



# On the Evolution of an Industrial Software Engineering Graduate Program

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**Abstract** - Software is the key enabling factor for many industrial giants in product development and the ability to deliver reliable software intensive systems in a cost-efficient manner is becoming the differentiating factor for their future competitiveness. This underlines the importance of an industrially relevant software engineering program and realization of the above fact has lead us to conceptualize a novel graduate program in this domain. The program originated from a set of mutually beneficial motivating factors, which were realized during close collaborations between industry and academia in a global setting. In this paper<sup>1</sup> we present the stakeholder perspectives as well as our experiences during the development and running of such a program.

**Keywords**- Education, Global Software Engineering, Industrial Software Engineering, Software Engineering Education.

## I. INTRODUCTION

GLOBAL competition is rising to unforeseen levels, but on the positive side, it also brings forth unprecedented opportunities for all. This applies equally well to countries, companies, institutions or individuals, who

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<sup>1</sup> Manuscript received September 6, 2009. This work was supported in part by various grants from Ericsson, Mälardalen University and Tata Consultancy Services.

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care to look beyond the obvious and build strategic collaborations. In this paper we describe one such endeavor in which we have been involved across industry and academia as well as between two countries to build a novel educational program in software engineering.

Sweden has achieved excellence in the engineering industry with organizations such as Ericsson, ABB, Volvo, SAAB and Scania, where embedded systems and Information Technology (IT) are the key success factors. India on the other hand is the most preferred outsourcing destination globally with close collaboration with the Swedish industry. India also has a strong educational system and a large pool of excellent students. Strengthening the Swedish-Indian partnership, involving both academia and industry, with the focus on IT is extremely important for the future competitiveness of the industries in both nations.

Academically, Mälardalen University (MDH) combines excellence in Embedded Systems and Software Engineering research with extensive collaborations with the Swedish industry. One of the main industrial partners of MDH – Ericsson - has been involved with MDH for several years in varied forms of cooperation such as joint projects, industrial doctoral studentships, short term industrial educational programs, and training programs. Ericsson had also been outsourcing projects to Tata Consultancy Services (TCS), Hyderabad, India, for almost a decade. These offshore development projects had half-yearly reviews together with management development programs and innovation initiatives and on several occasions MDH had also been involved in these review meetings along with Ericsson and TCS.

Such a setting and various discussions prompted us to envision a novel software engineering education program to be taught in pragmatic vein, suiting the Industry needs at the graduate level which could be beneficial to all



parties involved as well as to the countries in general. As Lancomb rightly points out, “A formal education aligned with industrial internships in a true software engineering discipline is EXTREMELY important to those that want (or need) to develop ‘real’ software systems” [1]. Our program is distinct from other existing Software Engineering Programs world-wide due to the fact that it is conceived ‘for the industry and driven by the industry’. This paper presents the conceptualization and the successful implementation of such a Masters program in Industrial Software Engineering.

## II. MOTIVATION & STAKEHOLDERS STRATEGIES

### A. *Global Scenario*

The number of well-educated people has increased rapidly over the last 10 years. This implies that small countries like Sweden have to absorb part of that increase of well-educated people to continue to be a competitive country. As Sweden with its 9 million people cannot educate enough talent in engineering, the Swedish industry has to collaborate even more with fast-growing economies, such as India and China. By exchanging students between countries we see a lot of positive effects on intercultural and intellectual understanding and efficiency in collaboration between companies residing in different countries, etc.

### B. *Student perspective*

A foreign degree will substantially raise the employment prospects of students in the global market. Students from India have been traditionally going abroad for higher education, and USA and UK have been their first choices. This is primarily due to the language (English) aspect. However the education in these countries has been quite expensive (high tuition fees) and many brilliant students cannot afford such high costs. Sweden presents a financially affordable and technically equivalent educational option which was hitherto unknown to prospective Indian students.

### C. *MDH Strategy*

Being a young and aspiring University, MDH is keen on recruiting top-ranking students and establishing global research collaborations. MDH is known for its research on embedded real-time systems and more recently for its software engineering research, both of which are among the top profiles of the University. In the area of real-time systems, MDH had been the forerunner in Sweden and currently has the largest research group in the world. More than 60% of the funding of the computer science department comes from research project funds. The

Software Engineering programs have been attracting a lot of Asian applicants as well, and have shown a monotonic increase in terms applicants and admissions over the past years.

In 2008, MDH initiated a new Industrial Software Engineering Masters Program together with a fellowship plan to attract and support brilliant students world-wide. One of the main goals was to generate a talent pool for recruitment of its industrial partners such as Ericsson, ABB, Volvo, and Scania. Another motivation was to potentially generate renewed interest in technology areas among Swedish students, which had been seeing a downward trend during the start of this century. A truly international learning environment with competitive minds around was expected to provide the necessary impetus to regenerate the Swedish students interest as well. The program was coded ‘Top Talent Program’ and during the first phase it was initiated for Ericsson and its Indian partner, TCS.

### D. *Ericsson Strategy*

Ericsson is interested in ensuring that their partners have the very best competence possible - technical excellence as well as solid software engineering principles. Therefore, they are interested in competency development at partner sites and in-house, and enhancing the talent pool for future recruitment cost-effectively. Moreover, one of the success factors that was identified in the course of running off-shore development projects is the existence of people who have a good understanding of the culture of both participating countries. This concrete educational program helps people to understand the cultural differences of the countries and develop personal contacts at Ericsson and TCS as well. This gives the future collaboration on off-shore projects a kick-start and fosters a better synergistic environment.

### E. *TCS Strategy*

TCS India, is a world leading IT Services Company which has a long-standing relationship with Ericsson AB, Sweden for research and development. TCS also has an on-going and active global academic interface program (AIP) involving many leading universities. Widening the scope of its academic interface program as well as providing it with a more international dimension and customer dimension was part of the TCS strategy. Also, Pragmatic Software engineering was very important in order to own complete product development. The students on completion of the masters program would work for TCS-Ericsson for a period of two years.



### III. THE PROGRAM

The above perspectives and strategies of the stakeholders were reflected very well in our 'Top Talent Program', which presented a win-all solution which instantly appealed to all involved. We now describe the details of the funding, logistics and program curriculum.

#### A. Scholarships and recruitment

To start with, Ericsson offered financial support with ten scholarships. A memorandum of understanding was signed by Ericsson, MDH and TCS to ensure continued organizational support irrespective of organizational changes. These also included specific responsibilities of each stakeholder including the students. TCS took on the recruitment of Top Talent and to promote the program visited a few Indian universities. However, due to legal issues which prevented TCS from conducting all-India student recruitment, it was decided to confine the recruitment to young TCS associates only and the program was announced in the internal portal of the company. An overwhelming number of applications were received and TCS arrived at a shortlist after interviews. MDH did the second level of eligibility checks as per the University admission norms and made the final selection list in consultation with Ericsson.

#### B. Logistics

During the process there were many unexpected delays and hindrances, but still the commitment of all involved saw to it that the first batch of students could start their studies as planned. The students were from different TCS global delivery centres (GDCs) and they had to be relieved from their current projects. The Visa support letters and admission letters were provided by Ericsson at MDH. TCS arranged a teleconference with the program coordinator and the students to clarify a large number of questions and doubts regarding study, accommodation, living conditions etc. TCS provided advance payments on behalf of the students to secure accommodation for them. TCS also provided financial support for travel and insurance during the program. The air tickets were arranged by TCS and in many cases, were done at the last minute due to visa issues.

#### C. Curriculum

MDH was primarily responsible for the design of the curriculum, while Ericsson and TCS were involved in the process and provided many useful suggestions. MDH has several years of experience in running Masters programs in Software Engineering. Though the focus of our

graduate education is built around the active research areas at the department such as component based software engineering, guidelines given by SWEBOK[2] have also been considered in the development of our curriculum. However, due to the specially intended industrial dimension, we did not plan to have a broader curriculum as in the case of some of the other generic degree programs elsewhere [3].

One of our existing programs was a one-year Masters program (known as 'Magister' program in Swedish). In this program the students need to take courses worth 30 ECTS (European Credit Accumulation and Transfer System [4]) and an advanced level thesis in computer science worth 30 ECTS in order to satisfy the degree requirements. An academic year at MDH is normally divided into 4 study periods and during the first two periods the student takes four courses (of 7.5 ECTS each).

The Top Talent Program was built on the foundations of our existing Magister program, which had courses such as Distributed Software Development, Component Technologies and Advanced Component-based Software Engineering. We specially introduced three new courses in the curriculum to provide the necessary industrial dimension to the program. Also the thesis work was specified to be an industrial one on themes and projects of relevance to Ericsson. The three new courses introduced were Industrial Systems Development (with many guest lectures on industrial development practices given by experts from Ericsson, ABB, Volvo etc), Software verification and validation (with focus on industrial software testing), and Innovation Science and Management (with emphasis on application innovation and creativity aspects during thesis work). In addition to more focused visits to Ericsson, several visits to the local industry were also conducted. The management and technical experts at Ericsson shared with the students, the management and work culture at Ericsson together with in-depth information on selected technical themes.

The Top Talent students at MDH were also associated with the Industrial Research and Innovation Lab at MDH which had been supported by Ericsson and has Ericsson's Base Station equipments installed. This provided the students with an excellent opportunity to learn about Ericsson mobile platforms as well as work on projects which could access the Ericsson networks while working from the University.

#### D. Mentorship

We also designed a special mentorship in which each Top Talent student was assigned an academic mentor at MDH and an industrial mentor at Ericsson. At MDH this



program was implemented with the support and interaction with an expert on mentorship. The concept of a mentor was new to many of the students as well as some of the junior faculty and hence the goals and program was designed with a common introduction meeting between the students, mentors and the expert. The students were assigned mentors who were, as far as possible, neither their supervisors nor teachers. This helped the students to interact freely with the mentors as well as provided them with an opportunity to discuss their concerns or bring any conflicting issues in academic matters to a sympathetic listener who could then impartially provide some advice or direction. The mentors were instructed to be as informal as possible at their mentoring sessions. Also the suggested mode was to direct questions at, and provide hints, to help students explore and find solutions themselves rather than provide them with quick-fix solutions. The mentors assigned at Ericsson were very helpful in providing the students with valuable guidance on career issues, etc.

#### IV. EVALUATION AND LESSONS LEARNED

Overall, the study program was well received by the students and all stakeholders, which is evident from the multitude of queries received from prospective students as well as industrial partners. The students in the first batch also took more credits than a typical Magister student. The Top Talent students were part of the team that reached the finals at the SCORE 2009 Software Engineering Project contest (<http://score.elet.polimi.it/index.html>) conducted as part of the world-leading International Conference on Software Engineering (ICSE).

We conducted an evaluation of the program by obtaining student responses to a questionnaire, and based on the feedback, several improvements are being incorporated. Based on our experiences as well as student feedback, we realize that a Top Talent program needs support programs like:

- interaction with researchers at the university
- social integration in the host country
- a 'tourist' program – to get to know the city and its environment

The program coordinator as well as teachers need to be prepared to take on extended responsibility for students – for example, sorting out accommodation issues or familiarizing students with the country/culture and how to get around.

It is also necessary to foster and support a group spirit through activities like having a home base (classroom, special lab) at the university. This was evident from the

group activities undertaken and the active participation of the students in them.

A proper introduction on how to write an academic paper (thesis/project works or even assignments) is essential to secure an efficient start in the academic writing process. Unlike the Swedish educational system, the Asian learning systems put less emphasis on this aspect and the first batch of students had many difficulties in the beginning due to this factor. Though a crash course on research writing was provided to the first batch, we have added a full course on research methodology (7.5 ECTS) during the first study period itself to the study plans of the current batch of students to take care of this deficiency.

As seen from the student responses, industrial mentors are needed and well appreciated. It is of great importance that these mentors know what the university and the students expect from them. The industrial mentors will be briefed accordingly for future batches of the Top Talent program. Also efforts will be made to increase the frequency of such mentor meetings.

Project management is key factor which can make a big difference to the success or failure of such programs. It is important to keep the stakeholders involved in the project and follow up on actions (study visits, payment of scholarships, student performance appraisals, etc).

There needs to be a clear plan which is communicated to the students, both regarding activities and responsibilities during the program. This should be supplemented by an individual career plan upon completion of the program. The students will otherwise feel neglected by the original employers and will search for newer avenues in education or career, which could substantially reduce the impact of such programs. Continuous contact with the employer during the program is crucial to avoid such misunderstanding. Students need to be informed about the plans for them on their return. Also, continued involvement in the thesis themes and keeping the group alive through special meetings even after their study program will be beneficial.

#### V. OUTLOOK FOR FUTURE AND CONCLUSIONS

We are now on to the second year of the Top Talent Program. The whole process of recruitment and installation of the second batch of students has been much smoother this time learning from the experiences of the first time. This program has generated a high level of interest among other Swedish multinational companies such as ABB, Volvo, Scania as well the Swedsoft consortium of Swedish companies. Due to their specific interests in specific world regions, the program will have more nodal centers in India (eg. Bangalore for ABB) or



Korea (for Volvo) as well as other countries. The involvement of multiple companies with their own units or outsourcing contractors in multiple developing countries is expected to raise the quality as well as the global dimension of our Top Talent Program.

#### ACKNOWLEDGMENTS

The authors wish to thank Lars Frank, Gudrun Paulsdottir, Jayaram Nutulapati, Tapas Das, Pär Asplund, Siva Guntreddi, Daniel Flemström, Malin Rosqvist, Johan Bartholdson, Srikanth Surampudi, Jyotirmay Jena, K. Suryanarayana, Shalini S., and other colleagues for their involvement and contribution at various stages in making this program a success.

The first batch of Top Talent 2008 from TCS also deserve special acclaim for their perseverance, performances in studies, suggestions for improvement

and commitment to the parent organization in spite of more lucrative offers.

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