended for disabled people, so called assistive technologies or technical aids, are sometimes rejected by their target users, mainly for the following reasons [2], [3]: (1) lack of usability, difficulty to use products made from a combination of different technologies, (2) lack of aestheticism, majority of assistive technologies having a stigmatizing effect, pointing up their disability to the users and to other people, (3) a high cost due to a potential small market. In 2003, the report "Diffusion of Innovation for the Handicap" from the French Ministry of Research and New Technologies, underlined that improving the stage of needs analysis in product design process for disabled people could become a full research area [4]. That is why this paper proposes to better investigate and accurately formalize user needs during the first stages of the product design process.

2 RESEARCH CONTEXT

2.1 What is handicap situation?
The design of technical aids requires a good understanding of handicap. This is the very first difficulty because there are several definitions. An error often committed by the designers is to think that the handicap is only the result of a disability (e.g. muscular dystrophy). But illiterate people can be considered as handicapped in our society although they do not have any disability. Many authors as Erving Goffman [5] describe handicap as a place of interactions. In this paper, we consider, as the Canadian trend of Production Process of Handicap (PPH) [6] does, that the handicap results not only from an impairment but also from interactions between 3 variables (see figure 1): (1) **personal factors** (sex, age, abilities, anthropometry, sociocultural identity, etc.), (2) **environmental factors** (social environment, urban architecture, assistive technologies, etc.): social or physical dimensions which determine organisation and context of society, (3) **customs of life**: activities of daily living or social role valued by the person him/herself or his/her sociocultural context according to his/her own characteristics (personal factors).

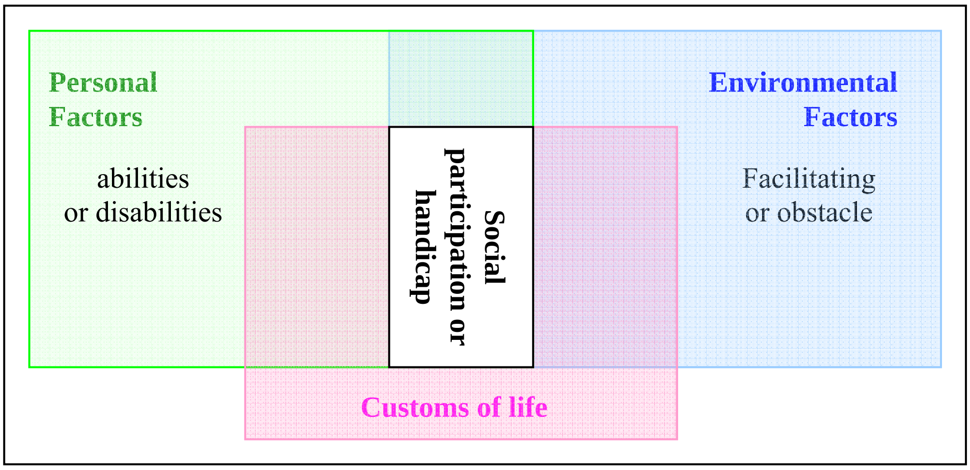

Figure 1. Figure inspired from PPH [6]

Because handicap is a complex situation it is difficult to understand user needs and, therefore, to design an adapted product. So our main research goal is to help designers understand what handicap is in order to improve product design, and to improve integration of user needs in the early stages of design process.

2.2 Product design process

Nowadays, products are more and more complex and offer a lot of capabilities, but they must be accepted for being used. Most authors define product acceptability as the combination of both practical and social acceptabilities. According to Inclusive Design approach [7], practical acceptability includes cost, compatibility, reliability and usefulness. Products must be designed for a maximum range of population, including people with disabilities. Social acceptability represents the perception of the product by users and by society. If social acceptability is not taken into account, products as technical aids can have a stigmatizing effect (pointing up their disability to the users and to other people) resulting in product rejection.
New Product Development should follow a user-oriented design approach [8], which seems to be key to satisfy user requirements [9]. Many authors as Von Hippel [10] underline the importance of user participation in the design process. Hartwick and Barki [11], [12] distinguish "user involvement" from "user participation" because user involvement refers to users' psychological state. So designers will be helped in their task by user motivation, i.e "personal relevance". In other respect, for disabled people their faith in product is equal to their hope in compensating their handicap situation. Moreover nobody can replace people with disabilities because nobody but them really knows what a handicap situation is. That is why the involvement of disabled users in a user-centred design method appears so relevant to improve design of technical aids.

3 OUR ORIGINAL APPROACH

The whole project follows the framework of New Product Design Method (NPD) [21] and the present study especially focuses on the two first phases, namely Need translation and Need interpretation [22]. The main goal of the need translation phase is to obtain a list of functional specifications for the "Need interpretation" phase. The advantages of NPD method in our case are the integration of « expert skills into multidisciplinary team », « tools as functional analysis, brainstorming, etc. », and the fact that it is a user-centred design method. « NPD method emphasizes the importance of taking users into account during the design process, notably with the evaluation of intermediate artifacts » (e.g. rapid prototyping, simulation, user tests, subsequent feedbacks) [23].
Our original approach for needs translation phase defines a methodological framework re–usable for other design projects. In the following sections, we describe how we recommend to adapt and use 3 complementary methods for needs analysis, namely functional analysis, use survey and creativity session. Usually creativity is used during needs interpretation phase for solution research. During the needs analysis phase, creativity aims at giving means to users and design team members to express needs by varying representations and/or images of products. So, users can imagine devices that exist

or not as well as features or social values they will have to meet. Moreover, this original approach allows offering the designer research thrusts he can use to define guiding concepts, etc.

3.1 Choice of methods for user needs analysis

A lot of methods exist to understand user needs in the early stages of new product development. According to Ellen van Kleef's review [13], we just expose in this paper the "most common consumer research methods and techniques":

- Empathic design ("form of observational research" where consumers are watched using products in their own environment),
- Category appraisal ("refers to a set of procedures to obtain a visual representation of positions that products hold in consumers' mind"),
- Conjoint analysis ("doing conjoint tasks, respondents are asked to express their preference toward experimentally varied product profiles"),
- Focus group (is a group discussion technique with a moderator in order to discuss views and opinions about topics),
- Free elicitation ("is a personal interviewing technique in which the respondent is asked to express the attributes he/she considers relevant in the perception of a particular product set"),
- Information acceleration (is a conceptual "testing method employing multimedia stimuli and experimental set-ups"),
- Kelly repertory grid ("is a personal interviewing technique used to elicit the constructs by which consumers structure and interpret a product category"),
- Laddering ("is a personal interviewing technique used to understand consumers' knowledge structure regarding a particular product"),
- Lead user technique ("selected consumers are involved who have advanced knowledge about the product and its usage"),
- Zaltman Metaphor Elicitation Technique (ZMET) ("is a projection technique in which consumers create collages, characteristics of their feelings and experiences about a product or research topic").

For our research, we focus on "need-driven methods" rather than "product-driven methods" because users are "asked to reveal their internals needs without being exposed to (pictures of) products". So, these methods seem to be more appropriate to design really new products (not incremental innovation). Lead user technique tries to give access to consumer's unspoken and latent need but it is risky because lead users are not always representative of the whole population few month or years later on the marketplace. ZMET and empathic design allow focusing on understanding user problems or motivation (more latent needs) and can be used more easily by marketing for example.

User needs analysis implies to define who needs what, to do what, how and when? Another method exists in human factor area called use survey. It includes different techniques [19], [20]:

- Interviews, questionnaires: provoked or spontaneous verbal behaviour
- Self-observation and user observation: provoked (simulation and experimentations) or spontaneous non verbal behaviour
- Task and activity analysis: activity includes all possible means to reach objectives.

Self-observation is a default technique used by many designers. Even though this technique is usually fast and cheap, results are not necessarily representative of target population, especially for disabled people. To solve this problem, many impairments can be simulated to mimic their effects [20] but it does not replace the real feelings of disabled users. Finally, user needs analysis allows apprehending several categories of users [19]: end-user or potential user, expert or novice user.

In conclusion, we can observe that these methods propose to define user needs under various more or less abstract points of view. Levels of abstraction can be functionalities, product characteristics, sociological values, mental representations, verbalizations, movements or gestures, etc. In this way, these methods of user needs analysis are complementary and for some of them, they use similar techniques. However results stemming from these techniques are not directly usable by all members of multidisciplinary design team.

That is why we propose to conduct user needs analysis by combining several complementary methods or techniques in order to process needs through many points of view: functional, technical, semantical. According to a user centred design process, we decide to use need-centred methods with several levels

of abstraction (see orange circles on figure 2). By the way, we go from more abstract level of data (global points of view, mental representations, etc.) to real data (functional specifications). Each method allows enriching functional specifications to be shared by the design team as well as to bring appropriate results to the team members according to their specialty. Activity analysis, observations, simulations and interviews are gathered into a use survey circled in red on figure 2.
We hypothesize that such a combined approach will allow us to formalize needs of people with disabilities so as to be understood and appropriable by each member of design team. In the following sections, we provide some guidelines to apply these methods in the context of assistive technology design.

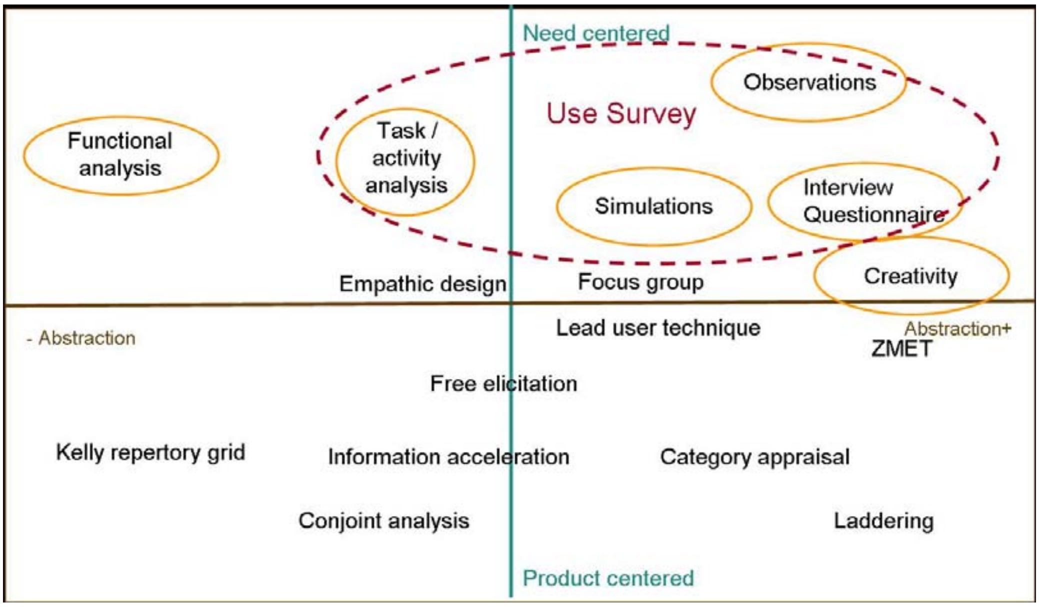

Figure 2. Perceptual map of existing user needs analysis methods and our choice (circled in orange).

3.2 Guidelines for interviews

3.2.1 Target populations

The first part of use survey consists in interviewing several people: end users (people with disabilities) and potential users (experts of handicap: help people, physiotherapists, occupational therapists, end-users families, psychologists, etc.). Interviews with experts allow having a global point of view on target population: what are the situations often met by users? What are the identified problems for a group of users? etc. According to disabilities, there are differences in activities achievement, living accommodations, and personalities between casualty people or diseased people, etc. Moreover, experts intervening in technical adaptation, parameters setting, installation or de-installation of technical aid, can be considered as users of the system and, so, they know some criteria explaining why some assistive technologies are not used. It is better to begin with experts' interviews, to collect global data and understand in a global way the handicap situation. Moreover, experts can help you meet users for your study.
Interviews with target users allow:

- To identify their profiles (age, sex, disability, etc.),
- To understand in which environment they evolve (living place, job occupation, wheelchair, etc.),
- To estimate users' daily living activities: what do they do? How do they achieve it?

3.2.2 Support of data collection

We recommend structuring these interviews around the 3 factors defining handicap: personal factors, environmental factors and activities of daily living.
It is necessary to determine the interactions between personal factors and environment of users for understanding whether they can participate socially and equally or not. According to your project you

can enrich any factor, with anthropometrical data, psychological profiles, taking into account social assistances, or choosing a type of activity such as leisure, etc. Finally, it is important to meet target users living in several environments because the handicap situation can be different depending on whether people live alone, or with their family, at home or in institutions, etc.
Interviews are composed of questions (e.g. profile of interviewed people) and structured as a table (see table 1) inspired from measure scales of customs of life created by Fougeyrollas [24].

Table 1. Example of table used and inspired from Fougeyrollas [24]

Activities of daily living	Achievement Level					Needed help type				Satisfaction level					Comments
	Without difficulties	With difficulties	Achieved by substitution	Not achieved	Do not apply	Without help	Technical aid	Human aid	living space planning	Very unsatisfied	Unsatisfied	+/- satisfied	Satisfied	Very satisfied	

It is possible to add other sections such as usability level, comfort level, etc. and to ask users if they are considering their technical aid as facilitating or as an obstacle to activities achievement. By setting a typical day, the interviewed people describe the activities they achieve (or not). Then, they organize these activities into a hierarchy. Finally, the last part of the interview asks about criteria for rejecting a technical aid and criteria of acceptability. This study allows having general data on the needs of people in handicap situation and to understand how these people use products, what problems they are faced to, what lacks they experience and how they would specify an adapted technical aid.
These data illustrate to team members handicap situations in a global way. They are exploitable by the ergonomist to define a protocol for an activity analysis. They are also input data for functional specifications.

3.3 Guidelines for simulation/observations

3.3.1 Items to collect

For activity analysis the following points should be considered for guiding the observations:

- Description of prerequisites (e.g. intellectual competences, school knowledge, … indispensable to activity achievement)
- Necessary equipments, materials for activity achievement (e.g. equipments and/or materials, optional or compulsory use, resources of substitution, comments, etc.)
- Activity’s environment: (1) type of space in which activity takes place (e.g. general-purpose space, specific space for an activity, etc.), (2) spatial organisation of the activity (e.g. premises, general arrangement of used equipments, localization of the people involved in the activity, etc.), (3) temporal organization of the activity (e.g. global duration of activity, breaks / deferments, periodicity, repetitiveness, etc.),
- Description of activity: sequences, positions, movements, gestural actions, cognitive actions, social interactions, sources of risk, etc.

The data stemming from the activity analysis are variables which can be qualitative (e.g. verbalizations) and quantitative (e.g. response time) useful to engineers as criteria and evaluation levels of solutions.

3.3.2 Compensating strategies

Then, filmed observations of users are necessary to complete this information and understand how people compensate (strategies, movements, and gestures, used to offset a functional limitation, figure 3). This phase illustrates the activity of people in a visual way and allows team members to have a visual representation of a handicap situation. Compensations are important informations usable to design the system because they can represent alternative solutions. The system has to be flexible to use and to allow disabled people to appropriate the product by using strategies.These global observations serve to define one or several variables (e.g. gestures, eyes movements, etc.) for a more detailed activity analysis in order to describe a global situation: users in interaction with their environments.

Figure 3. Example of compensation for people with a severe physical disability: this disabled person uses his hand under his arm to move it up and compensate a lack of elbow's flexion

3.3.3 Activities by valid people

At last we propose to use a pseudo-simulation for a more accurate activity analysis. As part of some projects, it happens that one of the acceptance criteria is that some gestures have to be restored. However those gestures cannot be observed with target people because they are not restored yet. Consequently, it is sometimes necessary to define which movements are involved in activities achievement, to quantify them as well as to evaluate their deflection (filmed observations). Unfortunately, movements and gesture vary depending on whether people are seated or standing up. Simulating the impact of environmental factors allows taking into account the effects on movements and gesture, particularly for electrical wheelchair (EW). EW dimensions, e.g. depth or height, imply a minimum distance from table edge, ticket desk, etc. As we cannot take the place of disabled people and simulate their deficiency, we call this technique "pseudo-simulation" to show how a handicap can arise from a lack of accessibility. For example, pseudo-simulation can consist in having a valid person in an electrical wheelchair to do some activities of daily living and to observe consequences on movement and gesture (Figure 4).

Figure 4. Picture of pseudo-simulation at cash dispenser showing bulkiness consequences of electrical wheelchair

3.4 Guidelines for Functional Analysis

3.4.1 Assistive technology lifecycle

In multidisciplinary workgroup (stylist designers, engineers, users, occupational therapists, ergonomists, etc.) functional analysis can be conducted for phases of product lifecycle corresponding to use, installation / de-installation and parameters setting of the system thanks to the tool called octopus (Pieuvre®). Let us define principal lifecycle phases of technical aid (figure 5) to understand the complexity of the process e.g. in France. These phases can be made parallel, redundant (e.g. use, maintenance, etc.) or optional (e.g. prescription, preconisation, etc.). System of financing technical aid is different from a country to another one (e.g. Social Security, mutual insurance companies, insurances, etc.). Doctor's prescription is made in parallel of recommendation of a type of material by a multidisciplinary team (occupational therapist, doctor, etc.).

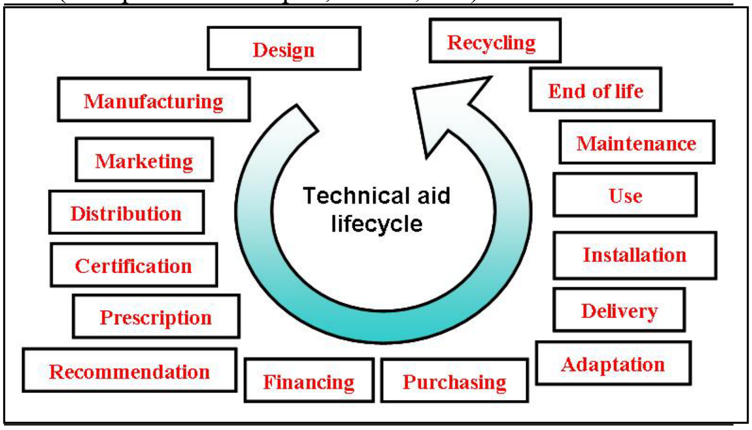

Figure 5. Product lifecycle valid for almost all technical aids in France

3.4.2 Framework of external sets

The Functional Analysis approach we use is based on European and French standards EN 1325-1, NF X50-151, and on the APTE® method [25]. It allows enumerating in an exhaustive way functions the system has to answer to. For adapting this tool to the domain of handicap, we established a general framework for the "octopus diagrams" to include the 3 factors of handicap situation.

This diagram defines main and constraint functions of a system. According to the lifecycle phases that are studied, interactions between variables and system are multiple.

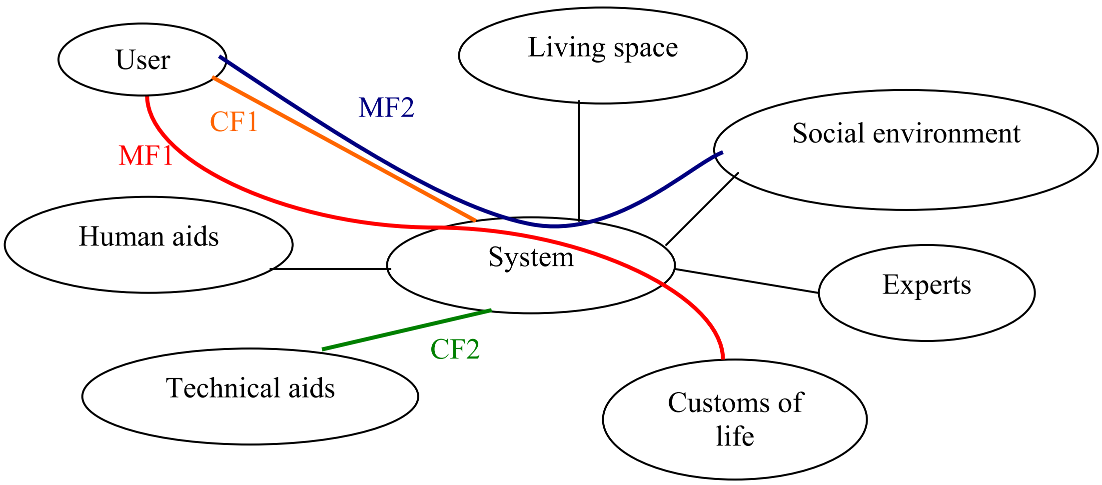

Figure 6. Example of Environment Diagram, graphic tool of the APTE® methodology, adapted for handicap situation

Thus, we define a framework of generic external sets likely to impact the design of assistive technologies (see figure 6):

- Experts, potential users (e.g. technicians for maintenance, occupational therapist for parameter setting, etc).
- Human aid (family, help people, etc) for installation for example.
- Other technical aids or medical devices (e.g. for compatibility, installation / de-installation, etc).
- Living space (e.g. furniture, internal architecture, urban accessibility, etc).

- Social environment (e.g. social values the product has to make reference to, social integration of disabled person, etc).

We call main functions (MF) the interactions between system and two variables and constraint functions (CF) connections between the system and one element of its environment. According to figure 6, here are presented in table 2 some examples of possible functions:

Table 2. Example of functions from Adapted Environment Diagram

Lifecycle phases	Functions
Use	MF1: System must allow the user to achieve his customs of life MF2: System must allow the user to become integrated in social life CF1: System has to be user adapted CF2: System must be compatible with other kinds of technical aids

This method allows defining functional specifications. This tool translates needs into functions, which are usable data for the whole design team, particularly engineers and designers before needs interpretation phase (solutions research).

3.5 Guidelines for creativity

We can use standard creativity techniques (e.g. analogies, reversing, discovery matrix, etc.), however user's participation is necessary. To create good cohesiveness and to avoid any gap within the group (e.g. distance between designers and users), you have to make sure that every participant is able to take part in the sessions whatever his/her disabilities. This implies to adapt creativity methods accordingly. The first step of this method normally consists in individually writing ideas on sticky notes. However, sometimes it is not possible for people with disabilities to write manually, so everybody can be installed on computers to type and print their ideas on stickers. Then stickers are placed on a table according to themes chosen by the participants.

4 EXPERIMENTATION

To illustrate our original approach, we will present a design case of assistive technology for severely motor impaired people (e.g. muscular dystrophy, quadriplegia). The aim of this project is to compensate or restore upper limb mobility. It consists in the design of an active system controlled by the user.

For reasons of confidentiality, we present in this paper only some general results stemming from our methodological approach.

4.1 Use survey

4.1.1 Method

In the first part of study, we met 7 experts (4 occupational therapists, several 2 help people and one psychologist) and 7 users living at home, in family or in institution. We carried out the interviews using the framework previously defined.

Then we have conducted filmed observations of two users with different levels of disability in terms of pathology and severity: we observed them during some vital activities such as eating, drinking, and door opening… The film was used to list strategies developed by users as well as compensation they go to. Filmed users spontaneously put into words why they were doing so to make our understanding easier and better.

4.1.2 Results

4.1.2.1 INTERVIEWS STRUCTURED WITH HANDICAP FACTORS

First, interviews with users and experts allowed us to define two main spaces in the handicap situation:

- Physical space: body space,
- Extra-physical space: reach zone or work area.

The system will have to allow users to recover their ability to act. Body space refers to activities realized by a person itself, including personal activities, related to his/her own body (e.g. to scratch oneself, to blow one's nose, to wash oneself, to eat, etc.). This corresponds to doing for oneself, to preserve one's dignity as well as to prevent others from embarrassing and frequently tricky actions.
Extra-physical space called mobility space is defined by the actions we can make in front of us, for ourselves and for others (reciprocity): to open a door (refrigerator, wall cupboard, building, etc.), to press on a button (elevator, digicode, etc.), to catch an object at a distance, etc. It implies to define a work area. This zone and the associated movements will allow to solve other handicap situations (e.g. to go out, to prepare a coffee, etc.). This method also enabled us to list and to organize into a hierarchy the activities of daily living to be restored by the system. The hierarchy of activities was as follows: "not negotiable", "negotiable", and "very negotiable". The importance scale was as follows: "vital", "very important", "important", and "less important". This list facilitated negotiations between users and design team for project feasibility. It is mandatory to restore "not negotiable" as well as a maximum of "negotiable" activities. Finally a first level of use criteria (e.g. level of noise, aestheticism, time of learning, etc.) was included in functional analysis to define specifications.

4.1.2.2 OBSERVATIONS AND ACTIVITY ANALYSIS

For engineers, a list of activities cannot be considered as data easily appropriable and useful for design and research of solutions. They need to understand e.g. what "eating" means technically. We, thus, performed an activity analysis using pseudo-simulation by measuring and quantifying variables such as movements and gestures (see table 3). We conducted pseudo-simulations for the following activities: having a meal, cash withdrawal at cash dispenser, washing one's hands, washing one's teeth, preparing coffee.
This analysis allowed us to determine articular angles necessary to these activities. These movements served for defining specification criteria and articular angles for level criteria.

Table 3. Example of table used for activity analysis: eating a soup with a spoon

Sequences	Position	Movement	Amplitude	Time	Comments
To carry the spoon up to the mouth	Sitting in a wheelchair	Shoulder flexion abduction interne rotation	 ≈ 25° ≈ 45° ≈ 20°	≈ 1.3s	Grip with 3 fingers
		Elbow flexion supination	 ≈ 135° ≈ 15°		

Then we compared our results to observations of severely motor disabled people to complete the corpus of data. These results served as data for negotiating the design of a system that would enable the restoration of some movements without being unaesthetic. The objective was to define minimum articular angles to achieve an activity in an optimal way (natural movement, time, physical cost, etc.) without using compensation strategies or using them as little as possible.

4.2 Functional Analysis

4.2.1 Method

In a workgroup session of 10 people (2 users, 3 occupational therapists at hospital and in institutions, 1 engineer, 1 ergonomist, 2 technicians of maintenance and 1 stylist designer), we had a functional analysis using the graphic tool from the APTE® methodology, adapted for handicap situation in several lifecycle phases: use, parameters setting, installation/de-installation and maintenance. We managed the session by noting participants' verbalizations on a paperboard before retranscribing these data into a document validated by iterations by the whole group.

4.2.2 Results
We obtained functional specifications defined by importance (IMP.), criteria, level and flexibility (FLEX.). Importance of functions can be rated 1 (not important), 3, or 9 (very important) and flexibility can be rated from not negotiable (F0) to negotiable (F2). For confidentiality reasons, we just present an example of functional specifications out of 32 obtained functions (see table 4).

Table 4. Example of functional specifications defined by our adapted framework of environment's diagram (Pieuvre®)

N°	FUNCTION	IMP.	CRITERIA	LEVEL	FLEX.
2.1	To bring hand of user in various points of space	9	Flexion-extension of elbow	From 0° to 145°	F0
		…	…	…	…

We may also mention that 26% of specifications correspond to environmental factors, 26% to customs of life and 24% to personal factors (12% due to the disability). So, 76% of functions could be defined by our adapted framework. The 24% remaining functions are related to safety and energy. In fact, we obtained with our adapted framework of environment's diagram (Pieuvre®), 64% of functions related to the broad handicap situation compared to only 12% of functions related to disability compensation.

4.3 Creativity session

4.3.1 Method
After the functional analysis session, we made with the same group a creativity session about the following question: if you had to wear this system for upper limb mobility, what should it look like? The session took place in two times: an individual brainstorming phase and a creativity phase. Individual brainstorming, by cleaning their minds, enables the participants to be free from existing solutions.
Creativity phase was supported by a paperboard to collect the ideas of the participants. To work on the previous question, we used two techniques:

- Analogies (e.g. if the system was an animal which one would it look like?).
- Inversion (e.g. what would be the worst system for you?).

Analogies allow to go away from the subject and to find out which existing mental representations the system has to make reference to. The technique of inversion aims at obtaining, first, the characteristics the product has to avoid, and then, to convert them into desirable features.

4.3.2 Results
The stylist designer used creativity results to design boards illustrating social values and mental representations of the desired system (e.g. performance, self esteem and comfort). For example with an analogy between the system and a vehicle, some of the participants said it should be like a Porsche for esteem value and performance. This session allowed her to work on two research axes: the system has to be an extension of the electrical wheelchair, it has to be included in user's environment and if it is worn by the users it has to look like clothes, or skin.

5 CONCLUSION
Users' involvement in our multi-disciplinary design team required adapting our methods to create a fair collaborative workgroup and, on top of that, it allowed us to understand their feelings and their needs better than a video or an opinion survey.
It appears necessary to conduct a deep needs analysis in order to draw a more representative view. Integrating the 3 factors of handicap situation is likely to facilitate the translation of this notion into data that each member of the design team can understand. Moreover it allows us to adapt methods in order to improve the stage of needs analysis.
The originality of our methodology using several complementary methods is to translate needs data in usable and appropriable data by the whole design team and by each team members according to their specialty. Interviews with users and experts serve for drawing outlines of handicap situation. In our

experimentation, these general data have been used by the whole design team and can be re-used in other projects. Moreover, they have been exploited by the ergonomist to define a protocol for an activity analysis. 12,5% of final specifications of our product stem from interviews (including one of the main functions), 6% of specifications come from creativity and 81% from functional analysis. Activity analysis is a method able to translate needs into useful and quantifiable technical data. In our project, levels corresponding to articular limitations came 100% from activity analysis. These data have been used by mechanical engineers to design prototype 0. We can also notice that creativity in need translation phase facilitates users' projection onto images of future product and can drive the stylist designer in his/her solutions research. Our stylist designer exploited creativity results to design boards and to research product architecture solutions. Figure 7 synthesizes our approach by showing that each method (use survey, functional analysis, creativity) contributed to the understanding of the three dimensions of handicap (personal factors, environmental factors, customs of life).

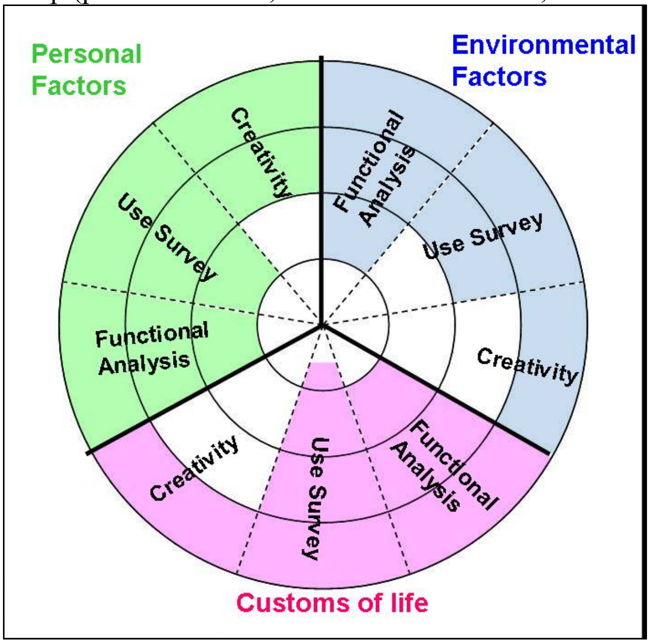

Figure 7. Scheme of our need analysis approach

In perspective, we want to validate our approach in this project in the evaluation phase, by conducting iterative user tests on prototypes. For this purpose, we intend to develop an evaluation method based on the 3 factors of handicap situation and inspired from existing measure scales of handicap. We could also try to compare our prototype with existing products but it will be difficult in this project because actually no such product is available on the market.

To conclude, designing products for disabled people is the same approach as for standard products; the only changes concern variables and criteria. However, considering that every user can be defined by his/her personal factors, environmental factors and customs of life, the generalization of our method could possibly bring improvements to standard products development as well.

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