Assistive Technology Student Demonstrators Developed in a Project-Based Learning Approach

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ABSTRACT

As a part of their educational program, the students in Biomedical Engineering and Mechatronics bachelor programs are required to develop projects for disabled people. The project activity is organized on teams, based on a Project Based Learning approach, focused on real-world topics and professionally relevant problems. This approach promotes creative and efficient design experience which led to the development of functional prototypes currently used as demonstrators for students. Thus the project activity provides support for an original educational infrastructure. The paper gives details about specific aspects of project activities and presents examples of student demonstrators developed in the field of Assistive Technology and Rehabilitation Engineering.

KEYWORDS: *Preoject Based Learning, Assistive Technology, Student Demonstrators.*

1. INTRODUCTION

In order to provide an adequate response to the various instances in which people that suffers due to diminished function (congenitally, inherited, or as a result of an external factor), Rehabilitation Engineering and Assistive Technology employ a wide range of solutions.

These representative components of Biomedical Engineering encompass varied knowledge from many areas of study, through a harmonious collaboration between individuals specialized in medical and engineering disciplines. As a basic principle, to correctly identify the most appropriate way that lost functions might be compensated, an extensive morphological and functional clinical trial has to be undertaken in order to establish the residual functionality, but the precocity, complexity, continuity, technicality, morality and legality of the procedure are also important success factors [1], [2].

Training engineers in Mechatronics and Biomedical Engineering raise challenging tasks related to interdisciplinary knowledge in the field of biosystems, especially human beings, in order to imagine and design innovative products and procedures. Based on our previous international experience, gained by carrying several educational European programs [3], [4] a new project based learning approach was implemented.

2. PROJECT BASED LEARNING APPROACH

As a part of their educational program, our students in Mechatronics, as well as those in Biomedical Engineering program are required to develop projects with various topics in the field of Rehabilitation Engineering and Assistive Technology.

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The supervisors seek to capture the students' interest by real-world and professionally relevant issues, suitable for one semester project. Over the years, the projects' themes were individual or for teams of two or three students. In the last case, the project has begun with learning to work in project-group. To the one-way traditional lectures, various information resources were added (scientific papers, articles, brochures, catalogues, patents, etc.).

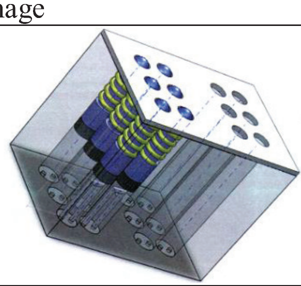
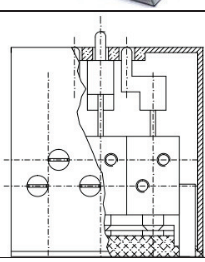
The students had some freedom regarding the schedules and the ways to solve the problem, but certain steps had to be performed: identification and familiarization with the problem to solve, specifying demands and required performances, knowledge acquisition about the impairments, disabilities, handicaps and patients capabilities and limitations, analysis of the design possibilities and final design specification.

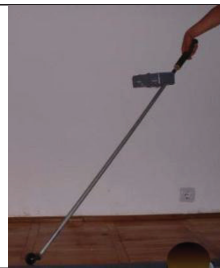
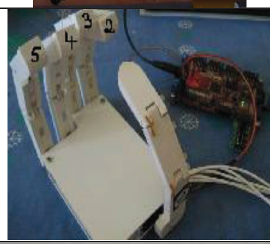
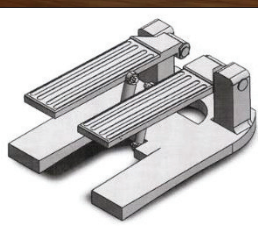
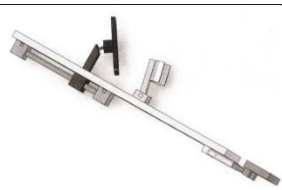
The impact of the discussed methodology is represented by the improved efficiency and increased complexity of the projects. Thus, this type of design experience led to the development of functional prototypes. Our goal is to use these prototypes as demonstrators for the students, therefore have to satisfy following requirements [5]: safety operation, allowing individual and group experiments, structure and operation in accordance with students' background and target competences, design in accordance with the ergonomic rules referring to the visual sense, hearing, noise and manual tasks, permitting a wide spectrum of learning experiences, facilitating the understanding the studied phenomena, in a well-defined manner. In this way, the project activity provides support for an original educational infrastructure.

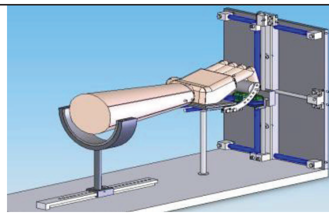
3. EXAMPLES OF REPRESENTATIVES PROJECTS

A wide range of topics are proposed for projects: prosthetic and orthotic systems, exercisers, components of the robotic systems for physiotherapy, systems for recovery of sensorial functions and others. Table 1 presents examples of student projects, developed later as useful demonstrators.

Table 1. Student projects examples

No.	Image	Description
1		***Solid-fluid thermally-transformation actuated Braille display*** This project employs a tactile display element composed of a paraffin actuator; the task was to study how a paraffin actuator might be miniaturized in order to fit in a standard Braille matrix, to design the heater control circuit and to write the program that drives it.
2		***Electromechanical Braille display*** This constitutes another approach that aims to restore the ability to read various texts output from a computer; it is composed of six small solenoids, each actuating a rubber pin; the project included mechanical and electric design, as well as a programming step.

3		***Intelligent blind stick*** It is equipped with ultrasonic sensor that takes information about the environment; information is processed and is delivered to the user through the handle (vibrations) or acoustically. The wheel offers information about the surface on which the user moves.
4		***Anthropomorphic hand with hybrid actuation*** The multi-fingers anthropomorphic artificial hand is based on two d.c. servomotors for the thumb actuation and four differential shape memory alloy actuators for the actuation of other fingers. These are represented by shape memory helical springs antagonistically operated.
5		***Electric Hook for upper limb prosthesis*** The electric hook is suitable for wrist disarticulation amputation. Its mechanism is provided with two fingers simultaneously actuated by a d.c. motor, a reducer and a simple and light weight twist-drive transmission.
6		***Hand orthosis*** The active hand orthosis assists the prehension and pronation-supination of the forearm. Two d.c. motors disposed on the forearm actuate the appropriate mechanisms. A control system based on mioelectric signals is implemented.
7		***Orthosis for tremor suppression*** It is an upper limb orthosis, attached to the hand and forearm, in order to suppress the hand tremor; it is used by the patients with Parkinson disease. Its operation is based on fluid viscous force.
8		***Stepping machine*** This project had the aim to familiarize the students with the general problems encountered in the design of an exercise-oriented machine; this particular solution provides an active as well as a passive training program, making use of Arduino controlled stepper motors.
9		***Lower limb rehabilitation device*** The solution provided here consists of a foot stand that move linearly along the longitudinal axis and an upper leg stand that oscillate freely.

10		***Wrist exerciser*** It offers the possibility to adjust certain dimensions to each user. The equipment meets passive movement's requirements: variable stroke and speed motor assist the user in the passive mode for flexion-extension and abduction-adduction of the hand, allowing various and useful exercises.
11		***Wearable wrist exerciser*** Wearable wrist robotic exerciser passively moves the hand in flexion-extension and abduction-adduction. A 2 degree of freedom mechanism is actuated by two d.c. motors and a control system based on a microcontroller allows adjusting the exercises characteristics for each patient.
12		***Knee orthosis*** This device has the purpose to assist a person that has impaired movement of the knee joint; the aim is to stabilize and maintain the orthostatic position, and, as needed, to allow the flexion-extension of the knee, in different activities (e.g. sitting on a chair).
13		***Gait-assistance system*** The goal of this project was to devise an exoskeleton that is able to assist the standing and gait. It is actuated by four direct current servomotors; the task included the design of the control circuit and the program thereof.
14		***Lifting device attached to a wheelchair*** It is a simple and compact system attached to a wheelchair backrest in order to support the body weight. The device consists of a d.c. motor, a screw transmission and an elevator frame with straps and corset

4. CONCLUSIONS

Engineering education in Biomedical Engineering and Mechatronics is strongly supported by experimental learning. Therefore is absolutely necessary to use laboratory equipment and demonstrators which provide the students with the challenge of implementing the relevant concepts and open new perspectives.

Our proposal consists of development useful student demonstrators based on project based learning approach. As supervisors, we have proposed community oriented real-life problems specific to Assistive Technology and Rehabilitation Engineering to be solved individually or in project teams. The applied methodology has enabled the development of interdisciplinary and more complex projects as well as practice-relevant functional and realistic prototypes.

Although the teamwork projects demands a higher degree of supervision and an assessment of both group and individual performances, we consider that the teamwork is the learning experience which better prepares students to apply their knowledge and skills to real-world situations.

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