SOFTWARE QUALITY ASSURANCE COMPETENCE CENTRE

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Abstract

The main contribution of this paper lies in the demonstration of a real academic-industry collaboration in the field of Software Quality Assurance. This collaboration is illustrated on the example of the Software Quality Assurance Competence Centre, being a part of the Faculty of Informatics and Statistics, at the University of Economics in Prague since 2012. Two successful projects implemented by the SQA CC are presented to illustrate the core activities of the competence centre. The main areas that are specific to competence centre management are identified and further discussed in lessons learned.

1. Introduction

As software expansion accelerates into the majority of medium and large enterprises and at the same time software acquisition costs decline thanks to an emergence of new technology and development methodologies, application development starts to focus on the issue of quality in software development as a way of gaining a competitive advantage. A number of authors as for example (Osterweil, 1996) or (Orso & Rothermel, 2014) confirm such a trend in application development. Moreoever, Jones & Bonsignour (2011) dealing with the issue of quality in their book the Economics of Software Quality identify potential cost savings in achieving high quality when developing a software product. It holds true that the larger the software project, the greater the savings. Indirectly, this fact presents a reason for pursuing high quality in projects and confirms that quality strengthens company's competitiveness.

Continuously, costs and investments into information technology have gradually been falling in the United States as well as in Europe since the outset of the financial and economic crisis. Companies strive to minimize their IT related costs to save company's financial means, increase operational efficiency and profit. The merits that distinguish strong software companies from their competitors are quality, reliability and low maintenance costs of software. These merits are crucial for European and American companies seeking inexpensive but reliable partners for software development.

Winter et al., (2011) point out that instead of the traditional approach to quality (i.e. complete, testable and consistent requirements, traceability to design, code and test cases, and heavyweight documentation) agility is needed due the demand for continuous and rapid results in a world of continuously changing business decisions.

With an increasing role of software quality, the issue of human resources that actively take part within the development process and shape the quality of produced software becomes an important success factor, especially the level of knowledge and experience. However, a research focused on the level of testing and quality management in software companies in the Czech Republic (Havlickova, 2012) showed that the employees engaged in shaping product quality had a very low level of understanding of basic concepts in the area of software quality. The research also pointed out a low availability of managed and structured training on quality management and testing aimed at the particular employees. This lack of training and education on quality management within software companies provides an opportunity for universities to engage in practice and provide expert guidance in this field. The knowledge of academics and their experience from the research field represents a substantial source of know-how as well as an opportunity to enhance company's processes and operation. On the other hand, collaboration with practice provides universities with an insight in practical business world and helps them to enrich course syllabus with real life situations and also better prepare the students for their future career.

Mandviwalla et al. (2015) point out that an academic industry collaboration is a strategic necessity in today's fragmented and turbulent economy as it addresses the human capital as well as knowledge challenges that IS practitioners and academics face.

Pilgrim (2013) states that research conducted in Australia points out to existing tensions between universities and industry regarding the design of curriculum for ICT degree programs. Primarily, universities focus on developing key knowledge foundations rather than particular ICT skills. Employers are then dissatisfied with graduates' understanding of business processes, project management and communications skills. Pilgrim concludes "that the main skills that industry requires from new hired persons are: team work, testing and evaluating capabilities, effective communication skills, quality measurement, and process improvement".

Various surveys focused on requirements of business practice on ICT managers and their coverage by ICT curricula was undertaken also in the Czech Republic, first in 2006. Doucek, Maryska & Novotny (2014) present a comparison between the 2006 and 2010 surveys and state that there was a substantial improvement in agreement between the requirements of company practice and the knowledge offered by university graduates between these surveys. Nedomova, Doucek & Maryska (2013) identified larger requirements on ICT knowledge by small enterprises than by medium enterprises which have on contrary higher requirements on "non-ICT" knowledge.

However, Software Quality Assurance knowledge domain is not explicitly covered in these surveys nor is the role of Quality engineer or Tester. To meet the growing needs of practice in the area of software quality and testing, it is necessary to educate students with adequate knowledge and skills as stated for example by Rusu et al. (2009). Rusu et al. claims that "many of the skills that students are expected to have can only be learned by doing. These include interacting with real customers with tight deadlines and budgets but high expectations, and being able to work effectively in an almost exclusively team oriented environment with increasingly complex team structures and compositions." Eldh & Punnekkat (2012) reach similar conclusions as they state that "students are taught theory of different processes, but often lack real work experience to understand their differences, the nuances and the impact that has on the work product – the software systems."

A suitable way how to enable students to participate in practical projects is the collaboration among industry and academia. There is a significant amount of research that shows the importance of such collaboration (Wohlin, 2013), presents its benefits (Lee, 2000), challenges (Runeson, Minör & Svenér, 2014) and gained experience (Bučar & Rojec, 2015).

The aim of this paper is to show the possibilities of academic industry collaboration in the field of Software Quality Assurance (SQA) and present lessons learned gained from such collaboration. This paper is organized as follows. First, the importance of SQA within IS development is outlined. Then, the Software Quality Assurance Competence Centre (SQA CC) is introduced and its main services that provides to business customers. To demonstrate provided services and core activities of the competence centre, two successful projects implemented by the SQA CC are presented. Finally, lessons learned gained from the implemented projects and personal experience are stated..

2. SQA Competence Centre

This section introduces the foundations and core activities of the SQA Competence Centre. The idea of creating competence centres at universities was introduced by the IBM Company. These centres were supposed to develop competencies in particular areas and provide them to business users and practice as a whole. This way a competence centre Software Quality Assurance (SQA CC) was established in 2012 being a part of the Faculty of Informatics and Statistics, University of Economics in Prague. The aim of this competence centre is to provide companies with expert advice and guidance in planning and implementation of software quality management processes, especially testing. Initially, it was focused on co-operation with IBM and application of IBM testing tools. Nevertheless, the competence centre had gradually become independent from the exclusive co-operation with IBM and now provides services as a fully independent competence centre using both commercial, namely IBM and HP tools being the main players, as well as open source testing tools.

The SQA Competence Centre has currently over 20 members. These include PhD students, students of bachelor's and master's program of Informatics and Information technologies. We plan to involve also students from other faculties of the University of Economics into the competence centre, particularly in the area of project management and marketing. Students have the possibility to participate in real and practical business and research projects during their studies and thus gain valuable experience. We also focus on their personal development and organize internal training and educate them in regular as well as block courses. Within bachelor and diploma theses, students develop a number of methodologies and manuals that serve as a basis for other students and also for educational purposes. Within the SQA Competence Centre, we collaborate especially with the following companies:

- NESS Czech, s.r.o.
- HEWLETT-PACKARD, s.r.o.
- TRASK SOLUTIONS, a.s.
- IBM Czech Republic, s r.o.
- Tesena s.r.o.
- T-Mobile Czech Republic, a.s.

- MSD

The SQA Competence Centre offers services in the field of quality management, which include know-how and special skills that are not usually available in the practice. These include:

- Automated functional testing using commercial and open source tools,
- Performance testing,
- Integration testing,
- Mobile application testing,
- Testing methodology implementation,
- Testing tools integration.

These areas are in compliance with the concerns stated by Engström & Runeson (2010) based on a recent survey of regression testing practices and challenges pointed out by Orso & Rothermel (2014).

3. SQA Competence Centre Projects

This section describes two examples of projects that were carried out within the SQA Competence Centre to illustrate concrete examples of academic industry collaboration.

3.1. REGAN Project

The Software Quality Assurance competence centre team successfully finished a project focused on an analysis of regression testing for the company T-Mobile Czech Republic a.s. (hereinafter TMCZ) in January 2015. According to ISO/IEC/IEEE 29119-1 (2013), regression testing is "selective testing of a system or component that has previously been tested to verify that modifications have not caused unintended side-effects and that the system or component still complies with its original requirements." There is a gap between research and practice of regression testing as stated by Engström & Runeson (2010). Research on regression testing mainly focuses on selection and prioritization of test cases with several techniques proposed and evaluated. However, industry practice on regression testing is mostly based on experience alone, and not on systematic approaches. (Engström & Runeson, 2010)

The objective of the REGAN (REGression ANalysis) project was to evaluate the possibility of regression testing automation. The project was carried out in collaboration with Hewlett-Packard s.r.o. The aim of the project was to determine a range of circa 20 systems out of a large number of available systems that would be analysed in detail in terms of possible automation of regression testing. The analytical team of the competence centre gathered information about the analysed systems, examined release and test plans, went through test case scenarios and conducted interviews and questionnaire surveys among the TMCZ's testers. The team members also participated in actual testing. This way the team gathered sufficient information to provide an adequate recommendation in terms of which systems and specific test cases are suitable for an implementation of automated regression testing including a timetable plan. This should allow TMCZ to move over testers' capacity in the future which could be then utilized for an even better assurance and management of software quality.

To fulfil this goal, the competence centre team developed a methodology for assessing the suitability of regression testing automation together with a method of estimating labour-intensity of automated testing implementation. Although the methodology was adapted and tailored to development and testing processes in TMCZ it could be applied also in future projects. Based on the developed methodology, automation could be viewed from both technical (whether it is possible to automate testing using standard tools) as well as economic perspective (whether it is feasible to implement such automated testing). Alongside, the competence centre performed an analysis of testing tools and recommended suitable tools for testing automation.

3.2. ITN Project

In the middle of 2014, the SQA Competence Centre was contacted by a Czech software company TRASK s.r.o. with a proposal for collaboration in the development a technical solution targeted at a comprehensive and integrated use of open source tools within software quality management. The proposal of this technical solution then resulted in a project aimed at development of an Integrated Testing Tool (ITN). This project involves a Supervisor (a head of the competence centre) and five students within the competence centre and two employees from Trask s.r.o.

The project rationale behind is as follows. Given the high price of commercial tools supporting testing, companies strive to utilize open source tools that are free of charge. However, the current method of deployment and usage of open source tools for software testing has a number of process as well as technical limitations. These tools are used, installed and deployed independently without any integration in place. Alongside, it is quite difficult to deploy such tools because they require numerous customizations due to their universality (openness) that prolong the entire deployment process. Currently, there is not any complex open source solution aimed at the testing area. Thus, the Integrated Testing Tool strives to fill this gap. The main aim of the project is to develop a software tool that supports software quality management within large software projects for external customers. The benefits of this system are as follows:

- Software support of the whole testing team (Test Managers, Test Architects, Testers and Programmers),
- Unified solution linking up test management, bug management and individual applications for automated software testing (functional, performance, integration and other),
- Low deployment price – the ITN will be delivered as a single functional package; that means low cost of human resources that will not be needed for installation and preparation of the environment, the ITN will allow zero software license costs given the use of open source tools.

The result of the first stage of the project lasting for one year is a functioning version of the ITN tool that interconnects test management with bug reporting and functional and performance testing. At this point, the tool is ready for deployment on a pilot project.

4. Lessons Learned

Being the head of the SQA Competence Centre for three years, I have gained a number of valuable experience that I would like to share with the expert and business community. The lessons learned are divided into three areas that are further described below.

4.1. Testing Specifics

Software testing is specific in the way that it is necessary to co-operate with the team that develops software as well as with the customer. Further, the test team members need to have an access to both the contractor's company and the customer. This access means not only the physical access to a building, but also to an information system environment. This requires administrative solutions and significantly prolongs the beginning of the project indeed.

Moreover, testing is carried out in various environments. Usually, a test environment is used and administered by the development team and an operating environment is then utilized by the customer. In this case, the testers get into a contact with sensitive company data. Thus, it is necessary to ensure a Non-disclosure Agreement NDA is included in the contract. An NDA is a legal contract between at least two parties that outlines confidential material, knowledge, or information that the parties wish to share with one another for certain purposes, but wish to restrict access to or by third parties.

Lastly, the competence centre's provided services in the area of testing require greater knowledge and skills and are usually associated with the use of software testing tools. The problem lies in the fact that commercial tools for testing are very expensive. Thus, companies that are interested in testing services prefer a complex delivery of such services, i.e. without having to buy licenses for testing tools themselves. However, neither the SQA Competence Centre nor the University of Economics are able to purchase such commercial tools. This is why the competence centre focuses on usage of open source tools and why it strives to develop the integrated testing tool which will be then utilized within future projects.

4.2. Resource and Project Management

Managing the competence centre that has more than 20 members is quite demanding. There are several projects running at the same time within the competence centre that need to be managed separately. Thus, the overall management includes management of the competence centre and management of individual projects. At the level of competence centre management, we defined the roles of a Head of the Competence Centre, Competence Centre Manager and Competence Centre Member. The Head of the Competence Centre is an academic staff or PhD student and represents the competence centre in negotiations with partners and customers, signs contracts, conceptually leads the competence centre and decides on remuneration. The Competence Centre Manager is a student who manages the competence centre, coordinates individual projects, assists the CC Head, organizes activities (e.g. internal training, lectures), handles promotion of the competence centre and manages human resources. The Competence Centre Member works in the competence centre on individual projects or is a part of a pool from which people are assigned to particular projects. At the level of individual projects, we distinguish the role of Project Manager who manages the whole project and Project Member who works on an individual project.

To manage the competence centre, we utilize a tool for teamwork the Active Collab. However, this tool does not fully cover the needs of competence centre management. Thus, we decided to develop our own tool for managing competence centre resources and projects.

A key role in the success and sustainability of the competence centre plays human resource management. The issue lies in the different degree programmes within the Czech Republic education system – the bachelor's and master's programmes. As we require the students to poses a basic level of knowledge in programming, software engineering and testing prior to joining the

competence centre, we look for students in the second year of their studies. However, most of the students are about to finish their bachelor studies when finally completely trained, assigned to a project and fully engaged as the bachelor's programme lasts only for three years. It is not certain whether the students will continue to the master's programme at the University of Economics and thus it is hard to predict the number of active members within the competence centre. With the master students, the situation is even more difficult since the bachelor's programme lasts just for two years. Also, most of the high scoring students often participate in the Exchange programme and study abroad for the whole semester. This also disrupts their activities in the competence centre. A more favourable situation then comes in the case that the master students continue with their PhD studies at the University of Economics.

Another issue related to resource management that we permanently struggle with represents the time constraints of individual students. In case of a project for practice, a full-time involvement of project members is usually required. However, the students are not able to satisfy such time requirement because they study full time and some of them even work on top of that. Thus, it is necessary to cover for the students and double their number in order to achieve a full working capacity. This significantly increases the complexity and demanding character of such project management. From the experience, innovative projects that are carried out by the students within their bachelor or master theses have proved to be an effective and functioning model.

4.3. Knowledge Management

Third key area for the sustainability of the competence centre represents knowledge management. Due to the high fluctuation rate of the competence centre members explained above, it is essential to preserve and transfer the knowledge acquired by the students throughout the project to others. There are already a number of resources that have been created within bachelor, master or PhD theses and can be made a good use of by the competence centre. These include the following resources:

- Testing methodology following the international standards,
- Selenium tool testing methodology and manual
- HP Quality center test management tool manual,
- Automation testing methodology and others.

5. Conclusions

The main contribution of this paper lies in the demonstration of real academic industry collaboration in the field of Software Quality Assurance. This collaboration between universities and business was showed on the example of the Software Quality Assurance competence centre, being a part of the Faculty of Informatics and Statistics, at the University of Economics in Prague since 2012. Two successful projects implemented by the SQA CC were then presented to illustrate the core activities of the competence centre. Finally, the main areas that are specific to competence centre management and contribute to its demanding nature were identified and further discussed in lessons learned.

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