Ergonomic Adaptation of Musical Materials Project: First experience feedbacks of a Two-year multidisciplinary human experience of mechanical engineering students

Guillaume Thomann, Alain Di Donato, Jacques Cordier, Julie Thony

ERGONOMIC ADAPTATION OF MUSICAL MATERIALS PROJECT: FIRST EXPERIENCE FEEDBACKS OF A TWO-YEAR MULTIDISCIPLINARY HUMAN EXPERIENCE OF MECHANICAL ENGINEERING STUDENTS

Guillaume THOMANN[1], Alain DODONATO[2], Jacques CORDIER[3], Julie THONY[4]

[1] Grenoble Polytechnique National Institute

G-SCOP Laboratory (INPG, UJF, CNRS)

46 Avenue Félix Viallet, 38031 Grenoble Cedex

[2] Grenoble Polytechnique National Institute

46 Avenue Félix Viallet, 38031 Grenoble Cedex

[3] Conservatoire à Rayonnement Régional de Grenoble – CRR

6, chemin de Gordes, 38100 Grenoble

[4] SESSD APF, 18, rue de Grugliasco 38130 Echirolles

ABSTRACT

Design in multidisciplinary fields is one of the important subjects discussed in importance and effect of design education. Considering the lack of industrial experiences for engineering students, in most of universities, some special projects are defined every year in order to provide a practical experience of the student, in order to help them feel about their possible future carrier. These projects are supposed to be different form final project, as they are team based, not purely engineering research and not in perspective of normal internship.

In this article, firstly we present the AE2M Project with general aim of make an orchestral (musical) practice for valid and handicapped children (http://projetae2m.free.fr/). Describing the organization in which these projects for mechanical engineering students are formed, we focus on the design and manufacture process of needed devices for handicapped children for play normal musical instruments. The project is team based and must be carried out by the students taking into account many constrains such as engineering, technical, musical, social, commercial and medical.

We review the lessons learned in two years of some different cases and discuss the educational issue of design for special user and immediate use. The purpose of this article is to expand upon the discussion of user-centred design in these student projects. In doing so, we will show how design in health industry is related with user, particularly through the mechanism to understand non-general needs of special user.

Keywords: Multidisciplinary field, Social, Human and Emotional relations, Engineering students' projects.

1 INTRODUCTION

The training of high school mechanical engineering students has to be in correlation with the real future issues of engineering. Sustainability, environmental challenges, demographic changes, migration and integration, quality of life and global interdependence are some of these issues students can inspire during their courses [1]. In the same way, in the demographic situation of our countries, it is our goal to demonstrate an increasing need for healthcare domain integration such as medical engineering, Minimally Invasive Surgery (MIS) engineering [2][3], employability of handicapped people [4], socialisation, rehabilitation and accessibility of elders (ex. for transport). Making the student aware of these new challenges by performing group projects during the formal education is one of the best ways for the student preparation
Domain Integration particularly in application fields needs an adapted approach for design and manufacturing systems and tools. Moreover, for the human machine interaction the design methodologies are somehow specific. In our former publication, authors discussed the importance of Participatory Design (PD) [5] and Human Centred Design (HCD) methodologies have to be learned and used to students during team based projects. The general reference model of HCD principles and process is the model presented by ISO 13407 [6].

In one of the specific institutes for handicapped children, a music teacher observes that some children have a significant respond to music, and even they are motivated to play. According to their low physical capacities, these children can not use the proper instruments. This context inspired the idea of the AE2M project (Ergonomic Adaptation of Musical Instruments: http://projetae2m.free.fr/) in which the goal was to develop, by engineering students, some solutions for the handicapped children.
The final aim of this project is to provide a similar condition for handicapped children for music play, as the normal ones use musical instruments. The ambition is to create an orchestral musical practice for both normal and handicapped children.
This multidisciplinary project (musical, ergonomics, social and technical aspects) tries to place engineering students in the context of reality, learns them to deal with numerous important specifications and different constrains around the special users of the product in design and manufacturing process.

2 A SPECIFIC MULTIDISCIPLINARY APPROACH

2.1 Presentation of a specific methodology

We propose an interactions representation around the AE2M project. The figure 1 shows the "competencies triangle" with the three main applications specialities: Engineers, Musicians and Paramedical specialists. These three competencies have been notified not only as a necessity, but also as interactive tasks for the design of adapted systems for handicapped children.
For a better comprehension of this competencies triangle, it is necessary to develop the roles and the work of these specialities in the project. The engineers are represented by the engineering students. Depending on the project, this team can be composed from 2 to 6 students. They do the main work in the AE2M project:

- They have to discuss with the paramedical specialists who spend all their times with the handicapped children. They know all the physical capacities of these children.

- They should be familiar with the properties of the musical instrument the children would try to play. So they consult the music specialists of the project, in order to acquire enough knowledge about the good position of the body, the playing mechanism such as the velocity and the position of the contact for instance for the percussion instrument.

All these specific requirements gained from the paramedical and the music specialists should be taken into account for the design of an adapted product. The mechanical engineering students team has the aim to compile these numerous data and to propose and discuss around proposed data user requirements.

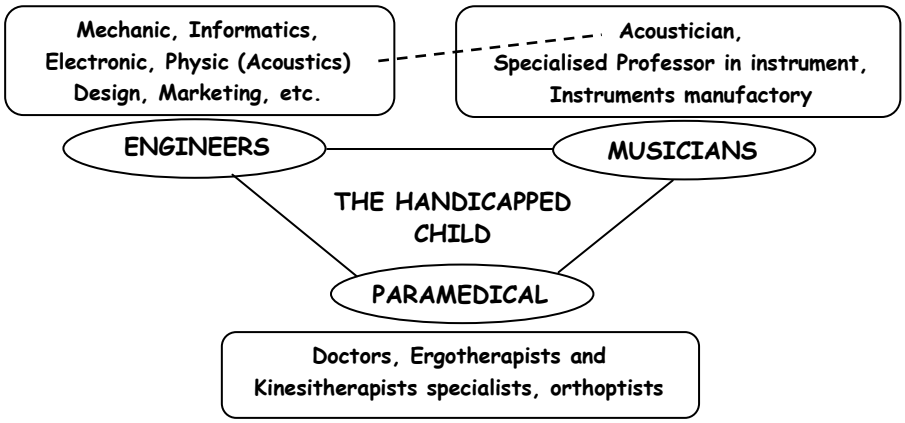

Figure 1 Proposition of the competencies triangle for the AE2M Project

2.2 Organisation of the work with students

The aim of this teaching lesson is to learn which, when, where and why the information should be known be the design team and how it has to be use. In this kind of project in direct relation with a specific user, prototypes have to be designed and tested in the early steps of the design process. That is the reason for why the students are asked to prepare these tests phase in the same time as the realisation of the prototypes. It is important for them:

- to find technological solutions in relation with electronic, material, informatics, design, etc. specialists,
- to organize emulations: take one or more appointments with the pedagogic responsible of the Motrice Educational Institute (ME Institute), prepare the experiments to do, list and prepare facilities for filming and taking pictures,
- to formalise their organisation planning of the advanced work,
- to take care of the children authorisations obtained.

This specific work allows students to organize them in a more global project like an engineering team in a company. We encourage contacts and data exchanges with other students' team in the AE2M global project. At the moment, about 65 students have participated to this project.

In the same time, and in direct relation with the students, the aims of the researcher are:

- to find which relations are necessary and useful between the different boxes presented following figure 2,

- to identify the best moments where the confrontations are necessary between the partners,
- to think about the design process methodology for specific users.

Discussions with companies showed the necessity to decrease the time of the design process and more precisely to reorganise the successive prototypes tests in the real situation with handicapped children.

3 NECESSITY TO WORK IN A PROFESSIONNAL ORGANISATION

The multidisciplinary field of this work imposes an important reflexion on the organisation of the AE2M project. In figure 2, a simplified diagram of the organisation is shown and only important institutions and teams are represented:

- the project team box represents the teachers and their students who are working especially on one ergonomic design subproject,
- the ME Institute box is the institute where specialized teachers provide education to handicapped children, in permanent relations with paramedical specialists,
- the AE2M team is represented by four specialists: paramedical specialist, musical specialist, mechanical engineer and researchers,
- the three others boxes represent the administration attachment of the AE2M team members: SESSAD, National Academy of Music, Grenoble INP and G-SCOP research laboratory.

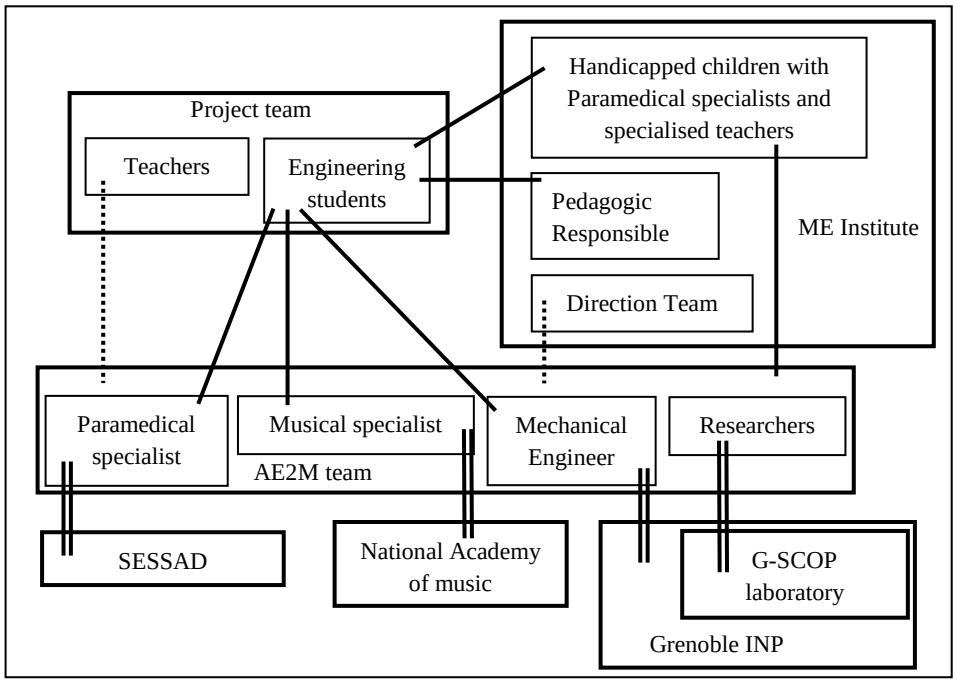

Figure 2 Simplified diagram of the AE2M project organisation

Three different kinds of relations are represented in this graph:

- the dotted line: after two years design experiments with these partners, it has been decided to better organised our relations especially with the EM Institute. Many handicapped children are educated in this institute and all have different

handicaps. In this case, it is difficult to decide which children will be able to practice a musical instrument with its own handicap. This decision must be taken in relation the Direction Team. Then, discussion with the teachers allows the finalisation of the initial step of one global subproject,

- the continuous lines: they represent the existing relations during one subproject. The most important work must be done by the engineering students' team with musical and paramedical specialists and engineer. One essential instruction is that students must be care of they displacement in the IEM. They must always take appointments with the pedagogic responsible without causing disturbance inside the ME Institute.
- the double line : administration attachment of the AE2M team members.

4 EXAMPLE OF ONE PROTOTYPE REALISED

During the music activity with young children in the ME Institute, the music teacher proposed an 8 years-old girl to play a specific percussion instrument. Then we asked a team of mechanical engineering students to think about a system that satisfies this initial demand.

It has to take into account the specific handicaps of that young girl and its physical capacities, the paramedical parameters, the requirement of the musical specialist concerning the tambour. After four months of study, two successive prototypes and some experiments in real situation, the team proposed a final system which is shown in situation in figure 3.

Figure 3 8 years-old girl is playing the tambour with the music professor

During this study, the emotional comportment of the children playing the music with prototypes guided some mechanical design decisions. Despites of the important handicaps of the children, students learn that users are able to give essential requirements thanks to their expressive comportment.

5 CONCLUSION AND PERSPECTIVES

In this article, we presented the organisation of the AE2M Project. This is a new kind of project which is quite different from the classic ones; this is an artistic and social approach of the mechanical engineering design. This study aims to focus on the design and the manufacturing process in the mechanical engineering field, and in the same focus, opens the students' mind to the other considerations of the final user such as handicaps, and deals with social and human relations and realities.

After two years of experience of this work with more than 65 students, it is possible to affirm that the students are given a different perception of the relation between designer

and future user of the product. Engineers use to take into account the requirement of the client, but as we learned in this project, the understanding of the user requirements in such a special situation becomes the main step in the design process.
In the University of Grenoble, the AE2M projects are examples of multidisciplinary studies that can contribute to the complete formation of the engineering students. Actually, electrical and mechanical engineering students from two different engineering schools are collaborating with paramedical and musical specialists around the handicapped children.
We hope this design approach can be transposable to companies that have to employ handicapped people, as well as the socialisation of the elders. Design for these people needs more specific adaptation and it necessitates more complementary researches.

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Dr. Guillaume THOMANN Assistant Professor Sciences for Design, Optimisation, Production Laboratory G-SCOP laboratory 46 avenue Felix Viallet 38 031 Grenoble Cedex Thomann.guillaume@g-scop.inpg.fr (0033)4 76 82 70 24	Mr. Alain DIDONATO Mechanical Engineer Ecole Nationale Supérieure d'Hydraulique et de Mécanique de Grenoble 1025, rue de la Piscine - Domaine Universitaire - BP 95 38402 Saint-Martin-d'Hères Cedex alain.di-donato@hmg.inpg.fr
Mr. Jacques CORDIER Music teacher Conservatoire à Rayonnement Régional de Grenoble – CRR 6, chemin de Gordes 38100 Grenoble jacques_musicjr@yahoo.fr	Miss. Julie THNOY Ergotherapist SESSD APF, 18, rue de Grugliasco 38130 Echirolles