FOSTERING PROFESSIONAL DEVELOPMENT THROUGH INTEGRATING WORK AND FORMAL LEARNING

David Radcliffe and Allison Brown

Abstract - The Undergraduate Site Learning Program (USLP) is an innovative work-based learning program that addresses the call to develop a broader set of attributes in engineering graduates. Unlike cooperative education programs, site learning can give students full academic credit for their placement without extending the duration of the degree through the use of an innovative learning alignment model. A central part of this program is a unique course entitled Professional Development in which students articulate and reflect upon the lessons they learn while on placement in industry. Students spend the bulk of a semester on-site in remote locations, which requires a flexible approach to course operation and fosters independent learning. Thus the USLP challenges both staff and students and produces outcomes that both the alumni and industry value.

Index Terms – Graduate outcomes, work-based learning, flexible learning, professional development.

INTRODUCTION

The idea of developing and assessing broader professional attributes in engineering graduates heavily informs the shape and operation of engineering programs in many countries. In 1995-96 a national Review of Engineering Education took place in Australia sponsored by the Institution of Engineers, Australia, the Academy of Technological Sciences and Engineering and the Australian Council of Engineering Deans. The critical part of the final report, Changing the Culture [1], was a recommendation to change the basis of accreditation of engineering programs in Australia to an outcomes basis focused on a list of desirable graduate attributes. Not surprisingly these attributes are very similar to the ABET Engineering Criteria 2000. The challenge for engineering schools was to devise innovative approaches to developing these attributes within an engineering program.

Even before the new accreditation rules [2] were developed, there was a requirement for the accreditation of engineering programs in Australia that all students to undertake 60 days of industrial experience as part of their program. While this does not count for credit, students cannot graduate until they have completed this period of experience in industry. However due to a number of trends in the industry over the past decade, finding suitable places has been increasingly difficult for students.

To meet the challenge of developing broader, not just technical, abilities of students and to satisfy the industrial placement requirement, a new type of placement program that combines formal learning for full credit and time in industry was developed. This Undergraduate Site Learning Program (USLP) has been operating successfully for 3 years and has won several awards.

This paper outlines the essential features of the USLP and critically examines the key ideas of alignment, flexibility and professional development that underpin it.

USLP OVERVIEW

Site learning aims to fully integrate a work placement into a period of study. The students on-site have a full study load with essentially the same syllabus as their peers on-campus, but they undertake a different set of learning activities.

The students spend between 10 and 12 weeks on-site, commencing prior to the scheduled start of semester. This is often preceded by a period of summer work with the company. Prior to going on the placement, the students are prepared for site via a three or five day induction program involving hands-on training in observation, communication, negotiation, time management, safety, library information skills and maintaining a professional log - all part of developing broader graduate attributes. They are also briefed on the courses they will be taking while participating in the USLP. Up to four weeks of the semester are spent back on campus.

This basic program is very flexible and has been tailored to meet the needs of particular engineering programs. Some students go to geographically remote sites and are off-campus for the entire 12 weeks, while others are based in closer to the university so they can attend classes up to one day per week. Placements have been geographically dispersed around Australia and three have been placed internationally, one each in the USA, France and China.

A typical study program for the semester on-site includes a thesis project, a capstone design course, and an integrative technical course plus a new course, specifically designed for the USLP called Professional Development. The specific site-learning program varies according to the particular engineering discipline as each discipline has a different set of courses and structure in the senior year. The specific program is also tailored to suit the needs of individual students. For each discipline there is a “preferred” program but individuals may have variants on...
this pattern. For instance a student may be enrolled in a dual degree and have an individual plan (irrespective of USLP) that does not follow the typical pattern for that discipline, or a student may have taken certain electives in an earlier year.

On-site students work individually and in teams on a variety of learning and work activities under an industry mentor. They do not attend lectures but are supported by a variety of means including paper-based and web-based learning resources. Students undertake reading and private study, prepare assignments and make progress reports to faculty. The program is coordinated through regular phone conferences (for remote students) or face-to-face meetings for those who visit the campus. Members of faculty visit the students on-site during the placement. Students receive a performance evaluation from their industry mentor upon completion and this is part of an on-site debrief involving site and university staff. In some instances, these debriefs are conducted via a videoconference.

The preparation, support and debrief phases form the framework for the professional development course. USLP students gain academic credit for analyzing and reflecting on the professional aspects of the work in which they engage. This subject uses an integrated suite of learning activities and assessment tasks that foster broader graduate attributes and reflexivity for lifelong learning. The students maintain a professional log with regular submissions back to the USLP team to enable their progress to be recorded and maintained. The students have a portfolio workshop after returning from site to consolidate the transferable ‘soft skills’ and professional attributes acquired in their placement.

The success of the program is measured anecdotally through feedback from placement companies but more critically through a number of awards from peers. In 2000, the USLP received a Highly Commended citation from the Australasian Association for Engineering Education - Motorola Award for Innovation in Engineering Education and in 2002 it was awarded an inaugural Enhancement of Students Learning Award from the University of Queensland.

ALIGNING WORK AND LEARNING

The major innovation in the USLP is the flexible alignment of work tasks and learning objectives. This alignment is based on a shift to a learner-centered paradigm and it is the most difficult challenge in implementing the site-learning concept successfully. This shift requires faculty to move from a largely information transmission style of teaching to one where the design of learning tasks and learning environments takes precedence. It also involves a perceived ‘loss of power’ for faculty, in its move from teacher directed learning to one where the design of learning tasks and learning environments takes precedence. Instead of focusing on inert/theoretical knowledge to practical applications in context.

This change shift requires faculty to provide a meaningful set of learning objectives and a corresponding set of assessment criteria and standards that are not tied to a single mode of learning, or to develop what Biggs [3] describes as ‘curriculum alignment’ through learning objectives, learning activities and assessment tasks. This change has been relatively easy for the University of Queensland adopted a policy and practice of criteria referenced assessment over 5 years ago. However the reality is that many faculty still have assessment practices that do not make explicit the meaningful learning objectives and corresponding assessment criteria and standards to decouple learning activities and assessment activities.

At its simplest, the workplace becomes the classroom and the work tasks are the learning tasks in USLP. Students substitute the set assessment with assignments that flow from the work they are undertaking on-site. Students negotiate the substitution of assessment with their course co-ordinators using learning proposals. Thereby, one piece of work can potentially provide two deliverables - one to the site and one to the university. This is illustrated in Figure 1.

This alignment is easily achieved in their thesis project if the topic of the project arises from the workplace. Further, the professional development course uses the experiences of the student in the workplace with such things as teamwork, negotiation, management, commercial issues, professional responsibility, balancing work and learning and technical issues outside the curriculum as the basis of the assignment work for assessment. These experiences are unique to the individual and the particular workplace but the course objectives are written independently of the specific experiences. This framed reflection on workplace experiences is a powerful way to develop a number of the graduate attributes which are not so amenable to classroom
activities. The thesis plus professional development account for 50 percent of the semester load for which there is clearly one-to-one alignment. In the case of mechanical engineers, their program is such that they can opt to undertake a larger thesis such that their whole semester load is achieved through thesis plus the professional development course.

For other USLP students, varying degrees of alignment can be achieved with the other 50% of their semester load, that is the other two courses. It is usually possible to get good alignment with at least one of the other two courses, usually the design project. Thus, a total of 75 per cent of the study program usually aligns well. Even if the other technical subject does not have a direct link to the placement site, by being in an engineering setting, the students can see the subject in context. Thus the USLP provides real learning contexts and authentic learning environments which encourage students to actively construct knowledge through problem solving and interaction with authentic tasks. This is in marked contrast to traditional teaching of professional skills where students passively receive transmitted decontextualised concepts with little opportunity to apply this knowledge in real situations.

The alignment model that underpins USLP accustoms students to the idea of work and learning being interwoven as a natural facet of continuing professional development and lifelong learning. It provides a transition from the world of formal learning and formal assessment they enter in grade school to the world of workplace competencies where progress is measured by what they can actually do. However undertaking this transition while the students are still operating in a formal educational structure challenges orthodoxy. The key characteristic required to meet these challenges is flexibility in many forms. Unfortunately we have encountered some resistance from faculty in the uptake of the program.

FLEXIBLE LEARNING

By its very nature, the USLP embodies learner-centred learning in ways that challenge academic staff. The students must balance the different rhythms and demands of the placement site and university subjects. For the learning alignment model to operate successfully, course coordinators must clearly articulate learning objectives and map these to assessment tasks and criteria in ways that are not enmeshed in set learning activities. This has not been the case in many engineering courses, where learning objectives are often expressed in teacher-centric terms or in such vague or global ways that provide very little guidance to students about what it is they should be able to do with their knowledge or how they will be able to gauge what exactly it is that they have come to know as a result of their course.

We also faced a fundamental problem with the different understandings that people had with terms such as flexible learning and flexible delivery. Often the two are used interchangeably and assumed to mean, or at least imply, the use of online (web-based) teaching. It is assumed flexibility necessarily implies larger costs and time. Thus the very mention of the word “flexible” in the context of USLP evoked a set of presumptions that immediately put a barrier between the proponents of USLP and other faculty. Critically this confusion over terms meant that it was difficult to realize the full potential of flexibility in its broadest sense. Figure 2 lists nine possible dimensions of flexibility and characterizes each in a spectrum from less to more flexible.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>from less flexible ➔ more flexible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>fixed time/place ➔ some choice ➔ many ways</td>
</tr>
<tr>
<td>Structure</td>
<td>fixed ➔ core+options ➔ alternative choices</td>
</tr>
<tr>
<td>Content</td>
<td>fixed ➔ negotiated ➔ learning contracts</td>
</tr>
<tr>
<td>Media</td>
<td>face-to-face ➔ online ➔ print</td>
</tr>
<tr>
<td>Mix</td>
<td>1 medium ➔ more than 1 ➔ resource based</td>
</tr>
<tr>
<td>Methods</td>
<td>lecture/lab ➔ PBL ➔ self-directed</td>
</tr>
<tr>
<td>Interaction</td>
<td>passive ➔ real tutorials ➔ high interaction</td>
</tr>
<tr>
<td>VWWW</td>
<td>content ➔ bulletin boards ➔ collaborative</td>
</tr>
<tr>
<td>Assessment</td>
<td>lecturer directed ➔ mix ➔ negotiated</td>
</tr>
</tbody>
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FIGURE 2
DIMENSIONS OF FLEXIBILITY

MacFarlane [4] argues that flexible learning promotes a shift from formal, whole-class didactic teaching towards individual or group management of learning through the provision, by the teacher, of structured resource materials, together with opportunities for the negotiation of tasks, self and peer-assessment, and collaborative group work, often on ‘real-life’ projects. This is a very different interpretation to the common one of flexible delivery which is mostly still a highly teacher centric approach with distance involved.

The way we teach and assess directly influences the way students learn. Didactic methods of education treat knowledge as a separate decontextualised substance, theoretically independent of the situations in which it is learned and used. Separating content (ie what is to be learned) from context (ie how it is to be learned and used) is ineffective inasmuch as it encourages surface approaches to learning and memorisation, without deep understanding or the ability to apply knowledge in new contexts. The flexible learning approach encouraged by the USLP acknowledges that learning is a process that takes place in a participation framework rather than just in an individual’s mind [5].

Over the three years that the USLP has been running, faculty have used many different strategies and a diverse combination of learning resources and technologies to support student learning on-site. There have been ‘high tech’ solutions and ‘low tech’ solutions – one size does not fit all and there is no single best approach.
Based on the cumulative lessons learned in individual courses and across the program, the staff in mining engineering decided to develop a more flexible approach to managing the curriculum content overall. They devised a year-long course worth the equivalent of one semester of credit that aggregates the syllabi from four traditional technical subjects. This enables the USLP student to choose when they do particular parts to match the type and timing of their placement.

For example, if a student is at an open cut coal mine, there will not be the opportunity to experience underground mining methods or mine ventilation. Accordingly, the student completes those parts of the syllabus relevant to open cut mining while on-site and completes the remainder in the next semester when they are back on campus. This enables students to better integrate their learning. It also leads to a more integrated development of knowledge as it is in practice, as compared to the traditional program and subject structure that compartmentalizes knowledge into disaggregated lumps.

**LEARNING NETWORK**

At a fundamental level, the USLP operates through many one-on-one “learning partnerships”. These individual partnerships may be explicit or tacit. They are based on shared objectives and resources, mutual dependence and obligations. For example, there are new dimensions and challenges in the student-faculty relationship as the students are asked to self-manage their learning; ideally the partnership becomes more reciprocal. Academic staff may have to confront cherished beliefs and practices as they work and learn with colleagues in preparing subjects for delivery to site and in running them. The program also brings about new networks and collaboration between individuals and units across the university that do not normally work together. There are often intense student-student partnerships as they work and learn together in the context and pressures of a real workplace. The academic staff and the industry staff are involved in learning partnerships at several levels: through the joint operation of the scheme and on a subject by subject level as they seek alignment between aspects of the course and how workplace activities might link to these. The students develop learning partnerships with their mentors on site and sometimes with other site staff with whom they work.

These individual learning partnerships evolve and change as they grow and mature and as external influences demand. They do not operate in isolation but rather they depend on a network of other learning partnerships and relations. These networks are distributed temporally and spatially and across levels in the two organizations. They are complex and require considerable effort and goodwill to manage. Some of the learning relationships are depicted in Figure 3.

Regular reviews, program evaluations and continuous improvement are hallmarks of the USLP. The program as a whole is a learning entity.

The bulk of the feedback from students has been acquired by informal means and this feedback has been largely formative in content. This reflects the developmental nature of the USLP and the relatively small numbers in the initial program. The primary mechanism for student assessment of the USLP has been through the reflexive exercises, the site debrief process and more recently the end of placement seminar. These clearly demonstrate the success of the program in developing broader graduate attributes.

Some examples include the following:

“Whilst on site I further developed many of my professional skills, such as leadership, negotiation, communication, time management and teamwork skills...The working environment provides many opportunities for students to extend themselves and become more efficient and self-confident.”

(USLP student, 2002)

“We believe the USLP offers a learning style unchallenged by any alternative, as graduates who partake in the program develop professional skills far in advance of their peers.”

(USLP students, 2000)

One of the paradoxes of the ULSP is that students really only appreciate the value after the event. Some students who are initially interested in the concept, fail to take up the option because of concern that their grades might suffer. In reality grades usually improve but more significantly it is there superior professional abilities that set the USLP alumni apart. At an on-site debrief in May, a recent graduate who had considered but then decided not to do USLP, freely admitted that with hindsight and observing the outcomes of a
The continuous improvement ethos of USLP and its responsiveness to industry (and student) feedback is evidenced in the letter from a hardened project manager, now an operations manager, who hosted students from 2000 to 2002.

"The ULSP commenced with a number of meetings to ensure all would benefit from this unique arrangement. With this new and innovative approach to learning there were some inadequacies in the initial phases, however a structured review process allowed these to be addressed. The changes effect saw students allowed the flexibility to align their UQ projects with tasks that they were allocated on site. These reviews continue to be conducted with management at each site and will underpin the ongoing effectiveness and sustainability of the program."

He went on to observe that the USLP is "... to be commended for developing a project that allows the involvement of industry in the education of prospective engineers and for their pro-activeness in modifying the process to meet the demands and needs of our ever-changing industry."

**DISCUSSION**

The development of this innovative approach has thrown up a number of issues that have had to be managed carefully. Some of these are a consequence of the expansion from a small pilot with relatively few parties involved to a scheme that encompasses most disciplines in the engineering school and organizations offering placements. Some of these issues arise as a consequence of different perceptions and personalities involved in the scheme ranging from the students, to the various personnel on site and the different faculty members involved.

There are a number of risk factors that must be understood and managed in a program such as this. These factors include the following:

- implicit and explicit perceptions and expectations
- guiding stories and work cultures
- academic license - autonomy and accountability
- balancing time-scales & temporal rhythms
- geography and location
- setting operational issues & priorities
- agreed measures of effectiveness.

With such a network of participants, there is a high probability that there will be different understandings develop about any manner of aspects of the operation of the USLP. The assumptions that might be fine in the university environment may not translate to the workplace. This can extend from how people dress, how they behave, how they accept responsibility through to overlooking the informal networks of support between student peers on campus in tackling assignments and generally dealing with things that are no longer there for students when they go to a remote site. We have found that both staff in industry and faculty in the university struggle with many of the concepts around independent learning that underpin USLP. Both groups have traditional set of assumptions about teaching and assessment and generally the way things work at university that make it difficult to grasp the USLP operation if these assumptions remain hidden or unchallenged.

For faculty concerned about the possible support or additional administrative load associated with having some students on site, it is recommended that they adopt flexible, student-centred teaching practices that work for both on-site and on-campus students, so learning resources can work equally well in either place. Faculty and the university must be prepared to continuously challenge teaching practices and the assumptions on which they are based.

The work environment, work culture (values, beliefs and behaviors) and priorities of the placement site and the university classroom are quite different. This must be acknowledged and taken actively into account in establishing the placement and in supporting the students on-site. The two environments have different time-scales and temporal rhythms, and this can lead to clashes in terms of getting certain work and assignments completed submissions to a fixed schedule. The placement is a more contingent environment that cannot be expected to be constrained by administratively convenient deadlines at the university. This can be a source of issues that the students need to balance carefully.

But on a positive note, the contingent nature of practice (the placement) offers unexpected but very rich learning opportunities that can benefit the student to develop desirable attributes, provided there is a sufficiently flexible vehicle for them to capture credit at the university. The Professional Development course was created specifically for USLP to capture such learning opportunities.

There has been considerable attention given to the transition from high school to university in engineering education conference and journals. However it can be argued that the transition to practice is an even more critical issue to be considered. In the Australian context, there has been a dramatic change in the organisaton of engineering in industry over the past decade. Until the early 1990s approximately 70% of professional engineers were employed in the public sector – this reflected the fact that all utilities were government entities and there was a relatively small manufacturing sector. Since that time many of these utilities have been corporatised and privatised, and for the remaining government utilities much of the work has been outsourced. Now something like 20% are employed in the public sector. These changes have resulted in the...
disappearance of many of the safe places where young engineers developed their professional skills.

Industry expects universities to produce engineers who are both streetwise but who also have a solid foundation so they are capable of adapting. On the other hand, universities say it is not their role to produce graduates attuned to the broader commercial imperatives. The USLP meets this stand-off head on and provides an opportunity for both parties to contribute to the development of engineers who are technically sound but also more aware of where their technical piece fits in industry, without the necessity of extending the duration of the degree program.

Generally, the world of engineering is responding to the challenges of “the profession formally known as engineering” articulated in the recent book by Rosalind Williams [6]. She highlights the desire of students to have qualifications in management, the broadening educational mission of engineering, and the trend towards more practiced-based labs and courses with an emphasis on design. The USLP meets many of these aspirations, but it can do much more.

The Undergraduate Site Learning Program is a concept as much as it is a specific program. Both the notions of learning that underpin it and the pragmatics of running such a program can inform a much bolder vision of a customized engineering program where students tailor their learning to suit their preferred futures, as depicted in Figure 4.

As a minimum this could see students selecting learning experiences from a variety of types including international study, learning in industry or learning in an intense research environment. While these are shown in Figure 4 as alternative pathways, it is possible to devise a program in which a student can undertake a combination of them. Thus the notion put forward by Williams [6] of engineers are constructing their own careers can begin at university.

CONCLUSIONS

The Undergraduate Site Learning Program has pioneered a new approach to meeting some of the systemic challenges facing the education of the profession in the future. It has successfully proved how industry and university can work together imaginatively in a way that provides a win-win-win, for students, for industry and for the university. It develops in graduates the ability to undertake the life-long learning necessary in times of rapidly changing knowledge and career patterns. It fosters a shift from teacher-centred to learning-centred pedagogy in engineering education. While it is contextual to the Australian higher education system, there is no fundamental reason why the concepts cannot be adopted and adapted in other educational traditions.

ACKNOWLEDGMENT

We acknowledge the many people who have made the USLP a success including the pioneering efforts of the staff in the School of Engineering, the efforts of the USLP coordinators who have made the roll out of the program possible, the unwavering efforts of the staff of the Catalyst Centre, the site staff who have hosted and mentored the students and the commitment of the companies to this new program and most importantly the sense of adventure shown by the students who have been co-pioneers in the development of the USLP.

REFERENCES