The Research Lines of the Computer Engineering Program as Guidelines to Themes of Scientific Initiation and Undergraduate Thesis

Authors:

Edson Pedro Ferlin, Computer Engineering, Positivo University, ferlin@up.edu.br
Valfredo Pilla Jr, Computer Engineering, Positivo University, vpilla@up.edu.br
José Carlos da Cunha, Computer Engineering, Positivo University, cunha@up.edu.br
Maritela R.W. Teixeira, Computer Engineering, Positivo University, maristela.weinfurter@up.edu.br
Mauricio Perretto, Computer Engineering, Positivo University, mperretto@up.edu.br
Marcelo M. Gonçalves, Computer Engineering, Positivo University, marcelo@up.edu.br

Abstract — *The Computer Engineering Program at Positivo University has been adopting its research lines in its political-pedagogic conception as a guideline to projects in several areas inside the program, allowing a stronger integration between its courses and its interrelations. In this context, the projects are developed keeping in mind its correlations with one or more research lines of the program. As examples of where this policy is applied, we can cite the undergraduate thesis projects, the research and scientific initiation projects. The research lines are dynamics and can be modified always as needed. These lines are defined from faculty current research activities. The immediate result of this policy is the effort and resource centralization to some specific areas looking for excellence.*

Index Terms — *Multidisciplinarity, Political-Pedagogic Conception, Scientific Initiation, Undergraduate Thesis.*

INTRODUCTION

It is not uncommon in many undergraduate programs the dissociation between research and education, leading to a work approach often judged inappropriate by the academic community. When this happens, the graduation program lacks a focus of actions because there is no clear direction of efforts aiming the excellence in areas of activity. Currently teaching must be firmly grounded by research and experimentation. Future professionals need to have a solid technical and research background in order to manage with current demands, as in the constant search for improvement of products and services.

Under this approach, the Computer Engineering Program at Positivo University established lines of research that were focused on the activities of teaching, research and extension, in order to have areas of excellence and become the program a reference in the academia. However, it is important to emphasize that this is not a punctual action, but a process that has been consolidating over the years since the establishment of the program in 1999.

In this context, this paper aims to present the research lines adopted in the program as well as some actions that help to consolidate this strategy, allowing the program to have an identity and a clear direction on projects and activities.

COMPUTER ENGINEERING PROGRAM

The Computer Engineering Program at Positivo University (UP – Positivo University, former UnicenP – Centro Universitário Positivo), as described in [1], 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), as described in [2], 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 [3].

MULTIDISCIPLINARITY

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 series as the previous series.

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. As a result, the course comes to be seen as a process in which integration with other subjects from the curriculum is essential. Subsequently, the student is motivated to participate in this of acquisition and knowledge exchange.

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 [4]. 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 [5].

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 series 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 [6]. Inter and multidisciplinary projects are adopted in every series of the program, culminating with the Undergraduate Thesis (UT). The projects themes, both UT as Scientific Initiation (SI), are aligned with the research lines adopted in the Program, and this enables further integration and development in selected areas.

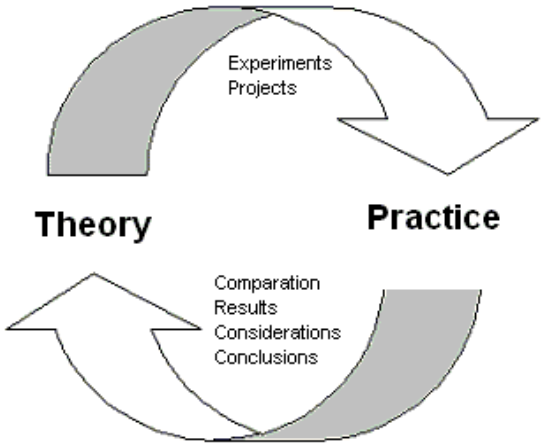

FIGURE 1
RELATIONSHP BETWEEN THEORY-PRACTICE IN THE TEACHING-LEANING PROCESS

RESEARCH

The professor must consolidate their knowledge before proposing the use of research in their work. It is important that the superficial aspects do not be overvalued. Then, the real power of the available didactic and pedagogical resources can emerge.

The professor's responsibility increases when he or she takes the goal of developing education on the path of research. This happens because the professor should highlight the multiple facets created by a challenging work proposition. A new professional, free of repetitive habits of exposure, should appear. Escape from a pattern present in our schools, classrooms and even in technical laboratories, the repetition of the repetition of the lessons copied from books that walk addicted cycle: blackboard, notebook, test; sameness of generations. Quit the habit of a model lived at the time the professor was a student through a personal resilience through the path of a work, is the order for the professor who declares himself a user of research in their professional lives.

The evidence that a new vision is given to the use of research in the classroom is due primarily to the transformation of the professor into a researcher, responsible for a dual task, because it is their duty also to research its area of work. The new figure of the professor comes from the seeking of their daily work reorganization and its merging into a research.

> *Professor is who, having won academic space by its production, has conditions and experiences to transmit through teaching. It should not be assigned the role of professor to someone who is not basically researcher [7].*

The traditionalism of the lecture, taken as a single resource, from beginning to end of the class, is the second point to be fought. The expositive class and memorization are the suffocation of a pedagogical process, accompanied by a repetition of content that should disappear. Methodologies defined as routes that over time have guided and judged the teaching in all areas and here in particular the teaching of engineering. The one-way speech, professor, content, student, restricts the initiative of research discovery.

The technical area, as no other branch of education, brings us the possibility to transform the research in an oxygenator element, because it creates laboratories as basic work environments. But, despite to be normal to have labs as ordinary and necessary elements of academic structure, they have its role distorted immediately, because environments become just a data collection place. Even concerning a topic of content, via a scheduled task to be assembled, tested and reported, this cannot be regarded as scholarly research. The best reached in this context is a technique of teaching and learning called (Individual) Programmed Task. The professor that (in laboratory class) merely asks for data collection that is implicit in the syllabus of the course resembles the one who uses of traditional lectures throughout their time in regular class.

So, if the role of a content repeater is no longer appropriate, it must seek to satisfy two factors intrinsic to research school work:

- Extrapolation of the average routine of content, teachable or "copyable", which permeate and dominate the common sense of those who work in our engineering schools. One should look for the professor who, well aware of the contents is able to assemble and present a summary, discuss and redefine with his colleagues concepts and principles.
- To become a continuous researcher in their science, the pursuit of knowledge, which is necessary to guide those who teach, supplementing it with the knowledge itself drafted. It teaches who do research and concludes by itself and conquer the difficulties that present themselves, then becomes really a professor [7].

The work of academic research, even being directed to programmatic content objectives, transcends its own guidance to take contact with the student. This transforms the professors' responsibility because it is their responsibilities, in a complex teaching situation, see the ramifications involved in the research process.

RESEARCH LINES

The research lines of the program are the result of ongoing research areas, in particular the research profile of professors, and also the vocation of the program and its interests.

Currently the Computer Engineering Program is dedicated to the following lines of applied research:

- **Reconfigurable Computing:** This research group aims to research and implementation of computer systems whose behavior of the hardware and / or software may be changed during operation [8], design methods for digital systems on a single chip, embedded systems and firmware [9], through the use of programmable logic devices like FPGAs and PLDs. This area has had a stamp on the multidisciplinary integration of basic courses in digital electronics as Digital Systems and Microprocessors [10], and with more advanced courses such as Reconfigurable Computing and Signal Processing, in which students are expected to develop cores for embedded DSP applications in FPGAs, and various applications involving Computational Intelligence [11].
- **Biomedical Engineering**: The research group aims to research and develop equipment and techniques for diagnosis, monitoring, therapy and management, applying principles and engineering methods for understanding, defining and solving problems in Biology and Medicine. Within this scope, it has developed a series of research projects in the areas of Biomedical Instrumentation and Rehabilitation Engineering, both internally, as proposed Graduation Thesis or research projects, and in partnerships with companies and research institutions [12]. Many of the projects developed have been presented in national and international biomedical engineering and related areas conferences.
- **Parallel and High Performance Computing:** The line of research in Parallel and High Performance Computing aims to research on topics such as parallel processing architecture of parallel machines, environments and languages for parallel programming, load balancing [13], operating systems, clusters and multiprocessor computers, with the goal of reducing the time application response costly in terms of processing and require large computational power.
- **Electronic Instrumentation and Experimental Physics:** The research group aims to research in control systems and data acquisition, measurements with ultrasound, infrared, vibration sensors, temperature and other [5]. Development of electronic instrumentation for automation of physics experiments in the laboratory. Development of

architecture dedicated to calculating the FFT (Fast Fourier Transform), interfaces, hardware and dedicated software for image viewing, remote monitoring system for measuring environmental variables, systems to detect moving objects, systems acquisition, processing and analyzing signals.

- **Computer Graphics and Pattern Recognition:** The research group aims to research on applications of neural networks, statistical learning techniques and other computational intelligence techniques for pattern recognition and knowledge discovery, development and validation of models of biologically inspired neural networks (EEG - Electrocencephalogram, ECG - Electrocardiogram), biometrics, recognition and interpretation from images, learning, intelligent tutoring systems and genetic algorithms.
- **Teaching in Computer Engineering:** This research group aims to research on effective teaching methodologies, seeking multidisciplinarity and a constant evolution in the learning process for the students [14]. A way to achieve efficiently the method of student learning is an important factor to the group, since each new generation brings another outlook on life and world. The professor must be aware of such changes in order to make their classes more interesting and motivating, because it competes with video games, animation and, other forms of visual communication. The professor has the duty to seek a new pedagogical mediation, aiming to promote learning and motivation of the students. Learning, for [15], is the replacement of values, reformulation of visions of the world, the addition of knowledge to models of interpretation of social life and confront with the new.
- **Embedded Systems and Robotics:** The line of research in embedded systems and robotics began their studies during the year 2009. This line is intended to provide solutions in embedded systems using special purpose operating systems like Windows CE and Linux, and programming in J2ME and C #. The main aim of this research line is to develop stand-alone modules with computational intelligence to solve problems in the field. This line also extends to post-graduate level through specialization in embedded systems and mobile devices.

SCIENTIFIC INITIATION PROGRAM

The Scientific Initiation Program (SIP) allows introducing undergraduate students to the first steps in scientific research. It is the possibility to place the student early on in direct contact with the scientific activity and engage him in the research. It is characterized as a program of theoretical and methodological support for carrying out a research project and is an appropriate channel aid to the formation of a new mindset in the student (research as an educational principle). In summary, the scientific initiation can be defined as a basic training of future researchers.

The SIP is an academic program that seeks to arouse interest in scientific research through the development of projects proposed by students (individually or in teams) and their faculty advisers.

The general purpose of SIP is to insert the graduate students in a process of basic scientific research, based on the view that research is the basic mechanism for generating knowledge that will feed the traditional educational background. Based on this goal, and for the SIP to get successful, the dedication and commitment of mentors and students with its assumed responsibilities are charged.

The scientific initiation is encouraged in the Computer Engineering Program, with the availability of professors to monitor the students during the project development. In addition, resources are available such as laboratories, equipment and components so that students are able to realize their projects.

As an incentive to scientific initiation a fraction of the hours the student dedicated to the project is accounted as a Curricular Complementary Activity. Additional hours for published papers arising from these projects are accounted also.

UNDERGRADUATE THESIS

The Undergraduate Thesis (UT) aims to provide to senior students the opportunity of to use, demonstrate and reinforce the knowledge gained throughout the program. This opportunity is materialized in a development and implementation of a solution for a real world problem, combining theory and practice.

Over a year, the student must specify, design and implement its proposal. The evaluation occurs at the end of this period through a presentation to an Examining Board.

The general factors to be assessed are: the knowledge of the subject by the student, the level of completion of the proposed work, the correction of the parties involved in the work, the documentation submitted by the student, the scope of work and, finally, the relevance of the subject area of Computer Engineering.

Besides assessing the level of student preparation for the profession, the UT of the Computer Engineering Program may also be used as a tool for evaluating the learning process, structure and curriculum of the program. In [16] there is a detailed description of the UT, as the rules and monitoring the various stages of project development.

FINAL CONSIDERATIONS

The adoption of lines of research enables the development of multidisciplinary works. There is also a conduit of efforts in selected areas, ensuring greater integration between the projects, besides consolidating the research strengths in some areas of the program.

Of course, there is an interrelationship between the areas and in particular the area of "Teaching of Computer Engineering" that is the focus in research. One such example is the project "Study of Impulse Theorem through the Computer Assisted Experiment" [14] that involves beyond the line of "Teaching", also the line of "Electronic Instrumentation and Experimental Physics".

In all lines, there is integration between the two basic areas of the program: hardware and software always focused to an application.

A project may address more than one line of research, depending only on the scope and comprehensiveness. This also occurs naturally with the professors who work in more than one line, depending on the project they are involved.

REFERENCES

[1] Tozzi, M., J.; Dziedzic, M.; Ferlin, E., P.; Nitsch, J., C.; Rodacoski, M., "Os Cursos de Engenharia do UnicenP", in: COBENGE 1999 - *XXVII Congresso Brasileiro de Ensino de Engenharia*, Natal-RN, Brazil: Abenge, 1999, p. 2662-2669.

[2] Pilla Jr, V.; Ferlin, E., P., Cunha, J. C.; Gonçalves, M., M., "A Integração de Disciplinas na Linha de Hardware no Curso de Engenharia da Computação do UnicenP", in: *COBENGE 2003 - XXVII Congresso Brasileiro de Ensino de Engenharia*, Rio de Janeiro-RJ, Brazil: Abenge, 2003.

[3] Ferlin, E., P.; Tozzi, M., J., "First Integrated Examination of the Computer Engineering Program", in*: FIE 2002 - 32th ASEE/IEEE Frontiers in Education Conference*, Boston-MA,USA: IEEE, 2002.

[4] Ferlin, E., P.; Pilla Jr, V.; Saavedra, N., "The Theory-Practice Partnership", in: *ITHET 2005 – 6th IEEE Annual International Conference*, Juan Dolio, Dominican Republic, 2005.

[5] Ferlin, E., P.; Saavedra, N.; Pilla Jr, V., "Improving Teaching and Learning Process through Computational Resources", *chapter 8, in: Engineering Education: perspective an, issues and concerns*, New Delhi, India: Shipra Publications, 2009. P. 98 – 130.

[6] Ferlin, E., P.; Pilla Jr, V., Cunha, J., C., "A Multidisciplinariedade Aplicada no Ensino no Curso de Engenharia da Computação", in: *COBENGE 2004 - XXXII Congresso Brasileiro de Ensino de Engenharia*, Brasília-DF, Brazil: Abenge, 2004.

[7] Demo, P., "Educar pela Pesquisa", 3rd Ed. Campinas, São Paulo-SP, Brazil: Autores Associados, 1998.

[8] Ferlin, E., P.; Pilla Jr, V, "The Learning of Reconfigurable Computing in the Computer Engineering Program", in: *FIE 2006 - Frontiers in Education Conference*, San Diego, USA: FIE, 2006.

[9] Junqueira, R. S., Pilla Jr, V., "PDA Based on Altera NIOS II Processor and uCLinux Operating System Embedded in FPGA", in: *Design Forum - IV Southern Programmable Logic Conference*, Bariloche, Argentina: IEEE, 2008.

[10] Pilla Jr, V.; Ferlin, E., P., "O Desenvolvimento de Processadores com Auxílio da Lógica Programável como Ferramenta Didática", in: *Cobenge 2007 - XXXV Congresso Brasileiro de Educação em Engenharia*, Curitiba-PR, Brazil: Abenge, 2007

[11] Oliveira, T., C.; Pilla Jr, V., "An Implementation of Compact Genetic Algorithm on FPGA for Extrinsic Evolvable", in: *Proceedings of IV Southern Programmable Logic Conference*, Bariloche, Argentina: IEEE, 2008.

[12] Cunha, J., C.; Ferlin, E., P., Pilla Jr, V., "O Desenvolvimento de Pesquisas em Engenharia Biomédica no nível de graduação no UnicenP", in: *WCETE 2004 - World Congress on Engineering and Technology Education*, Santos-SP, Brazil: WCETE, 2004.

[13] Perretto, M.; Ferlin, E., P, "FATOSS – sistema escalonador tolerante à falhas para cluster de computadores", in: *Proceedings of 4th International Information and Telecommunication Technologies Symposium*, Florianópolis - SC, Brazil, CDROM, Dezembro, 2005.

[14] Saavedra, N.; Perretto, M.; Cunha, J., C.; Ferlin, E., P., "Study of Impulse Theorem through a Computer Assisted Experiment", in: *ICEE 2008 – International Conference In Engineering Education*, Pécs-Budapest, Hungria, 2008.

[15] Pereira, L., T., V.; Bazzo, W., A., "Introdução à engenharia: conceitos, ferramentas e comportamentos", in: *COBENGE 2008 - XXXVI Congresso Brasileiro de Ensino de Engenharia*, São Paulo-SP, Brazil, 2008.

[16] Ferlin, E., P.; Pilla Jr, V., Cunha, J., C., "The Graduation Thesis in the Computer Engineering Program at UNICENP", in: *FIE 2003 – 33th ASEE/IEEE Frontiers in Education Conference*, Boulder-CO, USA, 2003.