APPLICATIONS OF ONLINE PEDAGOGY TO A FIRST YEAR BLENDED LEARNING MODULE USING A VLE

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ABSTRACT

This paper explores some of the educational research literature available (such as the design framework of Oliver and Herrington[1]) to help answer the following questions: how does a lecturer decide on how much online content is required and what will be sufficient to achieve the intended learning outcomes? What online pedagogic principles can be applied to create a blended learning approach with minimum effort, in terms of time spent creating online content, but maximum success, in terms of facilitating so-called independent learning by the students? The intention is to identify a workable approach applicable to engineering teaching. In the paper, the approach adopted is applied retrospectively to a blended learning module and it is demonstrated how some of the evaluations results could have been anticipated. The paper closes with suggestions for how this approach, based on educational research, can be more effectively disseminated to the engineering academic community.

INTRODUCTION

The word pedagogy[1] is used a lot in generic educational research literature. In order for an engineering academic to access and apply some of the learning theory from the field of generic educational research this word and other terminology need to be understood and applied in a meaningful way to their own discipline. This generates an implicit requirement to engage actively in subject related pedagogical research to a far greater depth than the more typical practice of reflecting upon standard end-of-module questionnaires/ surveys. However, it is unrealistic to expect research practising subject-specific academics to acquire the necessary educational based research methodologies and skills required to go beyond this due to the time and effort involved (see MacDonald Ross[2] for more details).

During the last two years, the authors have sought to address the need for better pedagogical understanding by one of them actively re-training from being an engineering discipline-related researcher to acquiring the necessary educational research skills. These skills have helped the authors to carry out a detailed longitudinal evaluation study for a particular first year engineering module using educational research methods for quantitative and qualitative data analysis (see Rossiter and Rossiter[3], and Rossiter *et al*.[4]). However although this detailed study has highlighted the strengths and weaknesses in the teaching and given useful insight into the effectiveness of the teaching for students' learning, the approach is still naïve in that it doesn't make use of established educational learning theory to inform teaching practice. In essence the motivation was simply 'to explore' how web-based resources might improve student participation and learning. Hence, the authors felt that it would be useful to explore further into the generic educational research literature with the aims of determining:

(i) whether some of the emerging issues from the longitudinal study could have been predicted and hence, whether
(ii) a pedagogical approach that is better informed by educational research findings could be adopted.

The findings would thus guide the authors to a more efficient way of carrying out curriculum design for learning than currently adopted.

[1] Definition: Pedagogy is the principles and methods of instruction, In this case as applied to teaching in higher education http://www.thefreedictionary.com/pedagogy

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The paper is organised as follows: in section 2 a generic online pedagogic approach from the educational research literature is outlined; in section 3 some of the findings of the detailed longitudinal evaluation study for the first year engineering module are compared with the prescribed online pedagogic approach; and in section 4 the conclusions and suggestions for the engineering community are presented.

GENERIC ONLINE PEDAGOGICAL APPROACH FOR ENGINEERING TEACHING

Theories of learning – behaviourist/constructivist

Robyler and Edwards(5) state that, of the several theories of pedagogy, the predominant ones are *Behaviorist* (based on outwardly observable actions, data) and *Constructivist* (based on scaffolding of learning on a foundation of the learners prior knowledge). Applications associated with functions like teacher-led lectures and 'drill and practice' are associated with behaviourist, teacher-directed, activities. Activities like student-centred creation of projects to 'scaffold' student learning are referred to as constructivist, student-centred, activities.

Within Engineering programmes familiar to the authors, both types of pedagogy are routinely adopted without an awareness of these learning theory labels. The appropriateness of which one is adopted is usually determined by the lecturer/course leader. In the more recent years with the advent of new lecturers' programmes (such as Certificate for Learning and Teaching at the University of Sheffield[6]), the choice of pedagogy is often based on the module's specific intended learning outcomes (see Biggs[7]). Also, there is an attempt to align the intended learning outcomes with the type of assessment to be carried out i.e. the lecturer is using Biggs' so-called constructive alignment theory(7) for curriculum design.

In **table 1**, an attempt is made to relate some engineering learning activities to educational learning theories. For example in engineering group projects[2], often carried out in the final year of a particular degree programme, the students are expected to bring together the engineering theory and practice acquired over the whole programme and apply it to a particular design problem. This is an example of what the educationalists would call a *Constructivist approach to learning*(5) which has four key premises:

(a) knowledge depends on past constructions of an individuals' understandings of the world hence we transform and interpret new information through this framework;
(b) new understandings of the world come

[2] This is often a requirement of external accreditors (such as the Engineering Institutions) who require the students to demonstrate the application of the engineering theory within design project settings.

Learning Activity within Engineering programme	Learning Strategy	Proposed Educationalist Learning Model (for more details of individual models see (5))
Develop engineering mathematics skills	Drill and practice	Behaviorist – Directed Instruction Approach such as Skinner's Programmed Instruction model.
Final year engineering design projects	Group work including peer and tutor support	Combined Constructivist Model incorporating Dewey's cognitive science learning theory, Piaget's cognitive development stages, and Vygotsky's learning scaffolding and tool mediation ideas.
Engineering problem solving	Tutorials, one-to-one tutor support	Behaviorist – Directed Instruction Approach such as Bloom's Mastery Learning model.

Table 1: Proposed relationships between engineering learning activities and educational learning theory

Process	Decision making	Comments
Designing learning tasks	# Formulate the forms of intended learning outcomes (ILOs) being sought. # Consider the appropriate form of learning setting to achieve ILOs such as task-based learning, situated learning, problem-based learning, case studies. # The learning task needs to have some real world relevance (i.e. be authentic) and provide a context that reflects the way the knowledge could be used in real life. # The task needs an authentic assessment that is seamlessly integrated with the activity and allows for appropriate criteria for scoring varied products.	The learning tasks are characterised by learner engagement in cognitively complex tasks involving activities such as problem solving, critical thinking, collaboration and self-regulation. Hence, these go beyond the simple practice of skills.
Designing learning supports	# An essential support is an active and involved teacher, as defined by Laurillard (9), who facilitates and coaches providing a scaffold that can be reduced as the learners' knowledge is constructed and they move towards independence. # Provision of formative feedback mechanism. # Additional supports e.g. for situated learning designs – creating collaborative learning opportunities (9); providing opportunities for reflective learning; encouraging articulation and expression of understanding.	Learning supports are the strategies planned to enable learners to successfully implement and enjoy success in completing the learning tasks by guiding and providing feedback which is responsive and sensitive to individual learners' needs.
Selecting learning resources	# Creation of online content needs to be focussed on the needs of the learner to achieve the learning task rather than content for content's sake. The resources must be relevant and authentic and preferably provide access to expert demonstration. # To support knowledge construction, learners need to be exposed to a variety of resources and have choices in the resources they use and how they use them. Preferably from a variety of sources and perspectives. # Not all content needs to be online. The use of conventional material along with electronic sources can provide the diversity often required.	Resources need to be selected to enable the learners to achieve the ILOs.

Table 2: Sequential design of online learning settings to promote knowledge construction(1)

through further constructions via accommodation and assimilation into our existing mental framework;

(c) learning is an 'organic process of invention', not mechanical. (Knowledge is more than facts or information. Learners must be able to hypothesize, predict, manipulate and construct knowledge.); and

(d) meaningful learning occurs through reflection and scaffolding of new knowledge upon the existing framework of knowledge.

In the case of the engineering design project, an attempt is made to *make the learning meaningful* by simulating a real life situation for engineers in the workplace. The *students are expected to be active learners* in that they work as part of a group on the assigned tasks with minimum supervision. The students within the group are expected to learn collaboratively from the lecturer but also from each other. The lecturer 'nurtures' their learning by providing a 'scaffold of learning' to build on students' existing knowledge and experience. This scaffold (via learning tasks, supports and resources) needs to be such that the students are not left to do too much independently resulting in failure. Rather, *students are sufficiently supported to succeed in 'constructing' their own knowledge and being reflective to move them from their existing framework of knowledge to that required.* So-called *'authentic' assessments(5), such as project reports, reflective portfolios and presentations*, are seamlessly integrated with the activities. These provide proof of learning within the constructivist approach. Here, the emphasis is on the learning being viewed as the 'construction of meaning' by the learner rather than their memorisation of facts. This is referred to by Ramsden(8) as a deep approach to learning compared to a surface approach.

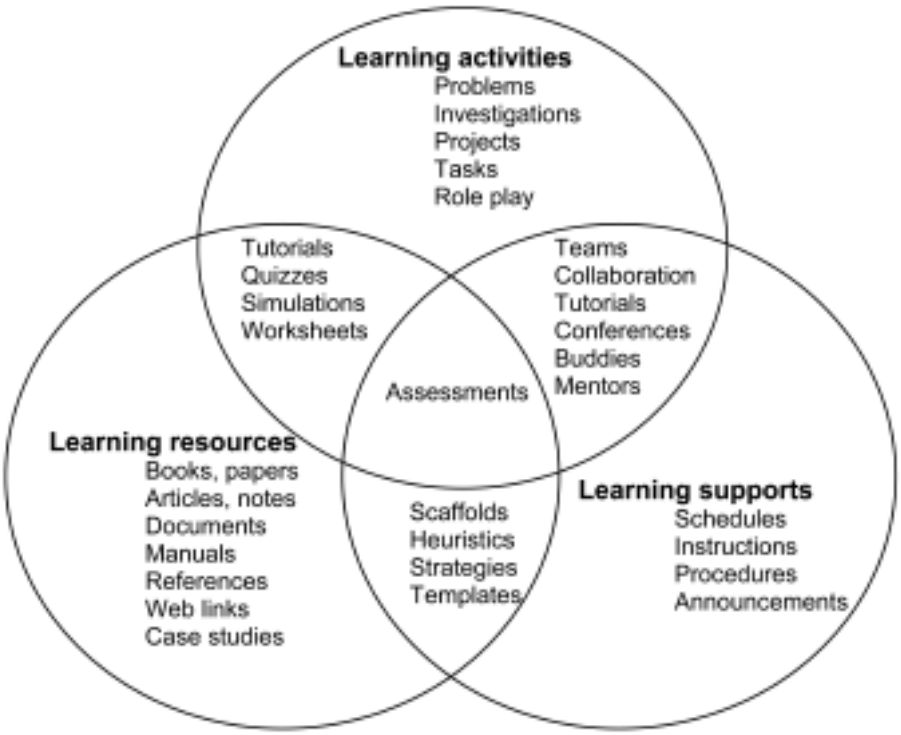

Figure 1: Constituent elements of online learning settings by Oliver and Herrington(1)

Online pedagogical approach

When exploring technology-mediated approaches to learning, Oliver and Herrington(1) postulate that the constructivist approach to understanding learning is useful and can provide guidance for the design of constructivist learning settings. In their paper(1), they describe a process, which they have used successfully, to guide the design of Web-based learning settings which promote knowledge construction. This is one of the key premises in constructivism learning theories as discussed in the previous section. They outline a three stage sequential design process(1) as an organising strategy involving the design and specification of:

Learning Tasks – to engage and direct the online learner in the process of knowledge acquisition and development of understanding.

Learning Supports - to scaffold the learning and provide meaningful forms of feedback for the online learner; and

Learning Resources - needed by the online learner to successfully complete the set tasks and to facilitate the scaffolding and guidance.

Table 2 summarises the decision making required at each of the design stages.

Often when creating online learning environments, the teacher spends 90% of their planning and development time creating online content for learning resources rather than focussing on ensuring there is a pedagogical need for this material(1). By adopting Oliver and Herrington's design process, a systematic framework and design strategy (1 – **figure 1**) is created where the overlap between the learning tasks, supports and resources is the authentic assessment. This helps avoid unnecessary and time consuming creation of superfluous online content. Instead, online content is created only where directly related to the assessment for the course.

COMPARISON WITH CASE STUDY

This section gives a brief overview of resources produced for a blended learning module for 1st year engineers in Systems and Control Engineering and its subsequent evaluation.

The module uses face-to-face content and a virtual learning environment (WebCT[10]) for

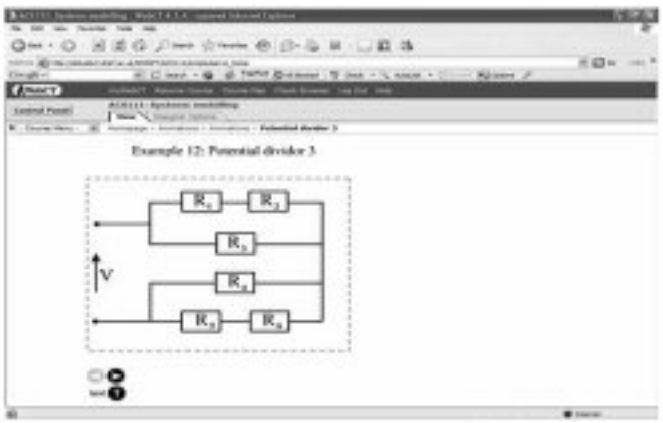

Figure 2a: Animation: Building mathematical model of electrical circuit – starting point

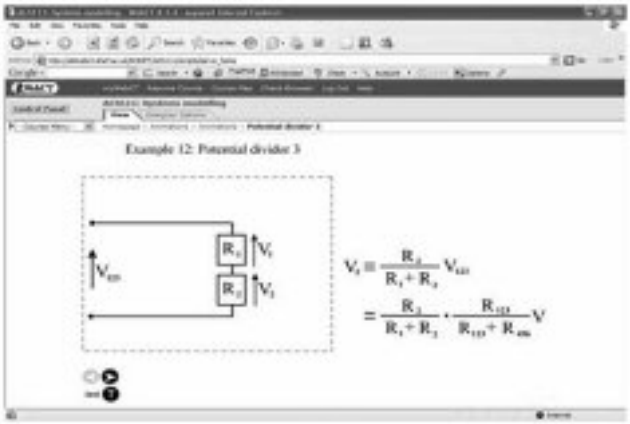

Figure 2b: Animation: Building mathematical model of electrical circuit – end point

delivering online content(3,4). A case study(11) consisting of detailed longitudinal evaluation data is available for the delivery of the module over a 3 year period. The module has been successful in improving the formative feedback to the students by using WebCT based self-assessment quizzes and improving overall assessment results. However, some online content (such as animations for building mathematical models of electrical circuits and the WebCT discussions board) have been under-utilised by the students.

Resources not used effectively

Thirteen electrical circuit animations were developed covering about 20% of the module syllabus and typical exam questions. The original idea was to have an equivalent lecture, available online, for students to use to enhance or revise their learning. The animations have an audio commentary explaining the stages in the circuit analysis from the start (e.g. **figure 2a**) to arrive at the final answer (e.g. **figure 2b**). (There is also an option to view the spoken text as well as hear the commentary.) However, although covering just a small part of the syllabus, the animations required about 3 weeks work by a professional Graphic Designer (the animations were made within the Macromedia authoring package Flash[12]). One reason they required so much work was due to the need for accurate mathematical notation in the animations; the symbols for the mathematics had to be created as individual graphics as there was no direct mathematics functionality within Flash.

Given the work involved, it was disappointing for the lecturer that these resources were under-utilised by most students. Although, they were appreciated by the few who did access them. However, it is our conjecture that a better awareness of the educational literature would have predicted this outcome and suggested that the funding would be better used creating some alternative resource. Specifically, by considering the design process outlined in the section 'Online pedagogical approach', the online animations (a potential *learning resource*) were not truly integrated into the module. There was no directly related *learning task*, which would be the first stage in the proposed design process. The students had no reason to visit the animations since they had had the content explained to them in a face-to-face lecture. Hence, the animations were a potential revision tool but not a primary learning resource for the module. Given the investment in time in creating them, they were an expensive revision tool.

The animations show the students how to build mathematical models of electrical circuits, which is a practical skill required by engineers. Thus, creating a so-called *authentic learning task* with real world relevance and context would be straightforward. So taking the proposed constructivist view and changing the role of the animations within the module learning setting would be feasible. For example, designing a directly-related *learning task* to be carried out by the students using the animations and remove the didactic lecture content relating to the material covered by the

animations. This would provide the students with the necessary motivation to use the *learning resource* and allow them to construct their own knowledge. Such an avenue is currently under consideration.

Resources used effectively

The website supporting this module also provided *learning supports* in the form of online self-assessment quizzes for the students to test their understanding and an online discussions board (see[11] for more on online collaborative learning). *Learning resources* such as paper-based lecture notes, past exam questions and tutorial questions were also provided. However, more importantly, the desired learning outcomes were closely matched to the online coursework assignments (*learning tasks*) with which the learning supports and resources were aligned. The results of the evaluation studies(3,4) showed the students made very effective use of these learning supports and resources to fulfil the assessment criteria.

The nature of the online coursework assignments (*learning tasks*) were such that the students were expected to adopt a 'drill and practice' learning strategy (see **table 1**) to develop their engineering mathematical modelling skills. That is, the students were expected to practice repeatedly the engineering calculations using the online self-assessment quizzes until they felt sufficiently competent prior to taking the online assessments at three points in the course. The self-assessment quizzes were used to provide instant formative feedback to the students during this process; thus replacing the tutor's role. Although this learning setting could be considered a behaviourist-type model for the students' learning, by using the online quizzes and tutorial material the students are taking control of their own acquisition of knowledge to achieve the learning tasks. Hence, it is proposed that the learning setting retrospectively satisfies the design strategy outlined in **table 2**.

CONCLUSIONS/SUGGESTIONS

This paper has used a case study to highlight a very important issue, that is, how do research active lecturing staff ensure that time put into producing teaching resources is used effectively. Unsurprisingly, one conclusion is that a proper awareness and understanding of the educational research literature is the key. However, this is unrealistic given the pressures on staff brought about by the RAE (Research Assessment Exercise) and the need, particularly within the Engineering discipline, to bring in high value research grants to underpin University finances.

In this case study, the authors got around the impasse by one of them retraining. Hence at the time of this study, they were not a member of academic staff but rather a member of teaching support staff (with consequent pay cut). Our belief is that a change of culture in some Universities away from too much focus on the RAE in recruitment is essential so that departments can employ some dedicated teaching staff with a specific remit and interest in understanding and transferring best research-informed teaching practise into their departments. This would help departments identify and produce the most effective teaching strategies and resources for student learning.

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EXPLOITATION OF THE WEB IN A QUEST TO RETHINK E-LEARNING METHODOLOGIES

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ABSTRACT

Future (and present) engineers need to be great communicators, complex problem solvers, interdisciplinary team members, system thinkers, and mindful of the socio-technical world in which they live and work. E-learning is a reality for many engineering educators and 'shovelware' will rarely deliver these graduate attributes!

The technology is only as good as the methodologies that it supports. While e-learning has had its fair share of criticism over the last few years, there are a number of approaches emerging that seek to exploit the advantages of the online learning medium. This paper does not seek to definitively address a formal research question but rather act as a catalyst for discussion and exploration. This paper introduces a range of e-learning activities that are designed specifically to encourage deep learning and take advantage of the educational potential of the World Wide Web.

Case studies highlighting the potential (and constraints) of using methodologies such as the Insight Reflector, WebQuest, Hotlist, Knowledge Hunt, and other e-learning activities are shared. Concepts discussed that are critical to the success of e-learning design include authenticity, learner scaffolding, usability and trust in the facilitator.

INTRODUCTION

Almost a decade ago Lenzner and Johnson(1) hailed the rise of 'cyber-universities', declaring:

'Thirty years from now the big university campuses will be relics. Universities won't survive. It's as large a change as when we first got the printed book.'

While cooler heads such as Baer(2) expressed that they were not so sure that the 'revolution' would be that revolutionary! Indeed now ten years into the Lenzer and Johnson(1) timeframe, and as the academics 'living the revolution', we concur more with Baer's(2) perspective in that we are witnessing and contributing to the development of web-based instruction which is more an evolution than a revolution. As Baer(2) has previously highlighted:

'Learning from the Internet will complement rather than supplant on-campus traditional higher education. Peter Drucker notwithstanding, one should not expect residential colleges and universities to disappear within a generation . . . Rather than today's dichotomy between 'traditional' and 'non-traditional' students, more students will earn their degrees by taking a mix of on-campus and Internet-based off-campus modules.'

The use of the worldwide web to facilitate learning for asynchronous modes of teaching has enormous potential of which some has been recognised and achieved. However a credible pedagogical or andragogical framework – depending upon your audience – needs to be adopted so as to ensure that the development and conduction of the course in an online environment is not emphasising the technology over the learning experience nor the learner. Thus both human factors and technological aspects need to be explored and addressed(3). Thus the 'shovelware' approach (noted more for the quantity apparent rather than for its quality or usefulness) needs to be continually challenged.

MODELS OF ON-LINE DELIVERY

Authors such as Roberts *et al*(4) and Marshall(5) outline four models of on-line delivery described as being the naïve model, the standard model, the evolutionary model, and the radical model. All models rely, to a varying degree, on the use

of printed material, in addition to any online features provided. The printed material is dispatched to the student prior to commencement of the academic term of study.

The Naïve Model

While this model has its critics (including us) this is arguably the most widely adopted model for non-computing courses. It may be characterised as making available the actual lecture notes, that would be used in the face-to-face lecture presentations and transforming them, with minimal alteration, into a web-based format. In doing so, no extra online features or capabilities would be made available; no opportunities for interaction or feedback. The method involves a rather unimaginative use of materials which have been specifically designed for a different educational dynamic and medium. Why is it so widely used? Its use is dictated by the economics of time savings: inherent in materials dual purpose (online, face-to-face), staff on-task time for generating and updating the materials to be used for a dual purpose (online, face-to-face), promotes less student-lecturer communication, money (inexpensive to implement – savings inherent in materials dual purpose (online, face-to-face) and; resources (minimum hardware and software, minimum number of staff).

There is a significant lack of opportunity for staff and student alike to participate, in any valuable learning experience that provides the chance for upskilling in order to operate successfully within an electronic medium. Although the minimal skills developed are transferable, once mastered, any other course offered in this manner will be identical. In terms of efficiency, the reasoning is that the student quickly masters the technology and has more time to master the subject matter. Likewise the lecturer quickly masters the technology and has more time to prepare the course's subject matter.

The Standard Model

The standard model seeks to successfully employ the features inherent in the system to provide a valuable and varied learning experience. Consequently there is greater opportunity for student-staff and student-student interactions and communication. There is a greater degree of maintenance of the system because of the expanded use of the features and the need to: monitor the interactions (student-student, student-lecturer using the electronic mailing list and/or newsgroup); respond regularly (sometimes to anonymous feedback student-lecturer; positive and negative); receive information (student 'postings' using the electronic mailing list and/or newsgroup); and provide information ('post' materials within the system; lecture slides and upload updates, access to other information sources).

Such a dynamic model enables more credible learning and teaching to occur. All actions are in the public domain and so are open and transparent. Lecturers may feel vulnerable owing to the ability of students to initiate anonymous feedback however protocols are in place and inappropriate behaviours would not be tolerated. Where negative feedback is valid it is an opportunity for lecturers to engage in reflective practice. Shortened turnaround times to student queries, concerns and the feedback on assessment items are possible owing to the facility for multiple communication traffic and also there is the facility to communicate the response to the whole group simultaneously. The model also provides the avenue for more imaginative teaching approaches through the ability to conduct virtual group work and to initiate discussion and debate about topics and issues as they arise in the wider world and may relate to the subject matter being offered. Deviations may occur from the schedule and scope of the materials set for the course. However with greater flexibility costs increase for: time (staff spend great deals of time uploading or checking currency of information posted, interactions need to be monitored, staff perform a more service orientated role – thus need to devote more time to meeting students needs and expectations); money (increase in expenses to staff monitoring and action roles); resources (student's expec-tations increase so staff busy with ensuring quality assurance issues with regards to information provided); study materials (paper-based materials, online materials); range of learning experiences (student-lecturer, student-student, virtual student groups); assessment items (submission and return by snail mail).

The Evolutionary Model

The standard model forms the basis of the evolutionary model. Additional features provide

students with alternatives to use and which better suit their learning style. Again there are considerations for planning and implementation: time (staff spend great deal of time uploading or checking currency of information posted, interactions need to be monitored, staff perform a more service orientated role – thus need to devote more time to meeting students needs and expectations); money (increase in expenses to staff monitoring and action roles); resources (student's expectations increase so staff busy with ensuring quality assurance issues with regards to information provided, online-based archive made available); study materials (CDROM, paper-based materials, online materials, pre-recorded audio – loaded onto CDROM and online – animations); range of learning experiences (student-lecturer, student-student, virtual student groups, negotiated 'live' lectures); and assessment items (items are varied electronic submission, record keeping and return).

Roberts *et al*(4) explains that the opportunity exists for 'live' lectures. These are conducted by negotiation between lecturers and students and only for extended discussion of a nominated topic. If decision is nothing to be discussed then no 'live' lecture that week. Archiving of materials also occurs and the previous year's materials can be used for discussion. Multiple forms of the same materials may seem redundant but as indicated previous in terms of equity can solve many problems. The CDROM version of materials means that students spend less time online (Roberts *et al*[4]).

The Radical Model

Whereas the other models are based on a conventional 'face-to-face' model adaptation in this case there are no lecturers. Instead student-lecturer discourses is minimised and the emphasis is for students to be independent learners and to operate autonomously. The manner in which students are to conduct their learning is in a team approach. This cooperatice learning model is similar in intent and process as Project Based Learning (PBL) except it is in an electronic medium. Assessment items are more open-ended and diverse. Typically this model may unpack as: time (staff spend minimum time interacting with students, students need to prepare presentation and use recommended text); money (decrease in expenses to staff monitoring and action roles); resources (student's compulsory use of centralised mailing list for communication, extensive use of the world wide web); study materials(online materials selected by student; textbook); range of learning experiences (student-lecturer, student-student, virtual student groups, use of the world wide web to seek information – develop ability to search, critique and analyse information – online presentations conducted by students); and assessment items (only assessment is that they are assessed on their own group presentations but it is a compulsory element of the course for them to also make critique peers presentations and they are assessed on the critique they conduct).

OPPORTUNITIES TO RETHINK E-LEARNING

In our experience many educators continue with the naïve model because they simply don't know how to take the next step toward developing richer learning environments.

We have such a short time to deliver on the many outcomes required for modern engineering practice. One identified need is the knowledge of people as an essential element of a system, that is, ergonomics (Toft,[6]). In response to the expressed need by educators that they required assistance to integrate these concepts into their curriculum – the Creating designs 'fit' for people: Learning Resource Centre was created (Toft and Howard,[7]) at http://peopledesign.cqu.edu.au/ (the following examples are taken from that site). The development of the site seemed a daunting task but soon became much more manageable by rethinking elearning. The following are some of the wonderful learning activity formats we discovered on our journey. March(8) provided the template for the activity formats that will see here and made the job much easier. You will notice that the 'content' is very similar but the method of learning and outcomes vary considerably.

Insight Reflector

A higher-level cognitive skill valued by many curricula and standards is reflective thinking

and writing. In brief, this is the kind of creative mental pondering that reveals a mind at work. It's the open processing of an intriguing stimuli through a person's experience, ideas, and emotions. It brings all aspects of the person's nature to the task of making sense of the stimuli. While a highly valued skill, it's also a very difficult thing to teach. The wealth of the Web can assist us here. The first aspect of reflective writing is an opening occasion, something that sparks an emotion or starts the mental gears to turn. With its abundance of special interests and overt agendas, the Web affords more chances for reflection than are usually found in a classroom. Teachers gather a page or pages from the Web that they feel will perturb learners in such a way as to create a positive dissonance, then prompt students to look at the topic in different ways, to mull things over, to chew their cog(itations).

Example: *Reflecting on the human dimensions of socio-technical systems*

This insight reflector was designed to help students reflect on people in socio-technical systems using 'engineering in society' concepts. (http://web-and-flow.com/members/ytoft/topic1/reflector.htm)

WebQuest

Basically, a WebQuest is an inquiry activity that presents student groups with a challenging task, provides access to an abundance of usually online resources and scaffolds the learning process to prompt higher order thinking. The products of WebQuests are usually then put out to the world for some real feedback.

Logistically, all students begin by learning some common background knowledge, then divide into groups. In the groups each student, or pair of students, have a particular role, task, or perspective to master. They effectively become experts on one aspect of a topic. When the roles come together, students must synthesize their learning by completing a summarizing act such as e-mailing government officials, industry champions or presenting their interpretation to real world experts on the topic.

Example: '*Disaster by Design' WebQuest*

The Quest (ion) is – What are the key ergonomics concepts that engineers should know to prevent 'disasters by design'? The task is to develop 'the seven golden rules for engineers to prevent disasters by design'. (http://www.kn.sbc.com/wired/fil/pages/webhumanceto.html

Hotlist

When you create a Topic Hotlist, your learners will be spared hours of fruitless searching. What they will have is analogous to when your diligent librarian gathers key works from the stacks on a topic your classes are studying and rolls them into your room for students to explore. The resources are likely to differ in quality, currency, and quirkiness, but the learning strategy is similar: give the students a breadth of materials on the topic they are studying. What's missing is the exact learning you'd like the students to achieve. Those tasks and instructions are probably on the handout they're working on, not the Webpage they're using to gain insights, experiences, and information. This is why a Topic Hotlist is an easy strategy to employ; you simply add the Web resources to an activity or unit you already have prepared.

Example: *Hotlisting Ergonomics: Keys to successful design*

Students are directed to explore the topic, their interests, and important questions that they might want to know answers to about ergonomics. (http://web-and-flow.com/members/ytoft/topic3/hotlist.htm)

Knowledge Hunt

When it's time to develop some solid knowledge on a subject, teachers and students can create Knowledge Hunts. The basic strategy here is to find Web pages that hold information (text, graphic, sound, video, etc.) that you feel is essential to understanding the given topic. You gather 10 – 15 links (and remember, these are the exact pages you want the students to go to for information, not the top page of a huge Web site). After you've gathered these links, you pose one key question for each Web site you've linked to.

A Knowledge Hunt can go far beyond finding

Advantages	Disadvantages
• Authentic learning, 'real world' • Fun for students & facilitators • Wide range of resources • Development of graduate attributes • Presents in consistent way - usability, learner scaffolding • Learner centred pedagogy • Development time upfront with less effort required during the term • Gives back to the professional community	• It takes time to find the right links • Links need maintaining • Need for students to develop trust in you the 'facilitator' to take them into a new learning paradigm • End user considerations - WWW availability, speed, computer literacy • Some students are initially reluctant collaborators • Doesn't self mark!

Table 1: Advantages and disadvantages of employing alternate elearning methodologies

unrelated nuggets of knowledge. By choosing questions that define the scope or parameters of the topic, when the students discover the answers they are tapping into a deeper vein of thought, one that now stakes out the dimensions or schema of the domain being studied. Finally, by including a culminating "Big Question," students can synthesize what they have learned and shape it into a broader understanding of the big picture.

Example: *Hunting for ways to reduce design-induced end user error*

This Knowledge Hunt helps students learn about reducing design-induced end user error. The goal is to get students to acquire defined knowledge about ergonomic design principles. The hunt takes them back to basic theory and application of cognitive ergonomics. The hunt aligns with an included study guide for the educators. (http://web-and-flow.com/members/ytoft/folder4/hunt.htm)

In our experience the following factors should be taken into account (**table 1**) when consideration is given to employing such methodologies.

CONCLUSION

The greatest impediment to people employing these types of methodologies can be the limits of their own imagination, knowledge of what is available and their level of understanding about how powerful each model can be in relation to learning outcomes. Another significant impediment is the daunting task of rethinking how you will teach online. There are many wonderful websites and software tools available on the web and it is now very easy to make the transition. We challenge you to try!

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POST-GRADUATE FORENSIC ENGINEERING AT THE OU

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Keywords: forensic, product, failure

ABSTRACT

We have prepared a new course in forensic engineering in our post-graduate programme. It introduces the subject of failure analysis in its widest sense, so includes product failure, accident investigation, and patent examination. With biannual presentation, it attracts about 80 students per year, and has a high retention record as well as excellent exam results. Most of our students have applied knowledge from the course in their jobs, with savings to their employers. However, the subject is poorly published with very few journals, and although metal failures are described in standard texts, there is much less available on non-metal product failures.

INTRODUCTION

We developed the course in Forensic Engineering as a direct result of forming an IGDS (Integrated Graduate development Scheme) with London Metropolitan University in the late 1990's, to address the needs of polymer technologists working in industry. Access to specialist polymer full-time courses has diminished over the past decade, so distance learning courses have a national role to play. The first course to be developed was a remake of a polymer engineering course(1), entitled Design and Manufacture with Polymers. It formed the core of a syllabus of other distance learning courses and practical short residential courses at London Met. Students can pick a selection to build up credits to qualify for an MSc or MEng, using separate routes for each institution. One of the options is Forensic Engineering, a 30 point course developed from scratch by a team assembled from the two universities(2).

Course Profile: The subject is of recent origin, although failure analysis is well-known in metallurgy, chemical engineering and so on. There is much published material but it is widely scattered, and text books are few and far between. Writing de novo, we produced 4 blocks of text with associated videos:

1. Introduction and failure of polymer products
2. Forensic Metallurgy
3. Natural and man-made disasters, and
4. Intellectual Property

Blocks 1 and 2: The first half of the course covers traditional failure analysis, including the major analytical methods available, such as optical and electron microscopy (ESEM), FTIR and DSC, crack detection (X-ray, powder exposure). However, the major emphasis is on training the student eye to examine scenes of accidents, making accurate records and collecting fresh evidence before forming theories as to the causes or sequence of events. A basic knowledge of maths, chemistry and engineering is assumed, although we provide extra support for design concepts such as stress concentration. The course guide provides students with a clear idea of pre-requisites.

Case studies taken from our own files of investigations include:

1. fuel line failures
2. ladder accidents
3. flooding from plumbing failures
4. automotive accidents
5. container breaks
6. storage tank leaks

All of the cases involve use of analytical methods taught in the course. A driver was seriously injured when her car skidded on diesel fuel in the road. The police traced the diesel to a garage recovery vehicle by following the trail in the road (**figure 1**). A nylon connector in the return pipe to the engine had split, and the Forensic Science

Figure 1: Garage recovery vehicle from which diesel leak occurred

Figure 2: Pipe fracture (upper arrow) from which fuel leaked

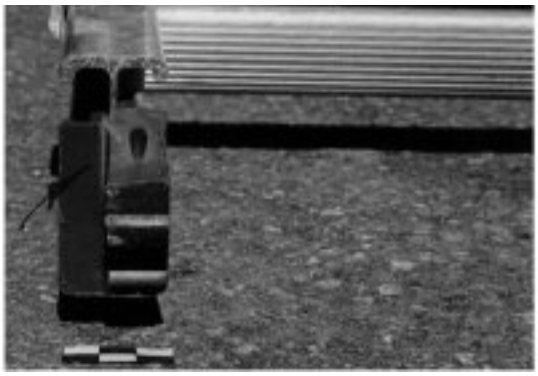

Figure 3: Broken plastic ladder tip

Service attributed the damage to vandalism. However, the part was buried too deep within the engine compartment for access, and our investigation revealed a quite different explanation. Microscopy showed the radial split to be a brittle fracture showing striations characteristic of intermittent growth (**figure 2**). EDX analysis also showed the presence of trace amounts of sulphur at the origin. It was concluded that a small leak of sulphuric acid from the battery immediately above probably started a stress corrosion crack (SCC), which then grew at each start-up of the engine. The number of striations suggested that the vehicle had been leaking slowly for about a week, then grew catastrophically just before the accident. The garage vehicle driver should have spotted the leak before the accident, and prevented it. The injured car driver received substantial compensation(3).

Figure 4: Accident traces of tips 'walking down wall'

Figure 5: Failed tank after accident

Ladder accidents are a common cause of death and serious injury, and an injured user claimed that a plastic tip on his ladder had broken and so caused the fall (**figure 3**). Examination of the wall where the ladder slipped showed a trail from the tips down to a wooden lintel (**figure 4**). The lintel had been damaged, and it was possible that far from causing the accident, the tip had been broken at the lintel and occurred after the initial slip. A series of reconstructions showed that the ladder had been leant at a much lower angle than the recommended 75 degrees, so increasing the possibility of slippage when the user was busy at the top. The compensation claim was therefore abandoned(4).

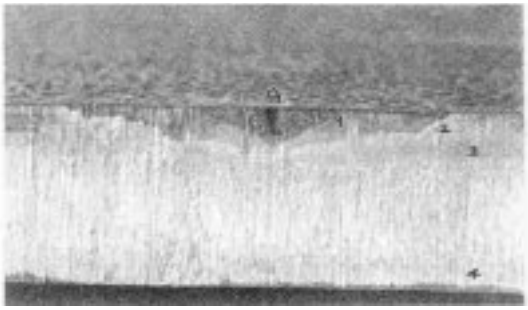

Figure 6: Fracture surface of weld seam

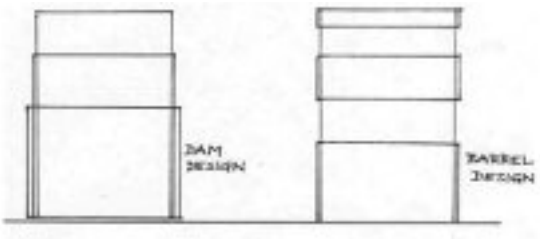

Figure 7: Faulty design of tank at right

Figure 8: Ruins of Tay bridge with Dundee behind

Failures of storage tanks are not uncommon, but their effects can be catastrophic, because failure of the wall usually occurs when the tank is full and the hoop stress in the lower part of the wall at its greatest. A 30 tonne polypropylene tank had just been filled with 40% caustic soda solution when a thermally welded seam in the side wall suddenly split, and a stream of fluid jetted into the factory over the bund wall, and causing extensive damage (**figure 5**). The critical crack showed four hesitation lines (**figure 6**), and had been filled just four times since installation. The crack had started in the middle of the centre of the wall, where only a single panel was present. A small

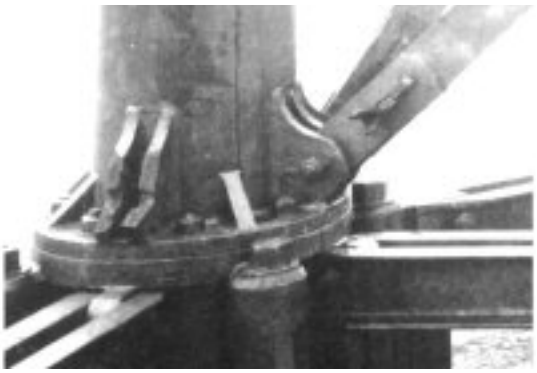

Figure 9: Broken cast iron lug at left

pinhole was present at the crack origin, suggesting that the design of the tank was faulty(5). Comparison of the design with that recommended by the relevant standard showed that the wall thickness should have increased steadily down from the top so as to resist the internal hydrostatic pressure (**figure 7**). The tank should have been built like a dam rather than a barrel(6).

Block 3: The next block examines natural and man-made disasters. The Tay Bridge disaster of 1879 occurred as a train was crossing the 2 mile long bridge built by Thomas Bouch. The half mile long high girder section was completely destroyed, and over 75 people died. We present the witness evidence from the subsequent Court of Inquiry together with blow-ups of the photographs taken about a week after the catastrophe (**figure 8**). The evidence fully supports the conclusions of the Court at the time, that the bridge was '. . . badly designed, badly built and badly maintained.' Blow-ups of the cast iron metalwork of the high girder section show many defects, but especially the very poor state of the column lugs to which the wrought iron tie bars were attached. The evidence shows that they started breaking at the start of the accident, and led to a runaway collapse of the whole centre section (**figure 9**). However, there is good evidence that the bridge had been deteriorating from its completion in 1877, judging by possible fatigue striations on the fracture surfaces of the lugs (**figure 10**) and polishing marks on the associated bolt holes. The conclusions contradict some recent assertions that the bridge was simply blown over by high winds that fateful night(7).

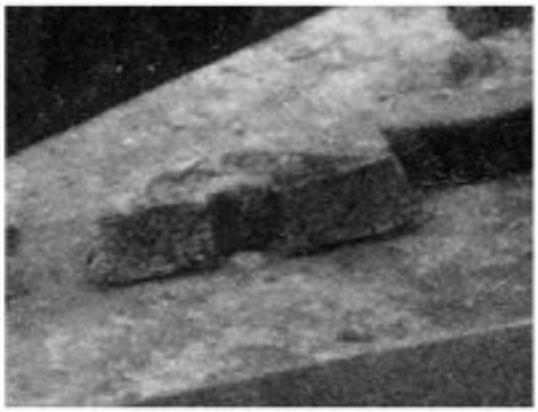

Figure 10: Lug fracture surface showing fatigue striations.

Figure 11: The Hindenburg fire disaster (1937).

We reinvestigate the causes of the Hindenburg disaster, when the world's largest airship suddenly caught fire when being docked at Lakehurst, New Jersey in 1937 (**figure 11**). We add new evidence from Addison Bain, an ex-NASA engineer who has reanalyzed the outer fabric of the craft. He suggests that the fabric was highly inflammable, using explosive ingredients such as cellulose polymers and thermite components, aluminium powder and iron oxide. The fire was probably started by a static discharge, rather than by a terrorist bomb, as some later investigators have suggested. There were many other problems with the fabrics on airships, and at least one other disaster, the R101 crash from 1930, was caused by ripping of the outer cloth during a storm (**figure 12**).

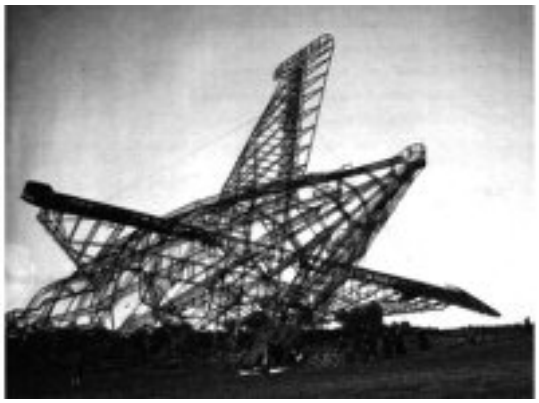

Figure 12: The R101 disaster (1930)

Final Block: The last part of the course studies intellectual property issues at some depth. It is a subject which usually includes expert evidence, and the methods employed often overlap with conventional analytical techniques. They include evaluation of documentary evidence, reverse engineering and product testing. The subject is reviewed in another conference paper.

ASSESSMENT

We examine by both essay-style assignments during the 6 month term of the course, and by a final exam. The former includes in-depth questions with practice in producing reports on real accidents not taught directly. We provide copious documentary and photographic evidence for the student to analyse, and ask them to draw conclusions. The final test also includes documentary evidence, albeit in attenuated form, for the 3 hour examination. We deliberately introduce new material in the exam, such as the Concorde crash in Paris in 2002 and the Boston Molasses disaster of 1919, when a large steel tank collapsed suddenly, destroying a nearby elevated railroad and killing local workers. We call for skills in report writing, document evaluation for key facts and development of likely causes of failure, built on taught failure modes for a wide range of materials in different structures. Video material includes court room drama, documentaries on well-known historic events (such as the Liberty Ship failures) and researching for patent validity. Although such material is not assessed directly, it provides student enrichment.

CONCLUSIONS

Forensic engineering places the spotlight on issues which are central to engineering skills, such as the ability to relate a given failure to structural mechanics, properties of materials and known failure modes. But it also involves assimilation of large amounts of information in standards, patents, witness statements and official reports. Although such skills are enhanced by current information on the web, the ability of a student to select the critical information is paramount.

Some universities have post-graduate provision, most notably Cranfield (at their Shrivenham campus) with an MSc in Forensic Engineering and Science, while Sheffield-Hallam has a unique undergraduate course, for example. By contrast, many universities present UG courses in Forensic Science. Some universities teach forensic engineering or failure analysis as a final year option. While the severity of natural and man-made disasters has appeared to increase in the last decade, there is a serious need for better provision for the subject in the engineering syllabus. The increased emphasis on the quality of consumer products also argues for greater provision.

But there does not appear to have been any greater provision of basic texts of specialist journals in the field. Although there is a corpus of specialist texts, there is little in the way of detailed case studies. We have published one such compilation(8), and are currently writing another on failure of non-metals, a field in which there is currently minimal coverage(9). Apart from *Engineering Failure Analysis* (edited by DRH Jones, published by Elsevier), there are few specialist journals, although many regular engineering journals do publish failure papers intermittently. The literature is thus scattered and rather incoherent for students. On the other hand, access on the web to databases such as the NTSB, NASA and the FDA is excellent. The HSE also maintains an informative web service. We present several case studies on our own website(10), as does Plymouth University(11).

It is important to overcome many prejudices held by engineers. The most important obstacle is fear of exposure. Companies often conceal accidents and near misses, although if the public is involved, exposure is inevitable in the media. Litigation is also another route where failure information becomes part of the public domain. Certainly the climate of opinion has changed in the USA, where deliberate concealment has created exemplary damages by juries. Companies there are now much more willing to publicise product failure so as to warn users of any problems. If product failures are to be reduced, there must be more openness from companies and institutions.

ACKNOWLEDGEMENTS

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TOWARDS DEVELOPING SUCCESSFUL RESIDENTIAL SCHOOLS FOR POSTGRADUATE PROGRAMS FOR INDUSTRY PRACTITIONERS STUDYING IN FLEXIBLE DELIVERY MODE

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ABSTRACT

Residential Schools are conducted for each of the courses in the Maintenance Management Postgraduate Programs at Central Queensland University. A recent review of the programs has identified those residential schools that lack structure and do not provide a focussed learning experience result in disgruntled students. This is compounded as some students need to travel thousands of kilometres to attend and their organisations sacrifice their ready access to these individuals during the two day residential school. This paper discusses the possible benefits that could be realised from improvements of conducting residential schools for students, for staff, for the university and for the industry employers. As these schools are not compulsory it is the university's responsibility to ensure that the investment of individual students and their organisation results in real-term benefits. The paper concludes with outlining strategies to achieve this.

INTRODUCTION

The Faculty of Sciences, Engineering and Health at Central Queensland University (CQU) conducts non-compulsory, two day residential schools which are held in week four or five of a twelve (12) week term. In a general sense residential schools in Australia are conducted over a short period (two days to one week) where students, who normally study in external mode are able to participate in a face-to-face (student-student, student-academic) environment. This provides them with the opportunity to engage in activities which provide learning experiences similar to those of internal student learning experiences. This has advantages of a social (formal and informal: promote a sense of connectivity and belonging), academic (group learning, shared knowledge) and professional (network with other practitioners (students and staff) from a variety of industries) natural. Students in the Graduate Certificate and Graduate Diploma Programs have the opportunity to attend residential schools at either the CQU Gladstone campus (Australian East Coast) or in the city of Perth (Australian West Coast). Each course within these programs has a residential school component. Currently residential schools include a 'Cook's' tour of the study program, a review of assessment items, workshop activities, opportunities for students and staff to share knowledge and can involve industry site visits and guest speakers.

'Introduction to Maintenance Management', as the first course in the programs additionally provides students with orientation information such as library use, faculty and university policies (eg. plagiarism) and progression through the program. These sessions are often repeated at future residential schools but with less emphasis.

Previously residential schools have been held for the masters program. There has been a change in the manner in which students are being supervised so that instead of there being one Faculty supervisor for all masters students each student is allocated two academic supervisors. This has resulted in more one-on-one working relationships where residential schools are redundant. A further improvement to the supervision of students is the inclusion of an industry-based supervisor.

STUDENT/COHORT MAKEUP

The Maintenance Management Programs are full-fee paying postgraduate programs. Students are mature-aged and working on a full time basis as practitioners in the maintenance engineering area and gain financial and temporal support from their employers. The student cohorts of the courses consist of people who live and operate their working lives

in urban, rural and even remote (rural) areas. To place this in context in Australia geographically remote means that the industry is based in a 'company-owned' town which exists only because of the industrial activity being conducted there. People are living in areas where they need to travel vast distances (6 to 10 hours by road) to reach urban areas.

The nature of some students' work-life is that they work 12 hour shifts and 9 day fortnights and then have four days off before returning to the same work cycle. Some of these students even operate on a 'fly-in/fly-out' basis and so can be living and working in an urban/rural or urban/remote (rural) existence. Consequently the ability to be involved in optional residential schools provides them with a valuable link for enhancing their learning experience and helps build their confidence through sharing experiences (work and study: positive and negative), knowledge and skills if they are able to attend. In some cases owing to their remoteness they are unable to attend, and we have attempted to accommodate this with the conduction of residential schools in Western Australia to be based in the capital city of Perth as a centralised location so that if they are able to attend they can take up this opportunity. If residential schools were mandatory our client base would not always be able to avail themselves of the opportunity of combining distance education (which suits their work/life style) with compulsory attendance at a residential school at a far-distant location, for a two day period, that may remove them from their work area so much that it jeopardises their work responsibilities. Employer support (temporal and financial) for such a commitment is always cited as a hindrance by students in them taking up study or continuing their study. Purnell et al (1996) highlight that from a study of rural and urban students undertaking study by distance mode that students expressed a preference for optional residential schools as they considered this provided increased flexibility in their study regime. From our observations of attendance frequency and point of original location to travel to scheduled residential schools and through informal discussions with students, anecdotal evidence supports this finding.

DELIVERY MODE

CQU has an established history as a distance educational provider. In Australia the terms distance, flexible and external all refer to students studying off campus. As part of the total learning environment it has been a consistent strategy to conduct residential schools. The aim of these residential schools varies greatly for courses offered in a wide range of programs. Some courses use them to perform tasks that could not be done off campus such as conduction of laboratory experiments. Others use the opportunity to create communities of learning. Sometimes it is a combination. The MM suite of programs, as a relatively new initiative, has aimed at using a 'communities of practice' approach.

In conducting courses within the MM programs an Interactive Design Model of the course(2) is adopted (see **figure 1**). Such a model comprises three major components, print-based study materials, residential schools and significant others (course coordinator, lecturer, guest speaker) in the process of the student's learning and they contribute to the student's academic understanding and progress. This is done within a framework supported by a number of avenues for communication (telephone, email, facsimile, web-based (Blackboard Study Management System), face-to-face). Study materials provide the basis of the theoretical, practical and assessment focus of the course, residential schools enable students to seek clarification of technical and practice issues and engage in experiential learning through sharing their individual knowledge and ideas to provide a collective knowledge and thus form an informal community of practice.

RESIDENTIAL SCHOOLS – PURPOSE AND IMPORTANCE

As outlined the courses are conducted in a distance mode and residential schools provide the opportunity for students to participate in face-to-face discussions between students-students, students-lecturer practitioners and student-university staff (Faculty staff, support staff, librarians) regarding the technical content of their courses, university procedures and policies and study advice. It is also an

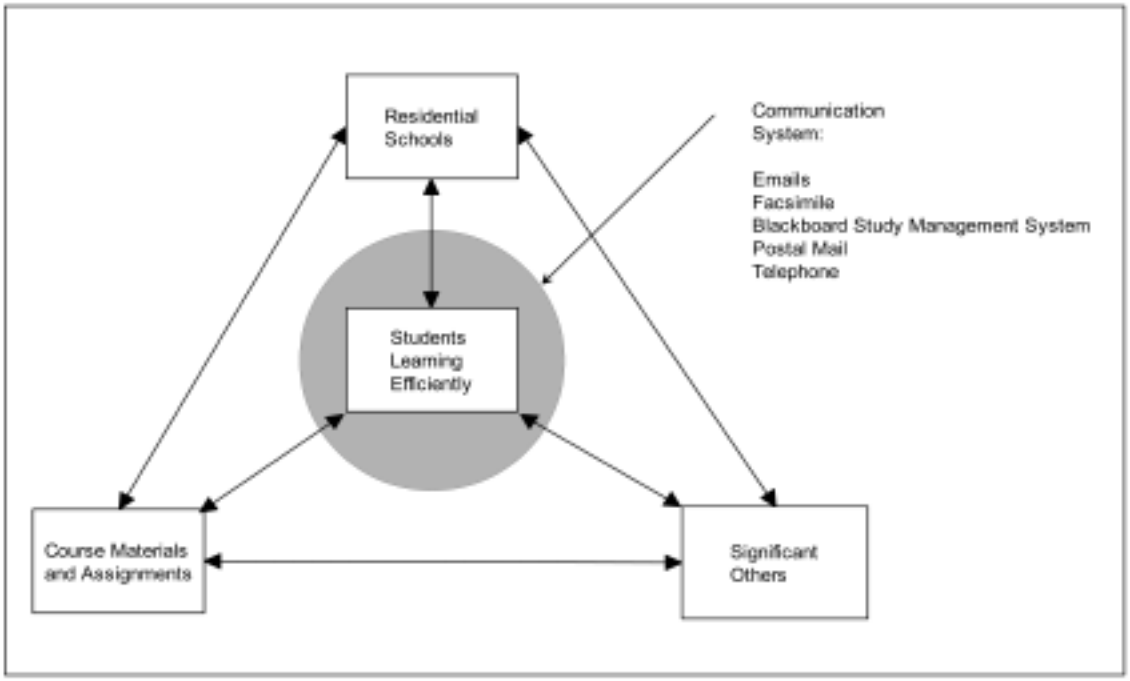

Figure 1: Model of the delivery system (based upon McKinnon and Nolan, 1992)

important professional networking avenue and also enables university and practitioners to discuss program goals and development. An entry requirement to the programs is that students are currently employed as maintenance practitioners at some level. All students work full time, and their study is in addition to their full time work.

In an endeavour to promote an informal 'on-campus' environment that allows reflection and group discussion of course content in the past, social gatherings were organised. However in the past two years this has been discontinued as it became apparent that students used the 'free time' while at residential school to 'check back at the office' as they tend to be on-call to solve current work-related issues and also they make their own arrangements to network or catch up with fellow students who are from the same organisation but from different locations in Australia to discuss organisational issues.

There are a range of aspects to why residential schools are not compulsory. The study material provided in print and web-based form provides everything they need to achieve the minimum learning outcomes. The corollary for on-campus students is that lectures and tutorials are generally not compulsory and while attendance may be seen to be advantageous it is possible to meet the learning outcomes without participating. As a self-directed learning responsible for their own learner it becomes their choice.

As these are full-fee paying postgraduate programs, students gain financial and temporal support from employers. Through our industry liaison the feedback has been that compulsory residential schools would not be supported by employers and so students would not enrol in programs with compulsory residential schools.

Feedback from students who chose not to attend, or to not continue to attend, highlights that the manner in which the residential schools are currently conducted does not add anything to their knowledge and skills. They see no advantage in attending especially when attendance involves such a high cost in terms of travel, accommodation and time off work. These students tend to be highly experienced practitioners. In one way by not making

Year	2002	2003	2004	2005
Average attendance	66%	62%	62%	61%

Table 1: Average attendance for courses over the last four years

Aspects in Favour of Conducting Residential Schools	Aspects Against Conducting Residential Schools
Students generally report them as a very positive experience and a highlight of external study; educationally and personally. Provide the only opportunity for external students to visit the campus and sense what it is like to attend a university as a student; indicates how closely they later identify with alumni. For some disciplines, they may be the only means to provide certain educational experiences; laboratory, practical or field work, face-to-face group interactions or language skills. May be seen as the only way for some disciplines to offer equity for external students who are funded the same way as internal students and who, therefore, deserve some parity in their educational experience. Can encourage high level interaction and engagement with the subject matter as well as scholarly interactions among students and staff. Some evidence they can lead to increased retention rates. Questioned whether it should be possible for student to be awarded a university degree without attending a university campus. High-point for many academic staff, because of intensive interaction with motivated students. University facilities are more effectively utilised at a time when internal students are not on campus; some cases includes teaching space, College accommodation	They are a financial burden for some students, while others find them an imposition because of family and/or work commitments. Loss of enrolments because of residential school requirements or do not study particular courses with residential schools; difficult to ascertain. Some (a minority) of students complain they do not gain enough from residential school to make it worthwhile; evaluate residential schools by cost-effectiveness. Alternative learning environments possible; on-line teaching for group projects and interaction; computer simulations for laboratory work. Inconsistencies in circumstances under which exemptions from attending compulsory residential schools are granted. Expensive to run; terms of academic and administrative resources required. Tie up University facilities at times when they could be used for conferences and other academic or community activities. Add to the workload of staff and reduce time available for research.

Table 2: Arguments in favour and against conducting residential schools (based on 2000 data of University of New England Data [2005])

residential schools compulsory we acknowledge Palmer's(3) understanding of the mindset and learning needs of the mature-aged and experienced students that are attracted by our programs when he highlights that 'the maturity and practical experience of the mature-age students need to be acknowledged and catered for; they are looking for knowledge and skills that will underpin their current practice with theory, and that they can apply in their workplace'. We do this by not locking them into an enforced commitment that is nothing short of a nuisance as it represents a meaningless learning experience. However on the other hand, even if in making the attendance optional, perhaps we are failing them by not providing a challenging, extending learning experience.

All of the above means that we cannot make the residential schools compulsory, however

we need to ensure that the learning experience is of value to those that do choose to attend. During 2006 as part of the continuous improvement process residential schools will be a focus of a program review.

Interestingly considering the comments of employers regarding compulsory attendance, faculty based information gathered regarding residential school attendance for the last four years (2002-2005) highlights that even though residential schools are not compulsory the attendance rate is quite high; 55 to 85%. Those students that make up this group usually return for future residential schools. In Australia data highlighting attendance rates at residential schools are difficult to obtain as they are not usually reported to the wider tertiary sector but are usually only reported internally within the individual university. It is worth noting our attendance rates are much higher than those from another regionally based university from which we have been able to access information. The University of New England quotes attendance rates for its non-compulsory residential school at 25%(5). The average attendance rate for courses over this period is presented in **table 1**. This table shows that the average attendance rate decreased from 66% in 2002 to 62% in 2003, and has remained relatively constant for the last three years (2003-2005). In the Australian context, this information shows that despite the current increased demand in the workplace resulting from the skill shortage in industry, the attendance at residential school has not been adversely affected.

Most of the aspects which are used to describe the favourable and non-favourable aspects of conducting residential schools outlined in **table 2** correlate well with the experience CQU as a regional university has as it does for the source.

POSSIBLE/PLANNED IMPROVEMENTS

Residential schools raises the issue of a student gaining the opportunity to engage with significant others (as defined previously) and one strategy being considered is to include mentors in the Interactive Design Model of the course. Already ppreliminary discussions have been undertaken by the Program Director with regards to a mentor program being formulated. The intention is that Graduated MM Masters students will be recruited as mentors. As the masters students have successfully completed a study program with the Faculty (University), they are in a good position to provide study advice to students. An added advantage is that these mentors are likely to be practitioners in the industry thus are suitable candidates for networking after students have completed their program. It is intended that interactions will occur between students and mentors at the residential schools.

Fraser and Deane(1) provide comments from lecturers conducting residential schools. They highlight the strategy of one lecturer, who has students undertake an examination, at the commencement of the residential school, which contributes to their overall grade; nominally 10% contribution. Consequently they believe students can be provided with ‘early and rapid feedback about how they are going’ and they challenge the student’s depth of learning because they are critical of distance education students as they believe that these students are working in isolation and that that gives ‘them a false sense of security about how well they are going’. We believe this to be a flawed approach as the students are being assessed on knowledge gained in the manner these authors criticise. This system would be of value if used as formative feedback rather than summative assessment.

There are pros and cons regarding the strategies of devoting a significant period of the residential school to lectures or reviewing the study materials. A problem highlighted by a student in the investigation undertaken by Fraser and Deane(1) is that ‘cramming’ a term’s work into a brief and intense residential school means that ‘any mistakes, or bad impressions made during this time cannot be easily rectified’. We would suggest that a useful remedy that could be adopted is that there be pre and post-residential school activities. These would focus on specific aspects and in some cases make the learning experience more interesting and more challenging and enabling a greater amount of time to be set to identify and discuss issues that are have risen as contentious or which

appear ambiguous. While we review the curriculum as a manner in which to provide clarification and extension we do not believe that this should be the focus of any residential school.

The Faculty's Process Engineering Programs do not conduct residential schools however they do make use of two or three teletutorial sessions (telephone conferences) in each course to enable students to speak with their lecturer regarding how they are proceeding. A similar approach could be adopted in the MM Programs to facilitate better pre and post residential school discussions so that these students are encouraged to seek clarification and assistance in undertaking their studies. However this becomes impractical for the size of the cohorts which are observed in the MM programs as a teletutorial having more than four people may be confusing and impractical.

While Fraser and Deane's(1) paper has a focus on undergraduate students it is still a valid and a prima facie argument that is reflected in the anecdotal evidence gleaned informally from discussing student progress, program content and delivery at postgraduate level.

CONCLUSION

Residential schools have been used to provide valuable learning experience to students studying postgraduate programs in MM by a flexible delivery mode. We believe the manner in which we currently conduct residential schools serves to provide students with both convenience and a valid educational experience. This is validated by the high attendance rates observed even though we conduct non-compulsory residential schools.

Continuous improvement process, involving faculty-industry liaison is identifying improvements which are to be prioritised and implemented.

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PLENARY
THE AUTOMOTIVE ACADEMY: AN APPROACH TO VOCATIONAL EDUCATION

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ABSTRACT

The automotive industry in the UK is currently in a healthier state than many perceive. However the challenges from global competition are such that continuous improvement has to become a way of life. Skills development is a key part of this.

The Automotive Academy is a unique partnership between industry and Government aimed at making world class training available to all; from shop floor to boardroom, and from the largest vehicle manufacturer to the smallest supplier.

The talk will review the structure and operation of the Automotive Academy, focussing particularly on its efforts to upskill trainers and secure the commitment of the industry.

The model for the Automotive Academy is that it develops curriculum materials of high quality: it sets standards for the delivery of its courses, and accredits existing training and academic institutions to do its teaching and assessment. The Academy does not undertake training itself. It does, however work with its 'customers' to:

- *carry out training needs analysis*
- *propose training solutions*
- *advise on funding support*

The range of curriculum which has been developed will be outlined, in particular the courses on lean manufacturing, where the car industry is seen to have a pre-eminent position. Some of the challenges, such as engaging the SME (small and medium sized company) community, will be reviewed

KEYNOTE PLENARY
INSTITUTIONAL STRATEGIC ISSUES WITH THE USE OF VIRTUAL LEARNING ENVIRONMENTS

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ABSTRACT

Almost every institution now uses a Virtual Learning Environment (VLE) and their use varies from a simple supplement to the traditional lecture-based classroom, providing access to course materials, all the way to more innovative applications. This has happened over a relatively short timescale, to the extent that most institutions have not yet been able to reflect upon what happens next and how they will adapt to the rapid evolution of digital and communications technologies, not only in education but in society. This is no longer simply a matter of extrapolating likely costs for institutional IT, but requires a much more fundamental re-assessment of our approach to teaching, learning and assessment. It has been ten years since Arthur Chickering and Stephen Ehrmann (Implementing the Seven Principles: Technology as Lever, AAHE Bulletin, *October, 1996) noted that technology could potentially play a vital role in changing the current educational model of higher education.*

This need for change has arguably become even more essential with the current generation of students – the Net Generation (Diana Oblinger & James Oblinger: Educating the Net Generation. *EDUCAUSE, 2005) - and the growing dismay of academic staff at attendance, student engagement, surface learning and associated issues with retention and progression. This lecture will examine the issues and consider a way forward based on recent experiences with producing a Strategy for Teaching and Learning Through Technologies at the University of Strathclyde. This has attempted to take a more forward look at strategic issues associated with all technologies – not only online but also in-class and their convergence based on the recognition that ubiquitous computing – any device, any time, any place – is already with us and is likely to become even more prominent in the reformation of teaching and learning.*