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Management Skills for Professionals - Are they Required? A Case Study on the Needs of Engineering Undergraduate Students

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Description

This paper examines issues around graduate professional engineers and their management skills, questioning whether they are adequate for the modern engineering workplace and goes on the consider the notion that for the majority of engineers, the development of managerial skills will be essential and cannot be 'picked up on the job'. Engineers increasingly need to understand the interactions between design, quality, sustainability, product planning, and organisation, management of people, team work and finance. This paper considers the need to develop managerial skills and will discuss the development of a survey to be carried out in an Australian context. The survey will cover a range of firms and governmental bodies which employ graduate engineers. The questions will cover a wide range of non-engineering skills which could be expected of engineers within the first five years from the commencement of their careers. The two disciplines, Engineering and Management have enjoyed a rather difficult relationship for some time. Each needs the other because complex engineering tasks cannot be carried out in an increasingly challenging business environment without an integrated management focus. Engineers are finding they need to take on more complex tasks which include very significant managerial issues. Most engineering faculties have attempted to teach managerial skills in their engineering curricula. However, management education has often been viewed as secondary to technical skills and hence does not encompass the integrated range of skills needed. This has not motivated students to become interested in and committed to the management aspects of their future profession with the result that management education for engineers remains an enigma. This paper considers some of the contemporary literature on teaching management to engineers. Some ideas are discussed outlining possible research which will be carried out and reported on by the authors, aimed at documenting current shortcomings with a view to developing a more effective future strategy for engineering management education.

Location

Innovation Campus, Mike Codd Building, 1st floor, Room 102

This event is available at Research Online: http://ro.uow.edu.au/sbshdr/2012/papers/2

FUTURE DEVELOPMENT OF GRADUATE ENGINEERING MANAGEMENT EDUCATION - ISSUES AND CHALLENGES

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***Abstract**: This paper examines issues around graduate professional engineers and their management skills, questioning whether they are adequate for the modern engineering workplace and goes on the consider the notion that for the majority of engineers, the development of managerial skills will be essential and cannot be 'picked up on the job'. Engineers increasingly need to understand the interactions between design, quality, sustainability, product planning, and organisation, management of people, team work and finance. This paper considers the need to develop managerial skills and will discuss the development of a survey to be carried out in an Australian context. The survey will cover a range of firms and governmental bodies which employ graduate engineers. The questions will cover a wide range of non-engineering skills which could be expected of engineers within the first five years from the commencement of their careers. The two disciplines, Engineering and Management have enjoyed a rather difficult relationship for some time. Each needs the other because complex engineering tasks cannot be carried out in an increasingly challenging business environment without an integrated management focus. Engineers are finding they need to take on more complex tasks which include very significant managerial issues. Most engineering faculties have attempted to teach managerial skills in their engineering curricula. However, management education has often been viewed as secondary to technical skills and hence does not encompass the integrated range of skills needed. This has not motivated students to become interested in and committed to the management aspects of their future profession with the result that management education for engineers remains an enigma. This paper considers some of the contemporary literature on teaching management to engineers. Some ideas are discussed outlining possible research which will be carried out and reported on by the authors, aimed at documenting current shortcomings with a view to developing a more effective future strategy for engineering management education.*

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1. INTRODUCTION

In the current economic climate graduate engineers are finding they are required to undertake an increasing range of complex tasks that require a challenging range of skills which include very significant professional managerial issues. Typical tasks required include some or all of the following:

> Strategic focus, financial management and control, quality management, human resource and stakeholder management and industrial relations.

More and more in recent times, due to the nature of their technical knowledge and education, engineers are also finding themselves leading the crucial thrust towards sustainable engineering business. However, university education has tended to rely on the knowledge of engineering technology experts who have little inclination towards engineering business and the resulting commercial challenges of the 21st Century. University engineering education can no longer be described as 'basically scientific and technical in nature' and must be integrated with a knowledge base associated with Commerce and Business. Most engineering faculties have attempted to teach managerial skills in their engineering curricula. However, these have often been approached as a secondary issue and, consequently, as a 'bolt-on' to the technical skills being imparted and hence they do not fully encompass an integrated range of management issues and skills needed. This approach has not motivated students to become interested in and committed to the management aspects of their future profession. Consequently the teaching of management is a problematical issue for many Faculties of Engineering. Employer dissatisfaction has also appeared because new graduates are not orientated to meet engineering management challenges and consequently they cannot immediately contribute to business outcomes in many engineering and industrial organisations.

Engineers tend to be uncomfortable with the management aspects of their profession because engineering is considered a rigorous, scientific discipline whereas management is a social science discipline, taught by case studies, anecdote and other non quantifiable methods. Many students chose engineering because they do not wish to study in that way, which leads to further compounding of the problems. This paper attempts to describe and review the professional managerial skills that will be needed by graduate engineers to allow them to perform to a satisfactory level within the current multiskilled work environment and better meet the needs of employers. The history of management skill identification is reviewed from the work of Katz (1955) through to the present and a list of the identified managerial skills needed of a manager is presented. This list is then modified to highlight those which the authors suggest are relevant to the training of a fully rounded and competent graduate engineer.

2. PROFESSIONAL ENGINEERING MANAGEMENT

For the purpose of this research, professional engineering management is defined as the skill of managing both engineers and other non-engineering employees in a practical, commercial and non-commercial environment. The additional skills which will be needed for engineers to successfully manage in this environment will include human resources, financial, operational, marketing and others.

The term Professional Management Skills for Engineers (PMSE) is suggested as a term to describe the skills believed to be necessary for both undergraduates and postgraduates to participate fully in the running of an organisation and be fully conversant with the skills and attributes to successfully manage disparate groups of both professional and non-professional employees in a timely and efficient manner.

This topic has been of relevance for some decades. In 1984 the following comment was made by Lord Flowers, FRS, Rector, Imperial College of Science and Technology, London at the Second

World Conference on Continuing Engineering Education, Paris, France in 1983 (cited by Martinec (1984)).

> "*For the majority of engineers, the development of managerial skills will be essential and cannot be picked up on the job. The engineer will, in general, increasingly need to understand the interaction of design with quality control, commercial and product planning, organisation and finances, and will need to develop the managerial skill of financial control, industrial relations and marketing.*"

Research has identified that since this time, PMSE has been considered an integral part of the skills and attributes that a graduate engineer should possess. This comment is backed by a large body of scholarly literature and reference is made to the following authors - Aldridge et al (1990), Brisk (1997), Carmichael & Gibson (2001), Childs & Gibson (2007, 2009), Director (1996), Jenson (2000), Kocaoglu (1984), (1994), Kocaoglu et al (2003), Martinec (1984), McCahon and Lavelle (1998), Nambisan and Wilemon (2003),Wilkinson (2002) and others.

To date little has been discovered on the needs and perceptions of employers as to the skills and attributes they perceive as being either essential or desirable for graduate engineers to possess and the resulting influence this has on business performance. Literature discovered to date covering this aspect and the limited scholarly research on the attributes and skills required by an engineer generally, is mostly discipline based and is covered by a small range of authors. Some authors have attempted to define these general skills without a particular reference to managerial skills. The generalised list of authors is as follows – Chisholm (1999), Editorial (2004), Edum and Fotwe (2000), Gibson and Carmichael (2001), Holfield and Thomas (1999), Plonka et al (1994), Rifkin et al (1999) and others.

Of other authors, Liyanage (2001), Gibson & Carmichael (2001) and Thilmany (2004) have all reviewed the needs and dimensions of postgraduate engineering courses and have highlighted the need for engineers to study and absorb 'management concepts'.

Gibson and Carmichael (2001) comment that:

> *Leading firms are working with universities to develop innovative ways to progress and develop their staff throughout their careers. The divide between working and learning is becoming increasingly blurred. The global dimension adds further challenges that will probably result in strategic alliances and networking capabilities that allow even greater degrees of customisation and just-in-time delivery. There are enormous challenges for engineering and technology schools in how they develop future profiles of their academic staff."*

Of recent literature Patil & Codnel (2007) have found that engineers now require global competencies such as an awareness of global political and social issues, and knowledge of cross cultural and multicultural issues. They also need to understand international business, the local and international economy and the world market. These points were also commented on by Nair & Patil (2009). Trevelyan (2008) comments on the way current engineering education is based on engineering practice which covers technical problem solving and design and this represents a misalignment between engineering education

and engineering requirements in real world situations. It does not take into account the very important factor that engineers spend time interacting with people.

Wei (2005) in reviewing current education commented:

> *' It has always been a point of tension to achieve both breadth and depth in 4 years, and the engineering accreditation process has accepted the notion that between one-eighth and one-quarter of the engineering curriculum should be devoted to humanities and the social sciences'.*

Wei continues to review the changes in both the developed and developing world in which the former is moving rapidly to become a service economy and then onto a knowledge economy, whilst the developing countries will continue to need traditional engineers for some time. However, it is believed that this time frame is shortening rapidly. This short review of the development of engineering management education has shown that this field is an area of concern to engineering educators. This area of concern questions whether it is possible to blend a hard fact driven education, such as engineering, with a discipline that seeks optimal solutions as opposed to an optimum solution.

3. PROFESSIONAL MANAGEMENT SKILLS FOR ENGINEERS (PMSE)

In the management area of academia the art of management was generally defined in the 1955 paper by R.L. Katz published in the Harvard Business Review (HBR). His understandings of the skills of an effective administrator (manager) were listed as follows (with the authors' comments in parenthesis):

> *Technical – need sufficient technical skill to accomplish the mechanics of a particular job for which he is responsible (*these skills would presumably be part of an undergraduate degree curriculum)
>
> *Human – (have) human skill in working with others to be an effective group member and to be able to build cooperative effort within the team he leads.* (generally not taught as an integral part of an undergraduate degree)
>
> *Conceptual – (have) sufficient conceptual skills to recognize the interrelationships of the various factors involved in his situation which will lead him to take that action which achieves the maximum good for the total organisation.* (generally not taught as an integral part of an undergraduate degree) *(Katz, 1955 p42)*

This seminal paper was reprinted as a HBR Classic in 1974 with the additional comment that all managers, whatever their level will need some skills in all these three areas. In 1986 HBR again reprinted sections of the paper and it was revisited by Peterson & Fleet (2004) who expanded and modified some elements but still stayed essentially true to Katz' original statements. In their review, Peterson & Fleet (2004) also identified an additional seven skills listed in the texts alongside Katz's three skills. Thus, from this series of papers we can postulate a summarised series of ten management skills that it is felt graduate engineers may need to possess. These ten

attribute skills are as listed below and encapsulate current thoughts on the skills a manager needs to be fully effective. These are - Technical, Analytic, Decision making, Human, Communication, Interpersonal, Conceptual, Diagnostic, Flexible, and Administrative. These correlate relatively well with those 'softer skills' identified by Robinson et al (2005).

These attributes/skills were used by the authors of this paper in their research into the development of a questionnaire to assess the current status and success of engineering management education that will be sent to Australian industrial and commercial engineering organisations to determine what skills they would desire from their newly graduated engineers. This list outlines the areas which should be considered when evaluating what management skills a graduate engineer should possess. However it does not mention financial concept skills, quality management skills, or marketing.

The basis of the research of the authors of this paper is to ascertain what skills employers believe they want their engineers to possess, particularly for those employers who expect their engineering employees to become professional managers (at some stage in their career). The skill set will be potentially different for different engineering disciplines as well as for different phases of the economic cycle.

A review of the literature did not identify any areas of agreement of what management attributes a graduate engineer should possess. A major paper reviewed by Robinson et al (2005) surveyed design engineers in the UK on what skills they should possess to competently carry out their tasks. They indicated six groupings into which the authors categorised the skill sets identified. This survey was biased towards an engineering perspective but surprisingly identified many of the softer skills of management as put forward by Katz (1955).

Research was carried out by Peterson & Peterson (2004) who researched the managerial needs of a mid-level management position within a USA government organisation. This research involved a series of surveys on management needs. In the first survey they requested 23 senior managers to comment on three aspects of management based on Katz' (1955) listing of technical, human, and conceptual, and required them to estimate the time spent within their positions on these three aspects.

Interestingly, in this survey, human skills ranked first with technical skills ranking last. The research continued with the senior managers asked to observe critical incidents, both those that were successful and those that were unsuccessfully resolved. They were asked to identify those skill categories which were used in the incident observed.

Again the ranking was the same as in the first survey and confirms Katz' original contention that managers need not only technical skills but also those of the 'softer'' variety.

The recipients of the survey were then requested to use a seven point Likert scale to rate how important each skill was in the opinion of the respondent. In addition each respondent was asked to rate their own capability.

The top three skills identified as essential were - acting consistently, is truthful and builds trust, all HR attributes. The study, although designed to assess skills for a particular position highlights the need for managers, of all types, to attain a certain set of (professional management) skills to be fully successful in a managerial position.

The surprising omission in all papers reviewed from the engineering side was financial skills, but this could be due to the focus of the study being on engineers and the group chosen for the study. More recently, it has also become necessary to add the need for new engineers to appreciate the need to manage engineering in an environmentally sustainable way. This adds further complexity to the engineering management teaching task.

It is proposed that in this research the authors of this paper will blend the work of Robinson et al with the work of Katz (1955 etc) and with later authors, Peterson & Fleet (2004). The work of Katz (1955 etc) and others is included as it reviews management skills from the 'commerce' side of an organisation. However, managing sustainability must also be included as an essential future dimension for engineers to attain.

Peterson & Fleet (2004) have developed a list of these skills together with an explanation of what is required of each skill. Their definitions were used to develop a list of suggested attributes which graduate engineers should possess. The skill listed as "technical" has not been included as it is expected that this skill would have formed part of the engineering curriculum.

> **Decision Making Ability** - *To be able to assess and decide between competing solutions to a particular problem. This skill will have been taught in relation to their technical skills but not necessarily in relation to the decision that a manager needs to make.*
>
> **Human Skills -** *To be able to work with, communicate, negotiate and relate to others both within the organisation as well as outside the organisation. Also be able to teach others, work in groups and with individuals at various levels of management. Resolve conflicts.*
>
> **Communication** -*Be able to send and receive information, thoughts and feelings, which create common understanding and meaning.*
>
> **Interpersonal -** *Ability to develop and maintain a trusting and open relationship with superiors, subordinates, peers and external personnel to facilitate the free exchange of information and provide a productive work setting.*
>
> **Conceptual** - *Ability to see the organisation as a whole and to solve problems from a systematic point of view.*
>
> **Diagnostic** - *Ability to determine the probable cause(s) of a problem from examining the symptoms and which are observed by the manager.*
>
> **Flexible -** *Ability to deal with ambiguous and complex situations and rapidly changing demands.*

Administrative - *Ability to follow policies and procedures, process paper work in an orderly manner and manage expenditures within the limits set by budgets.*

Other skills that should be included in the discussion are those mentioned by Lord Flowers –

> *"- quality control, commercial and product planning, organisation and finances, and will need to develop the managerial skill of financial control, industrial relations and marketing."*
>
> Lord Flowers (cited by Martinec (1984).

The above list of attributes will be used as the basis of the questionnaire which will be issued early in 2010 to a range of Australian organisations with results expected to be available by mid – year 2010. The respondents will also be questioned as to whether they feel these skills should be taught as part of a University engineering curriculum or as part of a normal 'on the job' training by the employing entity.

4. CONCLUSION

The authors of this paper have developed a questionnaire to be tested within the Australian context to ascertain the viewpoint of the employers of engineers (of all disciplines) as to whether engineers require knowledge of management skills upon graduation. It is the authors' belief that this is correct.

Based upon the authors reviewed thus far it appears there are problems with professional engineering management education and there appears to be no firm decision as to whether this skill is needed. The varied topics to be taught in professional management education across the papers reviewed and what constitutes this discipline require clarification as follows:

should engineers be taught professional management concepts

which subjects will constitute this discipline

where this discipline will be taught, (e.g. in the engineering faculty or in the commerce or business school faculties)

who will teach it and at what level (undergraduate or postgraduate) will the courses be offered

Underlying this dilemma is the question of how can engineers be trained to satisfy tomorrow's requirements. Sustainability is clearly becoming a further management challenge for engineers. What skills will these engineers need, what skills will academics need and how and by whom will these various skills be taught? The aim of the authors of this paper is to answer these questions and propose a list of skills that can be put forward as those required by engineers and

employers to allow the graduate engineer to seamlessly integrate into the organisation and be ready to assist in the attainment of the goals and objectives of the parent organisation.

To assess the attitudes of Australian employers a questionnaire has been developed that will be submitted to a suitable range of Australian organisations to evaluate the needs of employers and close the perceived gap in the relevant literature. The survey will particularly investigate the potential for employers to partner with universities in helping to develop and participate in curricula. Results of this survey are expected to be available by mid-year 2010.

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