The University-industry collaboration as a strategy for Engineering Education

Authors:

Luiz A. Gargione, University of Vale do Paraiba, Sao Jose dos Campos, Sao Paulo, Brazil, gargione@univap.br
Carlos A. Moura, University of Vale do Paraiba, Sao Jose dos Campos, Sao Paulo, Brazil, cmoura@univap.br
Jose Alfredo C. L. Costa, COMPSIS, Sao Jose dos Campos, Sao Paulo, Brazil, alfredo.costa@compsisnet.com.br
Leopoldo R. Yoshioka, COMPSIS, Sao Jose dos Campos, Sao Paulo, Brazil, leopoldo.yoshioka@compsisnet.com.br

Abstract *— Engineering and Technology are c ritical inputs for economic development and competitiveness. The Engineer of the Americas is a well educated professional prepared to move seamlessly throughout the Continent of the Americas, that can be achieved through a carefully designed, and appropria tely implemented university -industry collaboration. The partnership between universities and businesses is a key issue for the Engineer of the Americas proposal. University -industry collaboration can establish the models, strategies and processes for under standing and anticipating the development of new technologies and improvements in engineering education. This paper presents the experiences and the first results from an engineering and technology collaboration program called UNIVAP -COMPSIS Collaboration Program, where the University of Vale do Paraiba in the State of Sao Paulo, Brazil, and Compsis Computers and Systems Ltda., a Brazilian technology - based company, are working together in a project called Public Transportation Magnetic Guidance System. The project is a multi-technology and engineering based program that involves Public Transportation policies, Magnetic Sensor Systems, GPS Positioning Systems, Onboard Computing, Digital Signal Processing, Electrical -mechanical Engineering and Engineering Mana gement knowledge. The project started in the middle of the year 2003. More than 60 people are working in the project now. Fourteen people are faculty members. Twelve are students, including in this case graduates and undergraduates. The project team is ins talled in a 3,200 square feet office and laboratory space in the university building, Urbanova Campus of the University of Vale do Paraiba. The laboratories involved in the project are: Laboratory for Integration and Tests, Laboratory of Electronics and th e Laboratory for Computer Systems Integration. The project is being financially supported by a Government Transportation Agency. The activities planned for the project are: develop and integrate the electrical -mechanical engineering technology for a new bu s for public transportation; develop and integrate technology for a magnetic guidance system; develop and integrate technology for a GPS positioning system for the bus and develop and integrate technology for an onboard computer system for the bus in order to control speed and stops for the bus in the stations.*

Index Terms *— University -industry collaboration, Engineer of the Americas, engineering education.*

INTRODUCTION

Engineering and technology are critical inputs for economic development and competitiveness. The Engineer of the Americas is a well educated professional prepared to move seamlessly throughout the Continent of the Americas, that can be achieved through a carefully designed, and appropriately implemented university-industry collaboration. The concept of Engineer of the Americas has been conceived to generate a technical workforce in the Hemisphere that stimulates local and regional economies by attracting the industry and private corporations investments, especially high-tech industry that have interest in the region. The partnership between universities and businesses is a key issue for the Engineer of the Americas proposal. University-industry collaboration can establish the models, strategies and processes for understanding and anticipating the development of new technologies and improvements in engineering education.

The University of Vale do Paraiba – UNIVAP in the State of Sao Paulo, Brazil, and COMPSIS Computers and Systems Ltda., a mid-sized Brazilian technology based company are working together in a project called SGM Project - Public Transportation Magnetic Guidance System. The project opened several opportunities for the faculty and for the engineering students in the university. People from the College of Engineering, from the College of Computer Science and from the IP&D – Institute for Research and Development of the university are now collaborating for the project. Besides the people of UNIVAP, people from others local research institutions are also collaborating with the project. This paper presents the experiences and the first results from this partnership.

THE IMPORTANCE OF UNIVERSITY-INDUSTRY PARTNERSHIPS

The UNESCO's World Declaration and Framework for Priority Action for Change and Development in Higher Education on its 17th Article emphasizes the importance of partnerships and strategic alliances between the Higher Education Institutions and the world of work stakeholders:

"Partnership and alliances amongst stakeholders - national and institutional policy-makers, teaching and related staff, researchers and students, and administrative and technical personnel in institutions of higher education, the world of work, community groups - is a powerful force in managing change. Also, non-governmental organizations are key actors in this process. Henceforth, partnership, based on common interest, mutual respect and credibility, should be a prime matrix for renewal in higher education".

The higher education institutions should be ready to prepare people with new abilities, knowledge and credibility to build the future of the nations. One way to build the future is through reinforcing the collaboration between the higher education institutions and the working world, particularly industry that can support the workforce and create economy growth.

Besides UNESCO's recommendation, the concept of The Engineer of the Americas advocates that local and regional economic development will be accomplished only when the local higher education system gets closer to business. Industry needs a local well-educated workforce in order to establish local development and production businesses. In the other hand, the higher education system needs support from industry to develop research and educational activities.

The UNIVAP leaders, both in research and in administration, are convicted that collaboration and partnerships between the university and industry are fundamental requirements for the university development and regional economic growth. In fact, the creation of an environment based on cooperation – education-research and business – is mentioned in the UNIVAP Strategic Planning Program for the next 5-10 years.

THE UNIVERSITY OF VALE DO PARAIBA

The University of Vale do Paraiba – UNIVAP is located in the region of the Vale do Paraiba (Paraiba River Valley), in the City of Sao Jose dos Campos, State of Sao Paulo, Brazil. The place is one of the most developed regions in the country and concentrates a great number of technology-based corporations including EMBRAER, the Brazilian Aeronautics Corporation, PETROBRAS, the Brazilian Oil Company, ERICSSON, General Motors, Johnson & Johnson, besides several other companies and Research and Development organizations.

The beginning of the university was in 1952 with the creation of the School of Law in the City of Sao Jose dos Campos. During the following years the community founded the College of Engineering, the College of Social Sciences and the College of Education. All these colleges merged in the year of 1992 becoming the University of Vale do Paraiba. After the merge the university could improve the activities and was able to create research based programs and started several agreements with regional and local institutions in order to contribute for the development and growth of the region. The demand for high-qualified professionals in the region is very high, especially in engineering, computer science and health sciences. Nowadays the university includes seven colleges, two institutes, 33 undergraduate programs and six graduate programs, including one doctorate program in Biomedical Engineering. The Research and Development Institute – IP&D concentrates most of the research of the university. The IP&D has about 100 people working full-time in research and graduate education. These people are distributed in about 27 groups for research activities and graduate programs. The operations of the university are distributed in seven campuses, four of them in the City of Sao Jose dos Campos and three in the neighbor cities like Jacareí, Caçapava and Campos do Jordao.

The university is also responsible for the operations and management of two technology-based business incubators. One incubator is located in the UNIVAP Urbanova Campus and the second one is located in the PETROBRAS local plant, both in the City of Sao Jose dos Campos. Another important initiative of the university to improve collaboration between the university and industry is the creation of the UNIVAP Science and Technology Park. The first building of this project will start operations in the first quarter of 2005. Twelve technology-based companies have already presented proposals to install businesses in this building. These companies are usually small and mid-sized firms that develop computer systems, software, hardware, electronics, engineered materials and testing solutions for chemical and health sciences applications. Many of these companies are involved in Information Technology consulting services and management for the high tech industry.

THE COMPANY COMPSIS COMPUTERS AND SYSTEMS LTDA.

COMPSIS Computers and Systems Ltda. is a mid-sized firm that operates within the Traffic Systems, Automotive and Aerospace Industry sector and is a leader in the supply of Integrated Systems for the Management of Toll Collection

Processes and Audit. Created in 1989, it is based in Sao Jose dos Campos, State of Sao Paulo, Brazil. It provides products and integrated systems, composing a family of components that can be configured for a wide variety of applications within the sectors in which it operates. More than 150 employees, a large number of whom coming from the aerospace sector, strongly focused on engineering and after market services, render possible adequate assistance throughout the useful life of their implementations.

COMPSIS products act in critical operations, usually of the non-stop type, and have a long useful life. So as to support its systems operation, maintenance and technological evolution the company provides a full Services Center, with a Call Center, Integrated Knowledge Basis, 24-hour support service and a dedicated technical group, in addition to integration with the development division. Being a Systems Integration company, COMPSIS operation basis lies on its engineering team. Engineers with a broad background in Systems, Software and Product are the company's major assets. COMPSIS is a system integrator specialized in systems engineering, real time and Web software development and product engineering. Its technical team has developed directly or through partnership programs, projects and high technology products for the Aerospace, Telematics and Automotive Industries.

PROJECT DESCRIPTION

The SGM Project - Public Transportation Magnetic Guidance System Project is a high technology magnetic guidance system that will be integrated in Urban Bus Vehicles for use in public transportation in metropolitan areas. The objective of the implementation of this technology in public transportation is because this technology should be able to improve the quality of the services, improve the safety for the passengers and increase the number of passengers due the improvements in timing, scheduling and vehicles accessibility.

The magnetic guidance system can provide very accurate measurements of vehicle position within a lane, absolute longitudinal location of a vehicle, and advance information about upcoming roadway characteristics, including roadway curvatures, entrances, stops and exits, etc. The SGM - Magnetic Guidance System comprises a series of magnetic markers that serve as a roadway reference, plus vehicle-borne sensing and processing units that obtain information from the markers. Simple permanent magnets embedded in the center of a lane indicate the lane center. Alternating the magnetic polarities of the markers creates a code that indicates roadway characteristics. Magnetic sensors, mounted under the front and rear of the bus, measure the magnetic fields. A computer in the vehicle processes the magnetic field data to derive lateral and longitudinal position measurements and to decode the information.

The whole project is a multi-technology and engineering based program that involves Public Transportation policies, Magnetic Sensor Systems, GPS Positioning Systems, Onboard Computing, Digital Signal Processing, Electrical-mechanical Engineering and Engineering Management knowledge [Figure 1]. The project started in the middle of the year 2003 and the first phase should end in the middle of 2005. The project is being financially supported by a Government Transportation Agency.

THE INFRASTRUCTURE AND PEOPLE FOR THE PROJECT

The project team is installed in a 3,200 square-feet office and laboratory space in the university research building, Urbanova Campus of the University of Vale do Paraiba. The office space includes: management offices, secretary and assistant offices and meeting rooms. The laboratories involved in the project are: Laboratory for Integration and Tests, Laboratory of Electronics and the Laboratory for Computer Systems Integration.

The Laboratory for Integration and Tests [Figure 2] is responsible for electronics systems integration and testing for onboard software involved in the vehicle components and mechanisms. The Laboratory of Electronics [Figure 3] is responsible for electronics hardware development and its stand-alone tests. The Laboratory for Computer Systems Integration [Figures 4 and 5] is responsible for software development especially onboard software and control software systems.

More than 60 people are working in the project now. Fourteen people are faculty members from UNIVAP and other partner institutions. Two of them are Digital Signal Processing specialists. Twelve people are students from the university, including in this case graduates and undergraduates. More than 20 people are engineers and computer science specialized professionals from COMPSIS employees group.

The activities planned for the project are: develop and integrate the electrical-mechanical engineering technology for a new bus for public transportation; develop and integrate technology for a magnetic guidance system; develop and integrate technology for a GPS positioning system for the bus and develop and integrate technology for an onboard computer system for the bus in order to control speed and stops for the vehicle in the stations. The project started in the middle of the year 2003 and now is prototyping the controlling system for the first vehicle.

Other parts of the project are being developed and manufactured by COMPSIS on its own facilities. COMPSIS is the principal management actor for the project and is also responsible for the technical direction.

THE DIFFICULTIES AND OPPORTUNITIES RELATED TO THE PROJECT

Due the complexity of the project and the specific technology involved on it, the Public Transportation Magnetic Guidance System is considered a risky project in terms of results. In the beginning of the negotiations with the Government Transportation Agency, COMPSIS and UNIVAP expended months developing the final proposal for the project. Another difficulty for the project was the long way to convince the agency that the partnership between UNIVAP and COMPSIS should be the best choice for them to develop the technology and implement it into the buses.

Strengths and opportunities related to the project

Several strengths and opportunities were identified during the project negotiation and development:

- The interaction between the university and the technology-based firm in several fields of engineering and technology, especially on electronics, software development, transportation, road control systems and mechanical automation systems.
- The development of a model of cooperation and management standards actions in order to create the appropriate environment to foster academia and industry collaboration.
- The development of a real project inside the campus of the university including a real testing bus vehicle and a real two lanes road with magnetic markers.
- Visibility for the university due the involvement in this kind of project, including real technology based work, and many activities involving students and faculty members.
- The opportunity for the university people in apply knowledge in a real project that is fully integrated in a social inclusion purpose such as public transportation.
- The opportunity to offer scholarships for students involved in the project.
- The opportunity to provide finance for related research projects.

Weaknesses related to the project

However, several significant problems emerged from the project negotiation and development:

- Lack of understanding by the university staff and administration people, especially from the Legal Department of the university about the goals, difficulties and feasibility issues of the project. These lack of understanding affected the description and the negotiation for the Agreement and Contract documents.
- Several meetings and huge amount of hours to convince the legal department of the university to write down important items in the Contract and for the Agreements documentation.
- Difficult to define the responsibilities of the parties involved in the project.
- Hard to convince faculty and people from the research departments to collaborate with the project.
- Lack of experience from the university in activities related to university-industry collaboration in engineering and technology projects.
- Lack of experience from the university to follow the firm on its speed for deciding the contract of suppliers and subcontractors for the project.
- Difficulties for the university members in leading with money and resources allocated for the project.
- Lack of understanding from the university people in adopts the business management style for this project.

THE FIRST RESULTS

The project today is considered a great opportunity for the students and faculty to get involved in a real project where researchers can apply knowledge and previous experiences from the academia world. Several students are contacting the project administration in order to identify opportunities for work, new jobs and scholarships.

Other companies are contacting the university in order to check the possibility of partnerships not only for engineering based projects but also for co-working in services and social initiatives.

The Government Transportation Agency visited the project site many times and they mentioned that there are surprised with the great results from the partnership between UNIVAP and COMPSIS.

CONCLUSIONS

The partnership between UNIVAP and COMPSIS proofs to be a new model of cooperation between the university and the business world, where the university could learn a lot on how to develop and test a model of interaction and management standards for university-industry collaboration programs.

However, the university people should learn more about project management and the peculiar problems involved in technology development environment, especially the challenges that industry is submitted in the real world. Great ideas are now emerging from this experience and faculty and students are expecting new opportunities in the area.

REFERENCES

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[2] COMPSIS. **"Proposal for the SGM Project"**. Compsis Computer and Systems Ltda., Sao Jose dos Campos, Brazil, 2003.

FIGURES AND TABLES

FIGURE. 1
THE FUNCTIONAL DIAGRAM OF THE PROJECT

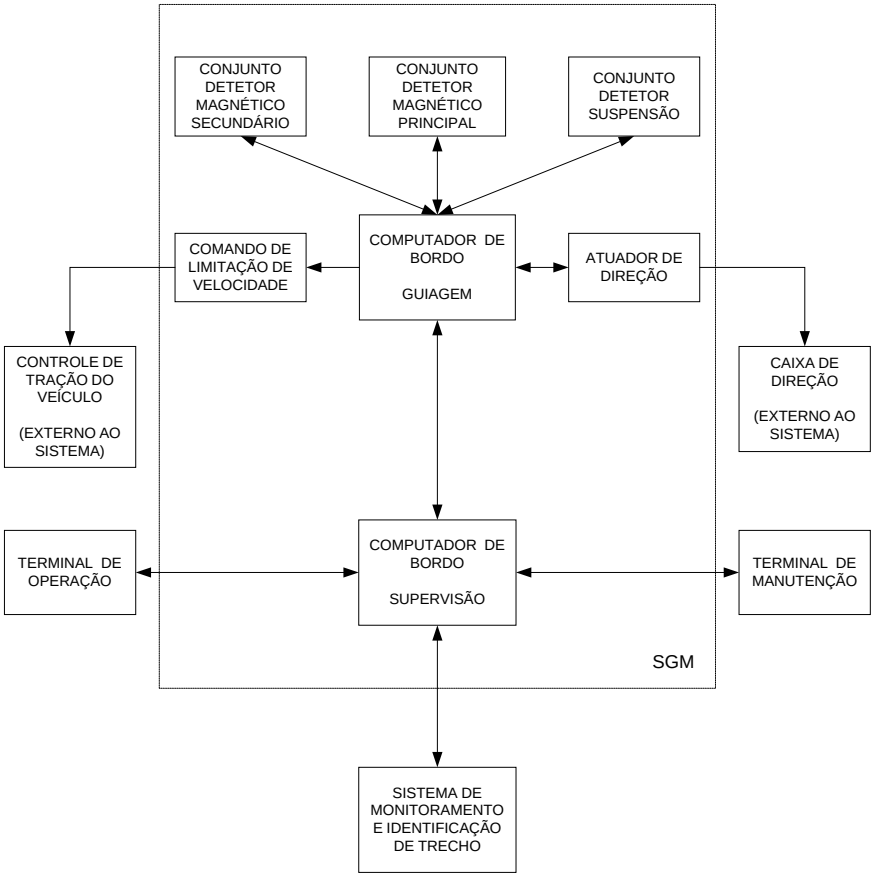

FIGURE. 2
THE LABORATORY FOR INTEGRATION AND TESTS

FIGURE. 3
THE LABORATORY OF ELECTRONICS

FIGURE. 4
THE LABORATORY FOR COMPUTER SYSTEMS INTEGRATION

FIGURE. 5
THE LABORATORY FOR COMPUTER SYSTEMS INTEGRATION