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Secondary to Tertiary Transition

Guest Editors: Ian Macdonald & Doug Hargreaves

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Editorial

This is the first of a number of special issues of the Australasian Journal of Engineering Education on a particular theme and with guest editors.

The theme for this special issue is *Secondary to Tertiary Transition*, a consideration of the challenges associated with the transition of students from secondary to tertiary study with an emphasis, where appropriate, to engineering.

The guest editors are Ian Macdonald and Doug Hargreaves. Ian is the Manager of the First Year Engineering Program and Director of the Centre for Learning in Engineering and Science at Swinburne University and has specific research interests in transition. Doug is the Director of Research Concentration in Tribology at the Queensland University of Technology and has published on transition and first year university issues at national and international conferences as well as in journals, particularly in the European Journal of Engineering Education.

There is no need for a specific editorial introduction to transition and why it is an important matter for both entering students and universities, because this is most adequately covered in the lead paper in this issue by Ian Macdonald.

The editors welcome any feedback from this special issue and matters can be raised in Letters to the Editor which will then be published together with any editorial or author response in following issues of the AJEE.

Terry Berreen

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What Do We Mean by *Transition*, and What is the Problem?

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THE RISE OF *TRANSITION*

Moving from secondary education to university has never been easy, but in recent times the problem of *the transition* has become more acute.

In the days of free tertiary education only a limited cohort was taken from the top few percent of the year 12 student ranks. Funding models encouraged the practice of taking in a relatively large numbers of first year students, to be instructed cheaply in large lectures, who cross-subsidised a substantially reduced number of expensive, more conscientiously taught later year students. Students had to prove themselves capable of coping with teaching practices that encouraged significant *shaking out* of numbers, and this capacity to cope became accepted as a measure of *ability* that survivors wore as badge of honour, and, in their turn as academics, demanded of their own students. Many degree programs, including engineering, not only had significant failure rates at first year, but prided themselves on the *standards* that this represented. Universities had the power, the students were grateful for a free opportunity to attend, and failure meant being reunited with most of one's school friends in the workforce. While some individuals had reservations about the number of previously well-performed students who stumbled or failed in their first year, the Secondary to Tertiary transition did not seem to warrant significant institutional concern or research.

Times have changed, and more students than ever before are entering the tertiary education system, with a wider range of backgrounds, a greater range of abilities, and more diverse expectations. At the same time society and its industries are demanding a wider variation in the characteristics of the graduates that universities produce.

Now that students are expected to make significant financial contributions to the cost of their education they consider universities to be providers which must meet the students' requirements, rather than regarding themselves as privileged to be given the opportunity to study at institutions which can set their own agenda. Students expect to be educated through their degree, rather than tested against a standard and either accepted or rejected. Universities in turn are aware that retention of students through degrees and into higher degrees is in their financial interest, and quality students are taking into account other students' experiences, not just institutional research strength, when choosing which university to enter. Meeting society's demand for diverse graduates also means retaining students who do not fit the traditional profile of university students.

Quite suddenly, student retention has become a hot issue, and universities are hastening to deal with the recently recognised peril of first year failure and withdrawal. What has been lacking is good research into what we mean by *transition*, what factors influence it, and how schools and universities can alleviate it. Only recently have some patterns begun to emerge. In this introductory article I shall attempt to summarise some of the recent work being conducted in Victoria to identify the critical transition issues, and how it links to other national and international research. Out of this review come some guidelines for action.

Recognising and describing the problem of student transition from secondary to tertiary education was the focus of a conference held at Monash University in December 1995, partly triggered by a damning study by McInnes and James: *First Year on Campus – Diversity in the Initial Experience of Australian Undergraduates* [1]. In the *Making the Transition* Conference Report [2] it was stated that despite Monash University drawing its intake of student from the top 30% of the student body in year 12, around 40% of first year students were failing at least one subject, and presumably many more were having a significantly poorer first year experience than they expected to have. Other universities acknowledged similar results. When teamed with predictions by Shah and Burke [3] that Australian school-leavers had only a 0.64 probability of completing their degrees, and engineering school-leavers had only a 0.50 probability of completing their degree, it was apparent that there was a serious problem current – particularly in engineering.

Research in the USA, Canada, UK, Israel, Asia and Australasia, recently assembled in the literature review of major report to DETYA *Transition from secondary to tertiary: A performance study* [4] (note that the literature review is not included in the released version on the DETYA website, but can be obtained from the authors), indicated a bewildering array of factors linked to transition problems. Using many different analysis techniques, from simple correlations to multi-level statistical modelling, authors found a variety of possible relationships. Depending on the study considered (and for the sake of simplicity I will not reference each aspect) student retention was not only related to success in assessment, but also:

- **Student demographic characteristics**, such as age; linguistic and cultural background; gender; student entry category and school type; socio-economic and socio-educational status; and their home and residency location.
- **Student psychological characteristics**, such as academic preparedness, learning strategies and locus of control; goal commitment; and academic motivation.
- **Student prior performance**, specifically, overall prior academic performance; subject specific prior performance; general scholastic aptitude; and the ranking of the tertiary offer that was received.
- **Social factors**, such as family and peer support, study mode (full or part time); and financial situation.
- **Institutional factors**, such as institutional commitment; academic integration with faculty staff; social integration; course expectations; the nature of the course; teaching pedagogy; and administration.

Such a variety of outcomes, none of which were conclusive or comprehensive, failed to advance understanding of the problem, other than to remove any particular background factor as a prime culprit, and reinforced the complexity of the issue. What was generally missing from the international studies were the voices of the students, reflecting on their own experience of transition. McInnes and James' [1] survey of over 7,000 first year students in Australian universities provided rich data in many dimensions, while Dr Peel [5] of the History Department at Monash University led a project, in which I was involved, to follow 600 students through their final year of school and into the first two years of their university study, looking not only at their recall of experiences, but the changes to their perceptions that occurred along the way.

Students interviewed for the second Monash conference *Tackling the Transition* in 1998 also provided compelling video testimony about the issues they faced during transition.

These Australian studies gave a much deeper insight into the importance of the students' experience at university, rather than their incoming characteristics. The students described a range of issues that affected their capacity to succeed in their first year. Students had to cope with each factor to a greater or lesser extent, and for some students particular issues were overwhelming. Attempting to classify and group these responses is difficult and reflects the particular perspective of the researcher, however in many workshops with both teaching staff and students in both secondary and tertiary contexts over the last few years I have used a cluster that has resonated strongly, and which provides a framework to consider students' experiences.

TRANSITION FACTORS EXPERIENCED BY STUDENTS AT UNIVERSITY

Low Success Rate in First Year

For high achieving students, with a history of success at secondary school, to experience academic failure (sometimes for the first time) is devastating. No matter why the failure occurs, and the lack of work done in sliding to failure, it is still a depressing and discouraging experience that can lead to withdrawal even when continuation is possible. Certainly, many capable students who have worked hard during the first year, and who pass their subjects, are often disappointed with the grades they achieve, and question their commitment to the degree. All students seem to have difficulty establishing the required standard for their work, as detailed criteria or exemplars are rarely provided when work is set, and there is usually little early feedback. Without positive feedback and a sense of progress it can be difficult to sustain a strong work ethic, and if one's first attempts are met with biting criticism and low scores morale can be shattered. In general success, not punitive marking, breeds motivation.

Of concern in many degree programs is the cohort of students who continue to bounce along the bottom of the teaching program, regularly failing the assessment, not engaging with content being taught, never seeking assistance, and, when interviewed, oblivious to their own academic state. These *sleepwalkers* [6] constitute 10-15% of many first year subjects in a variety of degrees (including engineering), inevitably moving towards failure, and seemly unaffected by improvements to teaching and curriculum that have significant effects on the rest of the cohort [7]. Their failure and quiet disappearance from the university creates few ripples, but remains an important contribution to the overall statistics. How they came to choose the course, and why they remain in the face of constant failure without seeking help, is an issue being currently researched. It has been hypothesised that they have made ill-informed choices of degree, and were later too poorly connected with the university to know how to change their selection and who to see for advice, but as yet there is no firm confirmation of this.

Coping with Independence and Decision-Making

When asked what they most look forward to at university, students in year 12 commonly respond in terms of asserting their independence. Relationships with the opposite sex, the opportunity to drink alcohol without restriction, to grow their hair, discard uniforms, or experiment with a range of drugs, are all manifestations of this need for assuming personal control of their lives, and making their own decisions. It appears that students are prepared to tolerate the lack of these freedoms during their school years in exchange for the assistance they need from parents and teachers to achieve the necessary Equivalent National Tertiary Entrance Rank [ENTER] for the course of their choice. In a system where all important decisions about lifestyle and learning are dominated by parents and teachers respectively, students have little opportunity to practice the important skill of informed decision making. When the opportunity comes at university to release the pent-up pressure young people often struggle to make good decisions. This is no argument for further restriction at first year university, as the students will not tolerate it, but a reflection of the lack of opportunity to gain important decision-making skills during their school years.

Changes in Motivation and Sense of Purpose

In recent times it has become necessary to get very high ENTER scores to access the prestige degrees, and social pressure exists on students to gain entry to these courses. As a result many Year 12 students set very high academic goals and elevate the final year of school to extraordinary importance in their lives. It is not uncommon for Year 12 students to make substantial sacrifices in the name of their study. Parents and teachers place enormous importance on success, and often foster the dangerous idea that *year 12 is the hardest year of your life, after this it becomes easy*. By the time students have endured this pressure, in many ways considered the culmination of 12 years of schooling and the most important single hurdle ever to be jumped, and gained the necessary marks to attain a university place, they are physically and emotionally exhausted. Too many first year students arrive at university ready to enjoy the fruits of their year 12 labour, and have a holiday. After a year of study directed at a very specific and near term goal – that of university entrance, first year university is only the first of 3 to 7 or more years of study, and many students find it hard to get motivated to give the same level of commitment as previously. The *letdown* experienced by first year students has been increasing as the pressure on year 12 performance has increased. Commonly students say they are *only aiming to pass*, but it is a fine line between the target 51% and failure at 49%.

Isolation and Loneliness

Compounding this change in motivation is the loss of the students' community. The final years of secondary school are usually characterised by a strong sense of community, with students, staff and parents all working in concert to achieve the highly valued goal of a good ENTER. This supportive community is also a crucial learning structure – a learning community that makes an important contribution to the success of all students who are part of it. For most students there is no continuity of this community at university, and by their integrated nature communities are slow to develop. As a result students often cling to the remnants of their previous communities, and spend the minimum time at the university so that they can return to their friends at their old neighbourhood. A lack of supporting community at university is a clearly identified risk factor in American Colleges [8], and work being done locally strongly supports this link to withdrawal. Low achieving students are regularly found to be those who only attend to the campus for classes and leave immediately [9]. It is a relatively easy progression to miss one class, miss a second, regularly not attend, and then withdraw completely.

Universities are, for many, intimidating places inhabited by a vast number of anonymous fellow students and a pantheon of powerful, but reclusive academics. Establishing a network of friends to form a social community, and then developing a parallel or overlapping learning community of students engaged in the same subjects, is one of the most crucial of the challenges facing new students. Failure to do so can result in isolation, loneliness, an inability to recover from minor setbacks, and poor academic performance. The final outcome can be personally devastating. Such a path is powerfully represented in the *Race Around Monash* video tape [10], when one of the student film makers *crashes and burns* in a deeply moving depressive spiral driven by loneliness and an inability to cope with relatively minor crises.

Without a community of fellow students to judge progress and share experiences isolated students can feel that they are the only ones who are not coping, and feel a fraud for being enrolled in the degree. Self-esteem can slump rapidly, and students are embarrassed to seek help as they see it as admitting their own relative inadequacy. This can be particularly true for international students who have even more cultural, linguistic, and social barriers to face.

Changes in Social Life and Living Circumstances

Moving into the university environment is a dramatic social transition, with complex interplays between personal and academic life. Once again students, as young people discovering new facets of their own selves, have difficulty in coping with the decision making required to balance the new opportunities of life and love, and the rigours of academic demand [11,12].

Changes in daily routine are dramatic. School days are often highly regulated, with a clear finish time, followed by a regular pattern of travel, and a defined *homework* period when tasks can be completed. University students often reflect that there is *no time* for study. Lectures or laboratories can run well into the evening, travel times can be extensive, and the temptation (and even requirement) to make new friends in new places, eats into the available time to complete work. With semesters of as little as 12 weeks, rather than the 20 weeks typical at school, it does not take long for a backlog to become overwhelming.

While the number of students leaving home to commence study is reducing, there are many who are now caring for themselves for the first time. New skills need to be developed, and rapidly. Shared accommodation also brings new challenges in relationships, and continues to tax the ability of a person to cope with change of any type.

Working for a Living

A specific problem of changing life situation that has become of greater importance, or at least far more visible in recent times, is the need to work to earn money. Few parents can now afford to provide sufficient allowance for their children to concentrate solely on study, and it is easy to argue that some development of the responsibilities involved in earning money is beneficial, however the average amount of time students are spending working for pay appears to be increasing. Faculty areas are reporting that failure of students is often linked to high external workloads, and students regularly seek to structure their classes around paid work, or even miss classes in order to meet employment demands.

Why this should become such a problem recently is still unproven, but there are many credible suggestions. The requirement to pay the Higher Education Contribution Scheme [HECS] has heightened the awareness of accumulated debt, and students are loath to carry more than they must. With a greater number of students, and a desire to broaden the range of students taken into degree programs, there are far more students of low socio-economic status attending universities than in the *white Anglo-Saxon middle-class privately-educated* past. Such students have no choice but to work to survive, as the government support packages do not even maintain a level above poverty. When combined with the modern requirement for personal transport, and a common university expectation that students will have their own up-to-date computer, software and Internet Service Provider [ISP], attending university is a significant financial burden. Work accessible to students is often low paid, and *on-demand*. Employers are not sympathetic to the requirements of timetables, and students who choose a late lecture over the offer of a shift are likely to be dropped from the roster for a more *reliable* employee. As a result students are rarely genuinely full time, and the laments from academics that students do not invest the 60 hour weeks expected of them in their degree seem rather disconnected from reality.

Changes in Teaching and Assessment

At least in Victoria there is a profound difference in the emphasis in teaching and assessment between the secondary and tertiary systems, and the change from one to the other is often a disturbing and disrupting experience for students. During their Victorian Certificate of Education (VCE) the emphasis of teaching tends to be on the *process* of learning, with emphasis on class discussion, sharing of ideas, multiple drafts of documents leading to final outcomes that are detailed in highly specific criteria. Teachers create learning environments based on professional knowledge of pedagogy, and the classroom is very much a place of learning. Teachers see their job to be to guide the students through a process of education. Tasks are intended to be used as learning vehicles, and students are expected to interact with each other and the teacher on a regular basis in the development of their understanding and their submissions. For most students the class time is an interactive environment, where much of the learning occurs, but it is an environment in which the teacher exercises enormous control. Commonly students are totally dependent on the teacher to decide what should be done, for how long, and with what outcomes. There are few opportunities in this highly structured domain for students to take much real responsibility for true decision making, or task analysis.

University learning, particularly in the first year of an engineering degree, is almost diametrically opposite. The emphasis in teaching is on the *outcomes* of learning. Students are required to be able to remember information and procedures for examination, and show the capacity to solve problems. Tasks are set with vague guidelines, and staff are rarely available for elaboration of the criteria. Drafting for feedback is no longer demanded, it is now firmly refused. Work submitted may not be returned for many weeks and is not seen as learning feedback, merely a measure of the students' *ability*. Students are expected to do large amounts of unsupervised work, but this is rarely collected or checked, and so students interpret this as indicating it is not important. Lectures, and commonly tutorials, are times of massive information dumping, with little emphasis on quality learning. There is little opportunity for interaction with teachers or even other students, and to do the latter is sometimes specifically forbidden as *cheating*. Learning decisions are entirely left up to the students, who are singularly unskilled in making them.

Academics commonly describe their role as one of *sorting the wheat from the chaff*. Students who can cope with the *system* are retained, while those who are not *capable* are culled out. Selection, rather than education, rules. Most academics have a primitive understanding of learning and teaching andragogy (or more relevantly, pedagogy), and usually defend their lack of teaching skills by declaring that students should know how to be *independent learners* and it is not their responsibility to teach them how to learn. It is not uncommon for those who *teach* their students to be considered to be in some way *letting the side down* and *reducing standards*, or more punitively *having to be teachers as they can't do good research*. The academic's role is to present the information, and the students' role is to learn it. Academics are defensive about their teaching, and seeking to improve teaching is often seen as some sort of admission of inadequacy of their specialist knowledge, rather than a recognition of the need to learn a whole new area of specialist knowledge they have not previously trained in.

This may be seen as an unduly harsh assessment, but having worked with a variety of staff in several faculties at a range of universities as a consultant in teaching and learning issues I confidently assert this analysis is rarely contradicted, with exceptions usually being isolated, committed individuals who are regarded by peers as eccentric at best. Recent national evaluations support this general view of university attitudes to teaching [13,14]. Engineering, in particular, has regularly suffered from damning student evaluations in this aspect, coming near or at the bottom of national polls of students' perceptions of teaching quality [15].

Students have to come to terms with the changes in teaching and assessment and the meaning they construct. The strategies they apply to cope are often low grade *Surface* ones to complete tasks, rather than *Deep* level understanding that values conceptual development and linkage to the real world (see Biggs [16] for styles of learning).

Rural or Isolated Location Students

Rural students, or those from other isolated areas, face even greater barriers. Research conducted at Swinburne University [17] reinforced the broader literature in suggesting that such students were even more exposed to problems associated with a loss of community, and financial issues. As a result rural students are only one third as likely to attend university, and the number is declining even as other society groups increase.

Parents of rural students are typically unable to obtain any financial assistance from the government, as they have considerable static assets tied up in their properties, but their cash flow does not allow for much financial support of their children when they move to the city, where most university campuses are sited. Rural students have very high costs, have difficulty finding appropriate jobs due to a lack of connections, and suffer intensely from homesickness and isolation. Typically they have come from small, personal schools with strong community structures, and the lack of any continuity of community for those most dependent upon it is particularly difficult to cope with. Such disconnection from their community is a very powerful disincentive to attend university, while the city and its impersonal intensity can be a real barrier to adjustment. Despite this the students who attend university from rural areas do appear to make friends easily, and build strong new communities during their first year. If helped through the early days the need to develop a new, university-based community results in a student more resistant to withdrawal than the urban student who is only partially engaged with the university life, and remains strongly based in his or her original community. Rural students have an intensified need for a supportive initial transition period.

This list of problems may make it seem that students have little chance of success, while clearly many students do make a successful transition to university study. All students have to deal with the problems to a greater or lesser extent, the issue is one of managing the change. Student who are able to adapt may not see these issues as problems at all, merely a new phase in their lives which they have keenly anticipated and whose challenges they now enjoy. Ensuring that students do make this transition smoothly is the real challenge for the education system, and this must be met at both sides of the transition.

THE ROLE OF SCHOOLS

Schools have been very concerned about the problem of transition, probably for longer than universities. The Transition conferences at Monash have been strongly attended by a wide range of schools, school career advisor associations have been taking an active interest in transition related research, and many schools are incorporating some sort of transition preparation into their year 12 student programs. Most schools now see their role as not only getting their students to university, but ensuring they have the skills to succeed.

The widening gap between the secondary and tertiary learning experience is a concern for both sectors, but there has been a tendency for each to blame the other for the problem. Tertiary academics are often scathing about the secondary school system, but often from a position of profound ignorance, or anecdotal experience vicariously gained from their offspring. Similarly secondary teachers are very critical of universities and their teaching methods, but again often from their own, rather dated, anecdotal experience, or that of a visiting ex-student. A lack of understanding of the other side of the transition is a particularly acute aspect of the problem.

In an attempt to extend the knowledge gained from my own experience as a secondary school teacher turned university academic, in 1997 I conducted a research project that paralleled Peel's study [5] of students moving from secondary to tertiary study, in which the schools involved in Peel's study were interviewed about the way they prepared their student for university study, particularly in their development of independent learning skills. The intention was to develop a *best practice* collection of materials that might be shared amongst all participating schools, and to compare preparation techniques with the experiences of the students in Peel's study in order to find the most effective or useful school-based programs.

Unfortunately, there was little to celebrate as *best practice.* While all schools nominated independent learning as one of, if not the most important outcomes of the school system, no school had an integrated program to develop independent learning skills during secondary education. Staff were poorly informed about learning issues; curriculum was dominated by the Victorian Certificate of Education Study Designs, and regarded as already too complex and demanding to include any further content; parents were mainly concerned with high Tertiary Entrance Rank [TER] results, with little understanding or interest in any other educational outcomes; students were resistant to any further programs that they did not perceive to have an immediate and directly applicable consequence to their objective of obtaining a high TER; and there were only occasional pockets of interaction with education faculties of universities intended to provide a staff professional development program that could lead to change in teaching practice. In short schools were locked into a transmissive, teacher-dependent learning model, reinforced by the imposed curriculum, and teachers', parents' and students' perceptions. All this in an environment where vitally important assessment, that was perceived to be life-determining, was imminent [18].

Schools suffer from a range of systemic problems, too complex to elaborate in this article, that create a barrier to any substantial change of this situation in the short term. It was clear that schools were producing students with limited understanding of independent learning, and with significant dependence on their teachers to guide all aspects of their education, and that this was not likely to change in the short term, despite the best intentions of many dedicated and enthusiastic teachers. Universities would have to take up the challenge of assisting the students they took in, and not expect schools to prepare the students to the universities' specifications.

UNIVERSITY RESPONSES

Although recognition of the transition problem was slow in arriving, in some faculties, and in some universities there have been organised attempts to deal with the transition problem. Monash University has been active at the organisational level, with a group of concerned academics from many faculties setting up the Transition Working Group in 1996. Recently it has been incorporated into the university administrative structure as the Transition Group, with Professorial leadership; a direct reporting link to the Committee of Associate Deans (Teaching) of the University; time release for key staff to promote the group's activities; and funding to run conferences (real and virtual), research seminars, practical workshops, student information sessions, parent information sessions, a school visiting program, a range of other student-run and faculty-based activities, and provide limited financial support to transition initiatives and research. The group has raised awareness of the issue of student transition within the university, and provided a forum for sharing ideas and experiences. Most important has been the high level recognition given by the university to the importance of transition related activity.

Specific attempts to manage the initial, often abrupt introduction to university life are well represented in this special edition, with emphasis on community building through orientation camps, while Queensland University of Technology have specifically designed first year subjects to counter some of these issues, augmented with a structured mentoring scheme [19]. While there are a profusion of approaches to managing transition appearing in response to the awareness of need, there appear to be a number of guiding principles for tackling transition related problems at the university level that are worth outlining.

Students Help Students Best

The strong need for independence of most first year students makes them very difficult to help directly. *Teacher* advice of any sort is often ignored, and sometimes resented, no matter how clearly applicable. Fellow students, however, seem to have a knack of communicating and supporting each other through quite complex problems. Successful students are more often than not students who are part of a small community of students, usually only a handful in number, who meet regularly to work. These groups, dubbed *Learning Communities* may or may not be a social group, but they do help the members to:

- problem solve in academic work;
- establish the priorities and outcomes of courses of study;
- teach peers as a way of constructing better personal understanding;
- develop a sense of belonging to the institution;
- create a commitment to working regular hours and a sense of accountability to peers;
- provide emotional support to help prevent being overwhelmed by the system, or the feeling that all other students are coping and that as an individual student he or she is a fraud for being enrolled;
- and, most importantly: for exchange strategies for effective learning in the new environment.

Unsuccessful students are almost invariably isolated academically, with any peer group being entirely social in its focus.

Student learning communities are consistent with academic knowledge about the learning process: the need to construct meaningful understanding by active exchange of information, challenging of concepts and views, and the tentative and hypothetical airing of partly formed ideas in order to establish links with between current knowledge and with other knowledge areas. Unfortunately the view that learning is the transmission of a body of professional knowledge from academics who have it to students who do not is still very common amongst tertiary teachers, and the learning communities are sometimes actively discouraged on the basis that they represents some kind of *cheating*. This is often a consequence of inadequate assessment structures, rather than a deliberate policy.

Supporting student bodies, particularly those working to integrate students at orientation, provides a very effective and extremely cheap way to assist students to fit into the university. They cannot be, and should not be, under university management control, but need some financial support. Some will challenge university policies in uncomfortable ways, but the overall effect is immensely beneficial.

Students Need Space

Overcrowding and pressure on resources has meant that even if students want to meet and form communities they have few places available to do so. Many students report that they only attend university for their scheduled classes (which they try to group into the minimum number of days), and leave immediately once they are over. Students need places to meet, to talk and to work with some degree of privacy and intimacy. These student spaces must be attractive enough to entice students to stay at university in preference to going home, yet not provide too many distractions. Ideally each faculty area would have its own specific area in which the emphasis is on meeting and working in the discipline, as well as there being cross faculty student union locations for general social contact.

Teaching and Assessment Practices Matter

The abrupt change in teaching and assessment practices experienced by students as they enter university is interpreted by the students as a guide for the type of learning that is required. Typically students respond to university teaching by adopting Surface learning approaches, as these seem best matched to what is assessed. Poor understanding, and low academic performance result. Teaching practices in the first few weeks of the first semester can be instrumental in allowing students to meet each other and develop nascent Learning Communities, while taking the effort to provide encouraging feedback early in semester, which does not have a major contribution to the final grade, will also benefit students.

In general, teaching and assessment practices have to value the learning skills desired, rather than reward recall of information in exams. It is pointless talking of *maintaining standards* by setting hurdles that most students cannot jump, and then having to compromise pass marks to ensure a reasonable flow through. Subjects at first year must be appropriate for the entry students, and if they lack necessary skills those skills must be actively taught, not just bitterly mourned. This may require extra work, or extra resources, but the long term benefits should repay this.

Students are Individuals with Social Needs.

Learning is a social activity, and universities are social environments. Students have been explicit about their desire to have quality face-to-face contact with teachers who know them as individuals [5]. Many first year programs have large class sizes, where it is easy for staff to see students as merely an array of homogeneous faces to be treated *en masse* as an administrative convenience, at a time when many have very specific needs and concerns that require only a small amount of time from a concerned academic to resolve. Our experience at Swinburne University is that students respond very positively, though with some surprise, when they are known by name by at least one of their lecturers or tutors, and a surprising number and diversity of problems are brought forward as a result of the apparent interest being shown in them as individuals.

There is a Parallel Curriculum of Learning Skills in Every Degree

As mentioned, students coming from secondary school rarely have the independent learning skills they need to cope with traditional university education. Most do not understand what it means to learn well, and have a very limited range of learning strategies. These skills are not the innate distinction between *able* and *not-able* students, they are learned skills that good students acquired through good luck or good teaching at school. When quite ordinary students learn how to learn well, and how to make good decisions about the strategies that are most appropriate for learning situations, they become very successful, quality learners [20]. Learning skills are a parallel curriculum within any university degree, taught through example as well as explicit direction, and are an important part of students' ability to cope with the direct academic demands of university study.

At Monash Education faculty the first year double-degree undergraduate students do a subject called *How Learners Learn*, in which they are required to reflect upon the learning processes they engage in during their first semester, and compare them with various theoretical models. Although relatively new there is already strong evidence from their reflective writing that students are finding the subject powerful in setting up appropriate learning strategies for their other subjects in other faculty areas. Not all faculty areas have the luxury of fitting such subjects within normal curriculum, but there may be opportunity for elective units of this type. Certainly there is scope for teaching and assessment practices to be modified to promote quality learning strategies. Incremental development of these is a integral part of any teaching situation.

Universities Must Understand the Learning of the Students

The learning environment of secondary school is very different to that of university, and it is in both the schools' and the universities' interests to better understand the other environment. Opportunities for academics to work in secondary schools are rare, but several universities have programs that bring secondary school teachers into universities. Such *teaching fellows* provide knowledge about the school system and the learning history of the students, and can assist university teachers to develop teaching approaches more in line with the learning skills of the students. Experience as a university tutor also provides the schools with important understanding upon the teacher's return to normal duty. While relatively expensive to set up, such programs provide long term benefits to both sides. A program with a strong research emphasis has run for several years at Monash University, while a more teaching-oriented program has run at Swinburne University in 1999. Individual reports by the participants are available from the respective universities, while a project has been proposed to properly compile and analyse the reports.

First Year Requires a Special Program

If university students are to learn how to adjust to the typical pattern of university learning, and it is evident that there is little prospect of university teaching being radically transformed across all levels in the near future, then first year students must be involved in a deliberate program to deal with the problems discussed above. Universities have the flexibility and autonomy needed to create and implement special curricula to meet the requirements of their own student body. They also have a responsibility to do so.

In this special edition there are a number of articles about universities that have taken up the challenge of student transition to university learning. I found them inspiring, and a source of new ideas to implement in my own work. It is my hope that others will also.

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BIOGRAPHY

Ian Macdonald trained and worked as an engineer before moving into the secondary school system for 8 years. During this time he pursued research into student learning, gaining a Masters degree in Education and then a Ph.D. in educational psychology. Moving to the Education faculty of Monash University he taught postgraduate teachers and continued his research into quality teaching, student learning, and in particular the problems of transition from secondary to tertiary study. In 1997 he joined Swinburne University where he is now manager of the first year engineering program and Director of the Centre for Learning in Engineering and Science, while remaining an Honorary Research Fellow at Monash University Education Faculty. His research is in the area of School to University transition, the development of effective learning environments, and in professional development strategies for university teachers.

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The Challenges and Benefits of an Orientation Camp for First Year Engineering Students

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In 1991, the UTS School of Electrical Engineering published an internal report which examined factors influencing undergraduate engineering course completion rates. The need for peer support within the student body was seen as a crucial factor. To address this issue, and others such as differentiating university education from secondary education, removing racial, cultural, social, lecturer-student barriers, the School formed a team to develop and run a 2_-day orientation camp program for first year students entering university directly from high school. The success of the first camp in 1992 has resulted in the camp becoming an annual event. With the restructuring of the Faculty of Engineering and the development of a new Engineering degree program, the camp was expanded and modified in 1998 to cater for the entire ex-high-school first-year intake into the degree. Over the years that the camp has been run it has continually evolved to meet changing needs, and in response to feedback from students and reflections from staff members. This paper provides a brief review of the evolution of the camp and sets the context for examining the activities of the camp especially in reference to the distinct aims of each activity. In addition, the ways in which issues such as the cultural and religious background of the students, and the significant gender imbalance are dealt with will also be discussed. Organising, managing, and running the camp for 350 students, 40 staff, and 20 current students over 5 days in the week prior to the commencement of semester is a challenging exercise in logistics. Therefore the review of the educational and social aims of the camp is complemented by a discussion of the planning and timetabling of the camp.

INTRODUCTION

The University of Technology, Sydney (UTS) Engineering Orientation Camp was one of the initiatives deployed in response to a 1991 internal report examining the factors that influence the completion rates of the undergraduate engineering degree programs within the School of

Electrical Engineering at the University of Technology, Sydney [1]. A key factor was the need for students to establish peer support networks. The cooperative education program at UTS often results in many students taking on full-time employment and completing their degree part-time. Thus there is not a strong sense of a student cohort moving through each stage of the degree. The net effect is that students need to form extensive peer networks and that they need to do so early in the degree and if possible with students from other stages in the degree. The main goal of the camp is for students to get to know each other in an informal environment away from the pressures and distractions that the university campus brings.

The other aims of the orientation camp are many-fold (and form a synergy with the orientation activities organised by the university and student union). Apart from meeting and forming networks with fellow students there is also the opportunity to meet and talk to students from later stages in the degree and to staff members; an introduction to life as a university student and to the engineering career they have chosen; and a start to the process of developing teamwork and communication skills. The camp also serves as a means of differentiating university from high school and ensures that the students' first university experience is not the daunting sight of a very large and crowded lecture theatre. During the 2_ day camp a number of both formal and informal team based activities (with team sizes varying from 2 to 20) are carried out which directly address these goals, as well as various other issues, such as safety, quality, the engineering process, and the concept of reflection. The range and nature of activities at the camp are as varied as the backgrounds and interests of the students entering the Faculty, and include a mix of organised social activities and free time to ensure the balance of the camp.

The camp first ran in 1992 within the (former) School of Electrical Engineering at the University of Technology, Sydney. While this first camp had some sceptics, the success of the camp was immediately obvious and the camp has been a permanent annual event and one of the highlights in the UTS Faculty of Engineering calendar. To explore the factors that contribute to this success, this paper will first provide a brief overview of the orientation camp program followed by a discussion of the camp's evolution. This sets the scene for a description and analysis of each of the current camp activities and an examination of the logistics required to ensure the camp runs smoothly. Finally, the short and long term benefits arising from the camp for the new students, current students, and staff are reviewed.

PROGRAM OVERVIEW

The orientation camp is held at the Young Men's Christian Association [YMCA] Camp Yarramundi which is on the Grose River at the foot of the Blue Mountains, approximately 2 hours west of the Sydney Central Business District. Having the camp away from the university and at a somewhat remote location has two key benefits: no distractions for students or staff, and the students can't come and go as they please, making management of them much easier and less stressful. Students are not told the location in advance and hence can't drive there. Instead they must all meet at a nearby railway station to be transported by bus to the camp.

While the camp has undergone many changes over the years, and different activities have come and gone, the overall concept and structure has remained stable. The camp runs over 2_ days with students arriving at the camp after lunch on the first day and departing mid-morning two days later (see Appendix 1 for a copy of the timetable). The first activity is an ice-breaking activity involving staff and students. This is followed by an information session where staff are introduced, the degree program is briefly reviewed, and most importantly students are given a chance to have their questions answered. Having had their questions answered, the students are free to devote their full attention to the forthcoming activities. The remainder of the camp is a balanced mix of team-based activities, organised social activities, and free time. The team-based activities, with team sizes varying from 2-20, are designed such that as the students get to know each other better and start to perform better as a team, the complexity of the challenges within the activities increases. Each activity also introduces various engineering concepts such as safety, design, planning, and risk, with the students completing a written reflection exercise at the end of each activity. The camp timetable also includes plenty of free time for the students and all activities are designed to be completed well within the allocated timeslot. On each night of the camp there is an organised social activity.

The camp is only run for Recent School Leavers (RSL). The non-RSL (NRSL) students are not invited to attend for many reasons. The NRSL students are expected to have already developed many of the skills the camp is intended to develop; they will not benefit as much from peer networking opportunities as they often get exempted from many of the early subjects; they usually work and can't get the time off; and finally in many of the team activities the mature NRSL students will automatically be looked upon as the team leader thus defeating many of the goals of these activities. NRSL students are encouraged to attend the university organised orientation program held at the UTS campus

EVOLUTION

The orientation camp was originally developed within the School of Electrical Engineering catering for students entering the Electrical, Telecommunications, and Computer Systems Engineering degree programs. While the camp was introduced in response to the study into completion rates, it was not the only initiative. Two new innovative first year subjects, Engineering Practice and Engineering Discovery, were also introduced in 1992 [2,3]. While these subjects had various educational objectives, they also reinforced the goals of the camp with Engineering Practice being very closely tied to the camp. For all of the activities at the camp, students were in the same groups that they would be in all semester for Engineering Practice. Where practical, their assigned Engineering Practice facilitator would also be at the camp working with the students. This served to forge strong links amongst a group of students who would not necessarily have independently formed a peer group.

The activities of the orientation camp formed part of the curriculum for Engineering Practice. As Engineering Practice evolved so did the activities at the camp. The camp also evolved in response to student feedback, new ideas, varying resource availability, and in accordance with the personality of the different camp coordinators. Over the six-year period 1992-7, approximately 33% of the original activities had been replaced or significantly modified. For example, the personality testing exercise was considered better suited to the classroom and was replaced by the more interactive dome building, the computer controlled battle simulation and fireworks display was replaced by a trivia night due to the unavailability of the graduate who ran this activity.

In 1997 the Faculty of Engineering was restructured replacing a School based structure (Civil, Electrical, Mechanical, Graduate) with a matrix structure. Accompanying the restructure was a completely new Bachelor of Engineering/Diploma in Engineering Practice (BE/DipEngPrac) which represented a major shift in the way the Faculty had approached the delivery of its engineering programs. There was now a common degree program with a significant set of *core* subjects running throughout the program which every student must do irrespective of their field of practice [4]. The engineering specialisation is achieved through the Field of Practice (Major) subjects which align with the degrees formerly delivered by the Schools. The current Fields of Practice are Civil, Civil & Environmental, Computer Systems, Electrical, Telecommunications, Mechanical, and Software Engineering.

The first intake for the new BE/DipEngPrac was 1998. A decision had to be made in regard to the orientation camp. Engineering Practice (EP) and Engineering Discovery (ED) were not part of the new degree (their content had been integrated into numerous subjects across the entire degree). These subjects had their origin in the same research that led to the formation of the camp and were used to reinforce and build upon many of the camp's goals such as student networking and peer support, and non-technical skills such as critical thinking, planning, teamwork, written and oral communication. The tight coupling between EP and the camp also guaranteed a minimum of staff (i.e. those staff involved in teaching EP) were present for the whole camp rather than just sections. The educational infrastructure which provided a lot of support for the camp was no longer available. Suitable substitutes would have to be found within the structure of the new degree. In addition, the number of staff and students to be catered for was doubled and the students were no longer from related engineering disciplines. The clear result was a camp that would require significant redevelopment, would need to run twice over 5 days (to cope with the entire student intake into engineering), would need twice as many student assistants, would use twice the consumable resources and, as expected, would need four times the organisation. The result of this redevelopment in 1998 and the further refinement in 1999 is the set of activities described in the following sections.

ORIENTATION CAMP PROGRAM

The following sections describe each of the activities at the camp and discuss the goals of each activity. The sequencing of the activities is shown in the copies of the 1999 camp timetable reproduced in Appendix 1. The team-based activities are scheduled such that the more complex activities occur later in the camp.

Ice-Breakers

Ice-breakers are a traditional initial activity for a team-building exercise such as the orientation camp. The aim of the ice-breakers is to have the students meet each other and learn a little about the group of people that they will be spending the next 6 years working with. Staff are encouraged to participate in the ice-breaker activity so as to meet the students and learn about them but also, and more importantly, to ensure that the students meet the staff first as a person rather than as an academic in front of a lecture theatre. As the ice-breaker is the first activity of the camp it sets the tone for the camp and it is essential that it is fun and runs well.

Up until 1998, ice-breaker activities were organised by the YMCA and run with the assistance of engineering staff. There was, however, some concern over the consistency and quality control of the activity. In particular, the activity needed to be sensitive to the cultural diversity of the student intake and especially to the gender imbalance. As a result, we developed our own ice-breakers for 1998 and they have shown to be well suited to our needs.

Signatures require participants (staff and students) to collect the signature of a person matching each statement on the handout. The key to the activity was the design of the statements such that students could not complete the exercise without interacting with staff (who must also do the exercise), without meeting students of different cultures, and without meeting at least one person in their camp group. This activity provided an excellent start as it did not push the students too far away from their comfort zones. The second ice-breaker was more intimate with students being broken into small groups (approx 10-15) to learn each other's names. Facilitated by a staff member, who again must participate, the students toss a ball around initially stating their names and gradually making this more complex by stating your name and the recipient's, the recipient's name only, and finally building up to calling the thrower's name. The activity is very effective yet is runs surprisingly quickly. Many staff improvise putting their own spin on the activity to make it more interesting.

Ice-breakers form the first crucial step in having the students meet each other and form networks and set the framework for this to continue through the organised activities and free time. The ice-breakers also have the effect of breaking the perceived barriers between staff and students. Staff at the camp are only known by their first names, irrespective of position and qualification.

Forums and Seminars

Show-and-Tell sessions at the camp are kept to a minimum but experience has shown that the students want an opportunity to have some of their concerns discussed and questions answered. Hence there are a number of information dissemination/question and answer sessions. These activities are kept as short as possible with the time saved simply adding to the student's free time. These sessions also provide an important buffer in allowing the students to become more comfortable with each other before we start to expect them to work closely together. The *Introduction to the BE* is used as the formal welcome to the camp and the degree. The aim is to introduce the Faculty and key staff (from the student perspective), such as the Program Directors and Directors of Studies for each program. The structure of the degree is briefly described, as is the Engineering Experience component of the degree. The session is particularly important in alleviating some of the students' fears, especially about getting a job to satisfy Engineering Experience.

The *PC computer forum* is a brief presentation related to student computer needs followed by casual discussion groups based on level of PC experience. It is not about making the students purchase a computer but rather to reassure them that the University does provide computing resources and to answer questions if students have or are intending to obtain a computer for university study. The members of the student society, Society for Electrical, Computer Systems and Mechanical Engineers [SECSME], are a particularly useful resource for this activity. Their view of the University's computing resources is likely to be far more relevant than an academic perspective of them.

A Day in the Life of a ……… Engineer runs later in the camp but is predominantly a mechanism for enthusing the students about engineering and broadening their generally very narrow view of the sorts of activities that engineers experience. Staff members from each engineering discipline describe an interesting event or project from their engineering experience. The attentiveness of the students to the presentations is a clear indication of the value of the session. It also provides another opportunity for the students to learn more about their lecturers and appreciate the engineering experience that lies behind their teaching. An interesting but unexpected outcome, is staff learning a lot about each other from listening in on the stories.

The *Trade Show* on the last evening has staff and final year students presenting and demonstrating their research and projects. It is another opportunity for students to find out more about engineering. In particular, the final year projects give the students an idea of what they will be able to achieve in a few years time. The projects provide tangible proof of the need for the theory they will have to master in the early stages of their degree. The final year students also provide another point of view about the degree, the availability of jobs, starting salaries - i.e. facts which staff can present but which are far more believable coming from students.

Introduction to Civil Engineering - Dome Building

This is the first of the team and inter-personal skills building modules. 15-20 member student teams (named after famous engineers and scientists) are given the simple specification: *build a relocatable, self-supporting dome inside which can fit the entire team and one staff member*. They have 3 rolls of sticky tape, a 40cm high stack of newspaper, and 1 hour [5]. Upon completion, a staff member inspects each dome and provides a critique for each team commenting on how well they met specification, the quality of their design and construction and their planning and teamwork. The need to work together and at close quarters further adds to the goal of getting the students to meet each other and form networks. While this activity requires the cooperative effort of 15-20 students to build their dome, it is a relatively straight forward exercise that does not require the level of team and communication skills of some of the activities later in the camp.

Figure 1. A team of students near the completion of their dome.

Introduction to Electrical Engineering - Shocking Electricity

Students, in their teams, examine an accident report involving an electrocution caused by an incorrectly wired extension cord. Working in pairs, students start by making an extension cord using simple hand tools, standard three core flex and re-wireable see-through three pin plug and socket. All these components are available at a hardware shop, and many students are keen to share their previous experience with the task. Students are then presented with the photos and investigation reports of an electrocution, and discuss how it could have been prevented, who is at fault, etc. The assembled leads are visually inspected by another pair and then electrically tested using an appliance tester. Although only one in one hundred pass all the tests, this activity is not about training students to be electricians. The activity covers issues such as safety, Australian standards, some electrical concepts, and professional responsibility. The students also learn about using tools, the need to carefully follow instructions (most cords fail the visual inspection), and the risks associated with the use of electricity.

Figure 2. A pair of students intently concentrating on constructing their extension lead.

Introduction to Mechanical Engineering - Operation Humpty Dumpty

Having had ample time to start forming networks, students are given the freedom to select a team of four for this exercise. Once they do, they are given a brief scenario describing the need to build a system to protect a device, remarkably well modelled by a raw egg, from impacts. Unfortunately budget cuts mean that all they have are office leftovers: 1 raw egg, 2m of masking tape, 50 drinking straws, and a rubber band. Upon submitting their design, each team fills in a reflection asking students to contemplate issues such as their effectiveness as a team, management of resources (broken eggs are not replaced), quality of design, communication, and planning. After lunch a drop test destructively tests each solution, with increasing height and throwing intensity used until there is a sole survivor, the designers of which are awarded a prize.

Figure 3. Students developing their design for Operation Humpty Dumpty

Introduction to Environmental Engineering - The Toxic Swamp

The *Toxic Swamp* is a large-scale outdoor exercise where the student teams (15-20) are commissioned to construct a decontamination plant before it rains and causes the toxic pond to overflow. Between the students and the *toxic pond* lies a 15m wide *swamp* and some of their essential construction materials are floating on the toxic pond 4m from the edge. This activity therefore engages each team in a major problem solving exercise requiring a high degree of planning, communication, and cooperation. Safety is a key theme. A staff member monitors the group and enforces penalties (time spent in the *first-aid* area) which apply should poor planning or execution result in a student *drowning* in the swamp or being *poisoned* by touching the toxic waste. Such accidents result in the affected person(s) being sent to the *first-aid station* to recuperate. Similarly items dropped in the swamp are *lost* and crucial time must be spent *looking* for them; any items touching the toxic pond instantly dissolve and are lost forever. Planning and careful execution of the plan is critical for success. It is important, however, that the students enjoy the sense of achievement in completing the task but it must remain a challenge at all times. The role of the staff member is crucial. They must assess how the group is progressing and generate *acts of god* to lend a helping hand (eg lost items reappearing) or issue a challenge (items in the pond get blown further away). At the end of the activity, the students fill in a reflection and staff members debrief the activity. Issues covered include quality, planning, and safety. Surveys filled in each year consistently rate the Toxic Swamp and Operation Humpty Dumpty as the most memorable activities.

Figure 4. Five students crossing the toxic swamp on their *swamp mobile.*

Flying High

Flying High is an engineering project based around the construction of paper aeroplanes. Based on an activity from Mears and Voehl [6], this activity introduces many engineering concepts such as engineering finance, engineering development process, risk analysis, testing, quality, and design. The scenario is such that the company employing the students has a contract for paper planes (of a complex design [7] to be built at a remote location. The contract states that the company is rewarded for each plane that successfully flies its mission. The project must be very carefully planned as there is only enough time to have raw materials delivered once. They can only train one *pilot.* Test flights carry a risk of losing the plane. Planes lost on flight missions carry a penalty due to the loss of valuable medical supplies that the flights carry.

This activity was first run in 1999 and was very successful – enjoyed by staff and students. Although no team made a profit, fast thinking facilitators, when debriefing the activity, justified the loss on the basis of the humanitarian nature of the project. The project will be modified so that a well organised and efficient team can make a profit and the activity will be scheduled later in the camp as the level of team skills and communication required make it better suited to a stage in the camp when the groups are working together better.

Surviving University

For many years the camp timetable contained a *Study Skills* activity to help students consider the differences between high school and university study. While some students found the activity useful, feedback from staff and students indicated that many students were unable to predict potential differences as they had not experienced university life yet. For some students it could have even been detrimental in reinforcing high school study techniques that are not at all effective in group based projects. At the 1998 camp two new activities were trialed: *The University Experience* and *University Resources*. *University Experience* paired a current student and an academic with a group of students with the intention of the current student discussing their experiences and answering questions that arose. The academic's role in the activity was simply as a resource, especially in regard to university procedures, in the event that the current student could not answer a question. *University Resources* was basically a show-and-tell session designed to illustrate that whatever the need or problem, there was probably someone within the university whose main role was to assist in regard to this problem. These two concepts were combined in 1999 resulting in *Surviving University*.

Most of the publicity the students have seen about university and the positive upbeat feel of the camp could give the students the impression that everything about university life will be rosy. The *Surviving University* activity is designed to illustrate that students do have problems but that there are people, policies, and resources available at the university to assist them. It also highlights that at university they are responsible for their own learning and well-being – if they don't seek help and assistance then none will come. The activity has three components: a critical reading exercise, a role-play scenario, and short talks from current students. The critical reading exercise is based on the Faculty of Engineering Student Survival Guide [8], a document which contains staff contact details, location and description of various units within the university, maps of the university and Faculty, etc. The activity is designed such that the students learn what the purpose and content of the survival guide is. For the role-play scenarios, each student is given one of four scenarios that have been developed and asked first to answer and then discuss in a small group their responses to the scenario *Could this happen to you? Why?, Where would you go for help?,* etc. Each scenario is intended to represent a different category of problem such as sporting injury, moving out of home, an emotional crisis, and not coping with university study. Once students have discussed their scenario they present their scenario and findings to the larger group. The last component of the activity is to have current students describe times when they have encountered problems at university and most importantly how they dealt with them. Having current students describe real problems and issues had much more impact and is more credible than having a member of staff deliver the same story. The overriding message about problems at university is for students to do something about them as soon as they can.

Free Time and Social Activities

Free-time is consistently rated by students as one of the most valuable activities of the camp, not because it means not having to do an organised activity but because of the friendships built through spending time together playing sport, talking, etc. A wide variety of sports are available including badminton, table-tennis, swimming, volleyball, abseiling (under qualified supervision), soccer and basketball. The camp timetable is designed to have free time between each activity. In addition, all of the camp activities are designed such that at worst they should finish on time so as not to impinge on the free time and also ensure that the camp runs on time and smoothly.

On each night of the camp there is an organised social activity. On the first night a recent release movie is screened. This activity serves two purposes: it does not rely on students having yet formed peer groups, and it does not get the students too wound up making it easier to get the camp settled after *lights out*. Originally the camp finale on the second night was a computer controlled pyrotechnics and fireworks display using equipment developed by a UTS student for his thesis. In 1996, this was not available and *Tricks 'N' Trivia*, a combination of party tricks and trivia, was born. It's initial success and popularity with staff and students alike meant that it became a permanent part of the camp timetable. While it is a social event, the trivia is used to further reinforce the peer and staff networking. Students submit teams of up to 8 and are encouraged to include a staff member in their team. The trivia is a multimedia event with film, music and TV clips, a paper aeroplane competition, component chaos (name the engineering artefact), puzzle sheets, who-am-I, and the usual science, TV, and general trivia. There is also a subtle education lesson in the trivia with a section about UTS. The competition has prizes awarded from around the university such as gym memberships. Of particular value are the *assignment extensions* which cost the Faculty nothing but which are priceless to students.

THE CHALLENGES

While it has been quite a while since the authors were involved in organising the camp, the challenges of developing and running the camp for the first time were again encountered in 1998. For 1998, the camp had to cater for the entire Faculty intake which not only doubled the number of students but also meant that the camp had to deal with students doing a *non-electrical* program. Involving the entire intake meant involving the entire staff of the Faculty. The staff education and training required would be comparable to running the camp for the first time. The camp facilities only just coped with the *electrical* intake - the camp would have to run twice. Twice the number of student assistants would have to volunteer and students from the Mechanical and Civil disciplines would be needed which raised two problems: finding them and then training them. While there are economies of scale to be gained from setting up once, much of the work had to be duplicated and certain management tasks were made more difficult with the camp coordinators unable to return to the university between camps. Finally sleep deprivation also became an issue - two nights is bearable but 4 nights followed by long and hard days takes its toll on the mind and body – especially when the temperatures at the second of the 1998 camps topped 45°C two days in a row.

Much like the first camp that was run, careful planning combined with group and individual meetings resolved many of the concerns and training issues for both staff and student assistants who were new to the camp. Individual meetings with staff members was especially helpful in enthusing them about the camp and its goals. And as happened with the original camp in 1992, there was no problem getting staff to attend the camp in the following year(s) once they had attended their first.

As the 1998 camp coincided with the new degree, there was no longer a strong association between the camp and a single subject. This meant that there were no staff strongly attached to the camp and would therefore attend the whole camp. A detailed schedule, produced well in advance, showing which staff were required at various times minimised the number of staffing conflicts and shortages but problems still arose in terms of having staff attend the camp on a full-time basis – especially overnight. A lot of leg work, many phone calls and a bit of luck resulted in enough overnight staff to run the camp in 1998. 1999 was not a problem as most staff had experienced the camp, were enthusiastic about the camp, and knew what they were signing up for.

Many of the camp's activities are based outdoors and cannot be moved indoors in the event of rain. To date we have been lucky and any rain that has fallen during the camp has not coincided with the outdoor activities, most particularly the Toxic Swamp. Just in case of bad weather, a *spare* activity has been developed. This activity is basically a set of puzzle pages, each of which is a different style of puzzle, such as spatial reasoning, lateral thinking, and logical reasoning. The aims behind the activity are to highlight to the group that there are many different types of problem in engineering and that people have differing abilities to solve different types of problems. While rain is the obvious weather problem, heat has proven that it can also be a problem. The second 1998 camp encountered a heat wave with the temperature topping 45°C on two days. Staff rose to the challenge running discussions in the pool, in the river, and making liberal use of the fire hose.

LOGISTICS

While the logistics of the camp are crucial to the successful running of the camp, the details are relatively boring. The key to a successful camp is enthusiastic staff and student assistants. With these two elements in good supply, the rest of the camp fell into place. For the curious, the students pay a $60 fee to cover their food and accommodation. The faculty subsidises the camp at approximately $10 per student ($4000 for both camps), not including existing infrastructure. The contribution provided by the student assistants (generally members of the engineering student society (SECSME)) cannot be over-estimated. They look after the BBQ lunches, handle the sporting equipment, they sell soft drinks, snacks, etc but more importantly they form a bridge between the new students and the degree. Having an academic make a given statement is nowhere near as reassuring as having a student express the same sentiment. The student assistants also play a formal role in many activities such as the Surviving University and the Toxic Swamp.

To manage the students, we have developed a streamlined process for getting them to the camp, allocating cabins, allocating activity groups, and getting them home. Transport to and from the camp is via buses which depart from a nearby railway station. Students are allocated a cabin randomly and are also randomly placed in activity groups which are named after famous engineers and scientists. This random allocation ensured that students meet many other students and interact with students, across racial and cultural boundaries, ie students with whom they might not automatically network. The only exception to the random allocation is the decision that female students are never the sole female in a group. A key to the efficient management of logistics is to set up an office at the camp including a computer and printer. This allows lists to be updated and consolidated, extra handouts to be printed, etc.

OUTCOMES

Benefits for New Students

Various feedback mechanisms have been used over the years to analyse the camp. A survey is generally conducted at the end of the camp or soon after back at UTS. These surveys display a consistent benefit: the development of friendships and peer networks. Surveys conducted at the end of first semester only lead to a strengthening of the students' appreciation of the camp with respect to the friendships and peer networks that it helped to establish. The activities most enjoyed are, in no particular order, the Toxic Swamp, Operation Humpty Dumpty, Trivia *N* Tricks, and free time. In the surveys, students are asked to rate each activity and it is pleasing to note that there was not a single activity that was not rated the most highly by at least one student - there was something in the camp for every student and every activity was important.

The specific benefits for the students match the goals of the camp: meeting fellow students and forming peer networks, meeting existing students, meeting and understanding their lecturers, discovering the big picture that engineering will allow them to paint, and developing team, planning, and communication skills. There is no doubt that the camp attains, if not exceeds, its objectives. Academics have no trouble identifying the students not at the camp - they are the ones who for the first few weeks are alone, are quieter, are less likely to come forward, etc. Staff commented (some even complained) in 1992, after the first camp, that students were far more willing to engage in discussion and far more likely to approach and question/challenge their lecturer. The camp offers a less threatening start to university and makes going to university less daunting. An unexpected outcome that arises occasionally is that the camp has made a few students realise that engineering is not the right career choice for them - better now than 3 years down the track.

Benefits for Student Assistants

Every year the student society SECSME is approached to provide 16 student assistants for each camp. Every year there are more volunteers than places. Clearly the students have enjoyed the camp as 1st year students and want to experience the camp from the point of view of assistants. The students who assist at the camp clearly enjoy it but they also benefit from their participation. Their communication skills develop through presentations to the students in Surviving University, and they develop leadership and management skills through participation as facilitators of some of the activities, especially the Toxic Swamp. They also benefit from the strong relationships they, as individuals, build with the staff due to the close working relationship over the 5 days. In 1999 we have introduced a mechanism whereby the personal and educational development of the student assistants can be rewarded. Students who assist at the camp and who then make a representation and complete a reflection exercise can gain credit in a new subject Professional Service Project [9].

Benefits for Staff

The goals of the camp are, and will remain, student focussed but there have been significant benefits for the staff involved, and the Faculty as a whole. The orientation camp is the only educational activity in which 100% of academic staff participate with associated benefits in terms of staff team building and socialising. The camp has also played a significant role in helping to integrate the Faculty in the light of the restructuring and the need for staff from all disciplines to work together on the new core subjects of the new BE/DipEngPrac. Apart from the clear benefits gained from working together on a common project and sharing free time together, consider the activity *A Day in the Life of a ______ Engineer*. An unintended result of this activity was that staff ended up knowing and understanding each other a little better. As with the students, the staff also benefit from the opportunity to meet the students away from the pressures associated with delivering and administering subjects. For staff who usually lecture later stage undergraduate and post-graduate subjects, the camp is a rare opportunity to meet the new students.

In 1992, some staff were sceptical about the camp. Once the camp ran the scepticism vanished. A similar experience occurred in 1998. Whilst many staff gave their wholehearted support to the camp, there were some who did not attend. Reports have been received concerning a *hum* in the corridors of Civil and Mechanical Engineering in the week following the camp and a sense that non-attendees have missed something special.

CONCLUSION

Every year the camp has been reviewed using student surveys, staff debriefing, and reflection. This has led to significant evolution in the camp's program and activities. A number of staff have taken on the role of camp coordinator and each one has left his/her mark. The result is a camp that is fresh and dynamic with staff who look forward to the camp. Overall, while the camps have meant a very busy time for the coordinators and other key staff, especially when you consider that the camp is usually run in the week before semester starts, the camp always runs smoothly. The value of the camp to the students is hard to quantify but staff have commented on the remarkable positive difference the camp has made to the behaviour and attitude of the first year students.

The UTS Engineering Orientation Camp has been extremely successful and its longevity proves the value of the innovations it has embodied. Further evidence of the success and value of the camp is seen through its emulation by the School of Computing Science who have borrowed heavily on the planning and educational resources developed for the Engineering camp. The Camp is well known within the UTS community and is highly regarded by departments such as Student Services (especially the student counsellors) and External Relations Unit. The Orientation Camp will continue to be a team effort and the Faculty will continue the process of innovation and improvement to ensure its future.

ACKNOWLEDGEMENTS

The camp has always been and will continue to be a team project with participation from the vast majority of Faculty staff. There are, however, a number of past and present staff who deserve particular mention. They are A. James Boswell (former associate lecturer), Bob Buckley (YMCA Camp Yarramundi), David Eager, Catherine Gordon (UTS ELSSA), Ange Griffiths (YMCA Camp Yarramundi), Betty Jacobs, Nancy Law, Peter Lewis, David Lowe, Michael Marriott (former UTS Engineering student), Jill Montague (UTS Student Services), all the members of the engineering student society SECSME (especially Rodrigo del Busto), the staff from the UTS Staff Development Branch, Terry Stevenson (former lecturer), Elizabeth Taylor, Keiko Yasukawa, and Warren Yates. There are also, no doubt, those who deserve recognition but whom we have failed to mention.

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Appendix 1: 1999 OrIEntation Camp TIMETABLE

The following are a reproduction of the orientation camp timetable as issued to staff and students. Note that the camp runs twice and hence the Day 1 timetable runs on Monday and again on Wednesday. Similarly for Days 2 and 3.

Mon 22nd & Wed 24th February 1999

1	Students meet at Penrith Station	
2	Bus transport to camp: Check off names Getting-to-Know-You Games (Meet at BBQl)	
3	Afternoon Tea: SECSME as orderlies	
4	Introduction to BE (Kidson Hall)	
5	BBQ Dinner: SECSME to cook - Assistance and cleanup Group - Ada - staff to assist if needed	
6	Intro to Aeronautical Engineering (Meet outside dining hall) Flying High Groups: Ada, Brunel, Carnot, Diesal, Edison	Intro to Civil Engineering Dome Building (Kidson Hall) Groups: Faraday, Gauss, Hopper, Joule, Kelvin
7	Personal Computers presentation (Kidson Hall) Personal Computers open forum	
8	Intro to Civil Engineering Dome Building (Kidson Hall) Groups: Ada, Brunel, Carnot, Diesal, Edison	Intro to Aeronautical Engineering (Meet outside dining hall) Flying High Groups: Faraday, Gauss, Hopper, Joule, Kelvin
9	Supper: Cleanup Group - Brunel Staff planning meeting (Dining Hall)	Video: “The Truman Show” (Kidson Hall)
10		
11	Lights Out	

Tue 23rd & Thu 25th February 1999

6	Pre-breakfast games : collect sporting equipment from SECSME students at Sports Store	
7	Return equipment to sports store by 0730	
8	Breakfast: Cleanup - Carnot	
9	Intro to Mechanical Engineering (Meet outside dining hall) Operation Humpty Dumpty Groups: Ada, Brunel, Carnot, Diesal, Edison	Intro to Electrical Engineering (Kidson Hall) Shocking Electricity Groups: Faraday, Gauss, Hopper, Joule, Kelvin
10	Morning Tea : Cleanup - Diesal	
11	Intro to Electrical Engineering (Kidson Hall) Shocking Electricity Groups: Ada, Brunel, Carnot, Diesal, Edison	Intro to Mechanical Engineering (Meet outside dining hall) Operation Humpty Dumpty Groups: Faraday, Gauss, Hopper, Joule, Kelvin
12	BBQ Lunch : SECSME to cook with assistance from Faculty staff as required Assistance and Cleanup Group - Edison	
1	Intro to Mechanical Engineering (Badminton Courts) Operation Humpty Dumpty Project Evaluation (The Drop Test)	
2	Surviving University (Kidson Hall) Groups: Ada, Brunel, Carnot, Diesal, Edison	Intro to Environmental Engineering (Meet outside dining hall) The Toxic Swamp Groups: Faraday, Gauss, Hopper, Joule, Kelvin
3	Afternoon Tea : Clean Up Group - Faraday	
4	Intro to Environmental Engineering (Meet outside dining hall) The Toxic Swamp Groups: Ada, Brunel, Carnot, Diesal, Edison	Surviving University (Kidson Hall) Groups: Faraday, Gauss, Hopper, Joule, Kelvin
5	Dinner Groups: Faraday, Gauss, Hopper, Joule, Kelvin Cleanup Group - Hopper	
6		Dinner Groups: Ada, Brunel, Carnot, Diesal, Edison Cleanup Group - Hopper
7	A Day in the Life of a ____________ Engineer (Kidson Hall)	
8	Trade Fair : Displays from senior students and staff (Kidson Hall and discussion rooms)	Social Evening : SECSME will sell refreshments Supper 2030 : Cleanup SECSME
9	Trivia and Tricks (Kidson Hall)	
10	Staff debrief if required All staff + 2 x SECSME reps	
11	Lights Out 2330	

Wed 24th & Fri 26th February 1999

6	Pre-breakfast games : collect sporting equipment from SECSME students at Sports Store
7	Return equipment to sports store by 0745
8	Breakfast: Clean Up Group - Joule
9	Cleanup Cabins and Camp (Kidson Hall):
10	Buses depart for Penrith - Check off names:
11	

BIOGRAPHIES

Craig Scott is a Senior Lecturer in, and Program Director of, the Computer Systems Engineering Program at the University of Technology, Sydney. He earned a PhD in positioning systems and holds a BE in electrical engineering. Craig’s main teaching role is in 1st and 2nd year software development subjects but he also coordinates the orientation camp for first year students. Craig's research interests are focussed on positioning systems, especially positioning mobile phones - an area in which he is co-inventor of two patents. Of particular interest to Craig are techniques for modelling and then integrating the many sources of information that can augment the radio-location process to resolve ambiguity and increase accuracy. He also maintains an interest in Intelligent Transport Systems.

Vicki McKain is a Lecturer in the Engineering Management and Practice Group at UTS, where she teaches subjects in the Engineering Practice Program and in the Electrical Engineering Program. She is currently undertaking a Masters in Engineering at UTS, has completed an M.S. in Physical Education at Pennsylvania State University, has undergraduate qualifications in Engineering and in Human Movement Studies, and has completed a Graduate Certificate in Higher Education at UTS. Since joining the UTS Faculty of Engineering in 1992, Vicki has been a member of a number of academic teams who have developed *learner focused* curricula for early stage engineering students. Her involvement with the Orientation Camp, both in an organisational and development capacity, has helped her to remain aware of the changing concerns and interests of students as they make that often difficult transition from High School to University.

Robert Jarman is a lecturer in electrical engineering at the University of Technology, Sydney where he teaches courses on topics such as circuits, electronics, and micro hydroelectric systems design. He earned a Graduate Certificate in Higher Education and a B.E (Electrical) from the University of Technology, Sydney, and a Diploma in Electrical Engineering from Sydney Institute of Technology. He currently co-coordinates the stage one subject Introduction to Electrical Engineering and is a member of the teaching team for the stage three subject Engineering Communication. He is also a member of the Faculty Curriculum Learning and Teaching Committee. Robert has had a close association with first year students since 1993 when he was first asked to develop hands-on practical modules focusing on electrical safety. Since then he has developed many self directed learning modules which engage student learning in telecommunications, electronics, and computer interfacing. In 1996, one of his modules was an award winner in the RMIT sponsored Green Heating Quest.

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Reflections on a Residential Orientation Program

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Transition from pre-University environments to University studies can be difficult for students encountering diverse teaching and learning styles, unfamiliar tertiary academic standards and expectations, and new life experiences. RMIT University's Department of Chemical and Metallurgical Engineering addresses these issues in a novel residential Orientation retreat aiming to identify and explore differences in staff and students' conceptions of what it means to be an engineering student within this department. Successful outcomes of the retreat include early establishment of a sense of identity and ownership, improved communication and a wider appreciation of the differences in conceptions and expectations of individuals within the department.

INTRODUCTION

The transition to university life can be difficult for many new students who, when starting at University, have to assimilate and accommodate new and diverse teaching and learning styles, unfamiliar tertiary academic standards and expectations and new social and life experiences. Students bring to their studies various conceptions of learning [1] and most of their views on learning are still evolving. Academics also conceptualise teaching in different ways and their educational beliefs are related to their teaching and assessment practices [2,3]. Furthermore increasing numbers of students enter engineering with considerable ignorance of their chosen profession and discipline [4]. On all fronts there is potential for divergent views and expectations. Failure to recognise and deal with these differences can lead to student frustration, anxiety, underachievement and suspension or cancellation of enrolment. The large drop out of first year engineering students was identified by the William's Review [5] as an area of concern for engineering schools. Attrition rates and retention programs have been studied by a number of investigators [6,7,8,9] who report that reasons for student withdrawal from a particular enrolment are multidimensional. However recurring institutional/cultural themes are lack of course/institution/academic preparedness [7], inadequate departmental or institutional provision for advising on academic, career or personal concerns [8], the competitive nature of engineering studies and failure to develop supportive and collaborative study groups [9]. Various support activities, including mentor and peer tutoring schemes, address these issues during the course of the academic year. We believe Orientation activities before the start of the academic year are also a prime opportunity that could be more widely used to work with students on these issues.

Most Australian universities run Orientation programs that attempt to make new students aware of the nature of university life and the various engineering disciplines, usually through a series of short introductory talks and welcomes from senior staff such as Deans, and Heads of Departments. Notwithstanding the official Orientation activities many first year students still find it difficult to adjust quickly to life at University and are unsure of and insecure with their choice of career, course and institution as they begin their studies.

The Department of Chemical and Metallurgical Engineering, Royal Melbourne Institute of Technology [RMIT] University decided in 1995 to introduce a substantial departmentally based orientation program aiming to assist students with and accelerate their transition to University. Prior to 1995 the department's orientation process involved a half day of fragmented on- campus activities including an address from the Dean, a formal introduction to departmental staff, a tour of campus facilities, a half hour *Getting to Know You Session* run by Student Services, and lunch. Competing demands limited the time and space available for these orientation activities and meant that students were not able to get to know one another, nor meet staff on a personal level. Nor was there any real chance to alert students to or help them develop the skills required for successful transition to University life in general and engineering student life in particular. An RMIT Faculty of Engineering tele-survey [10] of students who cancelled or changed their enrolment during their first year, cited the following as advice that all new students needed to be given explicitly -

- First year…often challenging and different from school…
- Get to know lots of lecturers and admin staff as they can help you lots…
- Be well informed on what the course entails – content, workload, etc…

The last point can be extended to cover course objectives, goals and outcomes which should be public elements of all engineering courses [11]. The prevailing belief that students could be better prepared for entry to engineering studies in the department initiated the development of a more comprehensive orientation program and the introduction of follow up first year activities intended to further address these issues. To deal with the start of year orientation issues a 2-day departmental orientation program was developed and implemented.

The orientation program runs as an off campus residential retreat held just prior to the start of the academic year. It comprises a set of semi-structured workshops, organised social activities, communal duties, and unstructured free time, all targeting specific achievements. Interactive workshop themes are the nature of engineering, communication, team work, learning styles, and multicultural awareness. Course organisation and expectations, from both the staff and student perspective are also major workshop themes.

ORIENTATION RETREAT GOALS

The overall aim of the departmental retreat is to ease the new student into RMIT University life, and in particular to life as a student member of the Department of Chemical & Metallurgical Engineering as quickly and painlessly as possible. Within this brief there are a number of clearly identifiable goals seen as essential.

Goal 1: Establish a Sense of Community.

The first sub-goal of the retreat aims to foster a sense of being part of a team who are interested in learning. This relates initially to meeting, communicating and feeling comfortable with people in the department. Perceptions of universities as unfriendly and impersonal, and staff who are unapproachable, unavailable, uncaring and uninterested in students are cited as concerns shared both by students who withdraw from and those who persevere with their enrolments [7,9]. The retreat aims to ensure that before a student's 1st academic class they have met, can recognise and are familiar with:

- new students with whom they will work for the next 4 – 5 years. Approximately 100 students enter the various courses run by the department every year. The curriculum is fixed with only 12% of the course consisting of electives. Hence the new intake of students will move through the various courses as a cohort. Good working relationships need to be established early to facilitate cohesive team work and learning. In an era where flexible learning, student centred learning, and learning technologies are increasingly important in engineering curricula, the support of fellow students is an essential learning resource for an individual and a vital part of creating and nurturing an effective learning environment for a student team. Living in close contact with each other for two days during which most working and social activities are cooperative in nature fosters interpersonal communication and promotes the early formation of working relationships.
- senior students from the department who can facilitate transfer of departmental *survival skills* to new students and assist with their integration into departmental academic, professional, and social activities. The early inclusion of later year students into the network of students who support the learning of the individual and the cohort is also significant in establishing a smooth transition into the department. Using senior students as facilitators of a workshop session *What I wish I'd known as a first year student* (staff are barred from attending or participating in any way in this session), is not only a exercise in information sharing but also aims at establishing vertical links within the student hierarchy. Using senior students to run the retreat social program further strengthens these connections.
- departmental staff, including administrative, teaching and technical staff with whom they will work. Attendance and full participation in all retreat activities by all departmental staff associated with first year is a key element of the retreat. These people are introduced to students as having a primary role as facilitators of learning. Their primary interest is to advance learning. They are teachers, engineers and mentors, but they also have roles as assessors with control of progression through the course. Students are encouraged to take advantage of the many opportunities provided to talk, work and socialise with these staff in order to establish good two way communication before the official start of the academic year. Students who have played volleyball, set tables and washed dishes with course advisers, lecturers and even their head of department are less likely to feel reluctant about approaching these people for help with their studies.

Goal 2: Investigate *Learning* Paradigms.

The second sub-goal relates to exploring and exposing the nature of the departmental learning environment. Students enter University from diverse educational backgrounds, and with a range of conceptions of engineering, teaching [2,3] and learning [1]. Formal and semi-structured activities are used as a vehicle for alerting new students to what they should expect from this new educational experience.

- Academically, a number of different teaching and learning styles will be encountered during the course. These may be tailored to suit the needs of individual subjects and their associated learning goals as well as the preferred delivery, assessment and communication styles of the teaching staff involved. Students need to recognise that there will be differences and there is a need for versatility in their learning approaches to individual subjects. They also need to acquire and refine the skills to cope with differences in delivery modes, learning objectives, and the underlying subjects' ethos. Another explicit expectation is that students will recognise that boundaries imposed by compartmentalising knowledge into *subjects* are artificial. Learning requires that students are able to move readily across these artificial boundaries and integrate the *compartments* into a personal knowledge hierarchy and learning continuum.
- Professionally, they will be treated as responsible adults entering the engineering profession. Most new students are comfortable with the *technical* attributes of a professional engineer. However many are less comfortable with what they perceive as *soft* attributes of a graduate engineer e.g.

  the ability to communicate effectively…,
  the ability to function effectively…in multidisciplinary and multicultural teams..,
  the expectation and capacity to undertake life-long learning

  The department aims to develop not just technical engineering competencies, but the full range of IEAust graduate attributes [11]. For example the expectation and capacity to undertake life-long learning means their undergraduate course is only one part of an ongoing education process. Attainment of a degree should not be seen as the end of their education but rather as a beginning of their professional engineering education. An integral part of this beginning will be development of the desire and the learning skills needed to embark on a responsible career of long term self directed learning. Each of the attributes identified above is addressed at the retreat during workshop sessions aimed at sensitizing students to these requirements.

Further exploration of the learning environment reviews what the department expects of students.

- Academically there is great diversity in students' pre-university experiences. The department has a large intake of international students (20%) whose educational backgrounds are both diverse and significantly different to that of local students [12]. The local students' educational background is also heterogeneous in nature, with students entering from local high schools, secondary colleges, TAFE courses, and occasionally with industry experience or trade qualifications. The retreat provides opportunities to canvass the assumptions made by the department as to incoming base knowledge, and skills, and how discrepancies may impact on individual student's experiences, particularly in the first year of a course. Identification of deficiencies and discussion of actions to redress these can also begin.

- Professionally, the engineering ethos or culture and professional conduct expected of engineers, particularly in relation to multi-culturalism is another significant focal point for examination during the retreat. The high proportion of international students and local students with English as a second language, or non-English speaking backgrounds are an added impetus for addressing multicultural issues in an attempt to encourage the *salad bowl approach… together, mixed but not merged, each individual enhancing the overall flavour of the mix* [13]. The ability to function effectively in multidisciplinary and multicultural teams is another of the generic IEAust graduate attributes [11]. A semi-structured workshop on Multicultural Awareness explores views of Australian and international cultures and societies from a young adult perspective. The session aims to cultivate both awareness and appreciation of the many differences individuals can bring to a team, particularly in the context of student learning, and also with recognition of the implications for future professional practice.

Goal 3: Disseminate Organisational Information.

The third sub-goal of the retreat is to expedite familiarity with University and departmental procedures, policies and resources. Such matters can consume disproportionate amounts of an ill-prepared student's time during the early weeks of the semester, or the student may continue unaware until ignorance precipitates a crisis. Using retreat time before the start of semester to thoroughly brief students aims to avoid such undesirable events. A number of department/course/subject specific topics including roles of course advisors, course and subject contents, organisation, timetables, assessment and progression, are able to be addressed comprehensively, along with more general themes including time management, and equity issues. The retreat concludes back at RMIT with a student run BBQ and tour of RMIT facilities.

ORIENTATION RETREAT OUTCOMES

The department has run the retreat in its present form for the last 4 years. Attendance at the retreat is not compulsory for new students, but is strongly encouraged. Attendance rates are high. 80% of local students attend, but participation of international students can be as low as 50%. Feedback is collected from students attending the retreat on completion of the retreat and at strategic intervals during their progress through the course. This feedback is used as input to the continuing quality control and evolution of the retreat and how it can best meet its goals. Since its inception student and staff responses to the effectiveness of the retreat have been overwhelmingly in favour of its continuation. Students rate the *effectiveness* of the retreat as 78% where student definitions of effectiveness are many and varied, but are usually aligned with the various goals of the retreat, ie. *getting to know people…, establishing a friendly, cooperative atmosphere…, and learning about the course.* Anecdotal evidence from staff closely connected with first year activities indicates that the retreat does result in a smoother start to the year for both staff and students and that effective communication between students, and staff and students is established early.

Running a residential retreat where explicit statements and examples of expectations and practices from key stake holders are exposed and explored in some depth allows mismatches in conceptions on a wide range of themes to be identified early. Communication channels which allow further investigation of divergence are also established. It is advantageous to all stakeholders (students, staff, the University, the profession and the wider community) to recognise and address such discrepancies promptly. Today's students are increasingly conscious of their status as paying customers, whether as full fee or Higher Education Contribution Scheme [HECS] students. The demands they make on staff, departments, courses and Universities to meet their expectations are likely to become more insistent as costs, both financial and personal, incurred by individual students increase. It is therefore incumbent on the Institution to ensure a reasonable degree of congruence. An orientation program is an early point of contact between the students and the department where management of expectations from both sides of the staff or institution or profession/student interface can begin. It is not possible to identify and solve all potential problems during such an orientation retreat. However it is an opportunity to demonstrate to students that staff, the department and the University are interested in supporting student learning and nurturing the development of a cooperative learning environment. And when students encounter difficulties there is support for working through and finding solutions to problems.

The initiative of such an Orientation program must be maintained, if the advantages accruing from the retreat are not to be dissipated as students progress through their courses. Various schemes such as mentoring, peer tutoring, industry interaction and formal structured staff student consultative processes can all be valuable follow up activities that build on this early interaction to further the goals embodied by this program. Furthermore it is our experience that the effectiveness of these schemes is enhanced when preceded by the residential orientation retreat.

CONCLUSION

The residential Orientation retreat has been a successful innovation for the Department of Chemical and Metallurgical Engineering at RMIT University and we intend to continue with this program. No quantitative evaluation of the program has been undertaken yet and so no correlations with indicators such as progression rates are available. Qualitatively, benefits accruing to students and staff are, a strong sense of identity and ownership, improved communication, an appreciation of the differences in conceptions of engineering, teaching and learning that individuals bring to the department, and an understanding of how those in the department can work together to manage differences. We recommend the use of such a program as a valuable transition support mechanism.

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BIOGRAPHY

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Easing the High School - University Transition for Students in Civil Engineering at UTS.

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Surveys about first year university students presented in recent literature often suggest that their classes are close to being disaster areas and their initial experiences are far from rewarding. In Civil Engineering at UTS there has been, for a long period of time, a policy that new students must be taught by experienced staff so that they may participate in good initial learning experiences. This is particularly necessary, if students are to quickly begin to become life long learners. The new subject, Introduction to Civil Engineering, uses many keen staff, who make use of a large number of teaching mechanisms which have been identified as guiding students towards self directed learning. Individualised open-ended assignments are set, which allow students to collaborate to develop basic concepts. The properties of engineering materials and basic structural principles are explained in non mathematical ways by using house hold items such as paper, marbles or spaghetti, so as to build on students' prior knowledge. In this way, the general problems normally faced by students in first year are largely overcome. If students are specifically asked to respond to an open ended survey, they will always identify that they do have some problems in making the transition from school to university studies. However the ones commonly identified by UTS Civil Engineering students are far removed from, and are far more minor than, the generally quoted problems facing new university students around Australia. In fact, over 80% of first year Civil Engineering students indicated they were happy or very happy with their initial course experiences.

MOST COMMONLY EXPERIENCED PROBLEMS

Most students commencing university studies experience very similar problems. Care needs to be taken when reading reports of students' perceived problems however, as different Faculties take very differing attitudes in making allowances for, or even recognising the existence of, such problems. The staff, of the Faculty of Engineering at the University of Technology, SydneyUTS, have for some time considered that the difficulties faced by new students would be:

- moving from a well known and familiar place, i.e. School, to a totally new environment, which may also include leaving home and family for the first time;
- commencing a new way of learning with few, if any, friends or other support;
- being the *juniors* again; and coping with a much longer day compared to the School 9 am to 3 pm day.

These issues indicate a perception that the significant transition problems are external to teaching staff's interaction with students.

McInnes [1], in a Committee for the Advancement of University Teaching [CAUT] initiative, using a sample from seven institutions around Australia reported that *barely half the first year students surveyed in 1994 for this study found their subjects interesting, and slightly less than half said that staff were good at explaining things. Only 53 per cent had the impression that the academics that taught them were enthusiastic about the subjects they were teaching. Only 43 per cent agreed they got satisfaction from studying and over one third had given serious consideration to deferring [their studies] in the first six months….* This paints a terribly negative picture of the experiences of new students. It also highlights students' expressions of satisfaction are likely to be, at least in part, related to their lecturers' performance.

More recently, Ramsay et al., [2] reported studies of first year students where interviews were conducted with 20 students. In their study, the major items of concern for students were:

Lecturer/lectures	40%
Group Work	20%
Tutorials	15%
Reading Skills	10%

This list was prepared from a group, which comprised 40% international students and related to a Business course.

Appropriate staff planning and improved pastoral care can overcome many of the difficulties reported by McInnes. Thus, it is important to realise that students' reported perceived problems will differ depending on the make up of the student body, the course of study, and the amount of planning and preparation that staff have done to previously identify students' problems and to implement assistance for students. However, an inescapable message from the studies by McInnes and Ramsay is that students often find first year lecturers uninspiring.

FACULTY WIDE INITIATIVES TO ASSIST STUDENTS AT UTS

The Faculty of Engineering at UTS undertakes several initiatives to assist first year students. Probably one of the most valuable is an orientation camp, conducted just before classes commence, at which all recent school leavers must attend. This can involve about 350 students and is therefore run over two, two-day sessions with up to 200 students. Here students have a chance to meet other new students and staff. There are opportunities to meet students both across the Faculty and in their own area of specialisation. While a core group of staff lives in for the whole camp, most staff attend for at least one half day session per camp. Any staff, who teach in first year or have specific duties that relate to programs or with student pastoral care, must attend and will talk with the appropriate student groups.

The other Faculty wide initiative is the operation of two Learning and Design Centres (LDCs) during semesters. A member of the support staff is always on duty during the hours of opening, which are typically between 11 am and 7 pm. The LDC provides a friendly, inviting place for students to study, where duty tutors are available at times of heavy student demand, such as lunchtimes etc. and many staff attend at other free times during the day. All staff are expected to spend at least one hour per week in one of the LDCs. The Centre also acts as a resources centre where video tapes, manuals, or specific items of equipment, which students may require for assignments, eg. planimeters, may be obtained for use inside the LDC. The LDC thus becomes a focus for student work, whether as an individual or in a group.

These two Faculty initiatives are aimed at encouraging students to develop supportive relationships with other students and with staff members.

ATTITUDES WITHIN THE CIVIL ENGINEERING GROUP TOWARDS NEW STUDENTS

Prior to 1997, the Faculty structure was of three independent Schools. The attitude of the Heads of the School of Civil Engineering, over many years, was that teaching to first year students should always be of top quality. Teaching first year classes was not seen a punishment, nor a way to blood new recruits. Wherever possible, only staff who have shown evidence of being good teachers to junior classes and who have relevant engineering experience are allocated to give the major components of the subject, so as to specifically avoid the problems referred to by McInnes above.

FIRST YEAR ENGINEERING PROGRAMS AT UTS AND INTRODUCTION TO CIVIL ENGINEERING

In 1997, the Faculty restructured and, in 1998, a totally new Faculty wide course was introduced. In the new BE DipEngPrac course, all students in the Faculty study eleven core subjects. They also study 16 field of practice subjects, which focus on their chosen major, and five totally free electives.

Core subjects occur throughout the eight semesters of study. However, as basic subjects such as Physics and Maths are in the core, there is a predominance of core subjects in the early stages. In first semester, for example, a student will study three core subjects, often in Faculty wide groups of about 300 students, and one field of practice subject. This subject aims to provide a context for their future studies and also assists students who may not be completely sure about which field of practice area they want to study. Each field of practice area, such as, Civil, Mechanical and Electrical Engineering etc. has created its introductory subject.

These introductory subjects therefore provide the first major opportunity for students to gain an exposure to the field of practice of their choice. It is also an excellent opportunity to use specially planned activities to overcome many of the transition problems which new students face. The Civil Engineering Group took a conscious decision that the new subject, Introduction to Civil Engineering, had to be of a high standard and promote student interest and motivation as well as learning. More simply put, lecturers and the subject had to be inspiring.

The Course Planning Document [3], prepared for the new degree at UTS emphasises that the outcomes of the new Course must be the development of particular graduate attributes. For each year of the course there is a particular educational development focus. Over the course, these range from focussing on the University experience to becoming a reflective practitioner. While they are written as applying to each year they are interpreted as being a continuum not as separate discrete steps. Some of the main objectives of first year are to have students become aware of the different fields of practice, gain an overview of professional engineering, to develop academic and information literacy skills. However, students are also expected to be introduced to some of the higher level skills associated with being a reflective practitioner such as critical thinking, and self-directed learning. This means that in the curriculum development for the new subjects there was a much wider scope than simply content. Introduction to Civil Engineering was developed after considering the skills of available staff and the content that they could provide that offered the best chance of enhancing the appropriate graduate attributes. Thus staff capabilities, subject content and graduate attribute issues were closely connected considerations as the subject curriculum was developed. This, in part meant that staff with a keen Laboratory focus arranged for special demonstrations in the Laboratories, while others with well known presentation skills were signed up for one off lectures or a series of classes. This approach may be considered an unusual one to adopt as a solution to an educational problem. However, a critical objective of the subject, in the development of graduate attributes, was to offer students role models, who are committed and dynamic, and who demonstrate a fascination and love for civil engineering. The ability to have a flexible curriculum in a first year introductory subject provided the scope to align staff with aspects of engineering they found interesting and exciting. The subject also was developed to allow for a mixture of learning styles. As well as normal lectures, the subject included aspects of problem based learning, small group work and individual learning.

The authors' experience is that obvious staff effort and enthusiasm motivates students. Other highly successful factors include:

- demonstrating the relevance of the subject content to the students' future professional practice;
- structuring tasks both in class and for assessment that mimic real, practical professional tasks;
- allowing reasonable individual freedom in approach and content of assessment tasks; and
- insisting that students take responsibility for their choices and progress.

In essence, it has been found that asking students to behave like employed graduates on tasks they perceive to be similar to what they could expect to encounter, is well received.

DEVELOPING SELF-DIRECTED LEARNING SKILLS

The highest education objective of the new BE is to have students who are able to carry out self-directed learning and research. For this to be achieved, students must make the transition from being child like, or teacher directed, students to adult self-directed learners. Knowles [4] provides an excellent table showing the major differences between child like learning (pedagogy) and adult learning (andragogy).

Table 1 Key Differences Between Pedagogy and Andragogy

	Pedagogy	**Andragogy**
1. The need to know	Learners only want to know what they have to learn in order to pass.	Adults need to know why they need to learn something (ie *relevance*)*
2. The learner's self concept	Learners assumed to be dependent on the teacher.	Adults recognise they are responsible for their decisions. (ie *maturity*)*
3. The role of experience	The learner's experience is on little worth as a resource for learning.	Adults experience is a key resource. Emphasis on *individualisation** of

		learning.
4. Readiness to learn	Teacher determines the moment of readiness - often based on chronological age.	Adults ready to learn when they see the need.
5. Orientation to learning	Learners assumed to be subject oriented.	Adults task centred or *problem centred.**
6. Motivation	External motivators such as grades, parental approval seen as dominant.	Internal motivators such as self esteem, job satisfaction seen as most potent.

(* authors' emphasis)

As can be seen in Table 1, adults learn because they realise that what they are learning is essential for them and their careers. They will learn when they are ready to learn because the material is seen as being relevant. They learn best when the situation is task centred and they have responsibility for their learning. Adult learning will be individualised as each learner draws on their own experiences and needs and also sees different results of their learning. According to Knowles [4], adult learning is highly dependent on the learner's pre-existing experience.

One difficulty for University educators is that it is impossible to even expect that many students straight from High School will have even started to move from pedagogy towards andragogy. While many may have good motivation, the vast majority will have no real world experience of engineering to draw on. Without experience to draw on, it is very difficult to expect that students will see why they need to learn or have a good orientation towards learning. However, it is the authors' belief that by careful presentations and provision of realistic learning experiences, which are closely related to the real world, students will begin to move towards the desired adult learning attributes as relevance is made apparent and real world consequences made clear. Students will be assisted in this journey if led by enthusiastic and dynamic staff. On the other hand, if the classes are seen as boring or irrelevant to the real world or students are unable to feel that they have some individual control they will continue along the pedagogical path.

It is noteworthy that the aspects the authors' have found to increase students' enthusiasm are the same as those identified by Gibbs [5] as promoting adult (or deep, rather than surface) learning.

The inclusion of aspects of problem based learning, small group work and some individualised learning amongst the learning styles allowed for also promote the transition to adult learning. Ramsden [6] indicates that the use of such styles increases the use of deep approaches, improves the retention of information and develops students' independence and motivation.

Thus, the subject, Introduction to Civil Engineering, encourages the development of adult learning styles by allowing students to undertake work in small groups, and also individually, on a variety of topics of their own choice and common assignments.

THE VITAL IMPORTANCE OF FIRST YEAR CLASSES AND TEACHING

Ensuring a top quality product for first year students does have a certain amount of self (ie. financial) interest for universities. In less popular disciplines, minimising the drop out rate and therefore having more students proceeding to senior years does make for a much more viable course. Many first year students have strong links to secondary school pupils and if first year is not fulfilling it is possible for a course to lose status amongst future potential students. However, one of the main aims of any university course, and certainly the new UTS course, must be to produce graduates who are life long learners [3]. In other words they will emerge as self-directed adult learners rather than the teacher directed child like learners of their school years. Despite excellent work by many teachers in High Schools in New South Wales, the vast majority of students, and males particularly, who enter university directly from High School are still immersed in child like learning habits.

University teaching therefore has to assist students to make the transition to adult learning habits. To generate greater value from University studies it is better if these habits are gained earlier rather than later.

From a cognitive point of view, Biggs [7] points out that *learning is a way of interacting with the world. As we learn our conceptions of phenomena change…the acquisition of information in itself does not bring about such a change, but the way we structure that information and think with it does. Thus education is about conceptual change, not just the acquisition of information.*

He goes on, *such conceptual change takes place when:*

1. *It is clear to students what is appropriate, what the objectives are, …and when these objectives are buried in the assessment tasks.*
2. *Students experience the felt need to get there…. Motivation is a product of good teaching, not its prerequisite.*
3. *Students feel free to focus on the task, not on watching their backs.*
4. *Students can work collaboratively and in dialogue with others, both peers and teachers.*

The subject Introduction to Civil Engineering tries to set students on the road to andragogy by following as far as possible the steps espoused by Biggs. As has been discussed earlier, this is seen as both academically responsible and as a means of inspiring students.

OVERVIEW OF INTRODUCTION TO CIVIL ENGINEERING

The aim of the subject is to not only talk about Civil Engineering in classes but to set assignments to ensure that the students actually experience, as far as is possible, the joys of Civil Engineering. It is structured with two major themes running over a large part of the semester. The first is Surveying, which leads, via levelling, plan reading and drawing, and calculations of areas and volumes, to students undertaking a design of a length of a stormwater drainage line. The second relates to the properties of basic engineering materials such as steel and concrete and culminates in students building and testing a spaghetti bridge. Woven through this is the context of engineering management and the engineering environment. The existence of central themes was considered important to provide curriculum cohesion and continuity that would help students to build a rapport with the subject and its leaders.

Around each of these two main themes are cameo lectures by other members of staff in which their special area of expertise is explained. Here students learn about topics as diverse as structures and structural dynamics; soils and earth retaining structures; roads and transport; bridges; water and hydrology, and an overview of the history of Civil Engineering.

The Surveying Section

For Civil Engineering students, basic Surveying skills are very relevant. Not only do they provide basic hands-on relevant experience, but it is an activity that many will be required to do in their first period of Engineering Experience. This section of the subject starts in week 1, so working in a small group for the field work (about three hours) is a good ice breaker and a way of students getting to know each other. One student comment garnered from student subject responses stated: *I liked the way we were able to do surveying so early on in the course which really got me involved in the subject… not only were we able to physically use these things* [levels etc] *but we were able to work in groups which enabled us to meet people.*

Having levelled a long section, students are then provided with a contour plan of the site and have to determine catchment areas. The overall aim is to design a length of stormwater pipe, plot the longsection and to cost the construction. The students are told that each one will have their own individual set of design data. The scope of the exercise allows for many items to be varied. For example, the land characteristics can be changed to vary run-off quantities and excavation costs, trench widths and bedding thicknesses can be varied and starting and finishing invert levels changed, amongst many others.

In this way, students have to make their own design decisions. It may be as simple as; do I use a smaller pipe, at a steeper grade with a greater excavation cost, or is a larger pipe at flatter grade to be preferred?

By having individual data to work with, students are able to discuss the problem to sort out their conceptual difficulties but ultimately each student has to do their own individual calculations, without worrying about competing against other students. This precisely meets the requirements Biggs [7] of focussing on the task collaboratively. In the words of one student, *It must also be noted that of all the exercises undertaken in the course, this has been one of the best exercises for encouraging teamwork. Not only in the practical session, but among people you have never spoken to in an LDC, or brief acquaintance, the assignment has often been discussed, questions asked, points clarified etc.…*

Students' fresh from the competition of Higher School Certificate [HSC] marks commented on the lack of pressure and the enjoyment of having their own particular project to do. *It also provided the opportunity to develop my own personal intuition and response since there was unique data I was to apply to my plans…* was one student comment. *The individual data sheet is a great way to avoid cheating and adds that extra bit of reality to the project…* commented another.

A debriefing session is essential when the work is handed back. With all the collaboration occurring, if a misconception gets planted it will take root and spread rapidly. At the debriefing, the students are also able to experience the joy or sadness that comes after lodging a Civil Engineering tender; finding out whether it was successful or not. At this stage it is revealed to them, that there were in fact only 14 sets of data. Even if some of them have realised this earlier, it does not cause a problem to the assignment, as there are three adjacent but slightly different longsections used, simply to avoid congestion during the Surveying field work. Thus even if the data set is common, the different longsections will require a sufficiently different design. By adopting a simple scaling method, based on the length of the line, to bring the three different longsections to a common cost standard, the students can now be informed of how their construction cost compared with others who used the same data set.

Winning tenderers are recognised and every student gets some feedback as to how their individual design rated when compared with others working on a similar problem.

Civil - Structural Section

In the second major strand, which runs through the course, students are exposed to many aspects of civil engineering. Initial lectures include the phases of engineering work and the concept of a project or facility life cycle, the role of engineering drawings, contract specifications, standards and industry practice. A major bridge (Mooney Mooney Creek) which is located north of Sydney is used as a case study in the development of these concepts. The integration of a case study assists in providing relevance. Following these initial lectures the strand pursues the properties of basic engineering materials, the structural behaviour of reinforced concrete, prestressed concrete and structural steel, important construction techniques associated with these materials and engineering decision making.

Simple demonstrations using home based materials such as lego, marbles, timber blocks, wire, rubber bands, foam rubber, paper and spaghetti are used to show aspects of material behaviour and concepts that are mathematically complex. Every effort is made to involve the students in classroom activities by asking them questions about what they think will happen, or what a particular observation means. The strategy is in part seeking to motivate but more importantly the aim is to get students thinking and informing themselves. Simple materials and home-fabricated devices are used to emphasise the point that students can investigate and gain basic understanding for themselves without any extensive laboratory equipment. In other words, students’ engineering concepts are created and developed by building on their existing knowledge. This has long been recognised as being an excellent way to achieve meaningful or deep learning, (Ausubel et al, [8]; Entwistle and Ramsden, [9]).

Demonstrations explore –

Concrete:	mixing, forming, casting
Reinforced Concrete:	tension and compression, reinforcement, flexural cracking, deflection, anchorage and bond, diagonal tension failure
Prestressed Concrete:	the concept, relationship between tendon location and internal stress distribution
Structural Steel:	primary buckling, local buckling and lateral torsional buckling

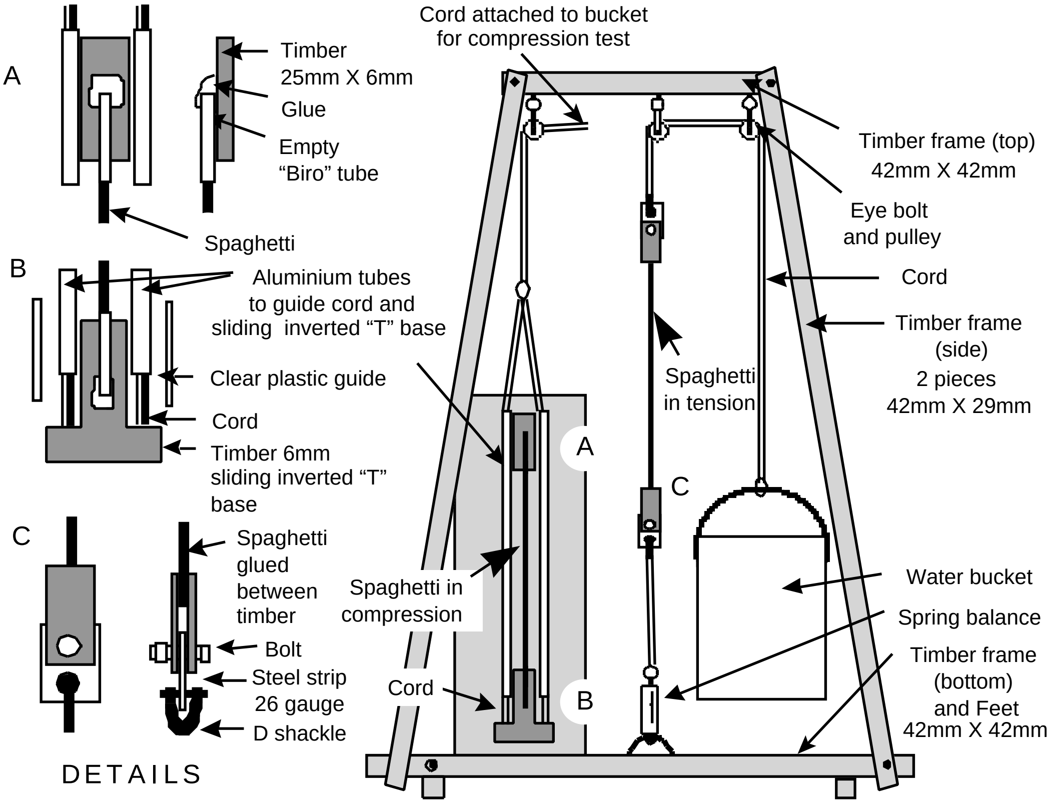

Figure 1 Schematic Diagram Spaghetti Testing Machine

A typical example of class demonstrations is the *spaghetti testing machine*, Figure 1 provides a schematic diagram of the home made apparatus. Water is used to provide the load because it is easy to progressively apply load, conversion to kilograms is easy and it also offers students some excitement as they hope for accidental spillage. (The first use of the machine involved the near drenching of slide and overhead projector power cords and provided a great opportunity to discuss occupational health and safety.) Students are asked to predict the behaviour of full-length spaghetti in tension and compression and half-length spaghetti in compression. (Typical failure loads are in the order of 6.5, 0.5 and 0.8 kg. for the three cases respectively.) The results and behaviour observed is related directly to discussion of structural steel members.

A final class activity requires students to work, in small groups, to build a bridge out of spaghetti and araldite glue to meet specified geometric and material requirements. The bridges are tested publicly in class time and prizes are awarded based on load per unit weight, elegance and cleverness of design, and ability to predict behaviour. Figure 2 shows one group testing their prototype structure.

The strand ends with case studies of a number of Sydney metropolitan pedestrian bridges. The case studies are used to emphasise the need to consider community views and that decisions throughout the feasibility, design and construction process rely heavily on judgement and common sense. The use of local examples, which many students have seen, creates interest.

Figure 2 Spaghetti Bridge Testing

Other Aspects of Introduction to Civil Engineering

The class also goes on one site visit to see an actual engineering project. This varies year by year depending on which particular projects are available or deemed most relevant.

In tutorials, students have the opportunity to develop communication skills through presenting seminars and other written work. One of the first topics to be researched relates to the history of Civil Engineering where they have to research and report on some structure or a famous engineer. In this way, again very early in their course, students are required to use the university library. Thus, the first part of the subject continues their orientation by forcing them, not only to find where the library actually is, but how to use it.

In another assignment, each student has to select one engineering artefact and to analyse it conceptually as to the likely forces it was designed to cope with, how it might have been constructed and the implications on its design that this might have had. Here again students are able to have control over their learning through their choice of artefact. Selected objects have ranged from bridges, to items of playground equipment to a tennis court fence to a cattle grid or a simple bus stop shelter. Again, collaboration is encouraged but individual work is required. There is an important by-product of having such a focus, which should be mentioned here. Because of the variety of topics, marking of these reports by tutors is much more interesting than marking multiple efforts at the same topic. Thus the feedback provided to students is of a higher quality.

SUBJECT SURVEYS

Staff have keenly sought student opinion on the new subject as part of reflective practice and to identify further improvements.

In 1998 the University’s Centre for Learning and Teaching’s (CLT) standard Subject Survey for student evaluation of teaching which incorporates a confidential collection process was used.

In late 1998, the CLT redeveloped its standard teaching and subject survey instruments. As a consequence it was not possible to use an identical survey to that undertaken in 1998. The decision was taken to survey the subject in 1999 using the National Course Experience Questionnaire (CEQ). In retrospect this decision may not have been the best. The survey instrument is designed to evaluate a course and has a thrust which does not necessarily suit a single subject, particularly a first year one. A seductive reason for the decision was the ability to make some benchmark comparisons to national data.

In addition to the CEQ survey, students were asked to complete a second survey. The survey was based on open-ended questions such as:

- what can a first year student expect at university? (Separate and equal sized spaces were provided to record GOOD and BAD aspects).
- what are the significant differences from your expectations**?**
- The survey also asked questions about selecting courses and careers, these will not be discussed in this paper. In addition to making comments students were also requested to indicate their opinion on a five point scale to the two final questions:
- What do you think of your course so far? and
- What do you think of UTS?

Open ended questions were chosen to *tease out the issues*, but the down side of the approach is that quantitative assessment is more difficult

SURVEY RESULTS

1998 CLT Survey

The 1998 CLT survey was returned by 70 out of 78 students. Figure 3 presents a histogram of the compilation of all responses to the 13 survey questions and thus gives an overview of student reaction to the subject.

On questions directly related to teaching, the average of student responses on a 5 point scale were:

Teaching staff seem very well prepared (4.7)
The teaching staff provided a well coordinated approach to this subject (4.2)
The lecturer presents material in an interesting way (4.4)

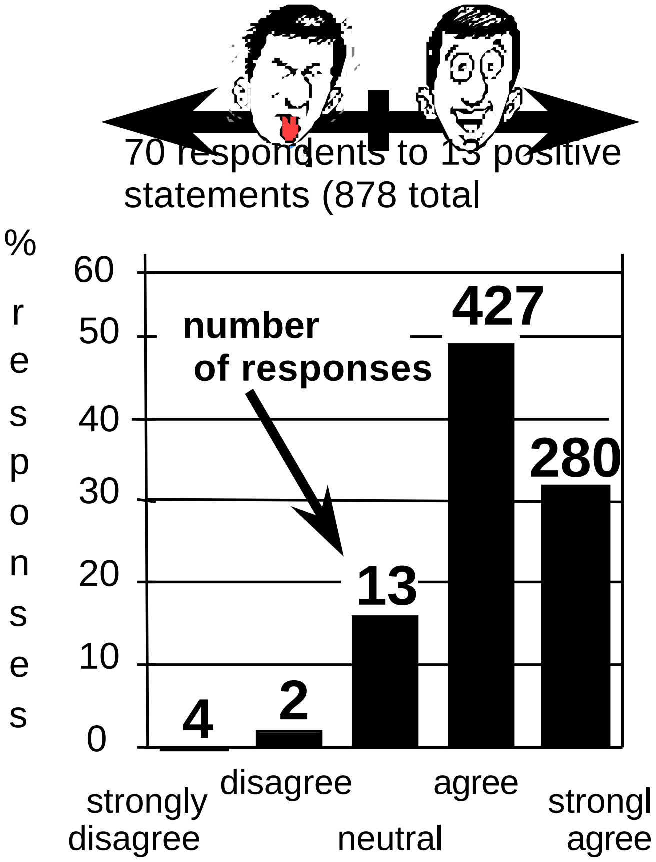

Figure 3 1998 CLT Survey Results

1999 CEQ Survey

A total of 66 students from a possible 83 responded to the CEQ survey used for the 1999 subject survey. Table 2 presents the responses in accordance with the standard CEQ scales together with the 1998 national results for engineering courses

Table 2 1999 CEQ Survey results

CEQ RESULTS	Introduction to Civil Engineering 1999	National Results Engineering Courses 1998
Good Teaching	36	-6
Clear Goals and Standards	13	11
Appropriate Workload	10	-18
Appropriate assessment	31	20
Generic Skills	27	36
Overall Satisfaction	54	30

1999 Issues Survey

The second 1999 survey (Issues Survey) containing open-ended questions was returned by a total of 75 out of 83 students. The content of the students' responses was analysed and Table 3 presents the most important issues identified and the corresponding percentage of students raising the matter as an issue.

Table 3 Issues Identified by Stage 1 Students.

Issue GOOD	%	Issue BAD	%
Freedom, lack of formality, few rules	53	High work load, fast pace	56
Social life, activities, interesting people	47	Expected to learn and manage by yourself	27
Learning interesting things	20	Travel distances	20
Expected to learn independently	16	Limited contact with teachers	13
Bar, alcohol available on Campus	15	Some lectures boring	12
Lecturers friendly	10	Expensive books, travel	9
Treated like an adult	8		

As part of the final questions of the Issues Survey students were asked to rate their opinion on the course so far and UTS. The results are presented in Table 4.

Table 4 First Year Student Opinion of Civil Engineering Course and UTS

ATTITUDE	**To Course**	**To UTS**
Very Happy	42%	45%
Happy	42%	46%
Not Sure	12%	6%
Disillusioned	3%	1%
Very Unhappy	1%	1%

Student Comment

The following comments are representative of the student written responses on the Introduction to Civil Engineering subject and the Stage 1 course experience.

- **Related to the course;** *a lot more relevant than school ..the surveying was fun and the bridge assignment is too, I am finding what I learn interesting, I think it is awesome, …. absolutely thrilled that I chose to move to Sydney from rural NSW, to study it, I have learnt a lot of new concepts, I am enjoying this learning experience, excellent hands on, I can see how it is related to the job I will be doing, good at developing our teamwork skills I loved it!, The fact that it covered such a wide range of subject matter gave us a great insight into the range of opportunities for specialisation.*
- **Related to the lecturers**; *The lecturers are enthusiastic, good lecturer/student relationship, I transferred from another University I love UTS lecturers…, the lecturers try to make it interesting and teach in other methods than just copying overheads or chalkboard, up to you to seek guidance, however the lecturers are very obliging, lectures were exceptional, all had a high level of preparation and included the students well, Overall I really enjoyed Intro to Civil and liked the staff. It was a good start to my studies at UTS.*
- **Related to people;** *not as scary as I thought it would be – there is always someone to ask if help is needed, ugly buildings but cool people, the people who run it are great, the whole atmosphere is very friendly, good support for students, very welcoming kind of place, very helpful in the way of teacher student openness …It…university that has no 'majority' feel about it whether the issue is political views, race or age.*

COMMENTARY ON SURVEY RESULTS

The 1998 CLT results are a strong endorsement, only 25 out of the 878 responses to all aspects of the subject were negative. An objective from the outset was for lecturing staff to act as role models demonstrating both enthusiasm and commitment. The students' responses to questions directly relating to teaching staff indicate that this objective was fulfilled.

The 1999 CEQ survey of the subject enables comparison at a national level. Again students have strongly endorsed the teaching staffs efforts in regard to *good teaching* and the *appropriateness of subject workload*. *Overall satisfaction* with the subject is also significantly high. The scale for *generic skills* is possibly misleading given that this subject is a first year one and a comparison is being made to data for overall courses. The result for *Clear, Goals and Standards* is not surprising as students expressed concern about this issue during the semester, this is further discussed below.

The results from the first year opinion survey are interesting. The obvious potential to have a great social life at UTS was a surprise! In the survey, even when some disillusionment was expressed positive social possibilities were noted *I thought that there would be better looking and more mature guys, work would be significantly harder and I wouldn't have much of a social life* It was also a surprise that a high number of students (20%) commented upon being unhappy about the time taken in travel. The authors, whilst not overjoyed by travel times themselves, thought that students would have been prepared for this unfortunate fact of working life in Sydney. Also UTS is located in the central business district and is better serviced by public transport than some other metropolitan universities.

The students' positive response (53%) to new found freedom and lack of formality and rules was anticipated. Positive comment on social life (47%), availability of alcohol on campus (15%) and being treated like an adult (8%) further emphasises that students appreciate the freedom they are afforded

The issue most raised by students (56%) was the high work load and fast pace of the course. This issue needs to be explored further. In regard to the subject Introduction to Civil Engineering, the CEQ based results suggest students were satisfied with the appropriateness of the work load.

Comments on high work load appear to be closely related to the issue of students being expected to learn independently and manage themselves. 35% of students mentioned this issue, a number (8%) seeing it as both positive and negative. 16% of students considered the need for independent learning as good thing, however, a much great number (27%) felt it was bad. The negative view is reinforced by 10% of students being unhappy about limited contact with teachers. *it's harder to see a teacher, one on one contact with teachers not as available* [as at school] and *no real relationship develops between students and teachers.*

The Civil and the Civil & Environmental Programs at UTS have in place a Student Staff Consultative Committee which meets three or four times each semester. This year's three Stage 1 representatives on the committee brought to light a difficulty that students were experiencing in the subject. Students were concerned by the breadth and volume of material being covered and the fact that little guidance was given as to the relative importance of different topics. At the next meeting of the class a discussion was held about the need for breadth to provide a realistic understanding of the discipline and its context within industry and the community. In addition, the material considered *important to know* and that requiring an *awareness* was identified. This was again noted by the students in the survey: [School] *teachers lead you through absolutely everything…..HSC was much easier to learn, there was a set textbook and the questions were basically always the same……… and definite things you had to know*. The CEQ based results suggest that the students were not entirely satisfied with the action taken as a result of their expressed concern.

It would be easy to dismiss the students comments on work load and unhappiness about being expected to learn for themselves as a lack of recognition that with the so seductive and captivating new found freedom comes responsibility. This concept was recognised by a number of students *you don't have to do anything you don't want to. However you must be prepared to accept the consequences of your actions*. However, assisting the early stage student to move from *child like learning* to *adult learning* should be an integral part of the lecturer's role. In the authors' opinion the responsibility is a shared one.

The most commonly experienced problems for first year students, as identified by McInnes [1] and by Ramsay et al.[2] and reported at the beginning of this paper, are predominantly associated with the teaching activities of staff. The results of all three surveys indicate that the steps taken by Engineering at UTS has greatly increased student satisfaction in these areas. The surveys do not provide evidence to conclude whether staff enthusiasm or an attempt to motivate students by use of teaching approaches known to promote adult learning has been responsible for high students' satisfaction. However, indications are that the presence of both can be a highly potent approach.

The Issue Survey results (Table 4) indicate that more than 84% of first year students in Civil and Civil and Environmental Engineering are happy or very happy with both their course experience and UTS. This is an excellent result particularly if considered in the context of the results of McInnes (1995) who found that *39% of first year students were not prepared to say that they were enjoying their course.*

THE NEXT STEPS

The concept of learning from experience, or action research, has long been recognised. Kolb [10], and Kember and Kelly [11] have written two books amongst a myriad of others. Thus, while staff are very happy with the results of the students' surveys, the task is never ending. This is important for two reasons. Firstly, good professional academic practice demands it and secondly it serves as a good example to the students. If it is expected that they will become reflective practitioners then they must see it being undertaken by staff in addition to being told about how to do it and made to do it themselves. To achieve this, staff tell each new group of students what were the concerns of the previous group and the steps that have been taken this time to improve the situation. In this action research is championed in a positive way.

Some thoughts, at this point in time, for the next student intake include, formal definition of *need to know* and *awareness* components, class discussion of the above survey results and discussion of self and time management skills.

CONCLUSION

The restructuring of the Engineering Faculty at UTS and the ensuing total rewriting of the BE degree created a unique opportunity to develop a special introductory Civil Engineering subject. The course was prepared with the development of specific graduate attributes in mind and critical educational development foci were listed for each year of study. In this way, the shackles of rigidity that a content focussed course can have were greatly relaxed. Civil Engineering staff created a subject, which was designed to inspire students, to make first year enjoyable and by capturing their imagination, move them along the path towards self-directed learning.

Adult learning will occur when the material is seen as being relevant and necessary and internal rather than external motivation is present. Further, it has been claimed that motivation is a result of good teaching not its prerequisite. From its creation therefore, it has been an essential prerequisite that the subject Introduction to Civil Engineering must be taught at a very high standard and must present relevant material, which directly involves the students. It is believed that these are essential ingredients in moving students from child like learners towards adult learning.

By analysing the difficulties for first year students that were noted both at UTS and more broadly, planning remedial actions, putting them into action then evaluating the results in a continuing cycle, the subject Introduction to Civil Engineering has now advanced several evolutions forward. Thus the problems mentioned by UTS Civil Engineering students in making the transition from school to university are a long way from the commonly presented list of problem areas for new university students. High quality teaching and an emphasis on established guidelines such as making sure students know what is expected of them and allowing them to focus on the assignment tasks collaboratively mean that there is a very high degree of satisfaction for new students in UTS Civil Engineering. Students will always identify problems, when given a chance to do so, but the problems noted are several generations removed from the usually published list and do relate to the expected difficulty of acquiring new learning skills.

Acquiring and utilising new learning skills is a major area of concern for students. Many do realise the importance of gaining these skills however, as a very perceptive comment from the survey said:- *School is the 'cradle of learning' Uni*[versity] *is where you learn to walk. The most significant difference is that those first steps are very awkward but it is our aim to eventually stand on our own two feet.* Clearly identified in this statement is the need for a transition between school and university expectations in regard to independent learning. Introduction to Civil Engineering has many components that were carefully designed to help in this regard. Some examples are the continuity of central threads and lecturers; tutorials led by academic staff members who take a tutoring and a mentoring role; small student numbers (12 to 15) in tutorials; well defined assignments that give some flexibility and choice, and detailed assessment information.

However, there is always more to be done. Another offering and more feedback will lead to more revisions ….. and on to another cycle.

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BIOGRAPHIES

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A Collaborative Project to Improve Teaching and Learning in First Year Programming

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In 1995, at Monash University, first year computer programming students in the Faculty of Computing and Information Technology were perceived as having an unacceptably high failure rate and a comparatively low retention rate. A collaborative project between the faculties of computing and education, beginning with a study to identify the problems experienced by students and staff, has resulted in a series of modifications to the structure and delivery of the subjects, and the development of a tutor training course. Responses of staff members and students have been mostly positive, and the subjects are still being improved each year. The transition from high school to university life, in which students were expected to adjust immediately to a different style of teaching and learning, was part of the problem. This paper describes the approach that has been adopted and which has resulted in improved learning behaviours. It also demonstrates the way in which a collaborative, cross-discipline approach to educational change can affect the teaching and learning process.

INTRODUCTION

In 1995, concerned at the percentage of first year students who were failing or discontinuing their computing studies, the Dean of the Faculty of Computing and Information Technology at Monash University asked the Faculty of Education for help in improving the level of teaching expertise within the Computing faculty. Most of the Computing staff have no formal teaching qualifications or training, having been employed for their computing expertise. They tend to base their teaching style on memories of lecturers or tutors that they considered effective during their own undergraduate years. Their teaching methods are therefore those that worked well for them, but that may not work well for most of their students. Many environmental changes have taken place in the last ten years or so, giving rise to a need for new techniques. These changes include increases in class sizes, number of students per staff member, and number of international students. Staff have had to develop expertise in producing high-quality computer presentations, maintaining subject websites and mastering other technological tools, all of which add to the workload of running a subject.

The initial request by the Dean of Computing was for a series of seminars on the latest teaching research and techniques. However, the Education faculty declined to provide these, recognising that they alone were unlikely to produce any real or lasting change in teaching behaviour. Faculty were also concerned that the high failure rates may be part of a more complex, integrated problem that was influenced by more than the teaching knowledge of academic staff.

The Education faculty suggested instead a research project to determine the source and nature of the problems in learning computing before any solutions could be applied. Introductory programming was chosen as the focus of the initial effort, as it is a subject taught in every course offered by the computing faculty, although in very different ways for different courses, and using different programming languages. Two Departments volunteered to take part in the project: Software Development and Computer Science. The Education faculty members were very unwilling to perform this research as *outside experts*, and so a collaborative team (the *Edproj*) was established to study the existing first year programming subjects in the two Departments and to suggest improvements that could be made.

The Edproj team consisted of the Associate Dean (Teaching) of the Computing faculty, two academics from the Education faculty, two lecturers in first year programming from the Software Development department, and the assistant lecturer in charge of coordinating and supporting the first year programming subjects in the Computer Science department. A few other computing faculty staff were also involved from time to time.

The two computing departments involved were on different campuses and had different philosophies: Computer Science was part of the traditional university with a primary interest in research, and Software Development was part of a former College of Advanced Education which had been merged into Monash University in 1990, and thus had many more staff members whose primary interest was teaching. The focus of the Computer Science course was leading-edge computing research, whereas the focus of the course taught by the Software Development Department was best-practice in commercial applications of computing. The responses of the two departments to the research project were different.

This paper focuses on the response of the Software Development department. The Computer Science experience has been well documented in conference papers such as Macdonald, Mitchell, Gunn & Carbone [1], and Carbone, Mitchell & Macdonald [2].

THE STUDENTS

The composition of the student body has changed since most academics completed their undergraduate degrees, consisting now of many more students than before, a large number of whom are international students with their own cultural backgrounds and learning approaches. As more local students are also accepted now, a wider range of abilities is found among them. There are full-time and part-time students, day and evening classes, and large variations in age, prior knowledge and experience, motivation, and expectations.

In the subjects run by the Software Development department, the number of students enrolled at the beginning of a year was typically about 400. In 1995, about a third of these would have had no experience of computing at all, and almost all would have had no experience of programming. These proportions have become lower each year since then.

In all computing courses in the Faculty of Information Technology, first year programming is compulsory and is seen by most students as the most difficult, least interesting and most time-consuming of their subjects. This is partly because the kinds of programs now required, and the programming languages in which they are written, are more complicated than those used ten or twenty years ago. It is also because learning to program involves research, experimentation, and problem solving, and many students lack these skills and must learn them as well as the programming language itself.

Typically, students find the subject interesting at the beginning, but by about week 5 find it becoming very challenging and requiring a great deal of time. Some students begin to lose motivation and interest. Programming is a particularly cumulative subject, as each concept and technique builds on all the previous ones, and students cannot related it to anything they have done before. It is not possible to ignore one topic if it proves difficult, as that will block understanding of later concepts. Learning programming requires great attention to detail, perseverance and a willingness to ask for help when necessary: attributes not characteristic of first year students grappling with a much broader transition to university.

THE TEACHING STAFF

At the time of Edproj academics were promoted exclusively on the basis of research, not on teaching performance. Teaching was therefore seen by some as comparatively unimportant and some lecturers devoted as little time as possible to it, concentrating their efforts on their research. Research related to computing education was not considered worthwhile in the Computing faculty. Staff who were interested in improving their teaching were not rewarded for doing so, and were given very little support. Never-the-less there were some staff who enjoyed the teaching role, and deliberately chose to take on high load first year subjects. There were also a large number of post graduate students, who depended on money earned by tutoring or demonstrating in laboratories, who had an interest (albeit sometimes only pecuniary) in teaching.

In the Software Development department, there was a tradition that the lecturer taught at least two tutorials in his or her own subject, to keep in touch with how the students were coping with the material. All administrative work related to the subject (e.g. handling tutorial timetabling and changes to enrolments, liaising with the computer centre about computer laboratories, writing and marking tests and examination papers, recording and collating results, organising and coordinating tutors) was also done by the academic staff. Many academic staff took tutorials in other subjects, to keep in touch with what was happening in the rest of the degree program. Financial constraints within the Department over the last 5 years had resulted in reduced numbers of academics, an increased number of students, a consequential increase in workload for staff, and hence increased pressure on them to perform better with less support. Staff were also required to demonstrate research productivity and perform administrative tasks not directly related to their teaching (e.g. committee memberships).

Most of the tutors in the undergraduate subjects were postgraduate students. In the Software Development Department, they were paid at a comparatively high hourly rate for the two hours per class per week, but were expected to contribute generously of their time to provide individual consultation for their students outside class time, a minimum of one hour per week for each scheduled hour of class time. They were also expected to help with the administration of the subject as requested. Most were keen on teaching and very willing to do all that was asked of them.

In the Department, the number of tutors engaged in teaching first year programming was typically about 18, with some permanent lecturing staff also tutoring - including the lecturers for the subject.

THE INITIAL STUDY

The initial stage of the Edproj involved extensive observations by Education staff of first year programming lectures and tutorials, interviews of all lecturers and many tutors, and some interviews with students. A random selection of students were invited to be case studies, and were interviewed each month during the second half of 1995, to obtain in-depth qualitative data about the students' experience and perceptions. All members of the research team were assigned students from a different campus to interview, so that their interviews were not affected by the students' fears of possible repercussions. Edproj guaranteed that staff members would not be disadvantaged by participating in the surveys, observations and interviews, whatever results emerged. The internal Edproj team members were also assured by the Computing faculty that this research would be considered legitimate research activity, and therefore worth the amount of time they needed to devote to it. An attempt was made to collect data from larger numbers of students by surveying them via email during the semester, but this was not very effective.

At the end of the semester, a report was presented to the Dean. This report covered both departments that had been investigated and, although written in a non-specific way, contained some observations that could have been damaging to certain members of staff, so it was not made available to the rest of the faculty. This engendered some resentment among tutors who had participated in the interviews on the understanding that they would see the final report, even though a summary of the recommendations was prepared for them. It did, however, reflect the great sensitivity that exists in any faculty area when academics feel that their teaching is under any sort of review, and the conflict between transparency and confidentiality in any research on teaching.

The primary finding reported was that the students were struggling to learn well, and that the major learning vehicle for students was not the lectures but the small group situations such as the tutorials in Computer Science and the laboratories in both departments. Teaching quality varied widely in that context, exacerbating some general problems students had in adjusting to university both academically and socially. As the small group sessions were important opportunities to meet other students and forge vital friendships and study partnerships, the students experiencing didactic monologues that discouraged or entirely prevented any student-to-student interaction were being significantly disadvantaged in ways beyond the academic.

There were also recommendations about restructuring and redesigning the content of the lectures, and providing discussion classes for students to complement the existing closed laboratories. As the payment schemes for tutors in the two departments were quite different, a recommendation was made regarding this, too.

At this early stage the problems were seen as primarily teaching and learning related, and the recommendations were made in that light. Subsequently, as the recommendations were implemented and data recorded, it became apparent that this issue was only a subset of the broader transition problem first year students faced, and changes to the teaching and learning environment could have far broader reaching affects than simply improving academic grades. The data collected in the context of programming was remarkably consistent to the Australia wide data of McInnes and James [3] when they looked at the experiences of first year students, and a follow up Department of Employment, Education, Training and Youth Affairs [DEETYA] funded investigation of the problem [4], suggesting that the problem was more than simply a difficulty with teaching the challenging subject of programming.

IMPLEMENTATION OF THE RECOMMENDATIONS

It was left up to the two departments to decide how they would respond to the recommendations. As stated earlier, this paper is concerned with the Department of Software Development response.

Students in a first year programming subject attended one two-hour lecture and one two hour tutorial/laboratory per week. One recommendation was that an additional type of class be provided for students, i.e. a one-hour discussion class to be held in a room without computers. This class was to allow students to talk about their understanding of programming concepts, as this is seen as crucial to their learning. Small group activities would be used to stimulate discussion and to encourage shy students to participate. Another reason for introducing this type of class was that students would very quickly get to know each other and begin to feel part of a group. One of the major reasons for students dropping out of university in their first year is that they feel isolated and not part of a community based around the institutions [5]. The entire class of about 400 was broken into tutorial groups with a maximum size of 16, and the same tutor took each tutorial group for both discussion class and lab session to assist in building a *learning community*.

The two-hour lecture was changed to two one-hour lectures, with the discussion class between them and a lab session after the second lecture. Observations had shown that students tended to disengage with the lecture in less than one hour, and two hour lectures were likely to be ineffective. At the lectures, copies of all the PowerPoint slides were handed out to the students, so that they did not have to worry about copying down what is being displayed, and can instead think about what the lecturer is saying. This was considered more effective than just making the slides available on the World Wide Web, as students need to have the notes during the lecture, and it is much easier, and ultimately cheaper, to print them *en masse* than to have 400 students trying to find available computers in the labs to download and print the notes before the lecture.

A three-day tutor training program, focused on teaching introductory programming, was developed by the Edproj team. The program was to be run separately for the two departments because of the numbers of tutors involved, and was to be presented jointly by staff members from Education and the appropriate Computing department. The structure and content of this tutor training scheme are described in detail in Gunn & Macdonald [6]. It focused largely on how to run the discussion classes in ways that would promote quality learning. Emphasis was placed on how to get students to talk and help each other to solve their own problems with some guidance from the tutor, rather than tutors supplying answers and solutions. Training was targetted to specific needs of the tutors in the subject of programming, rather than giving *generic* teaching tips that have are hard to translate into daily practice.

The Software Development Department took the initial report to the Dean very seriously, and decided that not only would all first year tutors be required to do the tutor training course, but also that all permanent staff members should be involved in tutoring these subjects, in order to upgrade their teaching skills. An advantage of this was seen to be that the most experienced academic staff would be teaching the first year students, and would provide the highest quality teaching experience. In fact, it became evident that it was much easier to train a new tutor to use the modern, student-focussed techniques espoused by the training course than to change the ingrained habits of a staff member who had been tutoring for a long time in a different way [1].

The tutor training program was followed up by a weekly staff meeting of the tutors in the first year programming subject. The purpose of this meeting was to reinforce the training program by reminding tutors of the techniques taught in the training course, discussing attempts that had been made to use them in the previous week with any successes, failures and possible improvements, and ways that they might be implemented in the following week's classes. At the beginning of semester, the lecturer asked for two student volunteers (one male, one female) to attend these staff meetings and represent the students' point of view. These students were asked to talk to as many other students as possible to learn of any problems. Their input to the meetings was very valuable. If there was a problem with the workload or understanding a particular concept, action would be taken to rectify the situation.

A *Teaching Community* [7] approach to the subject was adopted, whereby the Lecturers in Charge were seen as being just part of the team teaching a subject rather than as authorities handing down the work to be done to subordinates. Tutors were expected to attend all meetings and contribute ideas, suggestions, anecdotes, teaching materials, examination questions, etc. Discussions took place each week about the *Big Ideas* to be taught in the following week, and how they could best be taught in lectures, discussion classes and lab sessions. The *Big Ideas* are the concepts and underlying principles that students were intended to learn, rather than the implementation details. For example, the lecture might be about functions and parameter passing with examples using the syntax of a particular programming language, but the Big Ideas might be abstraction and modularisation. Often there was animated discussion in the tutors' meetings about the meaning of a particular concept in computing, as different tutors would have different understandings of its meaning. Computing is a comparatively young discipline, and many of its terms and concepts are still new. It is also changing constantly. It is important that the view presented by the tutors matches the view of the lecturers, otherwise students become confused. Tutors were also encouraged to attend the lectures so that they were familiar with the approach that the lecturer was taking.

The most important part of the Teaching Community meetings was the opportunity for the tutors to discuss likely student misconceptions and to develop specific teaching strategies that would give opportunities for the students to interact with each other, build relationships, and construct meaningful understanding of the key concepts. With so many committed individuals contributing, the range of ideas and innovations generated each week was remarkable.

For the first two years, the tutor training course was presented jointly by Computing and Education staff, and an Education staff member attended the weekly tutors' meetings. This lent a voice of authority to discussions about teaching and learning, and assisted the process of interpreting the experiences of the tutors in terms of the training course concepts. Since then, the Education involvement has ceased, and Computing staff are running the training program and the tutors' meetings alone. This has made it more difficult to convince some new tutors of the validity of the teaching philosophy, but also reflects the development of educational expertise in the ongoing staff.

Helping Students with Programming Problems

As it is at about week 5 of the first semester that many students start to fall behind and lose interest in the subject, at this point a test worth about 10% of the total marks is given. It is intended to be reasonably easy, so that it builds up students' confidence, however, anyone who fails it sees that he or she has serious problems and needs to address them immediately. Tutors advise anyone who has failed the test to seek individual help, but most such students do not do so.

To make it easy for students to get help almost immediately with programming problems, several kinds of assistance are provided. Tutors are rostered onto a helpdesk for one hour per week for each tutorial they take. The helpdesk is a well advertised room, that is open for much of the week, equipped with computers and other resources where students can seek help about any aspect of the programming subject. This helpdesk replaced the system of each tutor being required to specify consultation times for his or her own students. Because there are about 24 tutorials in the subject, there are about 24 hours scattered throughout the week that this service is available, including some convenient for evening students. Students can bring their programs along and ask for help. Tutors will not simply correct the code, but will prompt the student with questions to help them to find the solution to the problem themselves. Some students find this very frustrating, become angry and resentful, and give up using the helpdesk, but most understand that it is necessary to learn to solve their own problems, and that this is the way to do it.

There is also a website that contains all the documentation for the subject, including the subject handbook, PowerPoint lecture presentations, weekly exercises, assignment specifications, etc. It also has examples of how to do some things that students traditionally find difficult, and a frequently asked question file. Perhaps the most important element is an anonymous feedback page in which students can ask questions or make comments about the subject. The feedback postings are automatically emailed to the lecturers and a few of the tutors, so that someone usually responds to a posting within a couple of hours. This facility is described in detail in Hagan [8], and has become more popular each year since it was introduced, with over 800 postings during semester 1, 1999. It also gives students some sense of ownership of the subject, as they can see that their concerns elicit an immediate response and can produce changes in the way the subject is run. Anonymous feedback has been much more effective than a newsgroup, as many first year students are very reluctant to identify themselves when asking questions or making comments, although this reluctance diminishes as they progress through the course and become more confident [9].

Students are also able to email the lecturer or their tutors directly to ask for help. They are encouraged to read the lecture notes and the textbook first, and to try other sources such as online help and their peers, before turning to staff for help.

PREPARING STUDENTS FOR THE SUBJECT

One of the problems with transition seems to be that students have unrealistic expectations of university life. They imagine either that it will be just like school, or that it will be a harsh, uncaring place where they will be left to sink or swim on their own.

Students in the Bachelor of Computing degree attend a presentation by the course leader during enrolment time, where she explains that they are expected to spend on average 48 hours per week on their studies, and that undertaking too much outside work is very risky. She also explains that there are many people in the university who are willing and able to help them, and that asking for help when it is needed is a smart thing to do, and not a last resort when they have already failed subjects. Most students either ignore this advice, or are in such cognitive overload, due to the barrage of new information to which they are exposed, that they do not register it.

At the first programming lecture, the lecturer warns the students that this subject will probably require more time and effort than the others, and that 12 hours per week of study is a reasonable estimate for it, not an exaggeration. They are also shown all the avenues of help available to them, and the advantages of getting to know other students and helping each other with work are discussed.

At the first discussion class, an icebreaker activity helps students to get to know one another. Students are then put into small groups to discuss what they see as the role of the tutor and the role of the student. The small groups then report to the entire group. The tutor makes sure that he/she uses the names of the students at all times so that, within a couple of weeks, everyone knows everyone else’s name. If necessary, for the first couple of weeks students have their names printed on cards in front of them. Furniture is rearranged so that students are not sitting in rows, with their backs to other students, facing the tutor at the front of the class. Horseshoe or table groups put emphasis on fellow students as a learning resource, and de-emphasise the centrality of the tutor as a source of all learning.

In the laboratory session each week, students implement some of the techniques they have been shown in the lecture and have considered in the discussion class. A tutor takes the same group of students for both the discussion class and the lab session, both to ensure continuity of concepts, and to foster a sense of belonging among the students and to help them to get to know each other and form a learning community. They are encouraged to work collaboratively on the exercises during the lab sessions. Students are discouraged from changing tutorial groups, although this is impossible to prevent entirely. Depending on how much change has taken place in the membership of the group since the last class, it may be necessary to run more (and different) icebreaker activities in weeks after the first. This progressive engagement of the students in the subject and its requirements has proved the most effective way to induct students to the university.

MONITORING THE EFFECT OF THE CHANGES TO THE SUBJECT

As mentioned earlier, an attempt was made to interview students via email from time to time, but this was not very successful. A far better method was to use the subject website, and ask all students at the beginning of a tutorial in each of several weeks to respond to a radio-button survey. This survey asked questions about how well the students were coping with the subject, which types of classes they found most useful, how useful they found the textbook, the website and handouts given in lectures, etc. The results of the surveys were mostly positive, and were used to progressively *fine tune* the resources.

A survey of tutors after the subject was finished indicated that most enjoyed teaching the subject more after the training course, felt more confidence in their teaching ability, and found the tutors' meetings of great benefit. For many the sense of belonging within the faculty that was generated by their integration into the teaching community was a significant factor in their enjoyment of their own research agenda, as well as their teaching.

Measuring improvements in performance of students is not a simple matter of comparison of marks from one year to the next. Exam marks are probably one of the least reliable and valid measures of learning, but retain their premier position due to the lack of a universally accepted alternative. Exams are set to be similar each year, but inevitably vary in difficulty and in the weighting of content topics. Particularly in computing the nominated content changes from year to year as the subject evolves or new programming languages assume dominance. Teaching staff change. Cohorts of students vary as fashions in degrees wax and wane.

So many variables were changed by the intervention in all its manifestations that it is difficult to ascribe any particular cause and effect between a variable and exam marks with any mathematical significance, even if the variable could be quantified. Academic performance may have been the driving force of the original Edproj collaboration, but as previously mentioned, the many issues that affect student performance in first year particularly are influenced in many subtle ways by changes to the learning environment that may not be directly driven by teaching. The ability to make friends and build a social and learning community may result in a student being better integrated into the life of the university, with a greater resistance to discouragement and withdrawal. Such a student is likely to do better in formal assessment, but this is hard to directly attribute to icebreakers and group work in tutorials, though they may have played a very important part in initiating the social interactions.

All the above qualifiers may seem like the *softening up* for poor results, but in fact comparisons of tests, exams and assignments before and after the intervention showed strong improvements, improvements that have been sustained for several years. Overall results for the subject have shown a sustained one grade improvement for those students who pass the subject, compared to the performance prior to the intervention. In 1994 28% of students gained a High Distinction, in 1995 31% gained HD, and in 1996 40% gained HD. Performance on the exam was judged by the lecturers in charge to show much greater understanding of the main concepts of the subject, with less dependence on recall of information. However the exam was more weighted for this type of knowledge and it is impossible to generate comparison statistics. The proportion who fail the subject remain at similar levels, however, suggesting that the academic difficulty of the subject is not as important in the overall transition experience of the students as had been assumed.

The increase in grades could be dismissed as a *lowering of standards*, but other data suggests that this actually represents an increase in students' learning outcomes.

The students sat two unit tests during the semester, which contributed to the overall mark. During the second semester of 1996 the average score on the first test rose from 61.21% in 1995 to 70.46% in 1996, while the second unit test showed a less impressive rise of 62.87% to 67.06% average. With around 300 students included in the analysis these results are statistically significant, but for the reasons described above we hesitate to claim them as definitive proof of better learning.

The most compelling data for the Edproj team was the observational data collected by a team of trained research assistants from the education faculty. Two measures were taken, the *good teaching behaviours* or GTBs, and the *good learning behaviours* or GLBs. Ongoing research in education, particularly in secondary schools, has related particular overt behaviours of students to be closely associated with learning outcomes of a *deep* kind [10, 11, 12; also 13 for *deep* learning]. When these are observed to be occurring in the classroom it is a strong indication that quality learning is in progress. Similarly there are teaching behaviours that are closely associated with these GLBs incidence in students. Some of the more fundamental measures were the number of open questions being asked by the teacher, and the time spent by the class in discussion that did not directly focus on the teacher, but involved student-to-student interactions.

Prior to the intervention the GTBs were rarely seen, but after the training course, and with the support of the teaching community, the average number of questions asked in tutorial classes rose from 26 per class in semester one to 49 per class in semester two. Similarly the amount of time spent in class discussion (out of a nominally 60 minute class) rose from 20 minutes in semester one to 27 minutes in semester two.

The GLBs also showed remarkable increases: Student generated questions rose from an average 8.6 per class in semester one to 11.2 per class in semester two; while extended responses to questions (which involved the student explaining a point of view not simply giving an answer) increased from 4.6 per class in semester one to 12.6 per class in semester two – a 174% increase over the intervention's first year, and a total transformation from the previous year.

Student interviews also gave anecdotal data suggesting an approach to learning that valued understanding as an outcome, and regarded peer learning as a significant contributor, was far more common that prior to the intervention. Students also appeared to be more interested in the subject, better adapted to the university, and more positive about their university experience than the students interviewed during the research phase, though the number involved was too small to be definitive. Similarly, the feedback gained from the anonymous feedback page was also generally positive, though there was no comparison data available from prior to the intervention.

Although each of the data sources taken alone are hard to defend as conclusive, the triangulation of the various data collected suggests that there has been major shift in the learning approach and learning outcomes of the students in first year programming.

CONCLUSION

The changes made to the structure and delivery of the first year programming subjects have resulted in better learning behaviours in students and an improvement in teaching on the part of lecturers and tutors. There is more of a community approach to the subject among the tutoring staff, rather than an attitude of doing what the lecturer says. Students appreciate the amount of help given to them in this subject, as compared with their other subjects. In general, student results in the first year of the changes showed an upward shift of about one grade in the students who were passing the subject. There are still a number of students who fail or drop out, and more research is being undertaken to address this problem. There are more students taking programming electives in later years of the course, and more choosing to specialize in software development rather than some other aspect of computing. This indicates that the changes made to the subject have had some success, and there is ongoing research to try to improve the subjects still more, and to help students with the transition into university study.

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BIOGRAPHIES

Dianne Hagan is a senior lecturer in the School of Computer Science and Software Development at Monash University. She is a Director of the Computing Education Research Group of the Faculty of Information Technology. Dianne is also a course leader and has been teaching introductory programming for many years.

Ian Macdonald trained and worked as an engineer before moving into the secondary school system for 8 years. During this time he pursued research into student learning, gaining a Masters degree in Education and then a Ph.D. in educational psychology. Moving to the Education faculty of Monash University he taught postgraduate teachers and continued his research into quality teaching, student learning, and in particular the problems of transition from secondary to tertiary study. In 1997 he joined Swinburne University where he is now manager of the first year engineering program and Director of the Centre for Learning in Engineering and Science, while remaining an Honorary Research Fellow at Monash University Education Faculty. His research is in the area of School to University transition, the development of effective learning environments, and in professional development strategies for university teachers.

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Managing Variations in Prior Learning Related to Computing Skills

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During 1997-8 the Faculty of Engineering at UTS undertook a major overhaul of its undergraduate programs. As part of this redevelopment we moved to a common core across all Majors (i.e. Mechanical, Civil, Environmental, Electrical, Telecommunications, Computer Systems, and Software). One of the core subjects - *Informatics* - focuses on an appreciation of issues surrounding various software and information tools. Two key factors influenced the design of this subject. First, the subject is offered to students across the entire engineering spectrum. As such, their motivation, interest and expectations of a computing subject vary significantly. The second factor is that computing technology is an area that currently shows very diverse prior exposure and skills. Our incoming students vary from having very sophisticated (though often narrow) skill sets, to barely having used a computer. The students are moving from a context (secondary school) in which they naturally develop extremely diverse prior learning and understanding to a context (university) in which we traditionally have had relatively uniform expectations regarding their learning outcomes. In this paper we consider the various approaches that we have adopted to cope with this diversity as flexibly as possible. We look at the structure of *Informatics*, the responses of the students, and how successful this has been in addressing the diversity of prior learning (related to computing technologies) that occurred in the transition from school to University.

INTRODUCTION

In 1997, the Faculty of Engineering at the University of Technology, Sydney (UTS) undertook a major redesign of its undergraduate Bachelor of Engineering programs. As part of this redesign a new core subject – *Informatics* – was introduced. This subject, which is taken by all Engineering students irrespective of the particular Major (Mechanical, Computer Systems, etc.) in which they will be specialising, develops skills in, and an understanding of, a range of computing and information tools. This includes technical aspects, such as introductory programming, the internet, spreadsheets, and databases, as well as the students ethical and professional responsibilities in using these tools appropriately. It is agreed within the Faculty that skills in these areas are critically important to all students.

The nature of computing technologies, and their utilisation within society, is such that the students entering the degree program have a very diverse set of knowledge and skills. This varies from students who have very sophisticated (though often narrow) skill sets, to those students who have little or no familiarity with computers or related tools and technologies. There is a noticeable gap (that appears to be widening is some respects) between those with exposure to computers and those without exposure. It is also worth noting that there is a partial correlation between students' Majors and both their level of prior knowledge and their motivation and interest.

The consequence of the above observations is that *Informatics* needs to be very flexible in adapting to variations in prior learning. Without an appropriate consideration of the variations and mechanisms to allow students to suitably adapt their study, the subject would fail to provide an effective learning experience for many of the students. In this paper we look at how the subject has been designed to accommodate the variations in prior learning, including both the underlying educational philosophy that we have adopted and the resultant structure, content and approach that we have developed.

In the following section, we discuss the background related to the redevelopment of the UTS Bachelor of Engineering, Diploma of Engineering Practice degree and the role that the core subjects play within the structure of the course. We look at the contribution of *Informatics* to this structure, and the graduate attributes of the course overall. We then consider the variations in prior learning of the students and how this might influence various aspects of the subject. In the next section of the paper we look at how we have designed the subject to address the variations in prior learning. In particular we consider both the structure of the subject and the way in which the logistics of the subject are managed to provide flexibility whilst ensuring that appropriate learning outcomes are achieved. We then go on to look at the results of our approach and some experiences in the first few offerings of the subject. Finally we consider how we might continue to improve the subject, along with some conclusions regarding the approaches that we have adopted.

BACKGROUND TO SUBJECT DEVELOPMENT

Bachelor of Engineering Degree Program

The previous Schools of Civil, Electrical and Mechanical Engineering at the University of Technology, Sydney (UTS) had, since 1972, each offered programs leading to the award of a BE degree in one or more specialist engineering disciplines. These courses had various common features, such as a commitment to co-operative education, but differed substantially in structure, teaching methods and expected learning outcomes. This has happened despite the consensus across the profession that there exists a significant body of knowledge, skills and values which are held in common by all professional engineers, whatever their specialist discipline.

Supported by the arguments and recommendations of a plethora of reports on engineering education published during the mid-90's, culminating in the Australian Review of Engineering Education [2], the Faculty came to the view that the separate BE programs should be jointly redesigned as a unified degree with the option of specialist majors. The new program, which was designed during 1997, and introduced as a combined BEDipEngPrac

(Bachelor of Engineering, Diploma of Engineering Practice) degree progressively during 1998 and 1999, addressed the shortcomings that were raised in the above reports. These shortcomings included: inadequate attention to the professional formation of students; curriculum fragmentation and overcrowding; and insufficient opportunities either for students to cross traditional disciplinary boundaries or for courses to adapt to changing external demands.

One of the key design objectives for the new course was to explore how to accommodate diverse learning pathways that were adaptable to students' individual circumstances encompassing both guided and independent study either on campus, at home, or in the workplace. Such flexibility has the potential to improve learning, increase convenience, and reduce completion time. The resultant degree program contained various elements. One of the key ones was a set of core subjects common to all majors in the undergraduate Bachelor of Engineering degree, with the students focusing their degree through both subjects specific to their choice of a major (discipline) and electives which allow either further specialisation or a broadening of experience and knowledge (based on student preferences).

The core includes subjects covering aspects such as engineering communications, project management, engineering finance, uncertainties and risk, and – of course – computing. The computing aspects are predominantly covered in the subject *Informatics.* Being a core subject, *Informatics* is undertaken by all students irrespective of their field of practice - be it Mechanical, Civil, Environmental Systems, Electrical, Telecommunications, Software, or Computer Systems. This has several implications – such as large variations in the skills, prior learning, expectations and motivations of the students taking the subject. We shall consider these points in more detail shortly, but first let us consider the focus of *Informatics.*

Informatics

The aim of *Informatics* is to introduce 1st year students to the use of computing tools in the context not only of engineering problems (which is the way computing subjects are often taught in Engineering departments) but in the context of engineering practice. For example, software development subjects will often teach programming in a way that shows how it can be used to address specific problems; such as how to write software for engineering analysis. Such subjects will, however, rarely consider issues such as the impact of errors or inaccuracies in programs, the professional responsibilities of the students with respect to the developed software, or how students develop an ability to continually adopt changing tool sets and development environments. In developing *Informatics,* we explicitly attempted to address these considerations.

Another aspect that *Informatics* needed to consider was the rapid pace of technological change. Most computing courses fail to recognise both that the range of tools that students will encounter in engineering practice goes way beyond what can be even partially addressed within a formal degree program, and that many tools are changing so rapidly that there will be little similarity between those available at the start of a student's degree and those at the end of the degree. This means that the students will regularly encounter tools with which they have no experience or familiarity. *Informatics* therefore needs to ensure that students develop an ability to evaluate and learn new tools.

Further, students often lack the ability (or confidence) to continually develop their own skills. Yet as part of their professional engineering practice they will be constantly required to develop not only their knowledge, but also their skills in utilising the tools that support them in their professional practice. This means that the students need to learn not only specific tools, but need also to *learn how to learn* so that they may continually refresh their existing tool skills and acquire new ones without the support that a teaching and learning environment provides. This point is particularly critical in the context of a flexible approach to learning in the subject. Again, we shall return to this point shortly.

Given the above considerations, *Informatics* was developed with three core aims. The first is to develop specific skills in using information and computational tools (such as spreadsheets, the internet, and programming languages). The second is to develop an ability to continue to develop skills in a broad range of tools. The third, and most unusual, is to develop an understanding of the professional issues that surround the use of computational tools - the types of tools and resources that allow engineers to manage the information, models, complex calculations, and processes associated with carrying out engineering activities.

Student Profile

As was mentioned above, *Informatics* is taken by all Bachelor of Engineering undergraduate students irrespective of their particular major - mechanical, civil, environmental, electrical, computer systems, software, or telecommunications. This has several immediate implications. The first is that *Informatics* is the only computing subject to be undertaken by many of the students, whereas for others it is only an initial introduction prior to an entire thread of software subjects. This means that there are relatively complex requirements on the material that needs to be covered and the skills that should be developed within *Informatics.* It also means that the motivation of students varies considerably. Some of those students for whom this is the only computing subject see it as either unnecessary or are rather uninterested – especially in the ethics sections of the subject. For others, especially those for whom it is the first in a sequence of computing subjects (for example, telecommunications, computer systems, and software engineering students) they are more highly motivated and interested in achieving the maximum benefit from the subject. In each case, the students hold very different expectations of what they wish to achieve in the subject and their understanding of their own learning objectives.

Even more significant than variations in motivation, and the key focus of this paper, is variations in prior learning of the students. We are taking students from a schooling background where they have naturally developed extremely diverse prior learning and understanding, and placing them into a context where we traditionally have had relatively uniform expectations. Although we have long experienced a very broad diversity in the cultural and social backgrounds of the students entering our degree, the educational diversity is restricted by the entrance requirements (e.g. 3 unit Higher School Certificate [HSC] mathematics). We would claim that one of the most variable elements of prior learning (of those that relate directly to course material or expected learning early in the undergraduate programs) is the students' familiarity with computing concepts. This is partly due to the variations in access to computing technology, partly due to changing social expectations regarding familiarity with computers, and partly due to the lack of well-defined entrance criteria in this area (at least in the same way that we have well-defined expectations regarding English language, science and mathematical abilities).

As an example of the variations that exist, consider the data shown in Table 1. Several interesting observations can be made. For example, with specific skills (such as programming, spreadsheets and databases) there is a very strong bimodal distribution. Students in general appear to either be quite familiar with these, or very unfamiliar. This is in contrast to a technology such as the Internet, where the spread is much more even. Table 2 also shows that there is a relatively strong correlation between level of prior knowledge (as measured by the self-assessed familiarity with various technologies and tools) and intended engineering discipline.

Table 1: Variations in students' familiarity with a range of tools and technologies *(source: student surveys carried out at the commencement of the Autumn 1998 semester)*

Rank your familiarity with the following tools or technology (1=not at all familiar, 5=extremely familiar).	1	2	3	4	5
Computers	4	3	21	29	18
Microsoft Windows based computers	6	5	21	28	15
Macintosh computers	59	6	2	3	5
Any computer programming language	31	6	6	17	15
Spreadsheets	33	8	7	18	9
Databases	42	2	6	18	7
Internet / World Wide Web	10	14	31	6	14
Email	12	8	7	12	36

Table 2: Variations in students' familiarity across different engineering programs *(source: student surveys carried out at the commencement of the Autumn 1998 semester)*

	Average familiarity
Civil Engineering	1.97
Computer Systems Engineering	3.88
Electrical Engineering	3.13
Mechanical Engineering	2.43
Telecommunications	3.65

In the initial discussions regarding the subject prior to its development, it was made very explicit that *Informatics* needed to actively accommodate this variability in prior learning. It is also important to note that, as discussed above, a key goal of the subject was to develop the students' ability to not only use specific skills but to also continue to develop new skills in using computing tools. This goal meshes very well with the need to accommodate variability in prior learning. If we are able to develop this meta-skill, then the variations become much less relevant. If we are able to achieve the subject goals then where students do not have specific required skills then they should be in a position to be able to develop such skills themselves. This then means that the focus of the subject can shift to a combination of developing these required meta-skills and providing the students with the flexibility to extend their own learning relative to their prior knowledge. One factor worth mentioning that impacts on this is that there are also pragmatic constraints – for example, we need to ensure that students have the pre-requisite skills necessary for success in later stage subjects.

SUBJECT DESIGN

Development of *Informatics*

Let us now consider how the design of the subject has addressed these specific requirements. A consequence of the fact that *Informatics* is undertaken by all engineering undergraduates (and hence has both great diversity and large student numbers) is that it has rather complex educational requirements. In order to ensure that these were appropriately considered the development team for *Informatics* adopted a very structured approach to the subject development.

We began the development by identifying both subject constraints and resourcing issues, and the specific educational requirements. The subject requirements were constructed by initially selecting a subset of the graduate attributes defined for the overall BE degree programs. From these graduate attributes we identified the key educational objectives and hence formulated the subject requirements. For example, one of these requirements was:

> *Requirement 6) Informatics must provide the opportunity for all students to develop their knowledge and skills irrespective of their level upon commencing the subject.*

We then designed the subject in a way that specifically addressed the identified requirements. Full details of the design of the subject and the way in which addressed skills development can be found in [3,4]. Of particular interest in this paper is the way in which we addressed the issue of variations in the prior learning of students.

Flexible structure: Adapting to Student Expertise

A common approach for coping with variation in prior learning is to develop a bridging or remedial course (or several in different areas) that brings those students with minimal experience up to a level consistent with the subject entry requirements. This approach is appropriate where there is a small proportion of the students who lack relatively well-defined skills or understanding. In our circumstance, however, the diversity of understanding is such that the range and structure of bridging courses that would be required would be prohibitively complex.

Rather than having a remedial or bridging course we have taken a very different approach. Because the particular expertise of students varied considerably, with different students having very different prior learning, we developed the subject to have a modular structure. (Actually, the modular structure was also a consequence of various other factors, such as the difficulty of appropriately resourcing a computing subject with in excess of 500 students per year)

Essentially, the subject was designed around a series of subject modules. These modules focus on different aspects of the subject, and are broken into two main streams:

skills and issues. The issues modules cover the development of understanding of classes of informatics tools, uses and limitations of these tools, the relationships between these tools, meta-skills required to independently learn new tools, and ethical and professional obligations in using these tools. The skills modules cover specific skills in different tools, including spreadsheets, the Internet, operating systems, programming, and a number of other tools. It is in the skills modules where we encountered the greatest diversity in prior learning. An extract of the subject design documentation, detailing much of this development, is given in Appendix 1.

Students who are undertaking *Informatics* are required to complete a set of compulsory modules (the majority of the subject), and one or more elective modules (to demonstrate their ability to independently learn new tools, and to extend their skill set). To accommodate the huge variability in the prior learning and experience of the students, and the variations in student expectations, the students are given the option of negotiating to replace compulsory modules in which they can demonstrate appropriate prior understanding with an alternative selected from the elective modules. In this way we are encouraging students to utilise the opportunity to extend themselves and maximise their learning as much as possible. This also provides them with the opportunity to focus their learning in areas most appropriate to their needs. The consequences of this are that student expectations and motivations are positively influenced concomitant with positive changes to study strategies and learning outcomes [7].

Note also that to provide a sense of cohesion to the subject (especially in light of its module-based nature), students are allocated to a specific tutor for the duration of the subject. This tutor takes the students for all small class sessions, including both issues and skills modules. The tutor becomes responsible for the students overall subject program (including aspects such as negotiating with them about replacing compulsory modules with electives) and will normally be the students first point of call in the case of questions or problems related to subject content and logistics.

One concern that we had in designing this structure for the subject was that students would choose the *easy option*. Rather than electing to undertake a module with which they were unfamiliar (and required substantial learning effort) they may choose to simply keep quiet and accept a default module with which they were already highly familiar – and in which they were more likely to obtain a higher assessment grade. We addressed this concern in several ways. The first was to get the tutors to take an active role in discussing with students their particular study pattern in the subject. The second was to modify the subject assessment so that it minimised the benefit to students of completing modules with which they were already familiar – the focus of assessment was shifted away from the marks achieved and more squarely onto learning outcomes.

The assessment was structured such that the subject incorporated both Mastery and Advanced assessment levels. All students are required to complete the Mastery assessment component, which solely determines each student's pass/fail grade but not their final mark. If the student passes the Mastery component then they are guaranteed a pass result in the subject even if they do not attempt the advanced assessment components. If they fail any component of the Mastery assessment then they fail the subject. This approach removes the common problem of *mark-accumulation* and focuses the student on developing an appropriate level of understanding. To satisfy the Mastery requirements, the students must satisfactorily complete all the subject modules (including any negotiated elective modules), and pass the final oral and coding exams. Satisfactory completion of each module is based on evaluating, on a Pass/Fail basis, the student achieving an acceptable level of understanding. This is determined through the module assessment tasks and through the examination of a Journal that the students maintain throughout the subject. The Journal is an important element of the assessment and the students are encouraged to record their reflections as they engage with the subject matter. This is important in determining the extent to which they have extended themselves by undertaking modules that cover new material. Those students who wish to earn a grade beyond a Pass can attempt the advanced assessment component. The Advanced assessment components involve a major programming assignment and a learning contract. The learning contract requires the student to negotiate a task that demonstrates understanding of two or more of the non-programming skills modules and at least one major aspect of the issues modules.

The Mastery/Advanced approach to assessment has been used extensively in similar subjects (notably software development subjects) over the last few years and has proved to be particularly effective [5]. This structure encourages students to focus on their learning, as distinct from focusing on mark accumulation, yet provides the scope for more ambitious students to obtain a grade which reflects the extra learning and understanding they have achieved. This approach also allows tutors to concentrate on constructive feedback rather than focussing on allocating marks in situations where they matter little. The negotiated Learning Contracts that form the Advanced assessment allow students the freedom to explore topics and problems which are of particular interest to them. The diversity of Learning Contracts negotiated and submitted is testament to the motivational value of this approach. A compulsory component of any Learning Contract is a personal reflection examining the degree to which the student met their learning objectives, which approaches to the learning goal(s) were effective and why, and also those approaches that were less effective.

RESULTS AND EXPERIENCES

At the time of writing this paper *Informatics* has just completed its third offering. During this time we have gained substantial feedback on the effectiveness of the approaches which we have adopted. This feedback has been obtained from informal discussions with students, formal subject evaluations, small group discussions, and student reflections included in the students' journals. Based on this feedback, we can make various observations about the success (or otherwise) of our approach.

The first and most obvious observation is that, in general, the students have shown a high degree of enthusiasm for the subject. In particular the technical nature of much of the subject gains the interest of the students – especially when compared to the more theoretical subjects that the students typically encounter in their first year of University. Comments such as the following are relatively typical.

> *I came to University expecting to be able to do things – and this is the only subject where I got to do this.*
>
> *The programming and internet bits were good but I didn't like the ethics stuff – I got enough theory in other subjects!!!*

Student feedback has also indicated that the overall structure of the subject is appreciated since it offers considerable choice in both what is learnt and how it is assessed. For example, two students commented that:

> *the electives that are offered are helpful – they allowed me to learn things that are most relevant*
>
> *[the various modules] really challenged my existing knowledge.*

This choice has had a quite positive influence on the student motivation.

Despite this positive impression of the content and structure of *Informatics* there have been several negative aspects. The first is that the students found the logistics of the subject rather complicated. This especially related to the selection of elective modules and keeping track of what this selection meant in terms of attendance, assessment, etc. For the subject flexibility to have maximum positive effect the students need to be able to understand the structure of the subject, how the various components interrelate and the expectations on them. This also led to students having difficulties in managing their workload. Whilst subjects involving a programming component typically have a heavy workload, the modularised structure of the subject meant that each individual module was subject to *content bloat.* It also exacerbates difficulties which students typically have with time-management – a particular problem during their first year at University when they have much more freedom (both socially and intellectually) than that to which they are accustomed.

We are currently considering ways in which these difficulties can be addressed. First, we will be endeavouring to provide better guidelines as to how much work they should have completed at any stage in the semester and to assist them in managing their time. We are also considering ways in which we can improve the synergy between modules to control the workload expectations without making the logistics even more complicated. The simplest approach, and the one that can be implemented immediately, is to introduce one or more key problems and thread these through many or all of the modules. This will allow more direct comparison and evaluation of the various tools and issues arising from their use. This will also address some students' interpretations that the modules are isolated and unrelated components, as well as reducing the work load as students are not learning new problem domains.

Even more significant however was that our attempts to recognise prior learning were not as successful as hoped. Relatively few students elected to opt out of a mastery component with which they were already familiar and undertake an extra elective module. For example, consider the data shown in Table 3 (from the Autumn 1998 semester).

Table 3: Numbers of students who negotiated subject module changes based on prior learning *(source: Autumn 1998 student results spreadsheet and student records).*

Total number of students	259
Number of students estimated to have prior learning consistent with at least one module	134
Number of students estimated to have prior learning consistent with at least two modules	43
Number of students who discussed a module change	54
Number of students who undertook a module change	32

There are likely to be many reasons for this unwillingness to negotiate a change in modules based on prior learning, but a strong disincentive for the students is the scheduling of the electives. These were scheduled towards the end of semester when the students are busy with the advanced components of the subject as well as with all their other subjects. This can be overcome relatively easily by revising the schedule and running elective modules throughout the semester. This latter change may be supported through the development of self-learning packages.

We have used self-paced learning modules in both *Informatics* and other computing subjects to teach aspects of programming. Typically these learning modules are set out as a sequence of precise instructions for the students to work through – including readings, discussions, exercises, and material to be submitted to the students tutor for feedback or assessment. The students' response to these learning modules has been excellent, particularly in terms of the flexibility that they have provided to students in adjusting their pace and style of learning to their particular needs.

One avenue for using learning modules more effectively that we are currently investigating is to change the assumed baseline understanding in the subject. At present the default program for students is to undertake all basic modules, but allowing students to negotiate changes based on prior knowledge. Unfortunately, many students elect to take the easy option (through apathy, being unaware of options, or unsure of the processes for changing their program) and not negotiate any changes when they are definitely suitable. A possible change would be to remove the baseline set of modules and require all students to select a set of subject modules from a pool of modules. Their selection would be based on their prior knowledge. To ensure that we achieved a minimal level of understanding for all students we could construct a well-defined set of subject outcomes that all students would be expected to achieve. The students' selection of modules could be supported by providing all modules with a self-test which could be taken at the beginning of the semester by students to allow them to determine whether that module would be beneficial.

The self-test concept will also help address another problem with respect to student selection and/or negotiation of modules. We have found that in a number of cases the students were unable to effectively evaluate their own level of understanding with respect to a particular topic, technology, or tool. For example, many of the student had some brief experience with writing short simple software programs, and assumed that this meant they were familiar with (or at least able to write) much more complex software - an observation which has no support in current practice. By providing self-tests we would assist students in more critically examining their own knowledge and skills, and thereby being able to make a more informed decision about their selection of modules.

Finally, it is important to note that the diversity of coverage in the subject (ranging from various tools, to considerations of the students' professional obligations in using these tools) was seen as a strong positive factor. A typical comment was *The best aspects were that we got a good introduction to many applications which we will use throughout our education/career*. Subject surveys and anecdotal evidence indicate that the students are developing, very early in the degree, a sense of the context that defines how they can (and should) approach the practice of engineering in a professional context.

CONCLUSIONS

In this paper we have considered an approach to managing the diversity of computing experience exhibited by first year engineering undergraduates. Our approach is based on a combination of a modularised structure, student-negotiated selection of modules, and mastery-advanced assessment. The approach has proven to be very effective when students are motivated to undertake the negotiation. It however has problems when students do not have sufficient motivation or understanding to negotiate changes. This has unfortunately occurred with a rather large proportion of students.

Initial investigations have shown this to be at least partly because the students are not familiar with the increase in academic freedom which comes with the change from School to University. We discussed one possible solution involving making the negotiation of subject modules to be completed an integral part of the subject rather than an option. This has, however, yet to be trailed.

Overall, the subject has proved to be very rewarding for both staff and students. Creative ways of structuring the subject, flexibility in the student learning approaches, and providing an engineering practice context for the development of understanding computational tools, have all resulted in a valuable and effective learning experience. The subject has been logistically fragile, but educationally successful.

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Appendix 1: Subject Design Document Extract

The following information is an extract from the *Informatics* subject development documentation describing (in part) the initially proposed subject structure. This highlights the way in which *Informatics* provides a flexible structure which allows students to select learning modules that are best suited to their particular prior knowledge and skills.

Subject Structure

The subject structure involves two main threads of focus: issues and skills. The issues thread (equivalent workload approximately 48 hours) covers the development of suitable understanding of classes of informatics tools, uses and limitations of these tools, and the relationships between these tools. The skills thread (equivalent workload approximately 112 hours) covers skills development.

The subject is structured so that it is comprised entirely of teaching modules. Some of the modules will be compulsory (especially the issues modules and the several of the skills modules - including programming skills) and some of the modules will be electives. The issues modules will be scheduled so that they run essentially throughout the semester.

The formal sessions for the various teaching modules includes large classes (lectures involving presentation and explanation of material to the entire subject cohort), small classes (either lectures involving presentations or workshops involving interactive discussions with smaller tutorial-sized groups of students), individual study (tutor-supported study involving one-on-one interaction between a tutor and a student such as might occur in the LDC) and independent study (study undertaken solely by the student, including both LDC modules and personal study). Note that each of these modes of learning/teaching has different resource implications.

During the first week of the subject, students will be allocated to a specific tutor (who teaches them during any small class sessions for the issues modules - see the section below on the issues thread) for the entire duration of the semester. This tutor becomes responsible for the students overall subject program (including aspects such as allowing them exemptions on compulsory modules and maintaining their marks for the subject) and will normally be the students first point of call in the case of questions or problems related to subject logistics.

Learning Modules

Each module is run relatively independently and will be structured in whichever way is considered most relevant for that module. The students will be required to complete a minimum of 19 units of modules. A unit corresponds to approximately 8 hours of total time commitment - which will include the option of two 1.5-hour class sessions, and related self-study time (though the specific distribution of time can vary from module to module, for example, module B may be a two unit module with 4 class sessions and 10 hours of self-study, and module B may also be a two unit module but be entirely based around LDC modules with no formal class sessions).

The students are required to complete a minimum of 19 units, (though most will end up completing 20 units because of the structure of the units) , made up of both certain compulsory modules and additional elective modules. Where students have prior understanding or skills, compulsory modules may be replaced by the elective modules (obviously at the discretion of tutors or the subject coordinator).

An example suite of skills modules is:

Compulsory modules (18 units):

All of the following issues modules (6 units):
I1 Informatics Tools (3 unit)
I2 Informatics Issues (3 units)

All of the following skills modules (7 units):
CO Operating systems (1 unit)
CW Written communication and word processing (1 unit)
CS Spreadsheets (2 unit)
CI Internet tools and the WWW (1 unit)
PI Intro to programming (2 units)

And one of the following (note: the specific languages offered may vary from semester to semester and will be dependent on a variety of factors. Those listed are simply a typical set):
PC C programming (5 units)
PB Basic programming (5 units)
PF Fortran programming (5 units)
PJ Java programming (5 units)
Px User-selected language (n units) note: this incorporates a student-selected language, negotiated with the subject staff and dependant upon resourcing implications.

Elective modules: both skills and issues modules may be offered (each module is 2 units).
ET Teamwork tools
EO Oral communication tools
ED Databases
EP Project management tools
EC Computer Aided Design
Ex Self-Learning module (student-nominated field)
\+ others as developed or required

Each student will be able to select their particular pattern of modules. Each module will be commenced by a student by collecting the module documentation from the Learning and Design Centre. This documentation will describe the completion requirements for the particular module. This will include a combination of class sessions (up to two 1.5-hour sessions per skill unit), learning modules, self-study, and group projects.

Where the module contains formal class sessions (either lectures, tutorials or workshops) they must register for one of these sessions. The sessions will generally be scheduled to allow students to complete any combination of modules. Each small class session will be run by one tutor and have a maximum of 30 students. As an example, the spreadsheets module (2 units - 16 hours) may comprise 4 teaching sessions (6 hours), 4 self-taught modules (8 hours) and some self study (2 hours).

One introductory sessions will be held at the beginning of the semester. In this session the various modules will be described and the structure and approach outlined. At the end of the session, the students will be asked to provide an indication of the modules which they are likely to wish to undertake (including if they believe they will obtain permission to replace a compulsory module with an elective module - though this must later be confirmed by a tutor).

Assessment

With the described subject architecture it is impractical for every module undertaken by a student to have individual assessment tasks, as this would result in an excessive number of assessment tasks within the subject. Nevertheless it is important that the extent of the students understanding of both skills and issues be effectively evaluated.

One possible proposal for the assessment for the subject would be to incorporate Mastery and Advanced assessment levels.

All students would be required to complete the Mastery assessment component, which solely determines the subject pass/fail grade (but NOT mark). No marks are allocated to the Mastery component, but if students pass then they are guaranteed a minimum mark of P (i.e. they are guaranteed a pass in the subject, even if they do not attempt the advanced assessment component). If they fail the mastery component then they are given a mark of Z. To satisfy the Mastery requirements, the students must:

Complete satisfactorily 19 skills units (including all compulsory units unless given exemptions). The definition of satisfactory is module defined.

Pass the final oral/coding examination (which examines their understanding of both issues and skills - i.e. questions may be asked relating to any of the skills modules they completed).

Those students who wish to gain a mark beyond a basic pass can attempt the advanced assessment component. The advanced assessment component (of which each and every element is completely optional) determines the students mark once they have passed the mastery criteria. Note that irrespective of performance in the advanced assessment component, students CANNOT pass the subject without passing the mastery assessment component. The advanced assessment components are:

50 marks: The assessment task from the programming module which they undertook.

50 marks: A learning contract (or similar assessment task) which demonstrates understanding of two or more of the non-programming skills modules and at least one major aspect of the issues modules.

Note that those students who obtain an exemption from the programming module (due to prior knowledge) can still undertake the assessment task from the module for which they have been given an exemption.

Additional Comments

A few additional comments are useful. This proposed architecture not only addresses resourcing issues elegantly, but provides a convenient and effective mechanism for coping with the disparate entry-level skills and understanding of the students. If a student already has a solid grasp of the material for a specific (compulsory) skills module (evaluated through an appropriate mechanism prior to commencing the module) then they can remove that module from their program and add extra elective modules, covering skills which they do not yet have.

Appendix 2: Example Fragment from Self-Paced Learning Module

The following is an extract of one of the self-paced learning modules. This demonstrates the key elements and how they guide students through a particular body of knowledge.

Learning module 2

Objective

To develop your understanding of, and ability to code C programs incorporating complex data structures (pointers, arrays, structures, etc.), functions (especially passing of arguments, and passing by reference), the C libraries and the C preprocessor (including an understanding of header files).

Step 1: Arrays

Discussion:

As was covered in the first Learning module, programs utilise variables to store and manipulate data. Often we will have a collection of data which has the same type. For example we may want to read in an then analyse a group of 100 numbers. Rather than having to define 100 different variables, instead we define an ***array***. This is done as follows:

```
main()
{
   float i[100];          defines an array variable called i
...
```

[Material removed]

Reading:

Deitel and Deitel: Section 6.1 to 6.4

Action:

Try writing a short program which asks the user for a number of integer marks. As the numbers are entered, store them in an array. When the user enters a negative number, stop entering data (hint, try using a do-while loop) and calculate the average of the numbers. The program output should look like:

```
Please enter a mark > 56
Please enter a mark > 71
Please enter a mark > -1
Average is 63.500000
```

[Material removed]

Submission:

The file `mod2-8.c` contains the start of a program which will play tic-tac-toe (or "noughts-and-crosses") with the user. You are required to complete the program. Please note that you should leave the structure of the program unchanged and only add the sections specified. Where you are required to add type definitions, these should be consistent with the parts of the program which already exist. Finally, you can assume that the user always plays first (and is "O") and that the computer (which is "X") does not need to be particularly good at playing (ie. it can play by simply finding the first available empty square).

Once you have completed your program then you should compile and test the program. After you are satisfied with your solution then you should email your working (and suitably commented) source code to your tutor for evaluation.

BIOGRAPHIES

David Lowe is an Associate Professor, head of Computer Systems Engineering, and program director for the Information Systems Engineering graduate program at the University of Technology, Sydney. He has active research interests in the areas of hypermedia, multimedia and the Web. In particular he focuses on information contextualisation, hypermedia development process modelling, and web project specification and scoping. He has published widely in the area, including a graduate-level text (Lowe and Hall, "Hypermedia and the Web: An Engineering Approach", Wiley, 1999). He has consulted widely in the areas of web systems and software engineering, as well as running industry short courses in these areas.

Dr. Craig Scott is a Senior Lecturer in, and Program Director of the Computer Systems Engineering Program at the University of Technology, Sydney. He teaches predominantly in software development but he also coordinates the orientation camp for first year students. Craig's research interests are focussed on positioning systems, especially positioning cellular mobile phones. In particular, he is interested in techniques for modelling and then integrating the many sources of information that can augment the radio-location process.

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Low Achievement and the Mismatch between Personal and University Learning Styles in Mechanical Engineering Students

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This paper will discuss the question why some students, particularly those from non-traditional backgrounds, such as TAFE and other articulation students and lower socio-economic and disadvantaged groups, should have academic difficulty with the Bachelor of Engineering (Mechanical) at Queensland University of Technology (QUT) as opposed to other similarly theoretical courses. If students from non-traditional backgrounds can achieve academic success in other courses, it could be argued that the reason for their lack of success lies more in a mismatch between cultures and learning styles, rather than in an inability to cope with academic content. This paper will look at research on why some students under-achieve and/or drop out of higher education. The possibility of a mismatch between learning styles and personality types and the university teaching styles will be examined, particularly in reference to Kolb's Learning Styles and the Myers-Briggs Type Indicator of personality type. It will be argued that there is conflict between the learning styles and personality types of non-traditional background students that contributes to their difficulty in academic success at university.

INTRODUCTION

In the past two decades, the university client base has changed from the traditional, more *elitist* and academically oriented and focused student body. Students are increasingly *non-traditional*, that is, other than *traditional* students who: enter university from year 12, are from a middle to upper socio-economic bracket and have one or more parent who is tertiary educated. Students come from far more diverse backgrounds, socially and economically; entry levels have dropped; students, either from peer pressure or by necessity, often work to support themselves; and a greater proportion of students are mature age with concomitant responsibilities and commitments. Within the School of Mechanical, Manufacturing and Medical Engineering (MMMEng) at Queensland University of Technology [QUT] it has become apparent that there is a group of non-traditional students that experiences difficulty with academic achievement, particularly in the more theoretical subjects, resulting in low pass rates and, quite often, high attrition rates. An example of this group of non-traditional students is the TAFE (Technical and Further Education) articulation students who automatically receive a block exemption of 2 semesters in the BE (Mech) in recognition of their prior studies. Most writers investigating the success of TAFE students articulating into universities report the outstanding success of these students. Former TAFE students on average are reported to perform as well as other tertiary students. The granting of advanced standing due to recognition of prior learning and work experience does not appear to negatively affect university studies, however the standard of maths and physics is inadequate, which is particularly relevant in engineering courses. Alaba et al [1] surveyed TAFE students at the University of Wollongong and found that they performed better than average in Arts, Education and Mathematics and lower than average in Engineering, Commerce and Science. Surveys undertaken in the School of MMMEng at QUT show that TAFE articulation students in the Bachelor of Engineering (Mechanical) (BE(Mech)) generally have not performed well. A survey of TAFE articulation students in the BE (Mech) showed that only three out of fifteen students achieved a Grade Point Average (GPA) ≥ 4.00 (on a scale of 1 – 7). All students, apart from those with a forced offer, were ranked as eligible for entry by Queensland Tertiary Admissions Centre (QTAC), receiving estimated entry GPAs for their TAFE Associate Diploma ranging from 4.00 to 6.21.

The anomaly of the low achievement and high attrition rates of non-traditional students in the BE(Mech) when compared with other courses suggests that the problem may not lie in the inability of these students to *learn* the required material, but rather in the presentation of the material. Given the diversity of personality types among students and lecturers, it is not surprising that the learning style of a student (how the student perceives, processes and assimilates information) and the teaching style of a lecturer, (how the lecturer presents material – reading from notes, question and answer and use of presentation aids) can often be in conflict. Whether different groups of students require different presentations of materials to achieve the same, or similar, levels of academic achievement is the subject of this paper. The cultural differences between students and the university environment can also present difficulties for students that can affect academic achievement. Research into low achievement and non-continuance indicates that conflict between internal environmental influences, as well as learning styles, can compound to affect achievement.

CONTRIBUTING FACTORS IN LOW ACHIEVEMENT AND NON-CONTINUANCE OF UNIVERSITY STUDIES

Although not all low achieving students will discontinue studies, there appears to be a strong correlation between low achievement and attrition. It is accepted that there can be many contributing factors to both situations, some beyond, but many within the control of the institution. In many studies, the contributors to low achievement and attrition suggested both environmental and pedagogical influences. In an investigation into why some students failed to complete courses of study, Martinez [2] cited results from student surveys of a diverse group of seven British Colleges carried out between 1990-1994. The results suggested that *something* in the introductory and induction phases of university worked less well for students who did not complete. Non-continuing students reported far less satisfaction with the amount of tutorial time; speed and pace of teaching; the level of the course; and maintaining a level of sustained interest. In comparison to continuing students, non-continuing students had more problems with the internal processes of tertiary institutions, such as support from staff and other students, orientation and administration, and programme issues, such as tutorial time, speed of teaching, and entry qualifications than with external factors such as accommodation, finance, and family. In one study both withdrawn and current students cited financial hardship as a difficulty factor. The only statistically significant reason for withdrawal that applied more to withdrawn students than continuing students was the perceived (or real) lack of concern for their problems by the institution. It was suggested that withdrawal is most likely when financial hardship coincides with dissatisfaction with support and teaching quality.

In support of Martinez's contention that the environmental factors of the institution affect student retention, Tinto [3] argued that an institution's capacity to retain students is directly related to its ability to reach out and make contact with students and integrate them into the social and intellectual fabric of institutional life. This highlights the reciprocal relationships between the cultural emphases of both the student and the institution: it is never any one particular aspect of the relationship that causes students to withdraw, as causes are all interactive and dependent upon each other. In keeping with the cultural theme, Astin [4] stated that the greatest predictor of student failure is the student's past academic record and academic ability, followed by poor study habits, less educated parents, and small town background. However, it cannot be denied that some students with all these impediments succeed academically.

Beyond the obvious factors contributing to non-continuance of financial hardship, work and family commitments there are the pedagogical factors. Students’ learning styles are inextricably linked to lecturers’ lecturing/tutoring/demonstrating styles. A contributing factor to many students' inability to persevere with their education is a mismatch between personal learning styles and university teaching styles. Many researchers have highlighted the difficulties faced by students, especially those from non-traditional backgrounds, in adapting identity and learning style to conform to the university requirements.

An examination of Kolb's [5] Learning Styles and the Myers-Briggs Type Indicator of personality type illustrates how and why individuals have unique ways of receiving and processing information – that is, unique learning styles. The relationship between individual learning styles and the university learning environment is illustrated in the studies of Salter [8] and Felder [11]. Salter’s and Felder’s research supports a contention that above and beyond the environmental factors outlined above, pedagogical factors a strong contributors to non-traditional students’ low achievement and high attrition rates. Further, low achievement and discontinuance of studies have long-range implications, affecting students’ self-perception and propensity for life-long learning. This is supported by Markus and Nurius [12] theories on *possible selves*.

KOLB'S LEARNING STYLES

Kolb [5] stated that learning is a tension and conflict filled process between dialectically opposed learning dimensions. In Kolb's theory of learning styles there are two basic structural dimensions of the learning process. The *prehension* dimensions are concerned with how the individual receives experiences: either via *direct apprehension* of immediate concrete experience, or through *indirect comprehension* of symbolic representations of experience. Kolb stated that *apprehension* is comprised of personal knowledge from personal experience or realisation of actualities. *Comprehension* is social knowledge, which is the independent socially and culturally transmitted network of words, symbols and images that is based solely on comprehension. The second dimension *transformation* is concerned with the way in which the apprehended or comprehended experience is transformed into knowledge: either via *intentional reflection* or *extensional action.* Learning styles are composed of a *prehension dimension* where the individual receives an experience, and a *transformation dimension* where the individual processes that experience into knowledge. For example, an individual who grasps experience via *comprehension* and transforms that experience via *extension* falls into the quadrant of *convergent knowledge.*

Which particular combination of dimensions an individual will adopt as a learning style is a product of previous experience. A learning style is dynamic and will adapt and change as a result of new experiences. In relation to students in the university environment, it follows that if the previous social and cultural experiences of the learner are incongruent with the present culture and society of the university there will be difficulty in comprehension. A congruent culture is necessary to understand the words and symbols, and there must also be a congruent transformational process to arrive at the same meaning and understanding between the learner and the institution. If a student has not had the experience of a compatible transformational process, for example as an academically successful student in a private school, he or she would find more difficulty in adapting to the transformational processes required by the university. Kolb's learning styles and their relationships to learning environments and Jung's psychological types are summarised in Table 1.

THE MBTI AND ENGINEERING STUDENTS

McCauley [9, 10] examined the relationship between the MBTI and engineering students. The MBTI is a questionnaire that employs Jung's psychological types to represent individuals' preferences for a mode of information seeking and decision making [10]. The eight basic modes are:

Extraversion (E) vs Introversion (I)
Sensing Perception (S) vs Intuitive Perception (N)
Thinking Judgement (T) vs Feeling Judgement (F)
Judging (J) vs Perceptive (P) orientation to the world.

An individual can have a preference for any of the 16 possible types. It is only by using the preferred mode that an individual can excel in a task, but it is expected that they can function adequately within most, if not all, the types. McCaulley [10] stated that the (S) vs (N) difference is the most relevant to the educational situation as it deals predominantly with how information is received and processed. Reading, writing and listening are intuitive traits: sensing traits are exemplified in *hands-on* or applied tasks. Table 1 illustrates the relationship between the MBTI types and Kolb's learning styles.

In a study at the University of Florida, McCaulley [9] found that, in a ratio of 2:1, potential engineering students preferred introversion as a mode of receiving information. This suggests that the majority of students interested in engineering prefer a field of study where conceptualisation and individual work are the mode of learning. Introverted/Intuitive (IN) types score better on academic aptitude tests and find the reading, listening, lecturing mode of presentation easier to cope with. In the perception field of Sensing vs Intuition, engineering students are fairly evenly distributed with the sensing types more attracted to applied engineering and the intuitive types to the theoretical fields. In the Thinking vs Feeling field, the majority of engineering students preferred the Thinking category, which refers to working with objective analysis and cause-and-effect rather than people. With respect to the Judging vs Perceptive field, engineers are predominantly Judging, that is, they like systems and plans and regulation. Thinking/Judging (TJ) types are dominant in engineering.

Table 1

Basic Learning Modes *	**Learning Quadrants ***	**Learning Environments ***	**Optimal Learning Environment #**	**Negative Learning Environment ***	**Relationship to Jung's Psychological Types and MBTI**
Concrete experience – involvement in experience in an immediate and personal way; feeling as opposed to thinking; intuitive *artistic* as opposed to systematic *scientific* approach to problems.	***Accommodation*** – concrete experience plus active experimentation	***Affective*** – emphasising concrete experience. Learners recreate or simulate professional environments	***Concrete experience*** – affective, personalised feedback, sharing feelings, teachers as helpers, application of skills to real-life situations	Theoretical reading assignments	***Accommodative*** – sensing, perception
Reflective observation – understanding meaning by observation; understanding	***Divergent*** – concrete experience plus reflective observation	***Perceptual*** – emphasising observation and appreciation. Identifying conceptual relationships and problem definition	***Reflective observation*** – teacher providing expert interpretation, guiding discussion, lecturing	Task oriented situation	***Divergent*** - feeling
Abstract conceptualisation- use of logic, ideas and concepts; thinking as opposed to feeling; building general theories as opposed to intuitive understanding; scientific as opposed to artistic approach	***Convergence*** – abstract conceptualisation plus active experimentation	***Symbolic*** – emphasising abstract conceptualisation. Problem solving with a right or wrong answer	***Abstract conceptualisation*** – case studies, thinking alone, theory readings	Group exercises and simulations, self direction, personalised feedback, here-and-now information, professional experiences	***Convergent*** – thinking, extravert, judgement
Active experimentation – actively influencing people and situations; practical applications as opposed to reflective understanding pragmatism as opposed to absolute truth; doing as opposed to observing	***Assimilation*** – abstract conceptualisation plus reflective observation	***Behavioural*** - emphasising action with real consequences. Applying knowledge or skills to a practical problem	***Active-experimentation*** – small group discussions, projects, peer feedback, homework, teacher as professional	Lectures, teacher as taskmaster, right or wrong answers	***Assimilation*** – introvert, intuition

*Summarised from Kolb (1984)   # Summarised from Salter (1994)

McCaulley [10] presented a table showing the distribution of MBTI types within engineering disciplines. Overall, engineering has more IN types but, significantly, mechanical engineering had its highest distribution in the categories ISTJ (16.8%) and ESTJ (15.25%), the next highest is INTJ (10.62%). This suggests that the majority of mechanical engineering students are Sensates (Ss) and basically unsuited to the presentation modes of university courses which favour the Intuitive (IN) types although, as Ss, they may be drawn to this discipline in a belief of the *hands on*, sensing nature of mechanical engineering. There are very few Feeling (F) types in engineering, especially in mechanical engineering, which has the lowest percentage representation in all F categories. F types are those individuals who are attuned to the humanities and communications disciplines.

THE RELATIONSHIP BETWEEN STUDENT LEARNING STYLES AND UNIVERSITY LEARNING ENVIRONMENTS

Learning styles and psychological types can be related to learning environments. A typical lecture would comprise perceptual and symbolic orientations: it requires students to listen to and interpret a presentation utilising *reflective observation* and to reason and induce conceptual relationships of spoken information utilising *abstract conceptualisation* [6]. The learning environment can incorporate aspects of other environments. For example, if a question and answer session is incorporated into a lecture, the learning environment becomes more behavioural as increased interaction between the lecturer and students occurs.

From the relationship between Kolb's learning styles and the Myers-Briggs Type Indicator (MBTI) an extrapolation can be made to describe the most likely learning style and environment of a particular psychological type. For example, a student who is classed as Extravert/Sensing (ES) in the MBTI is likely to have either an accommodative or convergent learning style: grasping information by either apprehension or comprehension and transforming the experience by extension (active experimentation). In fact, Kolb stated that engineering students tend to fall in the convergent quadrant suggesting that, in the MBTI, they would be in the ES categories. Salter [7] described the related classroom situation to a particular type. For example, the introverted classroom puts the emphasis for the learning process on the student. It is self-regulatory and reflective. The sensing classroom is pragmatic and down-to-earth, emphasising concrete and established information in a *hands-on* format. An introverted student in an extraverted classroom could feel intimidated or threatened by the overt activity, while an extraverted student could be bored and unmotivated by an introverted classroom. Salter reported that extraverted classrooms, particularly in the first two years of university, reported better performance. However, this could be attributed to the fact that the students in Salter's study were second year and had not yet fully developed reflective and critical thinking attributes. As suggested by Perry's Model of Intellectual Development [8], reflective and critical thinking habits are the last stage of intellectual development.

Felder [11] contended that how much a student learns is governed by the compatibility between learning style and teaching style and outlined possible discrepancies between student learning styles and lecturer teaching styles which are prevalent in engineering education. These are summarised in Table 2.

It is obvious from Table 2 that traditional engineering educational methods fall well short of catering for E and S types as the bulk of engineering education is conducted in the lecture. Felder [11] stated that most engineering students are sensors, while educational styles clearly favour intuitive styles. Salter, Kolb and McCaulley supported the contention that most educational styles favour intuitive types. While this mismatch in styles represents a distinct problem for both lecturers and students, there are implications beyond the classroom for students if they fail to adapt adequately. The personal impact of failure to adapt can have a long-range effect on students' self-perception.

Table 2

Student Style 1	**Student Style 2**	**Engineering Education Style**
Sensing – observing facts, detail, experimentation	***Intuitive*** – perceiving concepts, symbols (words), abstracts	***Intuitive*** – concept and symbol based – theories presented in lectures, readings
Visual – sights, pictures, diagrams	***Auditory*** – sounds, words	***Verbal*** – lectures or visual representation of auditory information (words and mathematical symbols written in texts and handouts, overheads)
Inductive – reasoning progressing from particulars	***Deductive*** – inferring principles, deducing consequences	***Deductive*** – top down process – principles and theories stated first and worked down to applications that are presumed to be already understood.
Active learners – experimentation, discussing, explaining	***Reflective learners*** – observation, examining, manipulating, introspection	***Passive and non-reflective*** – lectures that do not encourage discussions or allow time for reflection
Sequential learners – materials learned in stages as presented, linear reasoning, convergent thinking	***Global learners*** – materials learned in fits and starts, often top down, intuitive leaps, divergent thinking	***Sequential*** – material presented in logical order

POSSIBLE SELVES AND NON-TRADITIONAL STUDENTS

From discussions with academic staff and observations during student academic and personal counselling by the author, it is apparent that there are significant differences in academic approach and style between the *normal* entry (Year 12) students and non-traditional students, for example TAFE students. The incongruence between non-traditional students' learning styles and university teaching styles has implications beyond that of academic success or failure. The theory of *possible selves* propounded by Markus and Nurius [12] proposed that the *possible self* is a construct of past and future representations of self that are based on past socio-cultural experiences, and function as incentives for future behaviour. As such, it could be said that non-traditional students' concept of possible self is grounded in the desire and motivation to achieve the professional status of *engineer.* However, in conjunction with the *possible self* of an individual is the *ought self*, which is the manifestation of what significant others believe the individual should be. For non-traditional students, this provides another level of mismatch: the University's concept of *ought self* for these students states that they should be type IN, as this is the way the University teaches, when in fact they may be ES or IS. The articulation programmes between TAFEs and universities is the result of a DEET and AVCC supported directive that there should be enhanced articulation between the institutions. This incentive stems from the desire for less *status* distinction between education institutions, following on from the amalgamation of universities and colleges of advanced education in the late 1980s. By accepting non-traditional students into advanced standing programmes, the Government and Universities have stated that these students have the ability to graduate as professional engineers, that is they have held out a promise of a *possible self* to which the student should strive. However, the universities have, for some students, misrepresented the promise because their concept of the *ought self* is incongruent with the *actual self* of the non-traditional student. This results in anxiety for these students as they strive to attain a *possible self* that is in conflict with the university environment.

If possible selves are a composite of previous social experiences, then it is most likely that non-traditional students will have increased difficulty in sustaining their concept of *possible self*. Most non-traditional students coming to university do not fit the *traditional* academic mould. They are not successful academically in high school and they are often from lower socio-economic groups. Many do not have a family background of higher education, and lack the previous experience of the university culture and environment, so their concept of *possible self* may be incorrect and distorted. It is very clear from the author's contact with these students that they have limited conceptualisation of the theoretical content of university work. For example, TAFE students are not used to the impersonal environment of the university after the small class environment of TAFE. They have little idea of the amount of work they will have to put in to succeed, particularly in mathematics and physics, which are academically taught in a way that is incongruent with their ES learning styles. University study requires more than doing what the teacher says to do. It requires students to develop a thirst for more knowledge and to delve deeper into subject areas than what is covered in lectures. Further, university students are expected to read further and analyse what is written. This lack of preparedness coupled with incongruent teaching style results, for most TAFE students, in repeated failure of subjects. This has far-reaching implications beyond that of immediate academic status. Markus and Nurius [12] stated that *possible selves* function as incentives for future behaviour. If the *possible self* is continually negated by failure, thereby bringing the negative *possible self* of low achievement or *drop out* to the fore, then the non-traditional student is unlikely to be able to sustain the positive *possible self*. Self-esteem is lowered and failure is reinforced.

DISCUSSION

Recommendation 3.2 of the Institution of Engineers Australia (IEAust) Review Report *Changing the Culture: Engineering Education in the Future* [13] stated that universities should ensure that their graduates have generic attributes which include: application of basis science and engineering fundamentals; effective communication; technical competence; problem solving; team work; understanding of sustainable development and globalisation; life-long learning capabilities. In order to comply with the IEAust's recommendations, and fulfil obligations to students, there are some fundamental changes in approaches to pedagogy that will have to occur. As discussed in Hargreaves and Ternel [14], the Newtonian reductionist/mechanistic concept that everything in science and nature can be reduced to, and understood as, separate objects and further reduced to *fundamental material building blocks whose properties and interactions were thought to completely determine all natural* *phenomena* epitomises engineering education [15]. There is a distinct similarity between this philosophy and the introverted/intuitive type favoured by academic institutions. The belief that a learned person was one who possessed a great deal of factual knowledge is still prevalent. Universities are still imparting knowledge for knowledge's sake (IN type) rather than for the functional, practical aspect of putting it to good use (ES type) [16]. This is not to say that there is not a role for *knowledge for knowledge's sake*, but for the majority of non-traditional students it is not the reason they are at university.

Education is traditionally conceived as a fairly one-way street where knowledge travels from the teacher and the textbooks to the students who try to memorise all they can. Students are expected to store information in their mind, but not necessarily to use their mind to process the information. As a result, there is no incentive to relate what they learn with other concepts or to apply it to situations outside of their school-related work [17]. Education has generally produced *knowers* rather than *learners*. As Kolb [5, 6] stated *...there has been a corresponding need for educational methods that can translate the abstract ideas of academia into the concrete practical realities of [non-traditional background] people's lives.*

It has been suggested by Tornkvist [18] that the emphasis on mathematics and physics in engineering education is employed as a filter to weed out those students who will not fit the mould and perpetuate the elitist, engineering set. Engineers maintain the elitism of the profession by filtering students through first year mathematics and physics; the attitude is *we learnt it this way so anybody who cannot learn it this way is not fit to be an engineer*. This serves the purpose of maintaining the elitism and perpetuating the current academic structure, but it also reinforces the screening hypothesis that universities serve the function of balancing supply and demand and filtering out those considered not suitable for employment. This is a wasteful process and does not necessarily achieve the ends it desires. The field of medicine already has discovered this. Previously the medical degree was considered only suitable to the academically elite, however it is now realised that these people are not always the best medical practitioners and entrance procedures have been broadened to include interviews to gauge personal suitability as well as academic ability in previous studies.

Most engineering educators will agree that a firm knowledge of the scientific *basics* such as mathematics, physics, and discipline specific engineering theory is necessary to produce an engineering graduate who will fulfil the requirements of employers. However, there are several levels of material presentation where traditional methods could be re-evaluated. For example, the majority of engineering courses are structured to introduce students with a heavy diet of *sciences*: at QUT first year engineering is comprised of mathematics, physics, and basic engineering sciences. Students are required to learn and understand mathematics' and physics' theory, however, the majority do not understand why they need this information and how it relates to their course. This situation is often exacerbated by the fact that mathematics and physics are taught by non-engineers who possibly would find difficulty in teaching applied mathematics in the engineering context. The *bottom* of the pyramid of engineering knowledge is an understanding of the concepts of engineering and the synthesis and synergy of mathematics and physics with, for example, fluids, thermodynamics and design. Only in this way can students truly understand why and how to apply what they are taught. One suggestion for achieving this result is to remove mathematics and physics from first year and replace it with a *top down* approach, project based, design year with mathematics and physics incorporated to support the broad concept. Future mathematics and physics should be incorporated within each discipline unit to support the unit content. For example, in Thermodynamics only introduce the mathematics and physics that is needed for this subject. This provides an *applied* and relevant approach to theoretical disciplines that is more in keeping with Salter's *sensing classroom,* which is pragmatic and down-to-earth, emphasising concrete and established information in a *hands-on* format, and is far better suited to ES students. Obviously, the way in which class rooms are structured and material is presented should be reassessed as well. It is the intention of staff within the School of MMMEng to undertake further investigation into the concept of redistributing mathematics and physics into discipline units.

CONCLUSION

The research on learning styles and learning environments illustrates the multiple possibilities for mismatches to occur. The fact that universities have accepted non-traditional students but have not adapted their teaching style or environment to cater for these students ensures that these students will be disadvantaged academically and, consequently, more likely to discontinue their studies. The environment of engineering education is particularly difficult for these students. Current educational environments favour intuitive types and the system ensures a continuity of type: the *best fit* and more adaptable types succeed academically and become postgraduate students, where they are further inculcated into the intuitive philosophy of pedagogy by supervisors. The postgraduate students in their turn become academics and the cycle is perpetuated. This suggestion is supported by the fact that university education methods have changed very little since the word *lecture* fitted the action, *to read* (that is, the lecturer read to students from books which were far too precious for students to handle) [14]. There is reduced opportunity for the sensing type student to attain academic status and, if perchance he/she is successful, the university's insistence on *publish or perish* ensures that the intuitive type is pushed to the fore. However, there are inherent dangers in perpetuating any given *type* in an academic discipline. One danger is tunnel vision and a narrowed perspective. This is evident in engineering education where the particular needs of non-traditional students are not being adequately addressed. IEAust is emphasising the need for communication and humanities skills in graduates, however, the educational environment of engineering does everything to discourage S and F types who are the most sensitive to these attributes. Engineering education will need to recognise that students with a different learning style to the traditional can learn the same material and be useful engineers if the profession is to encourage and nurture the best people for a changing world.

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BIOGRAPHY

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