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### ► To cite this version:

Guillaume Thomann, Rahi Rasoulifar, Matthieu Museau, Diana de Castro Perez. An educational perspective to integrate the handicap in the engineering program: case study. The 11th International Conference on Engineering and Product Design Education, E&PDE09, Sep 2009, Brighton, United Kingdom. 6 p. hal-00451842

**HAL Id: hal-00451842**

**<https://hal.science/hal-00451842>**

Submitted on 31 Jan 2010

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# **SATISFYING THE NEEDS OF THE HANDICAPPED TO AID DESIGN EDUCATION: CASE STUDY**

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## **ABSTRACT**

Research in design education recently showed an increasing interest the confrontation of engineering student and the real design activities. Although many student contributions to the industrial projects remained superficially and limited because of complexity and confidentiality issues, the user centric design activity proposes a new way to overcome the distance. The present paper is the result of our research and education program which aimed to provide the opportunity of student participation in the day to day engineering design activities in the context of design for the handicapped children. The specified context thought the student how to follow a generic design approach and how to face and over come the problems caused by having handicapped children who can not explain their needs, or even evaluate the designed prototype.

*Keywords: Design for All, Design for Disabled Children, Multidisciplinary Fields Projects, Music and Handicap*

## **1. INTRODUCTION**

In the last few years there has been an increasing awareness on a fundamental approach that covers a range of meaning with barrier free, inclusive, transgenerational; universal design, called Design for All [1]. Although there are various devices and instruments designed for disabled people, most of them meant to the essential needs ([2] and [3]). However, the handicapped situation, in fact, may prevent these persons from other activities which could be important subject in their progression in learning and self confidence.

The research behind this paper is focused on handicapped children and solutions for enable them playing music [4]. Children with extensive motor disabilities have very serious problems accessing subtle objects and instruments, for enjoying occupation/leisure activities or advancing their education and communication ([5] [6] and [7]). Music therapy was proposed in the related research as a way to improve handicapped children activities and to help them overcome their disabilities by developing and enhancing basic skills [8]. Defined by the American Music Therapy Association, "the prescribed use of music by a qualified person to effect changes in the psychological, physical, cognitive or social functioning of individuals with health or educational problems" [9]. Music therapy can be used in a passive or active way. Passive music therapy involves the child listening to music and discussing his/her thoughts and feelings while active music therapy involves the child playing an instrument or singing songs [10].

Playing musical instruments can help to develop gross and fine motor skills, as well as to improve cognitive skills, such as language and mathematics for example. Music as a source of motivation and reinforcement for children, open a new window to ability development: instead of focus on what they are unable to do, music shows them the abilities they do have. This way may help to develop mental capacity as well as physical potential for empower the lacking physical capability without overworking. Moreover, music can promote social insertion of children, as some of them can be enrolled in a music band with normal children. But because of their disabilities, in most cases children can't directly manipulate a musical instrument: there is a need for ergonomic adaptation of musical material.

A few methodological researches exist on the design for disabled people [11]. The present research, on one hand aimed to adapt a design method for the design activity in the context of handicapped

children. On the other hand, since the origin of the project was the university, the objective was to bring this design exercise to the educational program of engineering students. As explained in detail in the next section, the organization called AE2M, the collaborative research program developed some educational axes, with the objective of teach the engineering student how to anticipate and integrate the specific users' needs in to the design activity. According to the authors' knowledge, this is the first time that engineering students in France experience such an AtoZ design exercise in user-centered approach.

## **2. EDUCATION IN RELATION WITH HANDICAP IN GRENOBLE UNIVERSITY**

Last months, we observe an evolution of the numerous solicitations about handicap events in direction of the universities. Especially groups of companies want to inform and make students aware about working and taking into account handicap people in engineering design teams. Due to these increasing activities, the creation of a dedicated reflection group has been decided. The variety of actions through this domain is important and lots of competencies are needed. Thus, the composition of this group is currently seven persons:

1. Referent : University schooling service
2. Operations manager (an assistant professor)
3. Human resources Service Representative
4. Inheritance Representative
5. Hygiene and Safety Engineer
6. Handicap User
7. General secretary

In this article, we detail the main action oriented for and with students. Nevertheless, this group is for example in charge of

- The welcome of handicapped students and theirs access to buildings and to the learning supports,
- Discussions with the “service of the personnel recruitment” for the employment of handicapped collaborators.

In this group, the “handicapped operations manager” is especially in charge of educational aspect in the university. Following, we develop three main activities supported and encouraged in the University of Grenoble: *HandiManagement* French Program, Social/Handicap Personal Project and participation to a more global Project about handicap.

### **2.1 HandiManagement French Program**

This program consists of public awareness campaigns with the opportunity for students to be sensitized with the question of the professional insertion of the handicapped people, and to obtain the *HandiManager Label*.

These campaigns are carried out for the fourth year in 33 French engineering's schools and universities and with the support of 17 partner companies, by students organized in teams of volunteers.

With the program: conferences, formations, settings in situation... to cause in their comrades a change of glance by the meetings, the experiments, the exploration of the fears and the prejudices and to lead them to the *HandiManager Label*.

With four years of experiences, companies really await this Label which enables them to recognize the more “HandiQualified”, among the graduates whom they recruit.

All the *HandiManagement* partners Establishments supported this step of certification of their students. They regard the Label as a serious guarantee and an average objective to sanction a real appropriation of the subject. On 733 candidates to the Label in 10 campuses in 2008, 56% were “acceptable” and 33% “were finally “HandiManagers labialized”.

### **2.2 Social/Handicapped Personal Project (SHPP)**

The social/handicapped personal project with humane goal is an exercise where the student has to think alone on an experiment, a personal interest or a passion and to develop, on this occasion, a

critical reflection. It implies the necessity to develop an analysis starting from conscientiously built problems. The idea is to base the analysis on a personal approach of the subject. This asked analysis is multiple: it intervenes in the choice of the subject, its treatment (for example the recourse to a personal experience), or, in certain cases, in the creativity that was adopted.

All the students must validate a SHPP to obtain their university diploma. This project can be done when the student wants during its schooling plan.

### 2.3 Participation to a more global project about handicap

From February 2004, a group of people worked together to allow handicapped children to play instrumental music. In February 2009, an association was creating to promote this activity around the world. In strong relation with the University of Grenoble, a concrete part of its activity consists in working with student for the design and manufacture of some adapted systems. With engineering students, some teachers and researchers has been working together with musicians and paramedical specialists to allow disabled children to play the music.

Such a multidisciplinary project (musical, ergonomics, social and technical aspects) needs to place engineering students in the context of reality, learns them to deal with numerous important specifications and different constrains around the special users.

## 3. HANDICAPPED CENTRED DESIGN: GRENOBLE EXPERIENCE

In this part we present an engineering design project that took place at the university of Grenoble in 2008. Then we present a generic method for user-centred design that we have used in our study. Finally, the result of the application with a handicapped user are presented and discussed.

### 3.1 project context

Twenty mechanical engineering students, divided in four groups, have been contributing to this project. The aim was to make possible for two disabled children, with two different handicaps, to play marimba (see Figure 1).

The marimba is a musical instrument in the percussion family, for witch the keys are struck with mallets to produce musical tones. See details of the four subjects proposed to the four groups below.

- The first subject is about the miniaturization of the existing mallet, currently used to play drum or cymbal [4]. The aim is to obtain one blade for each notes of the instrument.
- The second subject concerns positioning and maintain of the mallets around the marimba.
- The third subject is about designing a "keyboard" that make possible for a disabled child to play music. Each key is connected to a miniaturized mallet and associated with a note of the instrument.
- The fourth subject is the same than the third, but the child has a different handicap and is in a different medical institute.

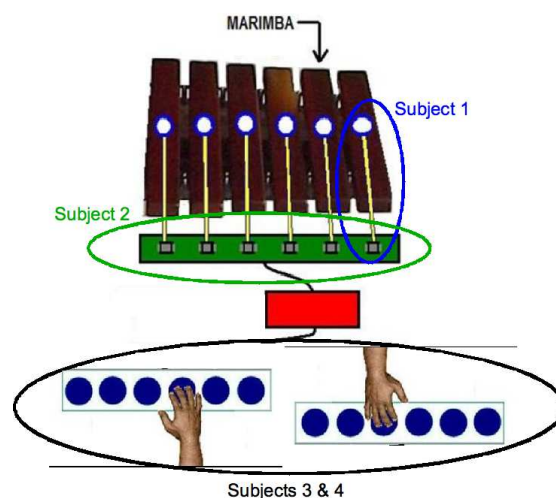


Figure 1 Specific engineering design project

One of the reasons of this engineering design project was to encourage the students to identify the specific use case of the handicapped user. In all four projects, their faces a real design approach began

with requirement identification and end by a working prototype of the product. In order to have a methodological approach for the progression, the user-centered design (UCD) method has been introduced to the project members, specifically for the two last projects in which the user anticipation seemed essential. UCD is presented in the next section and a confrontation between the theoretical model and what happened during the project is discussed.

### 3.2 User-centered Design approach

The idea of user involvement in the design process was initiated by the studies in human-computer interactions ([12] and [13]), and widely accepted as a principle in the development of usable and useful products and systems. User-Centered Design (UCD) was introduced in the format of the standard ISO 13407: Human-Centered Design Processes for Interactive Systems [14]. Figure 2 shows the UCD process model proposed by the standard.

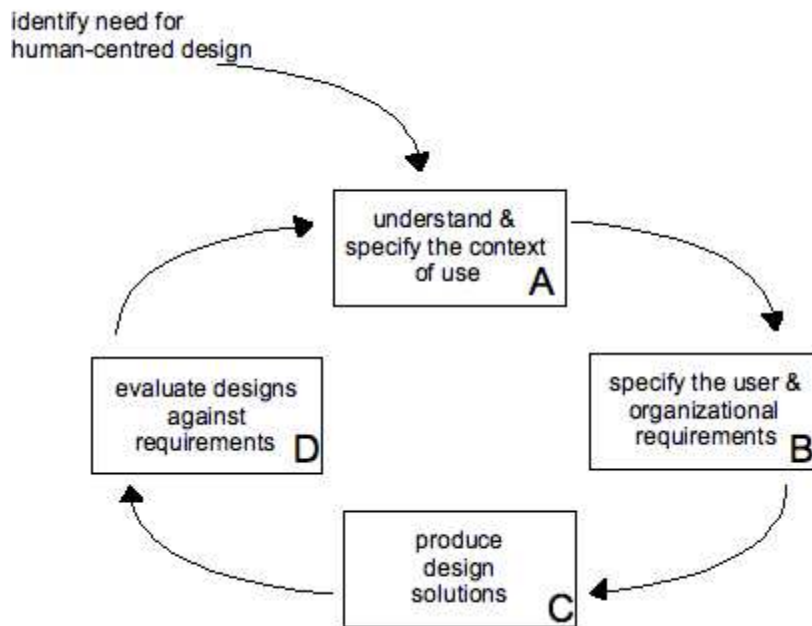


Figure 2 - Processes for user-centered design in ISO 13407

Once the need for human-centered design has been identified, the design process is organized in four iterative steps, from A to D in the Figure 2, that have to be repeated until the objectives are reached. To complete this design process, for each step, actors of the design project have to define one or several tasks that need to be made, how they will be made and the tool or support that will be used to make the tasks.

### 3.3 Handicapped specification in the UCD progression

As explained above, the design for the specific user like handicapped children here necessitates a modified approach relying on the concept of user integration. Two last subjects of engineering design have followed the UCD approach, modifying the tasks according to the project needs. The following table (Table1) summarizes the way the students design process was realized during the projects, classified vis-à-vis the UCD cycle.

Table 1. Idea of the student design process realized

UCD steps	Tasks	How	Tool - Support
A Understand & Specify the context of use	1: Understand the children disabilities	Discussion, observation	
	2: Discuss with paramedical specialist for possible improvement (objectives)	Meetings, literature study	Related publication
	3: Ethical issues for observation and recording	Negotiation, agreement	Contract
B	4: Understand the children's requirements and general limits	Discussion, observation	Video recording

	5: Specify the use case into the children situation	Set up test procedure for examine child capabilities	Scenario, recordings
	6: Analyze the traces of the test procedure	Annotation, task analysis	Recorded films
C	7: Concept design	Modeling	CAD software
	8: Prototyping	Hand made	GI-NOVA [Ref]
	9: Technical evaluation	Simple set-up	Prototype
D	10: Functional tests of the prototype usage	Make children play music	Prototype, the real instrument
	11: Evaluation of the real usage against the requirements	Observation and analysis Ergonomics specialist consulting	Multiple camera recordings

While some of the tasks are common in all the engineering design process, some tasks like B.5, D.10, and D.11 shows a particularity of the design in this context. It is observed that the closeness between the child and the engineering students helped the integration of the handicapped specificities during the design process.

To illustrate this issue, the task B.5 is detailed here. Following the UCD model, in order to specify the user and organizational requirements, the students had to specify the use case into the children situation. Since the child was very hard to be consulted, especially because the disability, the students needed to find a way to specify his capability. They designed a setup to measure his hand movement capacity and limits. A scenario has been created for his potential movement, and then a setup test was prepared for the measurement. As shown in the figure 3, a student asked the child to touch the colored paper to find out first his accuracy ability (size of button), and second for his distant access (maximum dimension of playing zone). This so called “setup test procedure” was recorded for the further analysis. However, there were some time limits for child consulting.



Figure 3 – Student and child during the task B.5

Having completed a requirement list based on tests and observation, the student developed the concept of the solution and made a working prototype for the evaluation (Table 1; D10, D11). These tasks also necessitated a special test setup and observation. Likewise what the UCD approach demonstrated, the disabled children anticipation made the student for though the requirement specification. However, the disability of children necessitated to design extra procedures for requirement specification.

#### 4. CONCLUSION

In this paper an educational organization aiming to teach the design for handicapped children was presented. The objective of the research presented here was to find out how the design for handicapped can help the design education in the university. More over, we investigated the new idea of introducing the user centered design in a specific context, handicapped, an to link the design project

to the end users. It was also interesting for us to see how a university course can prepare the opportunity for students to experience a real design project from idea to functional prototype in the specific user context.

UCD as a classical approach of user integration was taught to the students group. They were asked to follow the approach, to consult the experts in music therapy and paramedical in the association and to evaluate their design with the target child. In result, five systems realized by the students are currently being used to enable handicapped children playing music. In the same direction, about forty students are following the new design approach in the University of Grenoble per year.

A lot of efforts are done in order to a better integration of this social aim in the educational program of engineering students. In the same objectives, a specific group is created in the university for manage and follow-up of future handicapped related activities of engineering students. Thanks to this, we hope to offer the joy of music to more children in near future.

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