Methodology for Creation of Multidisciplinary, Transatlantic Engineering Program in Information Technology

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***Abstract* - The European Commission and the US Department of Education FIPSE Program have funded ATLANTIS initiative to promote collaboration in the higher education between European and American universities. The goal of the project was to create a new collaborative multinational model for interdisciplinary education in real-time software engineering. The project had not only created a framework for introducing new components to engineering programs but also had proposed a methodology for development of multinational, multidisciplinary engineering program. The purpose of this paper is to summarize the experience gained with this international project.**

I. INTRODUCTION

International cooperation is an essential element for any university to develop relevant educational and research programs in a cost-effective manner. Majority of universities are engaged in international study abroad programs [1]. However, they typically do not support new programs, particularly in interdisciplinary, computing-related fields. The European Community and the US Department of Education Fund of Improvement of Postsecondary Education (FIPSE) Program have funded an initiative (ATLANTIS) to promote collaboration in the higher education between European and American universities. One of the recently funded projects is described in the paper. The objective of the project was to create a new collaborative multinational model for information technology education. The project focus was a real-time software intensive control system (RSIC), a unique interdisciplinary specialization.

The project not only created a framework for introducing RSIC components to engineering programs but also proposed a methodology for development of multinational, multidisciplinary engineering program. The presented paper summarizes the experiences gained with the project.

II. PHASES OF THE PROJECT

Development and implementation of international transatlantic engineering curricula was conducted in several phases. In the case of ILERT project, three phases were defined: Preparatory Phase, Research Phase and Pilot Implementation Phase (Fig.1). The fourth phase (Long Term Application) has been started in October 2009, as a separate project: ATLANTIS – DeSIRE^2 [2].

A. Preparatory Phase

The Preparatory Phase started in 2005 with informal discussion about advantages of international relationships between the faculty of academic institutions of both sides of Atlantic. The following identify the activities of this phase:

- Inventory of international informal personal contacts already existing in institutions
- Brainstorming on the type of activities to be engaged and potential partners, defining goals and priorities (like curriculum-related cooperation and international exchanges of the faculty expertise)
- Proposing an initial consortium of universities offering expertise in the similar lines of engineering education
- A common thread within the programs at all the partner institutions must be identified
- Identifying the focus areas in the existing programs of the consortium partners. It was assumed that the selected courses from the focus areas must constitute a coherent value added, if selected by exchange students
- Recognizing financial support sources for research (including industry funding, international cooperation programs, international projects, international and national systems of grants).

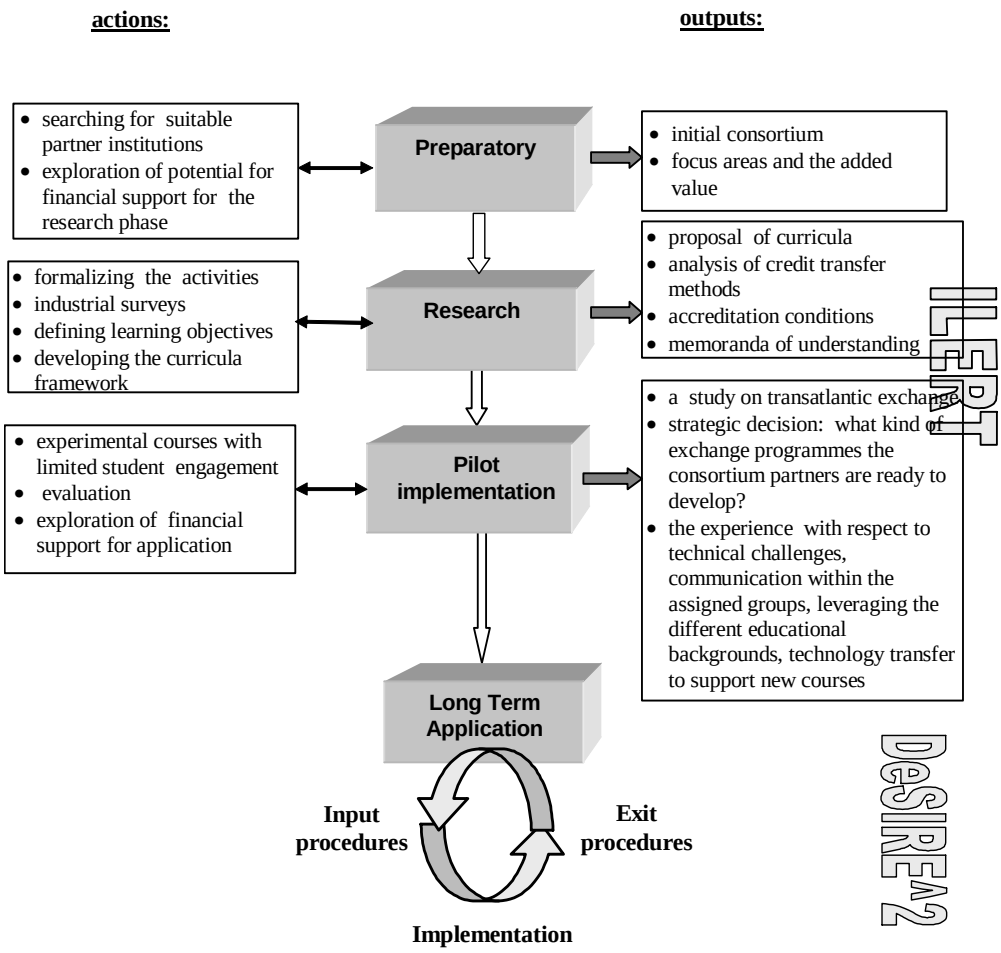

Fig.1 Development and implementation of international curricula

The preparatory phase was concluded by formally establishing the consortium of university partners and writing a successful proposal to support the planned educational research project.

B. Research Phase

The research phase started with the **analysis of industry requirements,** related to graduates in the proposed domain. A survey was designed to get a feedback from a specific sector of industry regarding what the employers expect graduates to have in terms of skills and attitudes as well as knowledge of technical topics. This internet-based survey was solicited from a representative sample of industry engaged in real-time software-intensive control systems. The collected data were analysed and the results were used to help identify academic program learning objectives and outcomes, thus preparing a base for creation of a new curriculum framework [3].

In the General Skills part, the highest rated skills were as follows:

- work as a part of a multidisciplinary team
- analyze, understand and define the problem.

For the Technical Knowledge part, the following were rated the highest:

- software design and development concepts, methods and tools
- system specification and design methods.

The next steps of the program development included: defining learning objectives and outcomes, developing the curriculum framework, exploring the partners' programs commonalities and laboratory infrastructure, comparing the curriculum content, and analysing the educational process assessment.

The existing consortium partners' curricula were reviewed as a way of prioritizing and integrating their elements, in order to fulfil the requirements of interdisciplinary specialization. It should be noted, that the existence of common characteristics does not mean that there is automatic commonality among the ways in which individual institutions pursue common educational objectives. Universities often find their own procedures and methods. By reviewing the existing programs and comparing them with the industry needs, this research phase identified missing topics and the topics that could be

strengthened. As the final outcome of this phase a comprehensive list of courses related to the RSIC domain offered at all of the partner institutions was compiled.

Curriculum development included the following activities**.** The courses were classified into one of the four categories: General Education (languages, humanities, social science), Math and Science (mathematics, physics), Basic (required towards the completion of the degree in the given line of study) and Domain Specific (which focuses on the selected RSIC engineering specialization).

The concept of the curriculum framework was applied [4]. The framework was defined as a high-level curriculum specification that is detailed enough to guide the development of a RSIC program, which supports the RSIC objectives and outcomes, and yet is flexible enough to account for specializations, constraints, and requirements of various programs, institutions, and regions. The basic organizational unit for the framework was a RSIC "component". A RSIC component is a curriculum unit which covers theory, knowledge and practice which supports the RSIC curriculum objective and outcomes.

The RSIC Curriculum Framework does not specify the way in which component topics might be formed into modules or courses. Component topics might be focused in one or two courses, or spread among several courses, along with other non-RSIC topics.

The components were assigned into six identified RSIC areas: Software Engineering, Digital Systems, Computer Control, Real-Time Systems, Networking, and Systems Engineering.

This research was followed by a practical case study adapting the selected curricula of partner institutions by including components of interdisciplinary specialization, thus creating an engineering program acceptable for all partner organizations.

Credit transfer and accreditation issues. The development of new curriculum framework in engineering may in turn require new approaches to their validation and accreditation. The transfer of credits and grades is a challenging undertaking for university systems which are significantly different in Europe and U.S. The existing and emerging structures for accreditation, quality control and credit transfer (such as the European Credit Transfer and Accumulation Scheme) have been analysed [5]. It should be noted that the proposed curriculum units must be reviewed according to the ABET standards applicable in U.S. and the applicable standards of Ministry of Higher Education in the European countries, focusing on the objectives and outcomes of the educational activity.

Formalizing the activities. A critical part of the work included: signing formal agreements or memoranda of understanding, defining responsibilities and structure of communication between partner universities.

C. Pilot Implementation Phase

Agreements between partner institutions or "memoranda of understanding" in delivery and the mutual recognition of courses were prepared at the beginning of the pilot implementation phase. During the pilot implementation phase the experimental course was created [6], instructional material was developed and experimental concurrent delivery with limited student engagement was initialized. The participating students are supervised by co-ordinators from the partners' institutions.

During this phase, experiences were gained with respect to technical challenges, international cooperation, communication within the assigned groups, leveraging the different educational backgrounds in the interdisciplinary context, technology transfer and interactions between international students and staff.

Final Report including guidelines for extension of the approach for long-term application was the most valuable output of this phase.

An important part of the pilot implementation phase is also analysis of the sources and mechanisms of potential financial support for future transatlantic educational collaboration. Generally, tangible and intangible resources, essential to the success of the project future, must be considered. Tangible resources include finances, facilities, and time. Intangible resources include will, commitment, and the ability to sustain the effort to conclusion.

The pilot implementation phase can be concluded by important **strategic decision:** what kind of exchange programs the consortium partners would like (and are able) to develop? Would they like to initiate a dual degree programs or develop one or more aspect of their current program in a close collaboration with a foreign partners? The general goals, including number of mobility years, number of mobility students must be decided at this stage.

The selection between single or dual degree programs or other forms of partner institution engagement should be made (Table 1).

D. Long Term Application Phase

The long term application and evaluation phase will develop internal and external procedures. Final agreement between partners on credit transfer, accreditation, tuition and student selection must be accepted by the administration of all partner institutions. The agreement must also define: responsibility of institution and students, admission requirements, registration procedures, precise learning agreement form (e.g. one semester taken course, receives recognition upon return), tuition waiver, language/culture engagement of the students and logistic/ administration details.

TABLE 1.
EXAMPLES OF FINAL PARTNER INSTITUTION ENGAGEMENT

Student spends abroad	Expected results	Formal effects	Comments
One semester in transatlantic partner university	Single diploma in home institution, mobility students focus on an area of concentration not available at home institution, experiences related to cultural immersion	US student receive special certificate of completion of a specific focus area. EU student receive appropriate entry in their Diploma and the Supplement identifying the focus area.	Bilateral agreements are necessary.
2 – 3 semesters in transatlantic partner university	Two diplomas are received, students may receive a new specialization, not offered at single university experiences related to cultural immersion	Dual degree *)	More detailed bilateral agreements are necessary, requires full validation and accreditation of learning programs. Ethical issue: is it fair that student receives two diploma without any increase of his work?
2 – 3 semesters in transatlantic partner university	single diploma is received	Join degree **)	
*) "double degree" means two national diplomas issued by two higher education institutions and recognized officially in the countries where the degree-awarding institutions are located. **) "joint degree" means a single diploma issued by two of the higher education institutions offering an integrated program and recognized officially in the countries where the degree-awarding institutions are located.			

The long-term mobility of students include three cyclic steps: input, implementation and exit procedures.

1) Input Procedures

Internal procedures include**:**

- Setting deadlines for all partners institutions
- Distributing information on international mobility - to recruit students
- Performing internal selection procedures for applicants from the home university (eligibility, mandatory orientation, interviews, language skills..)
- Performing placement procedures for incoming exchange students, e.g. assigning teacher and student mentors to incoming students
- Setting procedures for emergency cases
- Internal selection of the teachers interested to participate in the mobility exchange.

External procedures are:

- Exchange information with partner university on the selection results
- Identify the courses available for overseas students during the mobility period
- Signing joint learning (implementation) agreement forms
- Distributing information related to practical issues such as housing, insurance, etc.

2) Implementation Procedures

Assistance to the internal applicants:

- Explaining the program options and site/course selection
- Helping students with the application procedure.
- Assistance to the External Applicants
- Helping with questions from students/teachers interested in coming for the exchange (terms of exchange, reporting, application process).
- Facilitating mentoring process for incoming students
- Monitoring and reporting the students' progress.

3) Exit and Evaluation Phase

This phase includes:

- assessment and evaluation of the individual outgoing students at the end of the mobility period (based on transcripts of records and surveys)
- assessment and evaluation of the mobility exchange.

III. CONCLUSIONS

Successful completion of such a multinational program would result in bringing three components to the home institution not possible without the proposed activities:

- Mobility students will be able focus on an area of concentration not available at home institution, due to the opportunity to take classes, get engaged with host institution faculty, the host institution research activities and access to host institution unique laboratories
- Mobility students will gain experiences related to cultural immersion and to the international aspects of the program
- Home institution students interacting in the classrooms with the mobility students will gain better understanding and appreciation of international and global aspects of modern world, due to transatlantic nature of the project.

Due to worldwide implementation of such multinational programs, a well prepared workforce of scientists and engineers is required. They must be able to work cooperatively in multi-disciplinary and international settings.

ACKNOWLEDGMENT

This work was supported by the following grants:

ATLANTIS EU/EC: 2006-4563/006-001, ATLANTIS US: P116J060005, AGH University of Science and Technology 2009 Grant.

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