The Adoption of the Multidisciplinary Through Common Projects: a Microprocessors, Electronic Instrumentation and Industrial Informatics Courses Effort

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Abstract — *This work describes the integration of three courses (Microprocessors, Electronic Instrumentation and Industrial Informatics) from the technical area of the Computer Engineering Program at Positivo University. This integration is achieved through a common project, which has specific evaluation on each course. A brief description of the curricular structure of the Program and Courses contents are presented. After that, the methodology of project development and its evaluation are described. Finally, the challenges, advantages and difficulties in integrating courses in a single project for both the learning and the evaluation process are discussed.*

Index Terms — *Course Projects Integration; Multidisciplinary; Electronic Instrumentation; Industrial Informatics; Microprocessors.*

INTRODUCTION

The multidisciplinarity provides increased motivation on the part of students as they begin to understand the relationships between courses, both in lectures and especially in practical classes. This should occur with the development of the work and extracurricular activities, because the solution to the problems posed by the involvement of students with other concepts from other courses, both the current years as the previous years.

One way to achieve this is through the creation of multidisciplinary works, in which the work is prepared by a group of professors, in order to cover the most knowledge of the courses involved as possible. Thus, there is a reduction in the amount of work for the students, because the exclusive work of each course is replaced by a single common multidisciplinary work. One consequence is that the students produce a more complete work, allowing a more general vision for the students, reducing the segmentation that occurs in natural problems. Another point to note is that the multidisciplinary nature means that there is a greater cohesion among the faculty, because they have to know the content covered in the courses together to define the activities and skills that students will develop in a multidisciplinary work.

The multidisciplinary nature is rooted in a know-how that implies in a practical approach consolidated by a strong theoretical concept, which is one of the four pillars of education (to learn to know, to learn to make, to learn to live together and to learn to be).

The theory is the base for the practice, and it in turn develops, justifies and experiments new concepts that become new theories or formularizations providing new a practice, and thus successively [1]. Thus, the binomial theory and practice should produce an upward spiral, representing the knowledge that is being added by the student throughout the process. This should happen throughout the years of the program, as a solid and consistent process for the formation of the professional who is assisting in the development of technical and scientific knowledge of the student [2].

Figure 1 shows that the Theory produces the Practice through experiments and projects, which consolidates and enhances the knowledge. Moreover, the practice through a comparison and / or discussion, results, and findings adds new elements to the theory, providing new ways of teaching, including new tools produced in this process.

The multidisciplinarity permeates all courses and years of the Computer Engineering Program at Positivo University. It is implemented as multidisciplinary projects, which integrate courses of professional and basic formation areas, as detailed in [3]. Inter and multidisciplinary projects are adopted in every years of the program, culminating with the Undergraduate Thesis (UT) [4].

In this context of multidisciplinarity in engineering education, this work shows some actions in this direction involving three courses of the Computer Engineering Program at Positivo University, the courses of Microprocessors, Electronic Instrumentation and Industrial Informatics.

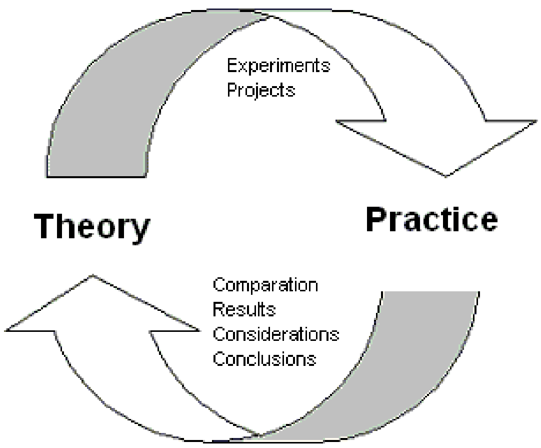

FIGURE 1
RELATIONSHIP BETWEEN THEORY-PRACTICE IN THE TEACHING-LEARNING PROCESS

COMPUTER ENGINEERING PROGRAM

The Computer Engineering Program at Positivo University (UP – Positivo University, former UnicenP – Centro Universitário Positivo), as described in [5], offers two programs: a morning and another nocturnal. Both programs have five years of duration and a serial structure, with the same curriculum and a total workload of 3960 in-class hours, including 160 hours for supervised internship, 80 hours for Undergraduate Thesis (UT) and 200 hours for complementary activities. Activities such as extra-class work, research and projects are not included in this workload.

The curricular structure congregates the courses of the program in two great areas of Professional Formation (hardware and software areas), courses of Basic Formation area (Calculus, Physics, and others), courses of Human Formation area (Philosophy and Ethics), Management Formation (Enterprise Management and Management of Projects) and Specialty Formation (Reconfigurable Computing, Computational Intelligence).

Additional details of the program are described in the Educational Project of the Computer Engineering Program at UP, presented in [2].

INVOLVED COURSES

Courses directly involved in multidisciplinary activity described here are those of Microprocessors, Electronic Instrumentation and Industrial Informatics.

The course of Microprocessors is associated with an important sub area of Computer Engineering that involves the project of automated and embedded systems based on microcontrollers' technology. Consequently, this course supplies theoretical and practical tools for several applications of Electronic Instrumentation and Industrial Informatics.

Electronic Instrumentation is a course that develops the aspects of analog signal processing, acquisition and the subsequent signal computational processing and analysis. In this context, the course covers the analog circuits and systems of data acquisition and processing, using, mainly, linear and non linear operational setups, the physical and chemical theoretical principles of sensors and transducers and its respective conditioning circuits.

The course of Industrial Informatics develops the themes of industrial sensors, industrial electronics and power electronics, Programmable Logic Controllers (PLCs) and robotic devices. This course has as main objective to apply these technologies in automation and process control in industrial environments.

Microprocessors Course

This course occurs in the program's forth year. Its contents include the concepts related to the project of microcontrolled systems, with the use of off-the-shelf processors and kernels of processors developed in hardware description languages [7]. The implementation can use programmable logic devices, protoboard assemblies, special kits developed inside the program or dedicated printed circuit boards developed by students. The firmwares are developed in machine, assembly or C language. Problems from industrial automation with embedded instrumentation are typical multidisciplinary applications of this course subjects.

Then, the Microprocessor course has a strong actuation as support to integrative applications from other courses, as Electronic Instrumentation and Industrial Informatics.

Electronic Instrumentation

The Electronic Instrumentation Course is inserted in the general context of the Computer Engineering Program addressing aspects related to analog signal processing, acquisition and the subsequent signal computational processing and analysis. In this context, the course covers the analog circuits and systems of data acquisition and processing, using, mainly, linear and non linear operational setups, the physical and chemical theoretical principles of sensors and transducers and its respective conditioning circuits.

Industrial Informatics

The course of Industrial Informatics occurs at the same time that the courses of Microprocessors and Electronic Instrumentation, which favors the proposal of multidisciplinary works, involving issues addressed in a complementary way, reducing the amount of proposals for practical work to students and enabling the unified assessment of the teaching process.

During the first semester and part of the second, it is used conventional teaching resources such as lectures in the classroom, development of practical experiments in the laboratory and seminars. The motivational peak occurs in the third quarter when is offered to the students a technological challenge in applying all the knowledge and techniques discussed in the course. The project is the implementation of an autonomous robotic device with the use of onboard electronics, electronic sensors for tracking and positioning, and processing and control carried out by one or more microcontrollers. Thus, they can be tested and evaluated by students in a practical and applied knowledge from three courses, questioning and consolidating the contents.

Consequently, the development of an activity common to all three courses occurs as a multidisciplinary project. The evaluation occurs according to specific criteria of each course. The projects are developed in teams of two or three students, the topics are defined by the proposition of the professors or the students' specific interests.

Modular Structure of Project

The project should be referred to a basic structure composed of compulsory and elective modules, according to the needs of each project and as defined in agreement between the teams and the professors of each course. Basically the project must have digital interfaces, analog input and actuators, and be managed by a microcontroller that can also act as a signal processor. Often it is required an external system acting as system supervisor and which has direct interface with the user, other times the system is completely embedded and organized around the module microcontroller. Figure 2 shows the basic structure of the modules described below.

The following modules comprise the basic architecture of all systems. The project does not need to use all the modules; the modules set and their features must be agreed between the teams and professors. As follow we have the description of the modules:

- **Actuator**: these are devices such as electric motors of various kinds (direct current, brushless, step motor), electrovalves or other electromechanical device actuator.
- **Analog Sensor / Transducer**: sensors and transductors of relevant parameters to the project, such as temperature sensors.
- **Analog conditioning**: amplifiers, filters and other analogical conditioning process.
- **Controller**: microcontroller that controls the low level system operation that sometimes should implements signal processing algorithms also. Usually the students have total freedom to choose this devices and its programming language.
- **Digital interface**: interface between digital sensors and microcontroller and between microcontroller and actuators.
- **Digital sensor / transducer**: sensors that supply measures directly in the digital domain, like encoders, accelerometers, optical barriers, and other.
- **Sample and analog to digital conversion:** devices that converts analog signals to a proportional digital representation.
- **Supervisor**: it is a remote computer or a function implemented in the same microcontroller module in order to manage the system and establish communication with the user.
- **User interface**: is the interface through which the user adjusts system settings and get relevant status information.

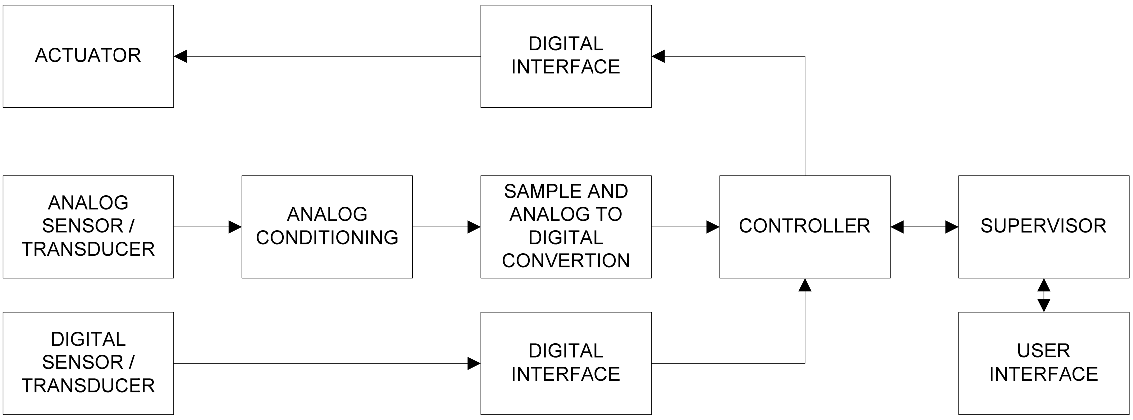

FIGURE 2
BASIC ARCHITECTURE FOR MULTIDISCIPLINARY PROJECTS

Examples of Multidisciplinary Projects

The multidisciplinary concept has occurred frequently in the Computer Engineering Program, especially in the final year of the program when students have mastered several techniques and tools for hardware and software. The multidisciplinary works have been developed by the courses of Electronic Instrumentation, Microprocessors and Industrial Computing, among others. Among the projects developed can be deployed the instrumentation amplifier with computer interface, parking sensor using ultrasound, cardiotocograph based on photopletismography, detector level of alcohol in fuel (there is a mixture of methanol in gasoline in Brazil, and called flex fuel engines are capable of operating on gasoline and hydrous ethanol in any proportion), jitter analyzer for evaluation of Parkinson's disease, electrocardiograph and electroencephalograph (biomedical engineering applications), several applications of LVDT (Linear Variable Differential Transformer) transducers (which can be used in industrial applications such as measuring impact), ultrasonic sensors for measuring distances (useful in several industrial applications), evaluation systems for fiber optics - optical reflectometer, among others.

Within the context of modular integrated projects, Figure 3 shows a sample of user interface of an analyzer system for the assessment of tremor of Parkinson's disease, while Figure 4 shows the analog conditioning module of that project.

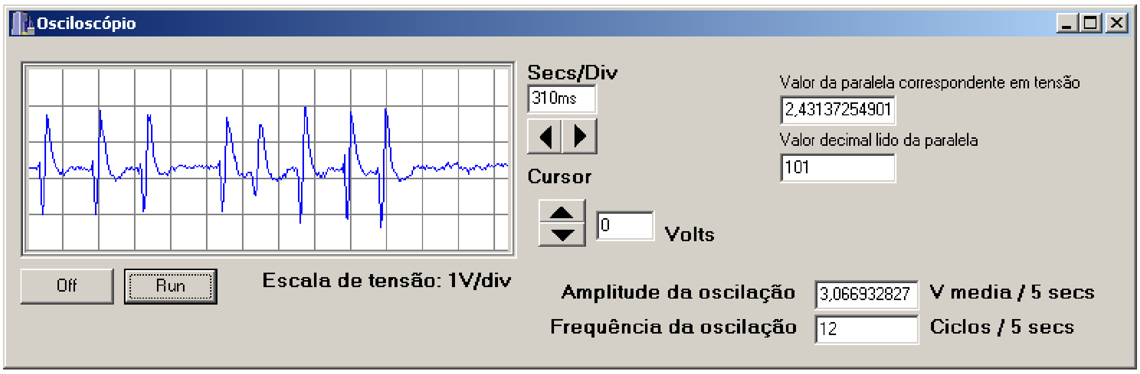

FIGURE 3
USER INTERFACE EXAMPLE – SCREEN OF THE JITTER ANALYZER FOR PARKINSON DISEASE TREMOR EVALUATION – INTEGRATION BETWEEN ELECTRONIC INSTRUMENTATION AND MICROPROCESSORS

These developments of Electronic Instrumentation associated with Microprocessor provide the base for joint course final projects as that shared with Industrial Informatics.

One of multidisciplinary projects proposed during the fourth year of the program that uses multidisciplinary knowledge is the “Robot Technology Challenge”. For implementation are formed several teams and each one must have a unique proposal for the completion of the challenge. The main objective is the implementation of a mobile robotic device that runs in a track printed with black ribbon on white background, no errors and deviations from the path and in the shortest possible time. It is also planned to place a barrier at any point of the track, which should be found to be diverted by the mobile device, returning to the track in sequence. The students can develop mobile devices with wheels, caterpillars or paws. In Figure 5 can be seen some of the devices developed in the form of an integrated and autonomous, in the years 2008 and 2009 for the competitions in the course of Industrial Informatics.

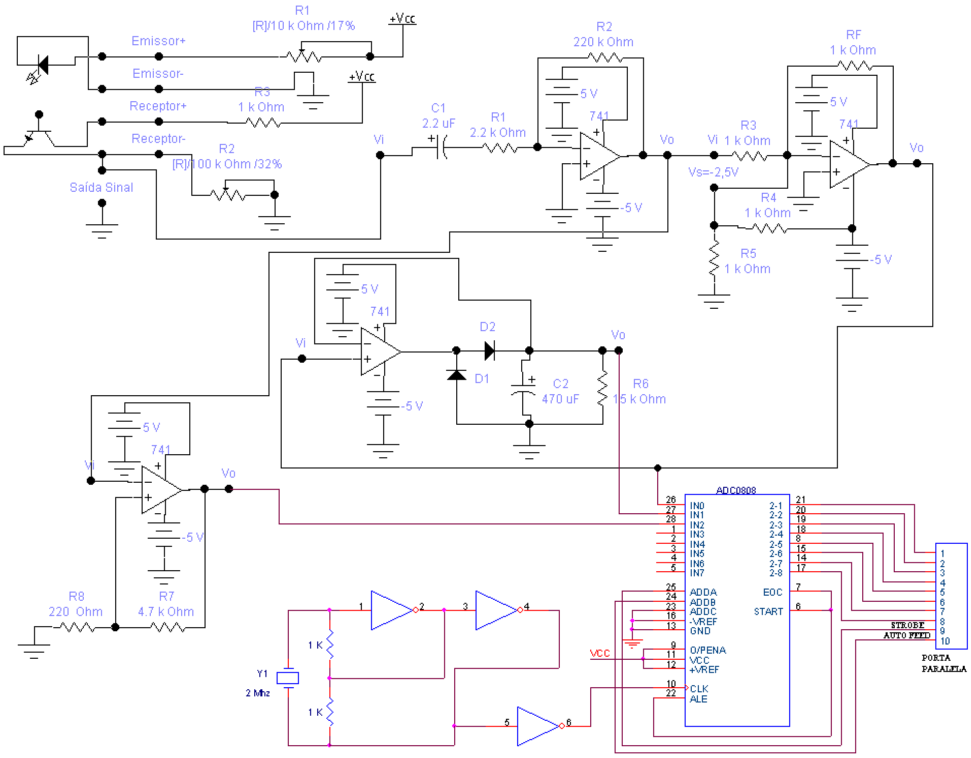

FIGURE 4
ANALOGICAL CONDITIONING CIRCUIT EXAMPLE – JITTER ANALYZER FOR PARKINSON DISEASE TREMOR EVALUATION

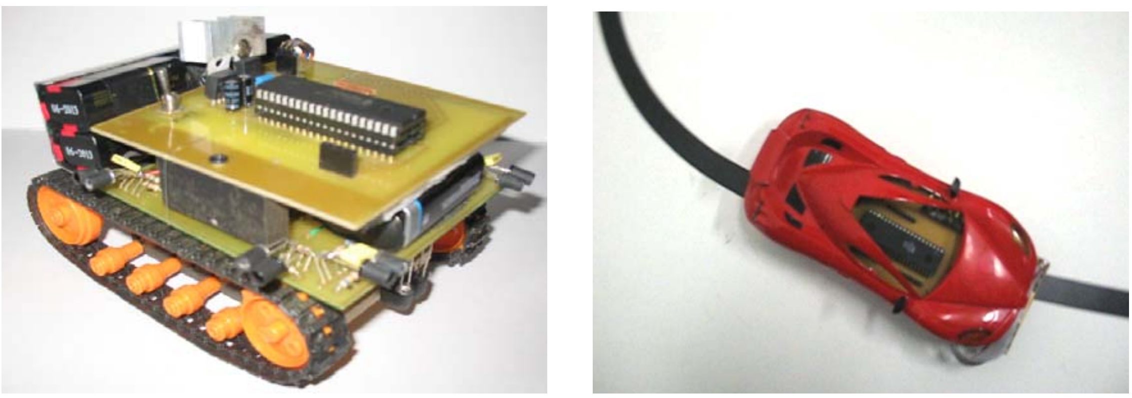

FIGURE 5
EXAMPLE OF INTEGRATED SYSTEM – AUTONOMOUS ROBOTIC DEVICES DEVELOPED AS SHARED ACTIVITY OF THE TREE COURSES

Figure 6 shows the block diagram of another example of the developed system, an optical reflectometer.

Project Evaluation

The evaluation of projects developed in a multidisciplinary manner to address issues related to the courses involved in them in an inter-related and may or may not have the same weight to each of these. In the specific case of multidisciplinary projects, researchers have tried to evaluate the development process of the work, from initial research and draft, passing through the phases of specification and implementation of the design until the final phase of validation and physical presentation of the same, time in which to evaluate the operation of the proposed system and mainly the domain of knowledge about the work of each element of the team, individually and in groups.

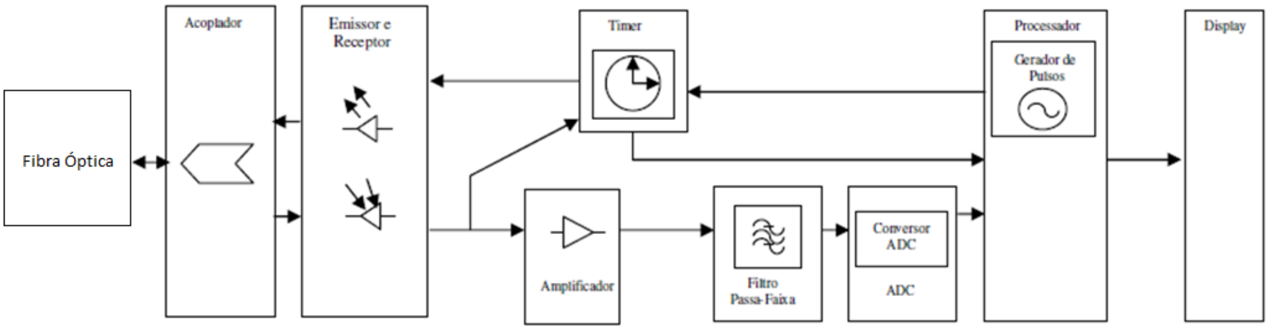

FIGURE 6
EXAMPLE OF INTEGRATED SYSTEM – REFLECTOMETER FOR ANALYSIS OF INTERRUPTION IN FIBER OPTICS

In the initial phase are set for all teams the minimum operational requirements, as the use of sensors and transducers, microcontrollers firmware programming, independent power-grid with batteries for its autonomous functioning, among others. During the presentation of projects are observed beyond the minimum requirements as other subjective factors, the innovative design, the technologies used and their respective degree of difficulty, reduced size and weight, cost and creativity, use of techniques of artificial intelligence, fuzzy logic and others. Thus, projects are more valued as much as possible to integrate acquired knowledge in the courses of the course, exercising the practice of a multidisciplinary approach to proactively and collaboratively.

The results have shown this to be a more fair evaluation, since in many cases it can detect flaws in the process of teamwork, especially when one observes that some element of the group is not developing his academic activities adequately. Another way to evaluate the projects have been developed to include essay questions on the same evidence, in which students need to show the results of the learning process of developing the theoretical and practical activity.

CONCLUSIONS

The multidisciplinarity is a key component in the teaching-learning process in Computer Engineering Program at Positivo University, since it has sought since the implementation of the course combine theory with practice, but not in isolation but integrated throughout the process. This has been achieved with the involvement of the academic community of the course (direction, professors and students). However, it is important to note that this is a process and not achieved solid results with just a few isolated actions or momentary.

Both courses as the works and even extracurricular activities are prepared taking as basic parameter multidisciplinarity. Thus, students are fully involved in the process; they understand that the training will only be strong if knowledge is embedded in its essence, not only in form, as happens when each course operates separately.

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