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Citation:

Simic, M, Spichkova, M, Schmidt, H and Peake, I 2016, 'Enhancing learning experience by collaborative industrial projects', in Ataur Rahman, Vojislav Ilic (ed.) Proceedings of the International Conference on Engineering Education and Research (ICEER 2016), Sydney, Australia, 21-24 November 2016, pp. 1-8.

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Enhancing Learning Experience by Collaborative Industrial Projects

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Abstract: This paper presents how collaborative industrial project are embedded into engineering curriculum at two departments: School of Science and the School of Engineering, at RMIT University, Australia. We introduce general structure of the industrial projects as Work Integrated Learning (WIL) modules, as well as provide a number of examples of recently completed projects.

Industrial summer projects, which were running in the years 2015/16 in collaboration with ANZ, ABB, Alfred Hospital, etc., were pipelined with final year projects from the School of Engineering as well as with the Software Engineering Projects (Bachelor and Master level) from the School of Science. The goal of these projects was to enable continuity of activities as per industry requirements and enhance learning experience, as well as, employability of the students. All the projects were successfully completed, also receiving positive feedback from industry partners. Some of the projects led to student's employment within the companies that have sponsored the projects.

With this approach, Future Designers Grant from the Department of State Development, Business and Innovation, Victoria, was efficiently implemented and a new product developed. After receiving Bosch Venture Forum Award in Germany, in June 2015 industry collaboration has extended to new partner, School of Science and activities continued over the summer. New design is implanted as well as large number of improvements.

Keywords: Learning Experience, Industrial Projects, Collaboration, Work-Integrated Learning

1. Introduction

Software Engineering (SE) is one of the most rapidly evolving and changing disciplines, which also influence the industry requirements on the skills that students need to obtain in universities for successful employment: some knowledge on SE might be extremely important in one decade and not required over the next years, cf. (Frailey, 2014). One approach to ensure a better experience and activate students in learning of Software Engineering (SE), is to focus on active and inductive learning, as this would provide a better understanding of what exactly SE really means and why there is a need for SE in the industry, cf. (Sedelmaier and Landes, 2015; Prince and Felder, 2006).

Sedelmaier and Landes (2014) provided justification from a pedagogical point of view that project-based learning (PBL) allows not only to gain technical knowledge in the related area, but also foster soft skills. Dagnino (2014) presented a method derived from the collaboration between North Carolina State University and ABB. This method brings diverse techniques to simulate an industrial environment for teaching a senior level Software Engineering course. In this paper we present our methods on enhancing learning experience, focusing of final year SE students at RMIT

University, Australia. In contrary to the approach of Dagnino (2014), we do not simulate the industry environment for our projects, but use a real one, based on collaboration with local and overseas industrial partners. In addition to that, project based learning is seen as a contributing factor to graduates' better work preparation, cf. (Jollands et al., 2012). We have already presented a number of collaborative partnerships in engineering education, cf. (Mo et al., 2008; Simic, 2006), but in this case we have additional stakeholder. It is Government with its grant for the business and innovation. Another good example of Government support for engineering education is in the design of flexible entry pathways to Mechatronics / Robotics profession as previously reported in (Simic, 2004).

2. Work Integrated Learning within Software Development Projects

The Computer Science and IT department of the RMIT School of Science has a long history of Work Integrated Learning (WIL) activities used to improve the learning experience of students. Software Engineering projects are conducted in collaboration with industrial partners. In this paper, we present two types of these activities, *YourSoftware* and Summer projects.

2.1 *YourSoftware* projects

YourSoftware projects were initiated by Astrid Bauers¹ more than 10 years ago, in 2005, as industry-based projects for Master of Software Engineering students. Currently the *YourSoftware* projects are provided as compulsory final year courses both on Master and Bachelor levels within the Software Engineering Program, and in Semester 2, 2016, we are going to allow enrolment into these courses also for Bachelor of Computer Science students as a “pilot study”. These projects provide, to RMIT students, a hands on practical experience in developing software within a real project environment, having meetings with stakeholders and the corresponding mentoring, as well as experience in a team work on larger projects.

YourSoftware teams consist of 4 – 6 students, where the size of the team depends on the project scope and number of students enrolled into the courses. Allocation to the teams is based on students' skills and preferences. Students work on the projects within a semester 13 weeks long for approx. 20-40 hours/week, depending on the courses they are enrolled in, which means that a team contributes in average 2,500 hours of work. The number of students enrolled in the corresponding courses grows over last years, e.g., from 87 students in 2013 to 124 students in 2015.

RMIT provides *YourSoftware* lab space to allow students to have an “office” where they can come to work in the team, either using the provided workstations (Windows and Mac OS) or their own laptops, as well as, the servers and software, supported by the RMIT technical services group. We also have a number of teams working in industrial environments, i.e. from the place of industrial partners. For example, RedBubble company² accommodates their teams in the RedBubble office space, to provide students more support and mentoring in a real working environment. Another option for students to work on real-life scenarios in an innovative environment is to use the RMIT VxLabs, cf. e.g., (Peake et al, 2015; Blech et al., 2015, Blech et. al, 2014, Spichkova et. Al, 2013), cf. also Section 4 for more details. The VxLab video wall is shown in Figure 1.

In Semester 1, 2016, we had 18 *YourSoftware* project proposals, and 12 of them got a team. The Project Proposal Sponsors of these teams are ANZ, Navy, Panviva, Bookon, RedBubble, Kaleido Labs, Carers Victoria, Bureau of Meteorology, Adept Consulting Group, and Department of Justice

¹ <https://www.youtube.com/watch?v=1FFw5CjMIsA>

² <http://www.redbubble.com>

& Regulation. The majority of the projects focus on the development of either web/cloud-based systems or iOS/Android apps, cf. Figure 2.

The Department of Justice & Regulation project was focused on development of Android and an iOS apps, that are implementations of Intelligent Speed Adaptation systems to contribute to the road safety in Victoria, Australia. The apps are named *DriveVictoria*, as the case study was based on the information about the locations of the speed signs and the schools in Victoria. The corresponding data sets are accessible via VicRoads³, the road and traffic authority in the state of Victoria, Australia, as well as Victorian Government open data⁴. This project was complemented by academic research, separated from the learning and teaching activities within the project, on intelligent speed validation and adaptation, cf. (Spichkova et al., 2016).



Figure 1. State of the art: RMIT VxLabs

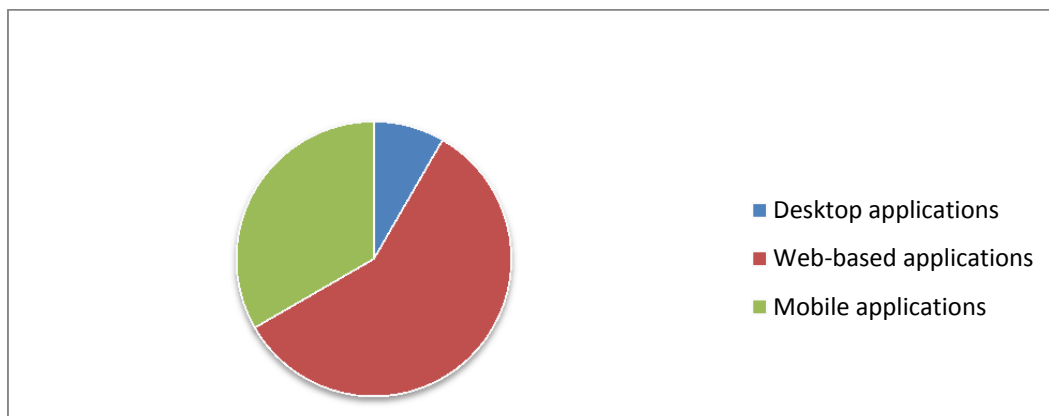


Figure 2. *YourSoftware* Projects (Semester 1, 2016): Types of developed software

³ <https://www.vicroads.vic.gov.au>

⁴ <https://www.data.vic.gov.au>

2.2 Industrial Summer projects

In 2015, we initiated Industrial Summer projects, to provide students the opportunity to gain the real-life industrial experience within the summer break 2015/16. Altogether, we had 40 student projects. 19 of them were industry led, involving 25 students and 10 academics. The industry partners of these projects were, for example, ANZ, ABB, Effusion, Alfred Hospital, Pop Tech, Compliance Group, Proximity, Future Grid, Gnosis Technology, Scientific Technology, SuperTooth, ICMTEL, etc.

After the Summer projects, two students received job offers from the companies with whom they completed the project. Like in the case of *YourSoftware*, the majority of the projects focus on the development of either web/cloud-based systems or iOS/Android apps, cf. Figure 3.

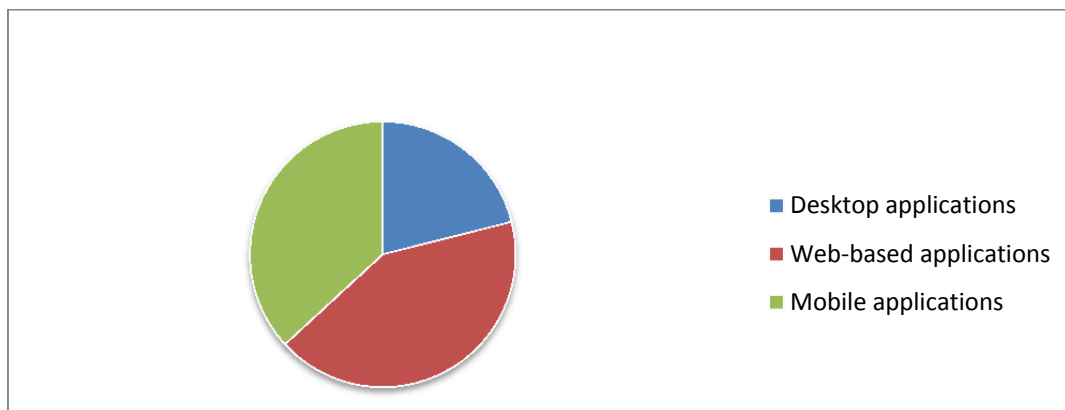


Figure 3. Industrial Summer Projects: Types of developed software

3. Future Designers

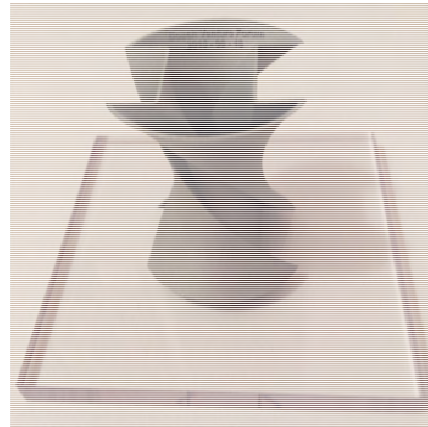
During the first semester of 2015 a joint RMIT University and industry, Effusion, team has designed a new 3D printer for metal printing. Whole project was funded by a Future Designers Grant from the Department of State Development, Business and Innovation, Victoria, Australia. This multidisciplinary project was structured as number of PBL projects conducted by Mechatronics Engineering, Design, Business and Management students. In June 2015 team has received Bosch Venture Forum Award in Germany. Robert Bosch Venture Capital (RBVC), is a private company that supports start-up companies across the world. Novel 3D printer is shown in Figure 4 (a), while Bosch award is presented in Figure 4(b).

The work was performed with the intention of developing a new application of the 3D printing technology in advanced manufacturing. RMIT team was working with industry experts from Effusion Company, while RMIT University has supplied all necessary resources.

After the first generation of the 3D printer was designed and awarded, collaboration was continued and extended to Computer Science and IT department of the RMIT School of Science. Instead of the application of Computer Numerical Control (CNC) type of solution, decision was made to introduce a robotic arm as shown in Figure 5. This new PBL or WIL project was now conducted using resources from the Computer Science and IT department, as an industrial summer project. After successfully finalising project work student was offered the job to stay with the company. Industry partners are exercising this practice very often which is extremely important for the students, academia and community.



(a) Novel 3D printer



(b) Bosch Venture Award

Figure 4. Future Designers Project



Figure 5. Robotics in Novel 3D printer design, second generation

4. VXLab

The Virtual Experiences Laboratory (VXLab) at RMIT is a virtual, distributed laboratory connecting industrial automation and visualization facilities for research, innovation and teaching. The VXLab has invested in platform technology in industrial automation, visualization and user interfaces and services/clouds, targeting industry and research collaborations in for example manufacturing 4.0, sensors, analytics, internet of things, virtual and augmented reality, serious games and global collaboration. We aim to create a virtuous cycle of opportunities for cross-disciplinary research and innovation, which is attractive to industry, researchers and students. Further advantages include the prospect of providing remote access to automation facilities to students off-site, or without “suiting up” with personal protective equipment.

The VXLab consists in particular of a networked ABB robot lab, large tiled video wall running SAGE2⁵, and the Virtual Experience Portals (VxPortals). The VxPortals are an ultra high-definition, head-tracked 3D visualisation platform developed jointly with the Centre for Games Design Research (Peake et al, 2016). For teaching in particular we are targeting industry-connected and cross-disciplinary experiences including through funded projects and industry-provided academic facilities such as IBM’s Bluemix platform. Each of these projects involved participation

⁵ sage2.sagecommons.org

either by RMIT researchers, or with some input from an external organization, or both. Typically supervisors and researchers are from the Australia-India Research Centre for Automation Software Engineering (AICAUSE), which is a partnership between RMIT and ABB, a multinational power and automation company.

Among the student projects which have been run in the VXLab since 2014 are⁶:

- Teaching robots using air commands remotely (TRAiCE) - summer studentship integrating ABB IRB120/IRC5 with Leap Motion hand tracking sensor via Unity3D
- Social media for robotics - capstone project integrating Collaborative Engineering research platform with twitter API (with AICAUSE supervisor)
- Telerobotic cloud – internship integrating of ABB IRB120/IRC5 with Leap motion hand tracking sensor and cloud-deployed OpenCV component
- Point cloud analysis for robotic feedback – capstone project using Microsoft Kinect sensor (with RMIT Architectural Robotics Lab)
- Making sense of open data using IBM Bluemix - summer internship based on Javascript and Bluemix technologies (with requirements stage participation by Melbourne City Council CityLab) [Figure 6]
- Robotic 3D printing Prestudy using ABB robots (with Effusion)
- SmartSpace 3D - visualisation of Smart Grid data from SmartSpace research platform via Virtual Experience Portals [Figure 7] (ABB-sponsored, with AICAUSE co-supervisor)
- Augmented reality for manufacturing quality control using mobile web technologies (with AICAUSE co-supervisor)
- Using Kinect sensors for feedback in manufacturing quality control (with AICAUSE co-supervisor)

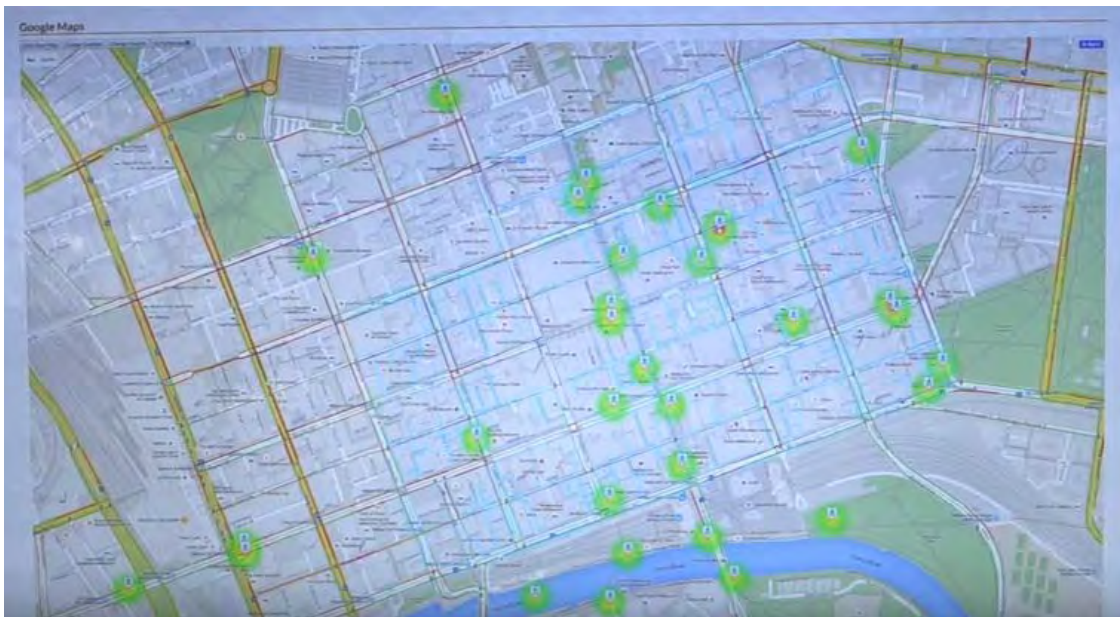


Figure 6: Open data mashup of pedestrian and parking data with IBM Bluemix

⁶ Many of these projects have been documented (e.g. via short video clips) at:
<https://plus.google.com/111014608163834449893/posts>



Figure 7: SmartSpace 3D (ABB-sponsored internship)

5. Conclusions

RMIT as a dual sector University strongly encourages Work Integrated Learning, i.e. Project Based Learning. In order to achieve that it has established strong links with industry and government institutions for many decades. Each engineering within the University nurture large variety of collaborative industrial project as presented here. Projects are always multidisciplinary since technology and engineering are becoming comprehensive and integrated. Very often those projects receive local community recognition, but they achieve international recognitions as well.

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