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Graduate Evaluation of Engineering Management Studies at Deakin University

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ABSTRACT: Australia has long recognised the importance of the inclusion of management studies in undergraduate engineering courses. A survey of recent graduates of the engineering programs at Deakin University was undertaken to evaluate the effectiveness of the management studies in those programs. The survey respondents suggest that those management skills most highly valued by graduates were generic professional practice skills, and that more opportunities to develop these skills in undergraduate studies would be beneficial. Survey respondents suggested the inclusion in the course of more 'real world' examples of engineering management.

INTRODUCTION

Australia has long recognised the importance of the inclusion of management studies in undergraduate engineering courses. In 1991 the Institution of Engineers, Australia (IEAust) mandated a requirement for 10% of Australian course content to be management studies [1]. Although recent changes to the IEAust course accreditation requirements have made the status of management studies less clear [2], there is still a requirement for 'some' component of management studies in Australian undergraduate engineering courses. This paper reports on research undertaken to evaluate the effectiveness of management studies in undergraduate engineering programs at Deakin University, Australia.

ENGINEERING PROGRAMS AT DEAKIN UNIVERSITY

The Deakin School of Engineering and Technology opened in 1993 and offers three year Bachelor of Technology (BTech), four year Bachelor of Engineering (BE), Masters and Doctoral engineering programs in flexible delivery mode. The undergraduate programs are delivered on-campus, full-time for conventional entry students. Mature age students may study the programs off-campus and/or part-time. In each year of the undergraduate programs, there is one unit out of eight (12.5%) devoted to

'engineering management' content. Table 1 provides a broad outline of the current syllabus of each unit – note that students studying the three year BTech course do not normally take the fourth level unit.

Table 1 - Outline of current undergraduate management syllabus

Year 1 - Fundamentals of Technology Management

- Communication skills
- Technology perspectives
- Introduction to management concepts
- Quality management concepts

Year 2 - Managing Industrial Organisations

- Systems concepts for engineers and technologists
- Managing people in organisations
- Manufacturing and environment
- Occupational health and safety

Year 3 - Methods of Managerial Decision Making

- Project management
- Accounting and financial management
- Operations research

Year 4 - Strategic Issues in Engineering

- Technological forecasting and assessment
- Policy design in engineering organisations
- Issues in productivity improvement

As part of a review of the engineering management stream at Deakin University, a survey of recent graduates was undertaken to

determine their perceptions of the current management studies syllabus, and to identify what management skills had proven to have been valuable in their professional practice.

METHODOLOGY

Using the university student information database, graduates from the years 1996 (first graduates of the School of Engineering and Technology at Deakin University) to 1999 were identified. These students were sent the survey by post, using their last recorded address. The survey included a reply-paid envelope so students could return their response at no cost. As required by University research ethics procedures, participation in the survey was anonymous and voluntary. The survey sought information under the following categories:

- demographic information — age; gender; study mode;
- experience in engineering practice;
- experience in management roles;
- identifying management skills that have been important in practice; and
- evaluating the effectiveness of the management stream in the Deakin undergraduate engineering program.

Based on the 17 unit model syllabus from the IEAust Guidelines for Management Studies in Engineering Undergraduate Courses [1], and supplemented by results obtained from two prior surveys of mature age engineering students [3] and Australian engineering management academics [4], a 45 item management skills inventory was developed, as presented in Table 2, and respondents were asked to indicate which of these management skills had been important to them in their professional practice since graduation.

RESULTS

Response rate

From a total of 135 graduates from the period 1996 to 1999, 20 surveys were returned as not deliverable. From the remaining 115 potential respondents, 42 completed questionnaires were received, a voluntary response rate of 36.5%.

Table 2 - Management skills inventory used by survey respondents

Communication skills	Project management
Legal / law	Supervision & leadership
Accounting & finance	Economics
Quality management	Professional ethics
Marketing	Organisational behaviour
Operations management	Business strategies
Project evaluation	Human resource manage.
Theories of management	Teamwork
Lifelong learning	Systems approach
Time management	Public relations
Maintenance management	International business
Strategic management	Cost estimation
Risk management	Environmental manage.
Industrial relations	Design management
Supply management	Change management
Dealing with customers	Decision making
Negotiation	Report writing
Contract management	Forecasting
Motivation	Competition
Conflict resolution	Occupat. health & safety
Creativity	Information management
Logistics	Inventory management
Work/time study	

Demographic information

The age range of respondents varied widely (23 – 54 years), with a mean of 30.2 years and standard deviation of 7.4. The proportion of female respondents was 19.0%; the proportion of male respondents was 81.0%. The proportion of on-campus students was 71.4%; the proportion of off-campus students was 28.6%. The breakup of the engineering disciplines studied by the respondents was: Manufacturing – 57.1%, Environmental – 26.2%, and Mechatronics – 16.7%.

Experience in engineering practice

The years of work experience reported by the respondents varied from 0 – 6 years, with a mean of 2.2 years and a standard deviation of 1.4. The employment sectors reported by the respondents covered a wide range, including public sector, private industry, manufacturing, IT, consulting, building, education and postgraduate studies. The job functions reported by the respondents covered a wide range, including director, lecturer, manager, designer, project manager and research and development.

Experience in management roles

The range of specific management roles reported as held by respondents is given in Table 3.

Table 3 - Management roles reported as held by respondents

Supervisor	Project manager
Team leader	Contract supervisor
Maintenance manager	Assistant site supervisor
Business unit manager	Director
Business devel. Manager	Head draftsman
Regional environ. Manager	Production manager
Engineering manager	Student representative
Supervisor for trades	Area manager
Plant project supervisor	

Management skills that have been important in practice

Figure 1 shows the frequency with which respondents indicated that particular management skills had been important to them in their professional practice since graduation. The following additional skills were identified by respondents as being important to them: *capital expenditure justification, marketing of services, empathy, organisational skills, scheduling, interpersonal interaction across the organisational hierarchy, and coaching.*

Effectiveness of the management stream in the Deakin undergraduate engineering program

Respondents were asked to evaluate the effectiveness of their undergraduate management studies. For a number of statements regarding their management studies, respondents were asked to indicate their agreement or otherwise using a five-point Likert-style scale. Table 4 shows the results; the mean agreement rating and standard deviation for each statement are given (based on a rating scale of 1 = strongly disagree, 2 = partially disagree, 3 = unsure, 4 = partially agree and 5 = strongly agree).

Respondents were asked to indicate any ways in which their undergraduate management studies could have been improved to make them more useful and relevant. Table 5 shows the responses received.

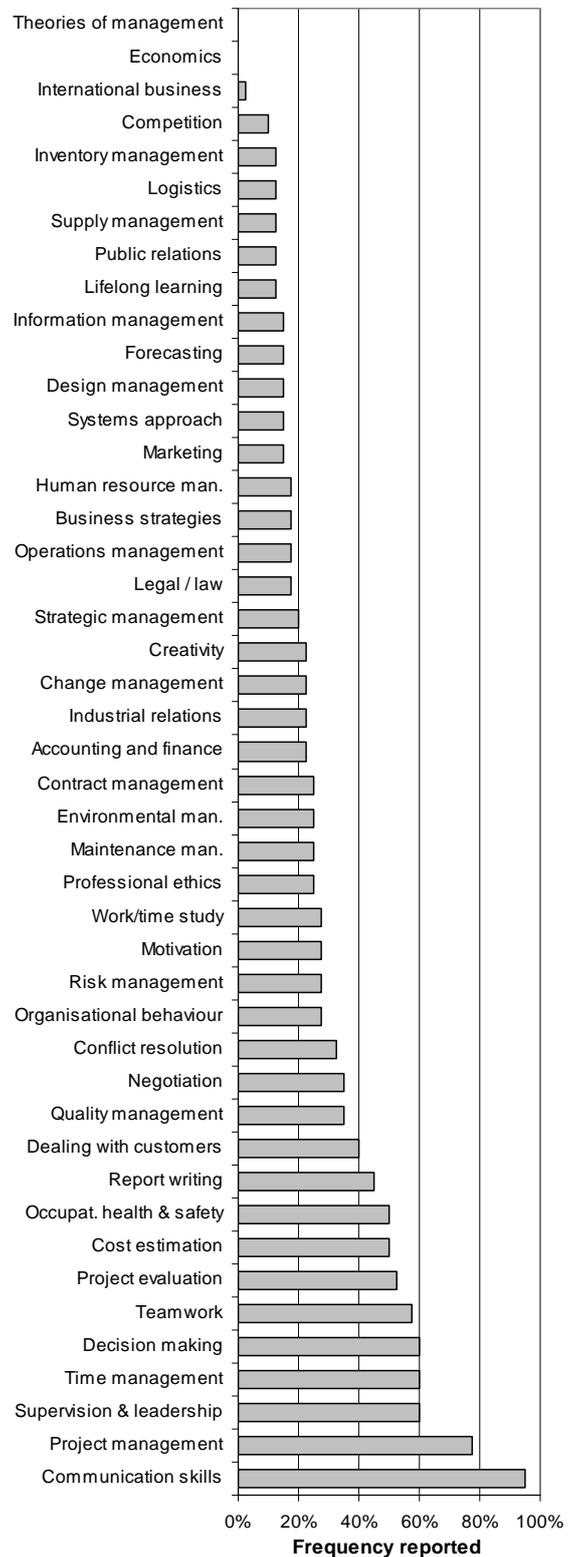


Figure 1 - Importance of management skills as identified by respondents

DISCUSSION

Response rate

The fact that 14.8% of the originally targeted recent graduates were no longer at the most

Table 4 - Respondent evaluation of effectiveness of undergraduate management studies

Statement regarding management studies	Mean rating	Stand Dev.
Overall, the engineering management component of your undergraduate studies has been of value to you	3.8	1.0
If you entered engineering directly from secondary school, your management studies helped prepare you for real engineering practice	3.5	1.1
If you entered engineering as a mature age student, your management studies helped formalise your understanding of management gained from your prior work experience	3.9	1.2
If you studied principally on-campus as an undergraduate, your classroom activities and assessment tasks helped develop your understanding of engineering management	3.4	1.0
If you studied principally off-campus as an undergraduate, your course materials and assessment tasks helped develop your understanding of engineering management	3.8	1.1

recent address recorded for them highlights the difficulty in maintaining contact with students once they leave the university.

Demographic information

The gender and graduating discipline proportions of the target potential respondent group were known, permitting a comparison with the actual respondent population. The proportion of female students in the target group was 16.3%, this was not significantly different from the respondent group ($X^2_1=0.298$, $p>0.58$). The graduating discipline proportions of the target group were Manufacturing = 54.8%, Environmental = 20.7%, and Mechatronics = 24.4%, these were not significantly different from the respondent group ($X^2_2=0.949$, $p>0.62$). This suggests that the actual respondent population is a representative sample of the target potential respondent group.

Two significant demographic correlations were found to relate to study mode. The mean age of off-campus students ($M=37.8$ years, $SD=6.5$) was significantly higher than on-campus students ($M=27.4$ years, $SD=5.6$) ($t_{18}=-4.834$, $p<0.0002$). Off-campus students were more likely to be undertaking a three year BTech course (56.3% of BTech enrolment), whereas on-campus students

Table 5 - Improvements to management studies suggested by respondents

<ul style="list-style-type: none"> • More real case studies • Teams, customers, budgets, contract management, tenders/specs, industry visits • Dealing with people, conflict resolution, effective meetings • Law, contract law • Negotiation, marketing, presentations by experts, teamwork • Projects, contracts and tendering, standards • Real HR, supervision, delegation, ethics, accepting authority • Communicating with all types of people • More hands on, more oral presentations • More on motivation and development • Project finance • Group work • Supply contracts, oral communications • Project management, project evaluation • Presentations by local managers • Quotation methods, maintenance management • Project management, scheduling, organising, more hands on, less theory • Skills in communication to large groups, interpersonal skills • More real life instead of theory • More in-depth units instead of a crash course • Team playing and open communication • More real world situations, rather than textbook situations • Body language

were more likely to be undertaking a four year BE course (87.5% of BE enrolment) ($X^2_1=8.75$, $p<0.0031$). These results concur with prior research in the Deakin School of Engineering and Technology [5] that indicates that off-campus students are principally mature aged and typically study part-time because of full-time work commitments, and choose the BTech as an attainable goal to upgrade their prior trade or technical qualifications into the professional workforce. The corollary is that on-campus students predominantly enter engineering studies directly from high school and normally aspire to the four year BE professional engineer status.

Experience in engineering practice and management roles

The experience in these areas reported by the respondents confirms that management responsibilities are part of the practice experience

of recent engineering graduates in a wide range of industries and sectors.

Management skills that have been important in practice

The most frequently reported management skills (reported as important by 45% of respondents or more) include *communication skills, project management, supervision and leadership, time management, decision making, teamwork, project evaluation, cost estimation, occupational health and safety* and *report writing*. These first ten skills are all important generic professional practice skills that are highly practical, action-oriented activities that members of the engineering workforce are likely to be involved in on a regular basis. The survey reveals that these skills are important even to recent graduates.

At the other end of the scale, *economics* and *theories of management* received no score at all, suggesting that they are viewed as too theoretical or too remote from the engineering practice of recent graduates. In between, there are a large number of management skills that were reported as important by less than 45% of respondents. Some of the management skills in this middle band are possibly more specialised than generic, such as *risk management, environmental management, maintenance management, legal/law, marketing* and *public relations*, and hence reported by a smaller proportion of respondents. Other activities in the middle band may relate to higher level management issues that many recent graduates are yet to experience, such as *contract management, change management, strategic management, business strategies* and *systems approach*, and therefore again have a lower rate of reporting.

Effectiveness of the management stream in the Deakin undergraduate engineering program

Overall, the value of the undergraduate management studies component of the courses at Deakin was rated highly, with a higher overall rating having a positive correlation with respondent age; the mean respondent age in each rating category was significantly different ($f_{3,36}=3.79, p<0.019$). Older students are likely to have had more experience of the engineering

workforce, and hence had an opportunity to experience the 'management' component of engineering work. It is the experience of the author that many students early in their undergraduate studies (particularly students entering directly from secondary school) experience some difficulty in appreciating the relevance of their management studies. The overall high rating of the management studies suggests that exposure to the real world of engineering practice quickly gives graduates an appreciation of the value of the management component of engineering. The clear message from the suggested improvements to the management studies stream is a desire for more exposure to those aspects of management practice already most highly valued. An even clearer message is the desire for more exposure to the real world practice of engineering management.

Other findings

Two moderately significant differences in the reporting rate of a management skill being important were noted between the qualification gained by the respondent. In Australia, the occupational classification 'engineering technologist' refers to a three year BTech degree qualification that fills the occupational niche in the engineering workforce between professional engineer and engineering associate [6]. Professional engineer and engineering technologist are classified as professional occupations; engineering associate refers to graduates of two year study programs in the vocational education sector. BTech graduates were significantly more likely (37.5%) to report that operations management had been important to them than compared to BE graduates (4.2%) ($X^2_1=7.388, p<0.007$). BE graduates were somewhat more likely (66.7%) to report that project evaluation had been important to them than compared to BTech graduates (31.3%) ($X^2_1=4.829, p<0.028$). These results perhaps reflect that a significant proportion of BTech students come from occupational groups focussed on operations, (engineering trades and engineering associates), and as engineering technologist graduates, they are likely to continue in an operations role – in Australia it would be common to find engineering technologists working under the direction of a professional engineer. Conversely, it is perhaps more likely

that professional engineering graduates would find themselves in the role of project planning and evaluating project feasibility sooner than their engineering technologist counterparts.

Comparison to the literature/other sources

Other surveys to establish what management skills are important in engineering practice are reported in the literature. Surveys conducted by the author of Australian academics involved in engineering management studies [4] and mature age engineering students [3] both confirm the general ranking of the importance of management skills as generic professional skills, followed by general management skills and technical discipline specific management skills, followed by other professional discipline skills and theoretical skills. This ranking appears to enjoy general support; other confirming sources from the literature include: a UK survey of 288 science graduates and 384 employers of science graduates [7]; a NZ survey of 120 engineers [8]; a US survey of 681 electronic engineers [9]; and a US survey of 307 academics and 300 executives in technology firms [10].

CONCLUSIONS

A survey of recent Deakin graduates suggests that those management skills most highly valued by graduates were generic professional practice skills, and that more exposure to opportunities to develop these skills in undergraduate studies would be beneficial. A large range of other management skills were valued as important, depending on the discipline and/or employment sector of the graduate. Only highly abstract management skills were not rated as important by any respondent. While the overall survey rating of the value of undergraduate management studies was high, engineering undergraduates tend to take some time to appreciate the value of their management studies [11]. One possible solution to this issue is suggested from the survey results relating to how the management studies stream could be improved. That is, recent graduates suggest the inclusion in the course of more 'real world' examples of engineering management, including case studies, hands-on activities, industry visits, more in-depth coverage of topics, and presentations from practising professionals.

REFERENCES

1. Institution of Engineers Australia, *Guidelines for Management Studies in Engineering Undergraduate Courses*. Canberra, Australia, The Institution of Engineers, Australia (1991).
2. Institution of Engineers Australia, *Manual for the Accreditation of Professional Engineering Programs*. Canberra, Australia, The Institution of Engineers, Australia (1999).
3. Palmer, S., "Engineering Management Studies as Part of Continuing Engineering Education", *International Journal of Continuing Engineering Education and Lifelong Learning*, 9(2), 128-137 (1999).
4. Palmer, S., "Management Education in Australian Engineering Undergraduate Courses", *The Engineering Management Journal*, 12(3), 3-10 (2000).
5. Briggs, H., Towards student-centred engineering education at Deakin University, *Proc. 12th Biennial Forum of the Open and Distance Learning Association of Australia*, Vanuatu, 2-11 (1995).
6. Institution of Engineers Australia, *National Generic Competency Standards for Stage 2 - Professional Engineers, Engineering Technologists, Engineering Associates*. Barton, Australian Capital Territory, The Institution of Engineers, Australia (1999).
7. Williams, C., "Management Competence and the Management Education Needs of Science Graduates", *Management Learning*, 27(3), 301-322 (1996).
8. Batley, T., "Management Training of Professional Engineers in New Zealand", *Journal of European Industrial Training*, Bradford, 22(6/7), 309-312 (1998).
9. Bellinger, R., "Which business skills pay off?", *Electronic Engineering Times*, (1023), 124-125 (1998).
10. Mallick, D. N. and Chaudhury, A., "Technology Management Education in MBA Programs: A Comparative Study of Knowledge and Skill Requirements", *Journal of Engineering and Technology Management*, Amsterdam, 17(2), 153-173 (2000).
11. Young, E. J., Developing interest and motivation in engineering management for engineering students, *Proc. 9th Annual AAEE Convention and Conference*, Ballarat, Victoria, Australia, 206-210 (1997).

