

# Three Ways of Globalizing IT Engineering Education

## *Experiences from Two European Universities*

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### **Abstract**

*In this paper, we present three different mechanisms for globalising engineering education: (1) student and staff exchanges, (2) joint courses, where the students work in globally distributed teams; and (3) joint degree programmes. We argue that the three mechanisms complement each other and that successful globalisation within an institution can be achieved by combining the three.*

*Our argument is based on the experiences of two north European universities, who successfully globalise their education.*

### **Keywords**

Globalisation, engineering education, computer science education, joint courses, project courses, distributed projects

### **INTRODUCTION**

Universities are important factors in the process of globalization. They belong to the local community in which they are situated, and are, at the same time, part of the international arena [2]. In research this has been manifested for a long time through conferences, workshops, journals, academic visits and similar events. A similar development can be traced within university education during the last decade. The current repertoire of collaborative forms includes exchanges of students and staff,

joint courses and programmes, as well as joint development efforts of different kinds (courses, programmes, software, lab equipment etc.). This trend has been encouraged both within Europe and between Europe and non-European countries by the European Union. The union has acted to integrate the European university systems and thereby to create links between the European countries (see for example [15] for a discussion on the topic in context of engineering education).

Within the research communities, there is agreement (in a broad sense) on how international work should take place, while the forms of educational collaboration are still under debate.

In this paper, we will argue, based on the experiences from two north-European universities, that it is an advantage to use different instruments, such as exchange programmes, internationally distributed projects, joint programmes, and joint research projects in parallel. We will suggest how these instruments with advantage can support each other, and present a palette of choices to be considered in this regard.

### **RATIONALE**

There are several reasons for a university, or a department, to act internationally in its education. The goals presented in this paper are based on the experience of our departments and the policy documents concerning global-

isation at Uppsala University, Sweden\* and IT University of Copenhagen, Denmark†.

#### *Concerning students*

- Our engineering students are educated for a professional life in a globalized, multi-cultural labour market. International teams are becoming common in industry, a fact that needs to be mirrored in education.
- Our on-going research project reports that the students “grow” by meeting and collaborating with peers from foreign cultures. [4]

#### *Concerning the universities*

- In the collaboration with foreign students, the competence of our students is tested. How well they master their engineering and how smoothly they manage to collaborate in a foreign environment is related to the quality of their education, thus of ourselves as universities.
- It might be hard, or even impossible, to attract enough students to a specialized education from a single city, region or country. Maybe this is particularly true for cross-disciplinary programmes, which, by their very nature are highly specialized. Global collaborations opens for a global recruitment

#### *Concerning engineering*

- Engineering is, by its nature, an international field, where needs from different cultures and countries meet.

## **TWO CASE STUDIES**

Two case studies form the base for the argument in this paper and stem from the Department of Information Technology, Uppsala University (UU) in Sweden and IT University (ITU) in Copenhagen in Denmark.

Both institutions are successful in both research and education within the field of information technology and computer science and both teach students with various backgrounds. Although the IT University of Copenhagen is a full university, it is only twice the size of the Department of Information Technology at Uppsala University, both when it comes to the number of staff (ITU: approx. 160 calculated as full-time employments; UU: approx. 80 calculated as full-time employments) and students (ITU: approx. 1800 calculated as full-time students; UU: approx. 800 calculated as full-time students). With these similarities, it is not surprising that the two institutions have selected similar means to globalize their education.

In this paper we refer to ITU and the Department of IT, Uppsala University as “institutions”, being aware that the term might carry a slightly different meaning to some readers.

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\* <http://www.inter.uadm.uu.se/pdf/HPINTeng0106.pdf>

† <http://www1.itu.dk/sw84318.asp>

## **INSTRUMENTS TO GLOBALIZE EDUCATION**

The globalization at both institutions rests on three globalization activities:

1. Staff and student exchanges
2. Joint student projects
3. Joint educational programmes

It is probably safe to assume that most universities have research projects involving global partners to some extent. Thinking about the development of global education, it makes sense to utilise the existing networks of researchers and teachers and also to think about the motivational factor among teachers in working with like-minded colleagues in partner educational institutions. Certainly, this is a track that is worth exploring, but it is slightly out of scope of this paper focusing on current work in education at the two institutions.

### **Globalization activity 1: Staff and student exchanges**

Both institutions exchange students and staff on a regular basis for a semester or a year, accept international students in degree programmes and recruit staff in an international competition. These mechanisms can, by now, be seen as the classic ways of globalizing higher education and form the core for both institutions in the drive to globalize education. In Uppsala almost 20 % of the students participate in exchange programmes or are enrolled in the international master programmes. The local environment becomes, at the same time, global by these activities.

Still exchanges have drawbacks, for example in the economic strength that might be needed to travel, in that a social situation might exclude travelling, and in difficulties to integrate in the local environment at the host university that students might face.

### **Globalization activity 2: Joint student projects**

Information technology has made it possible to collaborate across long geographical distances and over time zones in globally distributed projects [18]. Here, IT and engineering projects can be particularly suitable, both since the very result of a project often is an intellectual (or virtual) entity, such as technical artefacts, software systems and/or documentation. There are established methodological practices, such as for example the waterfall model [17], making it relatively easy to find good forms for the collaboration.

Although this idea is not new, until today there have not been many courses run in this way (but nice exceptions are presented in, for examples [12, 14]). We believe, based on our experience, that joint courses are a powerful way of educating our students.

The two institutions currently run the following courses, dominated by internationally distributed student projects:

### *ITU-Peking University (PKU):*

Twenty students, in equal numbers from China and Denmark took part in a joint innovative software development project during the spring semester 2008. The project included concept development, requirement specification, construction, test, usability test and feedback, as well as reflection on the work process.

The students worked with two different topics: (1) design and implementation of an e-commerce site and (2) design and implementation of a specific component in a software testing tool. The group who did the first project expressed frustration with the fact that the scope of their topic was too broad in the sense that they had to spend a large amount of time making decisions and agree on the basic content before they could get started. The other group however expressed frustrations that the topic area was too narrow and pre-defined. They felt that they lost ownership of the project and that this had a negative influence on their motivation.

The choice of technology was left entirely up to the students. The ITU students have expressed that the biggest challenge of online projects is learning how to work through the extremely narrow communication channels available (mail, messaging services, groupware, online conference systems etc.).

### *The Runestone project*

“Runestone” is a collaborative course in engineering systems development spanning several institutions Uppsala University, Sweden; Grand Valley State University, MI, USA; Rose-Hulman Institute of Technology, IN, USA; and Turku University of Technology, Finland [3, 11, 16] that has been run since 1997. Although the actual task assigned to the students has changed over the years, the design of the course remains relatively unchanged for these ten years.

During the course, the students work in teams of six, three in Sweden, and three at one of the collaborating universities. Each team designed and constructed a system which allowed a remote user to control a LEGO Mindstorms robot (of their own design) through a web browser. A view of the location of the robot was provided as a video stream in the GUI from a web camera, and the robot had wireless communication with the software system to the robot is provided. The teams were expected to identify, evaluate and decide on all the development software platforms and operating system to use, as well as communication protocol stack to handle communication between their software system and the robot.<sup>‡</sup>

As in the ITU-PK course, the students mostly selected their own collaborative tools.

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<sup>‡</sup> <http://runestone.it.uu.se/rune2008/tiki-index.php?page=Approach>

### *UU – Auckland University of Technology*

In a course, given yearly since 1998, students from Sweden and New Zealand blended problem-based learning drawn from a business case. [7] The joint task required students to develop a design proposal and feasibility study for a computer game to assist pharmacy assistants to acquire knowledge about a range of nail care products. Since the class sizes differed between the two institutions, AUT students in teams of two were matched with two to three teams of four Uppsala students.

### *The IT in Society course*

The IT in Society course has been run at Uppsala University since 1998, mainly for advanced students in the IT engineering education programme. From 2004, students from Rose-Hulman Institute of Technology, Indiana, USA, have been introduced into the course. An important goal of this course is to prepare students for their role as IT professionals in terms of personal development. Some of the characteristics of this are an ability to communicate with peers, other experts, as well as users, and to have an understanding of group dynamics in projects including a repertoire of how to deal with situations that might arise [10]. Collaboration with IT users at a local hospital has been a part of this course from its inception.

### **Globalization activity 3: Joint educational programmes**

New and better means of communication now make it possible to establish more complex relationships between educational institutions. The two institutions profit from this, by starting new educational programmes, jointly taught in Copenhagen and Uppsala respectively, together with foreign partners. The core idea is to benefit from specialised competences at different sites, so that the students can gain from a richer expertise. The very setting of the international programmes forces the students to meet peers from other cultures, in real life or through Internet-based tools.

We believe that “globalisation is going to change both what universities do and how they do it”<sup>§</sup>. In the field of engineering, universities will be expected to produce the knowledge and competences required to enable globalisation through appropriate use of information technology.

The two institutions have selected different ways to implement their joint programmes.

### *ITU - Georgia Tech*

An effort to establish a joint degree is currently undertaken by ITU and Georgia Tech, Atlanta, GA, USA. The two universities have a number of mutual beneficial complementary competence areas and it makes sense to look

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<sup>§</sup> <http://www1.itu.dk/sw84318.asp>

into options for sharing resources on common development and execution of an educational programme.

The programme will be run through joint courses and projects, paired with exchanges of teachers and students.

#### *UU - Tongji University*

UU will start a joint Master programme in Computer Science and Software Engineering with Tongji University, Shanghai, China, autumn 2009. The universities share many fields of expertise, such as embedded systems and Human Computer Interaction, but highlight different aspects of those areas. While UU has its core competence in the theoretical development, Tongji University works closer to industry.

Focus will here be on physical exchanges of the students, where the first year will be taught in Sweden, and the second year will take place in China.

### **OUR EXPERIENCES FROM THE DIFFERENT ACTIVITIES**

In this section, the emphasis of the discussion will be on the second activity, the joint courses. The exchanges already are analysed in several papers (for example [1, 8]); the joint programmes are too new for us to have generated evidence on which we can base our discussion.

#### **Joint courses**

Bowden argues that “that university students are engaged in learning for an unknown future and that we have to design the curriculum with that in mind”. ([6], p.37)

Some common features of professional work, which seldom are represented in university classrooms, and practical exercises, which are associated with the more open ended problem specifications, can arise. Such specifications are also often stated in rather fuzzy high level terms. An open problem specification places different demands on learners than traditional practical work or course assignments [13]. We consider it important to include analysis of the problem space and proposal of a feasible solution, identification of appropriate tools and techniques with which to solve the problem, managing and working in a team and learning about working with people from different cultures.

The objectives of the joint courses are to offer the students a possibility to gain experiences with problems and work situations which requires them to develop a greater level of self-reliance, teamwork capacity, as well as negotiation and communication skills. They should also learn to integrate and use theoretical knowledge from earlier courses, and (through experience of a wider systems development project cycle) understand that the theories we teach are not prescriptive and do not always lead to timely delivery and successful products.

By working to realise these objectives we hope to provide students with valuable experience relevant to their future working life in the ”safe” educational environment. By “safe” we mean that students can successfully complete the course and gain a pass even if their technical solution to the problem is non-functional.

The learning outcomes are, of course, within the subject area, but also concern organisation of work and personal development, obtained by working with students from other cultures. [5]

We wish to point out communication skills as crucial for all globalisation. This might be particularly true for the joint courses or projects, as communication channels are narrower than for physical meetings.

At ITU an academic reflection on the issue in the course curriculum was required of the students. This was organised in the project report, which included reflections. The aim was to encourage a mixture of hands-on experience and reflection as a strong way of preparing the students for a future global job-market.

For the Runestone course at UU, the goals have a higher emphasis on the technical course content. The Runestone web-page states that the course aims to encourage students to focus on three areas (1) cross cultural teamwork and communication skills (2) project management, design, timeframe estimation, and progress tracking (3) technical systems development. \*\*

#### **Choice palette**

We have summarized our experiences below in a short list of choices. The list is relevant to teachers/programme planners, and to some extent, we believe also to policy makers. In our experience both loose and tight coupled cooperation has benefits. For example tight coupling fosters a deeper level of involvement on both sides creating projects that are long-lasting and sustainable over time. Loose coupling on the other hand supports low complexity low cost setups that are adaptable to changes and easy to duplicate with other partners. The degree of freedom for institutions to make choices in this regard will influence cooperation initiatives and thereby globalisation of education in general. When considering globalisation of courses/programmes, we would like to emphasise the importance of student/teacher motivation as this is crucial to the success of the projects.

1. Loose vs. tight coupled cooperation with regard to:

- Establishing learning objectives?
- Sharing curriculum?
- Exam forms?

2. High vs. low level of teacher involvement in:

- Planning
- Group formation
- Choice of collaboration tools

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\*\* <http://runestone.it.uu.se/rune2008>

3. The use of video-conferencing equipment vs. low cost online available systems
4. Project topic: To what degree should the students be able to define their own project?
5. Student motivators; what are they?
6. Teacher motivators; what are they?

### OUR CONCLUSION: CULTURE MATTERS

These projects, together with our experience of student exchanges, and the on-going work with the global, joint educational programmes invite us to question claims stating that science is above or beyond gender, race, class, and other socio-cultural distinctions (see for example[9]). Instead, we argue that culture matters, and that different forms of collaboration serve as tools to improve education. The exchanges can be seen as a back-bone, create a continuum and influences the local environment. The global projects make students work in teams with peers around the globe. They are democratic in the sense that there are no travel costs – no students are more privileged than others. The global educational programmes, finally, aim to bring two universities closer, in that their resources become “pooled” to the benefit of their students. Combining physical exchanges with online collaboration can thus greatly expand the collaboration opportunities in a low cost fashion. We also argue that research collaboration is an important part of this: A combination of collaboration in research and education can keep the participants motivated and the collaboration sustainable.

The key to success for global collaboration in education is that students get to engage with students from other universities in a way that creates insights and experiences that could not have been obtained otherwise

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