University of Southern Queensland
Faculty of Engineering and Surveying

# How Engineers Become CEOs - Implications for Education and Training

A dissertation submitted by

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in fulfilment of the requirements of

**Courses ENG4111 and ENG4112 Research Project**

towards the degree of

**Bachelor of Engineering (Mechanical)**

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# ABSTRACT

The aim of this project was to investigate the career progression of engineers - determining the skills and qualities they need to become large company CEOs and thus recommend strategies for long term career development. Specific objectives included:

- determine the skills and attributes required by CEOs
- determine the attributes of generic engineers
- determine maximal path of career progression
- develop a 'Engineer Career Model'
- recommend improvements to education and training

The results and conclusions drawn from this project were derived from both qualitative and quantitative techniques using the following general methods:

- literature review
- questionnaire to top level executives
- database search and interpretation
- statistical analysis of findings

Findings indicate:

- CEOs often reach their position as natural career progression rather than actively seeking management
- Personal attributes are perceived as being more important than qualifications
- Leadership, communication skills and financial training are the most important training requirements
- Most universities do not cover some highly desirable skill sets and attributes

Implications:

- University courses can be adjusted to better reflect the needs of business
- Students and engineers can plan careers more effectively by considering their personal attributes and the skill sets required of executives (especially when seeking management roles)
- Professional development programs can be designed to maximise proficiencies at the most beneficial stage of their career

This project assists engineers in all stages of their career to understand the career progression of engineers within a management environment - thus allowing them to plan careers more effectively. It maximises the probability that an engineer can compete with graduates of other disciplines. Additionally it may allow universities to consider their course programs in order to develop the identified attributes assisting to develop the status of engineers in general.

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# ENG4111 Research Project Part 1 & ENG4112 Research Project Part 2

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I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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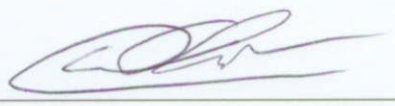

Signature

31 October 2007

Date

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# Glossary

**accredited course**[*] a structured sequence of vocational education and training that leads to an Australian Qualifications Framework qualification or Statement of Attainment.

**Australian Qualifications Framework**[*] (AQF) a nationally consistent set of qualifications for all post-compulsory education and training in Australia.

**Australian Quality Training Framework**[*] (AQTF) the nationally agreed recognition arrangements for the vocational education and training sector. The Australian Quality Training Framework is based on a quality assured approach to the registration of training organisations seeking to deliver training, assess competency outcomes and issue Australian Qualifications Framework qualifications and / or Statements of Attainment and ensures the recognition of training providers and the Australian Qualifications Framework qualifications and Statements of Attainment they issue, across Australia.

**Chief Executive Officer** the highest-ranking corporate officer or executive officer of a corporation, company, or agency; CEO (in the context of the project identical to Managing Director).

**Competency**[*] (also competence) the ability to perform tasks and duties to the standard expected in employment.

**competency-based assessment**[*] (or CBA) the gathering and judging of evidence in order to decide whether a person has achieved a standard of competence.

**competency-based training**[*] (or CBT) training which develops the skills, knowledge and attitudes required to achieve competency standards.

**core competencies** Units of competency within a competency standard that an industry has agreed are essential to be achieved if a person is to be accepted as competent at a particular level. All units may be core, but in many cases competency at a level will involve core units plus optional or specialisation units of competency. Core competencies are normally those central to work in a particular industry.

[*] recognised definition of the Department of Education, Science and Training

**continuing education*** educational programs for adults, usually at the post-secondary level and offered as part-time or short courses in personal, academic or occupational subject areas.

**core competencies*** identifies units of competency within a competency standard that an industry has agreed are essential to be achieved if a person is to be accepted as competent at a particular level. All units may be core, but in many cases competency at a level will involve core units plus optional or specialisation units of competency. Core competencies are normally those central to work in a particular industry.

**core curriculum*** that part of the curriculum which is considered essential for all students, and is usually compulsory.

**corporate education*** educational programs or services offered by business and industry, either in-house or co-operatively with an educational institution.

**course*** a structured and integrated program of education or training, usually consisting of a number of modules (subjects) or shorter programs, and leading to the award of a qualification.

**development** development is the growth or realisation of a person's ability through conscious or unconscious learning.

**education*** (1) the process of imparting knowledge or developing skills, understanding, attitudes, character or behaviours. (2) the process of acquiring knowledge, skills, understanding, attitudes, etc. (3) the knowledge, skills, understanding, attitudes, etc. acquired. (4) the field of study concerned with teaching and learning.

**educational institution*** any establishment providing education, including schools, colleges, universities and institutes.

**experiential learning*** learning through experience, either in a real situation such as a workplace or in role play.

**formal education*** also formal training education or training provided in educational institutions such as schools, universities, colleges, etc.or off the job in a workplace,usually involving direction from a teacher or instructor.

**higher education*** post-secondary education offered by a university or other recognised higher education institution, or through Open Learning Australia, leading to the award of a degree or higher level qualification.

**in-service training*** training and professional development of staff, often sponsored by the employer, and usually provided during normal working hours.

**knowledge** The mental skills involved in such processes as judgment, thinking and understanding; and the information base of factual and theoretical material that is accessed, manipulated and used cognitively in the application of mental and physical skills.

**leadership** The art of influencing and directing people to achieve willingly the team or organisational goal.

**learning*** the process of acquiring knowledge, attitudes, or skills from study ,instruction, or experience.

**learning organisation** A set of systems, mechanisms and processes in place within an organisation that are used to continuously enhance its capabilities and those who work with it or for it, to achieve sustainable objectives for themselves and the organisations in which they participate.

**lifelong learning** The process of acquiring knowledge or skills throughout life via education, training, work and general life experiences.

**management**[1] The process of planning, organising, directing and controlling organisational resources in the pursuit of organisational goals.

**Managing Director** the highest-ranking corporate officer or executive officer of a corporation, company, or agency; (in the context of the project identical to CEO).

**National Training Framework*** the system of vocational education and training that applies nationally. It is made up of the Australian Quality Training Framework and nationally endorsed Training Packages.

[1] From Pierce J.L., and Durham R.B, *Managing*, Fresman and Company, Illinois, 1980.

**off-the-job training*** training which takes place away from a person 's job, usually off the premises, e.g. at TAFE, but may be on the premises, e.g. in a special training area.

**on-the-job experience** On-the-job experience is expertise gained in the workplace as a result of actually performing a job over a period of time. On-the-job experience is not considered to be formal training. Some trades require completion of a period of on-the-job experience for trade progression to ensure that individuals can perform to the correct standard for current employment before undertaking further training.

**on-the-job training*** training undertaken in the workplace as part of the productive work of the learner.

**professional mastery** [2] professional mastery in the context of this project is an expression of personal competence displayed by an individual's ability to combine character, self-confidence, effective leadership, professional knowledge, and experience. It is a process of continual learning developed through education, training and experience.

**qualification** Qualification refers to the certification given in recognition of successfully gaining a defined set of competencies that relate to the Australian Qualifications Framework in ways defined in an accredited course.

**Registered Training Organisation*** (or RTO) an organisation registered by a state or territory recognition authority to deliver training and/or conduct assessments and issue nationally recognised qualifications in accordance with the Australian Quality Training Framework.

**self-directed learning*** learning in which the learner is the principal driving force, deciding how, when, and at what pace learning takes place.

**skill*** an ability to perform a particular mental or physical activity which may be developed by training or practice. See also basic skill generic skill.

**training*** the development of skills, knowledge, attitudes, competencies, etc. through instruction or practice.

[2] The term and idea behind 'professional mastery' is taken from the military usage but heavily adapted to apply to engineers' skill in management required as a life long improvement in order to reach senior management positions.

**training continuum** a complete training regime designed and developed from a suite of competencies and proficiencies within an occupation or career role. In the context of this project, it is the sequence or progression of education and training for engineer from undergraduate to the most senior position within the organisation.

**training effectiveness** extent to which training prepares an individual for a career role.

**training efficiency** extent to which training resources (including time) are used economically while achieving effectiveness.

**training organisation*** an organisation which provides vocational education, training and/or assessment services. See also registered training organisation.

**vocational education*** education designed to develop occupational skills. See also vocational education and training

**vocational education and training*** (VET) post-compulsory education and training, excluding degree and higher level programs delivered by higher education institutions, which provides people with occupational or work-related knowledge and skills. VET also includes programs which provide the basis for subsequent vocational programs. Alternative terms used internationally include technical and vocational education and training (TVET), vocational and technical education and training (VTET), technical and vocational education (TVE), vocational and technical education (VTE), and further education and training (FET).

**work-based training*** training provided by an organisation primarily for its own employees using the employer ’s own staff or consultants. Work- based training can be conducted either on- site or at an off-site location.

# ABBREVIATIONS

| | | |
|---|---|---|
| AAIM | - | Associate Australian Institute of Management |
| AFAIM | - | Associate Fellow Australian Institute of Management |
| AFIA | - | Associate Federal Institute of Accountants |
| AFIBA | - | Associate Fellow Institute of Business Administration |
| AFIIM | - | Associate Fellow Institute of Industrial Management |
| AFIM | - | Associate Fellow Institute of Management |
| AFIPMA | - | Associate Fellow Institute of Personnel Management Australia |
| AGSM | - | Australian Graduate School of Management |
| AICA | - | Associate Institute of Chartered Accountants |
| AICD | - | Australian Institute Company Directors |
| AIM | - | Australian Institute of Management |
| AIMCA | - | Associate Institute of Management Consultants in Australia |
| AIPM | - | Associate Institute of Personnel Management |
| AIPMA | - | Associate Institute of Personnel Management of Australia |
| AMP | - | Advanced Management Programme |
| ANU | - | Australian National University |
| APESMA | - | Association of Professional Engineers, Scientists and Managers, Australia |
| ASCPA | - | Australian Society Certified Practising Accountants |
| | | |
| BA | - | Bachelor of Arts |
| BBS | - | Bachelor of Business Studies |
| BBus | - | Bachelor of Business |
| BBusAdmin | - | Bachelor of Business Administration |
| BBusMgmt | - | Bachelor of Business Management |
| BBusMktg | - | Bachelor of Business Marketing |
| BCom | - | Bachelor of Commerce |
| BE | - | Bachelor of Engineering |
| BE (Civ) | - | Bachelor of Civil Engineering |
| BE (Elect) | - | Bachelor of Electrical Engineering |
| BE (Mech) | - | Bachelor of Mechanical Engineering |
| BEc | - | Bachelor of Economics |

| | | |
|---|---|---|
| CA | - | Chartered Accountant |
| CDU | - | Charles Darwin University |
| CEng | - | Chartered Engineer |
| CEO | - | Chief Executive Officer |
| CPA | - | Certified Practising Accountant |
| CPEng | - | Chartered Professional Engineer |
| CPEng | - | Certified Practicing Engineer |
| CU | - | Curtin University |
| DEng | - | Doctor of Engineering |
| DU | - | Deakin University |
| FAICD | - | Fellow Australian Institute of Company Directors |
| FAIM | - | Fellow Australian Institute of Management |
| FASA | - | Fellow Australian Society of Accountants |
| FCA | - | Fellow Institute of Chartered Accountants |
| FCPA | - | Fellow Australian Society of Certified Practising Accountants |
| FIAM | - | Fellow International Academy of Management |
| FIDA | - | Fellow Institute of Directors of Australia |
| FSSE | - | Fellow Society of Senior Executives |
| FU | - | Flinders University |
| GU | - | Griffith University |
| JCU | - | James Cook University |
| MA | - | Master of Arts |
| Mac.U | - | Macquarie University |
| MAIM | - | Member Australian Institute of Management |
| MASA | - | Member Australian Society of Accountants |
| MBA | - | Master of Business Administration |
| MCDA | - | Member Company Directors Association of Australia |
| ME | - | Master of Engineering |
| MIDA | - | Member Institute of Directors in Australia |

| | | |
|---|---|---|
| MIE Aust | - | Member Institution of Engineers Australia |
| Mon.U | - | Monash University |
| MSE | - | Member Society of Engineers |
| Mur.U | - | Murdoch University |
| PhD | - | Doctor of Philosophy |
| QUT | - | Queensland University of Technology |
| RMIT | - | Royal Melbourne Institute of Technology |
| SMIEAust | - | Senior Member Institution of Engineers, Australia |
| SU | - | Swinburne University |
| UA | - | University of Adelaide |
| UM | - | University of Melbourne |
| UN | - | University of Newcastle |
| UNSW | - | University of New South Wales |
| UQ | - | University of Queensland |
| USA | - | University of South Australia |
| US | - | University of Sydney |
| UT | - | University of Tasmania |
| UTS | - | University of Technology Sydney |
| UWA | - | University of Western Australia |
| UWS | - | University of Western Sydney |
| UW | - | University of Wollongong |
| VU | - | Victoria University |

# Chapter 1

# Introduction

*'The things that affect your career are always the things you never hear about. That's how institutions work.'* – David Keith Williamson in 'The Department' (1974), Part 2

## 1.1 Introduction

The career pinnacle for most people in business is that of the Chief Executive Officer (CEO). It is the highest 'rank' to which business professionals can aspire. This aspiration does not just apply to businessmen but extends out to others that have moved into managerial positions from specialist or technical areas. Engineers are one such group.

CEOs have no specific common background and need no specific training to reach that position. Many have university degrees and work their way from the graduate entry level. Their personal attributes and skills are recognised and their careers normally progressed rapidly.

It is generally thought that most CEOs come from accounting or law backgrounds. Particularly in a more traditional view, CEOs with these backgrounds are seen to have a better understanding of business and hence are more suited to the role. However, there are many CEOs with no background in either accounting or law that are perceived as being highly successful. It follows that there are other specific skills and attributes that may identify someone as having the ability to become a CEO.

Engineers are professional group that appear to be under-represented by CEOs in large companies. Given that engineers normally have a wide education base, often move into managerial roles (and so have business experience) it might be expected that many have the attributes and skills necessary to become a CEO.

It follows that by identifying the attributes and skills CEOs required to reach their positions, it should be possible to adjust the career management and education and training to maximise the career progression of an individual. The purpose of this project is to achieve exactly that.

## 1.2 Project Aim

The aim of this project is to determine the career attributes engineers need to develop to become CEOs of major corporations and identify training and development needs to assist that career progression in order to better orient career training for engineers.

## 1.3 The Need

Recognition of engineers is important in developing respect of the profession. It not only increases an individual's pay packet and chances of promotion but serves to attract more people into engineering. This is not only self interest but arises out of the increased responsibility engineers have as a result of increasing technology and liability for their decisions.

As part of this recognition it is highly desirable that engineers that do make the move into management (as many do) are capable, and make it to the pinnacle of their potential career structure. This assists to demonstrate the skills and attributes that engineers can bring to management positions.

Other professions do this well. Lawyers and doctors are traditionally well regarded – although doctors don't make the move into management on such a regular basis. Another profession that, like engineers highly regard professional status, but are more widely seen as good at management are accountants. They encourage membership / qualifications such as Charted Accountant or Certified Practising Accountant. These schemes highlight the advantages of such a professional organisation.

## 1.4 Those involved and those who may benefit

One of the aims of this project is that it provides some benefit to other individuals and / or to organisations. It is designed to be applicable to all engineers, engineering related educational institutions or other engineering organisations.

It is hoped that individuals will be able to use the results of this dissertation to examine their personal attributes with regard to those required by high level executives in order to maximise the chance of career success. It will not necessarily apply to all engineers but those who choose to move into management should be able to benefit by gaining the most useful qualifications and improving those attributes most desirable in CEOs.

Ideally this will apply not only to undergraduates but also to more experienced engineers. Undergraduates will be able to make a more informed choice of elective units that may be of benefit in the future. It will also presents them with the opportunity to make longer term plans to move into management. By identifying early a preferred career path, an undergraduate may maximise his chance of success.

More senior engineers may also make use of these results through the identification of the most important qualifications required or expected to assist in the move up the corporate ladder.

Universities and other learning institutions can also benefit from these results. By developing the attributes and skills desired for high level executives, the chance of later success by students in increased which reflects well on the institution. The reputation thus developed is very important to the continued future success of the University or school as well.

Other engineering institutions can also benefit from the increased success and perceived competence of engineering graduates. Building the public awareness of engineers and their competence in non-technical areas such as management assists the aims of these institutions.

## 1.5 Objectives of this project

The goal of this research project, *'How Engineers become CEOs? Implications for Education and Training'*, is to investigate the career progression of engineers determining the skills and qualities they need to become large company CEOs and thus recommend strategies for long term career development.

In order to achieve this goal a number of objectives need to be reached. They are:

a. To discover 'accepted' traits (skills and attributes) of established CEOs.

b. To develop further possible traits desirable in CEOs.

c. To identify a number of engineers that have reached the position of CEO.

d. To confirm the desirable CEO skills and attributes through contact with those engineers that have reached executive level in their careers.

e. To identify the training requirements to develop those skills and attributes.

f. To recommend training and development strategies for engineers desiring executive success based on the results found.

g. To write a quality dissertation of results found.

h. To complete all administrative requirements.

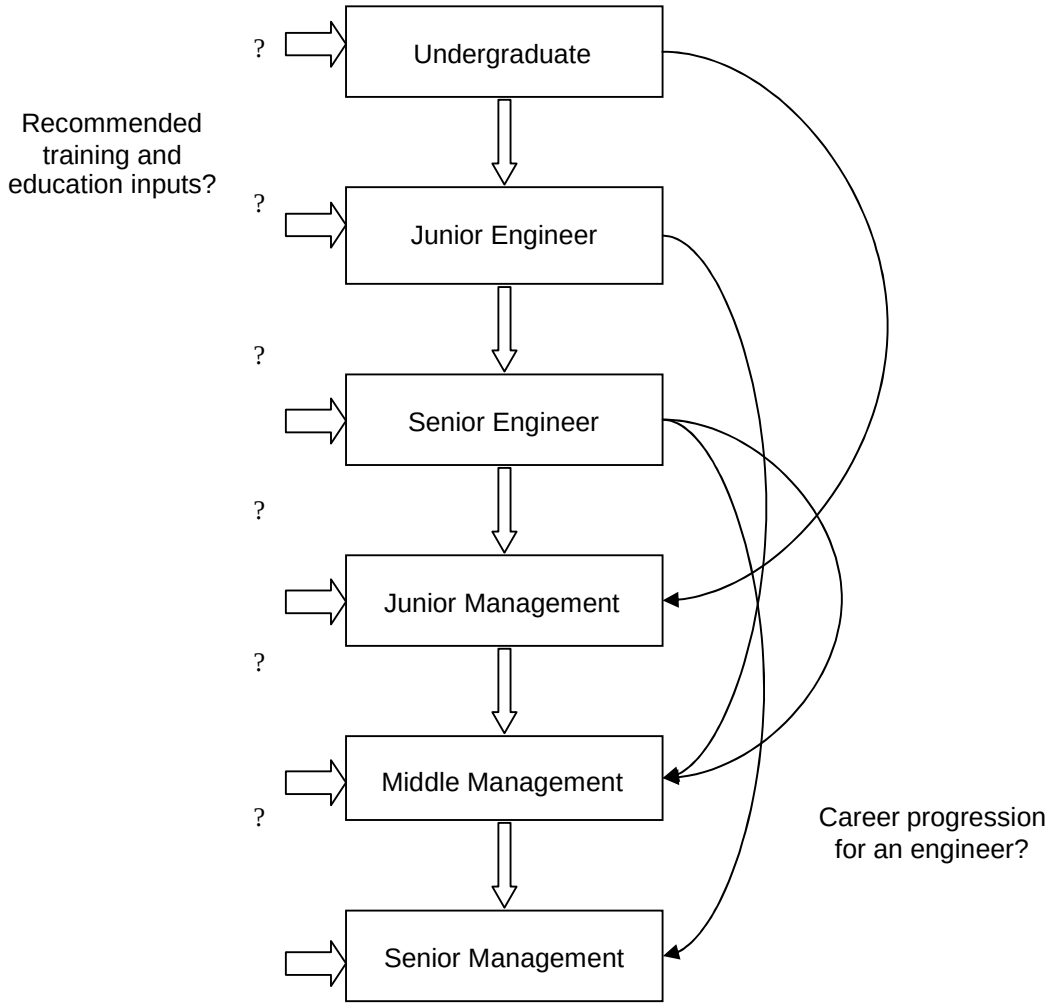


**Figure 1.1: Research project objectives**

## 1.6 Scope

The scope of this project is limited to engineers, their potential to reach senior executive positions (specifically that of CEO) and the potential training and development strategies that may assist engineers to reach those positions.

It will not attempt to address more general career development incorporating other professional backgrounds or even determine current numbers in CEO positions, except possibly in a very tangential manner that may add background to the central discussion.

To answer the broad question of required CEO attributes and the educational requirements to develop these attributes this dissertation will investigate a number of different issues. These are separated into the later chapters of this paper. This chapter is introductory and only intended to provide a short background of relevant issues.

Chapter 2 is a literature review that investigates the current body of knowledge in the subject area. It is necessarily grouped into different areas of previous research including CEO attributes, attributes of professional engineers and current training and education in management within Australia. Although this study is focused on the current Australian problem it does include some discussion of international trends dating back over a number of decades.

In Chapter 3 the methodology used by this dissertation is described in detail. In order to the robustness of the results the methodology is laid out explaining how various portions of data have been collected, and how it has been used to produce the results discovered later in this report.

A review of current education and training is included in Chapter 4. This chapter describes the education undergraduate engineers are receiving with emphasis on the non-technical skills taught at this level. Further, it investigates the education and training available to engineers at a post-graduate level. These factors are only looked at very briefly as they do not strictly relate to the topic being investigated.

As described in the methodology a database was used to identify high performing engineers. This database was also used to extract further information relevant to the project. The results from this source are looked at in Chapter 5. This information can then be used as an indicator of skills and qualifications that may help an individual to achieve success.

Chapter 6 reviews and examines the data collected from the questionnaire used in this study to provide basic data. The questionnaire was aimed at collecting data on those attributes that successful engineers have in common. It was used to validate the

results from other studies and to focus required CEO attributes to the careers of engineers specifically.

Chapter 7 uses the results obtained to propose a model for the progression of an engineer's career within the management stream. It uses this model to also propose a training continuum that will maximise an individual's chance of becoming a high level executive. Such a model and subsequent individual education and training concept also leads to suggested approaches for learning institutions.

In Chapter 8 the implication for training as investigated in this project are discussed. The chapter draws on the information from previous chapters in order to present some implications these findings have on training. It relates strongly to the discussion in chapter 7 but seeks to provide some more detail on individual attributes.

Chapter 9 concludes this dissertation. It outlines the most important issues discovered during the development of this report and suggests areas for further study.

## 1.7 Outcomes and Effects

There are a number of expected outcomes from this project. Some of these are as follows:

- Engineers will be able to better plan their careers, particularly if they have ambitions towards managerial roles.

- University courses will be able to adjust programs to cover any identified shortfalls in education, training or development of personal skill and characteristics.

- Human resource managers of engineers will be able to better develop applicable training and development programs.

- Companies will be more aware of engineer qualities and able to utilise this knowledge for company benefit.

- IEAust and other corporate bodies can design support schemes and other mechanisms to help develop the careers of engineers and eventually promote the engineering profession.

## 1.8 Background

There are a number of ways in which people can become CEOs. For example, they may create and build their own companies, get handed the position by a controlling interest (eg a family owned company) or through working long hours to develop the required skills. Usually, of course, the position is earned by working professionally over a number of years –either for the one company or by working in a range of employed positions. This project will look only at the latter for obvious reasons.

It is in the vast majority of cases it is a long path to success for a CEO. Generally they start as young professionals learning the basics of their original trade before moving into middle management and working their way up based on merit.

The career history and success of a CEO can be considered the result of their:

a. experience – a persons experience helps to shape not only their skill sets, but also their personal qualities to some extent.

b. ability or talent – including their intelligence and creativity.

c. skills – developed not only through experience but by training (related to their qualifications).

d. character attributes – a persons character is an essential requirement. While there is no one ‘character type’ needed by a CEO, there are certainly character types that are not suitable for CEO positions regardless of their intelligence or other skills.

These factors are common to the success of individuals in all careers – and not just ‘white collar’ industries but almost any way of earning a living. It is the nature of their experience, abilities, skills and attributes that changes between different career types. For example, financial skills are required for accountants, but project management skills vital to another industry may not be. Likewise, character attributes such as teamwork may be essential in one career type but not in others. Part of the challenge is to identify these factors in respect to what is required for a CEO.

Potentially the identification of these factors can lead to model of successful executive career progression. That is a construct that reflects how the majority of CEOs and other high level executives achieve their professional success. The development and validation of such a model can lead the basis education and training programs that maximise an engineer’s chance of achieving executive success.

# Chapter 2

# Literature Review

## 2.1 Introduction

This chapter discusses the current literature and body of knowledge surrounding engineers and career progressions in management. It will outline the latest theories in a number of areas including:

a. attributes of CEOs,

b. attributes of engineers,

c. models for maximizing career progression,

d. training and education.

Andre Kaspura (Taylor, 2006) found that there are approximately 270 000 people in Australia with engineering qualifications. Of these though, only 34 000 are working in technical roles but 100 00 work in engineering related management. The rest appear to work in fields unrelated to engineering.

## 2.2 Skills and attributes of CEOs

A number of studies have looked at the characteristics of CEOs and interest in the topic seems to be increasing in recent years.

Wood and Vilkinas (2006) of the University of South Australia have looked at the topic of CEO characteristics from a number of different angles. They have built their study on the work of a number of others – using some basic characteristics as the

basis for a questionnaire and follow up information. The characteristics of CEOs they identified through previous studies were:

a. achievement orientation;

b. humanistic approach;

c. positive outlook;

d. inclusive, participative and empowering style;

e. integrity;

f. balanced approach; and

g. learning and self awareness.

These characteristics were chosen as they were core components across a number of earlier studies based on theoretical, CEO perception and staff perception approaches. Wood and Vilkinas (2006) found that a humanistic approach and an achievement orientation were critical to CEO success. A positive outlook was also perceived to be very important. The remaining characteristics were confirmed as being important to CEO success but not as important as the others listed above.

James Hunt (2006) of the University of Newcastle also provides some valuable information in his research into the 'Key Components of Senior Executives in Australia'. His study has some direct correlation to the topic of this project although not focussed on engineers and not going as far as looking into education and training implications.

Managerial competency is composed of three interrelated components: knowledge, attitudes, and professional skills (Badawy, 2006). Badawy breaks down professional skills into three further criteria: technical, administrative and interpersonal. An

engineer needs to be competent in all of these fields although the relative importance of each varies throughout a professional career. He identifies the major failure of management is normally related to interpersonal skills.

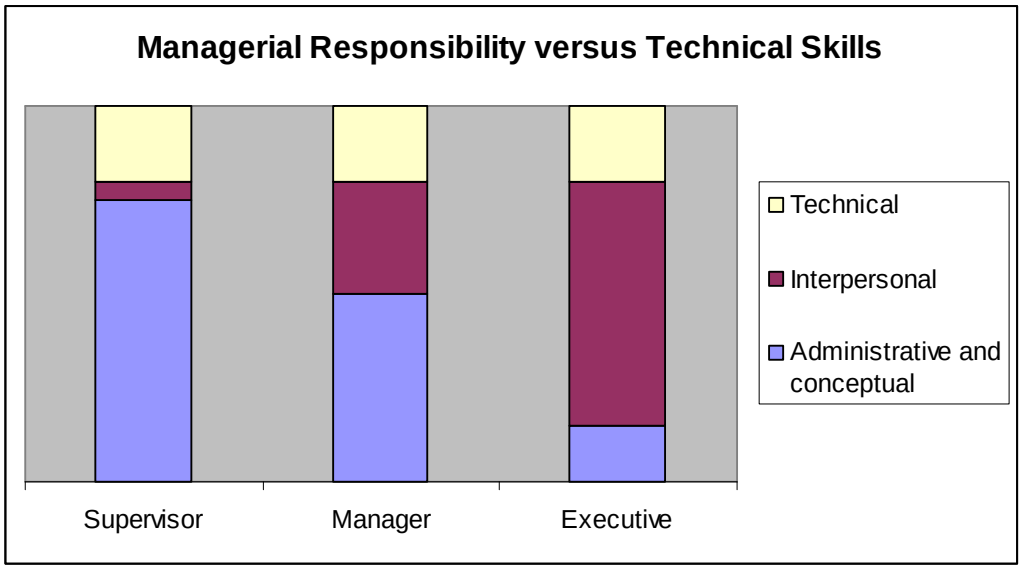


**Figure 2.1: Responsibility versus technical skill**

Badawy further proposes five unwritten 'laws' as follows:

1. Technical managers are made, not born – managerial skills can be developed.

2. Managing is a skill that takes practice.

3. Managing is an 'art' requiring creativity and experience – it cannot be fully quantified by science.

4. Good engineers are not necessarily good managers or vive versa.

5. The main challenge for managers is not technical but human.

In another study, conducted by The Executive Connection (TEC) similar attributes were found to be common across successful Australian CEOs (*Company Director*, 2006). The TEC CEO Leadership Study asked 55 CEOs to undertake an online survey – which led to the following conclusions about successful business leadership in Australia:

a. ambitious,

b. communicative,

c. energy creators,

d. strategic strength,

e. balanced, and

f. innovative.

The study also found that Australian traits appeared different to the equivalent in the United States. Although many traits were found to be similar, as might be expected, Australians were found to be more flexible, less conservative and show a greater sense of urgency (*Company Director*, 2006).

## 2.3 Selection of CEOs

The selection process undertaken by companies to choose a new CEO reveals a different viewpoint on the attributes required of a CEO. While most studies are based on the performance of CEOs, any selection process needs to assess individuals without the benefit of 20/20 hindsight. Thus the emphasis on types of attributes looked at may be slightly different.

Dean Ireland, a consultant with Egon Zehnder International lists five criteria that identify a good CEO (Clark, 2007). These are:

a. Integrity,

b. Resilience,

c. Strategic thinking,

d. Able to deliver results,

e. Team leadership, and

f. Collaborative and influencing.

Ireland notes that it not as simple as someone having these attributes will automatically become a good CEO. Rather 'when choosing the right CEO it is critical that the board selects the right person for the right role at the right time' (Clark 2007).

## 2.4 Skills and attributes of engineers

It might be expected that individuals with certain characteristics in common will gravitate towards similar careers. With this in mind it is important to identify the attributes of generic engineers in order to map these attributes to those required by CEOs. Similarly the skills developed by engineers can be mapped against those of CEOs so that any discrepancies can be investigated and then developed to mould engineer characteristics to that of CEOs.

Peter Taylor, Chief Executive of Engineers Australia quoted Luis Capretz, a Canadian researcher in a keynote address to the Engineering Leadership Conference 2006 (Taylor, 2006). Capretz examined over a thousand engineering students using

the Myer-Briggs Test[1]. Other studies back up the findings that personality types ISTJs (Introverted, Sensing, Thinking, Judging) dominate the engineering fraternity although types ESTJ (Extroverted, Sensing, Thinking, Judging) and INTJ (Introverted, Intuitive, Thinking, Judging) are also common. Taylor notes that from these studies it appears that a third of engineers have preferences for sensing, thinking and judging – and quotes a general description of these personalities as:

> 'cautious, conservative, and quiet; literal, realistic and practical; careful and precise; logical, honest and matter of fact; resistant to change and comfortable with routine; hard working and responsible. The most important thing to ISTJs is being of service, working hard, and being responsible." (www.careermag.com)

From looking at this data, Taylor (2006) concludes that engineers probably make good managers but is less sure about engineers as leaders – although he does say engineers do have 'a fair sprinkling of the traits that could see them become good leaders'.

This is backed up by other studies. Dr Mark Toner quotes some findings of Myer in his article in Engineers Australia. According to Toner (2006), in 1980 Myer found a Self-Selection Ratio (SSR) of 2.94 for introverted, abstract, logical, organised types choosing engineering. This SSR represents a much higher proportion of these personality types seek engineering as a career – almost three times higher than in the base population.

## 2.5 Professional and career development strategies

A great deal of information is also available about the career development of engineers at all levels. A lot of it can be found directly through the University. At a more senior level Engineers Australia can provide much of the career development

[1] The Myers-Briggs Test is a commonly used and accepted personality test used in industry. Information regarding the test is freely available from many sources, although the actual test should only be consucted by professional psychologists.

information needed. In particular, the training and experience needed to obtain "Engineering Executive" status is clearly laid out in as a part of that scheme. The required competencies are listed and give insight into Engineers Australia's view on what is needed by engineers in executive positions.

## 2.6 Management training for engineers

At the present all accredited engineering degrees in Australia include 10% of management material (Georg, 2005). Dietrich Georg in writing about the experience of Professor Archie Johnstons move into management says that 'engineering graduates generally do well in the first ten years of their technical careers. Then they often plateau unless they acquire broader managerial skills.

## 2.7 Other occupations / degrees

Considering the attributes of graduates with other degrees can provide a comparison of generic skills and attributes of business people generally.

Robert Skeffington (2005) discusses CFOs who make a successful transition to CEO in an article in BRW magazine. In the article Kokkong Chan says 'that the competencies of CFOs include: results orientation, people development, functional competence and strategic thinking'. It identifies these traits as desirable in making the move to CEO. This assessment and study demonstrated that it is not just engineers who are considering career paths that lead to being a success in business.

## 2.8 Other relevant issues in the literature

The Karpin Report (Commonwealth of Australia, 2005) included a number of point of interest in the skills it identified as being needed for 2020. Some of these are:

- 'The age of the generalist manager is coming to an end and leaders require a thorough knowledge of their industry.' This is good news for engineers who,

by the nature of their normal career progression generally develop a detailed knowledge at the grass roots level.

- ‘Implementation will require harnessing the capabilities of the senior executive team rather than a focus on the chief executive as an individual.’ This implies that communication, teamwork and leadership qualities are likely to become even more important in the future.

Other general attitudes to promotion and management career success include:

- ‘If career progression comes as a surprise or shock or is not evolving naturally, then it probably isn’t right,’ says Anna Fieldsend, general manager for brand marketers DNA Design (New Zealand Herald, 2004).

- ‘Reaching senior management requires innate ability and boldness rather than time served,’ says Darryn Melrose, managing director for direct marketers AIM Proximity (New Zealand Herald, 2004).

# Chapter 3

# Methodology

## 3.1 Introduction

This chapter details the methodology undertaken during the conduct of this research project. It intends to describe the process undertaken to allow verification of results. The process described in this chapter evolved over the life of the project and does not completely reflect that developed in an initial project appreciation.

As such this chapter will cover how the research was conducted, how the data was obtained and interpreted and will give an outline of the veracity of those results. This will be completed through a discussion of the verification and validation. A brief sensitivity analysis will also be conducted as part of this process.

The objectives of this project are laid out in chapter one. In order to achieve these, the methodology involved three main processes – a literature review, a questionnaire sent to relevant individuals and an analysis of a Who's Who database[14]. Further investigation and research was undertaken where required to confirm details or add additional information.

## 3.2 Assumptions

This project assumes that previous research is valid and the results of the intended questionnaire are accurate in terms of the participants who have filled out the details.

## 3.3 Constraints

This project was constrained in terms of the resources available to conduct it. Time was a significant constraint that did influence the extent of the research undertaken.

## 3.4 Background

The general outline of the conduct is shown in figure 3.1.

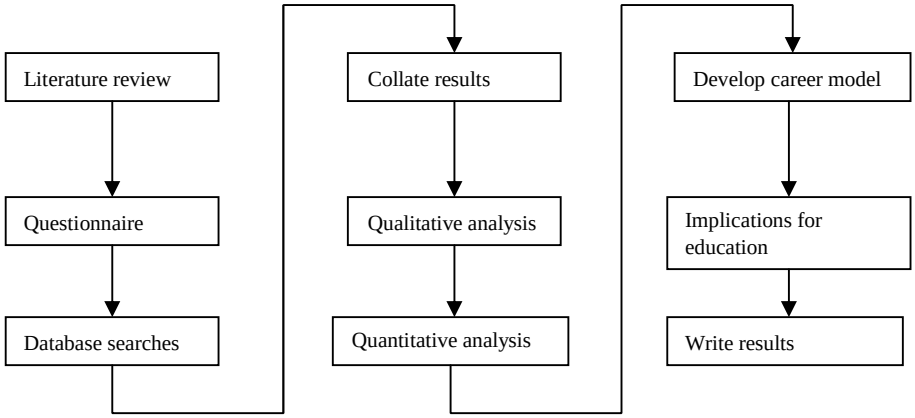


**Figure 3.1: Flow of project methodology**

## 3.5 Literature review

The first stage of the project was to conduct a review of the available literature. This review focused on the following areas:

a. the skills and attributes of CEOs;

b. the skills and attributes of engineers in general;

c. the educational background of CEOs;

d. the management background of engineers (in particular the level of management training received during an undergraduate degree);

e. the career paths of CEOs; and

f. the career paths of engineers.

Sources included the standard literature resources – libraries, internet and applicable journals. In particular Engineers Australia and the Australian Institute of Management were able to provide valuable information.

The Handbooks of Australian universities were also used to obtain information on the level of management education and training currently being taught in undergraduate degrees.

## 3.6 Questionnaire

A questionnaire was developed to gain a view on the perceptions of top-level executive. It was aimed at discovering their beliefs as to the skills and attributes that they possessed that had assisted in their commercial success.

Questionnaire participants were selected on the basis that they held a Bachelors degree in Engineering and have been successful in the business world. These participants were sourced from the Who's Who In Business database.

In order to maximise the level of response the questionnaire was distributed by both email and regular mail. Figure 3.2 depicts a breakdown of the questionnaires sent out.

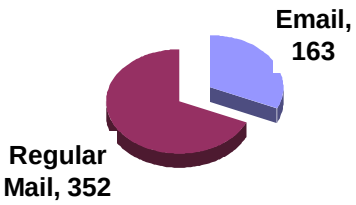


**Figure 3. 2: Questionnaire distribution type**

The questionnaire is attached at annex B. The two questionnaires attached were both used – the one being more suitable for email than the other. This aided to provide a differential between the two that may have allowed any particular trend or bias to be detected.

As shown in figure 3.2, a total of 515 questionnaires were sent out to individual engineers. There were 13 responses by email and 39 through regular mail. This represents a response rate of 8% electronically and 11 % in hardcopy.

The responses were analysed by calculating the results of the responses by the number, average and spread of those responses.

## 3.7 Database analysis

During preliminary searches for sources of information Crown Content's *Who's Who in Business in Australia* was discovered. An investigation of this database showed it to be ideal for much of the background research needed in this research project. It contains a comprehensive list of thousands of individuals in business in Australia as well as details of Australian companies.

It lists details of individuals including their educational background, career descriptions and current contact addresses. As such it was ideal for identifying and locating individuals of interest for the questionnaire.

More than that, it is a resource for providing information regarding the background of high level executives and their profiles. Although this data appears to be offered as provided by the individual or open sources it does allow extraction of important information if handled with the requisite care.

The information extracted from the database is discussed in chapter 5.

## 3.8 Collation of results

Results from all sources were collated in an attempt to provide a comparison across the issues. By comparing results obtained form one source, a level of validation and verification is achieved to support the findings.

## 3.9 Qualitative analysis

The qualitative analysis stage of this project consists of a discussion of the findings from the research. The results from the questionnaire were combined with the information obtained in the literature review and other sources in order to provide a picture engineers in management.

This was completed on the basis of previous research, the opinions of people with a engineering background in high level management positions and my own limited personal experience.

## 3.10 Quantitative analysis

Quantitative analysis was conducted where possible based on the results of the questionnaire and database searches.

The percentage of support in for each attribute and the range of that support formed the basis of the statistical analysis applied to the questionnaire.

The results of database searches were also analysed statistically. These analyses are presented in the relevant chapters – in particular chapters 5 and 6.

## 3.11 Career model

In order to provide a framework with which to describe the generic progression of a typical engineers career a model was developed from the findings. This model was designed to reflect the major features of an engineer's career, and link them to the skills and attributes required of a CEO in such a way as to help describe and develop the implications this project has on education and training regimes.

## 3.12 Implications for training

Having determined the skills and attributes required of a CEO, they needed to be compared against the current training regime in order to determine how education can be improved.

This comparison was conducted in stages to reflect the different skills and attributes required for a successful engineering career in management in line with the questionnaire findings.

## 3.13 Conclusion

This chapter has briefly presented the methodology used in the conduct of this research project. A more detailed description of the process used was not considered to add value as the various chapters reveal the detail of how the project progressed.

Essentially by using a literature review to present current thinking; a database interrogation to provide data on existing high level manager / engineers; and a questionnaire to assess the perceptions of those manager / engineers a range of information was used to evaluate engineers careers.

# Chapter 4

# Review of current education and training

## 4.1 Introduction

The purpose of this chapter is to very quickly review current education and training in order to clarify the current available learning environments. It is not intended to be an in depth study of the topic. That would be outside the scope of this project. The chapter will simply scan some of the education and training avenues that are currently available to engineers. This will include short discussions on the types of training available that an engineer, or indeed a member of any profession, may experience during his or her career.

## 4.2 National Training Framework

The National Training Framework is the Australian system of vocational education and training that applies nationally and is managed by the Department of Education, Science and Training[1]. It is made up of the Australian Quality Training Framework and nationally endorsed Training Packages.

The Australian Quality Training Framework (AQTF) is the nationally agreed recognition arrangements for the vocational education and training sector. The AQTF is based on a quality assured approach to the registration of training organisations seeking to deliver training, assess competency outcomes and issue Australian Qualifications Framework qualifications and / or Statements of Attainment and ensures the recognition of training providers and the Australian Qualifications Framework qualifications and Statements of Attainment they issue, across Australia.[2]

[1] Recent name change / restructure – was the Australian National Training Authority (ANTA).
[2] As per the definition of AQTF

Essentially the AQF provides a framework for recognised qualifications in Australia by setting agreed hierarchical layers of qualifications from Level 1 Certificates (Cert I) through to doctorates. Bachelor degrees fit towards the higher end within this scale.

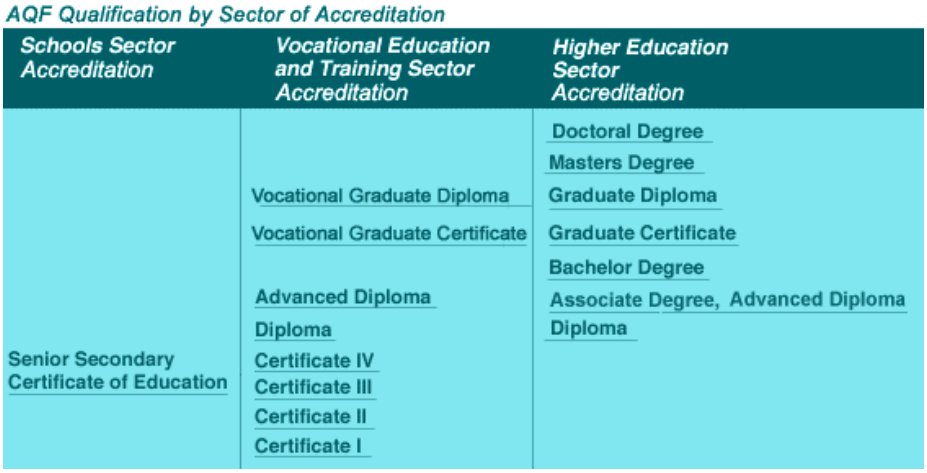


**Figure 4.1: Australian Qualification Framework**[3]

These qualifications are often used (rightly or wrongly) by employers to give a basic assessment of at what level they can expect to begin employment within the organisation. This is obviously combined with the experience and ability of the individual, but employers are often attracted to those with 'higher' qualifications.

Thus it is of benefit to the individual to pursue further studies on the completion of an engineering degree. Particularly for those who wish to move into the upper levels of management, a higher degree is beneficial. Normally this would be a Masters degree such as a Masters of Business Administration or similar. As will be discussed later in this dissertation, the results of the research, backed by the literature, support this assertion.

## 4.3 'Low level' qualifications and vocational training

There is a wide range of training available that fits within the AQF at levels below that of an engineering degree. This type of qualification includes certificates and diplomas that are recognised within the AQTF.

[3] Table taken from www.aqf.edu.au/aqfqual.htm

An alternative to gaining recognised qualifications to develop skills via vocational training. Vocational education and training is education and training designed to develop occupational competency by providing people with work related knowledge and skills.

This training is conducted by a number of institutions including employers themselves and may or may not be recognised within the AQTF. It covers an extremely wide range of training that can be directly or indirectly related to an individual's job. Some examples include:

a. Occupational Health and Safety courses;

b. (Workplace) First Aid Training;

c. Equity and Diversity Awareness;

d. Auditing Familiarisation;

e. Certificate courses such as Certificate IV in Complex Procurement;

f. Technical courses such as those taught in the various TAFE schools.

Many of these relate directly to engineers. This includes trades and other technical courses. A number of engineering students may already possess qualifications of these types before commencing an engineering degree at university. This is particularly true of mature age and 'distance' students.

Although not strictly necessary in order to become an engineer these types of courses can provide valuable experience in specialist technical areas.

As can be seen in the previous examples these courses are not restricted to technical trades only. Various qualifications exist that relate to various aspects of management as well. These also are potentially useful to an engineer interested in pursuing management as a career.

Even after the completion of a degree, these courses can be very beneficial to gain specific expertise at a level, and in a subject, not necessarily offered at a university.

## 4.4 Undergraduate studies

These are self-explanatory in terms of the framework for this project. However, it should be recognised that not all engineering degrees are the same. Apart form the obvious differences in the major courses of studies and the detail of the courses, some universities place different emphasis on aspects of engineering. For example, some universities focus mainly on theoretical studies, others on the practical side of engineering. Still others concentrate on 'well-rounded' studies that include more management and other non-technical components than other universities.

Also, for the individual student (or potential student), just the name of the university may become important in the future. Rightly or wrongly, some employers are attracted to students from more prestigious universities. This may influence the opportunities available for advancement. Whether or not this is a significant factor is outside the scope and will not be investigated in this project.

For these, and many other reasons, the undergraduate course are not all the same – some may be better than others in producing engineers prepared for management. Appendix E gives a short list of the management type courses included in engineering courses at various engineering institutions. It is a rather subjective list as explained in the appendix and it does not necessarily mean that a university offering more management courses will produce better managers.

## 4.5 Post-graduate studies

Post-graduate studies include all those courses available that are recognised under the AQF as having a Bachelors level degree as a prerequisite. This covers an extremely wide range of studies and typically the type of undergraduate degree does not restrict

the field in which further studies can be carried out. These courses include post-graduate diplomas, masters' degrees and PhDs.

Traditionally these types of studies have been offered by universities in 'classical' studies. The modern social and work environment has become more demanding however, and other learning institutions are offering these types of qualifications. Some of these institutions are run as businesses fulfilling a perceived need. Others are run by large companies and government in order to train their employees to an appropriate level in-house.

Traditionally the classic courses, most notably a Masters of Business Administration, have been the most desirable and have been perceived as being the most effective in developing a manager's business skills. This was borne out in the research as discussed later. In the current business environment however, recruitment agency appear to be looking for more targeted degrees. That is, masters of management that have a particular industry focus. For example, a Master of Management (Information Technology) may be more desirable in a executive working in the telecommunications industry than a standard MBA.

Therefore, it may be better for an individual to seek a management type masters degree in their specific area of interest. As discussed later, this is not explicitly borne out by the results of the questionnaire. Respondent had a strong preference for an MBA opposed to other degrees. However this is possibly a function of changing social and industry trends as most respondents completed their MBAs a number of years ago. That said, the public recognition and reputation for MBAs is such that they are good options for those people who may not identify with a particular industry or skill set.

Also, although it will not be discussed in this project, it should be noted that MBAs are often rated by the university or institution through which they were completed. MBAs from some schools are highly rated and are significantly more desirable from an employer's perspective (and therefore from a potential employee' perspective as well). Evidence of this is the hugely divergent costs associated with this course between different universities.

## 4.6 On-the-job training

An important complement to all education is on-the-job training and experience. Particularly in the early stages of any career, individuals need to learn the processes of the company for which they work. Even the few people who manage to start their own business need to learn the process and regulations involved with setting it up.

Even a prodigious technical knowledge a graduate or new employee may not necessarily be effective until he or she learns the process in which to apply that knowledge. For example, not knowing or understanding the process and paperwork for getting funding approval for a project can delay the whole thing, even if technically it is ready to go.

## 4.7 Conclusion

This chapter has very briefly looked at the various types of education and training available in order to provide a context for the discussion in subsequent chapters. It is by no means meant to be an exhaustive list of education and training within Australia – that is well outside the scope of this project.

It is expected that most people have a basic understanding of the normal education process in Australia. However, it is important to underline the fact that a lot of education and training is nationally ‘recognised’ and fits into a defined framework. Where possible and applicable, individuals should seek recognised training as it transferable and accepted by other organisations.

Discussions in the following chapters, although not always explicitly stated, generally refer to recognised training and qualifications and training. Other ‘unrecognised’ training is available, particularly in the vocational training sphere. But, as these courses do not usually include transferable skills, they are less attractive to potential employers and not as useful for climbing the career ladder.

# Chapter 5

# Database Findings

## 5.1 Introduction

The intent of this chapter is to outline the findings based on searches of Crown Content's Who's Who in Business in Australia database. By listing those individuals that have achieved success in business the current state of executive and their backgrounds can be determined.

The chapter will cover generic information in the form of database statistics of business people in Australia. While it is recognised that the database is not a complete listing of successful and important business people it had been assumed that it provides a reasonably accurate cross-section of that community. From this some basic statistics and data can be obtained.

## 5.2 Information Available

Only limited information is available from the database. The Who's Who listing of biographical details is necessarily listed and there are difficulties in obtaining data due to the restrictions to access and the flexibility of the system employed – it is not intended to provide the type of data this project wanted to extract.

The biographical data listed for individuals in the database includes:

- Title
- First Name(s)
- Surname
- Work Address

- Email
- Occupation
- Honours and Awards
- Recreations
- Clubs and organisations
- Postnominals (including qualifications)

None of this information is guaranteed to be correct. The details supplied for entry into the database are subject to the integrity and to human error. However, given Crown Content operates the database as a commercial concern, the accuracy has been assumed to be sufficient to derive general trends amongst successful business people within Australia.

One area of deficiencies is that of the addresses supplied. Individuals do change jobs and addresses and as such the work address, residential address and email addresses were not necessarily always correct.

The other major deficiency is that the level of detail is dependent on the individuals supplying the information. The background supplied on some individuals is quite detailed, listing detailed career and education history while for other individuals this history is quite sparse. However, over the number of people in the database it is expected that any trends can still be identified.

For privacy reasons no information that could be used to identify individuals is included in this dissertation. Information was obtained in order to send out questionnaires but this information and all resultant returns have been treated in confidence.

## 5.3 Business sector

The Who's Who enable the identification of the business, and hence business type of the listed engineers. In a general way, this shows how these successful engineers' careers have progressed. That is, if they have achieved success simply by working in an industry that has a technical element applicable to their training, or if the skill sets of these engineers are applicable to management in general – not just technical based industries.

To illustrate this idea for example, it would be expected that a larger percentage of the executives listed would work in the mining industry. And relatively few would work in finance. Table 5.1 identifies the industry sector of all listed engineers that work for companies listed on the Australian Stock Exchange (ASX).

It lists the number of engineers in each industry group and compares it to the percentage of the number of companies listed in that industry group within the ASX. The industry sectors are listed as per the Global Industry Classification Standard. The distribution of companies in the ASX should approximate the number of management executives represented in the Who's Who in Business.

The table shows a similar distribution between the number of engineers and the number of companies in the ASX. As expected there are proportionally more engineers in areas such as mining (materials), than there are mining companies in the ASX. This is a natural result of engineers basing their careers in industries that relate more closely to their chosen fields of study.

The industry sectors where engineers are 'over represented' by greater than 200% are capital goods, semi-conductors and (surprisingly) banks. There is over twice as many successful engineers in management within these groups than there are companies of these types within the ASX. The difference in the proportions for other industry groups is not as large.

**Table 5.1: Industry sector of engineers in management**

| | Engineers in Management | Distribution (%) | Percent of ASX |
|---|---|---|---|
| Automobile & Components | 1 | 0.5% | 0.5% |
| Banks | 4 | 2.1% | 0.8% |
| Capital Goods | 31 | 15.9% | 5.3% |
| Commercial Services & Supplies | 7 | 3.6% | 3.1% |
| Consumer Durables & Apparel | 1 | 0.5% | 1.2% |
| Consumer Services | 1 | 0.5% | 2.3% |
| Diversified Financials | 13 | 6.7% | 8.1% |
| Energy | 24 | 12.3% | 9.6% |
| Food Beverage & Tobacco | 2 | 1.0% | 2.4% |
| Health Care Equipment & Services | 8 | 4.1% | 3.5% |
| Materials | 65 | 33.3% | 28.0% |
| Media | 3 | 1.5% | 2.4% |
| Pharmaceuticals, Biotechnology & Life Sciences | 2 | 1.0% | 4.3% |
| Real Estate | 9 | 4.6% | 5.8% |
| Retailing | 3 | 1.5% | 2.4% |
| Semiconductors & Semiconductor Equipment | 1 | 0.5% | 0.1% |
| Software & Services | 11 | 5.6% | 4.2% |
| Technology Hardware & Equipment | 4 | 2.1% | 1.7% |
| Telecommunication Services | 1 | 0.5% | 1.7% |
| Transportation | 2 | 1.0% | 1.2% |
| Utilities | 2 | 1.0% | 1.5% |
| **Total** | 195 | | 2115 companies |

On the other end of the scale, engineers are under represented by more than 50% in comparison to the distribution of company sectors mainly within the consumer type industries and (again surprisingly) within the telecommunications sector.

Overall though, there is a strong correlation (0.94) between the number of engineers that have achieved success in management within a particular sector and the proportion of companies within that sector. This comparatively even distribution seems to suggest that engineers generally do have management skills that can be applied across all industries.

## 5.4 Title and sex

A review of individuals' titles can give a simplistic overview of what high performing individuals have achieved since gaining an engineering degree. Due to complexities of the searching mechanism the titles of those people with engineering backgrounds only were searched so there is no comparison with the wider business community in this aspect.

Table 5.2 displays a listing of current high performing engineers by title. The total number of occurrences in the table reflect that the title field was left empty in many cases.

**Table 5.2: Questionnaire participant titles**

| Title | |
|---|---|
| Mr | 248 |
| Dr | 35 |
| Prof | 31 |
| Sir | 4 |
| Ms | 1 |
| Mrs | 3 |
| Hon | 4 |
| Cmdre | 1 |
| Maj-Gen | 1 |
| HE Dr Dr | 1 |
| Total | 329 |

The number of engineers who went on to get doctorates or achieve other honours is indicated by this table.

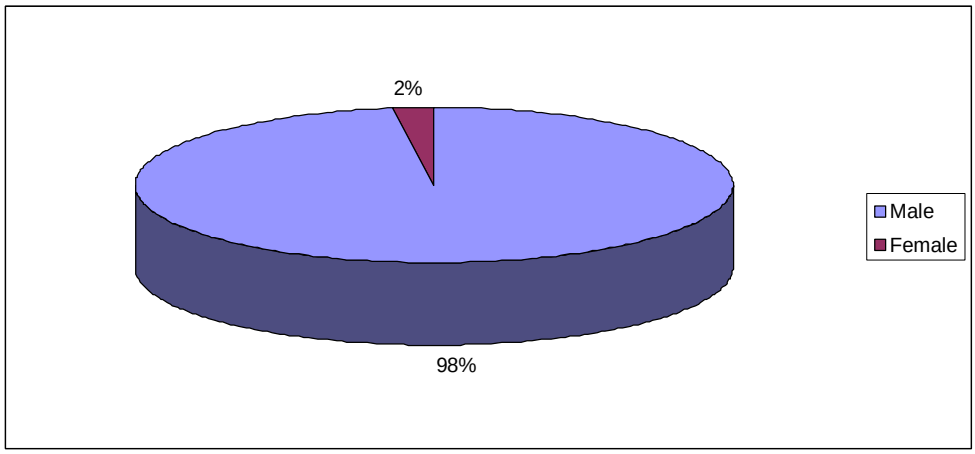


**Figure 5.1: Ratio of males to females**

Figure 5.1 shows the distribution of male to female engineers that have become prominent business people.

The low number of women in high level engineering positions is not indicative of the relative performance between the two groups. There are a number of factors which account for the difference – primarily the relatively low number of women completing engineering degrees, particularly in the period when most of those listed would have been undergraduates.

## 5.5 Location

The current distribution of high performing individuals, especially when related to engineering can give some insight into the industry type and size of the organisation in which that success has been achieved. This information is very generalist, and must be treated with care in attempting to identify any particular trends.

The current distribution of influential engineers by state is shown in table 5.3. It includes all those engineers listed in Crown Contents Who's Who in Business in Australia that had addresses identifiable by state (some did not list address details). Ten people were listed as working overseas – in New Zealand, Britain, United States, Singapore and the United Arab Emirates.

**Table 5.3: Top level engineer managers by state**

| | **Number of Engineer Managers** | **% of Engineer Managers** | **% of Aust. Pop$^{n}$** |
|---|---|---|---|
| NSW | 138 | 32.2% | 34.5% |
| Vic | 132 | 30.8% | 25.5% |
| Qld | 56 | 13.1% | 19.2% |
| ACT | 8 | 1.9% | 1.7% |
| SA | 27 | 6.3% | 7.9% |
| NT | 3 | 0.7% | 1.0% |
| WA | 65 | 15.2% | 10.1% |
| Total | 429 | | |

As would be expected there is a high correlation (0.95) between Australia's population distribution and the location of engineer managers. Possible reasons for variances in the two distributions could include the level and type of business in each state. For example, the number of high performing engineers in Western Australia may be due to the large amount of mining companies in that area in comparison to some of the other states.

## 5.6 Occupation

The setup of the database made extraction of occupational biographical details quite difficult and was not attempted in any detail. Preliminary evidence, backed up by the questionnaire results, indicate that people who have started out studying engineering have had a very wide range of careers. Some have stayed in technical positions for extended periods, others have never worked in a technical engineering role. Some have worked in finance roles, others in recruitment. Some have started their own business, some have had many employers and still others worked loyally at the same company for many years in order to achieve success.

To get a mention in the database, the listed individuals do not necessarily work directly in management. Some academics, politicians and military officers (amongst other career groups) were included. These were removed from data sets used in this study as these career types have different career progression models and/or skill sets than the managers being investigated in this study.

## 5.7 Honours and awards

It is interesting to note the honours and awards that some of the individuals listed in the database have in common. Given the high profile and influence of many of the database entries it is not surprising that many have received awards at some point. Approximately 20% of the engineers listed have cited some type of award. That is not to say that those not listed have not received awards – they may simply be more modest.

The listed honours and awards cover a very wide range. Some are sporting awards and other areas not related to engineering, business or this study. Many of these awards related to engineering – perhaps reinforcing the views of some put forward in the questionnaire that an engineer needs to be a good engineer before he or she can expect to become a good manager. Other awards do include awards for business related activities and 51 individuals received Centenary Medals in 2003.

## 5.8 Recreations and clubs

Although details such as the recreations and clubs that CEOs participate in may not immediately appear to be beneficial, they can provide some useful insight into the character of individuals who achieve this level of success. The communication and interpersonal skills of people who participate actively in 'outside' interests are likely to be better, in general, than those who do not.

Although not a true indication as many individuals listed may be heavily involved in outside interests that they did not list approximately 60% did list involvement with a committee, recreation or club. The range was large as would be expected - from sport to charitable organisations to professional organisations. It needs to be mentioned that some listed activities were as simple as 'golf', which many would say does not equate to an outside interest that could possibly develop character or communication skills.

Studies have shown, and anecdotal evidence supports this, that team activities, in particular sport, are quite good at developing leadership skills. There appears to be a correlation between team sports and leadership qualities. Does the evidence support this in regard to these CEOs and other high level managers? It is impossible to tell by the level of information in the database. It is suspected that most individuals would not have listed sporting interests. And, at their average age, sport is more likely to have contributed to their early development but has since dropped away.

## 5.9 Post-nominals (including qualifications)

The post-nominals listed in the database are the most useful for deriving meaningful information that can used for the purposes of this research. That is because it is in this filed that the higher education qualifications are listed. That is, post-nominals such as BE (Mech) or BBus. Affiliations with professional bodies, such as MIEAust, are also listed.

Table 5.4 show the post-nominals of 501 engineers listed in the database. It shows some of the additional qualifications that these engineers have gained and their membership of some professional associations. The list is not an exhaustive one – some engineers have other qualifications and post-nominals than those listed in the table. Likewise, some of the individuals have more than one of these qualifications or professional associations listed. As with much of the other data from the database, it is not likely to be a complete list – some individuals my not have all their details listed. However it does give an indication of common attributes that may have contributed to these individuals' success.

**Table 5.4: Postnominals of participants**

| Post-nominal | No of Occurences | Percentage of Total in Data |
|---|---|---|
| LLB | 5 | 1.0% |
| MBA | 108 | 21.6% |
| BSc | 33 | 6.6% |
| PhD | 73 | 14.6% |
| MIEAust | 17 | 3.4% |
| MAICD | 11 | 2.2% |
| FAIM | 45 | 9.0% |
| FTSE | 54 | 10.8% |
| FIEAust | 117 | 23.4% |
| CPEng | 37 | 7.4% |
| CEng | 9 | 1.8% |
| MEngSc | 50 | 10.0% |
| MAusIMM | 15 | 3.0% |
| FAICD | 75 | 15.0% |
| BCom | 17 | 3.4% |
| BE **only** | 146 | 29.1% |

This data in general seems to align with the information received from the questionnaire. However, not too many conclusions can be drawn from this table as it was difficult to include other high level degrees, such as Master of Management, in any real way due to the difference in abbreviations used (and in many cases their ambiguity).

Points of interest include:

a. over 20% have MBAs;

b. over 25% are members if Engineers Australia (MIEAust and FIEAust); and yet,

c. over 29% appear to have no further qualifications at all.

It indicates that while a significant percentage of engineers have found MBAs and memberships of professional organisations helpful in achieving success in management, they are not necessary components of a successful career. A significant proportion of engineers appear to have not needed additional education or training - at least, in a formal manner. It is highly probable that those engineers without apparent further education have completed a number of training courses in-house or otherwise that are of a vocational nature but not necessarily recognised in a formal qualification.

## 5.10 Conclusion

This chapter has briefly summarises some of the data found in Crown Contents Who's Who in Business in Australia database. Although not an exhaustive list, the information found here does give some general indications regarding the factors of success for an engineer pursuing a management career. It also offers collaborating evidence for the data gained through the questionnaire. Thus it helps to validate the findings of the questionnaire.

The findings show that engineers have achieved success in a wide range of industries – not just technically related fields. They have done so via a variety of paths in different states of Australia and with different qualifications. In general these individuals have achieved success not only in management but in engineering and other field as well. They appear to well rounded members of society with outside interests, that overall contribute to modern life.

Some of these issues are discussed further in the chapter dedicated to the implications for training. However, in brief, the information in the database seems to suggest that:

a. an engineering degree is a good basis for a career in a wide range of industries;

b. an MBA is helpful but not essential to a successful management career;

c. membership of professional associations is helpful but not essential to a successful management career;

d. success in engineering (or excellence in another field) may be an indicator of management success; and

e. outside interests that develop communication skills and social interaction ability may possibly be helpful.

# Chapter 6

# Questionnaire Findings

## 6.1 Introduction

This chapter discusses the findings from the questionnaire responses. It looks at the perceptions of CEOs as related to their own success. Although it may be argued that the respondents have a subjective view of themselves and the reasons for their success, these executives are best placed to answer the question of management success. Not only have they achieved success themselves but are in positions that often require the assessment of other managers in important positions.

In particular, as engineers the respondents know the pressures of an engineering career, and more importantly to this study the degree to which their university studies set them up for success. Although individuals do have different views as to the importance of various characteristics, the responses are sufficient to identify a general trend that indicates a generic standard.

The scope of this chapter is to cover the responses to each of the questions that were posed in the questionnaire. It discusses each question individually to identify that information that can assist in defining an engineer's career in some way or the training that is required to produce an effective manger. The implications of this in terms of training requirements are not discussed, as that forms the basis of a later chapter.

The questionnaire and the responses received are shown in detail in tabulated form in annex C. This table was produced directly from the responses received. The data used in this chapter (including that in the various tables) was derived from the data in annex C.

## 6.2 Discipline and management success

Part A of the questionnaire (refer to appendix B) was designed to obtain some general background material on the respondents. The first question was simply to confirm which engineering discipline that they studied.

Any bias based on degree type studied can be identified though the background of the participants.

Although care must be taken in terms of the number of graduates in each discipline Australia wide, there is the possibility that a certain discipline may have more success in business than others. This may be due to a better (wider base) education philosophy associated with that degree or personality types being attracted to that particular discipline over others.

**Table 6.1: Responses by degree**

| Degree | Number Surveyed | % of Total |
|---|---|---|
| BE (Chem) | 11 | 13.4% |
| BE (Civ) | 20 | 24.4% |
| BE (Elect) | 22 | 26.8% |
| BE (Mech) | 19 | 23.2% |
| BE (Mining) | 7 | 8.5% |
| Other | 3 | 3.7% |
| **Total** | 82 | 100.0% |

**Table 6.2: Current roles of respondents**

| Current Position | Number of responses | % of Total |
|---|---|---|
| CEO / Managing Director | 34 | 41.5% |
| Chairman | 14 | 17.1% |
| Other executive manager | 18 | 22.0% |
| Non Executive Director | 7 | 8.5% |
| Technical | 1 | 1.2% |
| Retired | 8 | 9.8% |
| **Total** | 82 | 100.0% |

## 6.3 Time spent in technical and management roles

In order to develop a model of standard engineering degree and to better understand the progression of successful engineers the standard length of time spent in various roles should be understood. This issue was addressed in the questionnaire. The idea was to identify if a general trend exists. That is, have successful engineers spent a similar lengths of time in technical roles before proceeding into management.

The length of time spent in a technical role was expected to vary – some very successful people have elected to never use the technical aspects of their training. For example some engineering graduates moved directly into the business world or even into public life or politics. Note: politicians were excluded from this study as the path to there success was considered to be significantly different to a standard management type career progression and would potentially require different skill sets.

Others have used their technical expertise built up over many years as a springboard into management. This may be considered to be the case for successful academics for example. In some cases, good research or other academic achievements have led people into management style careers. However, for the purpose of this study academics (at least those that could easily be identified) were excluded form this study as the focus here is on management in business.

The tables below show the time spent in technical and management type roles.

**Table 6.3: Years spent in technical roles**

| Years in technical role | Number of responses | % of Total |
|---|---|---|
| Nil | 4 | 4.9% |
| 1-5 years | 40 | 48.8% |
| 6-10 years | 24 | 29.3% |
| 11-19 years | 14 | 17.1% |
| 20+ years | 2 | 2.4% |
| **Total** | 84 | 100% |

Overall, the average time spent in a technical role before moving into management was found to be 6.6 years for all those surveyed. This spanned responses from individuals who spent no time in technical positions up to two respondents who spent 20 years in technical positions before moving into management.

**Table 6.4: Years spent in management roles**

| Years in management role | Number of responses | % of Total |
|---|---|---|
| Nil | 0 | 0.0% |
| 1-10 years | 9 | 11.3% |
| 11-20 years | 24 | 30.0% |
| 21-30 years | 30 | 37.5% |
| 31-40 years | 15 | 18.8% |
| 41+ years | 2 | 2.5% |
| **Total** | 80 | 100% |

Table 6.3 above simply shows the level of experience of those who replied to the questionnaire. After spending an average of six years in technical roles, the respondents have spent an average of 22.5 years in management. This was bounded by a range of 3 to 45 years in management roles.

## 6.4 Motivation

Everyone has their own reasons for pursuing a career and the own motivations for success. Although this study did not attempt to identify reasons and motivations for choosing careers type, it is important that the basic reason for moving into management are considered. This can relate to the personality profiles of individuals who achieve success – it relates to how ambitious someone is, and whether success comes naturally.

As stated, detailed reasons and motivations for career choices is beyond the scope of this study. It is an area more applicable to psychologist and those interested in personality profiles. Although there is potential relevance to an individual's success in the business world, any meaningful study could need to be conducted by a suitably qualified expert.

For the purposes of this study, it is considered that the motivations of engineers are similar for most graduates. This is based on the choice of engineering in the first place being an identifier of similar motivations and basic personality types. Research (Wood and Vilkinas, 2006) validates this supposition.

Despite this many of the characteristics and attributes investigated in this study are personality related. However these relate to issues of management competence and training requirements and do not necessarily reflect the nuances of the deeper psyche.

The motivation for the move into management was only questioned in a very simple manner. Particularly in the questionnaire sent electronically, the reason for going into management rather than pursuing a technical based degree was fairly clear cut. The choices offered to respondents were:

a. always wanted a career in management,

b. management offered only promotion opportunity,

c. wanted to move away from technical positions,

d. it was just a natural career progression,

e. had an offer too good to ignore, or

f. other.

Table 6.4 below shows the responses received to this question. Written replies were assigned to on of the categories above based on best fit.

**Table 6.5: Reasons for the move into management**

| Reason for move into management | Number of responses | % of Total |
|---|---|---|
| Always wanted management | 20 | 24.4% |
| Only promotion available | 4 | 4.9% |
| Avoiding technical career | 3 | 3.7% |
| Natural career progression | 46 | 56.1% |
| Good offer to move to management | 2 | 2.4% |
| Other reasons | 7 | 8.5% |
| **Total** | 82 | 100.0% |

While the motivation for the move into management was not a major focus of this project it gives some idea as to the personalities of these engineers that have succeeded in business. The majority believe that they reached their positions naturally through a normal career progression. That is, they did not actively chase management, but their individual skills were recognised as being of the requisite standard to progress to higher levels of management.

## 6.5 Qualifications of current high level executives

Participants to the questionnaire were asked to list the qualification that they hold. The purpose of this question was to determine common qualifications as this could indicate the type and level of training most beneficial to high level executives.

A comparison to these results is provided from the detail extracted from the Crown Content Who's Who in Business in Australia database. These results are discussed separately in chapter 5. However they do provide a comparison to the qualifications held specifically by engineers.

**Table 6.6: Qualifications of engineers in management**

| Qualification | No of Occurrences | % of Total |
|---|---|---|
| MBA | 24 | 29.3% |
| Other Management Masters | 16 | 19.5% |
| Higher technical qualification | 16 | 19.5% |
| Management Diploma | 18 | 22.0% |
| Technical Diploma | 6 | 7.3% |
| PhD | 7 | 8.5% |
| No other quals | 16 | 19.5% |

## 6.6 Skills and attributes of a CEO

Section B of the questionnaire listed a number of skills and attributes various studies and individuals have suggested as being important to succeed in management. It seeks to find the perceptions of CEOs as to the qualities that have led to their particular career paths. Further it identifies whether or not formal training is beneficial in the personal development of the individual.

The tables below scores these attributes on a scale of one to ten – one being the least important, ten the most. The score is taken as an average of all the responses. The percentage of respondents who suggest that formal training is required is also listed in the table. Table 6.7 is arranged in the perceived level of importance of each attribute and table 6.7 in order of the number or respondents suggesting that training is required.

These two tables demonstrate that there is no correlation between the importance of an attribute and whether or not training is required. The correlation coefficient is calculated to be -0.05. However, there are reasons for this lack of cohesion between the data. Many of the attributes listed represent personality traits or other factors for which formal training would not be appropriate.

**Table 6.7: Importance of individual attributes and suggested requirement for training**

| Skill / Attribute | Importance - Average Response | % Respondents Suggesting Training Required |
|---|---|---|
| Leadership | 8.96 | 55.00% |
| Business Acumen | 8.51 | 50.00% |
| Integrity | 9.52 | 7.50% |
| Administrative Ability | 6.24 | 31.65% |
| Energy / Passion | 8.49 | 3.80% |
| Strategic Planning | 8.07 | 67.50% |
| HR Management | 7.07 | 50.63% |
| Multi-company experience | 5.78 | 2.63% |
| Financial management | 7.81 | 88.75% |
| Team player | 7.99 | 18.75% |
| Disciplinary knowledge | 5.73 | 38.16% |
| Mentor | 6.28 | 6.49% |
| Achievement orientation | 8.33 | 7.59% |
| Self Awareness | 8.14 | 23.08% |
| Project Management | 7.02 | 65.82% |
| Interpersonal Skills | 8.72 | 41.25% |
| Drive / Ambition | 8.70 | 2.50% |
| Emotional Intelligence | 8.00 | 20.51% |
| International Experience | 5.99 | 7.59% |
| Planning ability | 7.23 | 41.25% |
| Communication Ability | 8.80 | 61.25% |
| Entrepreneurial ability | 7.12 | 13.75% |
| Decisiveness | 8.51 | 13.75% |
| Technical competence | 6.70 | 64.56% |
| Analytical / reasoning skills | 8.39 | 45.00% |
| Initiative | 8.62 | 6.25% |
| Conceptual skills | 7.90 | 12.50% |
| Sales / Marketing ability | 6.28 | 47.76% |
| Handle complexity | 8.79 | 11.94% |

This lack of meaning of the correlation coefficient can be investigated by removing those attributes from which formal education or training would not be effective or appropriate. That is removing some of the measured attributes such as initiative, ambition and international experience.

Table 6.8 shows the relationship between importance and the need for formal training once these attributes have been removed. It must be noted that some of these attributes are subject in term of whether or not training can be effective or appropriate.

For instance, leadership has been removed because it is more of a character trait than something that can be taught. This is a subject of some debate by leadership theorists and outside the scope of this study. However, while the author believes leadership can be taught to a limited extent, it is extremely difficult to do in a structured classroom environment. Leadership training requires a mixture of theory, practical experience and group and individual feedback in order to be successful.

**Table 6.8: Teachable attributes**

| Skill / Attribute | Importance - Average Response | % Respondents Suggesting Training Required |
|---|---|---|
| Leadership | 8.96 | 55.00% |
| Strategic planning | 8.07 | 67.50% |
| Financial management | 7.81 | 88.75% |
| Project management | 7.02 | 65.82% |
| Communication Ability | 8.80 | 61.25% |
| Technical competence | 6.70 | 64.56% |
| HR Management | 7.07 | 50.63% |
| Business Acumen | 8.51 | 50.00% |
| Adminstrative Ability | 6.24 | 31.65% |
| Analytical / reasoning skills | 8.39 | 45.00% |
| Sales / Marketing ability | 6.28 | 47.76% |

Table 6.8 has a correlation of -0.08 between the perceived importance of an attribute and the requirement for training in that attribute. This shows that the importance of a skill or attribute is not related to the need for training in that skill – at least in terms of the average perception of respondents.

Skills and training may or may not be important but that does not necessarily give an insight into whether or not further training is required based in this data. This was not an unexpected result in general. Most personality aspects cannot realistically be taught in a normal education environment – they rely too heavily on life experience and other outside factors.

What is surprising is that those skills suitable for a higher educational learning environment - such as financial skills and management skills – do not have a higher correlation when considered in this manner.

## 6.7 Training Type

There are multiple methods of conducting education and training. In order to develop a useful training continuum it is important not only to understand the focus of the training to be conducted but also the level of that education or training.

The most obvious, given the subject of engineering graduates, is university education but other options are available and may be more appropriate. In some cases vocational or on-the-job-training may be better suited to improving that particular characteristic.

Table 6.9 below shows the view of questionnaire respondents. For various attributes, respondents indicated what type of training should occur to assist an engineer's career. It shows by attribute, what type of training is most appropriate. The table records the number of responses that recommend that particular type of training and the percentage that that number represents for that attribute.

**Table 6.9: Types of training suggested for attributes**

| | On-the-Job Training | Vocational Training | Formal Qualification | Other | Nil (or no response) |
|---|---|---|---|---|---|
| Leadership | 54.9% | 30.5% | 12.2% | 4.9% | 3.7% |
| Strategic planning | 28.0% | 42.7% | 28.0% | 0.0% | 3.7% |
| Financial management | 11.0% | 31.7% | 59.8% | 0.0% | 4.9% |
| Project management | 30.5% | 39.0% | 34.1% | 0.0% | 6.1% |
| Legal awareness | 47.6% | 34.1% | 17.1% | 1.2% | 2.4% |
| Communication skills | 37.8% | 52.4% | 13.4% | 0.0% | 4.9% |
| Further technical skills | 26.8% | 30.5% | 28.0% | 1.2% | 18.3% |
| Change management | 57.3% | 26.8% | 9.8% | 0.0% | 9.8% |
| Economics | 24.4% | 28.0% | 39.0% | 2.4% | 11.0% |
| HR management | 51.2% | 34.1% | 14.6% | 0.0% | 8.5% |
| Logistics / supply chain | 62.2% | 18.3% | 8.5% | 0.0% | 13.4% |
| Information management | 52.4% | 29.3% | 12.2% | 1.2% | 8.5% |
| Business acumen | 57.3% | 22.0% | 12.2% | 1.2% | 13.4% |
| Administration | 68.3% | 14.6% | 6.1% | 0.0% | 12.2% |
| Analytical / reasoning skills | 34.1% | 30.5% | 25.6% | 3.7% | 12.2% |
| Sales / marketing | 50.0% | 37.8% | 7.3% | 0.0% | 8.5% |
| Accounting skills | 28.0% | 39.0% | 36.6% | 0.0% | 6.1% |

Those responses indicating a mentor would be the best solution were added to the on-the-job responses as the most similar to the hard copy mailed responses.

## 6.8 Training versus stage of career

In addition to identifying the type of training that engineers require for their career it is also important to identify at what stage of an individuals career that training is required to be given.

Some learning is more beneficial if taught at an undergraduate level whereby the individual has the opportunity to learn the details in depth and then build on that knowledge (or developed characteristic) through experience in the workforce. Technical skills is the most obvious example, but attributes such as communication ability is best developed at university so that the individual can gain confidence initially, then continue to develop the skill throughout a career. The same can be said for most skills and attributes that can be classes as 'life-skills' that generally develop naturally through human experience.

On the other hand, some other skills and attributes perish over time. Therefore, it is likely to be optimal if that training / skill development occurs close to the time that it is likely to be used. An example might be legal awareness or strategic planning. A university course in legal studies is not likely to be useful to an engineer that is several years away from requiring that knowledge. He or she is not likely to recall the detail and the law may have changed in that time. It is, of course, dependant on the position that the individual goes into – some graduates may begin their careers in positions that have immediate need of legal knowledge. (Some patent office type roles may be an example of this.

Other skills and attributes cannot be taught or only with great difficulty. Personal characteristics are more a result of an individual's environment rather than something that can be 'taught'. Some, like leadership, are debateable and subject to further

research around the world. University style learning is unlikely to effective teach these types of skills.

Table 6.10 below shows the number of questionnaire respondents who suggest when training should occur for a list of skills, related to generic stages of an engineer's career.

**Table 6.10 : Career stage suggested for attribute training**

| | At university | In a technical role | In junior management | In mid-management | In senior management | Nil (or no response) |
|---|---|---|---|---|---|---|
| Leadership | 9.8% | 35.4% | 54.9% | 23.2% | 11.0% | 4.9% |
| Strategic planning | 9.8% | 15.9% | 46.3% | 23.2% | 6.1% | 6.1% |
| Financial management | 26.8% | 32.9% | 39.0% | 14.6% | 2.4% | 6.1% |
| Project management | 28.0% | 43.9% | 30.5% | 4.9% | 0.0% | 8.5% |
| Legal awareness | 9.8% | 15.9% | 58.5% | 19.5% | 7.3% | 4.9% |
| Communication skills | 28.0% | 56.1% | 29.3% | 14.6% | 9.8% | 6.1% |
| Further technical skills | 12.2% | 52.4% | 22.0% | 3.7% | 0.0% | 19.5% |
| Change management | 2.4% | 8.5% | 70.7% | 18.3% | 6.1% | 11.0% |
| Economics | 26.8% | 17.1% | 29.3% | 15.9% | 2.4% | 15.9% |
| HR management | 7.3% | 20.7% | 57.3% | 14.6% | 2.4% | 12.2% |
| Logistics / supply chain | 4.9% | 22.0% | 53.7% | 9.8% | 2.4% | 17.1% |
| Information management | 18.3% | 31.7% | 45.1% | 8.5% | 2.4% | 9.8% |
| Business acumen | 9.8% | 24.4% | 53.7% | 19.5% | 6.1% | 13.4% |
| Administration | 8.5% | 43.9% | 39.0% | 8.5% | 2.4% | 14.6% |
| Analytical / reasoning skills | 34.1% | 42.7% | 20.7% | 3.7% | 2.4% | 15.9% |
| Sales / marketing | 7.3% | 26.8% | 48.8% | 18.3% | 1.2% | 9.8% |
| Accounting skills | 28.0% | 24.4% | 46.3% | 8.5% | 1.2% | 9.8% |

As table 6.10 shows, there appears to be distinctive trends as to when training for various characteristics should occur. Some skills are believed to be most beneficial at university, others after graduation in either technical or junior management roles.

In general, it appears that training later in a career is not thought to be as useful – by that stage a managers experience might be expected to have provided the requisite skills (when combined with earlier training) to be effective and efficient the roles to which they are assigned.

## 6.9 General qualifications and affiliations

Respondent were also asked to indicate if further common qualifications and affiliations are required to assist with the progression to CEO. These were kept simple and generic and are tabulated in table 6.11.

Responses that indicated the relevant sections were helpful were included as a 'Yes'. However across the results, many indicated that the qualifications and affiliations are always helpful but not necessarily 'required'.

**Table 6.11: Need for qualifications and affiliations**

| | Is Qualification / Affiliation required? | | | | | |
|---|---|---|---|---|---|---|
| | Yes | | No | | Undecided | |
| MBA | 41 | 51.9% | 28 | 35.4% | 10 | 12.7% |
| Post-graduate technical degree | 11 | 13.9% | 63 | 79.7% | 5 | 6.3% |
| Other higher degree | 18 | 22.8% | 50 | 63.3% | 11 | 13.9% |
| Membership IEAust | 21 | 26.6% | 52 | 65.8% | 6 | 7.6% |
| Other Professional Bodies | 20 | 25.3% | 48 | 60.8% | 11 | 13.9% |

Responses demonstrate that an MBA is a highly desirable qualification for individual to have if they wish to pursue careers in management. While there is certainly some support for other qualifications and for membership of professional bodies, the majority believe that these are not necessary.

This does not mean that an MBA is essential, or that other degrees or affiliations are not helpful in the pursuit of a successful career. A number of respondents do not have MBAs or other types of degrees. As outlined in section 6.2, only around 35% of the respondents actually have MBAs despite over 59% of them recommending the qualification to reach high level management.

Likewise, other degrees may not be essential for success but they certainly could be helpful. Several participants of the study commented that the pursuit of knowledge or life-long learning was important. Several others pointed out that they had completed a number of courses that were helpful but did not necessarily lead to a qualification.

Membership of professional bodies was also not considered essential for promotion. Once again though, depending on the circumstances of the individual, these memberships may be very valuable in networking and becoming ‘known’ in the industry.

## 6.10 General comments from participants

Questionnaire participants were also asked to make any general comments that they cared to on the topic of engineers in management. Most of the participants did make some short comments outlining their beliefs of why they had been successful and the attributes new engineers needed to develop in order to achieve similar success. These comments are included within annex C in an edited format.

Some general themes can be derived from these comments. These include:

- Engineering is good for the analytical skills required in higher levels of management.
- Leadership is very important and need to be developed.
- Communication and interpersonal skills are a weakness for junior engineers and need to be developed.
- Financial training is a very important management skill.
- Engineers need to be good at the technical skills in order to start the progression up the career chain.

## 6.11 Conclusion

This chapter has outlined the basic findings from the questionnaire. The number of responses while being only a fairly small percentage (less than 20%) of the questionnaires sent out is enough to give a fair indication of the perceptions of current business leaders that have engineering backgrounds.

The data that has been extracted from the questionnaire responses is enough to give a good indication of the perceptions of current engineers that have had a high degree of managerial success. These engineers have the benefit of experience and hindsight from their own careers and should be considered ‘subject matter experts’ in regards to engineers in management roles. There is sufficient cohesion within their responses to develop some understanding of the implications for the training of engineers. This will be discussed in subsequent chapters.

# Chapter 7

# Proposed model and training continuum

## 7.1 Introduction

The purpose of this chapter is to propose a model of the career of a standard engineer that moves into management. It seeks to provide a guide to the success of engineers who have reached important roles in management. This will enable engineer to plan their career in such a way that the skills required for management are developed at the most effective stage of their career and thus maximise their individual chance of promotion and success.

The subsequent chapter will also use the proposed model to suggest how education and training in universities and other institutions can be most effectively organised to assist engineers that foresee a management style, rather than technical, career. The intent of this chapter is simply to outline a model based on the career profiles of current successful engineers.

## 7.2 Proposed career model

Career progression consists of a series of steps up a promotion ladder. At each stage a certain level of competence must be shown and a certain potential to be effective at the next level must also be visible to those who do the promoting. Both of these factors require certain skills and attributes, without which the individual will either not be competent enough in the present role or will not be seen to have further potential.

Through the questionnaire results, and what has been found in other studies, there are a number of skills and attributes that have been suggested as highly desirable at

various stages of an engineer's career. These stages can logically be divided into the following:

a. undergraduate,

b. junior technical role,

c. senior technical role,

d. junior management role,

e. mid-management role, and

f. senior management role.

Although these stages may represent a standard career structure, they by no means cover all career paths. For example a new graduate may avoid technical roles altogether; or a senior technical engineer may move directly to a mid-management role. However, these stages are proposed as a basic structure around which a normal student or recent graduate can plan his or her career progression.

At each stage, an engineer will only progress if they have the right skills and attributes not only of their present job but also seen to have those of the next stage as well. These skills, or lack thereof, thus form a barrier for promotion to the next level.

Experience and natural talent may well overcome these barriers in many cases, but to maximise career opportunities an engineer can take steps to improve his or her skills and attributes in the required area in order to 'break through' the next barrier and get that promotion.

The model proposed then, is a series of sieves. Each sieve forms a barrier that will prevent an individual from moving to the next level in management. Each sieve then represents the skills and attributes to make that jump. At every level only some make

it through, until at the final sieve only the select few make it to the CEO type positions.

Education and training at appropriate junctions along an engineer's career path enlarge the holes in the barriers preventing further advancement. Larger holes in these barriers reflect a better chance of making the next step in the promotion ladder. Likewise self-development activities, particularly related to personality characteristics can further increase the size of these holes.

An individual with the requisite personality characteristics may already have quite large 'holes'; however, these can be made larger by education and training. Likewise an individual that does not have the necessary skills can create these opportunities or 'holes' by reflection on their personal strengths and weaknesses.

This is where guidance is required on skills and attributes needed at each stage of an engineer's career.

### 7.2.1 At university

The questionnaire revealed that current successful engineers believe the top five skills that should be learnt during university studies in order to be successful in management are:

a. accounting skill;

b. analytical / reasoning skills;

c. economics;

d. financial management; and

e. project management.

Despite the apparent emphasis on financial type skills, incorporating these type of courses into an undergraduates study program in not necessarily recommended unless the individual is certain of his or her intent to move straight into management. The is due to the fact that most engineers seem to spend about six years in a technical role before moving into management. In these roles it is expected that there is relatively little involvement with the financial side of the business. Also these skills are likely to degrade over time, so it may be more appropriate to learn these types of skills in later stages of a career.

Analytical / reasoning skills are likely to be important for most engineers and eventually to all who desire a move into areas of high level management. Hence these types of courses should be embraced where possible.

Project management type course are offered by some universities as part of their undergraduate engineering programs. It is recommended as a starting point for further management studies. Many of the principles of project management are neede dearly in an engineer's career, and can be translated effectively later on, into wider areas of management. Systems engineering has similar characteristics to project management and is considered to be potentially helpful where project management courses are not available.

The importance of communication and interpersonal skills were frequently highlighted both in questionnaire responses and in the literature. Although not strongly suggested by respondents as an appropriate skill to develop at university, it is something that requires practise in order to develop effectively. University offers an ideal environment to develop interaction skills, and perhaps where applicable breaking the introvert type tendencies an individual may have had at high school.

### 7.2.2 In technical roles

In technical roles, assumed to be the initial stage of a career at the completion of university, it is important to note that an individual needs to be recognised as performing effectively in whatever role he or she occupies in order to be considered

for promotion. As responses to the questionnaire mention it is important to be recognised as a good engineer – a good manager needs to be a good engineer first (if moving through a technical role), although a good engineer does not necessarily make a good manager.

Therefore, it is likely to be of benefit to pursue further technical education and / or training within the specific field within which the engineer is working. The aim of this additional training is to make that engineer more effective in their job – hence, making them more eligible (and visible) for promotion and other opportunities. This training would normally be of the form of diploma or certificates, either offered through in house training in large organisations, or through other technical learning institutions.

Project management skills, if not taught during the undergraduate program are likely to be of value in this stage f a career as well. Recognised accreditation through the Australian Institute of Project Management may be appropriate for some engineers. Otherwise diplomas of project management are available through a number of learning organisations.

Other skills that responses to the questionnaire indicate as being very important while in a technical role are administration and communication skills. In general these do not need formal training or qualifications. Administrative skills are likely to be learnt via mean of on-the-job training or experience (or possibly in-house courses) – especially as these skills can be specific to an organisation. Communication and personal interaction skills are a part of lifelong learning and should be continued to be developed.

### 7.2.3 In junior management

Questionnaire responses indicate that junior management is where a relatively large quantity of training is required in order to effectively produce the required outcomes for that position. This is not surprising, as most engineers are likely to have little

formal training in management up to this point. At this stage of a career, questionnaire respondents suggest the top five skills to be developed are:

a. legal awareness,

b. leadership,

c. strategic planning,

d. financial management, and

e. project management.

These skills can not only be learnt in this stage of a career but should be considered earlier, in the late stages of technical positions in order to best position the engineer for initial success in management.

Leadership is difficult to get effective training in, and is often best learnt through experience with good guidance from a mentor or individual at a higher level who can provide constructive feedback.

The other skills, either collectively or individually, can be gained through short courses, in-house training. The most effective training is likely to be a diploma in a financial management or accounting field. Budgeting and control of financial resources is often seen as the most important part of a management job. The emphasis in this stage of a career in terms of training and development is likely to be related to finance. A qualification could be helpful as it is more transferable (to a new employer) than in-house courses are likely to be. A degree or masters in a financial field is not necessary but a diploma level course should be considered.

### 7.2.4 In mid-management

Once in mid-level management an individual could be expected to have already developed many of the skills needed to be effective at this level. This is as true for engineers as for any other profession. The results of the questionnaire bear this out. Although many respondents suggest training at this level, the percentage is significantly lower that that suggesting training during technical and junior management type roles.

The skills required may have been developed through formal learning (that is qualifications or taught skills) or through experience at a lower level. The base skills learnt in 'junior' management might be expected to translate to that higher level – albeit with more of an operational or strategic focus. For some individuals the experience gained in other roles may be enough to develop the requisite skills. Others may need some actual training. Either way, for those who do seek advancement, training is most common way to increase the chance of advancement.

In terms of the personal character attributes an individual needs in this level of management many of these personality traits are likely to be fairly set by this stage of ones life. Psychologists in general appear to believe that a person's character is pretty much set by this stage, and although it can be changed it becomes a difficult task.

Some attributes, such as leadership, can be improved simply through practice. Mid-management is a good opportunity for many people to start to practice these types of skills on a daily basis. While it can be done at a lower level, most jobs do not have the responsibility levels that require these sorts of skills on a daily basis. It needs to be noted too, that skills such as leadership, need the right sort of practice. Bad habits can reinforce bad practice. For this reason suitably experienced (and skilled) mentors can be very effective. Unfortunately good mentors appear to be a very rare resource.

For an engineer, and likely for any degree background, professional development should be focused on rounding off existing skills while in mid-management. This is

likely to include completing a Masters of Management if not completed earlier and getting experience in genuine leadership.

The Masters of Management need not be a MBA. Although a MBA was strongly recommended amongst respondents to the questionnaire, it needs to be taken into context with the careers of those respondents. Most of them completed their studies many years ago, including their MBAs. Evidence seems to suggest that in the current work environment, recruiters are looking not specifically for MBAs, but for individuals who have management qualifications that target industry needs for the particular role being sought.

Thus, a Masters in Management specialising in acquisition (for example) may be of more benefit to a career that a MBA. In today's society where the amount of information available is massive, it may be that specialists to particular industries are required rather than general 'business' managers. This idea is yet to be proven either way. This study did not attempt to identify or confirm this trend.

### 7.2.5 In senior management

By the time an individual reaches senior management, it is likely that most their education and training is behind them. That is not to say that they will not continue to refine their skill – lifelong learning is possibly a habit by this stage – but the requirement for further formal qualification is likely to be reduced.

This assertion is borne out by the questionnaire responses. These responses showed a significant drop in the suggested level of training required between those in mid-management and senior management positions.

### 7.2.6 Summary

The suggested inputs of education and training are summarised in table 7.1.

**Table 7.1: Suggested education and training inputs**

| **Stage: At university** | |
|---|---|
| **Skills** | **Attributes (personality based)** |
| • Financial management<br>• Analytical / reasoning skills<br>• Project management<br>• Systems engineering | • Communication skills (written and oral)<br>• Interpersonal skills |
| **Stage: While in a technical role** | |
| **Skills** | **Attributes (personality based)** |
| • Specific technical skills<br>• Administrative skills<br>• Project management | • Communication skills (written and oral)<br>• Drive and determination<br>• Integrity<br>• Inter-personal skills |
| **Stage 3: In junior management positions** | |
| **Skills** | **Attributes (personality based)** |
| • Legal awareness<br>• Financial management<br>• Personnel management | • Leadership<br>• Communication skills (written and oral) |
| **Stage 4: In mid-management positions** | |
| **Skills** | **Attributes (personality based)** |
| • Masters of Management (MBA etc) | • Leadership |

## 7.3 Validation and verification

Verification of this model is provided from the conduct of the questionnaire. Although the results from the questionnaire were used in development of the model, these results do verify that the model is accurate. The majority of engineers that have been successful and have reached high level management positions have described in the questionnaire those required skills and attributes at the various stages of a career.

Validation of the model can only be achieved in the future by the comparison of current undergraduates' careers to the model itself.

## 7.4 Conclusion

This chapter briefly looks at the results obtained to provide an outline model of a career for a generic engineer. It attempts to highlight the most important attributes required at each stage of an engineer's career and hence suggest at which stage training in that attribute would be most beneficial for the 'standard' engineer.

Although different attributes, and consequently training requirements, are different at various stages of a career there appear to be three main themes which should be developed continuously throughout a career. These are: leadership, communication skills, and to a lesser extent, financial skills. The next chapter will move forward to try and identify the implications this has for training.

# Chapter 8

# Implications for Training

## 8.1 Introduction

This chapter draws on the findings of the questionnaire and other research in order to discuss the implications to education and training for engineers in Australia.

The chapter will look at the skills and attributes investigated by the questionnaire and discuss the optimal way in which to achieve an effective outcome for engineers and their careers. It will not look exhaustively at all the listed skills and attributes but will focus on the general areas identified as being important in order to determine possible generic improvements to education and training.

## 8.2 Relative value of skills and attributes

Chapter 6 presented the responses from the questionnaire and gave a score to each of the skills and attributes. Naturally the most important skills or attributes are those that are likely to have the most important implications for education and training.

Clearly the most important attribute required by CEOs, as identified in the questionnaire is integrity. Integrity had an average importance score of 9.5 compared to the next highest score being 9.07 for leadership. However, unsurprisingly, integrity was not seen a requiring training as it is to a large extent a character trait rather than something that can be ‘taught’.

Table 8.1 below shows the highest importance scores as per the questionnaire with the added criteria of scoring over 7.5 and over 50% of respondents suggesting that some sort of training is required.

**Table 8.1: Highest importance with training required attributes**

| | Importance - Average Response | % Respondents Suggesting Training Required |
|---|---|---|
| **Leadership** | 9.07 | 58.5% |
| **Communication ability** | 8.88 | 66.0% |
| **Business Acumen** | 8.70 | 56.6% |
| **Strategic Planning** | 8.15 | 73.6% |
| **Financial management** | 7.82 | 88.7% |

However, education and training can occur throughout an individual's career. When the importance factors are compared to the suggested stages that training should occur, a pattern or training continuum is suggested.

**Table 8.2: Attributes requiring formal qualifications**

| | |
|---|---|
| Strategic planning | 30.0% |
| Financial management | 70.8% |
| Project management | 31.1% |
| Economics | 41.9% |
| Accounting skills | 40.0% |

Table 8.2 shows those attributes that the questionnaire respondents thought required formal training. The percentage figure shown indicates the number of people who thought training was required – only those greater than 30% are shown.

This is developed further in table 8.3 which shows the questionnaire results in terms of skills that require training at each stage of an engineer's career.

In general, there appears to be four main skill areas that respondents believe engineers would benefit form specific training. These are:

a. Leadership.

b. Communication skills.

c. Financial skills.

d. Problem solving (including analytical reasoning and strategic planning).

**Table 8.3: Important attributes across career stages**

| **At university** | |
|---|---|
| Accounting skills | 35.7% |
| Economics | 32.5% |
| Analytical / reasoning skills | 32.5% |
| Financial management | 30.4% |
| Project management | 26.1% |
| **Technical role** | |
| Communication skills | 59.1% |
| Further technical skills | 56.1% |
| Administration | 56.1% |
| Analytical / reasoning skills | 47.5% |
| Project management | 41.3% |
| **Junior management** | |
| Legal awareness | 59.2% |
| Leadership | 46.7% |
| Strategic planning | 33.3% |
| Financial management | 32.6% |
| Project management | 30.4% |
| **Mid-management** | |
| Strategic planning | 27.1% |
| Leadership | 20.0% |
| Legal awareness | 18.4% |
| Business acumen | 16.3% |
| Change management | 15.9% |
| **Senior Management** | |
| Change management | 4.5% |
| Leadership | 4.4% |
| Strategic planning | 4.2% |
| Legal awareness | 4.1% |
| Business acumen | 2.3% |

Other skill areas are undoubtedly important but these four were consistent held to be very important across questionnaire responses and within the literature. Of these, leadership and communication were thought to be considerably more important.

## 8.3 Leadership

Of all the skills and attributes listed in the questionnaire, leadership was ranked as being the most important for potential managers. Only integrity was considered to be more important, but that is not a skill that can be taught explicitly. It follows then that, if possible, leadership should be developed as much as possible – whether by the learning institution or by the individual.

The nature of leadership does not lead it to be easily taught in a formal course. A major component of that characteristic is experience. Therefore it is likely that individuals would need to actively develop themselves, with support and encouragement from the university, rather than the topic being taught within a particular course.

Leadership is an area of considerable ongoing research. Questions such as: Is it innate, or can it be learnt? Does theory help develop leadership? How do you measure it? – amongst many others, are topics that are being debated and subject to such research. However it is generally agreed that it difficult to each effectively.

The military perhaps lead the way in the development of leadership abilities as it is a vital function of many in those professions. The experience of the military indicates that leadership is best taught through experience with appropriate feedback from personnel with experience in leadership themselves.[1] Leadership theory thus provides a framework on which to base the practical experience of leadership.

This indicates that the development of leadership as a specific outcome of a university course is unlikely to be effective for most participants. Appropriate support and counselling services based on character development are likely to be the most effective method for a university to help students develop leadership. For example, assisting / advising students to become active in extra-curricular activities while at the university or in their personal lives.

## 8.4 Communication skills

The second 'trainable' characteristic that was rated very highly by questionnaire respondents and the literature alike was communication ability. This skill set is something that, unlike leadership, can be positively taught and enhanced in the

[1] This is a personal view of the author who has taught leadership in a military environment. This included lessons on the theory of leadership, the conduct of small group leadership exercises and the ongoing assessment of those involved. Although thought on leadership could be greatly expanded, it is outside the scope of this project.

university environment. Like leadership though, communication is something that can be improved and developed by practice.

Communication ability includes both written and oral skills. Written communication and oral communication skills are normally interpreted as the ability to write well and speak well, being able to clearly express an ones thoughts. However, it is more than that in many subtle ways.

Being able to write a report or give a presentation is not enough. It is harder to write or speak in such a way as to support an argument and convince someone else of a particular point of view. This is a critical skill for success. Individuals need to have the ability to influence others, and this is usually achieved in one way or another through their ability to express ideas effectively.

Further to that, the ability to network with others is a highly important skill. An individual, who may be very good at writing and speaking, may still have difficulties in social situations. As mentioned by a couple of respondents networking and becoming known, is important for advancement. It is an additional component to communication skills that should be developed within engineers, and indeed everybody.

The implication for training in a university environment is therefore, to develop opportunities for practice in as many courses as possible. This should include both written and oral skills. Some suggested methods to develop communication skills within university courses include the following:

a. Report style assignments allocating marks not only for content but for presentation and ‘readability’. They should attempt to encourage logical thinking about the report in terms of what the end-user of that report wants and needs. In particular, this could include expected responses that are ‘outside the box’. That is, sections of a report are not specified in the question but are needed for completeness. For example, a report on the technical aspects of a design may not necessarily include an assessment of the environmental impact –

students would be encouraged to look at the wider implications and expected to come up with the idea themselves.

b. Constructive feedback on presentation and logical layout of written material.

c. Oral presentations where appropriate to develop confidence of speaking in public. This could include impromptu talks to assess student's basic knowledge and ability to think on their feet.

d. Debates, perhaps on design options, in order to encourage / practice convincing others of a point of view. Notably this would be difficult to achieve orally in a class environment giving everyone a turn, but could be used in a written format – for example, to produce a written report arguing the reasons why a 'boss's' preferred design is not optimal.

e. Team assignments, especially where students are forced to work with others outside of their social groups in order to develop group interaction skills. (Although this would be difficult to achieve for distance learning students.)

These methods are being used in many courses already and it is recommended that 'real world' communication styles are encouraged in as many courses as possible. Even so, it should never be at the expense of learning objectives for that particular course.

Communications skills are life-long skills that should be continuously developed. A fact backed up by the research. However, once out of university, there is little opportunity for individuals to get formal learning and feedback regarding their ability to communicate. The development of further skills in this area is likely through experience and living life. This would naturally include not just career activities, but extra-curricular activities as well.

It is therefore important that engineers get a good grounding in communication skills at university in order to position themselves well for later life. These sets of skills were highlighted again and again as being a vital career skill. No matter how intelligent an individual is, or how much knowledge they possess, they are unlikely to achieve success, if they are unable to communicate it. This is particularly true for management.

## 8.5 Financial Management

Financial management skills rated highly in the questionnaire and are perhaps the skills given least emphasis during an engineering degree. Being good at mathematics does not necessarily ensure an understanding of financial statements. Often this is an area that ambushes personnel moving from a technical role to a management role. Money is 'king' in business.

As personal experience attests, the control of money is often the most important, and likely the most reportable, role of a manager at all levels. No training or experience in this domain can make the transition difficult. Although different businesses have their own processes a basic understanding of the flow of money would in many cases be very helpful.[2]

Based on the questionnaire responses it is suggested that financial training be included as part of university engineering programs. It is recognised that this may be difficult to achieve given the already full nature of these courses, but the importance of understanding the financial aspects of a job should not be neglected.

As a minimum, undergraduates should be offered the opportunity to study finance as an elective within the undergraduate program. This is likely to be achievable at many universities by leveraging off existing courses offered by business schools. Although a course designed with engineers in mind would be preferred. A course for engineers

[2] The author recently moved from a 'technical' role into a management position where the control of budgets is considered extremely important. Just reporting on expenditure alone was additional effort for an extended period.

could include an introduction to a variety of topics that within a business school program would be taken as sperate courses.

In the absence of a course offered during a degree, individual engineers should consider pursuing such knowledge themselves. Depending on the individual's job and intended career path a number of different courses may be appropriate. For some a diploma of finance may be enough, others may consider a degree in commerce, or, go straight to a MBA or similar style course.

For institutions, it would be beneficial to support and encourage the development of engineers in these skill types as they are likely to be able to provide value to the organisation at a later date.

## 8.6 Problem solving and strategic planning

Problem solving, analytical thinking and strategic planning can be included together as reasonably similar skills. And, there is a variety of other terms that could be applied to what is essentially an ability to recognise a problem (or potential problem), identify possible solutions, evaluation those options and execute a plan to remove or mitigate that problem.

As identified in the research, problem solving is a core skill of engineers and the undergraduate programs appear to be successful in developing these skills. A number of respondents indicated that the problem solving skills of engineers is generally very good and translates well into management scenarios.

This implies a continued emphasis on these skills is warranted. Problem solving appears to have become more important to undergraduate degrees in recent years – a trend that is supported by perceptions of the need for engineers.

## 8.7 Business acumen

Although not identified as being important as some of the other skills and attributes, some degree of business acumen is essential for those engineers who wish to success within a business management environment. It is a generic term that covers many facets of business and relates to financial skills also.

In many ways, business acumen is developed through experience in business. Although many of business skills can be taught, they are outside the scope of an engineering degree. They belong more properly in a business or commerce degree.

However, business acumen in general should remain fixed in an individual's mind. It is business acumen that is wanted from a good manger – especially at the higher levels of a commercial business. An engineer, or any other profession desiring success in management, should keep this in mind.

Skill in this area can be developed via formal courses, but more normally (at least for engineers) is developed initially by experience. An MBA, or similar degree, should normally provide some polish. It is possibly the reason that MBAs are held in such high regard by many of the questionnaire respondents.

## 8.8 Project management

Project management was not rated as being very important in comparison to some of the other skill sets proposed. However, it is an area that a number of engineers get involved in throughout their careers. As a management topic is perhaps relates most closely to the engineering field.

For this reason it is proposed as a possible course of study to be included within an undergraduate program, even if only as an elective. Some universities currently include this topic as a core course.

The US Project Management Institute defines nine project management knowledge areas which are well recognised around the world including Australia. These knowledge areas are:

a. Project Integration Management.

b. Project Scope Management.

c. Project Time Management.

d. Project Cost Management.

e. Project Quality Management.

f. Project Human Resource Management.

g. Project Communications Management.

h. Project Risk Management.

i. Project Procurement Management.

These areas cover most of the functions of more general management reasonably well. Project management can in some ways be considered as a link between engineering and management. Thus it is suggested for consideration to include within an undergraduate course. It would be of benefit to all students, not just those keen on pursuing management careers.

## 8.9 Technical skills

Irrespective of the discussions in this dissertation, technical skills remain the focus of an engineering degree. Learning institutions and individuals should not lose sight of that. As one respondent to the questionnaire commented, an engineer needs to be a

good engineer first. An individual needs to be a good engineer to become a good manager, although the reverse is not necessarily true.

Technical skills should therefore remain the focus of an engineering degree and should not be compromised by the inclusion of too many ‘soft’ skills. The opportunity to introduce management and ‘life-skills’ should be taken but not to the detriment of a good engineering grounding.

Employers hiring an engineering graduate expect an individual with technical skills – it is through demonstrating these skills that a university gains its reputation and prestige as a learning institution. The later success of its graduates certainly helps, but those graduates need to be put on the right road in the first place. Getting a good job straight out of university can be the first step on that road – even for those intent on management.

## 8.10 Conclusion

This chapter has briefly looked at the implications the results of the research has for training. It identifies a few key areas where education and training philosophies of learning institutions can be aligned with the expectations of senior executives to produce engineers with the capability to move effectively into management roles.

It has not attempted to produce detailed assessments of improvements to training as this would require the detailed and specialised investigation into outcomes outside the scope of the project. However, it supplies a basis from which education administrators can target key areas of interest in order to develop new and effective training.

# Chapter 9

# Recommendations and Conclusion

## 9.1 Introduction

This chapter concludes this study. It aims to sum up the findings and to make recommendations regarding engineers careers based on them. A number of conclusions and trends have been identified through the data collected. The more significant of these are summarised in this chapter in order to highlight their contribution to the knowledge base on the topic.

The chapter will be divided into a number of sections in order to separate the information into groups that are most useful to a particular group of stakeholders. This will include individual engineers, learning institutions including universities, professional engineering associations and large organisations that conduct in-house engineer training.

The aim of this chapter is to wrap up the study and, where possible provide a way forward for further research. Although this research project provided insight into many areas that could be of interest for further development, the suggestions noted here will be restricted to those affecting the potential careers of engineers only.

## 9.2 Recommendations

The recommendations made in this section are divided into a number of parts such that they are made to individual engineers, to learning institutions, to large companies and organisations and to anyone interested in continuing this investigation further. The recommendations are made on the basis of this study as it applies to the career of an engineer and other literature related to this topic.

### 9.2.1 Recommendations to undergraduates / junior engineers

The following recommendations are made to undergraduates and junior engineers:

a. Have a career plan. Although perceptions and ambitions change, only by being aware of future potential options and by recognising and taking opportunities that may arrive can career progression be maximised.

b. Do not rush promotion, be recognised on your merits – the experience will set you up for higher level success. The majority of current CEOs and other high level executives believe that they arrived in their positions on merit without actively seeking management.

c. Technical skill is required for recognition of potential for advancement into management. Without a proven ability to work effectively at a technical level it is unlikely that future management potential will be realised. Conversely, great technical skill does not imply success or effectiveness in management.

d. Improve communication skills and interactions with others. The importance of communication skills is highlighted repeatedly, not only by CEOs, but in the literature and by empirical evidence that can be observed in daily life. Communication skills covers more than being able to write a good report or present a talk – it includes the ability to interact well with other people, building a rapport and the persona as an effective and efficient person.

e. Seek a Masters degree in a management field after time in a technical role. The majority of current CEOs recommend an MBA. However they are likely to be viewing the situation retrospectively – organisations and recruitment companies currently appear to be

looking for individuals with higher degrees in management that have been tailored towards a particular field or area of business.

f. Develop leadership potential. This cannot be done at university. It must be done through life experience, whether that be through the work environment or outside interests. An understanding of leadership theory can help but must used in context[1].

g. Gain a wide range of experience. Experience not only provides a basis of knowledge but can reveal interests in particular fields that can provide motivation towards a career path.

h. Learn to think and plan strategically (with an eye to the future). Combined with problem solving, the ability to appreciate the 'bigger picture' is an essential skill for those in high level management.

### 9.2.2 Recommendations to learning institutions

The following recommendations are made to learning institutions:

a. Technical skills are vital for undergraduates, they should not be compromised for management type skills.

b. Financial skills should be incorporated into undergraduate programs as an elective for those who wish to pursue an opportunity in management. It is a vital skill and one which most engineers will face in their careers. As a field of study, it is not well understood by engineers and, despite containing a large degree of mathematics, does not always make intuitive sense to an engineer.

[1] The work of John Adair and also Herzberg and Blanchard are recommended as a starting point. Their theories can be combined to form an effective framework for leadership- especially combined with organization and social theory such as the work of Maslov.

c. Undergraduates communication skills should be practiced though technical courses.

d. Management skills should be taught at a post-graduate level.

e. Management skills are best focused at a particular industry.

### 9.2.3 Recommendations to large organisations

The following recommendations are made to large organisations:

a. Engineers are generally suitable for management positions. Their education and training in problem solving makes them better suited to high level management than many other disciplines (including those more closely related to ‘business management’).

b. Engineers are trained in logical thinking, that can be enhanced into strategic management thinking / planning efficiently.

c. Communications skills generally need improvement but are worth the effort.

### 9.2.4 Recommendations for further research

Areas of focus for further research could include:

a. The effectiveness of leadership training.

b. The development of engineers communications skills specifically.

c. The usefulness of personality profiling to engineers.

d. The effectiveness of personality adjustment training.

## 9.3 Conclusion

This study has investigated the skills and attributes of CEOs and related them to the skills and attributes of engineers in order to determine how engineers can succeed in management careers and how education and training can best support those endeavours.

CEOs were found, in general, to have strong communication and strategic thinking skills enhanced by leadership. They reached their positions via many different career paths but in general agreed that on the types of skills and attributes required to reach senior executive level positions.

In comparison, engineers were discovered to be good at problem solving but, in general, lack leadership and communication skills. This was evident both in the literature as well as a general trend in the comments of respondents. This, of course, does not mean that some individuals are not highly competent in these areas – only on average that engineers are less skilled than their peers in some other professions.

The focus for both individual engineers and learning institutions should therefore be to develop the skill set that is not common across the two groups. Amongst many of the other skills and attributes, three stand out as being important for engineers intending to pursue a career in management: leadership, communication skills and financial skills.

There is some overlap between the skill sets of CEOs and engineers. Thus by effective education and training to increase the attributes in common, engineers may be in a better position to compete against other graduates to reach the top of the management profession.

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**University of Southern Queensland**
**Faculty of Engineering and Surveying**

**ENG4111 / ENG4112 Research Project**

**PROJECT SPECIFICATION**

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FOR: Warren COAKER

TOPIC: **How Engineers Becomes CEOs? – Implications for Training and Development**

SUPERVISOR: Steven GOH

PROJECT AIM: To determine the career attributes engineers need to develop to become CEOs of major corporations and identify training and development needs to assist that progression in order to better orient career training for engineers.

PROGRAMME: **Issue A, 26 February 2007**

1. Conduct a literature review of CEOs, the required attributes of the position and the engineers that have achieved it.

2. Identify and review attributes common to professional engineers. Provide a comparison of these characteristics to other occupations based on the literature review.

3. Conduct a survey of top-level engineers and identify characteristics, experience and training that have influenced their progression to senior management.

4. Identify weaknesses in current engineering education at graduate and post-graduate level. To include an assessment of current post-degree training continuums.

5. Propose a method / training continuum to rectify identified shortfalls with the aim of improving the opportunities for engineers to become high level managers.

*As time permits:*

4. Provide a comparison of training by other occupations in identified shortfalls and make an assessment as to their effectiveness.

5. If sufficient data exists, conduct a statistical analysis to determine the correlation of specific training and education backgrounds to an engineers managerial success.

AGREED: _____ (Student) _____ (Supervisor)

(dated) 27/03/07 /03/07

20-3-07

# Appendix B

# Questionnaire

The following pages of appendix B contain a copy of the questionnaire that was distributed to engineers in management that had been identified as high performers. As detailed in the body of this study these individuals were taken from Crown Contents Who's Who in Business in Australia.

This questionnaire was accompanied by a covering letter explaining the background for the project and requesting that the questionnaire be completed. That covering letter has not been included.

It must be noted that there is an error in the questionnaire that was sent out. Section B asked respondents to score (circle) attributes on a scale of one to ten – but seven was missing. Some respondents added their own seven, some commented on it, others may have missed the fact it was missing completely.

Due to the fact that that some respondents had added in the number seven and that any error in results would have been averaged out (and only been a maximum of 10%) the effect was minimal and was not considered in detail in this study.

# QUESTIONAIRE

## Engineer Career Path Progression to Senior Executive Management Positions

This questionnaire has been designed as part of an undergraduate project investigating the career paths of engineers who reach senior management positions within Australian companies. All assistance given by the completion of this questionnaire is greatly appreciated.

**Purpose:** To determine the skills and attributes engineers need to reach senior management positions and the training requirements needed to develop those skills.

The questionnaire has been divided into four sections as follows:

### Section A – Participant's background

This section sets out to determine the general background and position of the participant. It does not intend to gather any personal details, but by establishing a general career background, any bias or variance between different groups can be identified. (eg Mechanical engineers believing leadership to be more important to career progression than electrical engineers do.)

### Section B – Skills and attributes required of senior management

Section B is all about identifying the perceived skills and attributes needed by engineers and others to reach senior executive management positions such as CEO. It suggests some characteristics, based on both other studies and personal views that may identify an individual with potential for high level executive ability. This is a core component of the study and any expansions and / or view-points are welcome.

### Section C – Training requirements

In this section, the training needed to develop the aforementioned skills and attributes is investigated. The intent is to identify any shortfalls in current undergraduate engineering courses and/or early engineer development. This is a major focus of the project and any amplifying comments would be greatly appreciated in Section D.

### Section D – Other comments

Section D simply allows space for any amplifying comments or personal views for anyone who wishes to add them. Please expand as much as you like on any of the points above.

## SECTION A

1. What is your base degree? (ie Civil, Electrical, Mechanical etc) Please include any other Bachelor degrees you hold including combined degrees.

   _____

2. How long did you spend in technical roles (before moving into management)?

   _____

3. How long have you spent in management roles?

   _____

4. What is your current position?

   _____

5. Did you move naturally into management, or did you actively seek the change?

   _____

6. What other qualifications do you now hold? For each qualification, please indicate when you received it. Please include both technical and non-technical qualifications.

   _____

   _____

   _____

   _____

   _____

   _____

   _____

## SECTION B

The following skills and attributes have been identified as desirable requirements for CEOs and senior executives. On a scale of one to ten, please rate how you perceive the importance of each factor to an engineers career. Also indicate whether you would recommend formal training in these areas.

| Attributes/Skills/Abilities | Least Important → Most Important | Formal Training Required |
|---|---|---|
| Leadership | 1 2 3 4 5 6 8 9 10 | Y / N |
| Business acumen | 1 2 3 4 5 6 8 9 10 | Y / N |
| Integrity | 1 2 3 4 5 6 8 9 10 | Y / N |
| Administrative ability | 1 2 3 4 5 6 8 9 10 | Y / N |
| Energetic & passionate | 1 2 3 4 5 6 8 9 10 | Y / N |
| Strategic planning | 1 2 3 4 5 6 8 9 10 | Y / N |
| HR management | 1 2 3 4 5 6 8 9 10 | Y / N |
| Multi-company experience | 1 2 3 4 5 6 8 9 10 | Y / N |
| Financial management | 1 2 3 4 5 6 8 9 10 | Y / N |
| Team player | 1 2 3 4 5 6 8 9 10 | Y / N |
| Disciplinary knowledge | 1 2 3 4 5 6 8 9 10 | Y / N |
| Having a mentor | 1 2 3 4 5 6 8 9 10 | Y / N |
| Achievement orientation | 1 2 3 4 5 6 8 9 10 | Y / N |
| Self-awareness | 1 2 3 4 5 6 8 9 10 | Y / N |
| Project management | 1 2 3 4 5 6 8 9 10 | Y / N |
| Interpersonal skills | 1 2 3 4 5 6 8 9 10 | Y / N |
| Drive / ambition | 1 2 3 4 5 6 8 9 10 | Y / N |
| Emotional intelligence | 1 2 3 4 5 6 8 9 10 | Y / N |
| International experience | 1 2 3 4 5 6 8 9 10 | Y / N |
| Planning ability / experience | 1 2 3 4 5 6 8 9 10 | Y / N |
| Communication ability | 1 2 3 4 5 6 8 9 10 | Y / N |
| Entrepreneurial ability | 1 2 3 4 5 6 8 9 10 | Y / N |
| Decisiveness | 1 2 3 4 5 6 8 9 10 | Y / N |
| Technical competence | 1 2 3 4 5 6 8 9 10 | Y / N |
| Analytical/reasoning skills | 1 2 3 4 5 6 8 9 10 | Y / N |
| Initiative | 1 2 3 4 5 6 8 9 10 | Y / N |
| Conceptual skills | 1 2 3 4 5 6 8 9 10 | Y / N |
| Sales / marketing ability | 1 2 3 4 5 6 8 9 10 | Y / N |
| Handle complexity | 1 2 3 4 5 6 8 9 10 | Y / N |

**SECTION C**

For each of the skills and attributes below, indicate whether or not you believe formal training would be beneficial and at what stage of an engineers career.

The following codes can be used to indicate *training types* and *career stages*:

| Training Types | Career Stage |
|---|---|
| Q – formal qualification | A – during university education |
| V – vocational training | B – early career, still in technical role |
| OJT – on the job training (non-formal) | C – early management |
| O- other, please amplify in Section D | D - mid-management |
| | E – once in executive type role |

| | Training Type | Stage of Career |
|---|---|---|
| Leadership | Q / V / OJT / O | A / B / C / D / E |
| Strategic planning | Q / V / OJT / O | A / B / C / D / E |
| Financial management | Q / V / OJT / O | A / B / C / D / E |
| Project management | Q / V / OJT / O | A / B / C / D / E |
| Legal awareness | Q / V / OJT / O | A / B / C / D / E |
| Communication skills | Q / V / OJT / O | A / B / C / D / E |
| Further technical skills | Q / V / OJT / O | A / B / C / D / E |
| Change management | Q / V / OJT / O | A / B / C / D / E |
| Economics | Q / V / OJT / O | A / B / C / D / E |
| HR management | Q / V / OJT / O | A / B / C / D / E |
| Logistics / Supply chain | Q / V / OJT / O | A / B / C / D / E |
| Information management | Q / V / OJT / O | A / B / C / D / E |
| Business acumen | Q / V / OJT / O | A / B / C / D / E |
| Administration | Q / V / OJT / O | A / B / C / D / E |
| Analytical/reasoning skills | Q / V / OJT / O | A / B / C / D / E |
| Sales / marketing | Q / V / OJT / O | A / B / C / D / E |
| Accounting skills | Q / V / OJT / O | A / B / C / D / E |

Do engineers need the following qualifications / memberships in order to maximise their chance of progressing to executive level management? *(Please circle.)*

- MBA Yes / No / Undecided
- Post-graduate technical (engineering) qualifications Yes / No / Undecided
- Other higher degrees Yes / No / Undecided
- Membership of IEAust Yes / No / Undecided
- Membership of other professional bodies Yes / No / Undecided

**SECTION D**

Please provide any further comments you believe may be applicable to the study in the space below.

If you do not mind being contacted directly for further clarification or to answer any questions that may arise from your responses, then please indicate: YES / NO

Specific areas of interest include:

- what other skills and / or attributes are needed by CEOs?
- what training do young engineers need to compete more effectively against other professions in the performance of managerial roles?

# Appendix C

# Electronic questionnaire

The following pages of appendix C contain a copy of the questionnaire that was distributed by email. A number of individuals were approached by this means in order to obtain some quick initial feedback and potentially to see if this means of communication was more effective or yielded different results.

It is essentially the same questionnaire as that distributed by email except that for some questions answers were constrained to particular responses and there were slightly fewer attributes listed for assessment. These areas of difference are quickly obvious when comparing the two formats.

An explanatory email explained the purpose of the questionnaire but is not included.

# QUESTIONAIRE

## Engineer Career Path Progression to Senior Executive Management Positions

This questionnaire has been designed as part of an undergraduate project investigating the career paths of engineers who reach senior management positions within Australian companies. All assistance given by the completion of this questionnaire is greatly appreciated.

**Purpose:** To determine the skills and attributes engineers need to reach senior management positions and the training requirements needed to develop those skills.

The questionnaire has been divided into four sections as follows:

### Section A – Participant's background

This section sets out to determine the general background and position of the participant. It does not intend to gather any personal details, but by establishing a general career background, any bias or variance between different groups can be identified. (eg Mechanical engineers believing leadership to be more important to career progression than electrical engineers do.)

### Section B – Skills and attributes required of senior management

Section B is all about identifying the perceived skills and attributes needed by engineers and others to reach senior executive management positions such as CEO. It suggests some characteristics, based on personal views and other studies that may identify an individual with potential for high level executive ability. This is a core component of the study and any expansions and / or view-points are welcome.

### Section C – Training requirements

In this section, the training needed to develop the aforementioned skills and attributes is investigated. The intent is to identify any shortfalls in current undergraduate engineering courses and/or early engineer development. This is a major focus of the project and any amplifying comments would be greatly appreciated in Section D.

### Section D – Other comments

Section D simply allows space for any amplifying comments or personal views for anyone who wishes to add them. Please expand in any way you like on any aspects of engineers and their ability to be successful in management roles.

## SECTION A

1. What is your base degree? (ie Civil, Electrical, Mechanical etc) Please include any other Bachelor degrees you hold including combined degrees.

   *eg BE (Mech) or BBus*

2. How long did you spend in technical roles (before moving into management)?

   *eg 5 years*

3. How long have you spent in management roles?

   *eg 10 years*

4. What is your current job / position?

   *eg Managing Director*

5. How did you move into management, did you actively seek the change? Please choose the most appropriate response.

   *(Please click here to choose)*

   | |
   |---|
   | *(Please click here to choose)* |
   | Always wanted a career in management |
   | Management offered only promotion opportunity |
   | Wanted to move away from technical positions |
   | It was just a natural career progression |
   | Had an offer too good to ignore |
   | Other |

6. What other qualifications do you now hold? For each qualification, please indicate when you received it. Please include both technical and non-technical qualifications.

   *eg MBA, Diploma of Project Management*

## SECTION B

The following skills and attributes have been identified as desirable requirements for CEOs and senior executives. On a scale of one to ten, please rate how you perceive the importance of each factor to an engineers career. Also indicate whether you would recommend formal training in these areas.

| **Attributes/Skills/Abilities** | **Least Important → Most Important** | **Formal Training Required** |
|---|---|---|
| | 1 2 3 4 5 6 8 9 10 | Y / N |
| Leadership | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Business acumen | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Integrity | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Administrative ability | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Energetic & passionate | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Strategic planning | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| HR management | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Multi-company experience | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Financial management | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Team player | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Disciplinary knowledge | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Having a mentor | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Achievement orientation | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Self-awareness | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Project management | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Interpersonal skills | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Drive / ambition | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Emotional intelligence | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| International experience | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Planning ability / experience | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Communication ability | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Entrepreneurial ability | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Decisiveness | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Technical competence | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Analytical/reasoning skills | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Initiative | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |
| Conceptual skills | ☐☐☐☐☐☐☐☐☐☐ | ☐ / ☐ |

**SECTION C**

For each of the skills and attributes below, indicate whether or not you believe formal training would be beneficial; and, at what stage of an engineers career.

| | **Training Type** | **Stage of Career** |
|---|---|---|
| Leadership | (Please choose) | (Please choose) |
| Strategic planning | (Please choose) | (Please choose) |
| Financial management | (Please choose) | (Please choose) |
| Project management | (Please choose) | (Please choose) |
| Legal awareness | (Please choose) | (Please choose) |
| Communication skills | (Please choose) | (Please choose) |
| Further technical skills | (Please choose) | (Please choose) |
| Change management | (Please choose) | (Please choose) |
| Economics | (Please choose) | (Please choose) |
| HR management | (Please choose) | |
| Logistics / Supply chain | (Please choose) | |
| Information management | (Please choose) | |
| Business acumen | (Please choose) | |
| Administration | (Please choose) | (Please choose) |
| Analytical/reasoning skills | (Please choose) | (Please choose) |
| Sales / marketing | (Please choose) | (Please choose) |
| Accounting skills | (Please choose) | (Please choose) |

(Please Choose)
Nil
Formal Qualification
Vocational Training
On-the-job Training
Through a mentor
Other

(Please choose)
Not required
At university
In technical role
Early Management
Mid-management
Senior management

---

Do engineers need the following qualifications / memberships in order to maximise their chance of progressing to executive level management?

| | **Yes / No / Undecided** |
|---|---|
| • MBA | ☐ / ☐ / ☐ |
| • Post-graduate technical (engineering) qualifications | ☐ / ☐ / ☐ |
| • Other higher (post graduate) degrees | ☐ / ☐ / ☐ |
| • Membership of Engineers Australia | ☐ / ☐ / ☐ |
| • Membership of other professional bodies | ☐ / ☐ / ☐ |

**SECTION D**

Please provide any further comments you believe may be applicable to the study in the space below.

If you do not mind being contacted directly for further clarification or to answer any questions that may arise from your response, please indicate:

☐ Further contact okay
☐ Please do not contact again

Specific areas of interest include:

- what other skills and / or attributes are needed by CEOs?
- what training do young engineers need to compete more effectively against other professions in the performance of managerial roles?

*Add your comments here*

# Appendix D

# Respondent data

This appendix contains the data collected from the returned questionnaires. It is included both to provide evidence of the data collected and to demonstrate the range of responses that were received. Responses that included lengthy comment have been shortened (edited) to maintain relevancy with the topic.

Fields that have been left blank correspond to blank responses in the returned questionnaires.

A legend is provided at the end of each section where required.

| | Respondent Background | | | | | |
|---|---|---|---|---|---|---|
| **Ser** | **Degree** | **Time in Technical Role (years)** | **Time in Management (years)** | **Current Position** | **Sought Management or Natural Progression** | **Other Qualifications** |
| 1 | BE (Mech) | 11 | 30 | Chairman | Natural | MBA (1971), FIEAust (~1990) |
| 2 | BE (Elect) | 5 | 15 | Divisional General Manager | Natural (tried to avoid initially) | MBA (1997) |
| 3 | BE (Mech) | 4 | 30 | Executive Director | Sought Management | MBA (1977) |
| 4 | BE (Elect) | 1.5 | 3 | Managing Partner | Promotion not sought. | MBA (1995) |
| 5 | BE (Mech) | 6 | 30 | Chairman (plus) | Natural | MEngSc (1963), Phd (1966) |
| 6 | BE (Control) | 2 | 16 | Services Director | Sought change | CDipAcct&Fin (1991), MBA (2007) |
| 7 | BE (Civ) | 5 | 21 | Managing Director | Natural | GradDips Mngt (1986 & 1989) |
| 8 | BE (Civ) | 10 | 10 | Executive Director | Actively sought | MBA (1995) |
| 9 | BE (Chem) | 15 | 8 | MD, CEO (plus) | Told potential, then sought | MBA (1987) |
| 10 | BE (Elect) | 4 | 15 | Chairman | Actively sought | |
| 11 | BE (Elect) | 4.5 | 15 | General Manager | Naturally | GradDips (2) (Tech and Mngt), MBA |
| 12 | BE (Mech&Elect) | 5 | 40 | Retired | 2/3 naturally | International Management (1984) |
| 13 | BE (Chem) | 10 | 30 | Retired | Natural | CPA |
| 14 | BE (Mech) | 20 | 16 | Executive General Manager | Natural | Trade Certificate, Certificate (Tech) |
| 15 | BE (Chem) | 7 | 22 | General Manager | Bit of both | Diploma (Corporate Management) (1988) |
| 16 | BE (Civ) | 1 | 26 | Chair Boards (2) (plus) | Actively sought | MEngSc (1970), MPhil (1973), Cert (Mngt) |
| 17 | BE (Mining) | 10 | 23 | Managing Director | Naturally | Nil |
| 18 | BE (Mech) | 5 | 27.5 | Managing Director | Part of normal career path | MBA (1989) |
| 19 | BE (Elect) | 17 | 18 | General Manager | Naturally | Masters Elec Eng and Comp Science (1984) |
| 20 | BE (Chem) | 1 | 36 | CEO | Actively sought | MBA(1971), FAICD (1998) |

**Note:** many respondents indicated they had completed other courses that did not lead to formal qualifications or were not applicable to either business or management.

| | Respondent Background | | | | | |
|---|---|---|---|---|---|---|
| **Ser** | **Degree** | **Time in Technical Role (years)** | **Time in Management (years)** | **Current Position** | **Sought Management or Natural Progression** | **Other Qualifications** |
| 21 | BE (Civ) | 8 | 29 | Managing Director / CEO | Invited to advance | MEngSc (1975), MBA (2002) |
| 22 | BE (Chem) | 5 | 32 | Director (3 companies) | Actively sought | FellowshipDip of Management (1972) |
| 23 | BE (Civ) | 8 | 27 | CEO | Sought promotion | M.Urban Plan (1983), PostGradDip(Mngt) |
| 24 | BE (Civ) | 5 | 13 | Chief Executive | Natural | Harvard Advanced Management Program |
| 25 | BE (Civ) | 1 | 20 | Executive Director | Natural | MBA (1989) |
| 26 | BE (Mining) | 1 | 8 | Non-Executive Director | Natural | Diploma Accounting (1980), MBA (1985) |
| 27 | BE (Civ) | 11 | 28 | Retired | Came with promotion | MEngSci (1963) |
| 28 | BE (Mech) | 10 | 30 | Company Director, Retired | Naturally | ME (Automotive)(plus) |
| 29 | BE (Mech) | 6 | 27 | Managing Director | Actively sought | MBA, DBA (underway) |
| 30 | BE (Mech) | 8 | 30 | Deputy CEO | Combination | Nil (but taken various courses) |
| 31 | BE (Elect) | 18 | 7 | General Manager | Naturally | PostGradDip Business Management |
| 32 | BE (Chem) | 1 | 26 | CEO | Naturally | MComm (1986) |
| 33 | BE (Mech) | 7 | 27 | Director | Naturally | Nil |
| 34 | BE (Civ) | 2.5 | 17 | Managing Director | Naturally | MBA (2000), GCID (2005) |
| 35 | BE (Mech) | 5 | 35 | Directorships | Naturally | Nil |
| 36 | BE (Mining) | 10 | 25 | Managing Director | Naturally | Mine Managers Certificate |
| 37 | BE (Elect) | 7 | 33 | CEO | Naturally | BSc (1968), MEngSc (1973), MBA (1994) |
| 38 | BE (Mech) | 0 | 41 | Chairman | Actively sought | Advanced Executive Program (1997) |
| 39 | BE (Chem) | 4 | 20 | Retired | Naturally | PhD, PostGradDip (tech) |
| 40 | BE (Metal) | 3 | 24 | Chief Operating Officer | Actively sought | MS (1978), PhD (1980) |

| | Respondent Background | | | | | |
|---|---|---|---|---|---|---|
| **Ser** | **Degree** | **Time in Technical Role (years)** | **Time in Management (years)** | **Current Position** | **Sought Management or Natural Progression** | **Other Qualifications** |
| 41 | BE (CompSys) | 3 | 10 | Chief Operating Officer | Natural with opportunities | Nil as yet |
| 42 | BE (Civ) | 15 | 21 | Engineer / Board Member | Naturally | MEngSc |
| 43 | BE (Mining) | 13 | 3 | General Manager Operations | Actively sought | M. Int Finance |
| 44 | BE (Chem) | 0 | 20 | Managing Director | First job of management | M.Mngt (1995) |
| 45 | BE (Mech) | 0 | 45 | Board Chairman | Naturally | Harvard Advanced Management Program |
| 46 | BE (Civ) | 7 | 32 | CEO | Naturally | MEngSc, Hon.DSc |
| 47 | BE (Industrial) | 3 | 33 | Managing Director | Actively sought | Nil |
| 48 | BE (Civ) | 2 | 18 | MD/Chairman/Exec Director | Started own business | MBA (1994), PhD (1996), DBA, plus |
| 49 | BE (Civ) | 5 | 40 | Chairman / Director | Naturally | Nil |
| 50 | BE (Elec) | 0 | 35 | Non-Executive Director | Actively sought | MSc, DBA |
| 51 | BE (Mining) | 8 | 16 | CEO | Naturally | DipBusStud |
| 52 | BE (Mining) | 8 | 32 | Company Director | Sought change | No formal qualifications, many courses |
| 53 | BE (Elec) | 3.5 | | Chairman and CEO | Naturally | Nil |
| 54 | BE (Mech&El) | 1.5 | 35 | Retired | Natural | Harvard Advanced Management Program |
| 55 | BE (Mech) | 4 | 35 | Chairman | Actively sought | PhD (1974) |
| 56 | BE (Elec) | 15 | 20 | Chairman & Consultant | Started own business | |
| 57 | BE (Civ) | 11 | 30 | Chairman | Actively sought | MEngSci, numerous courses |
| 58 | BE (Civ) | 10 | 20 | Managing Director | Natural | MBA (1984) |
| 59 | BE (Mining) | 3 | | General Manager | Actively sought | MBA (2000), AMP (2002) |
| 60 | BE (Civ) | 5 | 32 | Director General | Naturally | MEngSc |
| 61 | BE (Chem) | 0-6 | 20 | Managing Director | Recognised potential | GAICD |
| 62 | BE (Elec) | 20 | 10 | Acting Managing Director | Actively sought | None |
| 63 | BE (Chem) | 3 | 21 | CEO | Naturally | PhD, AICD |

| | Respondent Background | | | | | |
|---|---|---|---|---|---|---|
| **Ser** | **Degree** | **Time in Technical Role (years)** | **Time in Management (years)** | **Current Position** | **Sought Management or Natural Progression** | **Other Qualifications** |
| 64 | BE (Civ) | 8 | 20 | Managing Director | Actively sought | Nil |
| 65 | BE (Elec) | 12 | 25 | Company Director | Natural | Accounting (10yrs after BE) |
| 66 | BE (Elec) | 5 | 16 | CEO | Actively sought | MBA (1992), Dip.AICD |
| 67 | BE (Elec) | 10 | 18 | Managing Director | | MBA |
| 68 | BE (Mech) | 10 | 22 | Managing Director / CEO | Naturally | Nil |
| | Electronic replies below | | | | | |
| 69 | BE (Civ) | 4 | 34 | Managing Director and CEO | Naturally | Bcomm (1973) |
| 70 | BE (Elect) | 3 | 19 | CEO | Offer too good to ignore | MBA (1992) |
| 71 | BSc / BE (Mech) | 5 | 14 | Executive Director (plus) | Avoid technical | Mcomm, CPA, FCIS |
| 72 | BE (Elect) | 5 | 28 | Company Chairman (plus) | Naturally | GradDip (Mngt, 1976 & accnt 1979)(plus) |
| 73 | BSc / BE (Mech) | 6 | 20 | Retired | Naturally | PhD (1967) |
| 74 | BE (Mech) | 3 | 22 | CEO | Naturally | Nil |
| 75 | BE (Civ) | 5 | 27 | Managing Director | Naturally | GradDip Business (1981), FIE Aust (1992) |
| 76 | BE (Elec) | 10 | 10 | CEO | Other | GradDip Business |
| 77 | BE (Chem) | 12 | 24 | Managing Director and CEO | Naturally | MEngSci (1981), OPM (!996) |
| 78 | BE (Civ) | 2 | 30 | Executive Chairman | Always wanted management | MBA |
| 79 | BE (Elec) | 12 | 24 | Retired Managing Director | Naturally | (Nothing formal but many courses) |
| 80 | BE (Elec) | 5 | 15 | Managing Director | Only promotion opportunity | MEngSc |
| 81 | BE (Elec) | 10 | 40 | Chairman of 3 companies | Always wanted management | MBA (1974) |
| 82 | BE (Mech) | 10 | 15 | Managing Director | Naturally | None |

## QUESTIONNAIRE RESULTS - CHARACTERISTICS AND REQUIREMENTS FOR TRAINING

The table below contains the results obtained from Section B of the questionnaire. Attributes are rated on their importance to an engineer's career in management on a scale of one to ten (ten being most important).
Respondents were also asked if formal training was required for that attribute. The responses are tabulated below.
Non-integer values indicate that the respondent circled two numbers and it could not be identified which was intended - the average was taken.

| Respondant Number | Leadership | | Business Acumen | | Integrity | | Administrative Ability | | Energy / Passion | | Strategic Planning | | HR Management | | Multi-company experience | | Financial management | | Team player | | Disciplinary knowledge | | Mentor | | Achievement orientation | | Self Awareness | | Project Management | | Interpersonal Skills | | Drive / Ambition | | Emotional Intelligence | | International Experience | | Planning ability | | Communication Ability | | Entrepreneurial ability | | Decisiveness | | Technical competence | | Analytical / reasoning skills | | Initiative | | Conceptual skills | | Sales / Marketing ability | | Handle complexity | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | Y | 8 | N | 10 | N | 7 | Y | 9 | N | 8 | Y | 8 | Y | 5 | N | 8 | Y | 5 | N | 8 | Y | 6 | N | 8 | N | 8 | N | 8 | Y | 10 | N | 9 | N | 9 | N | 6 | N | 8 | Y | 9 | N | 8 | N | 8 | Y | 8 | Y | 9 | N | 8 | N | 7 | Y | 8 | Y |
| 2 | 9 | N | 9 | N | 6 | N | 5 | N | 8 | N | 9 | N | 8 | Y | 8 | N | 6 | Y | 6 | N | 4 | N | 6 | N | 8 | N | 8 | N | 8 | Y | 9 | Y | 9 | N | 10 | N | 8 | N | 8 | N | 10 | Y | 8 | N | 9 | N | 5 | Y | 9 | N | 9 | N | 8 | N | 6 | Y | 9 | N |
| 3 | 10 | Y | 10 | Y | 10 | N | 5 | N | 10 | N | 9 | Y | 8 | Y | 9 | N | 10 | Y | 9 | Y | 5 | N | 4 | N | 10 | N | 9 | N | 6 | Y | 10 | Y | 10 | N | 5 | N | 9 | N | 8 | Y | 9 | Y | 10 | N | 9 | N | 8 | Y | 10 | N | 9 | N | 8 | Y | 9 | N |
| 4 | 9 | N | 10 | Y | 10 | N | 4 | N | 9 | N | 8 | Y | 9 | N | 2 | N | 10 | Y | 9 | N | 1 | N | 10 | N | 10 | N | 8 | N | 2 | Y | 10 | N | 8 | N | 10 | N | 2 | N | 6 | Y | 10 | Y | 10 | N | 10 | N | 1 | N | 5 | N | 10 | N | 5 | N | 4 | N | 9 | N |
| 5 | 9 | Y | 10 | N | 9 | N | 8 | Y | 8 | N | 8 | N | 9 | N | 9 | N | 9 | Y | 6 | N | | | 6 | N | 10 | N | 8 | N | 6 | N | 8 | N | 9 | N | 8 | N | 10 | N | 8 | N | 9 | N | 9 | N | 9 | N | 8 | N | 10 | N | 10 | N | 8 | N | 6 | N | 10 | N |
| 6 | 9 | Y | 8 | Y | 6 | N | 4 | N | 6 | N | 6 | N | 8 | N | 4 | N | 9 | Y | 8 | N | 6 | N | 6 | N | 9 | N | 10 | N | 8 | Y | 10 | N | 9 | N | 8 | N | 6 | N | 8 | N | 9 | Y | 6 | N | 9 | N | 5 | N | 8 | N | 8 | N | 8 | N | 6 | N | 9 | N |
| 7 | 10 | N | 10 | N | 10 | N | 6 | Y | 9 | N | 8 | Y | 6 | Y | 8 | N | 9 | Y | 9 | Y | 3 | Y | 6 | N | 9 | N | 8 | Y | 9 | Y | 9 | N | 9 | N | 8 | N | 8 | N | 8 | Y | 9 | N | 9 | N | 8 | N | 6 | N | 9 | N | 9 | N | 8 | N | 8 | Y | 9 | N |
| 8 | 8 | N | 9 | Y | 9 | N | 8 | N | 10 | N | 9 | N | 8 | Y | 9 | N | 9 | Y | 8 | N | 6 | N | 8 | N | 10 | N | 8 | N | 8 | Y | 9 | Y | 10 | N | 9 | N | 8 | N | 8 | Y | 9 | N | 10 | Y | 9 | N | 8 | Y | 8 | N | 9 | N | 10 | N | 9 | Y | 9 | N |
| 9 | 9 | Y | 9 | N | 9 | N | 3 | N | 10 | N | 8 | Y | 4 | N | 6 | N | 8 | Y | 9 | N | 3 | N | 10 | N | 8 | N | 10 | Y | 6 | N | 8 | N | 10 | N | 10 | N | 5 | N | 5 | Y | 10 | Y | 6 | N | 9 | N | 8 | Y | 8 | N | 9 | N | 8 | N | 3 | N | 10 | N |
| 10 | 6 | N | 8 | Y | 10 | N | 3 | N | 6 | N | 9 | N | 3 | N | 2 | N | 2 | N | 3 | N | 2 | N | 6 | N | 6 | N | 6 | N | 6 | N | 8 | N | 9 | N | 4 | N | 3 | N | 5 | N | 8 | N | 5 | N | 8 | N | 10 | Y | 10 | N | 10 | N | 10 | N | 9 | N | 9 | N |
| 11 | 10 | Y | 9 | Y | 10 | N | 4 | N | 9 | N | 9 | Y | 8 | Y | 6 | N | 9 | Y | 10 | N | 6 | Y | 8 | Y | 8 | Y | 8 | N | 6 | Y | 9 | Y | 8 | N | 6 | N | 6 | N | 8 | Y | 8 | Y | 6 | N | 9 | Y | 6 | Y | 9 | Y | 8 | Y | 10 | N | 5 | N | 9 | Y |
| 12 | 8 | N | 6 | Y | 9 | N | 5 | N | 6 | N | 9 | Y | 5 | Y | 6 | N | 5 | Y | 9 | Y | 6 | N | 4 | N | 9 | N | 6 | N | 8 | Y | 8 | Y | 8 | N | 5 | N | 6 | N | 8 | Y | 9 | Y | 8 | N | 8 | N | 6 | Y | 9 | Y | 9 | N | 8 | N | 6 | Y | 10 | N |
| 13 | 10 | Y | 6 | N | 10 | N | 8 | N | 9 | N | 8 | N | 6 | N | 3 | N | 8 | Y | 10 | Y | 5 | N | | | 8 | N | 9 | N | 5 | N | 8 | N | 9 | N | 8 | N | | | 5 | N | 9 | N | 5 | N | 8 | N | 5 | N | 8 | N | 8 | N | 5 | N | 8 | N | 6 | N |
| 14 | 9 | N | 9 | N | 10 | N | 4 | N | 8 | N | 8 | N | 4 | N | 8 | N | 8 | Y | 8 | N | 6 | Y | 6 | N | 8 | N | 8 | N | 8 | Y | 8 | N | 8 | N | 8 | N | 5 | N | 6 | N | 8 | Y | 8 | N | 8 | N | 8 | N | 8 | Y | 9 | N | 8 | N | 6 | N | 8 | N |
| 15 | 10 | Y | 10 | Y | 10 | Y | 8 | Y | 9 | N | 8 | Y | 8 | Y | 6 | Y | 9 | Y | 9 | Y | | | 8 | N | 9 | N | 8 | Y | 6 | Y | 8 | Y | 8 | N | 9 | Y | 8 | Y | 6 | Y | 9 | Y | 8 | N | 9 | Y | 8 | Y | 8 | Y | 8 | Y | 6 | Y | 8 | Y | 9 | Y |
| 16 | 10 | Y | 9 | Y | 10 | N | 9 | Y | 8 | N | 8 | Y | 10 | Y | 5.5 | N | 8.5 | Y | 10 | Y | 8 | Y | 6 | N | 10 | Y | 9 | Y | 7 | Y | 10 | N | 8.5 | N | 10 | N | 2.5 | N | 8.5 | N | 8.5 | N | 4.5 | N | 8.5 | N | 8.5 | Y | 10 | Y | 8.5 | N | 8 | N | 3 | Y | 8 | N |
| 17 | 10 | N | 10 | N | 10 | N | 3 | Y | 8 | N | 8 | Y | 6 | N | 10 | N | 4 | Y | 10 | N | 3 | N | 8 | N | 6 | N | 6 | N | 5 | N | 10 | Y | 10 | N | 10 | Y | 10 | N | 8 | N | 9 | Y | 8 | N | 9 | N | 4 | Y | 8 | N | 9 | N | 9 | N | 3 | N | 9 | Y |
| 18 | 8 | Y | 8 | N | 10 | N | 6 | N | 8 | N | 8 | Y | 8 | N | 9 | N | 9 | Y | 8 | N | 6 | N | 6 | N | 9 | N | 8 | Y | 8 | Y | 8 | Y | 9 | N | 8 | N | 6 | N | 6 | N | 8 | Y | 8 | N | 8 | N | 6 | N | 8 | N | 8 | N | 8 | N | 8 | N | 9 | N |
| 19 | 8 | Y | 8 | N | 10 | N | 9 | Y | 10 | N | 8 | Y | 8 | N | 6 | N | 8 | Y | 9 | N | 6 | N | 5 | N | 8 | N | 8 | N | 8 | Y | 9 | N | 9 | N | 9 | N | 8 | N | 6 | Y | 9 | Y | 6 | N | 6 | N | 8 | N | 9 | N | 9 | N | 8 | N | 6 | N | 10 | N |
| 20 | 10 | Y | 9 | Y | 10 | N | 8 | Y | 9 | N | 8 | Y | 6 | N | 3 | N | 8 | Y | 6 | N | 3 | N | 3 | N | 9 | N | 6 | Y | 6 | Y | 9 | Y | 9 | N | 10 | N | 6 | N | 6 | N | 10 | N | 6 | N | 8 | Y | 8 | Y | 9 | N | 10 | Y | 6 | N | 9 | N |
| 21 | 9 | N | 8 | N | 10 | N | 8 | N | 8 | N | 9 | Y | 8 | Y | 6 | M | 6 | Y | 9 | N | 5 | N | 8 | N | 8 | N | 9 | Y | 6 | Y | 9 | N | 8 | N | 10 | D | 8 | N | 9 | Y | 9 | Y | 6 | M | 8 | N | 6 | Y | 9 | Y | 9 | N | 10 | N | 8 | Y | 9 | N |
| 22 | 8 | Y | 10 | Y | 10 | N | 6 | N | 9 | N | 10 | Y | 5 | N | 5 | N | 8 | Y | 8 | N | 6 | Y | 8 | N | 9 | N | 9 | N | 6 | Y | 8 | Y | 9 | N | 10 | N | 9 | N | 8 | Y | 8 | Y | 8 | N | 9 | N | 6 | Y | 10 | N | 10 | N | 9 | N | 8 | Y | 9 | N |
| 23 | 10 | N | 8 | N | 10 | N | 6 | N | 9 | N | 9 | Y | 9 | Y | 5 | N | 8 | N | 8 | N | 6 | N | 6 | N | 9 | N | 9 | N | 6 | N | 9 | N | 9 | N | 6 | N | 5 | N | 5 | N | 9 | Y | 8 | N | 8 | N | 8 | N | 8 | N | 9 | N | 9 | N | 5 | N | 8 | N |
| 24 | 10 | Y | 9 | Y | 10 | N | 6 | N | 10 | N | 9 | Y | 9 | N | 5 | N | 8 | Y | 10 | N | 6 | N | 10 | N | 10 | N | 10 | N | 6 | N | 10 | N | 10 | N | 10 | N | 5 | N | 8 | N | 10 | Y | 8 | N | 9 | N | 6 | N | 10 | N | 9 | N | 10 | N | 8 | N | 10 | N |
| 25 | 9 | N | 9 | N | 9 | N | 9 | N | 9 | N | 9 | Y | 8 | Y | 5 | N | 6 | Y | 8 | N | 5 | N | 8 | N | 6 | N | 8 | N | 8 | Y | 9 | N | 9 | N | 6 | N | 8 | N | 3 | N | 8 | N | 8 | N | 8 | N | 8 | N | 8 | N | 8 | N | 8 | Y | 8 | N | 9 | N |
| 26 | 6 | Y | 8 | N | 6 | N | 4 | | 9 | N | 8 | Y | 5 | Y | 9 | | 8 | Y | 5 | N | 3 | N | 6 | N | 8 | N | 10 | Y | 5 | N | 6 | N | 9 | N | 6 | N | 5 | N | 4 | N | 6 | Y | 6 | N | 8 | N | 4 | N | 8 | Y | 8 | N | 9 | N | 6 | Y | | N |
| 27 | 10 | Y | 10 | Y | 10 | Y | 10 | Y | 10 | Y | 10 | Y | 8 | Y | 8 | N | 10 | Y | 10 | Y | 8 | N | 8 | N | 10 | Y | 10 | Y | 8 | Y | 10 | Y | 10 | Y | | | 3 | N | 8 | Y | 10 | Y | 10 | Y | 10 | N | 10 | Y | 10 | Y | 10 | N | 8 | N | 8 | Y | 10 | Y |
| 28 | 10 | N | 10 | N | 10 | N | 9 | N | 8 | N | 9 | Y | 6 | N | 6 | N | 10 | Y | 8 | N | 6 | N | 8 | N | 8 | N | 8 | N | 6 | N | 9 | Y | 9 | N | 8 | N | 6 | N | 9 | N | 10 | Y | 8 | Y | 9 | N | 8 | Y | 10 | Y | 8 | N | 8 | N | 8 | Y | 10 | N |
| 29 | 9 | N | 9 | Y | 10 | N | 8 | N | 10 | N | 10 | Y | 8 | N | 5 | N | 9 | Y | 9 | N | 5 | N | 8 | N | 5 | N | 6 | N | 6 | Y | 9 | Y | 8 | N | 9 | N | 5 | N | 6 | N | 9 | Y | 10 | N | 5 | N | 6 | N | 8 | N | 9 | N | 8 | N | 9 | Y | 10 | N |
| 30 | 9 | Y | 8 | N | 9 | N | 5 | N | | | 8 | Y | 8 | Y | | | 6 | N | 6 | N | 8 | N | | | 8 | N | | | 8 | N | 9 | N | 8 | N | 9 | N | 6 | N | 6 | N | 9 | N | 8 | Y | 8 | N | 8 | N | 8 | N | 8 | Y | 9 | N | | |
| 31 | 8 | Y | 6 | Y | 9 | N | 5 | N | 9 | Y | 5 | N | 5 | N | 6 | N | 8 | Y | 9 | N | 5 | N | 5 | N | 8 | N | 8 | N | 8 | Y | 9 | N | 9 | N | 8 | N | 6 | N | 5 | N | 9 | Y | 4 | N | 8 | N | 6 | N | 6 | N | 9 | Y | 8 | N | 3 | N | 8 | N |
| 32 | 8 | Y | 8 | Y | 10 | Y | 6 | Y | 10 | Y | 9 | Y | 8 | Y | 8 | Y | 9 | Y | 10 | Y | 9 | Y | 5 | Y | 10 | Y | 10 | Y | 10 | Y | 10 | Y | 10 | Y | 8 | Y | 8 | Y | 10 | Y | 6 | Y | 8 | Y | 9 | Y | 10 | Y | 9 | Y | 10 | Y | 8 | Y | 10 | Y |
| 33 | 10 | Y | 10 | N | 10 | N | 5 | Y | 9 | N | 8 | Y | 8 | N | 8 | N | 8 | Y | 9 | N | 6 | Y | 5 | N | 9 | N | 5 | N | 8 | Y | 10 | Y | 9 | N | 5 | N | 5 | N | 8 | Y | 10 | N | 6 | Y | 8 | N | 5 | Y | 9 | N | 8 | N | 9 | N | 8 | N | 10 | N |
| 34 | 10 | Y | 8 | N | 10 | N | 6 | N | 10 | N | 8 | N | 8 | N | 5 | N | 4 | N | 8 | N | 6 | N | 5 | N | 8 | N | 9 | N | 6 | N | 9 | Y | 9 | N | 10 | Y | 2 | N | 4 | N | 8 | Y | 5 | N | 9 | N | 3 | N | 5 | N | 8 | N | 6 | N | 5 | N | 8 | N |
| 35 | 8 | N | 8 | Y | 10 | N | 6 | Y | 9 | N | 6 | Y | 8 | Y | 6 | N | 8 | Y | 8 | Y | 6 | N | 6 | N | 9 | N | 8 | N | 9 | Y | 8 | N | 9 | N | 8 | Y | 8 | N | 8 | Y | 9 | Y | 8 | Y | 10 | N | 8 | Y | 9 | N | 9 | N | 8 | Y | 8 | Y | 10 | Y |
| 36 | 10 | N | 8 | Y | 9 | N | 6 | N | 10 | N | 6 | Y | 8 | N | 5 | N | 9 | Y | 8 | N | 6 | N | 6 | N | 6 | N | 8 | N | 9 | Y | 8 | N | 10 | N | 9 | N | 6 | N | 8 | N | 8 | N | 8 | N | 9 | N | 9 | N | 9 | N | 6 | N | 8 | Y | 8 | N | | |
| 37 | 10 | Y | 8 | Y | 10 | N | 6 | N | 9 | N | 8 | Y | 8 | Y | 8 | N | 8 | Y | 8 | N | 6 | N | 6 | N | 9 | | 10 | | 8 | Y | 9 | Y | 9 | N | 10 | Y | 6 | N | 8 | N | 9 | Y | 9 | N | 9 | N | 8 | Y | 8 | N | 9 | N | 9 | N | 8 | Y | 10 | N |
| 38 | 10 | Y | 8 | Y | 10 | N | 8 | Y | 6 | N | 9 | Y | 9 | N | 4 | N | 9 | Y | 8 | N | 8 | N | 4 | N | 9 | N | 9 | N | 8 | N | 10 | N | 9 | N | 8 | N | 9 | N | 8 | N | 10 | N | 9 | N | 10 | N | 8 | Y | 10 | N | 10 | N | 8 | N | 9 | Y | 9 | N |
| 39 | 10 | Y | 9 | N | 10 | N | 6 | N | 9 | N | 8 | N | 6 | N | 3 | N | 8 | Y | 10 | N | 5 | Y | 2 | N | 8 | N | 9 | N | 6 | Y | 10 | N | 8 | N | 9 | N | 2 | N | 8 | N | 10 | Y | 6 | N | 10 | N | 8 | Y | 8 | N | 9 | N | 8 | N | 8 | Y | 9 | N |
| 40 | 10 | Y | 9 | Y | 10 | N | 6 | N | 9 | N | 9 | Y | 9 | N | 4 | N | 6 | Y | 9 | N | 6 | Y | 8 | N | 9 | N | 8 | N | 8 | Y | 10 | N | 10 | N | 8 | N | 8 | N | 8 | N | 8 | N | 6 | N | 9 | N | 8 | Y | 9 | N | 8 | N | 9 | N | 8 | Y | 10 | N |
| 41 | 8 | N | 10 | Y | 8 | N | 8 | N | 6 | N | 6 | Y | 5 | Y | 4 | N | 8 | Y | 8 | N | 10 | Y | 6 | N | 6 | N | 9 | N | 9 | Y | 8 | N | 5 | N | 3 | N | 4 | N | 9 | Y | 9 | N | 2 | N | 9 | N | 10 | Y | 10 | Y | 8 | N | 9 | N | 1 | N | 10 | N |
| 42 | 8 | N | 8 | N | 10 | N | 6 | N | 9 | N | 9 | Y | 5 | N | 6 | N | 6 | Y | 10 | N | 4 | N | 4 | N | 8 | N | 8 | N | 3 | N | 8 | Y | 9 | N | 8 | N | 2 | N | 8 | Y | 9 | N | 10 | Y | 10 | Y | 2 | N | 5 | Y | 8 | N | 4 | N | 9 | Y | 9 | N |

## QUESTIONNAIRE RESULTS - CHARACTERISTICS AND REQUIREMENTS FOR TRAINING

| Respondant Number | Leadership | | Business Acumen | | Integrity | | Administrative Ability | | Energy / Passion | | Strategic Planning | | HR Management | | Multi-company experience | | Financial management | | Team player | | Disciplinary knowledge | | Mentor | | Achievement orientation | | Self Awareness | | Project Management | | Interpersonal Skills | | Drive / Ambition | | Emotional Intelligence | | International Experience | | Planning ability | | Communication Ability | | Entrepreneurial ability | | Decisiveness | | Technical competence | | Analytical / reasoning skills | | Initiative | | Conceptual skills | | Sales / Marketing ability | | Handle complexity | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | 10 | N | 10 | N | 10 | N | 6 | Y | 10 | N | 8 | Y | 8 | N | 6 | N | 8 | Y | 10 | N | 5 | N | 8 | N | 8 | N | 9 | N | 5 | N | 9 | N | 10 | N | 10 | N | 6 | N | 6 | N | 10 | Y | 10 | N | 10 | N | 5 | N | 9 | N | 10 | N | 6 | N | 6 | Y | 8 | N |
| 44 | 8 | N | 6 | Y | 10 | Y | 6 | Y | 9 | N | 8 | Y | 4 | N | 3 | N | 8 | Y | 8 | N | 3 | N | 3 | N | 6 | N | 8 | N | 9 | Y | 9 | N | 6 | N | 5 | N | 6 | N | 8 | N | 8 | Y | 6 | N | 9 | N | 3 | N | 9 | Y | 8 | N | 5 | N | 5 | N | 8 | N |
| 45 | 9 | N | 10 | N | 10 | N | 8 | N | 10 | N | 8 | N | 4 | N | 6 | N | 9 | Y | 9 | N | 6 | N | 3 | N | 10 | N | 8 | N | 4 | N | 9 | N | 10 | N | 9 | N | 3 | N | 6 | N | 8 | N | 6 | N | 10 | N | 3 | Y | 9 | N | 9 | N | 9 | N | 3 | N | 9 | N |
| 46 | 10 | N | 10 | N | 10 | N | 5 | N | 10 | N | 8 | N | 6 | N | 8 | N | 6 | N | 10 | N | 9 | N | 8 | N | 10 | N | 8 | N | 8 | Y | 9 | N | 10 | N | 8 | N | 8 | N | | N | 10 | N | 8 | N | 10 | N | 8 | Y | 9 | Y | 9 | N | 8 | N | 6 | N | | N |
| 47 | 9 | N | 9 | N | 10 | N | 6 | N | 8 | N | 9 | Y | 6 | N | 6 | N | 9 | Y | 6 | N | 6 | Y | 4 | N | 9 | N | 9 | N | 8 | Y | 6 | N | 9 | N | 10 | N | 6 | N | 8 | N | 8 | N | 8 | N | 8 | N | 5 | N | 8 | N | 9 | N | 8 | N | 6 | N | 9 | N |
| 48 | 10 | N | 10 | Y | 10 | N | 8 | N | 10 | N | 10 | N | 6 | Y | 5 | N | 8 | Y | 6 | N | 6 | Y | 7 | N | 10 | N | 10 | Y | 9 | Y | 10 | Y | 10 | N | 10 | N | 9 | Y | 9 | Y | 10 | N | 10 | N | 10 | N | 9 | Y | 10 | N | 9 | Y | 9 | N | 9 | N |
| 49 | 8 | Y | 8 | Y | 8 | N | 5 | N | 9 | N | 9 | Y | 8 | Y | 5 | N | 6 | Y | 5 | N | 5 | N | 5 | N | 9 | N | 5 | N | 5 | Y | 5 | N | 9 | N | 5 | N | 4 | N | 8 | N | 8 | N | 8 | N | 8 | N | 8 | Y | 8 | Y | 8 | N | 8 | N | 8 | Y | 8 | N |
| 50 | 10 | Y | 6 | N | 10 | N | 5 | Y | 10 | N | 8 | Y | 3 | N | 4 | | 8 | Y | 10 | N | 3 | N | 9 | N | 9 | N | 9 | N | 5 | N | 10 | Y | 8 | N | 8 | N | 5 | N | 5 | N | 9 | Y | 8 | N | 8 | N | 5 | N | 9 | Y | 9 | N | 8 | N | 5 | N | 9 | N |
| 51 | 10 | N | 10 | Y | 10 | N | 8 | N | 6 | N | 6 | N | 5 | N | 9 | N | 6 | Y | 8 | N | 6 | Y | 6 | N | 10 | N | 8 | N | 6 | Y | 10 | N | 8 | N | 8 | N | 8 | N | 6 | N | 9 | N | 6 | N | 8 | N | 5 | Y | 6 | N | 6 | N | 6 | N | 5 | N | 10 | N |
| 52 | 9 | Y | 6 | Y | 10 | N | 6 | N | 8 | N | 9 | Y | 6 | Y | 3 | N | 8 | Y | 9 | N | 4 | N | 5 | N | 8 | N | 4 | N | 5 | Y | 10 | N | 9 | N | 8 | N | 3 | N | 5 | N | 9 | N | 6 | N | 9 | N | 6 | Y | 8 | Y | 9 | N | 6 | N | 6 | N | 9 | N |
| 53 | 9 | N | 8 | N | 10 | N | 8 | N | | N | 6 | N | 9 | Y | 3 | N | 6 | N | 6 | N | 9 | N | 1 | N | 6 | N | | N | 9 | N | 6 | N | 8 | N | | N | 3 | N | 9 | N | 8 | N | 9 | N | 9 | N | 9 | N | 8 | N | | N | 3 | N | 8 | N |
| 54 | 8 | Y | 10 | Y | 10 | N | 9 | Y | 8 | N | 8 | N | 9 | Y | 4 | N | 10 | Y | 10 | N | 8 | N | 6 | N | 9 | Y | 8 | N | 9 | N | 9 | N | 10 | N | | | 10 | N | 10 | N | 10 | Y | 8 | N | 10 | N | 8 | Y | 9 | N | 8 | N | 9 | N | 8 | Y | 9 | N |
| 55 | 10 | Y | 6 | N | 9 | N | 5 | Y | 9 | N | 9 | Y | 6 | Y | 6 | N | 8 | Y | 8 | Y | 4 | Y | 6 | N | 8 | N | 8 | N | 6 | Y | 8 | Y | 10 | N | 6 | N | 9 | Y | 8 | N | 8 | Y | 6 | N | 9 | Y | 6 | Y | 9 | Y | 8 | N | 8 | N | 6 | Y | 9 | Y |
| 56 | 6 | | 6 | | 9 | | 6 | | 8 | | 8 | | 5 | | 6 | | 6 | | 6 | | 8 | | 4 | | 6 | | 8 | | 6 | | 6 | | 6 | | 3 | | 6 | | 6 | | | 6 | | 8 | | 8 | | 6 | | 6 | | 3 | | 6 | |
| 57 | 8 | Y | 8 | N | 9 | Y | 6 | N | 9 | N | 9 | N | 10 | Y | 8 | N | 8 | Y | 8 | N | 6 | N | 10 | N | 9 | N | 10 | N | 10 | Y | 10 | Y | 9 | N | 8 | N | 8 | N | 8 | N | 8 | Y | 9 | N | 8 | N | 8 | N | 8 | Y | 9 | Y | 8 | N | 8 | Y | 8 | N |
| 58 | 9 | N | 8 | N | 10 | N | 6 | N | 9 | N | 9 | Y | 6 | N | 6 | N | 9 | Y | 8 | N | 6 | Y | 5 | N | 8 | N | 8 | N | 8 | N | 9 | N | 9 | N | 8 | N | 8 | N | 8 | N | 8 | Y | 9 | N | 8 | N | 8 | N | 6 | Y | 8 | Y | 9 | N | 8 | N | 6 | N | 8 | N |
| 59 | 10 | Y | 10 | N | 10 | N | 5 | N | 9 | N | 8 | Y | 10 | Y | 10 | | 10 | Y | 6 | N | 5 | N | 10 | Y | 9 | N | 8 | Y | 6 | Y | 10 | Y | 8 | N | 10 | Y | 8 | | 5 | Y | 10 | Y | 8 | N | 9 | N | 8 | Y | 8 | N | 9 | N | 9 | N | 7 | Y | 9 | N |
| 60 | 9 | Y | 6 | N | 10 | Y | 6 | Y | 6 | N | 6 | N | 9 | Y | 4 | N | 6 | Y | 9 | N | 9 | Y | 6 | N | 9 | N | 9 | Y | 6 | Y | 9 | Y | 8 | N | 9 | N | 2 | N | 3 | Y | 10 | Y | 4 | N | 8 | N | 8 | Y | 9 | Y | 8 | N | 8 | N | 3 | N | 8 | N |
| 61 | 10 | Y | 6 | N | 9 | N | 5 | N | 8 | N | 8 | Y | 5 | | 4 | N | 8 | Y | 9 | Y | 6 | Y | 8 | N | 8 | N | 9 | Y | 6 | Y | 8 | Y | 6 | N | 6 | Y | 3 | N | 6 | N | 9 | Y | 5 | N | 8 | Y | 6 | Y | 6 | Y | 8 | N | 5 | N | 4 | N | 8 | N |
| 62 | 9 | Y | 8 | Y | 10 | N | 3 | N | 6 | N | 8 | N | 8 | Y | 4 | N | 8 | Y | 8 | N | 5 | Y | 10 | N | 9 | N | 9 | N | 8 | Y | 9 | N | 9 | N | 9 | N | 4 | N | 6 | N | 9 | N | 5 | N | 9 | N | 8 | Y | 6 | N | 8 | N | 6 | N | 5 | N | 8 | N |
| 63 | 9 | N | 9 | Y | 10 | N | 6 | N | 9 | N | 9 | N | 5 | N | 4 | N | 8 | Y | 9 | N | 8 | Y | 4 | N | 9 | N | 6 | N | 4 | N | 8 | N | 9 | N | 4 | N | 6 | N | 8 | N | 8 | N | 4 | N | 8 | N | 6 | N | 8 | N | 9 | N | 6 | N | 5 | N | 9 | N |
| 64 | 8 | N | 8 | N | 10 | N | 7 | Y | 8 | N | 5 | Y | 9 | Y | 6 | N | 8 | N | 6 | N | 6 | N | 9 | N | 9 | N | 8 | N | 9 | N | 9 | N | 10 | N | 7 | Y | 6 | N | 7 | N | 9 | Y | 9 | N | 6 | N | 6 | N | 9 | N | 9 | N | 8 | N | 6 | N | 9 | N |
| 65 | 8 | N | 8 | N | 9 | N | 8 | N | 6 | N | 8 | N | 6 | N | 4 | N | 8 | Y | 8 | N | 6 | N | 4 | N | 4 | N | 6 | N | 4 | N | 6 | N | 6 | N | 6 | N | 2 | N | 6 | N | 6 | Y | 4 | N | 6 | N | 6 | Y | 6 | N | 6 | N | 6 | N | 4 | N | 6 | N |
| 66 | 10 | Y | 10 | N | 8 | N | 6 | Y | 10 | N | 10 | Y | 10 | Y | 6 | N | 10 | Y | 8 | N | 5 | Y | 9 | N | 8 | N | 6 | N | 8 | Y | 10 | N | 10 | N | 10 | Y | 6 | N | 9 | Y | 10 | Y | 5 | N | 10 | Y | 6 | Y | 10 | Y | 10 | N | 8 | N | 10 | Y | 8 | N |
| 67 | 8 | Y | 8 | N | 8 | N | 8 | N | 8 | N | 8 | Y | 6 | Y | 6 | N | 6 | Y | 6 | N | 6 | Y | 6 | | 6 | N | 6 | N | 6 | Y | 6 | N | 6 | Y | 6 | N | 8 | Y | 8 | Y | 6 | N | 8 | N | 8 | Y | 8 | N | 8 | N | 8 | N | 3 | N | 8 | N |
| 68 | 6 | N | 8 | Y | 9 | N | 6 | N | 8 | N | 6 | N | 5 | Y | 4 | N | 9 | Y | 9 | N | 4 | N | 6 | N | 6 | N | 9 | N | 9 | Y | 8 | N | 6 | N | 9 | Y | 8 | N | 8 | N | 9 | N | 6 | N | 10 | N | 6 | N | 5 | N | 10 | N | 4 | N | 3 | N | 8 | N |
| Responses below this line were received from the the electronic (email) questionnaires. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 69 | 9 | Y | 9 | Y | 10 | N | 7 | Y | 4 | N | 10 | Y | 9 | Y | 3 | N | 8 | Y | 3 | Y | 4 | | 5 | N | 9 | N | 9 | N | 9 | Y | 10 | Y | 8 | N | 8 | Y | 7 | N | 9 | Y | 9 | Y | 8 | N | 9 | Y | 3 | Y | 9 | Y | 9 | Y | 10 | Y | Not used for emailed questionnnaires. | | | |
| 70 | 10 | N | 10 | Y | 9 | N | 8 | N | 8 | N | 7 | Y | 7 | N | 5 | N | 7 | Y | 9 | N | 7 | Y | 5 | N | 8 | N | 8 | N | 7 | N | 9 | N | 8 | N | 8 | N | 7 | N | 7 | N | 10 | Y | 7 | N | 8 | N | 7 | Y | 8 | N | 8 | N | 8 | N | | | | |
| 71 | 7 | N | 8 | N | 9 | N | 7 | N | 8 | N | 8 | N | 7 | N | 3 | N | 7 | Y | 9 | N | 6 | N | 5 | N | 9 | N | 6 | N | 8 | N | 8 | N | 9 | N | 7 | N | 5 | N | 7 | N | 7 | N | 7 | N | 9 | N | 8 | Y | 9 | Y | 8 | N | 6 | N | | | | |
| 72 | 9 | N | 9 | Y | 10 | N | 6 | Y | 9 | N | 9 | Y | 8 | Y | 7 | N | 8 | Y | 9 | N | 8 | Y | 8 | N | 8 | N | 10 | N | 7 | Y | 9 | Y | 8 | N | 9 | N | 6 | N | 7 | Y | 8 | Y | 7 | Y | 8 | N | 7 | Y | 8 | Y | 8 | N | 9 | Y | | | | |
| 73 | 9 | N | 7 | Y | 8 | N | 6 | N | 7 | N | 7 | N | 8 | N | 7 | N | 7 | Y | 6 | N | 5 | Y | 8 | N | 8 | N | 8 | N | 7 | N | 8 | N | 9 | N | 7 | N | 5 | N | 8 | Y | 8 | Y | 9 | Y | 9 | Y | 7 | Y | 8 | Y | 9 | N | 9 | N | | | | |
| 74 | 8 | Y | 9 | Y | 10 | N | 4 | Y | 7 | N | 8 | Y | | Y | 3 | N | 8 | Y | 8 | Y | 7 | Y | 6 | Y | 8 | N | 9 | Y | 5 | Y | 9 | Y | 8 | N | 10 | Y | 4 | Y | 5 | Y | 7 | Y | 6 | Y | 6 | Y | 6 | Y | 8 | Y | 7 | N | 7 | Y | | | | |
| 75 | 9 | Y | 9 | Y | 10 | N | 8 | N | 10 | N | 8 | Y | 8 | Y | 7 | N | 9 | Y | 9 | N | 9 | Y | 8 | N | 8 | N | 10 | Y | 9 | Y | 8 | N | 8 | N | 7 | N | 9 | Y | 9 | Y | 8 | N | 9 | N | 10 | Y | 9 | Y | 9 | N | 9 | N | | | | | | |
| 76 | 8 | | 9 | | 10 | | 1 | | 8 | | 1 | | 8 | | 8 | | 8 | | 1 | | 7 | | 1 | | 10 | | 10 | | 10 | | 7 | | 10 | | 6 | | 10 | | 5 | | 8 | | 8 | | 10 | | 8 | | 10 | | 10 | | 10 | | | | | |
| 77 | 10 | Y | 9 | Y | 10 | N | 2 | N | 9 | N | 10 | Y | 8 | Y | 5 | N | 8 | Y | 10 | Y | 1 | N | 9 | Y | 10 | Y | 10 | Y | 10 | | 10 | Y | 10 | N | 10 | Y | 8 | Y | 10 | Y | 10 | Y | 7 | Y | 9 | Y | 5 | Y | 8 | Y | 7 | N | 7 | Y | | | | |
| 78 | 10 | N | 8 | N | 10 | N | 8 | N | 8 | N | 8 | N | 8 | N | 8 | N | 9 | Y | 9 | N | 8 | Y | 8 | N | 10 | N | 8 | N | 8 | Y | 9 | N | 10 | N | 10 | N | 8 | N | 9 | N | 8 | N | 8 | N | 8 | N | 8 | N | 10 | Y | 10 | N | 9 | Y | | | | |
| 79 | 10 | N | 10 | N | 10 | N | 8 | N | 8 | N | 10 | N | 8 | N | 5 | N | 9 | N | 8 | N | | | 6 | N | 9 | N | 8 | N | 10 | N | 9 | N | 9 | N | 7 | N | 6 | N | 10 | N | 10 | N | 8 | N | 10 | N | 7 | Y | 10 | N | 9 | N | 9 | N | | | | |
| 80 | 10 | Y | 8 | N | 9 | N | 7 | N | 8 | N | 9 | Y | 5 | N | 7 | N | 7 | N | 4 | N | 1 | N | 3 | N | 7 | N | 5 | N | 3 | N | 8 | N | 7 | N | 7 | N | 7 | N | 6 | N | 9 | N | 6 | N | 8 | N | 7 | N | 6 | N | 8 | N | 8 | N | | | | |
| 81 | 10 | Y | 9 | Y | 10 | N | 7 | N | 9 | N | 8 | Y | 9 | Y | 7 | N | 7 | Y | 10 | Y | 6 | Y | 8 | N | 9 | N | 9 | Y | 6 | Y | 9 | Y | 9 | N | 10 | Y | 8 | N | 8 | Y | 9 | Y | 9 | N | 8 | N | 6 | N | 9 | Y | 9 | N | 8 | N | | | | |
| 82 | 7 | Y | 8 | Y | 10 | N | 8 | Y | 9 | N | 5 | Y | 5 | Y | 8 | N | 8 | Y | 8 | N | 8 | N | 6 | N | 6 | N | 8 | Y | 7 | Y | 8 | Y | 8 | N | 9 | N | 3 | Y | 6 | N | 7 | Y | 3 | N | 6 | N | 8 | Y | 9 | N | 7 | N | 7 | N | | | | |

## QUESTIONNAIRE RESULTS - SECTION C - TRAINING TYPE AND STAGE

The table below shows the results from Section C of the questionnaire. For a number of skills / attributes it lists respondants' views of the type of training and the stage of an engineers career that training should occur in order to be most effective.

| Respondant Number | Leadership | | Strategic planning | | Financial mangement | | Project management | | Legal awareness | | Communication skills | | Further technical skills | | Change management | | Economics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | J | C | Q | D | Q | B | Q | C | V | C | J | B | V | C | V | C | Q | B |
| 2 | J | D | V | C | Q | C | Q | B | Q | C | V | B | Q | B | V | C | Q | C |
| 3 | V | B | V | C | V | B | J | B | J | C | J | B | Q | A | J | C | | |
| 4 | J | B | V | C | Q | B | V | A | V | A | J | B | V | A | V | C | Q | B |
| 5 | V | C | J | D | V | C | J | C | J | D | V | B | V | B | J | C | J | C |
| 6 | V | C | Q | D | Q | C | V | B | V | C | V | A | | | J | C | | |
| 7 | J | all | V | | Q | B | V | B | Q | C | V | B | J | C | V | C | Q | B |
| 8 | Q | C | Q | B | Q | B | Q | B | V | C | V | | Q | B | Q | A | Q | A |
| 9 | J | C | Q | B | Q | C | | | J | D | Q | A | Q | A | J | C | Q | A |
| 10 | | | | | | | | | | | | | | | | | | |
| 11 | Q | D | Q | D | Q | C | Q | C | V | C | V | C | V | C | Q | C | Q | C |
| 12 | O | E | V | A | J | C | V | A | J | D | V | B | J | C | J | C | J | B |
| 13 | J | C | J | D | Q | A | J | C | J | C | J | C | | | J | C | J | C |
| 14 | J | C | J | D | J | B | V/J | C | J | C | J | B | J | B | J | C | J | C |
| 15 | J | all | J | C/D/E | Q/V | A/B/C | Q/V/J | A/B/C/D | J | B/C | V/J | all | V | C | J | C/D/E | Q/V | B/C |
| 16 | J | C | V | C | V | D | V | B | J | D | V | B | J | C | J | D | V | C |
| 17 | V | B | V | B | Q | B | Q | A | V | C | V | B | V | B | V | D | V | B |
| 18 | J | D | J | D | V | D | V | B | V | B | V | B | V | B | V | C | V | C |
| 19 | Q | C/D | Q | D/E | Q | C/D | Q/V | A/B | Q | B/C/D/E | J | B/C/D/E | Q | B/C | Q | B/C | J | A/D |
| 20 | J | all | Q | B | Q | B | Q | B | Q | D | J | B/C/D | | | | | Q | B |
| 21 | V | C | Q/V | C | V | A/B | V | A | J | C | V | B | J | B | V | B/C | Q | A |
| 22 | V | C | Q | D | Q | B | V | B | V | C | V | B | V | B | Q | C | Q | A |
| 23 | J | C | V | B | J | C | J | B | J | D | J | B/C/D/E | J | B | J | C | J | C |
| 24 | Q | B | V | C | Q | B | V | B | J | B | V | C | V | B | V | C | V | C |
| 25 | V | D | V | D | Q | C | V | C | J | C | J | C | V | C | J | C | V | C |
| 26 | J | E | V | B | Q | A | V | C | V | C | V | B | V | B | V | C | V | C |
| 27 | V | B | V | C | Q | A | V | B | V | C | Q | A | Q | A | V | C | Q | B |
| 28 | J | B | Q | D | Q | A | J | C | J | E | J | C | J | B | J | D | Q | C |
| 29 | J | B | Q | A | Q | C | J | B | V | C | V | A | V | B | J | C | O | |
| 30 | | | | | | | | | | | | | | | | | | |
| 31 | V | C | J | E | V | B | V | B | J | C | V | B | J | B | J | C | V | B |
| 32 | Q | All | V | B | Q | A | Q | A | Q/J | A | Q | A | Q | A | Q | A | V/J | A |

## QUESTIONNAIRE RESULTS - SECTION C - TRAINING TYPE AND STAGE

| Respondant Number | Leadership | | Strategic planning | | Financial mangement | | Project management | | Legal awareness | | Communication skills | | Further technical skills | | Change management | | Economics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | V | B | V | B | Q | A | V | B | J | C | V | B | Q | B/C | V | C | V | C |
| 34 | V | C | V | D | Q | A | Q | A | Q | A | V | B | J | B | V | C | Q | A |
| 35 | O | B | V | C | V | C | Q | A | V | B | V | B | J | C | J | C | V | B |
| 36 | J | B | V | A | Q | C | Q | C | J | D | J | B | J | B | J | B/C | Q | A |
| 37 | V | C | V | C | V | C | V | B | V | C | V | B | Q | B | V | C | V | B |
| 38 | V | B | V | B | Q | A | J | B | V | C | Q | A | Q/V | B | J | C | V | C |
| 39 | V | C | J | D | V | D | V | D | V | E | V | B/C | | | | | | |
| 40 | J | B | V | C | V/J | C | V/J | C | V | C | V/J | V | V/J | B | J | D | V | A |
| 41 | J | C/D | V | C | Q/V | C/D | Q/V | B/C | J | C | J | B | J | B | V/J | C | Q/V | C/D |
| 42 | J | C | V | C | V | C | Q | B | V | E | Q | A | | | | | J | D |
| 43 | J | B | J | B | V | C | J | B | V | C | Q | A | J | B | J | D | Q | A |
| 44 | V | C | V | C | V | D | J | B | J | B | V | B | J | B | J | B/C | V | D |
| 45 | Q | C | Q | D | Q | A | Q | A | Q | D | V | A | Q | A | J | C | Q | A |
| 46 | J | E | J | E | Q | B | Q | A/B | J | E | J | E | Q | B | J | E | J | E |
| 47 | V | C | V | C | V | D | J | D | J | C | J | C | | A | V | C | J | D |
| 48 | J | B | J | C | Q | C | Q | A/B | Q | C | J | A/B | Q | B | J | B/C | Q | A |
| 49 | J | C | V | C | V | C | Q | B | V | C | J | B | V | B | J | D | V | C |
| 50 | J | C | V | C | Q | B | Q | A | Q | B | V | C | Q | B | Q | C | Q | A |
| 51 | O | B | J | C | V | C | V | C | V | C | V | B | Q | B | V | C | Q | B |
| 52 | Q/V/J | A/B/C/D | Q | C | Q | B/D | Q | B/C | Q/J | A/B/C/D | J | B/C/D | | | J | C/D | Q | A/D |
| 53 | J | A | J | B | J | B | J | B | J | C | | A | V | B | V | C | J | A |
| 54 | V | B/C | V | C | Q | B | V | C | J | C | Q | A/B | O | A/B/C/D | | | V | C |
| 55 | V | B | V | C | V | C | V | B | J | C | V | B | Q | C | J | C | J | D |
| 56 | J | | J | | V | | J | | V | | J | | J | | | | V | |
| 57 | J | B | Q | C | J | B | J | C | J | B | J | C | Q | B | J | C | Q | B |
| 58 | J | C | V | C | Q | B | V | A | V | B | V | B | V | B | V | C | J | D |
| 59 | J | all | Q/J | C | Q/V | all | V | B/C | J | all | J | all | | | Q/J | C | Q | B |
| 60 | Q | A | J | C | Q | A | Q | A | Q | A | Q/V | A/B/C/D | V | B | J | D | Q | A |
| 61 | V/J | B/C/D/E | V | C/D | V | A/B/C | V/J | A/B/C | J | C | V/J | all | Q/V | B/C | V/J | C/D | | |
| 62 | J | C | J | C | J | C | V | B | J | C | V | A | J | B | J | C | J | C |
| 63 | J/O | B/C | V | D | V | C | | | J | C/D | V/J | all | | | J | B/C/D/E | J | C |
| 64 | V/J | B/C | Q | A/B | Q/V/J | all | Q/J | B/C | J | D | Q/V/J | all | Q/J | A/B | J | B/C | Q/J | A/D |
| 65 | J | C | J | C | Q | C | J | C | J | C | V | C | J | C | J | C | Q | C |
| 66 | V | B | Q | C | Q | C | J | A | V | C | V | A | J | B | J | C | Q | D |
| 67 | Q | C/D | Q | C/D | Q | C/D | Q | C/D | Q | C/D | Q | C/D | Q | C/D | V | C/D | V | C/D |
| 68 | J | C | J | C | | A/B | Q | A | J | B | J | B | V | B | J | C | J | E |

**QUESTIONNAIRE RESULTS - SECTION C - TRAINING TYPE AND STAGE**

| Respondant Number | Leadership | | Strategic planning | | Financial mangement | | Project management | | Legal awareness | | Communication skills | | Further technical skills | | Change management | | Economics | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | |
| 69 | J | C | Q | A | Q | A | Q | A | J | C | V | C | | | J | C | Q | A |
| 70 | V | C | Q | A | Q | A | J | B | V | C | J | B | | | J | D | | |
| 71 | J | D | J | D | Q | C | V | C | V | C | V | B | V | B | J | D | V | D |
| 72 | M | C | Q | A | Q | A | V | B | J | C | V | B | V | B | J | C | M | A |
| 73 | M | B | J | C | V | B | J | C | V | A | V | A | V | B | J | C | V | A |
| 74 | J | D | M | E | Q | A | Q | A | O | C | Q | A | | | M | E | O | A |
| 75 | V | D | V | C | Q | B | V | C | V | C | J | B | Q | D | V | C | | |
| 76 | | | | | Q | | J | | Q | | | | J | | J | | Q | |
| 77 | V | D | Q | C | Q | C | Q | A | V | B | V | A | Q | A | M | E | V | C |
| 78 | M | C | J | C | Q | A | J | C | J | D | V | C | V | C | V | D | Q | Q |
| 79 | J | C | Q | A | Q | A | Q | A | Q | A | J | C | Q | C | J | C | Q | A |
| 80 | J | D | J | B | | | | | J | C | J | B | | | | | | |
| 81 | Q | C | V | C | V | D | J | A | J | D | V | D | J | C | Q | C | J | D |
| 82 | J | C | V | C | J | B | V | B | J | C | J | B | V | B | J | C | J | C |

## QUESTIONNAIRE RESULTS - SECTION C - TRAINING TYPE AND STAGE

| Respondant Number | HR management | | Logistics / supply chain | | Information management | | Business acumen | | Administration | | Analytical / reasoning skills | | Sales / marketing | | Accounting skills | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | J | C | J | C | J | C | J | C | V | B | Q | A | V | C | Q | C |
| 2 | Q | B | Q | B | V | B | J | C | V | C | V | C | Q | C | Q | C |
| 3 | V | C | J | C | J | C | V | C | J | V | | | V | C | | |
| 4 | J | C | J | C | J | D | J | B | J | C | J | A | V | B | V | B |
| 5 | J | C | J | C | J | C | | | J | B | V | B | J | C | J | C |
| 6 | | | | | | | J | D | | | V | C | | | Q | B |
| 7 | Q | C | J | B | V | A | J | D | J | B | V | B | V | C | Q | B |
| 8 | Q | A | V | B | Q | A | Q | B | Q | A | Q | A | Q | A/B | V | B |
| 9 | J | B | J | B | J | B | J | C | Q | B | J | B | J | C | Q | A |
| 10 | | | | | | | | | | | | | | | | |
| 11 | Q | C | V | C | Q | C | V | D | J | C | V | C | V | C | Q | C |
| 12 | J | C | J | C | V | A | O | E | V | A | J | B | V | A | V | A |
| 13 | J | C | J | C | J | C | | | J | C | Q | | J | B | Q | A |
| 14 | J | D | J | C | J | C | V/J | C | J | B | J | B | J | C | J | C |
| 15 | V/J | C/D/E | J | C/D/E | V/J | D/E | V/J | all | J | C/D | V/J | all | V/J | B/C/D | V/J | A/B/C/D |
| 16 | V | C | J | B | V | B | J | C | J | C | J | C | V | C | V | C |
| 17 | | | Q | A | V | A | J | B | J | B | V | B | J | A/B | V | B |
| 18 | V | C | J | C | V | B | J | B | J | B | J | B | J | B | J | C |
| 19 | V | C | J | B/C | J | A/B/C | V | C | J | B | Q/V | A/B | J | B | J | B/C |
| 20 | J | C/D | | | J | A/B/C/D | Q/J | A/B/C | J | B/C/D | Q | A | J | B/C | Q | B/C |
| 21 | V | B | V | B | Q | A | Q/V | A/B | J | B | V | B | J | C | Q/V | A/B |
| 22 | V | C | V | B | V | B | V | B | | | Q | C | V | C | Q | A |
| 23 | V | D | V | B | V | A/B | J | C | J | B/C | J | C | J | C | J | |
| 24 | V | C | J | C | J | C | V | C | J | B | V | B | J | C | J | C |
| 25 | J | C | J | C | J | C | J | C | J | C | J | C | V | C | V | C |
| 26 | V | C | V | B | Q | A | J | C | V | B | J | B | V | B | V | B |
| 27 | V | B | J | C | V | B | V | B | V | B | Q | A | V | B | V | B |
| 28 | J | C | J | C | J | C | J | C | J | B | J | B | J | C | Q | A |
| 29 | J | B | V | C | V | B | Q | C | J | C | O | | J | C | V | C |
| 30 | | | | | | | | | | | | | | | | |
| 31 | J | C | J | C | J | B | V | B | J | B | J | B | J | B | J | B |
| 32 | J | A | Q | A | J | A | Q | A | J | A | Q | A | J | A | Q | A |

## QUESTIONNAIRE RESULTS - SECTION C - TRAINING TYPE AND STAGE

| Respondant Number | HR management | | Logistics / supply chain | | Information management | | Business acumen | | Administration | | Analytical / reasoning skills | | Sales / marketing | | Accounting skills | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | J | C | J | B | | | J | B | Q | C | Q/V | A/B | V | C | Q/V | A/B |
| 34 | Q | A | Q | A | Q | A | J | C | J | B | J | B | V | B | Q | A |
| 35 | V | B | Q | A | V | B | Q | A | V | B | V | B | V | B | Q | A |
| 36 | J | B | J | C | J | C | Q | C | J | B | J | B | J | C | Q | A |
| 37 | J | C | J | C | J | C | J | D | J | C | V | B | J | D | V | C |
| 38 | J | C | J | C | Q | A | J | C | J | C | V | B | V | C | V | A |
| 39 | | | | | V | B | | | | | | | V | D | | |
| 40 | J | D | J | D | J | C | J | C | J | C | J | C | V/J | C | V/J | A |
| 41 | V/J | C/D | V/J | B/C | J | B/C | J | C | J | C | J | B/C | J | C/D | V/J | C/D |
| 42 | J | D | J | D | J | C | V | B | J | D | V | A | V | A | J | C |
| 43 | Q | A | V | C | J | B | J | C | J | B | Q | A | V | D | Q | A |
| 44 | V | D | J | B | J | C | V | C | J | B | V | B | V | C | J | B |
| 45 | J | C | J | C | J | C | J | C | J | C | Q | A | J | C | Q | A |
| 46 | J | E | J | E | J | E | J | E | J | E | J | B | J | E | J | E |
| 47 | J | D | J | D | V | C | | | J | C | V | B | J | C | J | C |
| 48 | J | C/D | J | C/D | J | B/C/D | J | B/C/D | J | C/D | J | A/B/C | V | C/D | Q/J | C |
| 49 | J | C | J | C | J | B | J | D | V | C | J | C | J | C | V | C |
| 50 | V | C | V | B | J | C | J | C | J | C | J | C | V | B | Q | A |
| 51 | J | C | J | C | J | C | Q | D | J | C | O | B | J | C | J | C |
| 52 | Q/J | B/C/D | J | C/D | Q | A/B | Q | B/C | J | B/C/D | Q/O | A/C | J | C/D | Q | A/B |
| 53 | V/J | | J | C | | C | J | C | J | C | V | A | J | D | V | C |
| 54 | V | B | J | C | Q? | B | J | C/D | J | B | Q | A | V/J | C | Q | B |
| 55 | V | B | J | C | V | C | J | C | J | B | V | B | V | C | V | C |
| 56 | V/J | | J | | V | | V | | V | | V | | J | | V | |
| 57 | Q | B | | | J | C | | | | | | | | | Q | B |
| 58 | J | C | J | C | J | C | J | C | J | B | J | B | J | C | V | C |
| 59 | Q/J | C | J | C | J | C | J | all | J | all | J | all | J | C/D | Q/V/J | A/B/C/D |
| 60 | V | B/C | J | C | V | B | V | C | V | C | Q | A | J | C | V | C |
| 61 | J | C | J | C | V/J | B | J | C | | | | | | | | |
| 62 | J | B | J | B | J | A | J | B | J | A | J | A | J | B | J | C |
| 63 | J | B/C | | | O | C/D | V/J | B/C/D | V | A/B | V | B | J | C | V | B/C |
| 64 | Q/J | A/B/C | Q/J | B/C | J | C/D | J | all | Q/J | A/B/C | Q/J | A/B/C | J | D | J | C/D |
| 65 | J | C | J | C | J | C | J | C | J | C | J | C | J | C | Q | C |
| 66 | Q | B | Q | C | V | B | J | C | J | B | V | B | Q | B | Q | C |
| 67 | V | C/D | V | C/D | V | C/D | V | C/D | V | C/D | Q | C/D | V | C/D | V | C/D |
| 68 | V | C | V/J | B | V/J | B | J | B | J | B | J | A/B | V | B | V | C |

**QUESTIONNAIRE RESULTS - SECTION C - TRAINING TYPE AND STAGE**

| Respondant Number | HR management | | Logistics / supply chain | | Information management | | Business acumen | | Adminstration | | Analytical / reasoning skills | | Sales / marketing | | Accounting skills | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | |
| 69 | Q | A | | | J | C | V | A | J | B | Q | A | Q | A | Q | A |
| 70 | J | C | J | C | J | C | Q | C | Q | C | | | | | V | C |
| 71 | V | C | D | C | J | C | J | B | J | B | Q | A | V | B | V | B |
| 72 | V | C | J | D | V | B | M | D | J | B | J | B | V | D | Q | A |
| 73 | J | C | V | B | V | A | J | C | J | B | V | A | J | B | V | A |
| 74 | | | V | | | | | D | | | | A | Q | D | J | C |
| 75 | V | C | J | C | V | C | J | C | J | B | V | | Q | D | V | C |
| 76 | J | | J | | Q | | | | J | | | | | | Q | |
| 77 | V | C | | | Q | Q | V | C | | | V | B | V | B | V | C |
| 78 | V | C | V | C | J | C | | | J | C | Q | Q | J | C | Q | A |
| 79 | J | C | J | C | J | C | J | D | J | C | Q | A | J | C | J | C |
| 80 | | | J | C | | | | | | | | | J | B | J | D |
| 81 | J | B | | | J | B | J | C | V | B | Q | A | J | D | J | C |
| 82 | V | C | | | J | B | J | C | J | C | J | A | V | B | V | D |

## QUESTIONNAIRE RESULTS – SECTION C – TRAINING TYPE AND STAGE

### Explanatory Notes

There are two columns of data for each attribute listed in the table.

The first column indicates what type of training respondents believed was most relevant and applicable in order to develop an engineer in that attribute or skill.

**Legend – first column**

| Code | Training Type |
|---|---|
| Q | Formal qualification |
| V | Vocational training |
| J | On-the-job training |
| O | Other |

The second column indicates at what stage the suggested training type should occur.

**Legend – second column**

| Code | Stage of Career |
|---|---|
| A | At university |
| B | While in a technical role |
| C | In junour management |
| D | In mid-management |
| E | In senior management |

No response by respondents is indicated by blank cells.

Many responents indicated more than one type of training was apporpriate and/or it should occur over multiple career stages. Hence, multiple entreis for some cells.

# QUESTIONNAIRE RESULTS - QUALIFICATIONS AND MEMBERSHIPS

The table below shows the responses to part of Section C of the questionnaire. The questionnaire asked if the degrees and memberships shown were required for engineers to have a successful career in management.

| Respondant Number | MBA | Post-graduate technical degree | Other higher (Masters level) degree | Membership IEAust | Other Professional Bodies |
|---|---|---|---|---|---|
| 1 | Y | U | U | Y | U |
| 2 | Y | N | N | N | Y |
| 3 | Y | N | N | N | N |
| 4 | Y | N | U | N | Y |
| 5 | N | N | N | N | N |
| 6 | Y | U | U | U | U |
| 7 | N | N | Y | N | N |
| 8 | Y | N | N | N | N |
| 9 | Y | N | N | N | N |
| 10 | | | | | |
| 11 | Y | N | N | N | N |
| 12 | N | N | N | N | N |
| 13 | U | N | N | Y | U |
| 14 | U | N | N | N | N |
| 15 | U | Y | U | U | U |
| 16 | Y | N | Y | N | N |
| 17 | Y | N | N | N | N |
| 18 | Y | N | N | N | N |
| 19 | Y | Y | Y | N | N |
| 20 | Y | N | N | N | N |
| 21 | Y | H | H | H | H |
| 22 | Y | N | N | N | U |
| 23 | Y | N | Y | H | H |
| 24 | Y | N | N | N | N |
| 25 | Y | N | U | N | N |
| 26 | Y | N | Y | N | N |
| 27 | Y | N | Y | Y | N |
| 28 | N | N | N | N | N |
| 29 | U | H | H | H | H |
| 30 | | | | | |
| 31 | Y | N | N | N | N |
| 32 | Y | N | N | N | N |
| 33 | Y | N | U | N | Y |
| 34 | Y | N | N | U | U |
| 35 | Y | N | N | Y | N |
| 36 | N | N | N | N | U |
| 37 | Y | N | Y | Y | Y |
| 38 | N | N | N | N | N |
| 39 | U | N | N | Y | N |
| 40 | N | N | N | U | U |
| 41 | U | N | N | N | U |
| 42 | Y | N | N | N | N |
| 43 | N | N | U | N | N |
| 44 | Y | N | Y | N | N |
| 45 | U | N | U | N | N |
| 46 | N | Y | Y | Y | Y |

# QUESTIONNAIRE RESULTS - QUALIFICATIONS AND MEMBERSHIPS

| Respondant Number | MBA | Post-graduate technical degree | Other higher (Masters level) degree | Membership IEAust | Other Professional Bodies |
|---|---|---|---|---|---|
| 47 | U | N | N | N | N |
| 48 | Y | N | Y | N | N |
| 49 | Y | N | N | Y | N |
| 50 | Y | N | N | N | N |
| 51 | N | Y | N | N | Y |
| 52 | N | N | N | N | N |
| 53 | N | N | N | Y | Y |
| 54 | N | N | H | Y | Y |
| 55 | N | N | N | N | N |
| 56 | N | N | N | N | N |
| 57 | N | N | N | N | N |
| 58 | Y | U | N | Y | Y |
| 59 | N | N | N | Y | Y |
| 60 | H | H | H | Y | Y |
| 61 | N | N | N | U | U |
| 62 | N | U | U | N | N |
| 63 | H | H | H | H | H |
| 64 | N | N | N | N | N |
| 65 | N | N | N | N | N |
| 66 | Y | N | N | N | Y |
| 67 | Y | Y | Y | Y | Y |
| 68 | Y | N | N | N | N |
| Responses below this line from emailed questionnaire. | | | | | |
| 69 | N | N | N | N | N |
| 70 | N | N | N | N | N |
| 71 | N | N | Y | N | N |
| 72 | | | | | |
| 73 | N | N | N | N | N |
| 74 | U | N | N | N | N |
| 75 | Y | Y | N | Y | Y |
| 76 | Y | N | N | N | N |
| 77 | N | N | N | N | N |
| 78 | Y | N | Y | U | Y |
| 79 | Y | N | N | Y | Y |
| 80 | N | Y | U | N | U |
| 81 | U | U | U | N | N |
| 82 | N | N | N | Y | N |

**Legend**

| | |
|---|---|
| Y | - Yes |
| N | - No |
| U | - Undecided |
| H | - Helpful |
| (blank) | - No response |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| Respondant Number | Relevant comments (edited - not word for word) |
|---|---|
| 1 | Keen understanding of social systems. Maximum participation in external groups, both technical and cultural. |
| 2 | Must gain experience through engineering management first. Training and practice in finance, PM, legal, HR thru MBA or other combined with OTJ training. |
| 3 | Engineers analytical -good for CEO. Business acumen difficult to 'teach' - personality more significant. If does not have either cannot be trained to become CEO. |
| 4 | Reclassify skills as experiences, competencies and motivation. If want to manage, start ASAP and get an MBA. |
| 5 -7 | *(No comments.)* |
| 8 | Vision blended with skills, determination, confidence, energy, people skills. Develop business skills in financial, HR, marketing, operations, IT. |
| 9 | First be successful engineer. Should be natural move. CEOs need good communications skills. Clear thinking, drive and determination are key. |
| 10 | *(No comments.)* |
| 11 | Ability to process and analyse complex information and environments.Make decisions and execute. Lead by example and values of organisation. |
| 12 | Management taught but leadership inate. Other attributes - discipline in meeting deadlines;delegation; reporting controls; compensation policy for subordinates; team work structure. |
| 13 - 14 | *(No comments.)* |
| 15 | Multi cultural exeriences. Forecasting / managing change. People management skills. EQ awareness and understanding. Sales and sales management skills and experience. |
| 16 | Key is problem solving skills, leadership, emotional intelligence. Futher education beyond BE also essential. |
| 17 | Dislike HR Management - cover for bad leadership. Engineering training is in logical thinking. Develop leadership, team thinking and distilling complex to simple - these cannot be taught in an academic environment. |
| 18 | *(No comments.)* |
| 19 | Ensure good technical grounding early on. But rapid rise in technical management does not guarantee top jobs. |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| | |
|---|---|
| 20 | If time over would do a generalist degree. Good CEO needs management experience - handling people, business strategies and financial accountability. Wisdom, experience of society, some knowledge of law and economics are important. Advanced engineering has not much value. |
| 21 | Lots of experience -challenging roles and new projects. Overseas experience in developing projects. Plan career moves - min 2 yrs in each role. Business and project management most important additions to technical qualifications. Managing people well. |
| 22 | Engineering good background for business - develops logic and complexity skills. Broad foundation of experience including financial good before upper middle management. |
| 23 | Keys relate to leadership and ability to achieve change. Priorities are vision, communication, personal commitment and capacity yo work and contribute in a team environment. |
| 24 | Leadership. People management. |
| 25 | *(No comments.)* |
| 26 | Assessing people who will work for you. Understand in business it is ALL about making money - engineers do not understand this. Engineers must decide early in career what he wants - many organisations have selected management aspirants by 25 when many engineers still technical. |
| 27 | Relative importance of factors depends on organisation. Not possible to definitively cover all attributes - too many. Engineers generally good analysts, poor communicators. Those that succeed exhibit leadership, integrity, commitment, good communicators and skilful strategists. |
| 28 | There is an element of luck in progressing to CEO. Technical qualifications do not have much to do with it. Leadership, energy and communication skills are much more important. Engineering degree provides an excellent platform to build a career in senior management. |
| 29 | Engineers need: improved communication skills, improved presentation skills, detailed understanding of finance, experience and training in selling and marketing, determination and confidence, focus and passion, not expect it to happen overnight. Leadership best developed in school of hard knocks complimented with continuing formal education can lead anywhere. |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| | |
|---|---|
| 30 | Superior listener. Ability to delegate. Experience is a critical element - basic training is a necessary foundation. Tough times are extremely valuable in the long term. It is mostly about people. Some elements difficult based on training - eg handling ambiguity. Emotional intelligence is very important. |
| 31 - 33 | *(No comments.)* |
| 34 | Most important are integrity, passion, energy, leadership, emotional intelligence and genuine interest in people. Engineering degree to narrowly focused (never worked as engineer). |
| 35 | In the past the simple path to management was project work in remote areas. Now basic experience and ability to react to unexpected is essential. |
| 36 | Definitely more formal training in economics/ accountancy either at University or early in career. Marketing can come later. |
| 37 | *(No comments.)* |
| 38 | The three critical aptitudes for CEO are: technical ability (in relation to the business), ability to communicate persuasively, integrity - all three vital. MBA not critical but useful to pick up skills. Many other skills/attributes are life skills picked up by osmosis from non-business activities. |
| 39 | *(No comments.)* |
| 40 | Engineers usually good at project management, analytical thinking and problem solving. They need to add strategic planning, interpersonal skills and leadership early in career (first 5 years). Sales and/or marketing particularly useful in building required skill set. |
| 41 | Other areas: genuine commercial ability, leadership strength, critically 'people' rather than 'project' management, finance/economics/accounting/budgeting skills. |
| 42 | *(No comments.)* |
| 43 | Engineers need more Human Resources training early on. We are not good people managers. |
| 44 | *(No comments.)* |
| 45 | Formal problem solving techniques in addition to analytical skills. |
| 46 | Intuition. Ability to lead and inspire a team. CEOs are not all knowing. Selecting the right people for the job and giving them responsibility, flexibility and freedom to do their job. Have a system of reward and incentive for effort. Engineering is a great foundation for a career in management - whether in engineering or other sectors. |
| 47 - 48 | *(No comments.)* |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| | |
|---|---|
| 49 | Commonsense. Curiosity. Guts and determination. Need some financial, legal and IR skills as well as marketing and PR sense as well as obvious technical skills. Need ability to motivate others by having them share your goals - hence interpersonal skills (acquired and/or learned) are essential - a sense of humour helps with the latter. |
| 50 | *(No comments.)* |
| 51 | Many CEO types show leadership even before studying through sports etc. Training can help but does not automatically make a difference. Some people will always surprise - there is often an element of luck and timing. Many 'successful' CEOs put family behind career. Let young professionals grow without constraining them with procedures - ie recognise flair along with 'qualifications'. |
| 52 | Finance degree / training would help. Integrity very important. Financial / commercial training is very important. Must understand the equity market (for public companies). Presentation skills very important. Must understand that the people who do the work are the most important people in the company - must ensure that people at every level are well led. CEOs must understand they are working for the owners of the company (shareholders). The higher the level in the organisation the longer the timespan of discretion (vision). Managers must earn the respect of their employees - it is not a god given right. |
| 53 | During university vacations work **every** holiday in a manual engineering job to understand and relate to the work force. This is not available after graduation. |
| 54 | Team leadership is the key to success. You must build a **team** The leader must understand each facet of the business. The leader must be recognised as best qualified in at least one facet. Can't be best in everything but need to appreciate others problems in order to guide them. An ability to critically analyse problems and suggest a course of action makes for good team spirit. Conversely get advice from experts whenrequired. Some, at least informal, training is essential in finance and management and generally marketing. |
| 55 | Engineers' training provides a good basis for success in management. Problem solving, not accepting 'facts' at face value, creative thinking, logical thinking are all needed in management. There is also a necessity to want to exercise power and ambition to achieve control of the resources to do so. |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| | |
|---|---|
| 56 | The stage of career and type of training for an individual is specific to the individual. Exposure to most skills/attibutes starts at undergraduate level. That way engineers are aware of information and opportunities that may otherwise be wasted. I have little faith in MBAs as I believe they are more suited to mega-nationals and those trying to make a step to which they are potentially unsuited. Done at a very challenging school they seem to work. |
| 57 | Skills/Attributes - ability to listen, integrity (people watch what you do not what you say), energy and drive, stamina, ability to pick great people, ability to build great teams, clear/honest feedback. Training - financial skills, management skills, leadership skills. |
| 58 | Engineers need broad management skills including strong financial skills to compete for senior management positions. They need to have strong interpersonal skills to deliver internal leadership and external networking (opportunity creation). |
| 59 | An appropriate set of personal values is critical; a keen ability to listen; ability to apply sound judgment; good luck; strongly developed internal locus of control; networking^2. Don't believe engineers compete against other professions per se for manager roles. Really all about establishing solid core competenices, demonstrating success and ongoing self development combined with appropriate networking to create career opportunities. |
| 60 | *(No comments.)* |
| 61 | Ability to manage relationships at all levels. |
| 62 | Young engineers need to focus on good interpersonal skills - good communications (written and verbal) - good man-management skill and good leadership qualities. These, coupled with a sound engineering background will provide excellent opportunity for individuals to rise through the business ranks. |
| 63 | Core is clear sense of purpose and own view of career. Individuals need to have plans with 5-7 year horizons but against a vision. Communication, leadership, integrity, energy / passion and sense of purpose are core elements. Engineers need to develop / be exposed to the commercial aspects of running a business - you cannot build business acumen unless you have an understanding of both halves and people skills. |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| | |
|---|---|
| 64 | No distinction is made with regard to the size of the company which I believe is important. In a larger enterprise a more varied and extensive support structure exists whereas in a small company a greater degree of flexibility is required. Public perception places engineers in 'boxes', especially relating to discipline of expertise. Too many of today's engineering graduates leave university with double degrees and no commercial skills or experience. They then follow corporate careers without ever 'practising' as engineers. A high percentage of my peers have pursued careers without stepping beyond or out off the limitations due to conservatism which is reinforced in undergraduate training. |
| 65 | Attending an 'in-house' management school is invaluable for an engineer mid-career particularly if there is a good mix of professions in attendance. To compete more effectively against other professions in management roles it is essential that engineers develop a strong understanding of accounting, economics and financial management because this is a significant part of most areas of management. |
| 66 | The best CEOs: have a broad knowledge of all the key business functions (IT, engineering, supply chain, HR, finance, sales and marketing); have strong selling skills - need to be able to lead the company's sales activities; be financially literate enough to understand financial statements (P&L, balance sheet and cashflow); have strong strategic vision - difficult to teach this, but not impossible to learn; most importantly have high emotional intelligence and strong empathy for your staff or they won't strive for you. Best training is a combination of an MBA and to move into a sales role within 3-6 years of graduation. |
| 67 | People management, leadership, financial understanding are important. |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| | |
|---|---|
| 68 | It is difficult for engineers to stay technical and progress in Australia. If they wish to expand into business and management then their logical and structured approach helps, but they should also be able to see the bigger picture and visualise all potential outcomes. Financial management is important but if you have good support it is less important. MBAs and similar are good adjuncts if engineers desire to move into these directions but not absolutely necessary. Engineers should have the advantage in technical based businesses, but flexibility, an understanding of hearts and mindsets; together with some business acumen and a bit of entrepreneurial flare would help a lot. Business is not just numbers. |
| Emailed responses below this line. | |
| 69 | *(No comments.)* |
| 70 | To succend in management scientists/engineers need: ability to deal with people and business understanding. Nature of degree less important once out of university. Engineers good at numbers, analysis and problem solving. Real power is when good engineer can combine technical, people and business skills. |
| 71 | Engineers require a basic understanding of business/commerce to compete. Some accounting/financial skills are a must and these are best obtained through a formal course (eg Bcomm, Mcomm, MBA etc). |
| 72 | Be very competent in your own technical area of specialist expertise and be an exceptionally good listener who is seen by others and considers the inputs of people around him/her. |
| 73 | Executive management requires strategic planning, leadership and decisiveness. An engineering career is an ideal precursor for management but the engineer must be prepared to let go of detail and to delegate responsibility. |
| 74 | Engineers do better than most other profession in terms of the move to senior management roles. This is due to the disciplines learned in the course and the fact that a lot of engineers get exposed to business rather than technical issues at an early stage. |
| 75 | Young engineers need to develop a passion for leadership, be entrepreneurial, ability to design and drive business processes, be excellent people managers, be financially savvy and streetwise, understand how to achieve results through others. Good communication skill is essential. |
| 76 | Don't mix with the 'I can't' people. |
| 77 - 80 | *(No comments.)* |

# QUESTIONNAIRE RESULTS - GENERAL COMMENTS

| | |
|---|---|
| 81 | Engineer training impedes advancement in management - taught to act individually. Leadership and teamwork are required. Engineers tend to micro-manage employees. Young engineers need exposure to the social sciences to gain some insight into behaviour and motivation. Mentoring is critical to hear how one is performing as assessed by a third party. |
| 82 | Questions all related to requirements for an engineers career not a CEOs. Skills required for a CEO include all of the things listed - many require a combination of natural ability and training. Training for engineers should include: real world applications of theory; commercial nous; contracts experience; self-esteem development. |

Annex E

# Summary of Undergraduate Management Courses Offered at Australian Universities within Bachelor of Engineering (Mechanical) Degrees

Existing engineering courses do contain some elements of management either as a core component of the course or as available elective. In general it is thought that universities in recent times have recognised the need of wider base of education that includes some business training.

The level of units outside of the technical components varies from university to university. Most universities have some sort of 'Professional Engineering' in the first year which can include some wider issues within engineering. Work experience is also an essential component of the engineering discipline. Both of these are more of a technical nature and do not focus on management.

Another feature of the degrees on offer is the electives that are generally available. Most universities offer electives that can be taken throughout the course of studies. At some universities these are electives within the university, at others electives outside the engineering field are encouraged.

Listed below are the non-technical (management related) units[1] offered by Australian university engineering degrees in 2007. It is not an exhaustive list being picked somewhat subjectively from the university course handbooks. Thus they have only been chosen by the title and there may be significantly less management content than expected – or significantly more in courses that have technical-sounding names.

[1] All units listed are taken from a standard course structure. Some universities may allow non-standard units to be studied. Also the amount of management units at a particular institution may vary from degree to degree (eg electrical engineering may have more non-technical units than civil engineering) – where this is the case the standard mechanical engineering course has been considered.

Indeed many technical units do have components that are non-technical in nature. For example some may have a requirement to give a short presentation on a technical topic. These types of activities aid in the development of communication skills and can be valuable in the developing the attributes of students.

**Table E.1: Management courses in Australian Universities**

| Serial | University | No of Management Units | Standard electives |
|---|---|---|---|
| 1 | ANU | 3 | 0 |
| 2 | CDU | 3 | 3 |
| 3 | CU | 1 | |
| 4 | DU | 3 | |
| 5 | FU | 3 | |
| 6 | GU | 4 | |
| 7 | JCU | 2 | |
| 8 | Mac.U | 1 | |
| 9 | Mon.U | 1 | |
| 10 | Mur.U | 1 | 5 |
| 11 | QUT | 1 | 5 |
| 12 | RMIT | 2 | |
| 13 | SU | 3 | 1 |
| 14 | UA | 4 | |
| 15 | UM | 1 | 1 |
| 16 | UN | 0 | 2 |
| 17 | UNSW | 3 | 1 min |
| 18 | UQ | 0 | |
| 19 | USA | 3 | |
| 20 | US | 1 | 2 |
| 21 | UT | 2 | |
| 22 | UTS | 3 | |
| 23 | UWA | 1 | |
| 24 | UWS | 1 | |
| 25 | UW | 2 | |
| 26 | VU | 2 | |

As the table above demonstrates all Australian Universities offer some sort of management. Some only require one non-technical course other universities require students to complete up to four such units. In addition to this electives are offered that give additional exposure to management as a discipline.

Suitable care needs to be taken with all this data due to the subjective interpretation of the unit titles. However, it does give a general idea of the current status of management within engineering courses.

**Australian National University**

ENGN3211 Investment Decisions and Financial Systems (or specified equivalent)
ENGN3221 Engineering Management
ENGN4611 Engineering Law (or specified equivalent)

**Charles Darwin University**

CUC100 Academic Literacies
CUC107 Northern Perspective
PMO201 Project Management
Non-preferred electives:
CMA100 The Business Environment
LAW101 Introduction to Law
MKT101 Principles of Marketing

**Curtin University**

Engineering Management 302

**Deakin University**

SEB323 Managing Industrial Organisations
SEB322 Research and Design Project Management
SEB421 Strategic Issues in Engineering

**Flinders University (BE (Software Engineering) is only course in offer)**

ENGL1001 Professional English
ENGR3508 Engineering Project Management
BUSN2006 Enterprise Management

**Griffith University**

1113ICT Writing Skills I
1114ICT Writing Skills II
1115ICT Writing Skills III
4003ENG Integrated Design and Project Management

**James Cook University**

EG3000:03 Engineering Project Management (odd years)
EG4000:03 Engineering Economics and Entrepreneurship

**Macquarie University**

MPCE360 Technology Management, or
MPCE361 Technology and Management

**Monash University**

Inter-faculty (commerce) elective (in 4th year)

**Murdoch University**

ENG453 Engineering Law, Management and Ethics

**Queensland University of Technology**
MMB376 Professional Practice (Engineering Management)
For engineering management degree:
MMB476 Operations Management
MMB470 Engineering Asset Management and Maintenance
MMB402-1 Engineering Management Project
Electives:
MMB470 Engineering Asset Management and Maintenance
AMB240 Marketing Planning and Management
BSB122 Quantitative Analysis and Finance
MGB211 Organisational Behaviour
MMB451 Energy Management

**RMIT**

MIET 1199 Management of Design 12
MIET 2136 Mechanical Design 1

**Swinburne University**

Forms part of the Management and Business Studies component of the course:
HES3380 Engineering Management 1
HES5380 Engineering Management 2
HBSG200 New Venture Development and Management
Plus specialist studies units:
HBP228 Manufacturing Management

**University of Adelaide**

| | |
|---|---|
| ENTRSHIP 5023B | Project Management Project (6 units) Part 2 |
| ENG 3002 | Engineering Communication ESL/EAL |
| MECH ENG 4038 | Engineering Management and Professional Practice |
| MECH ENG 4039 | Finance for Engineers |

**University of Melbourne**

| | |
|---|---|
| 436-105 | Engineering Communications |
| Elective: | |
| 325-209 | Human Resource Management |

**University of Newcastle**

Electives:

| | |
|---|---|
| MECH4830 | Engineering Economic Analysis |
| GENG3830 | Engineering Project Management |

**University of New South Wales**

| | |
|---|---|
| MECH3000 | Professional Responsibilities |
| MANF4430 | Management for Engineers |
| MECH4001 | Communications for Professional Engineers |

Plus:

General Education Electives (minimum of 3 units) overall

**University of Queensland (only have first year units)**

| | |
|---|---|
| ENGG1000 | Introduction to Professional Engineering |

**University of South Australia**

| | |
|---|---|
| MFET 3008 | Project Planning and Control |
| MFET 5022 | Total Quality Management |
| MFET 3017 | Supply Chain Management |

**University of Sydney**

| | |
|---|---|
| MECH3661 | Engineering Management |
| Electives: | |
| MECH4611 | Industrial and Engineering Management |
| MECH4651 | Workplace Industrial Relations in Australia |

**University of Tasmania**

| | |
|---|---|
| KNE211 | Engineering Design and Project Management |
| KNE301 | Engineering Project Management and Economics |

**University of Technology Sydney**

| | |
|---|---|
| 48250 | Engineering Economics and Finance |
| 48260 | Engineering Project Management |
| 48270 | Engineering Enterprise |

**University of Western Australia**

| | |
|---|---|
| MECH2401 | Engineering Design and Visual Communication |

**University of Western Sydney**

| | |
|---|---|
| MG102A.1 | Management Foundations |

**University of Wollongong**

| | |
|---|---|
| ENGG361 | Project and Business Management |
| ENGG461 | Management and Human Factors in Engineering |

**Victoria University**

| | |
|---|---|
| VAN3052 | Engineering Management |
| VAN4051 | Engineering Project Management |