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# Who leaves and who stays? Retention and attrition in Engineering Education

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***Abstract:*** *At a time of high demand for engineering graduates, the mean graduation completion rate of engineering undergraduates in Australia has been identified as approximately 54% (with considerable variation across institutions and sectors). This proportion of non- completions has been viewed as an excessive loss to the qualified workforce of Australia. Broad brush, government-collected statistics do not, however, provide the level of detail required to understand who leaves, when and why they leave, and where they go. This paper reports on a pilot study undertaken to precede and inform final decisions on research design and methodology for a multi institutional project seeking to understand and reduce student attrition from engineering degrees across Australia. The aim of the project is to produce guidelines on curriculum formulation and delivery strategies to reduce attrition in engineering programs while meeting outcomes.*

*The pilot study was conducted at an institution which has a relatively diverse range of students, a high proportion of whom study part time, and engineering degree structures incorporating traditional and internship-based degrees. Results from a cohort analysis, tracking pathways to completion or non-completion of the degree for the cohorts from two specific entry years will be presented. From this analysis, groups of students who "persisted over long periods", "switched to another degree" or "withdrew from the university" were identified and interviewed. Their experiences and stories, were an essential ingredient for a better understanding of the dynamics of retention/attrition and factors which required further questioning before proceeding with the multi institutional study.*

## Introduction

The consultative review of the Australian engineering education system "Addressing the Quality and Supply of Engineering Graduates" (King, 2008) undertaken in 2007-2008 by the Australian Council of Engineering Deans reported that the demand for engineering graduates in Australia and globally is increasing with an estimated shortfall of 20,000 engineers in Australia alone. It also noted that the mean graduation completion rate over 2001 to 2006 of engineering undergraduates was approximately 54%. This corresponded to a mean annual course success rate in the range of 0.77 (domestic part-time male students) to 0.908 (international full time females) and mean course retention rates of 0.653(international part time males) to 0.923 (international full time females). This loss of approximately 46% of the commencing cohort was not only viewed as an excessive loss to the qualified workforce but a loss of return on public investment in the case of domestic students. The aggregated attrition data for engineering presented in the review, confirmed data from several Australian higher education reports (Krause et al.,2005; Marks, 2007; Olsen et al., 2008) but provoked disquiet and considerable discussion which focussed around the need for a better understanding of the impact on retention of institutional differences, new degree structures, part time study, the introduction of "learning spaces", and targeted retention strategies.

An overarching project aimed at underpinning and strengthening Australia's education system for engineering education through informed and systematic curriculum renewal and delivery support has been funded by the Australian Learning and Teaching Council. One of the four themes in this project specifically addresses "Understanding and Reducing Attrition". The purpose of this project theme is to gain a better understanding of who leaves, when and why they leave, and where they go to, in order to identify strategies that can be implemented within university administration, curriculum specification and delivery that will increase retention to completion of the qualification. The overall research question for the attrition project theme could therefore be framed as “How could Australian engineering degree granting institutions and their staff adapt their current processes and practices to improve retention of students to completion of the engineering degree”. One of the proposed outcomes is the production of guidelines on curriculum formulation and delivery strategies to reduce attrition in engineering programs while meeting outcomes standards.

The first phase of the project was a best evidence synthesis of literature on retention/attrition internationally in engineering education, and in the higher education sector within Australia. Initial analyses of attrition and completion data using Department of Education, Employment and Workplace Relations (DEEWR) statistics were also part of this initial scoping exercise.

This exercise revealed that for engineering education in Australia:

- Attrition is higher in engineering than in other professional disciplines such as medicine and veterinary science, but lower than more open entry degrees such as sciences, or arts
- Attrition is higher for part time students than full time students
- There is less migration into engineering from other degrees, than migration out.
- Attrition is higher for domestic students than international
- Attrition for the 19-23 year age group is the lowest of the age groups
- Attrition varies markedly by institutional characteristics such as status, admission score, urban/regional
- On average, attrition and failure rates are higher for male students than for female students (although female participation in engineering averages nationally at <15%)
- Average retention is 85% per year which would result in 52% still enrolled or eligible to graduate after four years

The second phase of the project is an in-depth analysis at each of two case study institutions with the aim of piloting models and processes, and highlighting issues related to attrition to be explored in the third phase of the project. One institution is a traditional, highly-ranked, research-intensive university. The other, is one of the Australian Technology Network (ATN) universities, which has incorporated more varied degree structures. This paper reports on the initial results from the ATN university hereafter known as ATN1.

The third phase of the project will be to extend the cohort analysis model and instruments developed in the pilot studies, to a selection of 10 engineering schools with common and contrasting characteristics. Similarities and anomalies in retention/attrition patterns revealed by these cohort analyses will be further explored by the individual institutions.

## What do we know about Retention?

Retention, persistence and completion in post-school education have been the focus of increased attention internationally in recent years. Reports from the USA (Hauptman, 2008), UK (National Audit Office, 2007; van Stolk et al, 2007), NZ (Scott, 2005) and Australia (Olsen et al., 2008) demonstrate that governments throughout the Western world increasingly expect improved learner outcomes for money spent on post-school education.

Surveying the wealth of literature on student retention within engineering, Heywood (2002), provides an excellent synthesis and review for the preceding twenty years. He particularly highlights the theoretical foundations and motivation for this focus on student retention in both the USA and UK, also noting the cyclic and unchanging nature of many of the issues.

An annotated bibliography on attrition in engineering education, recently completed for this project, has revealed that the majority of the research literature has focussed on investigating causes of attrition and predicting students at risk of dropping out using statistical analyses, surveys and qualitative studies, rather than evaluating intervention strategies. Such studies have sought to identify candidates with the capacity and motivation to complete the degree and practice engineering (Bernold & Anson, 2007; Besterfield-Sacre, Atman & Shuman, 1997; French, Immekus & Oakes, 2005, Matusovich et al., 2008). The theoretical model most commonly referred to in this student retention/dropout literature is that of Tinto (1988). His model gains support because it immediately appeals to commonsense, with its central notion of "integration" claiming that whether a student persists or drops out is quite strongly predicted by their degree of academic integration, and social integration. These evolve over time, as integration and commitment interact, with “dropping out” depending on commitment at the time of the decision. Moller-Wong & Eide (1997) extended this theory to group the factors attributed as influencing attrition into five categories: academic background, academic and social integration, attitude and motivation, and institutional fit. Reports from several large scale, longitudinal studies (; Brainard & Carlin, 1998; Eris et al., 2007; Haag et al., 2007; Marra et al., 2008; Ohland et al., 2008; University of Hull, 2002, Seymour & Hewitt, 1997) support that categorization and provide compelling evidence of the importance of factors such as self-efficacy, appropriate academic background, and motivation and engagement, for persistence in engineering degrees.

Critiquing the model of Tinto, Georg (2009) suggests that it emphasizes individual attributes, and does not give enough consideration to the institutional characteristics of a subject area, such as, the extent of regulation of a programme of study, and the quality of teaching and advising. His own research findings, however, suggest weak commitment to the course of study has a dominant influence on departure choices, with institutional factors having a more modest influence limited to maintaining or improving teaching quality.

Of the research recommending and reporting on strategies to improve retention, a high proportion focus on the first year experience, adding hands-on, problem solving courses (Knight, Carlson & Sullivan, 2007) to engage students by relevant, real life examples of engineering practice. Evaluation of the effectiveness of the implementation of curriculum redesign or support strategies is less readily available and evidence is often based on "one-off" implementations (Aziz, 2008; Hammoudeh & Barrett, 2002;Light & Davis, 2004; Ohland et al., 2004). Only a few studies such as Ohland et al. (2001) have attempted to evaluate the effect on retention of the implementation of curriculum redesign by tracking retention data over a number of years, pre and post implementation. Looking back over 30 years of retention/attrition studies Tinto (2005) suggested that it is not only necessary to identify effective action, it is also necessary to implement it fully and in ways that will endure and enhance student retention over time.

Internationally, engineering education provides many areas of similarity to the Australian context, making much of the research directly applicable. Australian engineering programmes, particularly at first year level, have led the way internationally in the area of integrated curricula and there is a clear need to evaluate the impact of restructured curricula. The current study will provide answers to the suggestion that "drop-out" may have shifted from first year to later years as found in Ohland et al (2001). Whilst significant differences continue in retention rates between institutions and sectors, demonstrating that retention and attrition are not mono-causal but the result of complex interactions, evidence based research will assist in identifying, and evaluating strategies and practices which appear to have been successful in improving progression and completion rates. From this research it is hoped that "best practice" guidelines for institutional policies and practices will emerge.

## Research Question and goals

The research question for the pilot study, reported here, is:

"What are the characteristics of those who leave before completion of an engineering degree at this university, at what stage do they go, where do they go to, and what are the driving forces behind their choice not to persist with their engineering studies".

## Methodology

### The pilot study institution ATN1

ATN1 is located in the central business district of the largest city in Australia, with approximately 3000 on-campus undergraduate engineering students enrolled in 12 accredited engineering specialisations. The majority of students commute into the city, with limited university-provided accommodation. The engineering student body identifies over 40 languages other than English spoken in their homes, reflecting a diversity of ethnic backgrounds. The 'flagship' undergraduate engineering degree is the Bachelor of Engineering/Diploma of Engineering Practice (BEDipEngPrac) degree which incorporates 2 semesters of work experience or internship. This degree is a 5 year degree undertaken by approximately 70% of the entering cohort. A traditional coursework only 4 year degree is offered, predominantly to international students. Approximately 16% of the entering cohort study a double degree combining engineering with Business, Arts, Science or Law, and a smaller group (~3.5%) study for a 3 year non accredited engineering technologist degree.

## Sources of data for the Pilot study

One of the first difficulties encountered in research on attrition is consistency and clarity in defining “drop out”. Government statistics tend to use the definition of “not re-enrolling in the current degree”, but in seeking to understand the impact on the future engineering workforce of students dropping out of an engineering program it is necessary to be more definitive. A student may terminate his/her engineering studies without completing a degree program, but this must be differentiated from cases where students change institution but continue in engineering study, change to a non engineering program at the same or other institution or interrupt their studies for various reasons. This clarification, hidden by aggregated statistics, needs uncovering before strategizing at the institutional level to reduce attrition can be effective.

The mixed methods approach used in this study, was appropriate where answers are sought to questions not only of “who, how many and “when?”, but also “why?”. The first source of information, investigating the dynamics of attrition at an individual level, was a Cohort analysis providing the opportunity to compare the characteristics of those students who stay to completion, and the destination, timing, academic performance, and characteristics of those who leave. An exit questionnaire was sent to all those had left, prior to completion, in the most recent year – 2008. The questionnaire sought broad brush data on destination and the factors influencing the decision not to continue. It was recognised that decisions to persist or not persist with study in a degree are rarely as straightforward as questions on a questionnaire might imply. Interviews were therefore conducted to hear the ‘stories’ of students who had persisted in their studies over a longer period than usual, switched to another degree or not persisted and left the university. A summary of each of these methods of data collection follows.

## Cohort analysis

Two factors needed consideration before selecting an entry year for a cross institutional comparative study. The first was to pick an entry year for which a significant proportion of entrants would have graduated by 2009, recognising the potential diversity in pathways and degree structures across institutions. The second pragmatic consideration was the ability to extract consistent and reliable student data from student database management systems, noted in other studies (Cao & Gabb, 2006) to be susceptible to categorical or data entry errors.

Looking at the records of students graduating in 2008, it was found that approximately 47% of the BEDipEngPrac graduates had taken between 6 and 11 years to complete. Clearly perceptions that only a small proportion of students completed in the minimum time were accurate. In consultation with the university Statistics and Planning Unit, the decision was made to choose 2003 as the year for inter-institutional comparison, with data also to be analysed from the 2006 entering cohort. Human resource and project funding constraints precluded doing this analysis for each year since 2003.

The cohort of students enrolling for an engineering degree for the first time in 2003 was identified. The following attributes were identified for each of this entering cohort: citizenship (classified as domestic or international fee paying), gender, and number of points of credits or exemptions available on entry from previous academic study. Where available the following attributes were collected for further in-depth analysis: admission index, entry pathway, birthdate, school type, languages spoken in the home and engineering specialisation (discipline).

A time series of enrolment information comprising course enrolled, number of subjects attempted, and number of subjects completed, for each semester was downloaded as a spreadsheet for each student. The enrolment for each student for each semester was then coded as:

A Currently enrolled

B Enrolled at the same institution in a non engineering degree

C Not enrolled because of engineering degree completion (graduation)

D Not enrolled at the institution

Two codes specific to the pilot study institution were included

E Not enrolled because student on work experience/internship

G Not enrolled but returned to enrolment in a later semester

For each semester, fulltime/part time status and the level of academic success achieved was also coded. A table containing the data for each student in the entering cohort was obtained with a layout similar to Table 1, with each student ID cross linkable to individual attributes as identified above.

| stu_id | 2003a | 2003s | 2004a | 2004s | 2005a | 2005s | 2006a | 2006s | 2007a | 2007s | 2008a | 2008s | 2009a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1007 | A | A | A | A | A | A | G | A | A | A | D | D | D |
| 1008 | A | A | A | A | A | A | A | A | A | A | A | A | D |
| 1009 | A | A | A | E | A | A | A | A | A | A | A | A | C |
| 1010 | A | A | A | A | D | D | D | D | D | D | D | D | D |
| 1011 | A | A | A | E | A | A | A | A | A | A | A | C | |

**Table 1: Simplified representation of the Base data used in the cohort analysis.**

This base data enabled enrolment patterns and levels of attrition to be identified for a variety of attributes.

## Exit Questionnaire

Whilst acknowledging that obtaining responses to a postal survey from students who had left the engineering degree had been found by other studies to give low response rates (Baillie, 2000), a questionnaire was deemed to be an effective method of acquiring data from a wide range of non-persisting students. An exit questionnaire which had been used at the other pilot study institution, across all disciplines including engineering, had been extensively tested and validated and was potentially suitable for use in the third phase of the project with collaborating institutions. The use of a previously validated instrument has been recommended by Cresswell (2008).

The questionnaire was posted to Domestic students who had withdrawn from engineering in 2008 or early 2009 (n= 170) with an accompanying letter of explanation, invitation to interview and a stamped addressed envelope.

Those questionnaires which were returned as “address unknown” were followed up by a cell or home phone call where a number was available. Where contact could be made the questionnaire was re-sent, or a brief discussion was held by phone. It was noted that approximately 75% of the cell phone numbers provided, were still in use, suggesting that a future strategy to increase response rate might be to use an appropriately worded phone call or text message.

Ultimately only 16 copies of the exit questionnaire were returned (9.4% response rate) although phone contact was made with 5 additional ex-students. Because the survey was anonymous, it was not possible to know who had returned the questionnaire except where they had sent back the accompanying Invitation to Interview letter.

## Interviews

Three categories of students were invited to interview: persisters - being those students who were identified from preliminary cohort analysis data as taking longer than minimum time to complete the degree, non-persisters - those who had not re-enrolled in any degree at ATN1 during 2008 or 2009, and switchers – those who had left engineering in 2008 or 2009 but enrolled in a non engineering degree at ATN1. Switchers and persisters were sent an invitation to interview by email, and the invitation was included in the exit questionnaire mailout for the non persisters. The aim of the interviews was to add depth to the factual information available from transcripts, and survey data, by hearing the students’ “stories” and perceptions of the factors which influenced their decision to persist or leave engineering.

In the month before lectures finished in 2009, interviews were conducted by the project Research fellow with 6 persisters, 6 switchers and 6 non-persisters. The interviews followed a semi structured format extending the exit questionnaire around the themes of: motivation for choosing engineering, self perception of preparedness, academic background, academic progress and engagement, and factors influencing the decision to persist or leave engineering. The interviews were professionally transcribed and are being coded using nVivo software. Detailed analysis of the interviews is underway, but incomplete at the time of writing. Each of the switchers and non-persisters interviewed had completed the exit questionnaire, and although it is already apparent that the interviews contain much rich detail, their essence is contained in the responses outlined below to the Exit questionnaire.

## Cohort Analysis – Information on Retention pathways

It is not possible in the space available to adequately convey the wealth of information provided by the cohort analysis, and further analysis is ongoing. Initial findings found to be both affirming and contradictory to previous perceptions by the host institution are provided. Although data was collected as a semester based time series, in preparation for comparisons with collaborating institutions, the findings are presented by year, with counts of students in each category at the beginning of the year. Please note that the academic year matches the calendar year in Australia.

Although the primary focus of the study is on Domestic students, in keeping with the overarching aim of the project to increase the potential engineering workforce in Australia, the patterns shown in Figure 1 reinforce the difference in completion rates between Domestic and International students. Attrition for international students appears higher after one year, although attrition proportions become more similar in later years. Although attrition for domestic students after 6 years is higher than that for international students, the difference is not statistically significant. By contrast, the difference in graduation rate is visually and statistically significant. It is to be noted that the majority of international students pursue the four year degree option, whereas Domestic students tend to pursue the five year degree option.

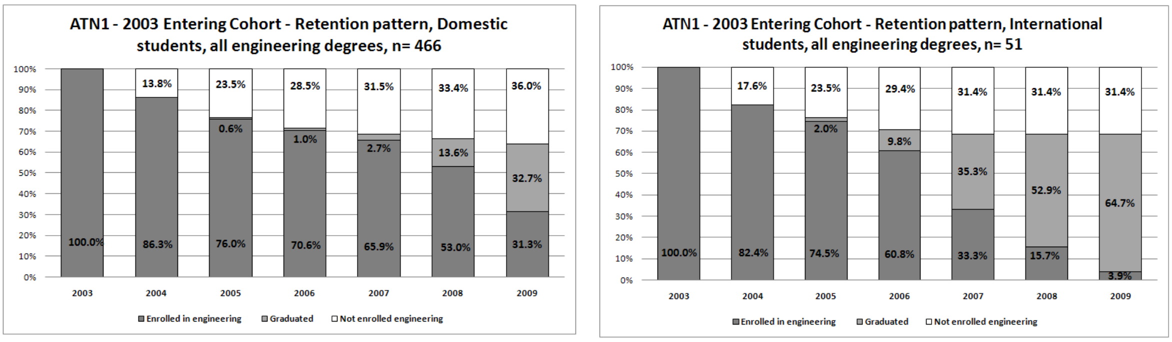



**Figure 1 Retention Pathways for the 2003 Entering cohort by citizenship**

Although these initial graphs do not attempt to distinguish between the different engineering degrees studied, the very low proportion of Domestic students who completed their degree in 5 years of study, (13.6%) was of concern. Staff at ATN1 were aware that the proportion of students completing in the minimum time was low, but the proportion was lower than expected.

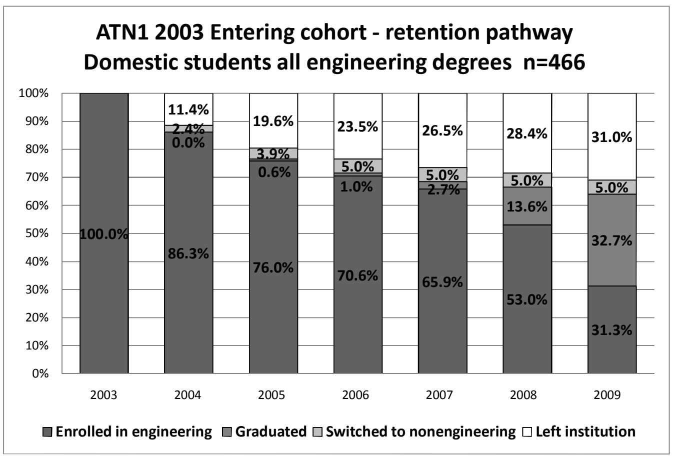



**Figure 2 Retention Pathways for the 2003 Domestic entering cohort, including information on switching to a non engineering degree at the same institution**

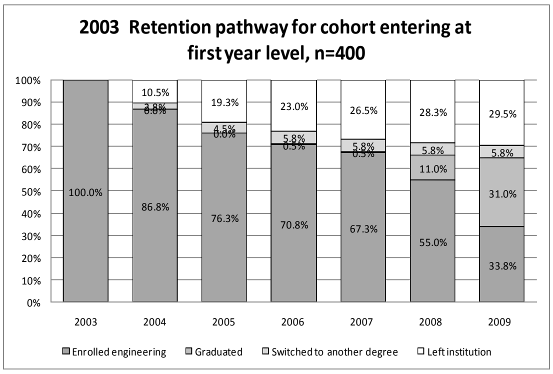
When the information for Domestic students leaving engineering is split to differentiate between those who switch to a non- degree at ATN1, and those who leave the institution completely it is seen from

Figure 2 that only 5% of the original cohort appears to switch to a non engineering degree at the same institution. This proportion had been perceived as higher by some of the collaborating institutions.

The highest annual attrition for those leaving the institution and those switching to a non engineering degree occurs after one year or two years, and it had been the perception of ATN1 staff that these students may have been influenced by their experience on their internship which is usually undertaken in the second year. The fine grained analysis possible from the base data, refuted this perception, as no student in the cohort switched or left the institution after their first semester on work experience. In fact, interviews confirmed that for some students the inability to obtain a suitable internship was a factor in their decision to discontinue.

**Comparisons of attrition patterns for those entering with credit (advanced standing).**

Potential differences in attrition patterns between those who entered at first year level and those who came in with sufficient advanced standing to be deemed as entering above first year level and the likelihood of a shorter degree completion time were of interest. ATN1 had a high proportion of students entering with advanced standing (23.6% in 2003) relative to more traditional universities. These students predominantly entered after completion of an engineering technician qualification or transferred from one of the regional universities. Using the classification that advanced standing of at least ¾ of a year's point loading would qualify as entering above first year it was found that 65 (14%) of the entering cohort fitted  into this category. With their proven commitment to engineering study it was expected that this group might have a lower attrition rate and this is demonstrated in Figure 3.



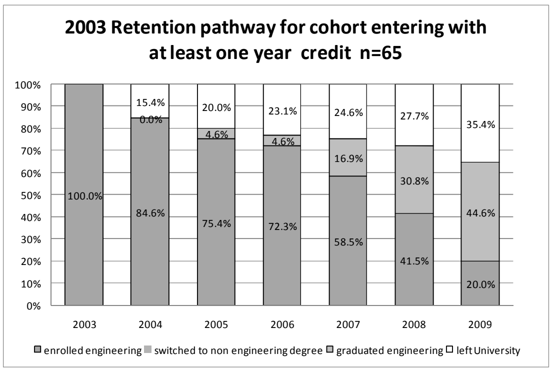




**Figure 3 Retention pathway for 2003 cohort split by entry at first year level or above.**

Of note was the almost complete absence from the second group of students switching to a non engineering degree. Clearly, students entering after prior study were confident and committed to the engineering program.  The seemingly higher graduation rate after 6 years of study of 44.6% compared to 31% for the first year entrants is negated if the advanced standing of one year credit is accounted for. A more equitable comparison would be to look at the graduation rate +5 years for the non-first year entrants and this is 30.8%, remarkably similar to the +6 year graduation rate for the first year entrants. There is an apparently higher attrition rate for non-first year entrants after one year of study 15.4% compared to 10.5% and it was expected that interviews would provide further insight into possible causes.

**Full time and Part time study**

The low proportion of completions in minimum time alluded to earlier, appeared to reinforce the tendency of ATN1 students to shift to part time study as they progressed through their degree, particularly after completing an internship. Figure 4 illustrates this tendency. The high proportion of part time study by those students entering with advanced standing points to these students being likely to be in employment whilst studying right from their first entry. This data is given by semester rather than year, because of the confusion the internship semesters give to annual full time/part time calculations.

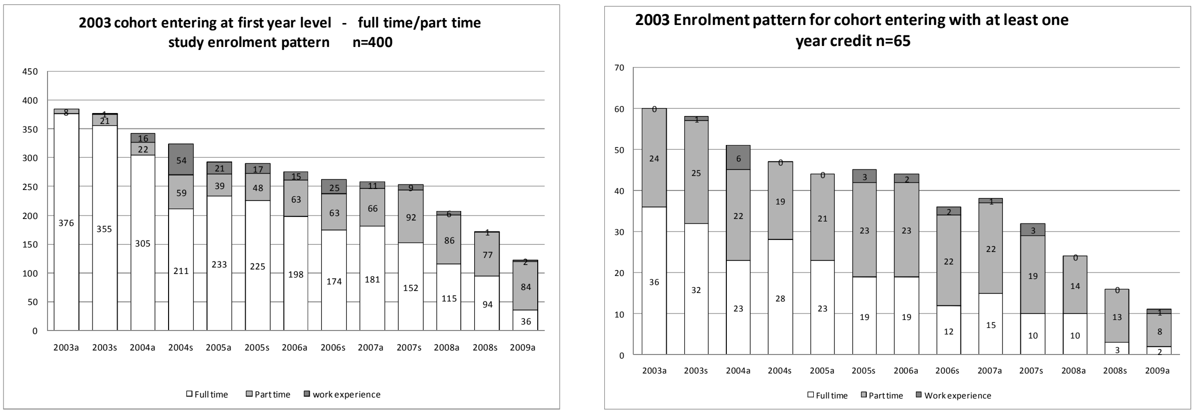



**Figure 4 Full time- part time enrolment pattern for the 2003 entering cohort, split for entry level.**

### By Gender

Australian statistical data had suggested that, on average, male attrition was slightly higher than female attrition within engineering, which was in agreement with the findings of Cosentino de Cohen and Deterding (2009). The data from ATN1 were in agreement with these findings, but an interesting feature that was gender differentiated was observed when non-persisters were split between "left ATN1", and "left engineering but continued at ATN1 in a non engineering degree". Figure 5 demonstrates that 4.5% of the male cohort entering at first year level (remembering that no switchers were identified for entry above first year level) and 15.2% of the equivalent female cohort transferred from an engineering degree to a non engineering degree at ATN1. This result was statistically significant at the 95% confidence level. It would appear that female students tend to switch out of engineering particularly after the second year of study, whereas a higher proportion of male students tend to persist with their study, although neither the graduation nor currently enrolled differences is statistically significant. As noted earlier, this is not linked to work experience and questions arise whether switching is related to the engineering education culture at the institution, lack of understanding about the engineering degree content and career or achievement levels.

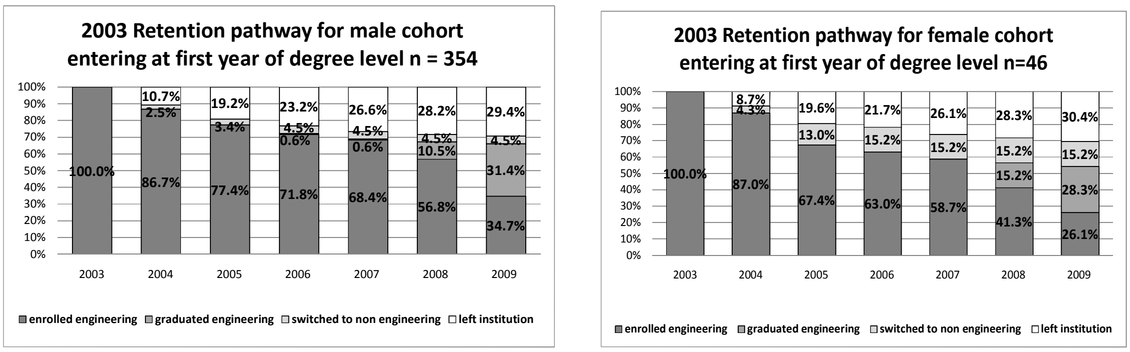



**Figure 5 Retention pathway for entry cohort at first year degree level, differentiated by gender**

### Transferring to a non engineering degree

The transcripts of all students in the 2003 cohort who switched from an engineering to a non-engineering degree but stayed at ATN1 were examined to seek any pattern. Two patterns were evident: One group entered with reasonable entry grades were successful in their study and appeared to be using their engineering grades to gain them entry to a preferred degree for which their original admission score did not gain them entry. The other group struggled in engineering particularly in mathematics subjects and subjects known to be "killer" subjects. These "killer" subjects have provided a major barrier to progression in electrical, computer and software engineering over some years and are the subject of a separate project within the institution.

## Comparison of overall attrition rates from 2003, 2005 and 2006

Attrition data from 2006 was deemed of special interest to ATN1 because previous statistics aggregated for census purposes had appeared to show a dramatic reduction, from 20% to 9% in attrition after one year for the 2005 and 2006 entering cohorts. The cohort analysis for the cohorts entering in 2003, 2005 and 2006 more accurately demonstrates that the 2006 attrition after one year was 12.9% which was not a significant reduction. More accurately the increase in attrition after first year for the 2005 entry cohort was a statistically significant increase relative to both the 2003 and 2006 entering cohorts.

When attrition is viewed as entry year, entry year +1,+2 and +3 as displayed in Table 2 it becomes apparent that after 3 years attrition for all three entry cohorts has evened out.

| Entering Year | Left engineering +1 year | Left engineering +2 years | Left engineering + 3 years |
|---|---|---|---|
| 2003 | 13.9% | 23.5% | 28.4% |
| 2005 | 20.0% | 26.3% | 31.2% |
| 2006 | 12.9% | 24.8% | 31.7% |

**Table 2 Comparison of attrition after 3 years from entry**

This type of evidence leads to questioning a focus on curriculum redesign and support strategies at first year level. A variety of interventions were in place for the 2006 entering cohort, yet the effect does appear to have been merely a shift in the timing of attrition rather than a reduction, confirming the findings of Ohland et al (2001)

## Findings from the Exit questionnaire

The exit questionnaire contained two open ended questions: What factors influenced your decision to leave the university? and Was there anything that the university could have done differently to support you with your studies? Specific information was then sought about destination on leaving the university, intention to return to studying engineering at ATN1 or another institution and preparedness for their engineering studies.The major portion of the questionnaire asked the respondents to state how true a list of statements were in affecting their decision to withdraw from engineering degree studies at ATN1, given the choices: not at all true, slightly true, very true and extremely true. The responses to this part of the questionnaire are displayed in Figure 6.

Whilst recognising the lack of reliability in using a sample size of 16, the main causes given for withdrawals, as displayed in Figure 6 were:

1. I was not performing as well academically as desired
2. Time taken to travel to university was limiting
3. I had a lack of enjoyment or interest in course content
4. I felt there was a lack of information available to help guide me in my choice of program
5. I had too many external commitments to allow time for university study
6. I had difficulty in understanding academic content and concepts
7. I had doubts regarding my ability to perform well enough.

It is reasonable to suggest and it has been evidenced in the research literature ( French et al., 2005; Matusovich, 2008) that lack of academic progress can be strongly linked to deteriorating self confidence, motivation, commitment, engagement and lack of enjoyment and interest - all strong predictors of attrition. Only one of the questionnaire respondents indicated that they came in well prepared for engineering, whereas 13 out of the 16 respondents suggested they were either poorly or mildly prepared for their engineering studies. In particular, a lack of confidence and familiarity with mathematics at an appropriate level for entry were identified by a third of the respondents. Interview data is indicating that a high proportion of non-persisters and switchers were either not well prepared academically, or in their understanding of engineering, and where it was possible to check transcripts these perceptions were able to be confirmed. Finer grained analysis of the cohort analysis data will allow logistic regression models to explore whether a causal relationship exists between lack of academic progress and attrition.

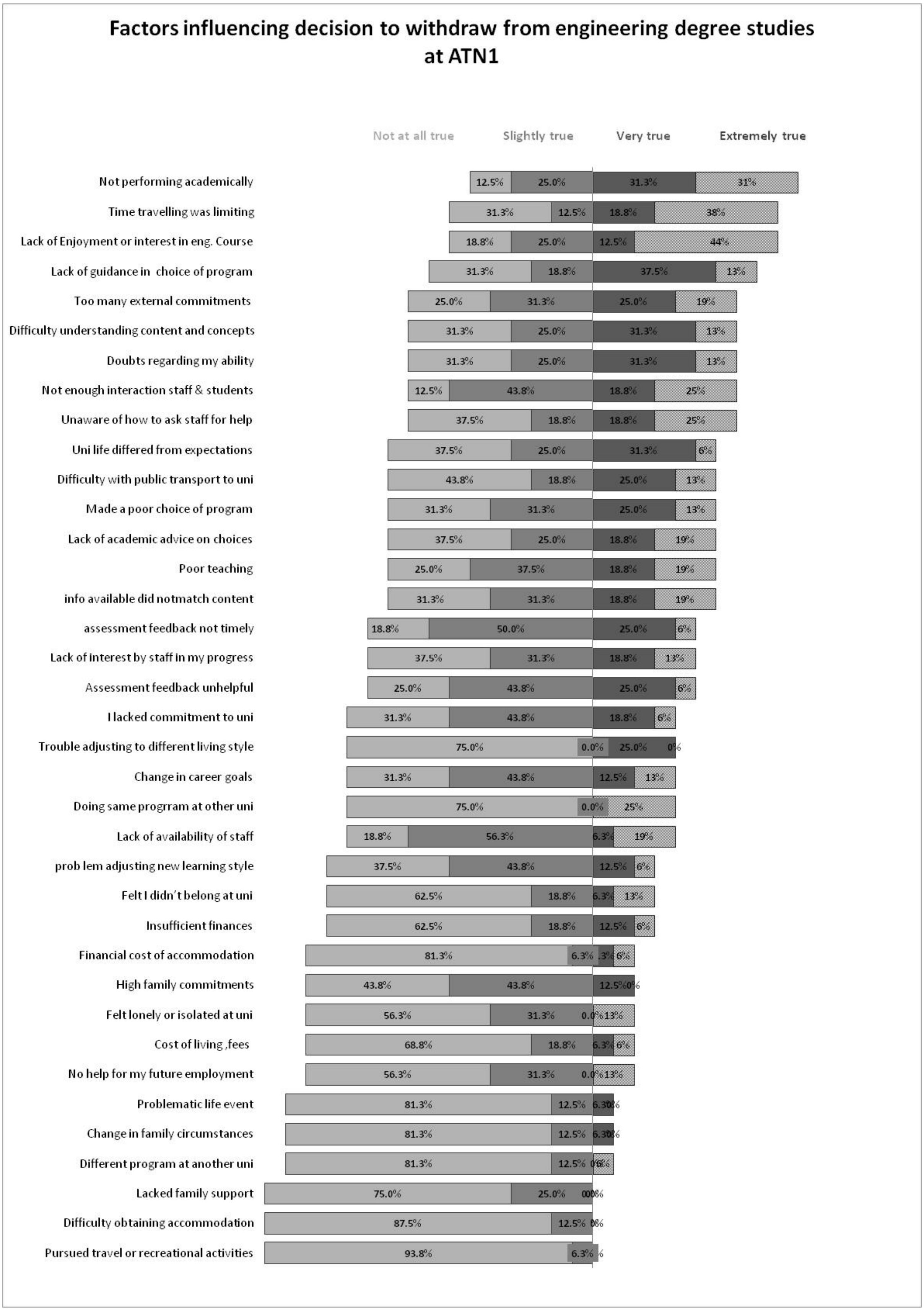



**Figure 6 – Factors influencing the decision to withdraw from engineering study at ATN1**

Unique to ATN1, and of concern as major causes of attrition were the naming of the limiting factor of time travelling to university and lack of guidance in choice of programme as influencing decisions to withdraw. Public transport and parking are challenges in a large, central-city university, particularly one which has a high proportion of part time students. In an age of ever-expanding communication technologies, these are challenges ATN1 will clearly need to address if the attrition rate of motivated students is to be lowered.

Lack of suitable guidance in choice of program resulting in students entering engineering without a clear understanding of the course content and career options is also of concern. A mismatch in expectation and reality around the engineering course and content was evident with several of the non - persisters interviewed and these students discussed a lack of connection with the course material. It has been noted in the research literature (Hammoudeh & Barrett, 2002; Ohland et al. 2008) that the goal of retention strategies is to retain those students who were qualified and interested in engineering. So what of those who enter without a strong motivation and commitment? Improving advising processes and early exposure to the engineering profession, appear to be a necessity, to prevent students entering engineering without a commitment to the course.

The sample size of responses to the exit questionnaire is too small to give a clear picture of destination on leaving ATN1 but the responses did indicate a reasonably even split between continuing engineering at another institution (5), studying a non-engineering degree (5) employed (6 – four of which were in an engineering related area.

## Conclusions and Recommendations

Several issues have emerged from these initial findings. The first, is the need to investigate attrition by engineering specialisation. “Killer” subjects discussed by interviewees appeared to come from one engineering specialisation. The second is a need to investigate the link between the internship experience and drop out. Although no student appeared to have dropped out immediately after an internship, a connection did seem to be evident between timing of the internship, a shift to part time study and delays in degree completion. Links between part time study and drop out, particularly for those who had entered with advanced standing, highlight the urgent necessity, expanded on by students interviewed, to investigate ways of optimising timetabling constraints and student needs.

Evidence that advising systems could be improved needs closer examination by the institution. Questionnaires and interviews to non-persisters and switchers may provide a biased viewpoint of the effectiveness of the current advising system. Evidence being gathered in this study appears to support the need for better risk management, not only strengthening advising around program choice, but identifying students at risk of failing as early as possible and implementing support systems.

As the pilot study is expanded to work with collaborating institutions, the cohort analysis model has demonstrated its potential to increase our understanding of the “who”, “how many” and “when” questions of attrition. The limitation in the use of survey methods to expand our understanding of the “why” questions lies in obtaining feedback from those who leave the university. Not only are contact details subject to change, but students who drop out, are likely to have more personal difficulty discussing their situation than someone who has successfully graduated.

The initial findings mentioned here for the cohort analysis and the exit questionnaire, are only a starting point but they have already highlighted some confirming and contradictory trends. Further in-depth analysis including interview data and documentary evidence for triangulation are expected to extend and expand the understanding of attrition causes and dynamics at the pilot study institution.

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## Acknowledgements

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# Engineering Education 2010

Inspiring the next generation of engineers



## EE2010 Conference Proceedings

These are the conference proceedings for EE2010 - Inspiring the next generation of engineers.

Edited by Engineering Subject Centre Staff
Published by the Higher Education Academy - Engineering Subject Centre
ISBN: 978 1 907632 09 9 (electronic copy of full papers)

This international conference will provides a platform to consider how universities can inspire the next generation of engineers. It will address how to inspire young people to study engineering, how to engage and retain students in their studies and continue to professionally develop the engineers of the future.

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# Engineering Education 2010

Inspiring the next generation of engineers

EE 2010 | Programme & papers | Keynotes | Contact us

## EE 2010

### 6 - 8 July 2010, Aston University

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# Engineering Education 2010

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# EE 2010 Programme and papers

The provisional programme can be downloaded in PDF format here. Click on the links to view the papers.

| Day 1: TUESDAY am | | |
|---|---|---|
| 10.00 - 11.00 | Conference Registration | |
| 11.00 - 11.15 | Welcome address – Vice-Chancellor Prof. Julia King, Aston University | |
| 11.15 – 11.50 | Keynote address: Euan Lindsay<br>Program Leader - Mechatronic Engineering, Department of Mechanical Engineering, Curtin University of Technology, Perth | |
| 12.00 - 13.00 - Parallel 1 - First Year Students and Progression 1 | | |
| P5 | The wheel has already been invented: facilitating students' use of existing mechanics resources | Thomas Goldfinch and Anne Gardner |
| P47 | Progression of Engineering Students who attended a Pre-sessional Residential Summer School | Glynis Perkin, Sarah Bamforth and Carol Robinson |
| P105 | A Validated Approach to Teaching Engineering Mathematics | Charles McCartan, Paul Hermon and Geoff Cunningham |
| 12.00 - 13.00 - Parallel 2 - Learning Technologies 1 | | |
| P111 | Improving Engagement and Learning Experience for Students using<br>Lab-in-a-Box Concept | Diane Rossiter, Stephen Beck, Martine Delbauve, Marian Hogg and Geoffrey Priestman |
| P99 | Use of e-learning to encourage engagement and depth of understanding across engineering science and design within the first year of an engineering degree | Kay Bond, Carol Eastwick, John Prentice, Mike Johnson and Arthur Jones |
| P54 | Online assessment is not always quick and easy | Elizabeth Smith |
| 12.00 - 13.00 - Parallel 3 - Supporting Diversity | | |
| P35 | Engineering the curriculum | Bland Tomkinson |
| P104 | Analysis of a diagnostic and support programme for improved learning of Civil Engineering students | Peter Mills and Panagiotis Georgakis |
| P77 | Can a story deepen comprehension, engagement and analysis skills of undergraduate engineering strategy by students with diverse backgrounds? | Christopher J. M. Smith, Owen Richards, Nerea Etura Luque and Elizabeth Miles |
| 13.00 | | |

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|---|---|---|
| – 14.00 | Lunch | |
| Day 1: TUESDAY pm | | |
| 14.00 - 15.30 - Workshop 1 | | |
| W42 | Bridge to Schools | Norman Seward, Gareth Williams and Keith Jones |
| 14.00 - 15.30 - Workshop 2 | | |
| W20 | The role of manual simulation/games in learning | Laurence Legg |
| 14.00 - 15.30 - Workshop 3 | | |
| W82 | Enquiry Based Learning, what's that then? How to inspire your students, develop their professional | Ivan Moore and Mike Bramhall |
| 14.00 - 15.30 | Engineering Education Research SIG | |
| 15.30 – 16.00 | Afternoon Tea | |
| 16.00 - 17.30 - Parallel 4 - Enhancing the student learning experience | | |
| P18 | Non-traditional subjects taught to engineers: a case study of teaching anatomy | Tom Joyce |
| P62 | Motivation of engineering students – considerations for programme design | Sarah Green and Erik Meyer |
| P48 | Perceptions and their Influences on Approaches to Learning | Jenna Tudor and Roger Penlington |
| P43 | Academic Success of First Year Engineering Students: Emotional Intelligence a Predictor? | Frankie Stewart and Colin Chisholm |
| 16.00 - 17.30 - Parallel 5 - Learning Technologies 2 | | |
| P61 | Improving the Learning Experience for the First Year Engineering Students using Technology Enabled Activity Led Learning | Jayaraman Ramachandran and Olivier Haas |
| P94 | Laboratory focussed learning of core electronic engineering concepts in the first year of an honours degree programme | Kate Sugden, David Webb and Richard Reeves |
| P38 | Flowchart driven Robot to promote Educational Development (FRED) | Anthony Bateson, Nathan Brown and Antony Wilkinson |
| P22 | Problem Solving and Creativity in Engineering: conclusions of a three year project involving Reusable Learning Objects and Robots | Jonathan Adams, Stefan Kaczmarczyk, Phil Picton and Peter Demian |
| 16.00 - 17.30 - Parallel 6 - Research Discussion Papers | | |
| P78 | Engaging and retaining distance learning engineering students: the development of effective engineering communities | Kath Clay |

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|---|---|---|
| P124 | Does pre-feedback self reflection improve student engagement, learning outcomes and tutor facilitation of group feedback sessions? | Anne Gardner and Keith Willey |
| P75 | The Impact of a Large Cohort of Chinese Students on the Delivery of an Engineering Degree in the UK | Junxia Hou, Catherine Montgomery, Peter Harrington and Liz McDowell. |
| 19.30 | Drinks Reception | |
| 20.15 | Conference Dinner – Aston University | |

| Day 2: WEDNESDAY am | | |
|---|---|---|
| 7.30 - 8.30 am | Conference Run | |
| 9.15 - 9.50 | Keynote Address – Richard Earp Education and Skills Manager, National Grid | |
| 10.00 - 11.00 - Parallel 1 - Design and Activity based learning | | |
| P11 | An activity led learning experience for first year electronic engineers | Nigel Poole, Robert Jinks, Stephen Bate, Mark Oliver and Christopher Bland |
| P96 | Group Design-Build-Test Projects as the Core of an Integrated Curriculum in Product Design and Development | Paul Hermon, Charles McCartan and Geoff Cunningham |
| P117 | The proof of the pudding is in the eating | John Swagten, Faas Moonen and Ivette Wennekes |
| 10.00 - 11.00 - Parallel 2 - Project Based Learning | | |
| P118 | Internationalization of Undergraduate Group Projects | Martin Pitt |
| P109 | Making projects work: a review of transferable best practice approaches to engineering project-based learning in the UK | Ruth Graham and Edward Crawley |
| P40 | Service-learning experiences: a way forward in teaching engineering students? | Elena Rodriguez-Falcon and Alaster Yoxall |
| 10.00 - 11.00 - Parallel 3 - Education for Sustainable Development | | |
| P39 | Approaches to the embedding of sustainability into the engineering curriculum – where are we now, and how do engineers become global? | Simon Steiner and Roger Penlington |
| P84 | Developing awareness about sustainable development in Civil Engineering studies | Barbara Karleusa, Aleksandra Deluka-Tibljas, Suzana Ilic and Nevena Dragicevic |
| P64 | An engineering design course: developments over five years emphasising hands-on learning and topics of sustainability | Tom Joyce, Iain Evans and Bill Pallan |
| 11.00 – 11.30 | Coffee | |
| 11.30 - 13.00 - Parallel 4 - Meeting the needs of Industry | | |

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| P55 | Meeting the needs of industry: the drivers for change in engineering education | Carol Arlett, Fiona Lamb, Richard Dales, Liz Willis and Emma Hurdle |
| P74 | Major Hazards Management – a finishing module for undergraduate engineers on how to manage risk | Graham Schleyer, Nicholas Underwood, Graham Dalzell and Nicola Stacey |
| P19 | The career aspirations of a cohort of Associate Degree students: Implications for the engineering educators and the profession | David Dowling |
| P13 | Engineering your Workplace Advantage: Personal Development Planning resources for undergraduate engineers | Andrea Duncan |
| 11.30 - 13.00 - Parallel 5 - Research Discussion Papers | | |
| P101 | A Quantitative Approach to Identifying Threshold Concepts in Engineering Education | Martin Holloway, Esat Alpay and Anthony Bull |
| P45 | Towards developing a coherant notation in dynamics that will aid learners | Peter Vivian |
| P41 | "How do we encourage the next generation of engineers?" | Susan Forder, Kieran McDonald, Gary Drabble and Jeremy Twyman |
| 11.30 - 13.00 - Parallel 6 - The Engineering Subject Centre Teaching Award Finalists 2010 | | |
| 13.00 – 14.00 | Lunch | |
| Day 2: WEDNESDAY pm | | |
| 14.00 - 15.30 - Workshop 1 | | |
| W71 | Getting girls into engineering and women onto engineering degree courses | Heather Hawthorne and Rachel Epson |
| 14.00 - 15.30 - Workshop 2 | | |
| W69 | A Global Dimension for Engineering Education | Petter Matthews and Caroline Baillie |
| 14.00 - 15.30 - Workshop 3 | | |
| W33 | Inspirational teaching and learning: Developing and encouraging autonomous student learning | Michael Bramhall, Keith Radley and Ivan Moore |
| 14.00 - 15.30 | Network Meeting – NTFS and Teaching Awards Finalists | |
| 15.30 – 16.00 | Afternoon Tea | |
| 16.00 - 17.30 - Parallel 7 - Work-Based Learning | | |
| P36 | Credit bearing work-based learning: learning from other's practice | Sarah Bamforth, Debra Lilley, Caroline Lowery and Adam Crawford |

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|---|---|---|
| P70 | Work-based MSc Professional Engineering: an evaluation so far | Deborah Seddon and Deborah Lock |
| P122 | An effective practice in preparing students for workplace | Fakhteh Soltani-Tafreshi, David Twigg and John Dickens |
| P57 | Development of a work-based learning MSc course which incorporates the development and demonstration of professional engineering competence standards | Bill Glew and Ted Elsworth |
| 16.00 - 17.30 - Parallel 8 - Recruiting and Retaining Engineering Students | | |
| P60 | Discourses, identities and learning: implications for the training of student ambassadors in engineering | Clare Gartland, Heather Hawthorne and Claire McLoughlin |
| P97 | Inspiring young people to engage in engineering education: The Aston University Engineering Academy Birmingham | Alison Halstead, Mike Jerome and Anne Wheeler |
| P15 | Engaging Future Engineers: Pedagogy, Policy & Practice | Robin Clark and Jane Andrews |
| P66 | The effects of gender on the success of a cohort of engineering students | Lorelle Burton and David Dowling |
| 16.00 - 17.30 - Parallel 9 - Assessment and Feedback 1 | | |
| P29 | Designing an Ideal Assessment Scheme for Dual Mode Delivery | Vasantha Aravinthan |
| P26 | Motivating students to learn through good and helpful coursework feedback | Shun Ha Sylvia Wong |
| P53 | Developing a Departmental Strategy to Improve Student Feedback | Jane Horner |
| P52 | Addressing the Learners' Needs for Specific and Constructive Feedback | Jenna Tudor and Noel Perera |
| 19.00 - 23.30 | Gala Dinner, National Motorcycle Museum<br>18.45 Coaches depart<br>19.15 Drinks Reception and museum tour<br>20.15 The Engineering Subject Centre Teaching Award Presentations, supported by the Engineering Council.<br>20.30 Dinner<br>22.30 Coaches depart for Aston | |

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|---|---|---|
| Day 3: THURSDAY am | | |
| 09.15 - 09.50 | Keynote address by Jack Lohman Vice Provost and Professor, Georgia Institute of Technology, Atlanta, Georgia | |
| 10.00 - 11.00 - Parallel 1 - Engineering Education – Perspectives from Students | | |
| P103 | Reflections on an integrated team approach to the creation of new e-learning resources for first year engineering students | Holly Fox, David Whitley, Julian Tenney and Carol Eastwick |
| P125 | A Student's Perspective on the Effectiveness of Personality and Learning Tools in Engineering Education | David Whitman and Dorothy Missingham |
| | Engineering Humour: A student's perspective on the | Amelia Greig, Dorothy Missingham and |

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|---|---|---|
| P127 | effective use of humour in engineering education | Colin Kestell |
| 10.00 - 11.00 - Parallel 2 - Learning Technologies 3 | | |
| P25 | Promoting collaborative learning in engineering management education through the use of wikis | Fiona Saunders, Mark Jasper and Peter Whitton |
| P28 | Impact of using Moodle as an educational management tool to enhance learning for on campus and external mode electrical students at USQ | Ronald Sharma |
| P81 | How do we build sustainable e-learning tools to meet the needs of engineering educators? | Nicola Wilkinson, Adam Crawford and Fiona Lamb |
| 10.00 - 11.00 - Parallel 3 - Developing and motivating students | | |
| P128 | Leadership in a technological environment | Gary Codner |
| P8 | Supporting development of independent learning skills | John Anthony Rossiter and Linda Gray |
| P23 | Understanding Motivation in Large Groups of Engineering and Computing Students | Roberto Ramirez Iniguez and Ursula Canton |
| 11.00 – 11.30 | Coffee | |
| 11.30 - 13.00 - Parallel 4 - Assessment and Feedback 2 | | |
| P9 | Using audio to support student learning | John Rossiter, Anne Nortcliffe and Andrew Middleton |
| P90 | Challenges of developing engineering students' writing through peer assessment | Teresa McConlogue, Jens-Dominik Mueller and Julia Shelton |
| P31 | Effectiveness of self-assessment quizzes as a learning tool | Vasantha Aravinthan and Thiru Aravinthan |
| 11.30 - 13.00 - Parallel 5 - First Year Students and Progression 2 | | |
| P12 | The impact of task value upon stress and workload levels of first year engineering students | Euan Lindsay |
| P121 | Six-week introductory programme of activity led learning to improve student engagement and retention | Paul Green |
| P46 | Who leaves and who stays? Retention and attrition in Engineering Education | Elizabeth Godfrey, Tim Aubrey and Robin King |
| P14 | Evaluation of initiatives related to engagement and retention of first year mechanical engineering students at two Russell Group Universities | Tom Joyce and Elena Rodriguez-Falcon |
| 11.30 - 13.00 - Parallel 6 - Research Discussion Papers | | |
| P34 | Who chooses the "E" in STEM? | Darryl N. Williams and Michael A. Gottfriend |
| P7 | Engineering – young people want to be informed | E. Ekevall, E. L. Hayward, G. Hayward, J. Magill, E. Spencer, G. MacBride, C. Bryce and B. Stimpson |

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|---|---|---|
| P16 | 'Catching Them Young': Inspiring Future Engineers, An Exploratory Study | Robin Clark and Jane Andrews |
| 11.30 - 13.00 | WebPA SIG | |
| 13.00 – 14.00 | Lunch | |
| Day 3: THURSDAY pm | | |
| 14.00 - 15.30 - Workshop 1 | | |
| W129 | OERP Workshop; Methods & Processes | Alex Fenlon and Rob Pearce |
| 14.00 - 15.30 - Workshop 2 | | |
| W17 | Building Bridges for Future Sustainability? Breaching the research-teaching nexus in Engineering Education | Robin Clark and Jane Andrews |
| 14.00 - 15.30 - Workshop 3 | | |
| W93 | Climbing up the Slippery Slope - helping first year engineers to master the peaks and troughs of differentiation | Glynis Perkin and Jan Robertson |
| 14.00 - 15.30 | WebPA SIG | |
| 15.30 – 16.00 | Afternoon Tea and Closing address | |



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