Crafting a Postgraduate Degree for Industry and Government

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Abstract— This paper discusses experiences in crafting postgraduate degrees for industry and government in the USA and Australia. The paper discusses the needs, delivery formats and curricula, concluding with a summary of the lessons learned.

Keywords—Flexible delivery, distance delivery, competence, postgraduate degrees, industry, government

INTRODUCTION

We live in a time of change where the half life of knowledge in a particular area in information technology can be as short as two years. This has led to an emphasis on lifelong learning and an increase in the number of mature-age students enrolling in postgraduate education. Many of these mature-age students are employed full time and cannot take classes in the traditional undergraduate manner of full-time study, or regular attendance on campus in the face-to-face classroom. As a consequence, the requirements for the knowledge component (as opposed to the skills and attitudes) of postgraduate education are changing from generic qualifications to qualifications optimized for specific industries and government agencies. In addition, crafting these specific awards has to consider not only the content of the courses but also the delivery mechanism and the pedagogical approach.

This paper discusses the experience of crafting postgraduate awards for industry and government in the USA and Australia, and summarizes a set of lessons learned. The scope is limited to the identification of the need and the solution provided, skipping the details of the internal processes of arriving at the solution.

EXPERIENCES AT UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE

In 1999, the Graduate School of Management and Technology at University of Maryland University College (UMUC) was faced with the problem of cancelling or continuing a Master of Software Engineering (MSWE) degree when their sister institution decided that it no longer wanted to be part of the degree program. Analysis showed that the short term costs of cancelling the degree were the same as for continuing the degree since the courses still had to be staffed for the 200+ students in the program. However, the degree would only be viable if it could be offered through distance learning via the World Wide Web as well as on campus in the traditional classroom. At that time several courses were already online and the remainder scheduled for conversion. In conjunction with the University System of Maryland's Web Initiative in Teaching, the courses were converted to the distance learning online format and included audio lectures coupled with the PowerPoint slides.

The analysis performed to decide if the program would continue also benchmarked the proposed program with that of 19 similar offerings from other institutions around the world (15 in the USA, three in Australia, and one in the UK) with the following results:

- It was found that UMUC seemed to be the only institution offering a course on Software Maintenance.
- The status oft the course on software verification and validation was changed from being an elective in the joint program to that of a required course in the UMUC program.
- A new elective covering modelling and simulation was proposed as a future addition.

Once the new program was operational, pressure for customization surfaced. This pressure took three forms:

- Customized courses,
- Accreditation of company-organized courses in the postgraduate degree program, and
- Flexible delivery.

A. Customised courses

The MSWE degree was a coursework degree comprising 12 courses, each worth three credit hours. Students however wanted cedit for individual research which did not fit into the coursework format. This need was met by introducing a new elective:

• **MSWE 697 Independent Research (3 credits).** To take this course, a student has to submit a proposal to perform research in, or other study of, a systems and software engineering topic. The student would report the results of the effort in written and oral form. The research would be conducted under the guidance of an advisor. The course is in effect a one semester thesis.

B. Company-organised courses

A Division of Lockheed-Martin in suburban Maryland provided a number of in-house postgraduate subjects to its fast-track management trainees. Several universities in the Northeast of the USA accredited these subjects as elective courses in their individual postgraduate IT degree programs. Students enrolled in their university of choice and took the institutional subjects when appropriate. When they took a Lockheed-Martin subject, the in-house instructor provided each university with the grade information for their students. Lockheed-Martin wanted the same arrangement with UMUC. After some discussions, and examination of the curriculum materials, the courses were either approved in place of a current course or as new electives. Two electives were added to the program to meet this and similar future needs. The courses were:

- MSWE 698 Advanced Topics in Systems and Software Engineering (3 credits). This course, offered to cohort groups either on-line or on-site at corporate locations, covers topics in systems and software engineering selected by the university and the corporate sponsor.
- MSWE 699 Advanced Topics in Software Engineering (3 credits). This course covers advanced topics selected by the faculty from the literature of Software Engineering to suit the interest and background of students.

C. Flexible delivery

Students desired flexible delivery in the form of faceto-face classrooms at specific locations as well as online. The National Capital Area (NCA) is large enough to contain enough students for several simultaneous sections of many of the classes. Students in the I-270 Technology Corridor for example, wanted classes in their area, rather than having to drive to the main campus. Other students wanted classes available online via the World Wide Web for various reasons including:

- They were at a distance and couldn't take the faceto-face classes in the NCA.
- They were local, but didn't want to take the face-toface classes. Some of these were single parents, others simply didn't want to have to face the prospect of classroom study after a day at the office, or face the traffic.

Classes were scheduled to meet the students' need with one caveat. For a specific class to run, a minimum number of students were required. At the start of a number of semesters, shortly before the close of registrations, the Academic Advisors had to telephone students and notify them that classes they had registered for, were not running, and guide them into other classes. This needed careful attention to the degree programs the students were in (some were in the Master of Computer Systems Management degree which shared courses with the MSWE program), the remaining courses, they had to take, and the number of enrolments in the classes that were running. When it got to the point where a student needed a class that wasn't offered or running that semester, in order to graduate, and a substitute class could not be found, and the Academic Advisor was willing, the student took the class in an individual studies format, effectively as private tuition.

THE DEFENCE SCIENCE TECHNOLOGY ORGANISATION CONTINUING EDUCATION INITIATIVE

The mission of the Australian Defence Science Technology Organisation (DSTO) is "to give independent, expert, professional advice on the application of science and technology to the defence of Australia." In order to fulfil the mission statement in the current environment, Neil Bryans, the Director of the Information Sciences Laboratory, recognised that there was a need for a structured induction and development program particularly for staff without postgraduate qualifications that were in the earlier part of their career [1]. The stated drivers for such a scheme were given as:

- To increase the overall postgraduate education level of DSTO staff with the longer term aim to have the Masters degree as the base qualification level.
- To provide increased opportunity for talented staff to acquire a PhD. Access to the senior positions within DSTO requires demonstration of a significant record of research achievement. The research training acquired through completing a PhD and the subsequent exercise of research skills in conducting R&D programs was seen as the most assured way of gaining the research credentials necessary to progress to the higher career levels of the organization.
- To attract talented graduates who would see this program as a cost-effective way of gaining higher qualifications without suffering from the perceived high-income differential that exists between scholarship holders and graduates working in industry.
- Provide DSTO with a source of postgraduate qualified staff (particularly at PhD level) in areas directly relevant to DSTO's programs.

While PhDs by research only are the norm in Australia and the UK, this is by no means universal. In many countries with large postgraduate student populations, it is more customary to require candidates to undertake up to two years of advanced coursework as part of a PhD program prior to commencing the research element. Coursework is an efficient way to obtain specialist skills in areas where the fundamentals are well established. The principle disadvantage with postgraduate coursework is that minimum class sizes of around 20 are required to make them economically viable. It is not surprising then, that US-style PhD programs are not adopted in Australia given the low postgraduate student numbers and the fundamentally specialist nature of PhDs. It was also recognised that no single university could provide the breadth of postgraduate offerings needed by an organisation such as DSTO [2]. Consequently, DSTO required that their students would be able to register for a Master's degree at several universities in Australia, thus cutting down the number of students each individual university could expect to teach from the organisation.

The scheme became known as the DSTO Continuing Education Initiative (CEI). The curriculum also needed customising. DSTO decided that all students in the CEI program would take two core courses at the University of South Australia (UniSA) irrespective of which postgraduate degree the students were taking at any of the universities in the program. These subjects, crafted for the DSTO to provide a set of fundamental skills for the research activities at DSTO, were:

- Research Methods in a Multidisciplinary Environment;
- Systems Engineering for Complex Problem Solving. Delivery of the course content is in three different modes to suit DSTO and the students, namely:
- Classroom Block mode One week of synchronous face-to-face seminar-format lectures and tutorials followed by a 60 day period for the students to complete the assignments. Delivery is at a DSTO location.
- Classroom Semester mode The traditional synchronous classroom sessions meeting for two or three hours once a week over the course of a semester.
- Asynchronous Distance delivery Semester mode in which the subject takes a semester to be delivered but each classroom session lasts a week instead of the few hours of the synchronous face-to-face session.

In Semester 1 of 2004, Systems Engineering for Complex Problem Solving was taught in all three modes. The plan is to examine the quality of the student assignments to determine if there is a difference and publish the results in the future.

THE DEFENCE MATERIEL ORGANISATION MASTER OF PROJECT MANAGEMENT DEGREE

The Defence Materiel Organisation (DMO) is an important and vital organisation for Australia. The primary role under the new leadership of Chief Executive Officer, Dr Stephen Gumley, is to deliver projects and sustainment on time, on budget, and to the required quality, capability and safety.

The DMO is in the process of undergoing change and will continue to do so as it positions itself to become the prime professional project management and engineering services organisation in the country. The reforms DMO have made to date have delivered some positive and lasting advances in the way it acquires and sustains capability for the Australian Defence Forces.

Each year DMO spends about \$3 billion on new military assets and another \$3 billion sustaining and keeping in operational readiness, the approximately \$45 billion in military assets owned by Australians. If the DMO were a private firm it would be one of the largest on the Australian Stock Exchange.

A. The Project Managers Development Program (PMDP) Background

The Project Managers Development Program (PMDP) was implemented in 1999 as a key plank in the DMO People Strategic Plan. It was designed to address an identified need to develop specific programs to bridge vital project management skills gaps.

Over a period of 12 months, PMDP provides selected individuals seen to have potential for project management positions in the future, with an opportunity to enhance the skills, knowledge, and experience needed to further and/or redirect their careers within the project management area of DMO. Specifically it provides:

- A best practice framework for project management;
- A thorough appreciation of the components of effective project management and the integration of these in the DMO environment; and
- Practical skills and experience in project management that can be readily applied in the DMO environment.

B. PMDP Now and the Future

Project management is core to DMO business. By making this investment in project managers, Defence are investing in their future and turning the DMO into the prime professional project management organisation in Australia.

As graduates of this program, participants can contribute to this change process by applying what they have learnt during the program into delivering capability to the ADF on budget, to schedule and to the required quality.

The PMDP is a living example of a program that can and has professionalised the workforce. By participating in the program, participants take personal responsibility for their own career development to earn a masters degree in project management.

DMO is investing heavily in up-skilling its workforce in project management and associated disciplines. PMDP forms part of a technical, professional and management development continuum that together provides a framework to professionalise the workforce. Achieving a Master's level qualification will enable PMDP graduates to become certified under DMO's developing Program Managers Certification Framework.

C. The DMO Master of Project Management Degree

The DMO invited universities to propose a customised Master of Project Management degree, received nine tenders for the degree and selected UniSA as the preferred tender with which to negotiate and subsequently award the final contract. UniSA proposed to provide the DMO with a customized Master of Project Management degree program optimized for the engineering management of the acquisition of information technology and other Defence materiel while providing flexible delivery options meeting the needs of a geographically distributed workforce situated at over 54 locations. The framework for the Master of Project

Management degree was the recently released ISO/IEC systems engineering standard (ISO/IEC 15288:2002). The new degree was crafted by combining UniSA courses in project management, systems and software engineering and integrated logistics and takes the form of a USA-style Masters by Coursework with a major in project management and a minor in systems engineering. The UniSA approach, crafted to meet the needs of mature-age students employed in industry and government, offered the DMO maximum flexibility including:

- Providing for part-time as well as full-time students.
- Delivery to students anywhere in the world via UniSA's state-of-the-art, web-based delivery capability (UniSAnet).
- Options of a Masters by Coursework only, or by a mixture of courses and either a project or a minor thesis.
- Flexibility in the way the curriculum is customized to incorporate the standard DMO templates and other DMO products and processes.
- The capability to select up to two appropriate subjects from other institutions of tertiary education.

The degree offered comprised a full calendar year of coursework consisting of 12 courses as follows:

- Seven required core courses.
- Five elective courses to be chosen from a list as standard. However, in order to provide flexibility to DMO, the UniSA approach allowed students, having a need to study specific aspects of project management, engineering management, systems and software engineering, business, and/or test and evaluation, to enrol for other appropriate courses offered by UniSA, or up to two courses offered by another accredited institution of higher learning.

After completing the seven core courses, students would be able to choose from the following options to complete the degree:

- **Eight courses and a minor thesis** one additional core elective course and a minor thesis (18 units). This option is a traditional University route for completing the degree.
- Ten courses and a project one additional core elective course and two additional elective courses and a project (9 units). This was an option for students to synergize their work placement experience towards gaining a degree. The nature of the final report would be a paper suitable for submission for publication in a conference or learned journal.
- **Twelve courses** one additional core elective course and four additional elective courses. This option was for students who did not wish, or were unable, to undertake a project.

During the contract negotiations DMO indicated that they wished UniSA to use the following two courses and instructor which they already owned, Systems Engineering and Integrated Logistics Services. UniSA assessed the curriculum materials, against existing UniSA courses, and accepted the "government furnished materials" as equivalent to specific UniSA courses.

The DMO elected the 12-course option, and opted for the following courses:

- Project Management
- Systems Engineering
- Requirements Engineering
- Time, Cost, Quality & Management
- Project Law
- Human Resources and Communications
 Management
- Integrated Logistics Services
- Project Development
- Project Procurement
- Integration, Scope and Risk Management
- Test and Evaluation
- Software Engineering Project Management

LESSONS LEARNED FROM CRAFTING POSTGRADUATE DEGREES

The lessons learned from crafting postgraduate degrees for industry and government can be grouped into several areas as discussed below.

A. Bespoke courses have additional stakeholders

In all university degrees there is a tension between the desires of the students and the position of the university. In addition to this, programs designed and delivered for a particular client organisation involve additional stakeholders and this fact changes the educational environment. As a minimum, the human resources people from the employer are involved as are very often senior management. This means that the university needs to not only work to achieve good student satisfaction but it also has to satisfy other stakeholders in the client organisation. We have found that the key to satisfying both the students and the client organisation, while maintaining the university's expectations, is to adopt best practices in both university teaching and project management.

B. Curriculum objectives

Client organisations are invariably interested in their staff acquiring valuable skills that will translate into enhanced workplace performance in the short term. Biggs states that, traditionally, teaching for the professions has involved primarily declarative knowledge that deals with labelling, differentiating, elaborating and justifying with the professional procedural knowledge taught separately through experience in practice [3]. It is not surprising then, that postgraduate students and client organisations that are looking for professional knowledge that deals with executing, applying, and making priorities, find traditional university offerings inadequate. Biggs goes on to state that what is really needed is for educational programs to impart functional knowledge that involves declarative knowledge (the academic knowledge base) together with procedural knowledge (the skills) and conditional knowledge (knowing the circumstances for using them). Thus, curriculum and assessment design need to take this into account. An important point is that there is no tension whatsoever between good educational practice and the educational outcome desired by the students and the client organisation from which they come.

Biggs uses a four-level framework to categorise the level of understanding achieved of the subject matter:

- Unistructural: characterised by a knowledge of terminology and a focussing on one conceptual issue within a complex case; it is evidenced by the ability to recall facts and the ability to do simple procedures.
- **Mulitstructural:** characterised by the ability to enumerate, describe, combine, and do algorithms. Understanding at this level appears as a disorganised collection of items; the ability to show great detail but the concepts are used inappropriately.
- **Relational:** characterised by the ability to compare and contrast; explain causes; analyse; relate and apply. Understanding at this level is demonstrated by the correct use of concepts to integrate a collection of data and the ability to apply concepts to a familiar problem.
- Extended abstract: characterised by the ability to theorise, generalise, hypothesise and reflect. Understanding at this level is demonstrated by the ability to use principles to tackle unseen problems and through questioning and going beyond existing principles.

At the level of an advanced master's degree, the aim is to impart a deep level of understanding of the subject matter, the ability to apply it correctly in the appropriate context, and to draw new insights in the process. Thus the curriculum needs to be designed to achieve at least the relational level of understanding. It should be noted that undergraduate programs often fail to reach this level and all too often assess the ability of the student to regurgitate lecture notes and text books. Assessment design for the higher levels of understanding needs to look for evidence of the abilities listed and these are unlikely to be displayed in exams. Assessment is usually through substantial assignments that demonstrate deep understanding of the subject matter. It is not unusual for lecturers to comment on early drafts of these assignments to ensure that the work is appropriately focussed and the learning objectives are being demonstrated.

In order to ensure that the students understand the expectations of the program, and of each course within it, it is important to explain how the learning outcomes of an advanced masters degree, in particular one that is sponsored by their employer, are likely to differ from those of their undergraduate programs.

C. Student attitude

In many government departments and private firms it is customary to assist staff who wish to pursue part-time degrees. This support encourages the staff member to put in a solid effort but should the student fail to complete the program, the consequences are usually minor. In this environment students consider their studies to be something they are privileged to undertake and invariably display a very positive attitude to the programs and the student's focus is on achieving an enjoyable and valuable learning experience.

In contrast, when an organisation selects individuals to attend one of their sponsored programs, it places much greater pressure on the students to do well and there is a noticeable increase in concern from the students about the assessment and how best to achieve a high grade. In addition, in bespoke programs, there is a greater probability that at least a few individuals would prefer not to be involved. These factors contribute to a somewhat less positive attitude amongst the student cohorts in these programs.

It is also noticeable that student cohorts in bespoke programs are noticeably more discerning than public cohorts and expect very high-quality materials and good administrative service from the university. These issues once again reinforce the need to adhere to good educational and administrative practices. It has also been found helpful to invite senior management from the client organisation to address the students during the program to state the organisation's expectations of the students and to provide personal endorsement of the quality and relevance of the program to the organisation.

D. Delivery

The customers want flexible delivery which translates to delivery at their convenience rather than the traditional semester mode face-to-face classroom.

Students have mixed responses to asynchronous online distance delivery classes. However, it is the mode of the future and the educational experience has to be made effective. This requires a paradigm shift because the pedagogy is different and simply placing classroom materials online is not the ideal way to implement online delivery.

CONCLUSIONS

Crafting relevant postgraduate degrees for industry and government customers is not a simple task. The issues to be confronted cover non-traditional delivery modes, curriculum adjustment, and the need to ensure that the attitudes of the academics, the customers, and the students are aligned to ensure that genuine functional knowledge is imparted.

The addition of a corporate client also requires that sufficient resources are allocated to manage the corporate interface to the program.

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