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The rise and fall of management: undergraduate engineering management education in Australia

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Abstract: The modern disciplines of engineering and management are inextricably linked. Frederick Taylor, Henry Gantt and Henri Fayol are engineers whose names are also part of the history of the theory and practice of management. As far back as 1968 it was identified that, ”In all phases of practice in the profession the technical work is coupled, to a greater or lesser extent, with engineering management.” For more than 20 years the call had been increasing for an improvement in the preparation of engineering graduates in the area of management skills. In 1989 the IEAust created the task force on management engineering with the goal of formulating a policy for management education in engineering undergraduate courses. In 1990, the Council of the IEAust approved the Policy on Management Studies in Engineering Undergraduate Courses that said, “From January 1991 the Institution will require at least 5% management content in all professional engineering undergraduate courses and that the total of all management and management related components rises to the vicinity of 10% by 1995.” A 1999 analysis of engineering programs showed that the Policy had been applied with enthusiasm by about one-third of the engineering schools, fairly well in another third, remaining responses were ineffectual. Around the same time, revisions to the IEAust accreditation requirements de-emphasised the importance of management studies, mentioning it only as a subset of ‘professional practice’. By 2004 the IEAust stage 1 competency standards for professional engineers mentioned ‘management’ in only three of 79 indicators of competency. In 2002, the IEAust established the Centre for Engineering Leadership and Management. In December 2005 CELM established a working group, “…for improving the business and management content of undergraduate courses. It appears that it’s back (about 20 years) to the future for Australian undergraduate engineering management education.

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Introduction

The modern disciplines of engineering and management are inextricably linked. Frederick Winslow Taylor (1856-1915), an American mechanical engineer, known as the ‘father of scientific management’, first developed methods of work study and attaching financial reward to performance. In 1911 he published the book Principles of Scientific Management, though these days he is more commonly remembered in the term ‘Taylorian’, used in a derogatory sense to describe work methods that are repetitive and dull. Henry Laurence Gantt (1861-1919), another American mechanical engineer, adapted Taylor’s methods and is known today for developing charts that graphed project activity versus elapsed time. The French mining
engineer Henri Fayol (1841-1925) believed that management was the most important function in industrial organisations. His division of management into ‘planning, organisation, leading, coordinating and controlling’ is still widely held today. Fayol was perhaps the first to note in print the incomplete preparation of engineering graduates in the area of management skills:

Our young engineers are, for the most part, incapable of turning technical knowledge received to good account because of their inability to set forth their ideas in clear, well-written reports, so compiled as to permit a clear grasp of the results of their research or the conclusions to which their observations have led them. (Fayol, 1949, p. 79)

It is well known that most engineers make the transition from technical to management responsibilities some time in their careers (Babcock, 1996). The career advancement of engineers depends principally on their ability to become effective managers of the engineering function in particular, and of technology in general (Kinsky, 1994). From the literature – Samson:

Few people would dispute the proposition that shortly after beginning their careers, many professional engineers move from spending the bulk of their time solving technical problems to doing other things...They are managerial activities. (Samson, 2001, p. xvi);

…and Kinsky:

Most graduate engineers in business...will devote only a small part of their working lives to traditional engineering activities...Instead, they will spend most of their working lives in activities which might be termed management activities… (Kinsky, 1994, p. xiii).

The American Society for Engineering Education (as far back as 1955) concluded:

It is clearly recognized that many engineers progress into managerial and top executive positions in industry and government. For such individuals the foundation should be laid in college for an understanding of human relationships, the principles of economics and government, and other fields upon which the engineering manager can build.” (Grinter, 1955, p. 7)

Engineering continues to be linked to management and business. Of the top 1000 publicly listed American companies in 1998, the most widely held qualification of the chief executive officer was engineering (Anonymous, 1998). Engineers were prominent as leaders of organisations during the first industrial revolution, and are again commonly the founders/leaders of new organisations arising from the second industrial revolution based on communications (Anonymous, 1998). In the United Kingdom 32 percent of Master of Business Administration (MBA) students are engineering graduates (Hegarty, 1996), this being the most common first degree discipline of MBA students (Gault, 1999). In Australia the largest MBA program is one designed principally for engineers and focused on the management of technology (Ashenden & Milligan, 1999). A recent Australian review of continuing professional development in engineering identified that while only 3.5 percent of engineering graduates pursue a higher degree in engineering, the dominant competency chosen for formal postgraduate study is management, with 15 percent of engineers studying an MBA (Kean, 1997).

The rise of engineering management education
As far back as 1968 it was identified that, “In all phases of practice in the profession the technical work is coupled, to a greater or lesser extent, with engineering management.” (Lloyd, 1968, p. 43) A 1972 survey of 1426 practising Australian engineers found that 92% of respondents indicated management studies should be included at the undergraduate level (PE Consulting Group (Australia) Pty Ltd, 1972). Lloyd et al. (1979) identified the increasing importance of management in the success of technological development, the desirability for managers of engineering activity to have an engineering background and that the formation of engineering management skills should begin in undergraduate courses. In the same document an analysis of the content of tertiary engineering courses revealed a wide variation and general lack of management studies in Australian undergraduate engineering courses – “Most of the universities include a small amount of management studies, but some include none.” (Lloyd, Stokes, Rice, & Roebuck, 1979, p. 220). The 1988 Review of the Discipline of Engineering, chaired by Williams, extensively investigated many aspects of engineering education, including surveying employers of graduates, recent graduates and students to determine their views on the content of undergraduate courses. From the employers’ perspective, the review found:

The majority of employers judged as “satisfactory” the emphasis given to the basic sciences, the skills, knowledge and practice of the particular discipline of engineering studied, ... But they judged as unsatisfactory the emphasis given to oral and written communication skills, industrial relations and the management of people, the management of costs and resources, engineering as part of a broader business context, and the involvement with non-engineering disciplines in project work. (Williams, 1988, p. 31)

From a national survey of students and graduates, the review identified those components of the course with the largest discrepancy in emphasis between “what should have been covered” and “what has been covered” as, “industrial relations, management of people, management of costs and resources, written and oral communication skills, social responsibility in engineering and engineering as part of the business context”. The recommendations of the review included references to the importance of the “human side” of technology and the need for a more emphasis on the deficiencies identified by employers, students and graduates. A 1987 Institution of Engineers, Australia (IEAust) task force on management education reported similar concerns. A submission to the task force by the Association of Consulting Engineers, Australia (ACEA) observed that, “most engineers were not people orientated, and that many lack communication skills”. The ACEA submission proposed a need to moderate the emphasis given to purely technological subjects with an early grounding in management studies. In particular, the ACEA argued that minor increases in a small base of management course content would not be sufficient, and that...

The need is for management to occupy a place in the syllabus that places it on a par with the major technological elements. We consider that 15 per cent of total course time would be appropriate. (Institution of Engineers Australia, 1991b, p. 3)

For more than 20 years the call had been increasing for an improvement in the preparation of engineering graduates in the area of management skills. For this to be effective, it would have to be made a course content ‘requirement’ in the course accreditation process of the IEAust. Lloyd (1994) describes how the IEAust created the task force on management engineering (TFME) in 1989. One of the goals of the TFME was to formulate a policy for management education in engineering undergraduate courses. A draft policy was quickly developed and circulated to relevant professional bodies, gaining wide support, many constructive comments
and minimal negative criticism. Following a process of consultation and review with stakeholders, and with personal intervention from the president of the IEAust, in 1990 the Council of the IEAust approved the Policy on Management Studies in Engineering Undergraduate Courses. The policy became known as the ‘10% rule’, its essence being:

From January 1991 the Institution will require at least 5% management content in all professional engineering undergraduate courses and that the total of all management and management related components rises to the vicinity of 10% by 1995. (Institution of Engineers Australia, 1991a, p. 1)

The policy was accompanied by detailed, but non-prescriptive, guidelines for management studies in engineering programs. The history of the development of the ‘10% rule’ has also documented by Young (Young, 1991). In 1993 the IEAust released its National Competency Standards for Professional Engineers. This document sought to, “identify the overall balance of knowledge, skills, judgement, ethical standards and experience required by Professional Engineers” (Institution of Engineers Australia, 1993). In the Competency Standards these objectives were achieved by defining 11 ‘units of competency’, including:

- professional engineering ethics and principles;
- management; and
- communication.

With the adoption of the policy on management studies in engineering undergraduate courses there existed a requirement for management content in engineering undergraduate courses. In the context of undergraduate education, it should be noted that the term ‘engineering management’ actually covers a wide range of material that could be classified as non-technical and/or generic professional skills.

The fall of management education

It should be noted that this policy was not greeted with unanimous support by engineering schools around Australia. A small number of senior engineering academics argued that the primary role of engineering education was to produce ‘technical problem solvers’ (Lloyd, 1994). A 1995 Norwegian survey found a majority of Australian courses approached 10% management content, but that some had markedly less (Solem, 1998). A compounding difficulty in the achievement of the target of 10% management content was the rapid increase in technical knowledge and the struggle to keep pace with it within a four year undergraduate engineering course, even though undergraduate engineering programs in Australia are typically one year longer in duration than undergraduate programs in most other disciplines, and the weekly contact hours for engineering can be 20%-50% greater than other undergraduate programs (Seethamraju & Agrawal, 1998).

In 1996 a major review of engineering education in Australia (sponsored by the IEAust, the Academy of Technological Sciences and Engineering, and the Australian Council of Engineering Deans (ACED)) was published. The review reaffirmed the importance of instilling graduates with an understanding of the management context in which engineering functions, including, “...economics, finance, accounting, teamwork and competition...” (Johnson, 1996). The Australian review also proposed more freedom for, and scope for innovation by, individual engineering schools in determining their course content and modes of delivery, moving from a prescriptive system of accreditation to one focussing more on demonstrated outcomes and graduate attributes. In response to the recommendations of the
review the IEAust issued a revised framework for the accreditation of undergraduate courses in 1997. The new policy on the accreditation of professional engineering courses contained the following revised course content requirement relating to engineering management:

...integrated exposure to professional engineering practice (including management and professional ethics). This element should be 10% of the total course content; (Institution of Engineers Australia, 1997, p. 4).

It became apparent in 1998 that, while the objectives of the new accreditation regime were widely supported, both the engineering schools and the IEAust were experiencing difficulty in implementing the operational requirements of the system. In June 1999 a task force comprising members of the IEAust and ACED was formed to review the accreditation process and devise a workable policy and process for accreditation of undergraduate engineering courses. In October 1999 a revised version of the Accreditation Manual was approved and issued. It had been subtly modified to de-emphasise engineering management studies even further:

...integrated exposure to professional engineering practice (including management and professional ethics). This element should be about 10% of total program content; (Institution of Engineers Australia, 1999a, p. 6)

At the same time, though never formally announced, the 1991 management studies guidelines were removed from the accreditation system. In early 1998 the IEAust commenced a review of its national generic competency standards, the second edition being published in April 1999. The new edition was more comprehensive than its predecessor, with the competency standards for professional engineer, engineering technologist and engineering officer included in a single volume. While this edition still contained references to management competencies for professional engineers, competencies such as business management, project management and engineering operations were now classified as ‘elective’, and the ‘core’ competencies for professional engineers had been reduced to ‘practice’, ‘design’ and ‘self-management’ (Institution of Engineers Australia, 1999b). By 1999 the level of compliance with the 10% rule for management studies in undergraduate programs still varied significantly:

An analysis of engineering courses shows that the Policy has been applied with enthusiasm by about one-third of the engineering schools, and fairly well in another third, other responses appear to be so ineffectual as to indicate that the educators concerned simply do not get it concerning the nature of modern professional engineering employment. (Lloyd, Ferguson, Palmer, & Rice, 2001, p. 54)

The national generic competency standards were revised and re-released again in 2004 as an appendix to the Guide to Assessment of Eligibility for Membership (Stage 1 Competency) for Candidates not holding an Accredited or Recognised Qualification. There are now three ‘units’ of competency (knowledge base, engineering ability and professional attributes), each unit has a range of elements, and, each element has a range of indicators. Of the 79 ‘indicators’ listed, only three include any reference to management, one being risk management, one being project management, and, the final being an, “Introductory knowledge of the conduct and management of engineering enterprises…” (Engineers Australia, 2004). In 2005 the entire undergraduate engineering accreditation documentation system was revised, and, the new accreditation policy and guidelines for undergraduate
programs retained the 1999 references/requirements relating to management studies (Engineers Australia, 2005).

Conclusion / Back to the future

It is clear that over the last two decades there has been a remarkable rise in the recognition of the need for ‘management studies’, to the point where a separate accreditation policy requiring ‘10% management studies’ was issued, and, together with its associated guidelines, it formed a document that was about the same size as the general course accreditation policy, and, for most of the 1990s, in addition to the annual Australasian Association for Engineering Education conference, there was also a separate annual conference of Australasian engineering management educators. This rise has been mirrored by an equally dramatic fall from the spotlight, to the point where ‘management’ is mentioned in the accreditation policy only as a subset of ‘professional practice’, and, in the stage one competency standards it is mentioned in three (out of 79) of the indicators of competency. A charitable view would see this simply as a change in terminology, as the 1991 policy and guidelines on management studies included professional practice and ethics (and many other things) within their scope. A more cynical view would suggest that those opposed to undergraduate management studies simply waited until those providing strong advocacy for it in the senior ranks of the IEAust departed, and, the eyes of the engineering profession returned to, “…being preoccupied with technical issues to the exclusion of all else, unwilling or unable to appreciate contextual imperatives or to contribute effectively to business and political decisions” (Johnson, 1996, p. 54), for which the profession has been historically criticised. It has been noted that the 1997 accreditation policy (which is materially identical to its descendants) would permit just about any non-technical course content to count toward the ‘about 10 %’ requirement (Young, 1998). It could be argued that the new criteria were adopted to suit the status quo, permitting all existing programs to comply, rather than defining a benchmark against which engineering programs should be assessed.

Interestingly, an somewhat incongruously, at the same time as engineering management studies at the undergraduate level were being significantly downgraded in the program accreditation requirements, the IEAust developed a strong (and commercial) interest in engineering management at the postgraduate level. In 2002, Engineering Education Australia (EEA), a subsidiary of the IEAust, launched its ‘Engineered MBA’ program to tap into the highly lucrative postgraduate engineering management education market (as noted above, engineering figures prominently as the first degree of many postgraduate students completing further studies in management). Also in 2002, the IEAust established the Centre for Engineering Leadership and Management (CELM), which has defined ‘advanced’ competency standards for Stage 3 Leadership and Management Competencies. These are competencies beyond stage 1 (graduation) and stage 2 (chartered status), and, will entitle the holder, after payment of a fee, to use the postnomial ‘Chartered Engineering Executive’ (CEngExec) (Hammer, Evans, Anderson, & Wallace, 2004). As of December 2005 (and with a hefty dose of nearly two decades of déjà vu), CELM have established a working group, “…for improving the business and management content of undergraduate courses.” (Adamson, 2005)

The title of this paper is a play on the title of another AAEE conference paper on the theme of engineering management education (Ward, 1998). In that paper, Ward recounts a personal story of his role in the development of engineering management education at the University of Technology, Sydney (UTS), over a period closely paralleling the history of the ‘10 % rule’ in
Australian engineering education accreditation policy. Ward opens his story just prior to the Williams discipline review of engineering education, which was a catalyst for concerns by the IEAust about engineering management education, and, concludes as the IEAust was revising the post-‘Changing The Culture’ (Johnson, 1996) accreditation requirements and quietly laying the 1991 management studies guidelines to rest. Ward concludes his story during a time of change at UTS, where management studies will be restructured from a significant and integrated stream in one engineering program to a series of smaller and perhaps less integrated subjects in all engineering programs. He was cautiously optimistic that those picking up the baton of engineering management studies would negotiate a path through the changes occurring. He closes by noting that a final conclusion about the state of management studies could not be drawn at that time, and, that this could only be done, “…some time in the future when the path is seen.” (Ward, 1998, p. 354)

The intervening period since Ward’s story has cast some illumination on that path, and, has seen a decline in the status of management studies in the official Australian engineering education accreditation requirements. No doubt, there remain programs where engineering management is an important part of the curriculum and/or programs where academic staff present management studies in a way that engages and enthuses students, and provides them with an appreciation of the importance that ‘management’ will have to their longer-term career should they remain in the engineering field. With the benefit of some future history over Ward, unfortunately, this author cannot conclude with the same optimism as the former. Ward, in the introduction to his unintentional allegory of Australian engineering management education, and alluding to the impending changes at UTS, warns us to take a lesson from history by quoting Santayana, “Those who cannot remember the past are condemned to repeat it.” (Santayana, 1954, p. 82) Clearly, the world moves on a lot in two decades, but, as we return nearly 20 years back to the future to find another IEAust (now Engineers Australia) committee examining how to improve the management content of undergraduate programs, let us hope that someone has access to the minutes and work of the last group, so that they might at least be considered in the current deliberations. Perhaps, these new efforts will see the engineering management education debate turn full circle, and, perhaps, we can look forward to a phoenix-like second ‘rise and rise of management’.

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