Collaborative Partnership for Development of Mechatronics Engineering Education of the Future

Abstract: A collaborative partnership between Royal Melbourne Institute of Technology (RMIT) University and industry partner SAGE Didactic has been developed. This partnership is born for the shared commitment to “Advancing the technical skills of today’s and tomorrow’s workforce”. This ambitious commitment engages with students in the early stages of high school with the view to exciting them about the critical role engineering trades, paraprofessional, professional and postgraduates contribute to society. To enable early student excitement to be qualified and nurtured, the collaborative partnership develops a full set of laboratory systems and support courseware that provides a robust educational experience to students, school teachers, trade and professional participants. The expected outcomes are an increased interest in the aforesaid study areas, a reduction in the drop out rate in the first and second years of higher education and progressively an expansion in the skills a graduate will present.

Introduction

RMIT University is one of the few Australia’s oldest and largest educational institutions (DEEWR 2007). RMIT began as the Working Men's College in La Trobe Street, Melbourne in 1887. The University has grown to become one of the largest in the country and has built a worldwide reputation for excellence in professional and vocational education and research. More than 60,000 students study at RMIT campuses in Melbourne and at 100 partner institutions throughout the world (e.g. Vietnam) in different modes of study such as online, correspondence (RMIT, 2008).

RMIT University has the mission to education students to be relevant to industry. The University works with partners in outcome-oriented Research and Development (R&D) that is client-collaborative and delivers leading-edge high quality results on time. RMIT University manages specific groups of academic disciplines through three colleges. The Science, Engineering and Technology (SET) College is the largest college in the University with 10 schools.

The School of Aerospace, Mechanical and Manufacturing Engineering (SAMME) is the largest School in the SET College and combines three engineering disciplines:

- Aerospace and Aviation Engineering
- Manufacturing and Materials Engineering
- Mechanical and Automotive Engineering.
Programs range from apprenticeship, undergraduate to postgraduate levels and are structured to meet industry requirements. Multiple entry and exit pathways allow students to continue their formal education by articulation with credit standing into higher-level programs or associated disciplines.

This paper describes the development of a collaborative partnership between RMIT University and SAGE Didactic, the educational arm of SAGE Group, for creating new courses and laboratory facilities in Mechatronic Engineering Education. Many schools in RMIT had in the past, and currently have, partnership agreements with industry partners, like ABB, Intel, CISCO, CRCs, most of which are primarily focussed on industry application research. This new collaborative partnership with SAGE Didactic extends to collaboration in creating an interactive learning environment for Mechatronic Engineering, which also has significant impact on tertiary education and research in advanced manufacturing and automation.

**Advanced Manufacturing and Mechatronic Engineering**

The application of information and communication technologies has changed the way manufacturing engineers tackle problems in industry and production environments. Mechatronic Engineering is an important part of these changes in enabling the manufacturing engineers to combine electronics technologies with traditional machines to achieve high efficiency in product design, automation, manufacturing processes, system control, logistics and other businesses.

RMIT has responded to these changes and introduced Mechatronic Engineering as a core stream in the manufacturing and mechanical engineering degrees. Over the last 15 years since the two engineering degrees were taught at Bundoora campus, a number of key laboratory facilities including programmable logic controllers, robots, instrumentation, flexible assembly equipment have been acquired and developed. However, the changes are considered too slow to cope with the increasing demand of teaching and practical requirements in this area. There is also additional expectation to expand this activity to work with local schools so as to attract more dedicated students to engineering. In the last couple of years, several school holiday programs were organised to promote mechatronics studies to high school students. There were overwhelming responses from students particularly in practical experience in laboratory based learning, which is a great experience and feedback. SAMME has conducted participation surveys after every holiday program delivery and positive responses were received. These positive responses, together with the Course Experience Survey (CES) feedback from our own degree program students, encourage us to continue with this type of activities and also implement more hands on content in the engineering education.

It is clear that as Mechatronic Engineering becomes more well-known among high school students and acceptable to school leavers as a potential career option. However, organic growth of the educational facilities is too slow to cater for the needs. One of RMIT’s key priorities is to “position RMIT as the first choice provider of work- and industry-relevant learning”. SAMME has recently invested over $100,000 into teaching and research resource based on National Instruments (NI) and FESTO platforms. It has also established special agreement with the world’s leading robotics and automation company, ABB. According to the agreement SAMME labs are equipped with the state-of-the-art robot cell programming and simulation software, RobotStudio. Subsequently, RMIT students are involved in the second National Robotics Innovation Competition for 2008, which was announced by the Society of Automotive Engineers (SAE-A) Australasia and ABB Australia.

To further address modern engineering education priority, a new collaborative partnership is created between RMIT and SAGE Didactic, the training arm of Australia’s leading privately owned integrator of Automation and Advanced Manufacturing Technologies, SAGE Automation. This partnership is born for the shared commitment to “advancing the technical skills of today’s and tomorrow’s workforce”. This collaboration relationship has a number of objectives including development of a joint RMIT-SAGE Mechatronic Engineering and automation training centre at RMIT Bundoora campus which will support a range of educational goals.

SAMME has a range of educational programs from undergraduate degrees to postgraduate master by coursework and doctoral research degrees. The wide variety of courses demands significant synchronisation and use of the teaching facilities at different times. The situation is made more
complicated by the fact that the School has operations on two campuses. The Bundoora campus is the main campus for senior undergraduate and research programs. The City campus is used for junior undergraduate and masters by coursework. For undergraduate programs, the teaching process has to be synchronised. It is necessary to establish laboratory facilities that can invoke further thinking and investigation capability suitable for degree level students’ learning. The undergraduate students will be professional engineers in the future. They require the ability to conceptualise engineering problems both at system level as well as component level. The system level capability enables them to develop solutions irrespective of scale. The component level enables them to attend to the details that will realise the implementation, i.e. to make it work. Development of the mechatronics laboratory is aimed for fulfilling the above educational goal.

Referring to the Bloom's Taxonomy (Bloom 1956) as a classification of the different objectives and skills in education we could state that the approach explained here is fulfilling the comprehensive list suggested in the taxonomy: Affective, Psychomotor and Cognitive. The special emphasis is on Cognitive as Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation, and also in any engineering education Psychomotor (Sampson 1972).

A reasonable level of investment has been made in the past to acquire electronic or Information Technology (IT) controlled equipment for use by our students (both undergraduates and postgraduates). Obviously any further expansion of the laboratory facilities must be integrated with existing equipment and lay the pathway for future development. While the existing equipment are useful to serve individual aspects of Mechatronic Engineering teaching, they are not sufficient to give the students an essential overview concept of how these components can be put together to form complex integrated products and manufacturing equipment. Many educational institutions take the view that acquiring a turnkey solution will provide the students with an overall view of a future manufacturing environment. However, experience shows that this type of turnkey solutions can only operate as an integrated set for a short period. When people become familiar with its operations and start to make changes, the system will never work as a complete set again. A lot of money will be wasted in trying to revert the system back to its original, thereby disabling the new additions, or leave it as disintegrated and the historical moment of a singing and dancing set will never return.

It is important to understand that the educational outcome is to teach undergraduate students to be thinkers and innovators. The laboratory facility should encourage new ideas to be explored by realising an illustrative set of the ideas, but not necessarily a complete working solution. To achieve this strategy, we need an emulated environment, one that is partially real to the extent that something uncontrollable may exist during experiment for the purpose of injecting innovation, plus partially virtual in the digital world which represents the known and controllable elements in the system. A flexible, industry based system that can be used to train industry professionals as well as paraprofessionals will be ideal for this purpose.

**The collaboration**

SAGE Didactic has its origins and core in industry through its relationship in SAGE Automation. As one of the Australia’s leading privately owned integrators of Automation and Advanced Manufacturing Technologies SAGE Automation has exposure to industrial needs and latest technologies being utilised and developed by industry. By incorporating education, innovation and leading-edge technology, SAGE Didactic is actively promoting “work-readiness” among students and creating lifelong learning opportunities through the utilization of TTIM™ (Targeted Technology Introduction Modules) in secondary schools and the operation of the state-of-the-art Didactic training facility located at Melrose Park.

SAGE Didactic initially developed the TTIM™ system to train internal SAGE Automation staff (graduates, technicians, trades and engineers) and other staff of SAGE Automation clients. These training programs give participants practical experience to accompany automation theory and the opportunity to experiment in a controlled environment without the risk of damaging client machinery or systems. The fast tracking of the skills development process allows participants to get out on site earlier and put their skills in practice, therefore not only relieving staffing pressures on the company but also improving the job satisfaction level of individual. Observations of career progress indicates a
reduction in the time it takes for a new Graduate engineer to become “work ready” from 24 months to 18 months. In collaboration with education and industry partners, this industry-relevant system has now been updated and adapted to reflect the specific needs of secondary schools, VET and university that want an enduring engagement with industry. The endorsement of Stage 1 & Stage 2 courses and assessment plans by Senior Secondary Assessment Board of South Australia (SSABSA) is a local example of the value outcomes that will be delivered by continued collaboration between SAGE and the secondary school sector. Department of Education, Employment and Workplace Relations (DEEWR) formally confirmed eligibility for funding of the TTIM™ system for the Trade Training Centre initiative in October 2008.

SAGE Didactic training platform, used in the schools and University, is shown in Figure 1.

![Figure 1: SAGE Didactic training platform](image)

Commencing 2009 intakes, formal statistical analysis will be undertaken on participant performance within the online formative quizzes imbedded in the TTIM™ e-learning resources. It is anticipated that this will confirm the current preliminary estimate that a third year apprentice will average 85-87%, a graduate engineer will average 87-88% and a year ten or eleven high school/college student will average low 90% using the same resources.

RMIT and SAGE Didactic have entered into a formal understanding to provide mutual benefits and progress our shared goal of “advancing the technical skills of today’s and tomorrow’s workforce”. Whilst the shared goal is the focus of the agreement, it is mutual respect and integrity that will ensure success. RMIT has already allocated a dedicated lab space at Bundoora campus for a SAGE Didactic Centre of Excellence, which will be established by the end of 2008. Centres at other locations will be developed in due course. The initial Centre of Excellence will house a Conveyor TTIM™ asset with provision to expand the number of assets to meet student demand. SAGE Didactic will maintain the assets at all levels including hardware, firmware, software, e-learning resources for the life of the agreement. The maintenance extends to technology upgrades to match industry needs and professional development for University staff.

RMIT can use these assets for students enrolled in undergraduate or postgraduate studies. SAGE Didactic will contract RMIT to part deliver Professional Development to High School and College teachers within the Centre of Excellence to support the TTIM™ in schools project. SAGE Didactic will undertake training for industrial clients including SAGE Automation within the centre. A small working team has been established to develop courseware that will part of the credits toward RMIT undergraduate and course work master awards. The first of these courses will be focussed on TTIM™ training with substantial development of control logic and process control capabilities.

**System support**

Taylor & Wright (2006) noted a weakening of commitment to Advanced Manufacturing Technology (AMT) but the significance of information infrastructure is critical to system success. Dawson (2007) studied the ongoing role of humans within the AMT environment and confirmed a different trend where the mean perception shows either increased or static commitment. This tendency encompasses
all key areas of the technologies utilised in the AMT environment. A weakening commitment would be expected to result in a softening of the perceived Importance & Priority of the skills associated with these technologies. This Study does not attempt to measure productivity associated with AMT. However, the clear intention of the stakeholders in continuing and growing the technologies and concepts supports the findings of Gupta & Kohli (2006). They summarised that AMT systems such as Enterprise Resource Planning (ERP) have been successful in improving internal operations and efficiencies. The modern business environment requires companies to internally monitor and to make rapid decisions in response to changes in the marketplace. This requires positioning themselves to quickly access both internal and external market information. Furthermore, the study confirms the continuing need for human interaction in tandem with technology, in the Advanced Manufacturing Technology environment, for the foreseeable future. Despite the impressive developments and technological advances in AMT, the worker remains the most versatile and flexible element in a manufacturing system and will remain so for the immediate future. There is overwhelming evidence to support Adler (1991) and Mital & Pennathur (2004) that the integration of humans into AMT systems is especially important to successful implementation and that AMT must extend to making the best use of people skills.

Like many system development, the collaborative facilities require significant system support to enable proper usage by staff and students. Fundamental to the provision of support is the implementation of computer networks and management (Mo & Chan, 1992). SAGE Didactic already has a large amount of web based training modules in use. Most of them are in the form of learning and presentation files, incorporating formative quizzes, interactive challenges and the requiem to develop and upload complex materials such as PLC programmes and system specification / portfolios for assessment.

The RMIT and SAGE collaboration not only covers the usual undergraduate learning environment, it also extends to the engagement with high schools at the pre-degree levels, and to the professional development of teachers. Resources for teaching and learning in a range of curriculum areas including mathematical applications; scientific studies; information technology; physics; business, enterprise and technology; industry and workplace practices; technology studies and engineering are already available. TTIM™ provides many educational outcomes both in logical and creative thinking but also in strengthening the students’ numeracy and information and communications technology (ICT) skills.

At the other side of the spectrum, the SAGE Centre of Excellence will be used for training professional staff including design and operations of automation systems. Training resources within RMIT (via the SAGE centre) will be extended. SAGE work ready programs will be strengthened by articulation into formal qualifications administered by RMIT. The collaborative environment facilitates the partners leveraging each other’s strength to expand the combined reach. This collaborative arrangement enables the partners to build a model that closely matches the Federal Governments agenda. SAGE works very closely with a small private Registered Training Organisations (RTO) so this consortia is the complete package engaging with mass students from about year 9/10 catering for all engineering careers from Trade through Para Professional, Professional and Post Graduate levels. This is in line with government guidelines and policies, especially having in mind interstate collaboration.

Surveys conducted at RMIT for each subject in every semester after the delivery show that students achieve best results in acquiring new knowledge and skills if they were given problem or project based tasks in a similar way as in a typical industrial workplace. This work integrated approach is applied across the range of subject and especially during the final years of study. The collaborative partnership agreement will enable University to offer all students experience with the latest technology.

**Future plan**

As part of the comprehensive plan of concentrating academic locations and focussing on future opportunities, RMIT has decided to redevelop the Bundoora campus with the development of a new laboratory building for the School. The development of the RMIT-SAGE Centre of Excellence
laboratory at the original campus will be a timely addition to the wider consideration of work integrated learning environment for this.

This collaborative arrangement allows SAGE Didactic to have a super-highway in which to deliver its practical knowledge about the integration and application of emerging technologies directly into the core of one of Australia’s prominent technical tertiary institutions. The rate of technical change and breadth of technologies is increasing at an extraordinary rate. Thus the knowledge super-highway option is essential for success. In exchange for making this knowledge and assistance in accessing and maintaining the necessary training platforms, we anticipate a rapid integration into the formal qualification of the skills we deem most important for the prevailing graduate to be work ready.

**Conclusion**

University and industry have to join forces in order to ensure quality education and research for the future. Education for engineering starts with the primary and high school education. Formally it finishes with Diploma, Degree, Masters or PhD qualifications, but in reality it is a continuous everlasting process. It is the only way to cope with technology changes, but the same technology is used as tool to enhance education. Active exchange of academic and industry staff ensures continual Professional Development and collaboration of course content. The SAGE industry and work ready training programs are able to be articulated into selected formal RMIT qualifications. In addition to that, through the process of credit transfer and recognition, skills and knowledge attained in the workplace, or simulated workplace, are recognised and valued in compatible subject areas.

**References**


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