An Evaluation of Generic Skills
Outcomes in Engineering Education
In Hong Kong

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EdD Thesis

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Certificate of Originality

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written nor material which has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

(Signed)

Raymond Work

(Name of student)
Acknowledgment

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Abstract

A survey driven evaluation of the outcomes of generic skills in higher engineering education in Hong Kong was conducted. The survey techniques involved questionnaire and interviews with both recently graduated engineers and their work-related engineering managers as well as with a focus group of university academics. The results indicated that, overall, mostly the recently graduated engineers did possess adequate levels of generic-type skills to carry out their basic tasks in the workplace. However, the graduate engineers appeared to be insufficiently prepared in certain specific areas, especially for job-related problem-solving and communication skills. The study's results also indicated that the majority of the graduate engineers and the engineering managers, viewed problem-solving and communication skills are most important priorities for the engineering profession. The majority of the engineering managers also rated the graduate engineers as generally satisfactory in performing their tasks in their organization.

The results of the self evaluation of the overall knowledge and skills, relevant to the generic-type skills learned at university by the graduate engineers, indicated that a significant percentage did not have adequate generic-type skills to carry out a range of tasks in their workplace setting. The findings from the surveyed employers were of a similar nature, although some interesting differences in perception emerged. Some of the recent graduates were also critical of certain subject material content, inadequately provided in some of their university subjects.

With the political change in Hong Kong society, the strategic improvement in communication in both English and Chinese (Putonghua) becomes more critical for the
Hong Kong university graduates, because Hong Kong is closely tied with China and the Western world. Other generic-type skills, such as problem-solving techniques, inter-personal skills, team building, creative thinking, work integrity and ethics are absolutely necessary for all engineering graduates to meet the new requirements of the workplace. The importance of the generic-type skills was validated by the study results and showed agreement in these areas across industry (engineering managers) between graduate engineers and academics.

Well educated citizens in Hong Kong will determine Hong Kong’s competitiveness and its future. The process applied to teaching and learning in university and will also significantly affect future graduate engineers. Strategic improvements such as stressing the importance of communications in both English and Chinese (Putonghua), in addition, the application of problem-based learning, work-integrated-learning and lifelong learning are recommended to be improved in teaching and learning in university education. Lifelong learning, self-motivation and sense of self-efficacy are a must for all graduates in order to meet the new challenges of this changing world.

Today, we live in an age when technology is advancing faster than at any other time in history. Educators should educate and provide graduates with generic-type skills to help them adapt intellectually to a changing world. Advances in technologies have also put engineering education at the forefront of innovation and creativity, two traits which have contributed to Hong Kong’s global status. The old misconception that engineers are only about technology, needs to be broken. Engineers who can communicate, have innovative mindset problem solving skills plus good people skills and leadership ability, as well as be technically competent and proficient are needed in the 21st century.
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Chapter 1 Literature Review

1.1 Introduction

Over the past twenty years, globalisation and modernisation have been creating an increasingly diverse and interconnected world. Technological changes have revolutionized the workplace, work patterns, job requirements and organizational structures. To make sense of and function well in this world, individuals need, for example, to master changing technologies and to make sense of large amounts of available information. Our increasingly diverse and interconnected population and the instantaneous availability of vast amounts of information represent but a few of these new demands.

This necessarily sparks related questions about what are the competencies that are most important for today’s and tomorrow’s world of work and how they can be developed and fostered at schools and at universities. In work contexts, the skills that individuals need to meet institutional and their own goals have become more complex, requiring more than the mastery of certain narrowly defined skills. As stated by the Organization for Economic Co-operation and Development (OECD) Education Ministers (2005):

“Sustainable development and social cohesion depend critically on the competencies of all of our population – with competencies understood to cover knowledge, skills, attitudes and values”.

Pithers (2000) noted that, in any field of university education, the contemporary education curriculum is a highly contested arena. Nevertheless, it should not only provide the requisite skills for effective work performance, there is a growing
consensus that it should also help students to think well and to think for themselves. Thinking well or thinking smarter than before, involves being able to identify questions worth pursuing, being able to pursue one’s questions through self-directed search and interrogation of knowledge and being able to present evidence to support one’s arguments (Ennis, 1993).

Thinking well or thinking critically involves at least two critical generic components: problem-solving and communication skills. These two generic-type skills are demanded in many professions and businesses. Nevertheless, many studies have indicated that engineering graduates lack these basic generic-type skills. Studies from the Accreditation Board for Engineering and Technology Engineering Criteria (ABET, 2000) and Comer (1987) in the US, Dearing (1997) in the UK, Education and Manpower Bureau (EMB, 2000 and 2006) in Hong Kong, Kelly (2001) in Norway and New Zealand and Todd, Sorensen and Magleby (1993) have supported these claims. Although the majority of major studies in this area have been carried out in the United States and Europe, a few were carried out in Hong Kong. The issue is just as important for Chinese higher education, including that in the Hong Kong Special Administrative Region (HKSAR).

Indeed, the Vice President of the City University of Hong Kong (Clem, 2004) commented in one report:

“Depth of knowledge in a specific discipline remains important but it is no longer sufficient. What we need is to prepare students for worldwide employability. Generic skills that cut across disciplines are the key, especially the ability and motivation to learn”.
The Vice President stated that engineering students studying only engineering disciplines may not be good enough to find good jobs; they need to have other skills such as inter-personal skills to manage people if they want to become successful and, later on, managers themselves.

The Hong Kong Special Administrative Region (HKSAR) recognized the need for the development of knowledge, skills, and competencies in the general population – through education systems and learning opportunities. The Chief Executive Officer of HKSAR, in his opening speech at the Report Session on the Progress of Education on June 14, 2003, assured the public that education had always been given top priority in the policy agenda. The education reform proposal had a strong advocating message for the development of a knowledge-based society, through nurturing quality people who possess knowledge, all roundedness, global outlook, creativity and adaptability to meet future challenges for business and industry in Hong Kong.

Angel Gurria (OECD, 2005), Secretary-General of the Organization for Economic Co-operation Development has stated:

"Quality education is the most valuable asset for present and future generations. Achieving it requires a strong commitment from everyone, including governments, teachers, parents and students themselves..."

The success of an individual and the prosperity of the society require the joint efforts of the individual and the education institution to integrate the competencies, based on the model such as that shown in Figure 1.1.
In order to identify what are the key requirements (generic-type skills) by industry and the adequacy of these skills possessed by the current graduate engineers, a study was initiated by the present researcher, to identify the graduate engineers’ and the engineering managers’ perceived importance of the generic-type skills required in their workplaces, the adequacy of these skills of the graduate engineers in carrying out their tasks and, the learned knowledge and skills in university with regard to the curriculum design. Through this study, the researcher wanted to quantify the adequacy of the learned knowledge and skills as perceived by the graduate engineers and the engineering managers in their workplaces and to evaluate a broad range of generic-type skills that the graduate engineers need in order to face the challenges of the present and the future in their careers. The results hopefully will also provide an opportunity to improve the communication in engineering education between the academic world and the industry. Last, based on the survey results obtained from this study, the researcher also aimed to provide recommendations for university educational institutions to
improve the teaching and learning of engineering education in Hong Kong and elsewhere.

1.2 Are graduate engineers equipped with the required generic skills?

The transition from university to the workplace and the matching of what graduates have learned at university to the requirements of industry are persistent themes in relevant debates (Barnett, 1994). As society becomes more complex and more integrated, the pools of knowledge and expertise acquired in university education are no longer sufficient to meet the new requirements of the workplace. There are various signs that engineering education and training are not keeping up with the new technology applications within business and the industry; thus they may be delivering graduates with inadequate and/or obsolete skills. What is now required is the ability to put that knowledge and expertise to use in unfamiliar circumstances, along with ‘flexibility’, ‘communication skills’, and ‘teamwork’ for graduates. The lack of these generic-type skills for graduate engineers has been raised by various sectors of academia and the industry.

Comer (1987) studied 94 engineers in 13 companies in the United States of America. The study was to identify what skills that engineers needed upon entering industry and what engineers typically did and the skills that they felt were necessary to accomplish their tasks in industry. Comer’s study revealed that graduates from the United States were deficient in two major areas. The first one was communication and interpersonal skills and the second one was the application of theory and knowledge into practice. The study concluded that the possible reason for the deficiencies was the higher educational system in the United States and Comer recommended making
changes in the engineering curriculum to improve the quality of engineering education outcomes in North America. Comer (1987, pg. 27) suggested that certain course curricula should be modified to enhance engineering students’ communication skills.

“To integrate the communication skills into technical courses where there would be a context in which communication skills could be applied or even to add formal writing courses to the curriculum. The bottom line is... the curriculum needs to be devoted to the development of communication skills, regardless of which department actually does the instruction”.

In the interpersonal skills category, Comer (1987, pg. 37) recommended:

“To modify curriculum so that more of the courses were conducted in a ‘group environment setting’ and should involve more ‘group project works’... Group work should be an integral part of courses and not an add-on. Group interaction skills should be developed during the full four year curriculum”.

A report by Todd, Sorensen, and Magleby (1993) identified areas of concerns for engineering graduates in the United States. These concerns were:

- No understanding of manufacturing processes.
- Lack of design capability or creativity.
- No knowledge of value engineering.
- Lack of appreciation for variation.
- Poor perception of overall engineering processes.
- Narrow views of engineering and related disciplines.
- Weak communication skills.
- Little skill or experience of working in teams.
Although Todd’s study was conducted in 1993, the same issues still appear to prevail at the present time.

Curry (1991, pg. 50) also made a strong statement about university engineering education and its application in the workplace.

“Colleges and universities are producing great scientists but mediocre engineers. As a result, engineering schools are producing entire generations of engineering faculty who have never practiced engineering... Universities should develop engineering talent that meets the requirements of American business”.

More recently, Lee (2004, pg. 2 - 3) echoed Curry’s statement and made the following comment at the ‘Future of Engineering Education in Hong Kong Forum’:

“The CEO of Hewlett Packard (HP), who has been very successful in re-engineering her Research & Development Department, is a history graduate... Very often what seems to be an obvious engineering problem is ultimately not solved by technical but by human-psychological solutions. It occurs that what industry needs nowadays are engineers or other graduates of any particular disciplines who are good at problem solving. Engineering graduates are commonly perceived as people, technically competent but rigid-minded and lacking attributes such as communication skills, people skills and management skills which are necessary pre-requisites for advancing up the management ladder.”

Lee’s comments were clear: facing a changing world, which was significantly different from that of thirty or forty years ago, engineering educators were challenged to think hard and redefine their academic roles and the curricula design. The people who excel are those who are ready to take up the challenges of tomorrow and move
with the times.

Lau (2004), the Vice-Chancellor of The Chinese University of Hong Kong, Hong Kong SAR, stressed the importance for students to develop self-learning ability and communication skills, especially in a fast-changing knowledge economy.

“In the past, it was possible for a person to stick to one job his entire life. Not any more... A graduate may change careers twice or more during his life... Our future graduates may work in Hong Kong, Shanghai or New York or three places at the same time. Therefore, it is important to ensure that they are biliterate (Chinese and English) and trilingual (Putonghua, Cantonese and English), which will help with their employment prospects”.

More specifically, the lack of generic-type skills in graduate engineers was echoed by the Society of Manufacturing Engineers, USA. The Society named ‘lack of communication skills’ among the top ‘competency gaps’ in engineering education (Rogers 1999). Both Lau and the Society of Manufacturing Engineers reiterated the importance of good communication skills. Communication skills include both verbal and written forms. If graduates can communicate well in their professions, they should have better chances to become successful leaders in those professions.

Two surveys (EMB, 2000 and Gan, 2006) that were conducted in Hong Kong related to the quality of the generic skills of graduates. The Education and Manpower Bureau’s survey (EMB, 2000), indicated that the employers had great concerns about the language proficiency of their staff (university graduates), especially in spoken English and Putonghua. Employers preferred managers and professionals who, besides having skills relating to new technology and information system applications,
also possessed communication, problem-solving and general management skills.

The other survey reported by Hong Kong Chinese Ming Pao Daily, Hong Kong SAR, (Gan, 2006), was concerned with the general generic-type skills of Hong Kong university graduates. The study focused on the four major categories of:

- Individual’s ability
  - Analytical skill;
  - General knowledge;
  - Dependency under work pressure;
  - Communication skills.

- Work attitude and ethics
  - Self discipline;
  - Responsibility and accountability;
  - Punctuality.

- Work performance
  - Time management;
  - Quality and complete task on time;
  - Application of knowledge and technology.

- Inter-personal skills:
  - With customers;
  - With colleagues;
  - With management.

The survey results indicated that most of the new graduates failed to meet the expectations of their employers. Employers gave the graduates low ratings in the areas of ability to work under pressure (2.5 points), self-discipline (2.5 points), time management (2.6 points) and responsibility and accountability (2.8 points). The score
in the study was tabulated from a 5-point scale in which 5 is the full mark and 3 was a 'passing grade'. The results indicated that the graduates in Hong Kong were deemed to have failed in 'ability to work under pressure', 'self-discipline', 'time management', 'responsibility and accountability'. The results also reflected the current deficiencies of generic-type skills training in the higher education system in Hong Kong.

Yue, the Chairman of the Hong Kong Small Medium Enterprises (SME) Federation commented on the Ming Pao Daily results during a press conference in June 2006. The Chairman agreed with the survey results but also elaborated on some common attitudinal problems of the young graduates. He commented that young graduates often lacked working experience and technical skills when entering the workplace and were weak in communication in English. He elaborated upon some common attitudes of those young graduates, such as arriving late at work, leaving early and arguing without solid support. Although not all graduates possess negative attitudes, some do. Yue advised graduates that any work experience they can gain outside their normal duties, is just like the savings that they have in the bank. The more generic skills graduates possess the better are the chances for them to be successful in their careers. If graduates do not work hard and enhance their generic-type skills, their advancements could be slower or limited.

Develop all 'roundedness' of graduates in university education is an important task, particularly in respect of the 'people' and 'leadership' dimensions. As Yue (Gan, 2006) suggested that universities should develop an awareness of the perceptions of the industry's requirements and prepare graduates to fit in with the actual workplace trends. Moreover, universities need to be aware of the changes in the workplace and the long term implications of these changes for their graduates.
As Forestier (2006, pg. E3) stated:

“The schools could no longer operate in isolation but had to work with many stakeholders in preparing young people as individuals for flexible careers rather than as units for factory jobs. Teachers should work closely with all stakeholders, including professionals, the business community, in shaping education”.

The Hong Kong Special Administrative Region (SAR) has also recognized the need for the development of more generic-type knowledge, skills, and competencies in the Hong Kong population, through education systems and learning opportunities. In 2000, it released a report ‘Learning for Life, Learning through Life’. The report recommended that:

- Universities need to review their first-degree programs to strengthen general education and multi-disciplinary learning, to develop students’ thinking and communication skills, adaptivity and creativity as well as to broaden their vision.

- Universities should provide students with more exposure at an international level and let students acquire more practical experience in the workplace, e.g.
  - Student exchange programs
  - On-the-job training in local and overseas organizations.
  - Starting one’s own business.

- Apart from imparting academic knowledge, first-degree programs should also enhance students’ personal qualities and nurture their professional ethics.

- In addition, students should be provided with opportunities for work attachment.

The report outlined the key objectives of Hong Kong’s education reform, which now serves as the education blueprint for the 21st century there.
1.3 Generic skills requirements in the learning society

The workplace is now characterized by swift change, such as restructuring, de-layering, outsourcing, downsizing, one stop-shopping and empowerment and the new technologies and processes used in manufacturing. Globalization and free trade have major impacts on the way organizations operate, and sometimes on whether they survive. One of the major concerns about further education is an effective match between what students learn in university programmes and what they need to know and to be able to perform in the workplace.

Traditionally universities have claimed for themselves a responsibility to be critical, to raise questions and to search for reasons, rather than to accept blindly and to teach their students to do the same. The traditional engineering programs in universities, which place heavy emphasis on science and mathematics, need to be updated to include professional disciplines such as ethics, values and generic-type skills within the context of the engineering discipline. For example, communication skills are acknowledged widely as a desirable capability but the nature of communication and what constitutes skilful performance varies markedly between Marketing and Engineering Studies. Second, in any sort of instrumental view of educational planning, specific provision for the development of the skills requires commitment within the curriculum development process. Teaching only engineering and technical subjects in university for engineering disciplines is surely not sufficient.

Knowledge changes quickly as do the skill requirements of graduates. Universities should certainly place emphasis on both technical knowledge and skill development for students and the skills which can enable them to learn, critique, and use of knowledge. Indeed, there now appears to be a greater need for a shift toward an emphasis on generic
skills in university education. Besides deploying 'knowledge' in the workplace, graduates should also possess the ability to use other generic skills such as 'insight', 'understanding', 'reflection', 'wisdom' and 'critique'. University education should have concurrent emphases on both specific engineering content-rich curricula and generic-skills-based learning.

Higher education in particular must provide its graduates with the skills to be able to operate professionally within the environment required for the 'learning society'. The UK National Committee of Inquiry into Higher Education, UK (Dearing, 1997, Summary report, pg. 16) suggested that:

"Institutions of higher education begin immediately to develop, for each programme which ... gives the intended outcomes of the programme in terms of knowledge and understanding that a student will be expected to have upon completion".

The report also emphasized that generic skills should be part of university education:

"Key skills: communication, numeracy, the use of information technology, an understanding of methodologies or ability in critical analysis and learning how to learn".

The Dearing report reflected the current views of employers in UK, but its recommendations are also valid to other institutions.

Another report by the Higher Education and Employment Division of the Department for Education and Employment (Dearing, 1997, Appendix 4, p. 31) in UK expressed some specific dissatisfaction from the UK employers.
"Practical engineers with excellent communication skills. Interpersonal and teamwork skills are in need of improvement."

Knowledge and generic-type skill learning must be inferred from student performance. As stated in Brumm's (2006) study, most of the generic skills essential to the professional practice of engineering – are best developed and demonstrated in the workplace. Therefore, the results from any studies of the workplace, that indicate the knowledge and the generic skills by the graduate engineers and their managers, should provide a unique report card of the university graduates' knowledge and generic skills capabilities and their abilities to perform there.

When employers recruit graduates, they are typically seeking individuals not only with specific skills and knowledge, but with the ability to be proactive, to see and respond to problems creatively and autonomously and all the predicted trends in the world of employment suggest that the yardstick of employment will be higher. Higher education institutes should develop or modify their programmes and to produce graduates with the qualities which are needed in the changing workplace.

Conceiving key generic skills is inevitably influenced not only by what is valued in industry but also by the goals set for a country's economic future and for individual development. At the same time, depending on how key generic-type skills are conceived, certain visions of industry are strengthened or weakened. Generally speaking, any concept is a social construct. It is assumed to facilitate the understanding of reality while also constructing it. Concepts are conventions, explicit in scientific content, more often implicit in everyday use. In general, the term 'generic skills competence' can be interpreted as roughly specialized skills or proficiencies that are
necessary or sufficient to reach a specific goal. This can be applied to individual dispositions or to the distribution of such dispositions within a social group or an institution (Barnett, 1994).

Rychen (2003) defines a generic skill as the ability to meet complex demands successfully in a particular context, through the mobilization of psychosocial prerequisites, including both cognitive and non-cognitive aspects. This represents a demand-oriented or functional approach to defining competencies. The primary focus is on the results the individual achieves through an action, choice, or way of behaving, with respect to the demands, for example, related to a particular professional position, social role, or personal project.

The conceptualization of generic skill is problematic for several reasons. The term ‘generic skill’ has several meanings. Some interpret ‘generic skill’ as competences, core, transferable, key, process, common, work- or employment-related, soft, and attributes skills. There is no one standard definition of the term ‘generic skill’. Different studies apply the term ‘generic skill’ in different ways to meet their purposes (Comer, 1987; EMB, 2006; Gan, 2006; McMasters, 2003), reflecting differences in definitions and interpretations of their significance. One of the key issues is for educators and employers with the support of the government, to work together to develop a common generic skill list and language that will later come together as one of the core university objectives. It is essential that graduates acquire the key generic-type skills during their university education before entering the workplace.

Knowledge, insight, skills and attitudes are part of the basic core requirements of any profession or its related jobs. These skills are most desirable and with the possibility
that the graduate will ultimately transfer to other new jobs within their professions, will contribute to the development of a person's work-related competence and facilitate transitions within a career. It is essential that these key generic skills be acquired within the framework of university education, but also within the framework of a profession (during initial training and during work) and be further developed as regards occupational content in the workplace. One great advantage of acquiring key skills in contest is that, under the right learning conditions, graduates hopefully can apply and transfer these skills to minimize the problems that they counter in their new jobs.

In various studies related to skill concepts such as basic skills, generic skills, core skills, or competencies, attention has been drawn towards the differences in the definition and scopes of such concepts. Generally four types of concepts can be distinguished and summarised (see Abata, 2004; Braham, 1991; Comer, 1987; DeGrazia, et al., 2001; Ferguson, 1980; Fromn, 2003; Magee, 2003; McMasters, 2003; Nijhof, 1999):

- **Basic skills as necessary preconditions for learning:**
  This concerns basic skills in their most basic sense: literacy (reading and writing) and numeracy.

- **Basic job-oriented or generic skills:**
  Generic skills refer to behaviour (visible or invisible) that are fundamental for performing tasks that occur in a broad range of occupations and that also form the basis for more job-specific skills. This rather abstract definition results in more empirical work often in listings like decision-making skills, communication skills, interpersonal skills, logical-reasoning skills and problem-solving skills.

- **Transferable key qualifications:**
  The concept of transferable (key) qualifications brings a new dimension to the
issue of key qualifications or core competencies. It stresses the issue of transferability of skills, lifelong learning and employability.

- Contextualized transferable key qualifications:
  The connotation ‘contextualized’ means that these qualifications are not common across occupations, work places or life situations, but depend on the actual situation of the application.

David Eldon, who stepped down as chairman of the Hong Kong and Shanghai Banking Corporation in May, 2005, said in an interview (Becherling, 2005) that getting professional qualifications is the advice he would give those wishing to follow in his footsteps, even though he did admit to having a ‘slight dilemma with that’, as a trawl for academic excellence might miss applicants who could bring other attributes to their work.

“What might be described as the softer skills of being able to get on with people... There was a joke in the bank that when you walked into the interview they’d throw you a ball. If you caught it, you were obviously a team player and were worth having. If you dropped it, end of interview”.

Generic skills, such as team-work and being a team-player, are considered as very important skills in the banking sector and nowadays in many other industries.

With the changing of technologies and business practices, individuals should assess whether their skills are up-to-date or were on the verge of becoming obsolete. Morgan (2006), director of Hong Kong operations for Manpower Hong Kong, stated that if individuals want to be successful they need to be proactive about their careers and should adapt their skills to suit the jobs that are available today and those that will be available in 10 or 20 years. If individuals equip themselves with the right knowledge
and skills through work experience and training, they will be able to choose the organizations to work for and also demand better remuneration. She also advised individuals to take control of their career paths and stay up-to-date with their skills as this will ensure their continued career success and viability in the future.

Finally, social skills appear to be becoming increasingly important in the future as work becomes more interconnected, the demographic diversity of the workforce increases and organizational entities become more interdependent. It is becoming more and more certain that in order to meet these new challenges, universities must prepare their graduates' (including engineering students') capabilities for effective functioning in a 'new' society of work in which the interpersonal domain is paramount. Surely this means that lecture room experiences must become more interactive to allow interpersonal skills to be developed, and more studies must be provided, allowing graduate engineers to develop the ability to work effectively in groups or on their own. It is also becoming increasingly important to provide more problem-based project studies for graduate engineers to develop effective problem-solving skills.

1.4 Conceptualization of generic skills

There is a wide range of issues when selecting and defining key generic skills that might be taught to engineering students during their higher education. There have been discussions about the actual match between the qualifications acquired through engineering education and training and the generic skills required by business and industry. For example, the University of Queensland (UQ) in Australia, developed its engineering courses to match with specific course learning outcomes as required by the Institution of Engineers Australia (IEAust). The Accreditation Board for Engineering and Technology in the United States released the Engineering Criteria (ABET, 2000)
and established a guideline for generic skills for all universities that offer engineering programmes in the United States.

Defining and selecting the key generic skills necessary for the graduate engineers to lead to successful career paths raise many questions, for example:

"What types of generic skills do industry desire?"

"What are the ‘musts’ and what are the ‘desirables’?"

The challenges, therefore, are to decide what types of key generic-type skills are useful and relevant, taking into account a plurality of values and new industry requirements.

World-wide generic-type skills are known by a number of names in different countries. Generic-type skills can be related specifically to employment, or they can also be placed according to their social relevance or the qualifications of individuals. Table 1.1 shows the generic-type skill terminologies used in various countries (Australian National Training Authority, ANTA 2003). The generic-type skill terminologies provide a succinct model that all employees, not just managers, need to complement their technical expertise.

Table 1.1 Generic skills descriptions in various countries (ANTA, 2003)

<table>
<thead>
<tr>
<th>Country</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Key competencies, employability skills, generic skills</td>
</tr>
<tr>
<td>Canada</td>
<td>Employability skills</td>
</tr>
<tr>
<td>Denmark</td>
<td>Process-independent qualifications</td>
</tr>
<tr>
<td>France</td>
<td>Transferable skills</td>
</tr>
<tr>
<td>Germany</td>
<td>Key qualifications</td>
</tr>
</tbody>
</table>
Hay/McBer published the McBer’s Scaled Competency Dictionary in 1996 (Hay/McBer 1996). This Dictionary listed a set of generic competencies. Some key ones include:

- **Achievement orientation** (Does the individual think about meeting and surpassing goals and taking calculated risks for measured gains?)
- **Analytical thinking** (Does the individual understand cause-and-effect chains and relationships?)
- **Directiveness** (Does the individual set firm standards for behaviour and hold individuals accountable to them?)
- **Flexibility** (Does the individual change gears or drop the expected tasks when circumstances demand it?)
- **Impact and influence** (Does the individual use deliberate influence strategies or tactics?)
- **Initiative** (Does the individual think ahead of the present to act on future needs and opportunities?)
- **Integrity** (Does the individual act in line with beliefs and values even when it is difficult to do so?)
- **Self-confidence** (Does the individual take on risky tasks or conflicts with those in...
power over that individual?)

- Team leadership (Does the individual lead groups of people to work effectively together?)

- Teamwork and cooperation (Does the individual act to facilitate the operation of a team of which he or she is a part?)

- Develop others (Does the individual work to develop the long-term characteristics (not just only skills) of others?)

According to the definition, people will only reveal the generic skills level at which they are capable of functioning while carrying out their tasks. A successful career in industry is not only based on objective facts or realities, grounded in empirical and non-controversial evidence rather it also comes from objects of value judgments. Yet the later kind of normative comprehension always remains prescriptive, and its translation into reality is subject to controversies and conflicts. A gap continues to exist between what is imagined ideally and postulated in social discourse and the kind of actualities that are produced in a particular socio-economic context. It is therefore, both a political and an ethical choice and challenge to construct and endorse key generic skills in a manner that is consistent with the principles of human development.

Individuals need a wide range of generic skills in order to face the complex challenges of today’s world, but it would be of limited practical value to produce very long lists of everything that they may need to be able to do in various contexts at some point in their lives. The Organization for Economic Co-operation and Development (OECD, 2005) has collaborated with a wide range of scholars, experts and institutions to identify a small set of key skills or competencies, rooted in a theoretical understanding of how such competencies are defined. From this, it has identified that
each key skill or competency must:

- Contribute to valued outcomes for societies and individuals;
- Help individuals meet important demands in a wide variety of contexts and
- Be important not just for specialists but for all individuals.

The conceptual framework for these key generic skills or competencies classifies such skills in three broad categories. First, individuals need to be able to use a wide range of tools for interacting effectively with the environment: both physical ones such as information technology and socio-cultural ones such as the use of language. They need to understand such tools well enough to adapt them for their own purposes – to use tools interactively (such as communication and problem-solving skills). Second, in an increasingly interdependent world, individuals need to be able to engage with others and since they will encounter people from a range of backgrounds, it is important that they are able to interact in heterogeneous groups (employing, for example, general communication and management type skills). Third, individuals need to be able to take responsibility for managing their own lives, situate their lives in the broader social context and act autonomously (social and ethics type skills).

These frameworks, each with a specific focus, are interrelated and collectively, form a basis for identifying and mapping so called key skills. The need for individuals to think and act reflectively is central to this framework of skills. Reflectiveness involves not just the ability to apply a formula or method routinely for confronting a situation but also the ability to deal with change, learn from experience and think and act with a critical stance (Barnet, 1994; Evers, 1998; Fallows, 2000 and Raven, 2001).
A study quoted by Nijhof (1999) based on an earlier study by van Zolingen (1995) in the Netherlands, stated that the new version of key generic skills is somewhat more geared to current developments in industry and that it consists of six dimensions, namely:

- **General-instrumental dimension:**
  - Occupational knowledge and skills which have a fundamental and/or lasting character and which can be applied in many situations (these include basic skills such as arithmetic, language and reading, general technical know-how, general knowledge or languages, general knowledge of computing, the ability to handle information, the ability to plan work, quality awareness, commercial insight).
  - Inter-disciplinary knowledge.

- **Cognitive dimension:**
  - Thinking and acting (identifying and solving problems, abstract thinking, methodical thinking, intellectual flexibility, learning to learn skills).

- **Personality dimension:**
  - Showing individual behaviour (self-reliance, sense of responsibility, precision, self-confidence, decisiveness, exercising initiative, coping with stress, creativity, imagination, willingness to achieve, perseverance, modern citizenship).

- **Socio-communicative dimension:**
  - Communication (ability to express oneself orally, ability to express oneself in writing, having knowledge of modern languages) and the ability to work together with colleagues, managers and clients (social skills, solidarity, empathy).
• Socio-normative dimension:
  - Ability to adapt oneself to the corporate culture (loyalty, identification, dedication, complying with safety measures. Readiness to take part in further training, presentability, knowledge of the organization)

• Strategic dimension:
  - Emancipatory behaviour: showing a critical attitude to work and one's own interests (dealing critically with choices in the technical field and the effects they have; taking an active part in decision-making and promotion of interests).

Evers, Rush and Berdrow, (1998) developed a 'Making the Match' (MTM) as a foundation for a common language for competency. They defined the definitions into four bases:

• Managing self;
• Communicating;
• Managing people and tasks and
• Mobilizing innovation and change.

Each of the four bases represents a grouping of skills. For example, communication is made up of inter-personal, listening, oral and written communication. The 'Making the Match' model that Evers (1998) developed should be the generic skills that university graduates need to develop to be able to thrive in the workplace. They represent an integration of classical and contemporary managerial functions in business and other organizations. However, the basic skills of 'managing self' and 'communicating' can be taught, but are usually further developed in the workplace. Universities typically do
not run standalone courses in time management and other managing self skills, nor do they teach oral and written communication skills. What has happened is that the learning environment promotes and rewards these skills. For instance, students get better grades when they deliver a good written presentation for their assignments.

In higher education, besides the understanding and application of subject-specific skills and knowledge, the general key generic skills or competencies are becoming key requirements in any learned society. Generally, it is argued that these skills should be part of the curriculum design of all subjects and they should be transferable. These skills are often related to the broadening of general education and not only technical education.

1.5 Generic skill theory and model

Raizen (1994) stated that the traditional models of schooling based on classroom instruction are no longer effective. It is assumed that, once students have acquired the basic skills, they will be able to transfer them to a variety of work and learning situations. However, it is this ‘transferability’ that often does not occur. Learning processes are social processes that take time and place and in all different settings.

Barnett (1994) stated that the university curriculum can be illustrated in terms of two super-imposed axes as shown in Figure 1.2. This configuration is divided into four quadrants. One axis separates the curricula either derived from the internal or academic community requirement or derived from the external work environment. The internal general education reflects the values of the academic world and expects to impart the general knowledge, which will carry the graduates forward to the external workplace. However, it is not easy to assess the success of the “transferability” from the internal
(academic world) to the external (workplace), unless a clear channel or feedback loop is established between the academic community and industry. The other axis is formed at one pole with specific curricula (usually discrete disciplines) and by general aims on the other side.

The model, shown in Figure 1.2 is a traditional higher education model. Most of the engineering curriculum designs fall into this configuration and typically, fall into quadrants 1 and 2. Quadrant 1 indicates the academic requirements (internal) while quadrant 3 is the external (the later) requirements of the society. Figure 1.2 shows two forms of generality: forms of general education that come from the values of the academic world and those that reflect a keenness to impart general characteristics and capacities that will carry graduates into the workforce.

The horizontal line, separating the academic world and society, perhaps should not exist at all because there should not be this division, although many skills fostered by the university are derived from their institutionalization in society. Skills in quadrant 3 and 4 are the needs of society as much as they are of university education. Although the horizontal line which separates the academic world and the society is real, it lies within the academic world. According to Barnett, the discourse of the academic community and the discourse of society – even if they appear to be about the ‘same’ state of terms – are ultimately different. An example is the practice of ‘engineering’ and the academic discourse called ‘engineering’. In industry, the practical discourse of ‘engineering’ is about the practices and applications of engineering and the academic discourse of ‘engineering’ is about the engineering disciplines, claims and theories at university.
With the changes brought about by globalization and the new requirements for generic-type skills, the 'Barnett model' could be modified. The model could include one more dimension such as generic skills and could perhaps place more emphasis on the skill sets listed in quadrant of 2 and 3.

A revised model was developed based on the needs of graduates and society (Bennett, 2000). This 'new' model takes into consideration the generic skills that are needed badly for graduates and industry. The added-on dimension of the 'generic skills' provides a link between the academic community and the workplace and should form an integral part of the education system. The proposed model is shown in Figure 1.3. An added 'generic skills box' is placed in the centre of the new model. The relationships of the generic skills with regard to other categories are shown by the directions of the arrow-heads. The relationships between these four categories and the
generic skills are complex. There may be vast variation across disciplines in what are considered as the major or minor subject-related contents to be taught. However, with the four categories outlined in the four quadrants, the options are up to the academic staff's professional judgment based on business, industry, professional evaluations and government requirements. The subject contents, applying a workplace environment and workplace experience approach, can provide opportunities for students to apply their theoretical knowledge in the 'simulated' working environment activities through the application of skills such as problem-solving and decision making. The disciplinary knowledge and generic skills can be acquired through work experience, through the lecture room and placements in the workplace.

Figure 1.3  A 'new' proposed model of generic skills in higher education

The two elements of the workplace environment (quadrant 3) and the workplace experience (quadrant 4) in this model (Figure 1.3) are represented by an 'authentic' or simulated learning environment in universities. Courses using a workplace environmental approach aim to enable the application of theoretical knowledge in
simulated ‘authentic’ environments that approximate the activities of the workplace. Curriculum provision identified by the experience of the workplace element should incorporate direct links with the workplace and be integrated largely into engineering-oriented courses as work placement. In this model, there is no assumption about directionality. Hence disciplinary knowledge can, for example, be acquired in the university, then for subsequent use in the workplace, or vice versa.

The new proposed added-on module of generic skills in higher education as shown in Figure 1.3, could generally be further grouped into four broad generic skills categories:

- Communication (both verbal and written, languages);
- Problem-solving (data analysis, critical thinking and application of new technology);
- Management (team work, leadership, self discipline and motivation); and
- ‘Other’ generic-type skills (adaptability to change, honesty, integrity and professional ethics).

These four categories of generic-type skills plus a set of ‘set-skills’ within each category tend to cover most of the skills required by graduates when they enter into the workforce and should form a useful basic framework for generic-type skills generally in higher education. These four categories of skills can potentially be applied to any discipline and to any course in university education or to the workplace.

With a set of ‘sub-skills’ to be developed and included within each of these four categories, the ‘new’ added-on module of the proposed generic skills model would serve as more useful example of generic skills learning outcomes. Of course, the ‘new’ model would be used as guideline rather than as a rigid set of skills to be achieved in
each university department or any employment setting. So, this model could be considered as an in-built tool for planning and that academic staff can amend or adapt these sets for their own subject purposes. Based on the ‘new’ proposed model of generic skills, a set of ‘sub-skills’ statements for each category could also be developed.

Indeed, in many higher education institutions (ABET, 2000; ACER, 2001; Atrens, 2004; Fromm, 2003; Kelly, 2001), academic educators have started to make changes to their curricula that support the external requirements of society; these external requirements have thus sometimes become part of the university official internal course requirements. It is expected that the university remains the source of skills development and of supplying the skills required by society.

1.6 Changes in generic skill requirements

The individual’s ability to contribute so-called generic skills to progress society, seems to be considered a key to a society’s success and prosperity. As stated by The Organization for Economic Co-operation and Development (OECD, 2005);

“The success of an individual and the prosperity of society require the joint efforts of the integration of individual’s and institution’s competencies and their contributions”.

In fact, as early as 1988, the government of the United States recognized the importance of a similar list of generic skills. In 1988, the U.S. Congress’ Office of Technology assessment report listed the key qualitative skills vital to the employment environment that had to be developed:

- Communication skill:
  - Hypothesizing counter arguments;
- Skills of implementations.

- General Management skill:
  - Negotiation and conflict resolution;
  - Human Relations;
  - The ability to recover from mistakes.

- Problem-solving skill:
  - Skills of problem recognition and definition;
  - Recognizing a problem that is not presented clearly;
  - Defining the problem in a way that permits clear analysis and action;
  - Collaboration in problem solving;
  - Tolerating ambiguity;
  - Analytical skills;
  - Recognizing the feedback of proposed solution to the system.

- Application of learned knowledge to industry:
  - Handing evidence;
  - Collecting and evaluating evidence;
  - Working with insufficient information;
  - Working with excessive information.

- Understand the need of industry:
  - Learning Skills;
  - The ability to identify the limits of your own knowledge;
  - The ability to ask for pertinent documentation;
  - The ability to penetrate poor documentation;
  - The ability to identify sources of information.
More recently, Drexel University (Fromn, 2003) in the United States, adopted the following five party strategies to challenge its traditional engineering programmes:

- Identify the desired characteristics of graduates for the 21st century;
- Identify the program emphases necessary to develop these characteristics;
- Assess the present program's effectiveness in those new terms;
- Identify new program components and characteristics, such as content, structure, and methodologies, to create these new emphases; and
- Develop a strategy to implement required changes while retaining existing strengths.

Drexel University believes that all future engineering graduates need to possess:

- Communication skills:
  - Strong oral and written communication skills.
- General Management skills:
  - A creative and intellectual spirit, a capacity for critical judgement, and enthusiasm for learning;
  - A sense of social, ethical, political, and human responsibility;
  - A culture for life-long learning.
- Problem-solving skills:
  - A capacity to apply these fundamentals to a variety of problems.
- Application of learned knowledge to industry and understand its need:
  - A strong foundation in basic sciences, mathematics and engineering fundamentals. Knowledge and skills in the fundamentals of engineering practice and process;
  - A unifying and interdisciplinary broad view and a sense of corporate and business basics;
- Advanced knowledge of selected professional-level technologies and their impact on the society.

Based on these new criteria, the university authority proceeded to define the optimum blend of programme emphases to create a total educational experience suitable for the development of the culture and characteristics of its graduates.

In another global geographical context, three major reports outlined the key competences in Australia (ACER, 2001). These reports included the Finn Review Committee (Finn, 1991); Quality of Education Review Committee (Karmel, 1985) and Mayer Committee (Mayer, 1992). Their recommendations were:

- Achievement in basic skills and in certain generic skills areas, including mathematics, science and technology, should be assessed.
- Emphasis be given to six key areas of competence: language and communication, mathematics, scientific and technological understanding, cultural understanding, problem-solving, and personal and interpersonal skills.
- Develop an assessment process for key competences:
  - To elaborate the basic concept of key competencies.
  - To operationalize it for the school and training sectors.
  - To specify levels of achievement.
  - To recommend arrangements for assessing and reporting on student achievement.
- Key competencies must:
  - Be essential to preparation for employment.
  - Be generic to the kinds of work and work organization emerging in the range of occupations at entry levels within industry, rather than occupation or industry specific.
- Equip individuals to participate effectively in a wide range of social settings, including workplaces and adult life more generally.
- Involve the application of knowledge and skills
- Be able to be learned.
- Be amenable to credible assessment.

Following these governmental leads, the Institution of Engineers Australia (IEAust) developed its own guidelines and expected all engineering graduates to possess these key attributes. The IEAust graduate attributes can be summarised into the following groupings:

1. In-depth knowledge of the field of study and ability to gain and apply knowledge:
   - Ability to apply knowledge of basic science and engineering fundamentals,
   - In-depth technical competence in at least one engineering discipline,
   - Ability to undertake problem identification, formulation and solution,
   - Ability to utilize a system approach to design and operational performance,
   - Expectation of the need to understand lifelong learning, and capacity to do so.

2. Effective communication:
   - Ability to communicate effectively, not only with engineers, but also with the community at large,
   - Ability to function effectively as an individual and in multi-disciplinary and multi-cultural team, with the capacity to be a team leader or manager as well as an effective team member.
3. An understanding of ethics:

- Understanding of the social, cultural, global and environmental responsibilities of the professional engineer, and for the need for sustainable development,
- Understanding of the principles of sustainable design and development,
- Understanding of professional and ethical responsibilities and commitment to them.

Basically, the Institution of Engineers Australia expects all engineering graduates to possess the basic science knowledge and technical competence, problem-solving skills, good communication skills, to be able to collaborate and co-operate with others and work as team, execute duties with high ethical standard and have the sense of social responsibility for others.

In response to the Institution of Engineers Australia’s competency requirement, the University of Queensland (UQ) in Australia, developed the statements of graduate attributes for all its undergraduate engineering programmes to comply with the graduate attributes of IEAust. These now include:

1. In-depth knowledge of the field of study:
   - A comprehensive and well-founded knowledge of the field of study;
   - An understanding of how other disciplines relate to the field of study;
   - An international perspective on the field of study.

2. Effective communication:
   - The ability to collect, analyse and organise information and ideas and to convey those ideas clearly and fluently, in both written and spoken forms;
   - The ability to interact effectively with others in order to work towards a common outcome;
- The ability to engage effectively and appropriately with information and communication technologies.

3. Independence and creativity:
   - The ability to work and learn independently;
   - The ability to generate ideas and adapt innovatively to changing environment;
   - The ability to identify problems, create solutions, innovate and improve current practices.

4. Critical judgement:
   - The ability to define and analyse problems;
   - The ability to apply critical reasoning to issues through independent thought and informed judgement;
   - The ability to evaluate opinions, make decisions and to reflect critically on the justifications for decisions.

5. Ethical and social understanding:
   - An understanding of social and civic responsibility;
   - An appreciation of the philosophical and social contexts of a discipline;
   - A knowledge and respect of ethics and ethical standards in relation to a major area of study;
   - A knowledge of other cultures and an appreciation of cultural diversity.

Atrens, Truss, Dahle, Schaffer and St John (2004) undertook a critical analysis of the University of Queensland's (UQ) undergraduate engineering programmes and compared them with the IEAust's expectations of graduate attributes. The results found that the graduate attributes were embedded within the engineering programmes and graduates' attainments could be assured, using the assessment technique
developed by UQ. The University of Queensland also developed a suite of courses to ensure that the students are exposed to a learning environment so that each graduate could achieve the required graduate attributes. Each course has been re-designed with specific course learning objectives informed by graduate attributes and allowing the student to acquire the necessary abilities, skills and knowledge.

The University of Technology, Sydney (UTS) in Australia has also identified desirable generic-type skills within the discipline of engineering and introduced them into the curriculum in a whole-degree programme. The students were required to write a reflective journal as part of the assessment task on how they have developed their concepts and their arguments for their assigned project and they are also required to outline how they would advocate and defend their views if they were challenged by academics, industry and community representatives. The communication and the analytical skills were part of the generic skills built into the project assignment.

A document developed in New Zealand, gives a useful outline of broad key goals of education in that country, specifying eight essential skills that all students should possess (Kelly, 2001):

- Communication skills;
- Numeracy skills;
- Information skills;
- Problem-solving skills;
- Self-management and competitive skills;
- Social and co-operative skills;
- Physical skills and
- Work-hard skills.
Elsewhere, in Canada, generic skills programs have been developed since 1979. In the 1990s, employers became even more involved and the Conference Board of Canada developed an extensive scheme of employability skills (Conference Board of Canada, 2000). These employability skills include:

- Fundamental basic skills, such as communication, managing information, use of numbers and thinking/solving problems.
- Personal management skills, such as demonstrating positive attitudes and behaviours, being responsible, being adaptable, learning continuously and working safely.
- Teamwork skills, such as working with others, participating in projects and tasks.
- An orientation to values and attitudes with reference to self-esteem, integrity and responsibility.

Based on previous research and findings, the researcher could categorise the general generic-type skills into four main groups:

- Social Competence
  - Ability to exchange information and to communicate, ability to build and maintain social relations (e.g. the ability to co-operate) and the ability to mobilize the capacities of others.

- Self Competence
  - Attitude toward the world, work and oneself (e.g. discipline, motivation, self-confidence, and flexibility), ability to adapt to changes and deal with changes in a positive way.

- Method Competence
  - Ability to diagnose, develop, choose and apply adequate problem-solving
strategies (e.g. analytical thinking, educability).

- Professional Competence/Expertise
  
  Interdisciplinary use of skills and knowledge (e.g. computer skills, foreign language skills), gaining access to new ideas and ability to synthesize information and implement ideas.

The criteria for success in the generic key skill areas will appear to be judged in at least the following areas (Chang, 2005):

- Judgment/decision-making (Problem-solving skills)
  - More independent action and decision making;
  - More analytical thinking with alternatives and recommendations without all necessarily data.

- Task complexity
  - Broader perspective on the contribution and added value to the overall organization; doing more with less resources; creativity.

- Time span of discretion
  - Risk assessment and time management skills;
  - Planning for short-term and long-term goals.

- Interaction with others
  - Interpersonal management skills; team building and strategic influence.

- Level of uncertainty
  - Having to plan for one’s own future;
  - Self-directed continuous learning.
1.7 Linking generic skills with education and industry

Clearly, the demands of the workplace and the nature of work itself have changed dramatically during the last twenty years. Global competition in business is increasing, jobs are being redefined through re-engineering, and telecommunications and data processing are revolutionizing the workplace. More of the work that used to be performed by full-time employees of large companies is being and will continue to be outsourced to smaller companies, part-time employees and subcontractors (Chang, 2005; Cheng, 2004). These work environment changes are often used to identify labour-market needs or at least to indicate whether or not these needs are being met. University education programmes which fail to boost their students’ prospects in the market place are assumed not to have met market demands. In all these cases market signals such as the (un)employment rates of former graduates, have been interpreted as indicators of the extent to which education programs have met the needs of the market. These signal indicators may, therefore, influence educational policy decisions. They may also influence education system more directly, for example, by encouraging students to enrol in the programmes which offer the best market prospects of a job shortly after graduation. In Hong Kong, business and logistics subjects are currently in 2007, the most in-demand programs for students.

University education no longer simply resides ‘in society’, it is ‘of society’ (Light, 2001). University education no longer simply shapes society through its ‘knowledge’ contribution; rather it is shaped by society through the ‘knowledge specification’ in terms of students, research and market demands. This ‘specification’ is characterised by the current social and economic transitions, particularly those associated with the concepts of ‘globalization’, the widely discussed shift to a ‘knowledge-based
As stated by Light (2001), higher education has become a key target of society’s focus and demands. The current quality of graduates and the new requirements of the changes in the society indicate that the traditional structures of higher education do not appear to be adequate to deliver the requirements of the specifications effectively. Consequently, the progress of change, has insisted that higher education transform itself and remake itself in the new social environment. The key challenge for academics, is the conceptual shift from thinking about practice as teaching to thinking about it as learning, from delivering knowledge to developing and fostering independence of learning in which students develop the ability to discover and reconstruct knowledge for themselves.

Prados (1998) outlined the salient attributes of a new engineering education paradigm. Some of the attributes were highlighted below:

- Encouragement of diverse student academic backgrounds and faculty dedicated to development emerging professionals;
- Connection of solid mathematics and scientific knowledge foundation with engineering practices;
- Maintenance of regular, well-planned interaction with industry - including industry-based projects;
- Emphasis on inquiry-based learning and preparation for life-long learning, with much less dependence on lectures;
- Stress on integrative, systems thinking, coping with change, communications skills (listening, speaking, reading, and writing), teamwork and group problem-solving skills (from identification through analysis and resolution); and
- Focus on design issues involving life-cycle economics, environmental impact,
sustainable development, ethics, timeliness, quality, health and safety, manufacturability, maintainability, social, legal, standard and ad hoc concerns.

McMasters (2003) and Magee (2003) have pointed that higher education in engineering is major emphasised on engineering science but not on overall individual development. There are common calls for increased emphasis on synthesis and design for engineering disciplines, maintenance of depth and strength in technical subject matter and the provision of problem-solving, development of management and communication skills for students. Although some studies have emphasised inter-disciplinary exposure, international exposure and preparation for continuing professional development and career-long learning, many have claimed that generic-type skills are not addressed in traditional engineering education in universities. Of course, generic-type skills can be learned at university but there need to be both practice and further development at later stages. It is clear that students need to be given a number of opportunities to develop their skills, a series of experiences through which they can practise and develop their skills. Their learning cycle may well be a movement from experience to theory, rather than the more traditional approach of learning theory before application. Programmes that reflect these attributes will not only yield renaissance engineers with the tools to face unpredictable future with confidence in their abilities, but may also yield untold benefits to the world in which they live.

Figure 1.4 shows a fundamental view of what engineering in the new century is really about. It illustrates that students require the three keys elements that can be drawn from Science (What?), Humanities & Liberal Arts (Why?) and Engineering (How?) to solve 'A Technical Problem'.
Due to changes in working environments, current course activities may not satisfy today's requirements, for example: how to deal with organizational change, delayering, outsource and lay-off, how to secure a second career at the age of forty-five or how to prepare and improve oneself through lifelong learning. Some of the engineering course designs are still based on the traditional engineering disciplines and graduates are provided only or mostly with the traditional technical skills. However, the most valuable graduates today are those who are not only technically competent but are also kept up with the new requirements.

Engineering is not a standalone discipline. As a matter of fact, engineering (design) is not (engineering) science: it is not practised for its own sake but always within a broader context. Baker (1994) expressed the belief that the interactions between engineering institutes and work places should be spontaneous for students, faculty, and student-employees. The integration of academic study and experiential learning to enhance leadership aspirations and the skills of engineering students requires
structured interactive programmes to provide students with the benefits of direct and diversified practical experiences.

Engineering is a complex system and requires individuals who possess different skill sets to work as teams. McMaster (2003) described engineering as a system that is integrated and is done in context. Figure 1.5 shows that engineering is applying knowledge (in a systems sense), from a broad range of disciplines (including maths, science, economics, services and processes), that meet societal and institutional needs and, hopefully, enhance the quality of life.

**Figure 1.5** Engineering is practised in a ‘System’ (McMaster, 2003)

Figure 1.5 illustrates an excellent message for engineering academics and students: engineering disciplines are always practised professionally within a broader context in any society. Engineering and design control of any products or services are an integrated operation. A good engineering designer, besides considering the technical
function, should also consider the product life cycle and the impacts on the stakeholders, including the environment and the society. The industry and the society will need a great supply of 'systems' engineering graduates and the development of this talent pool must begin in the universities.

In the United States, the failure of the set of generic-type skills to be adopted into higher education in the 1990s at least in part was a reason for the emphasis on a new paradigm for engineering education, to support the current and future demands for the solution of problems involving human values, attitudes, and behaviour, as well as the inter-relationships and dynamics of social, political, environmental and economic systems on a global basis. The Accreditation Board for Engineering and Technology (ABET) realized the importance of generic skills for all engineering students, and recommended that all engineering curriculum should include the generic-type skills as part of the knowledge requirements for all engineering programs in US.

The Accreditation Board for Engineering and Technology (ABET) took the most important step and released the report - ABET Engineering Criteria 2000, to ensure that the United States university engineering programmes meet the quality standards established by the profession for which it prepares its students. Two major outcomes of an undergraduate engineering education should have the following capabilities for all engineering graduates:

1. Engineering disciplines
   - Identification, formulating and solving engineering programmes.
   - Use of the techniques, skills and modern tools necessary for engineering practice.
   - Application of knowledge of mathematics, science, information technology
and engineering (design and manufacturing).

- Design and conducting of experiments, as well as analyze and interpret data.
- Design of a system, component, or process to meet desired needs.

2. Social and generic skills (Possess the broad education necessary to understand):

- The impact of engineering solutions in a global and societal context.
- Recognition of the need for, and possession of, the ability to engage in lifelong learning.
- Contemporary issues (political, economics, environmental, etc).
- Recognition of the need for and possession of the ability to communicate effectively.
- Recognition of the need for, and possession of, the ability to function on multi-disciplinary teams.
- Professional and ethical responsibilities.

The focus of the generic-type skills went beyond the need to keep the graduates at the cutting edge of technology and also help graduates to include a better balance in the various areas of social and personal developments. Engineers are creating and designing products or services, but they also need to understand the impact of their products or services to the society. This includes cost, safety, reliability, maintainability and environmental impact.

Drucker (1987) described the role that educational systems have to play in the new paradigm:

"University should serve as a place for self-development, rather than just a place for learning. Equally, private enterprise, should view universities not as a source
of workers but as places to be used actively for employee re-education. There should be 'knowledge exchange' between private industries and universities."

Besides mastering engineering subjects, graduates are expected to understand the values of society and humanity. Georgia Institute of Technology, in Atlanta, has made two changes to cope with the new requirements since 1994 (Lau, 2006). First, the Institute expects that all First Year engineering students should know how to play at least one musical instrument, or to become a member of a choir that participates in competitions. The Institute also believes that engineering students, besides having, clever and curious minds, should also have good inter-personal skills, multi-interests and different outlooks. Second, students taking a computer engineering discipline have to take two compulsory computer application subjects. This new requirement is to ensure that graduates have a better understanding of the application of the computer with society, not just an understanding of 'pure' computer engineering. The multi-interests, inter-personal skills and the applications of their learned knowledge training in university will enhance students' generic skills.

The State University at Buffalo, USA and McGill University, in Canada, both developed credit electives that address the topics of technical communications for engineers and problem-solving and decision making courses to improve the oral and presentation skills of their students. The Hong Kong PolyU has also developed a complementary subject (no credit bearing) to improve communication in English in the English Centre. Another development in the language area for the Hong Kong PolyU students is that engineering students have to take the University-developed Graduating Students' Language Proficiency Assessment (GSLPA) in Chinese and English as the required language proficiency exit test before graduation.
University education, besides having in-depth knowledge of the field of study, should also ensure that all graduates are expected to be able to communicate ideas clearly and effectively, be able to learn and work independently and have the ability to make decision and to reflect critically on the justifications for their decisions. Graduates should also be expected to possess ethical and social understanding and responsibility. The changes, it is hoped, will create a new generation of graduate engineers.

1.8 Employers’ perspectives on generic skills

In industry, employers do now tend to focus on generic skills as a guiding framework for career development and human resource management. Generic skill development and management are viewed as tools that will better ensure their employees’ ability to respond to new and changing environments in the workplace. Employers are more and more convinced that generic skills development and qualifications will contribute toward increasing the knowledge and value of their individual employees. A survey (Kelly, 2001) conducted in New Zealand indicated that the vast majority of employers preferred candidates possessing effective communication, interpersonal, creativity and problem-solving skills for entry-level job applications (fresh graduates). Work experience tells managers that if a candidate possesses good verbal and written communication and has good interpersonal skills, the candidate should have fewer issues in working with others in a team working environment, particularly in problem-solving tasks. As well, in time, the young engineer should be a more effective supervisor in managing people and delegating work.

The aircraft designer and manufacturer Boeing developed a list of ‘Desired Attributes of an Engineer’ for its new graduate engineers when they established the company (McMasters, 2003). The list is shown in Table 1.2. These attributes helped
management to map specific skills reflecting the diversity of the overall engineering environment in which professional engineers practised and operated. It can be seen from the list that many 'soft' skills are required for a successful engineer placement.

Table 1.2  Boeing's list of engineering attributes

<table>
<thead>
<tr>
<th>Desired Attributes of an engineer</th>
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</thead>
<tbody>
<tr>
<td>1 A good understanding of engineering science fundamentals</td>
</tr>
<tr>
<td>Mathematics (including statistics)</td>
</tr>
<tr>
<td>Physical and life sciences</td>
</tr>
<tr>
<td>Information technology (far more than 'computer literacy')</td>
</tr>
<tr>
<td>2 A good understanding of design and manufacturing process (i.e. understanding engineering)</td>
</tr>
<tr>
<td>3 A multi-disciplinary, system perspective</td>
</tr>
<tr>
<td>4 A basic understanding of the context in which engineering is practiced</td>
</tr>
<tr>
<td>Economics (including business practice)</td>
</tr>
<tr>
<td>History</td>
</tr>
<tr>
<td>The environment</td>
</tr>
<tr>
<td>Customer and societal needs</td>
</tr>
<tr>
<td>5 Good communication skills</td>
</tr>
<tr>
<td>Written</td>
</tr>
<tr>
<td>Oral</td>
</tr>
<tr>
<td>Graphic</td>
</tr>
<tr>
<td>Listening</td>
</tr>
<tr>
<td>6 High ethical standards</td>
</tr>
<tr>
<td>7 An ability to think both critically and creatively – independently and cooperatively</td>
</tr>
<tr>
<td>8 Curiosity and a desire to learn for life</td>
</tr>
<tr>
<td>9 A profound understanding of the importance of teamwork</td>
</tr>
</tbody>
</table>

Table 1.2 shows the Boeing management's expectation of the basic requirements of graduate engineer. Technical know-how, such as engineering science, manufacturing process and other related disciplinary areas is a must, followed by communication skills in the oral and written are plus, listening and presentation skills. Possession of curiosity
and a creative mind will help engineers to think critically and independently on work issues. Working cooperatively with others is a ‘must’. High ethical standards are ‘given’ and lifelong learning is a continuous process for improving one’s skills and knowledge. Boeing’s list of engineering attributes is a good model for the academic world to follow and for universities to produce these kinds of graduate engineers for all industry. However, neither the current university-level education systems generally, nor the industry are providing such adequate training in these skills for graduate engineers.

Education is a social system that has been the subject of constant innovation and change. It has only been within recent decades that the structure of curriculum design and needs have been studied in a systematic way. In this present period of accelerated social changes, university education systems change very slowly. Society has created the institutions of higher education in order to ensure social continuity through the mediation of its essential culture and values, and these also reflect very closely the concepts and values of their new environment. It is expected that the recommendations from this study will give impetus for both educators and industries to start to think and support each other through modification of the existing curriculum design and offering job opportunities for students’ summer placements and work-integrated practices to meet the new challenges of the 21st century.

1.9 New perceptions of generic skills and learning environment

The recent past and current changes in Hong Kong society provide both challenges and opportunities to educators to re-evaluate their current approaches to higher education. These changes include:
China’s economic development;
Graduates from Hong Kong having to work in Mainland China;
Global economic development and competitiveness;
Local and international entrepreneurial activities;
Merger and acquisition activities;
Perceptions of value of the graduates to hiring organizations;
Competition among local and international universities for students;
Environmental issues.

Three key trends that have emerged in industry have direct implications for generic skills in the workplace of the future (Raven, 2001).

• Employees will be required to do more.
  - Due to flat organization and process re-engineering, jobs are getting bigger and skill requirements have increased;
  - Employees will manage more activities, but become more flexible for career paths;
  - Employees will become more versatile and more effective at leveraging people and resources;
  - Employees with in-depth technical and specialized knowledge about business contexts and other discipline will be the winners.

• Relationships among employees will be more complex.
  - Closer relationships with customers, and provision of solutions.
  - Teamwork, including teams that transcend functional and geographic boundaries;
  - More interdependence of employees, better communication, and increased
ability to build and maintain productive work relationships.

- Employees will have to think more flexibly.
  - Virtual corporations, independent contractors;
  - Experimenting with new ways of getting things done in a less structured and directional organization.

With these new trends continuing, graduate engineers will have to develop clearer lines of sight to their outside and inside customers, and to think 'outside the box' of their job descriptions to provide more value to their services.

With the expansion, restructuring and refinancing of the Hong Kong tertiary education sector in the 1990s, university education systems have undergone many changes. Classes are much larger and consist of students from a diversified range of backgrounds: abilities, motivations and cultural backgrounds. Academic staff members have to review the current curricula and teaching methods in order to motivate and encourage students to learn. Different approaches, such as higher-order learning processes and learning outcomes, are applied. Higher-order learning processes mean student-centredness: the academics will act as facilitators, helping students to learn, and focus on achieving the required outcomes.

As stated in the Teaching Learning Quality Progress Report (TLQPR) (Leung, 2005):

"Besides acquiring knowledge, understanding, skills and attitudes that are pertinent to the discipline or professional studies, university graduates should attain generic competences and attitudes that enable them to function effectively as citizens in the local and international communities".
The TLQPR report also recommended the inclusion of mandatory components within curricula to ensure that students acquire such competences and the establishment of extra curricular activities for promoting them. The report was endorsed by the Hong Kong University Grants Committee (UGC) and recognized that traditional university education has always been the preparation of graduate for an academic discipline or a profession. However, more generic knowledge, together with other competences and attitudes, is an essential part of an all-rounded individual. All universities in Hong Kong, implicitly or explicitly, now embrace the concept of graduates’ attainment of generic competencies and desirable attitudes.

The Hong Kong Education Commission (2000) report stated that:

"We must address the inadequacies within the existing education system to enable the majority of Hong Kong people to achieve lifelong learning and all-round education".

Traditionally, some university programme designs have been based on market analysis which typically consists of breaking down requirements according to the skills, temperament, and interest level required with respect to needs, students, and market demands. The key factors that influence Hong Kong’s students learning have been described in the Figure 1.6.
There are many other competing interests within the education system. Figure 1.7 represents a puzzle that exits in engineering disciplines in education.
As shown in Figure 1.7, there are many parties that have to be satisfied. The challenge is how to align many stakeholders' interests into a common goal in engineering education.

1. Where does the department get the funding to support research and teaching?
   In normal circumstances, funding could be obtained from government, private sectors (e.g. consultancy) and public donations. In Hong Kong, all university undergraduate programmes (and some postgraduate programs) are funded by the University Grants Committee (UGC). Currently, there are some programs that are self-financed.

2. How is it possible to attract talented academic staff and students to support research and teaching?
   Besides teaching, the academic staff members have to conduct research. Talented research students are difficult to recruit due to competition. In Hong Kong, due to the UGC policy, only a certain percentage of students comes from other parts of the world for their undergraduate and postgraduate studies.

3. Are the programs aligned with society's needs?
   This study may share some findings that answer this question. Engineering programmes should strike a proper balance between fundamentals (such as maths, engineering science, etc.) and the provision of in-depth experience in applying engineering skills and leading with issues that are important to industry. Engineering graduates are expected to be equipped with a solid foundation for engineering knowledge, professional skills and lifelong learning capabilities.

4. Can students find jobs after graduation?
   In Hong Kong, the majority of engineering graduates can find jobs in Hong Kong or in Mainland China. A survey conducted by the Student Affairs Office of the Hong Kong PolyU in 2004 indicated that 97.4% of The Hong Kong
Polytechnic University (PolyU)'s first-degree graduates of 2003 were employed after graduation.

As requirements change significantly, university education is no longer producing graduates for employment in a stable work environment, but one which is dynamic and increasingly complex in ways which are both new, challenging and which demand ever greater program design on the part of students. Moreover, the university needs to be aware of the changes which are happening in the workplace and the likely long-term implications of these changes for their graduates.

The Hong Kong education system reform proposal (EMB, 2000) will nurture the basic attitudes, skills and knowledge of Hong Kong students and enhance their lifelong learning attitudes. The reform will help to cultivate students' positive values, which include moral and civic education, by providing them with the appropriate learning environment and experiences at the early stages. The reform also includes complementary subject learning for nurturing the five essential traditional Chinese virtues, namely ‘Moral and Civic Education’, ‘Intellectual Development’, ‘Physical Development’, ‘Social Skills’ and ‘Aesthetics’. It hopes to develop students' independent critical thinking, creativity and the ability to learn independently, live and work in a diverse social and cross-cultural environment.

In Hong Kong, some higher education institutions have started to make changes to their courses and programs. For example, one university in Hong Kong has recently reorganized its mandatory curriculum requirements under ‘Complementary Studies’, and focuses on the core requirements such as:
- English language;
- Chinese language (both spoken Putonghua and Chinese);
- Values and the meaning of life;
- Society and the Engineer (compulsory for all engineering students);
- Humanities;
- Business and communication.

This university has adopted the strategy of broadening students’ exposure by requiring them to study a range of regular subjects outside of their normal disciplinary focus. These contemporary studies, which include biliteracy and trilingualism in communication skills (i.e. to communicate clearly and effectively in English, Cantonese and Putonghua, in commonly acceptable formats and with sensitivities), and the ethics and responsibilities of an engineer to society, will definitely enhance graduates with “all-roundedness”.

Generic skills have also earned a place in the overall educational goals in other higher education institutions in Hong Kong and in other countries. In Norway and New Zealand, comprehensive curriculum statements that focus on the whole education systems demonstrate a broad view of the purpose of education and include many overarching generic skills to develop students into “integrated human beings,” individuals who are spiritual, creative, hard working, liberally educated, social, and environmentally aware (Knain, 2001). The most valuable graduates today are those who are not only technically competent, but also possess leadership skills, global outlook and problem-solving skills.
All of the foregoing raises some important questions for consideration:

1. What generic skills are perceived to be needed to be successful in industry?

2. Do graduate engineers possess adequate generic skills to perform well in their workplaces?

3. How do graduate engineers perceive the usefulness of their learned knowledge and skills in university?

4. How do their employers perceive the usefulness of their learned skills in the workplace?
Chapter 2    Background

2.1    An economic overview

Hong Kong’s industrial manufacturing environment has completely changed since the late 1970. Hong Kong is no longer a manufacturing centre in the world. The changes were mainly due to the establishment of the ‘open-door’ policy of Mainland China, China joining the World Trade Organization (WTO) in 2001 and the establishment of the Closer Economic Partnership Arrangement (CEPA) between Hong Kong and China in 2002. The majority of Hong Kong’s manufacturing facilities have moved to the vicinity of the southern part of China, particularly in Shenzhen and the Pearl River Delta (PRD) regions. This shift of manufacturing locations to Shenzhen, combined with globalization, technology and environmental changes, have impacted on every part of the manufacturing sectors in Hong Kong. The challenges are for any university to adapt the changes and develop and manage the engineering education programmes of manufacturing engineering disciplines. The working environment changes have also impacted on the engineering graduates, who now have to face new challenges in their career.

The new environmental changes in the workplace can be grouped into the following categories:

1. Organization - Organizational structures have changed from the traditional fine division of labour; rigorous structure; clear lines of command, to re-engineering; downsizing; de-layering and outsourcing. The new organizational structures and their functionalities are less structured. The traditional rigid classification into specialist and occupational identities is being weakened. Staff members are ranked according to their roles in the organization and these roles may change as
job requirements change. Rewards and appraisals are based on the fulfilment of a specific task or tasks. Rules and regulations, superior-subordinate relationships and social networks are also changing rapidly. Organizations are moving towards smaller Business Units (BU), with staff contributing through integration of different talents and working as a team towards common goals. This change tends to eliminate the strict and well-defined job-descriptions, meticulous procedures and detailed rules and regulations of the past. A whole team will now bear the total responsibility and the delivery of the final products or services.

2. Products - The days of the same patterns of work and the same clients are gone. Organizations are expected to provide total solutions to customers and are responsible for the whole solution, doing what they know and outsourcing activities that they may not know. Some organizations may pioneer their own tasks, paths and pace according to the needs of specific projects or clients. These included scale production against customised products; quality (small batch) against quantity (mass production); task specific against general.

3. Work environments - The working environment is increasingly volatile: organization may change, restructure, merge or dismantle in relative short time. Bureaucracy is being replaced by fluid and client-specific functions. Engineers may require taking on varying tasks within an organization, working as a team leader or a team member and more intense human interaction and collaboration. Engineers’ skill set requirements increasingly vary from task to task. Sometimes, engineers may have to change jobs and even move across careers in their work span. Besides possessing an expertise in their own engineering disciplines, engineers need increasingly to have the ability to communicate well, good interpersonal skills and adaptability to change if they want to make progress in their career in the new environment.
A knowledge-economy society means that new corporations assume a predominantly ‘weblike’ organizational design that links business partners, employees, external contractors, suppliers and customers in various collaborative arrangements. These corporations are ideas intensive, build their core competencies, outsource the rest and are virtually integrated. The most precious resources are those with human skills, expertise and good working relationship with others. The Business Week (Byrne, 2000) outlined a very concise, yet comprehensive summary of the differences of the future structure of corporations as shown in Table 2.1.

Table 2.1 shows that future corporation will be increasingly dynamic and with change. The full-time regular employees in any progressive corporations are typically young and technically literate. They must embody the core competencies of these corporations.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Tradition Corporation</th>
<th>Future Corporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>Pyramid</td>
<td>Web/network</td>
</tr>
<tr>
<td>Focus</td>
<td>Internal</td>
<td>External</td>
</tr>
<tr>
<td>Style</td>
<td>Structured</td>
<td>Flexible</td>
</tr>
<tr>
<td>Source of strength</td>
<td>Stability</td>
<td>Change</td>
</tr>
<tr>
<td>Structure</td>
<td>Self-sufficiency</td>
<td>Interdependencies</td>
</tr>
<tr>
<td>Resource</td>
<td>Physical assets</td>
<td>Information/ideas</td>
</tr>
<tr>
<td>Operations</td>
<td>Vertical integration</td>
<td>Virtual integration</td>
</tr>
<tr>
<td>Products</td>
<td>Mass production</td>
<td>Mass customization</td>
</tr>
</tbody>
</table>
The changes have brought almost a significant departure from many of the traditional skill sets hitherto deployed in establishments. New generic skills are set to be a 'must' in combination with technical skills as a means of employment. University educators and future graduates must be aware of the changes for their preparation for employment. These include:

- Flatter organizational structures.
- Increased emphasis on autonomy and individual responsibility.
- Sophistication of products, services and systems.
- More job flexibility and job rotation.
- Team-orientated environments.
- Increased interface with customers.

The changes in the socioeconomic context have inevitably caused transformations in the university sector. More stress is being attached to the principle of 'efficiency and quality' in education as, education institutions encounter more challenges and are subjected to more internal and external scrutiny, particularly the demands from the
industry and business sectors as well as the changing expectations of government and employers. With the advance in technology and new knowledge, Castells (1996) states that information technology (IT) will play an increasingly significant role in influencing the process of socioeconomic restructuring in modern societies. Living in such a wider socioeconomic context, the knowledge-based economy has a very different demand for a ‘labour-force’. The ‘new’ labour-force should be of high value (knowledge workers) with an entrepreneurial culture to induce innovations and creativity in the knowledge economy, together with the skills of lifelong learning. A key question is, then: “Are universities preparing graduates and especially engineering graduates, for such work requirements in this changing society?”

2.2 New skill requirements in the 21st century

Due to the advancement in technology and the expansion of the global market, tomorrow’s organizations will be quite different from that of the recent past (Corta, 2000). The new technology in communications has made various business transactions faster and better to serve customer demands than before. Rapid changes in manufacturing, service, and logistics technologies will result in even more organizational reform. For some jobs’ locations, the ‘office’ can be anywhere in the world. With advances in telecommunication technology and long-distance phone costs decreasing, the ‘office’ may be located in whichever country in which workers are skilled enough or willing to work for low wages out of their homes (Thurow, 1996). Unless graduate engineers are trained to work in the high-skill or high-value-added end of the market, they may find worldwide competition intensifying as the number of home-engineers grows in an increasingly crowded world. It is important for today’s engineers and future engineering managers to proactively anticipate the future, to
recognize the significant changes that lie ahead and to prepare to capture the new opportunities associated with the changes.

Universities produce scholars, professionals, researchers and leaders. Universities should transfer professional culture from one generation to the next, and provide services to aid the society. Yet the same powerful economic, social and technological forces driving changes in society are also transforming their needs and expectations for the contribution of the universities. The high-performance workplace is creating new needs for university education to provide graduates in a form that is compatible with future career. A graduate’s present degree qualification, which is the threshold requirement for entry into any organizations, may be secondary after work experience. Their performances will be a key indicator in their working environment. The degree qualification indicates only how well one learned in the past. The knowledge that is previous achieved could easily become obsolete on a time basis. Qualification may 'qualify' an individual to work in a certain occupation or profession at the time of graduation, but would not take account of the subsequent careers in one's life. It does not always provide a license for lifelong earning.

According to a study by Cheng, (2004), demand for higher education is growing across geographical and social boundaries. Higher education is no longer a local business, but an industry where institutions compete for students globally. Depth of knowledge in a specific discipline remains important but it is no longer sufficient. Generic-type skills that cut across disciplines are the key, especially, according to Cheng, the ability to manage people and motivation to learn. Developing the self-learning ability and lifelong learning is essential. Universities must know what their students need to know to further their careers (technology, business process).
Cheng predicated that future graduates will increasingly work in Small Medium Enterprises (SME) or in a large organization under a small business unit. The majority of graduates may be free-lancers/part-time workers in the future.

Educators are concerned about the new social environment changes that affect the future employment of graduates. The Second Worldwide Forum for Comparative Education held at Beijing in September 2005, discussed how globalization will impact on graduate engineers' learning and on the influence of education worldwide. This forum focused its discussion particularly on the effects of government, the market and the society on graduates (Clem, 2005). Although no final solutions were released from the forum, academics there were concerned about the generic skills of future graduates.

The introduction of new technology in education continues to exercise the education imagination and open opportunities for learning and teaching in higher education; these include ‘distance learning'; virtual classrooms, global education, computermediate communication, and so on (Bourner, 2000). Some of the traditional lectures in classrooms will soon be replaced by computer-conferencing, chat-systems, audio-based systems, video-based systems and multi-based systems. Basic understanding of the technology for all students is essential; no matter they are engineering or non-engineering students. However, before embarking on new steps to modify the education system, educators needed to objectively ‘assess the effectiveness of the current courses, identify areas and methods for optimally expanding and improving the program’ (Sageev, 2001) to meet the new requirements. The most valuable graduates are those who are not only technically competent, but also possess leadership skills, global outlook and problem solving skills.
Chang (2005) outlined the future full-time regular employees in any progressive corporations are typically young and technically literate; they embody the core competencies of these corporations. Some of the employees may reside locally, or aboard, and have modern attitudes toward the employer-employee relationship, and change jobs frequently, preferring opportunities for interesting and challenging work that stretches their abilities globally. Supporting these core employees are various part-time workers, independent contractors, agency temporaries, employees of vendors and consultants who will also engaged.

In the 21st century, the roles of the professionals will be quite different from the current ones. There will be major changes in the work patterns and new generic skill requirement (Chang, 2005):

- Free agents, who can provide their skills around the world via the Internet. Each employee may have many different jobs throughout a career of 45 years. They tend to constantly bargain for better deals within their organizations.

- Professional groups, who offer the senses of identity and community, health insurance, and other benefits needed by free agents who float from one corporation to another.

- Workers seek to acquire a broad set of marketable skills, as corporations will continue to outsource white-collar jobs and spread centres of excellence around the world to seek advantages in cost, speed, and expertise. Managers and professional workers need to be flexible and adaptable to organizational changes and become cosmopolitan, equally at ease both at home and abroad.

To enable graduates to prepare for their future, educators should understand the 'restructuring’ changes in the society and the new requirements from the business and
the industry, and have to engage in a much needed change in the education systems. Of course, educators cannot bear all this responsibility alone, they need support from government, universities and industry to work together in complementary ways to assure that the mutual needs are met.

From an engineering discipline perspective, besides the basic fundamental core engineering subjects, graduates need to learn and fully understand the ‘value’ of engineering and the ‘integrity’ of an engineer. Subjects such as ‘communication and presentation skills’, ‘problem-solving skills’ and ‘critical thinking and evaluation’ should be included in the engineering programme. After graduation, training and continuing education should be provided by employers or initiated by graduates in close association with universities and professional institutions. If graduate engineers want to control the future of their careers, and do not let the future control them, all they have to do is to choose and prepare for the future. Otherwise they are then forced to choose.

2.3 The Hong Kong Institution of Engineers (the HKIE) accreditation programme

The Hong Kong Institution of Engineers (the HKIE) is the professional engineering learned society and qualifying body for Hong Kong for setting and maintaining the professional and technical standards of its members. One of the functions of the HKIE is to determine whether the academic standards of an institution of higher education are comparable with the internationally recognised standards. It includes course validation, course revaluation, institutional review and institutional accreditation (HKIE, 2003). The institutional accreditation involves the evaluation and comparison of the academic standards of a degree or sub-degree and consideration of the
appropriateness of the education components of that degree or sub-degree for professional practice.

The academic qualification for Corporate Membership (Ir) of the HKIE is an accredited engineering degree at honours level. The HKIE is a signatory institution to the Washington Accord. The Washington Accord was first established in 1989, some key signatory organizations are:

- The Accreditation Board of Engineering and Technology of USA (ABET).
- The Canadian Council of Professional Engineers.
- The Engineering Council of United Kingdom.
- The Institution of Engineers of Australia.
- The Institution of Engineers, Ireland.
- The Institution of Professional Engineers of New Zealand.
- The Hong Kong Institution of Engineers.

The main purpose of the Washington Accord is the recognition of degree engineering programmes to be mutually comparable. Each organization has the responsibilities of fostering, maintaining and developing bilateral and international agreements for the international engineering initiatives, which have been established to harmonise qualifications and to recognise accreditation methods and standards.

In Hong Kong, an engineering degree programme, should have a minimum duration of three years full-time equivalent (with the education reform in Hong Kong, the engineering degree programme will be four years in 2012). The HKIE provides feasibility on universities in relation to curricula and syllabuses but encourages them to develop courses, making the best use of resources, responding to academic and technological change and recognising the needs of the students, community and
profession. The HKIE expects the curricula for engineering degree programmes to have three main emphases, namely: engineering subjects, mathematics and complementary support subjects. For example:

1. Engineering subjects:
   (a) Engineering sciences (other basic sciences, but carry knowledge further towards creative application depending on the professional engineering disciplines)
   (b) Engineering design and synthesis (creative, iterative and often open-ended process, financial, quality safety and environmental implications)
   (c) Laboratory and field work
   (d) Computing and information technology (IT)
   (e) Project (group and individual projects)

2. Mathematics:
   (emphasis on mathematical concepts, and principles, numerical analyses and applications and their relationship to the modelling of engineering systems)

3. Complementary studies:
   (a) Practical training (such as ‘sandwich’ programmes, summer practical training.
   (b) Health, safety and the environment
   (c) Communications (oral and written communication skills as well as presentation skills)
   (d) The professional engineer (the role of the professional engineer in practice and their responsibilities towards the professional, colleagues, employers, clients and the public)

The HKIE outlined the accreditation criteria for the professional accreditation of
engineering degree programmes but the question remains of how to measure the actual outcomes of the graduate engineers' learned knowledge and skill when they graduate and enter the workplace.

2.4 General concerns of generic skills of graduate engineers

As stated in the Literature Chapter, there are various studies and survey results that have indicated graduate engineers are lacking of generic skills. Both the academic world and industries are concerned about the inadequacy of the generic type skills of graduate engineers. Some industrialists have criticized the ability of engineering graduates to perform in industry, and they are sometimes quite critical. Issues, for which some hold the educational system accountable, include the lack of understanding about engineering and technology of people with a general education (a serious problem, given the importance of engineering and technology) and shortfalls in the practice skills of new engineering graduates. Whether the accusations are correct or not, it is important for the graduates, academic staff and employers to work together as a join force to enhance the quality of graduates' generic skill levels.

University is a means of preparing graduates for future eventualities that will impact significantly both their working and personal lives. Moreover, universities need to be aware of the changing environment in the workplaces and the likely long term implications of these changes on their graduates. Universities should be able to foresee the new ways in which the work environments are changing so as to offer programs that will be pertinent for the benefits of both graduates and society. The challenge for all engineering educators is how to teach graduate engineers effectively and efficiently so that engineering is more than differential equations and that using technology to help society involves more than engineering. Linking academic and
industry together has great advantages for understanding the curriculum design and creates competitive edge for graduates. Brown (1998) indicated the design(s) of learning processes as one of the 'causes' or remedies for the mismatch between education and relevant labour market requirements.

Magee (2003) briefly examined the activities that successful engineers did well in operations (manufacturing) in the United States’ factories in comparison with new graduates at the Boeing Aircraft Company in the United States. The new graduate engineers were asked to do a critical self-assessment of Boeing’s key graduate-attributes and then to review their perceptions with a senior engineer mentor for feedback. The majority of these new graduate engineers received high grades (either A's or B's) in their courses at top engineering schools in the United States, but received low-level scores on the attributes being assessed. Graduate engineers scored extremely low grades on business and customer related issues that reflected graduate engineers were very weak in understanding the operations of the business. Table 2.2 shows the attributes and the results in the ‘Assessment of New Engineers’ at Boeing. In this case, the data indicated major gaps in what universities teach and what the industry wanted for its graduate engineers.

**Table 2.2** Attributes for assessment of new engineers (Magee, 2003)

<table>
<thead>
<tr>
<th>#</th>
<th>Activity</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Determine whether customer value and enterprise value are aligned</td>
<td>D-</td>
</tr>
<tr>
<td></td>
<td>(business sense)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Much of this requires ‘domain-specific knowledge’ and experience</td>
<td>D-</td>
</tr>
<tr>
<td>3</td>
<td>Determine what customers want</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>Build or create a prototype version</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>Quantitatively and robustly test a prototype to improve concept and to predict effectiveness</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6</td>
<td>Several require systems thinking and statistical thinking</td>
<td>D</td>
</tr>
<tr>
<td>7</td>
<td>All require teamwork, leadership, and societal awareness</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td>Create a concept</td>
<td>C-</td>
</tr>
<tr>
<td>9</td>
<td>Communicate all of the above to various audiences</td>
<td>C-</td>
</tr>
<tr>
<td>10</td>
<td>Determine quickly how things work</td>
<td>C-</td>
</tr>
<tr>
<td>11</td>
<td>Use abstractions/math models to improve concept</td>
<td>C</td>
</tr>
</tbody>
</table>

The relatively low results demonstrated graduate engineers' lack of business sense and of generic-type skills, when they joined the Boeing workforce. It is true that the traditional engineering disciplines do not include the study of business subjects. But with changes in society, maybe engineering curricula should be modified and include certain business subjects as part of the curriculum of the engineering disciplines.

Engineering academics face many challenges today as does industry as a whole. In Hong Kong, with budget cuts and a reduction in resources in higher education (Hong Kong Higher Education Commission, 2003), educators must invest the limited resource wisely and effective mechanisms must be in place to monitor the quality of education and outcome of graduates. Measurements of the graduate engineers' learned knowledge and generic skills made by employers and the graduate engineers in their workplaces present the best opportunity for feedback about the learning outcomes of the graduate engineers and for the academic world. Feedback could help any university to address the rapidly changing society and the new requirements of the business and industry.

In the 1990s, there were major changes in Hong Kong university education; these included the expansion, restructuring and refinancing of the Hong Kong tertiary education sectors. Classes are now much larger and consist of different diversified students' capacities, abilities, motivations and cultural background. Facing with these
challenges and to maintain standards of university education, academic staff members must invest their limited time and resources wisely. Different approaches, such as higher-order learning processes and learning outcomes (Biggs, 2003), should be considered and applied. Higher-order learning processes mean student-centred, teaching staff members acting as facilitators and helping students to learn, plus focus on achieving the outcomes. The intended learning outcomes represent achievements attained by students instead of topics to be covered.

In order to be successful in their professions, graduate engineers should pay more attention to the areas of their workplaces as recently suggested by Chang (2005).

- **Demonstrate technical competence and innovative capabilities:**
  - Graduate engineers need to demonstrate excellent technical skills in performing tasks and projects. It is also critically important for graduate engineers to demonstrate their innovative capabilities in product design, problem solving, and other technological areas.

- **Practice people skills:**
  - Graduate engineers should ensure that they communicate effectively with others in both verbal and written forms. They also need to demonstrate that they are easy to work with and get along well with most people.

- **Show and unfailing reliability:**
  - Graduate engineers need to show that they are reliable in taking on assignments that add value to their management and are capable of discharging responsibilities delegated to them.

- **Be proactive:**
Graduate engineers should proactively seek team assignments, project coordination, and other roles to practise their managerial skills, foster teamwork, and showcase leadership qualities.

The emphasis on acquisition of generic-type skills and knowledge has become even more critical now. The concept of an ideal graduate is emerging. This statement is true in the academic world; however, in any industry, the academic qualification is for the basic requirement and entrance to an organization. Once a graduate enters into an organization, their performance is most important. A graduate who possesses academic qualifications and generic-type skills will play a fuller organized and citizenship role by contributing in a broader sense to the local and international communities.

To enable graduate engineers to prepare for their futures, educators should be aware of and understand the ‘restructuring’ changes and the new requirements of society and have to engage in a much needed change in the education systems. Of course, educators cannot bear all these responsibilities alone. Development and upgrading of the skills of graduates should be the responsibilities of graduates themselves, education institutions, industry and government. These four parties must work together in complementary ways to assure that the mutual needs are met to cope with changes arising from Hong Kong’s economic restructuring and to maintain Hong Kong’s competitive edge as a global city.

As stated by Kir (Kir, 2004, pg.42)

“With the future of the Asia-Pacific region pointing to growth, universities are keys to sourcing the top talent in the market. To remain competitive with the times, universities must know what their students need to know to further their
careers... help their students find employment and build careers, and guide them
to prepare for the real world. It is a win-win situation”.

2.5 Current education system in Hong Kong

The traditional secondary school education systems in Hong Kong are based on the
These learning process characteristics are large class, expository methods, relentless
norm-referenced assessment, and is teacher-centred. Teachers’ talk and students’ listen.
Teachers base teaching on the syllabus (particularly for the public examinations) and
prepare the contents of teaching material. Students are given instructions, and do their
‘homework’ or ‘assignment’ as per instruction. In order to score high marks in the
examination, most of the students memorise (rote learn) the contents, and try to
answer as many questions as they can. As described by Biggs (2003), students are
using a ‘surface approach’ to learning. It is common practice when teachers plan their
curricula to start by thinking about the relevant topics to teach based on the syllabus.
Although there may be changes in the classroom instruction, the major public
examinations in Hong Kong for university entrance still play very important roles in
the learning and teaching for both the secondary students and their schools
respectively. The majority of students who enrol into the Hong Kong universities, are
still guided by their secondary school education training. Some students still practise
their rote memorisation and are full of ideas in ‘achieving’ higher marks.

However, as Biggs (2003) stated that:

“Learning is not imposed or transmitted by direct instruction, but is created by
the students’ learning activities, their approaches to learning”.

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Thus, learning is a way of interacting with the world. As students learn, their conceptions of phenomena hopefully change, and they see the world differently.

Education reform is not a new ‘vocabulary’ in Hong Kong’s educational system. Over the past three decades, the Hong Kong government has implemented education reforms of various kinds. For example: the ‘nine-year’ free and compulsory education from primary to junior secondary levels during the 1970s and the structural reform from a 5-2 (5 years secondary school and 2 years matriculation leading to university) secondary education and three university education system to a 3-3-4 (3 years junior high, 3 years senior high secondary and 4 years university) secondary and higher education system in 2004. In the past decade, higher education institutions in Hong Kong have been scrutinized with intensified demands for improving teaching quality. Teaching quality has significant funding implications to the institutions. Realizing the changing environment and globalization challenges, the majority of the higher education institutions in Hong Kong have begun to adopt a proactive approach in promoting their curriculum design and increasing the employability of their graduates. The majority of the traditional engineering programmes at Hong Kong universities place a heavy emphasis on science and mathematics. Their programs offer limited professional disciplines, values and generic-type skills for students, although these generic-type skills also have started to earn a place in the overall educational goals in higher education institutions in Hong Kong. Recently, some universities in Hong Kong offered some programmes with subjects that have cross discipline boundaries. These cross discipline boundary subjects enable students to realize the different roles of an organization. In other countries, such as USA, UK, Canada, Norway, Australia and New Zealand, comprehensive curriculum statements that focus on the whole education systems demonstrate a broad view of the purpose of education and include
many overarching generic skills that developing students into ‘integrated human beings’, individuals who are spiritual, creative, working, liberally educated, social, and environmentally aware (Knain, 2001).

With emphasis on engineering science; engineering undergraduate education might easily have become largely disassociated from the practice of engineering (Ferguson, 1980). The emphasis on analysis had outpaced the incorporation of synthesis and design as well as a number of broader educational and intellectual imperatives that were becoming increasingly evident (Fromm, 2003). That included the ‘sandwich programmes’, ‘work placements’ during the summer period and industrial-based projects, which heavily involved industrial sector or business sector.

In order to promote the linkage between university and the industrial sector, many universities in Hong Kong have now established an ‘industrial centre’ to promote entrepreneurial spirit and practice for staff and students and to serve as a bridge between the university and the industrial and business sectors. The Hong Kong University of Science and Technology (HKUST) established a Technology Transfer Centre and the Engineering Industrial Consortium to establish industrial contacts and cooperation and to organize professional development and training programmes for employers and graduates. The City University of Hong Kong (CityU) has set up a Technology Transfer Office as the technology-marketing arm of the university to reach out to the industrial and business communities. Like HKUST and CityU, the Hong Kong Polytechnic University (PolyU) also established the PolyU Technology and Consultancy Company Limited (PTeC) to serve as the professional arm of the university to offer fresh ideas and leverage business plans towards higher productivity and competitiveness of the industry in Hong Kong. The establishment of technology
transfer centre or office besides transfer the advanced technologies into commercial products to enhance the competitiveness of Hong Kong industry, also aims to strengthen the links between the university and the industrial as well as business sectors in Hong Kong. The tri-cooperation of government-university-industry network system should certainly strengthen and improve not only the quality of engineering education but also promote the entrepreneurship spirit of students in Hong Kong.

Reform in education requires new ways of delivering knowledge and assessing students. Both academic staff members and students need to understand why curriculum designs are changing and why alternative assessment methods are needed. That means the traditional roles of ‘teacher-centre’ are transformed and shifted to a new paradigm (student-centre). This situation, coupled with the fact that there is no ‘one-size-fit-all’ transition paradigm, represents the new challenge to change. In order to produce ‘modern’ engineers of real value to the industry and society, the curricula design should be a proper balance between engineering fundamentals and actual requirements. The 21st century graduates are expected to be all-rounded and with professional competence. Universities have to be able to foresee the new ways in which the work environments are changing so as to offer programs that will both be pertinent for the benefits of graduates and the society. The tri-cooperation of government (funding) – university (knowledge) – industry (employment) network system will certainly strengthen and improve not only the quality of engineering education but also promote the entrepreneurship spirit of students in Hong Kong.

2.6 Motivation of this Research

Two general issues are of importance here:

“Are universities producing engineering graduates that can meet the ‘new’
requirements and satisfy the needs of the industry?"

"Do graduate engineers possess the 'right' balance of knowledge and skills to perform their functions in their engineering sector?"

No doubt, that the majority of the engineering educators would also like to find some answers to these questions. Indeed, Cheng (2004) in his inaugural professorial lecture at the University of Hong Kong raised similar questions. The researcher himself had been working in the engineering sector of telecommunication industry in a multi-national organization for over thirty years and started as a graduate engineer-in-training and later promoted to senior manager. He had been working in engineering operations, design engineering, research and development and international marketing departments. The researcher also had the opportunity to recruit graduate engineers and managers during his management capacity. He understood the characteristics of 'good' engineers and managers and the benefits of employing 'good' engineers and managers in the manufacturing industry. While teaching at a university in Hong Kong, the researcher had the opportunity to 'develop' what kind of technical knowledge that he would like to share with his students, and what kind of graduates he would like to produce for the benefit of industry and society.

Based on the researcher's own values and philosophy, he believes:

- With the changing of the society, education system should be upgraded and prepare graduates with the ability to meet the new changes,

- Although education in Chinese communities is known for its emphasis on examinations, and competitions; there should be an alternative way of looking at motivation for student learning than just examination,
• Learning is a construction of knowledge by students and not just transmission of knowledge by the lecturers. Students should actively participate in learning. When graduates enter into the workplaces, they should be able to identify the causes of problems and provide solutions by all means. They have to construct solutions based on what they have learned,

• Students learn more effectively in a team setting, i.e., in groups, rather than as individuals. Besides learn to be independent, teamwork is also an important process for students to learn at university.

Experience has shown that the majority of the work for an engineer in an engineering organization is related to technical know-how and problem-solving. However, in order to complete the work, the engineer also required all types of generic skills to support the task in the workplace. Activities in the workplace are all inter-related and an integral part of any organization. The key generic skills such as communication, problem-solving, decision making skill and general management type skills are a ‘must’ in order to fulfil task requirements. The majority of these generic-type skills could be effectively learned at university if students were given the right opportunities and environment and they were willing to learn.

Learning in practice and learning at work are still considered an important activity for preparing graduate engineers for working life. Learning while working, just-in-time learning and job rotation are considered important components in gaining work experience and skills. Training within organizations can also contribute to the process of becoming skilled. Learners learn best if declarative knowledge (the ‘what’), procedural knowledge (the ‘how’) and strategic knowledge (the ‘when’) are integrated both in university and in actual working environment. Learning experiences should
integrate domain knowledge, problem-solving strategies and real-world applications (Soden, 1994).

In this study, the researcher would like to get answers for the two basic questions:

"Are universities producing engineering graduates that can meet the 'new' requirements and satisfy the needs of the industry?"

"Do graduate engineers possess the 'right' balance of knowledge and generic type skills to perform their functions in their engineering sector?"

Besides, the researcher also would like to identify the generic skill requirements for graduate engineers in their workplaces and help future graduates (plus the current ones) to meet or exceed their performance and become successful leaders in industry.

2.7 Research Questions

According to Cronbach (1982), researchers should consider a wide number of potential research questions in the first place before they finalize the research topic. These questions should be developed to provide descriptive, normative, and impact (cause-and-effect) data, and to evaluate the implications of each one of them for the development of a research topic. The process will help researchers to identify and agree on which questions have a highest priority, as well as on which ones can easily answered, which ones are more difficult, expensive and / or time-consuming, and which ones cannot be at all answered, and why.

In this study, the researcher has the following research questions in mind:

1. What generic skills are perceived as important by recent graduate engineers and engineering managers in the industrial engineering sector in Hong Kong?
2. Do graduate engineers have adequate knowledge and skills learned at university to meet the industry's need in their workplaces?

3. How do graduate engineers and their employers perceive the quality of engineering education in Hong Kong higher education?

4. What are the recommendations for changes in engineering curriculum design to enhance the generic skills based on a study of generic skills, and later to improve the teaching and learning process?

Based on the research results, the researcher would be able to establish the perceived importance of certain generic-type skills requirements for graduate engineers, particularly in those areas such as communication skills, problem-solving skills, management skills, technical know-how and the breadth of the knowledge. This information is needed to enhance further the quality of higher education and to improve Hong Kong's competitiveness in the global markets. The study also will provide a feedback loop between industry and university for closer co-operation to develop a better understanding of the implication of the curriculum design as a source of competitive advantage for the Hong Kong engineering graduates and Hong Kong industries in the face of globalization. The final research results would be shared with academic staff and serve as guidelines to improve university teaching and learning. A final list of recommendations would be tabled to academic staff for future consideration in the design of course curriculum development.

Currently, the Hong Kong SAR recently published a consultative document on revamping the academic structure for senior secondary and higher education. The document has proposed the implementation of a '3+3+4' model and will be implemented at all Hong Kong universities in the year of 2011. The proposal is now
soliciting opinions from the general public and academic institutions. The proposed ‘3+3+4’ model will extend university education from the tradition of three years to four years.

Professor Li, Secretary for Education and Manpower of Hong Kong SAR (EMB, 2004), stated that the change of the higher education from three years to four years is because society and the economy are changing dramatically and the rapid development of new technologies and knowledge and increasing global competitiveness require that Hong Kong nurtures the talents of not just a few people, but all of its human resources. The additional extra year in university education would raise the overall quality of graduates. He believed the current higher education systems with a narrow knowledge base continues to dominate teaching so that the reforms would provide more attention to teaching students how to learn in basic education which includes generic type skills and to create lifelong learning and a learning society. The goal of the education reform is for all students to develop into balanced individuals who can understand and contribute to their society, and draw upon their internal resources to continue to learn productively over their lifetime. The ‘3+3+4’ system reform in Hong Kong will mean a 12-year academic system for primary and secondary education, better aligning with Mainland China and the international community. This will promote Hong Kong as a better international articulation for global positioning as a world city.

The majority of the universities in Hong Kong firmly believe that the proposed ‘3+3+4’ academic structure is more in tune with the prevailing trends of education communities around the world and is a crucial step forward for the future advancement of education in Hong Kong.
The Hong Kong PolyU also fully supports this forward-looking proposal from the Government (Poon, 2004). PolyU believes the addition of an extra university year will be extremely beneficial to the grooming of next younger generation and allow the university to offer different programs and to re-arrange some curriculum contents and activities that can help to enhance students' generic skills. The addition of one summer break will increase the summer placements for students in industry and study trips to foster students' industrial exposure and all-round development. The expected outcome will definitely enhance and prepare graduates to future professional development and career advancement.

This study after completion and releases may provide some relevant data to link to the Hong Kong SAR education reform on the new curriculum design for new courses (subjects) for the first year programmes at least in the engineering area.

2.8 Research Objectives

Industry, particularly the manufacturing sector in the world, had undergone major restructuring as a result of political condition, technological change and global competition. The change had caused many employees to lose their jobs, as a number of functions traditionally done in-house have been contracted out or automated (Drucker, 1993). According to Tapscott and Caston (1993) in their book, Paradigm Shift, "Paper-based systems, bureaucratic approval processes, labour-intensive clerical activities, batch processing cycles and multilayered decision-making processes are being replaced by source date capture, integrated transaction processing, electronic data interchange, real-time systems and expert systems". Information Technology (IT) is becoming part of the foundation basis for all graduates. Technology, such as Local Area Networks (LANs), enables staff from other departments to be able to share the
information as long as they understood the terminology of other departments’ functionalities. Peavey (1993) states that:

"Organizational structures are moving from linear, hierarchical and fixed structures to fluid, organic structures with a good deal of plasticity between organizational structure and worker activity and between workers themselves".

University is a key knowledge-production institution. First, it is considered as a producer of knowledge, whether in the form of scientific results or of scientifically trained scholars. Secondly, as a producer of ‘knowledgeability’ in the shape of both a more highly educated and more scientifically rational and literate population and a more enlightened and sophisticated culture society. The substantial changes that are currently in progress in the society will have significant implications on the education systems for the skill requirements of the working conditions of the graduate engineers and their expectations. University must start to address these changes in terms of what new skills are likely to be increasingly in demand. There are needs to study and to identify the generic-type skill requirements for industry and also the adequacy of these generic skills possessed by graduate engineers. Results collected here would then help to improve understanding of what generic skills that the industry needs and how university could support the requirements. The study results would also provide an opportunity to bring a closer communication loop in engineering education between the academic and industry.

This research therefore, is an empirical/analytical study and has the following key objectives:
1. To identify and analyse what generic skills are perceived as important by graduate engineers and engineering managers in the Hong Kong workplaces.
2. To evaluate the perceived adequacy of the learned knowledge and generic skills of graduate engineers and their degree of skill levels as perceived by their engineering managers.

3. Finally, briefly to develop a set of recommendations for changes in engineering curriculum designs so as to later improve the teaching and learning process.

In this study, the researcher expects to gain enhanced understanding of the acquisition and development of generic skills in both the higher education and the employment settings, from the particular perspectives of those involved – the graduate engineers, the engineering managers as well as the university academic staff.

2.9 Research design

One of the key research design issues is the ‘orienting decisions’ (Morrison, 1993). Orienting decisions are just like the ‘scope’ of a project, which set the boundaries or the parameters of constraints on the research. The orienting decisions help researchers to focus their minds and energies for data collection and set their priorities based on requirements. The priority and the time span all affect the questions to be asked, the data collection instructions, the resources to which the research might go; the sample size and the focus areas (Cohen, 2003). Figure 2.1 shows a general outline of the research design based on Morrison’s (1993) model. In this model, the researcher generates the research questions based on his study objectives and his interest and his experience, discussed and reviewed with others (including his supervisor and colleagues). The outcome of the orienting decisions is set of research questions which later converted into the study objectives.
In this study, the orienting decisions are divided into the following phases.

Phase 1:
Define the importance of generic-type skills based on the research literature. Identify concerns related by the graduate engineers and the engineering managers about their generic skill levels. Summarise the study and formulate the research questions which are later developed into the objectives of the research.

Phase 2:
Develop questionnaires and solicit views on generic skill levels from the graduate engineers and the engineering managers.

Phase 3:
Pilot test questionnaires and make changes as required

Phase 4:
Conduct main study and tabulate survey results.

Phase 5:
Conduct interviews and discussions to further validate survey data.

i) Focus group interview with graduate engineers

ii) Individual interview with engineering managers
iii) Focus group and interview with academic staff.

Phase 6:

Final data analyses, describe the results, draw conclusions and list a brief set of recommendation based on the study.
Chapter 3  Method

3.1  Introduction

This chapter gives a brief review of research methodology and identifies the appropriate research instrument procedure to be used for this project. The justification for the research process used is also presented in this chapter.

The research is empirical and analytical by nature and its purpose is to assist the researcher in his field to become aware of the relationship between research and his professional activities in areas of teaching and learning in the higher education in Hong Kong. The design and data analysis procedures were based on general design concepts to be found in Cohen, Mansion and Morrison (2000) and Babbie (2004).

Questionnaires, sample sizes and interviews had been successfully deployed for research in empirical studies in various institutions and organizations and in different regions or countries (Comer, 1987; Dearing, 1997; EMB 2000; Gan, 2006). However, the development of questionnaires is considered as one of the most important parts of research in any survey and there is no exception in this study. The major challenges are what questions should be asked and what are the criteria constituted as good questions and measuring scales for the questionnaire.

The first stage in deciding what questions to ask involves precisely defining what information is needed and writing the fewest number of questions to obtain it. As Bradburn (2004) stated;

"Well defined objectives are the best way to ensure good questionnaire design…

A ‘good’ question asks for only one answer on only one dimension, and yields a
There are four research questions for this study as stated in Chapter 2 (page 79).

Two groups of individuals were used in this study: graduate engineers and engineering managers. These two groups formed the core of this study and specific instruments were developed for collecting the data. Instruments used to collect the data included:

- Questionnaires;
- Focus group discussions and
- Individual interviews.

The decisions to apply questionnaires were supported by the following factors:

1. The researcher has a pool of graduate engineers and engineering managers on hand in Hong Kong;
2. The survey meets the purposes of this study;
3. Gathering data on a one-shot basis is economical and efficient;
4. Data from engineering managers and graduate engineers collected at a particular point in time when describing the nature of existing conditions could be compared.
5. Data from questionnaires could be processed statistically and it also provided descriptive, inferential and explanatory information; and
6. Open-ended questions could be added to the questionnaires to invite personal comment from the respondents.
3.2 Samples

The quality of empirical research not only depends on the appropriateness of the methodology and instrumentation used but also depends on the suitability of the sampling strategy that has been applied. Qualitative researchers usually work with small samples of people, in their context and studied in-depth. The samples tend to be purposive, rather than random (Kuzel, 1992; Morse, 1989). Samples sometimes are not wholly pre-specified, but can be evolved once study begins. Sampling in qualitative research involves two actions that sometimes pull in different directions. First, one needs to set boundaries: to define aspects of one's case that one could study within the limits of time and means. Second, at the same time, one needs to create a framework to help one uncover, confirm, or qualify the basic processes of the study. Judgment on sampling should be based on four factors (Cohen, 2003):

- The sample size;
- The representativeness and parameters of the sample;
- Access to the sample; and
- Sampling strategy to be used.

The general strategy for this study can be divided into three major components with the following focus on the respondents:

1. Graduate engineers who graduated from university about 2 to 3 years earlier with full-time employment.
2. Engineering managers who had been working in industry for more than 10 years and fully understood the operational requirements in their own business.
3. Academic engineering staff that was responsible for engineering curricula designs and teaching.
The sample size strategies for these three groups varied accordingly to their availability and their suitability.

3.2.1 Sample sizes for the main study

The selection of recipients for the graduate engineers' questionnaire was based on the Hong Kong PolyU Alumni list. The targeted sample size for graduate engineers was between 100 to 150 candidates. These graduate engineers had graduated in engineering disciplines, within two to three years and were all full-time employees working at various positions in different industrial sectors. One hundred and fifty candidates were selected from the Alumni list but with only 123 candidates with valid email addresses formed the basis of the sample from whom data was gained.

The targeted sample size for the engineering managers was planned to be about 80 to 100 working engineering managers. Engineering managers were selected based on organizations in Hong Kong that involved student summer placements and provided project works for engineering students. Some of the managers were selected from engineering organizations that have employed graduate engineers. The majority of these targeted engineering managers had graduated in engineering disciplines with more than ten years working experiences in engineering fields. Usually these managers had worked as engineers before being promoted to their current positions as engineering managers. One hundred and twenty engineering managers were composed from the list. However, only 113 names were identified as current and valid in the organizations.

3.2.2 Sample size for focus group discussion and interviews

After the main study was completed and survey data analysed, focus group discussion
was arranged with graduate engineers and more individual interviews were conducted with engineering managers because of their busy schedules. Academic staff members were invited to attend a discussion forum and for those who could not attend, individual discussions were being set up based on their schedules.

Focus group discussion was specially arranged for the graduate engineers, because of their working routines. The targeted sample size for the graduate engineers' focus group discussion was 20 people. For engineering managers, because of their limited availability, the researcher planned to invite 10 to 15 of them to an individual interview. Since the researcher is a member of the teaching staff at the Department of Industrial and Systems Engineering of the Hong Kong PolyU, there are 30 academic staff members in this department, and it was targeted that at least 5 to 8 members would attend a discussion forum. For those members who could not attend due to their teaching schedules or other meetings, the researcher planned to conduct individual interviews with them on their available schedules if they showed interest in this topic.

3.3 Survey instruments

Applications of questionnaires and interviews were conducted in this study. The questionnaire provides structured, often numerical data for data analysis and comparison. The survey results could support the quantitative analysis while the group discussions and interviews would provide qualitative analysis. Usually, the conduct of a questionnaire survey will always be an intrusion into the life of the respondent, in terms of time taken to complete the questionnaire, the level of threat or sensitivity of the questions, or the possible invasion of privacy. So the questionnaire developed for all participants remained anonymous.
The development of the questionnaire should be simple and easy to complete, but at the same time, it should consist of all required information to support this study. There were in fact two questionnaires developed, one for the graduate engineers and the other one for engineering managers. The basis for the design of this research instrument can be found in Biggs (1987) 'Study Process Questionnaire (SPQ)'.

The first set of questionnaire was for the graduate engineers and emphasized the graduate engineers' perception of the importance of the generic skills in their workplace, their own evaluations of their adequacy of these generic skills and their own assessments of the adequacy of their general learned knowledge and skills at university. The second set questionnaire was for the engineering managers. It emphasized the managers' own views of the importance of the generic skills and their perception of the adequacy of their graduate engineers' applications of those skills in their workplaces. These questionnaires were reviewed, pilot tested, modified before being mailed to the graduate engineers and engineering managers selected for the main study.

3.3.1 Questionnaire for the graduate engineers

The questionnaire for the graduate engineers comprised three sections:

Section 1 focused on the assessment of the importance of generic type skill categories. Four major categories were specially selected and each category focusing on one of the key generic skills, namely:

- Communication skills category (using 5 statements);
- Problem-Solving skills category (using 6 statements);
- Management type skills category (using 11 statements); and
- Other-generic-type skills category (using 6 statements).
The statement on each category was designed to link to a Likert-type Scale of 1, 2 or 3 to indicate a relative strength of the preference (3 = High importance; 2 = Moderate importance and 1 = Low importance).

On the far right-hand side of each statement, the paper was divided into Column A and Column B. In Column A, graduate engineers were asked to indicate their ratings on each statement of their perceived importance: ‘(3) High Importance’, ‘(2) Moderate Importance’ or ‘(1) Low Importance’. And in Column B, they were requested to rate their perceived learned knowledge: ‘(A) Adequate’ or ‘(L) Less adequate’. The questionnaire for the graduate engineers is at Appendix 2.

For example:

<table>
<thead>
<tr>
<th>Col A</th>
<th>Col B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importance</td>
<td>Adequacy</td>
</tr>
<tr>
<td>L M H</td>
<td>A L</td>
</tr>
</tbody>
</table>

1. Communicate effectively in English. .................. 1 2 3 A L

At the end of each skill category, there was one general statement in which respondents were requested to answer ‘Yes’ or ‘No’ regarding their overall rating of the adequacy of this category.

After the completion of all of the statements in these four skill categories, graduate engineers were requested to rank their perceived priority of importance of these four categories into ‘(3) High’, ‘(2) Moderate’ or ‘(1) Low’ of communication, problem-solving, management and other generic-type skills categories based on their working experience.
Section 2 focused on the evaluation of the learned knowledge at university and it purported to measure the graduate engineers' view on their general learned knowledge at university. This Section 2 only applied to the graduate engineers and not their managers. There were seven broad types of statements in this section. Statement 1 also sub-divided from (a) to (e), which grouped to do with a specific issue.

On the far right-hand side of each statement, the paper was also divided into Column A and Column B. In Column A, graduate engineers were asked to indicate to what extent do they 'Agree' (A = 2) or 'Disagree' (D/A = 1) with each of the statement. In Column B, they were requested to rate the usefulness of the learned knowledge, using 'U' (Useful) and 'L/U' (Less than useful).

For example:

<table>
<thead>
<tr>
<th>Col A</th>
<th>Col B</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA 4</td>
<td>A 2</td>
</tr>
<tr>
<td></td>
<td>Usefulness</td>
</tr>
</tbody>
</table>

1. Overall, in my university course:
   a. Content was relevant to my career needs. ............ 1 2 U L/U
   b. ...

3. I was encouraged to learn actively both inside and outside of the classroom. ......................... 1 2 U L/U

Section 3 provided open-ended questions for comments. Open-ended questions were used to invite personal qualitative comment from the respondent. With the open-ended questions, the researcher hoped that the respondent would provide some details information that otherwise could not have been caught by the scale of the questionnaire. Graduate engineers were invited to give their comments on three open-ended questions.
3.3.2 Questionnaire for the engineering managers

The questionnaire for the engineering managers was comprised of only two sections. Section 1 focused on the importance of the four generic type skills areas. All statements in Section 1 of the engineering managers' questionnaire were identical to the Section 1 of the graduate engineers' survey. These statements for both groups should allow a direct comparison of the data obtained.

On the far right-hand side of each statement in Section 1, engineering managers were asked to rate their perception of the extent of the 'Importance' of each statement required in the workplace in Column A by circling the number of '1' (Low), '2' (Moderate) or '3' (High) based on their experience and their perceived value. In column B, they were requested to rate the extent of the 'adequacy' of the generic skills of the graduate engineers working in their organization by circling the letter 'A' (Adequate) or 'L' (Less Adequate).

At the end of each category, there was one general statement regarding their overall rating of the adequacy of the skill level of their graduate engineer in this category. The engineering managers were requested to answer only 'Yes' or 'No' in this statement.

After they had completed Section 1 of the four skills categories, the engineering managers were requested to rank their perceived priority of the importance of these four categories of communication, problem-solving, management and the other generic-type skills categories into '(3) High', '(2) Moderate' or '(1) Low' based on their working experience.

In Section 2, there were four open-ended questions for engineering managers to respond. Engineering managers were encouraged to provide their successful criteria
for their industry. The researcher expected these four open-ended questions would provide extra qualitative information that was not obtained in Section 1.

3.3.3 Pilot test of the instruments

The second stage of the survey instrument developed included a pilot test of the questionnaire before the starting of the main study. The main objective of the pilot test was to test the questionnaire and the survey arrangement. The pilot test was also used to increase the reliability, validity, practicability of the instrument and to test the procedure. As stated by Cohen and Manion (2003), besides to improve the quality of the questions, the pilot run also served some of the followings purposes:

- To check the clarity of the questionnaire items, instructions and layout;
- To gain feedback on the validity of the questionnaire items, the operationalization of the constructs and the purposes of the research.
- To eliminate ambiguities or difficulties in wording;
- To gain feedback on response categories for open or closed question;
- To check the time taken to complete the questionnaire;
- To identify commonly misunderstood or non-completed items.

The pilot run questionnaires were email to recipients by internet. This process was much better by the traditional postal services. Within days, the researcher received the first batch of the pilot test questionnaires from 6 graduate engineers and 4 engineering managers. A gentle reminder was sent to those non-responded recipients (9 graduate engineers and 11 engineering managers) with the same attachments after the first week. A total of 10 and 9 responses received from the graduate engineers and the engineering managers respectively for the pilot test. The pilot test response rates for the graduate engineers and engineering managers are shown in Table 3.1.
Table 3.1  Response rates for the pilot test of graduate engineers’ and engineering managers’ questionnaires

<table>
<thead>
<tr>
<th></th>
<th>Number of questionnaires sent</th>
<th>Number of questionnaires returned</th>
<th>Response rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate engineers</td>
<td>15</td>
<td>10</td>
<td>67</td>
</tr>
<tr>
<td>Engineering managers</td>
<td>15</td>
<td>9</td>
<td>60</td>
</tr>
</tbody>
</table>

Based on the pilot test results, the researcher made the following changes:

1. The initial version of the questionnaire in Section 1, after the respondents had completed all statements in Section 1, they (both graduate engineers and engineering managers) were requested to rank the priority of the perceived importance of the four skills categories, into a 3-point scale of high, moderate or low priority. The pilot test results indicated two respondents (engineering managers) ranked all of these four skills categories into high priority and three (1 engineering manager and two graduate engineers) ranked only high or moderate priorities.

In the main study, the researcher modified the instruction by ‘Underlining’ and ‘Bolding’ the instruction note in order to stress to respondents that they were required just to indicate the high, moderate or low priority of these four generic skills. This simple clarification helped respondents to focus on what they needed to do. For example:

The pilot test version:

“Now, considering your work from Section (1), rank the priorities into high, moderate or low according to your perception of the importance of the following categories”.

99
The main study version:

"Now, considering your work from Section (1), rank the priorities into High, Moderate or Low according to your perceived importance of the following categories.

2. Another change was made in the graduate engineers’ questionnaire of Section (2) 'The Evaluation of the Learned Knowledge at University' (Questions 2.1a to Question 2.7). The graduate engineers were requested to indicate to what extent do they 'Agree', Undecided' or 'Disagree' of the knowledge they had learned at university in Column A on a three-point scale, where 1 = Disagree; 2 = Undecided; and 3 = Agree.

The pilot-study results indicated that the percentage of respondents in the ‘Agree (A)’ and the ‘Undecided (U/D)’ categories were high. The range of the ‘Undecided’ percentage ranged from 35% to 65% and the ‘Agree’ percentage ranged from 35% to 60%. In order to ‘force’ the graduate engineers to make a clearer decision about agreeing or disagreeing with the statements, the ‘Undecided’ alternative was eliminated. In the main study, for this reason, the researcher changed the three-point scale into a two-point scale indicator. Graduate engineers were asked to indicate either Agree (A = 2) or Disagree (DA = 1). Change to a two-point scale indicator would provide a clearer and more decisive response.

The pilot test results indicated no major changes to the actual statements were required for either the graduate engineers or the engineering managers’ questionnaires. Both graduate engineers and engineering managers understood the meaning of each statement in relation to their own requirements. Some minor clarifications were made
to the wording and minor grammatical corrections were corrected before the main study version of the questionnaires was sent.

3.4 Procedures

3.4.1 Main survey

After the pilot test, the data results were reviewed and analysed, all changes required were updated to the questionnaires for the main survey. The key issue for the main survey was how to maximize the response level when using postal surveys. All email addresses for the graduate engineers and the engineering managers were updated and documented. Copies of the questionnaires, together with a covering letter which explained the purpose of the survey, were emailed to those selected graduate engineers and engineering managers. This process saves time and cost effective. The return rate was monitored closely because the return rate was a good indicator showing the successful rate of data collection and served as a guide on how the data collection was going.

The main study was conducted from March 2006 to June 2006 for both graduate engineers and engineering managers. A follow-up procedure was applied to ensure that the response rate for the main study was satisfactory.

3.4.2 Focus group discussion and interview questions

In order to validate the main study data results, focus group discussions and interviews were also applied in this study. The main purposes of applying focus group discussions and interviews to this study were:

1. It may be used as the one of the principal means of gathering further information having direct bearing on the research objectives
2. The interview may be used in conjunction with the survey in this research to clarify or validate data obtained from questionnaires.

3. The presence of an interviewer could also decrease the number of 'don’t know' or 'no comment' statement.

4. The face-to-face discussions and interviews would clarify against confusing data results and obtain relevant responses.

5. To ‘probe’ any further answers as required.

Since it was not possible to bring everyone together for the group discussion or interviews, the plan was to organize focus group discussion with the graduate engineers, individual interviews with the engineering managers and discussion meeting with the academic colleagues.

Before the focus group discussion with graduate engineers and individual interviews with engineering managers, interview questions were be prepared in advance for these two activities. In this instance, all discussion and interview questions were prepared based on the tabulated survey results obtained from the main study on both graduate engineers’ and engineering managers’ questionnaires. The academic staff members' discussion forum and interviews were at the last stage of the survey when all graduate engineers’ focus group discussion and engineering managers’ individual interviews were completed and their results were made available.

Focus group discussion with graduate engineers, individual interview with the engineering managers and discussion forum with academic staff were conducted from July to October 2006.
A set of statements and questions were prepared after analysing the results before the graduate engineers' focus group discussion. The focus group discussion questions were designed around the following five areas, using data generated from the questionnaires. For example:

“Based on the graduate engineers’ questionnaire feedback, in the communication skills category, many of the graduate engineers indicated that good communication skills in both English and Putonghua are ‘very important’ in the workplace”;

“How important are these skills in your day-to-day operations and why?”

“How can these skills be improved at university?”

Besides the prepared questions, the researcher would also ‘probe’ the graduate engineers’ general comments on issues not listed. Similar question format would apply to the problem-solving skills, management skills and other-generic-type skills categories.

For the engineering managers, it was better to conduct interviews at their offices, due to their busy schedules. Although a set of interview questions was prepared well in advance, based on the survey results for engineering managers, it was more important to probe their general opinions of the generic skills required in order to be successful in industry.

Following is a brief outline of the statements and questions posed to managers at the interview. For example:

Opening statement:

“During a recent survey for engineering managers regarding the generic workplace skills for graduate engineers, the following findings were identified. I
would like to seek your opinion about those findings”.

Other statements and questions:

“In the engineering managers’ questionnaire feedback, for example, in the communication skills category”;

“Engineering managers indicated that communication skills in English and Putonghua are “very important”, but that not many graduate engineers employed in industry have adequate generic skills in communication in either English or Putonghua”;

Please comment on:

“How important are these skills in your industry and why?”

“How might these skills be improved at university?”

Similar statement and question format were posed for managers in the communication, problem-solving, management and other generic-type skills categories. The interviews concluded with the final managers’ comments on any other issues that they believe graduate engineers should possess.

The engineering academic reviews were scheduled as the last component of the study. The survey data and the qualitative interview results from both the graduate engineers and the engineering managers were tabulated and the main differences in their ‘perceptions’ on the survey data were presented to engineering The academic staff members were from the Department of Industrial and Systems Engineering (ISE) of the Hong Kong PolyU.
3.5 Questionnaire survey procedures and results

3.5.1 Main study

The main questionnaires were updated after the feedback from the pilot test run, before being emailed to the selected graduate engineers and engineering managers. All email addresses for both graduate engineers and engineering managers were documented. In this study, the researcher recorded the varying rates of return among respondents on a daily bases. The return rate is a good indicator showing the successful rate of data collection and a guide to how the data collection is going. Non-respondents were followed up by sending another follow-up email, with a new copy of the questionnaire attached.

The main study was conducted from March 2006 to June 2006 for both the graduate engineers and the engineering managers.

After the despatch of the questionnaires to both the graduate engineers and the engineering managers, the researcher recorded all respondents’ response rates. The first follow-up was conducted with those non-respondents one week after the first original email was sent. The second follow-up was conducted on the third week. The last follow-up was done on the fourth week. A thank you email was sent to those graduate engineers and engineering managers who did reply to the questionnaire. Besides email reminder, the researcher also tried to make phone calls to those non-respondents (if the phone number is available) after the second follow-up to ensure they received the questionnaire through their internet system. Table 3.2 shows the numbers of completed questionnaires returned with follow-ups and the final response rates for both graduate engineers and engineering managers. The follow-up procedure managed to increase the response rate in the main study to 60% for the
graduate engineers and 46% for the engineering managers. Overall, the return rates for both graduate engineers and engineering managers appeared to be at 'acceptable' levels when compared with the pattern, illustrated by Cohen and Manion (2000, p263).

The return rate for graduate engineers was 60% and engineering managers' was 46%. The lower return rate for the engineering managers might have been because of their busy schedule or that they were on business trips. The majority of the engineering managers have offices in both Hong Kong and the Mainland China. Usually these managers work 4 days in the Mainland office and 2 days in the Hong Kong office (6 working days per week).

### Table 3.2  
Response rates (with follow-ups) of the in the main study of graduate engineers' and engineering managers’ questionnaires

<table>
<thead>
<tr>
<th></th>
<th>Graduate engineers</th>
<th>Eng managers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original despatch</td>
<td>123</td>
<td>113</td>
</tr>
<tr>
<td>First week received</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>First follow-up</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Second follow-up</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Total returned</td>
<td>74</td>
<td>52</td>
</tr>
<tr>
<td>Response rate</td>
<td>60%</td>
<td>46%</td>
</tr>
</tbody>
</table>

The researcher planned to organize 'focus group discussion' with the graduate engineers, 'individual interviews' with the engineering managers and 'discussion forum' and 'individual discussion' with academic staff members. Before the
discussion and interview meetings, the researcher tabulated the data results obtained from the main study on both graduate engineers’ and engineering managers’ questionnaires and prepared the interview questions.

Twenty selected graduate engineers were invited to attend a ‘focus group’ discussion on one Saturday afternoon. Due to the overwhelming response, all 20 selected graduate engineers planned to attend. The researcher had to divide the graduate engineers into two focus group discussion meetings on two Saturday afternoon. Based on their availabilities, 11 graduate engineers attended the first focus group discussion and the other 9 attended the second meeting. The graduate engineers’ survey results were tabulated and presented at both meetings. The focus group discussion questions were designed around the five areas of communication, problems-solving, management, other-generic-type skills categories and the general comments for the open-ended questions as outlined in the survey. Besides clarification and validation of the data results, this focus group discussion also provides a forum for the graduate engineers to share their own experience and issues. The discussion results would form part of the ‘qualitative’ data in the result chapter.

For engineering managers, it was decided by the researcher to conduct individual interviews at their offices due to their busy schedules. Fifteen engineering managers accepted the invitation for an individual interview in their office. The planned interview time was less than 30 minutes. A set of summarised data results obtained from both graduate engineers and engineering managers were tabulated and the proposed interview questions were forwarded (email) to each individual engineering manager before the interview. It would be important to probe their general opinions of the generic skills required in order to be successful in industry.
Academic staff ‘discussion forum’ and ‘individual discussion’ were planned as the last activity of this study. Five engineering academic staff from the Department of the Industrial and Systems Engineering (ISE) of the Hong Kong PolyU attended the ‘discussion forum’, 3 ISE engineering academic staff accepted the invitation for a one-to-one ‘individual discussion’ based on their schedule. The survey results, the quantitative, qualitative analysed data, different perceptions and the interview comments between the graduate engineers and the engineering managers were presented to them before the ‘discussion forum’. The aim was to help engineering academic staff to become aware of the different ‘perceptions’ and requirements from graduate engineers and their employers, with the expectation that the academic staff would take this opportunity to review their curriculum designs for better future teaching and learning for students.
Chapter 4   Results

4.1   Introduction

This chapter describes the findings from the survey of the graduate engineers and of the engineering managers on their ratings of the perceived importance and the evaluations of the adequacy of generic skills in the workplace.

The objectives of this survey were as follows:

1. To collect feedback from graduate engineers who graduated two to three years’ prior to this study. Graduate engineers were requested to provide their ratings of their perceived importance of the selected generic-type skills in their workplaces and their opinions of the adequacy of their learned knowledge and skills in university.

2. To collect feedback from engineering managers via their ratings of their perceived importance of generic skills and their evaluations of the adequacy of the generic skills of those graduate engineers under their supervisions or working in their organizations.

3. To conduct group discussion with the graduate engineers, individual interviews with the engineering managers and meetings with engineering academics about the survey results and to seek their recommendations for future developments of engineering education relevant to generic skill development in Hong Kong.
4.2 Quantitative results (from questionnaire)

4.2.1 The perceived importance of generic skills: A comparison between the graduate engineers and the engineering managers

The questionnaires were specially designed and structured in such a way as to allow a direct comparison of the responses of the graduate engineers and the engineering managers. Therefore, using the results of the questionnaire, the researcher could make an overall comparison between the perceptions of the graduate engineers and the engineering managers about the selected generic-type skills for a range of statements in the areas of communication, problem-solving, management and the other generic-type skills categories.

At the end of Section 1 of both questionnaires, the graduate engineers and the engineering managers were requested to rank their priorities into 'High', 'Moderate' or 'Low' for their perceptions of the importance of the aforementioned generic-type skills categories. Figure 4.1 shows a comparison of the perceptions of the ranking priorities for the four generic skills categories. The far right-hand column of Figure 4.1 shows the percentage of the perceived ratings given 'High Priority' for each generic skill category.
Figure 4.1 Overall comparison of the ranking of priorities of generic skills: graduate engineers and engineering managers

<table>
<thead>
<tr>
<th>Category</th>
<th>High Priority</th>
<th>Moderate Priority</th>
<th>Low Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager</td>
<td>66%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grad Engr</td>
<td>67%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager</td>
<td>64%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grad Engr</td>
<td>65%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td>37%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grad Engr</td>
<td>39%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other-type</td>
<td>33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grad Engr</td>
<td>26%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Perceived Priority (%) by graduate engineers and managers

Based on the graduate engineers’ two to three years’ working experience, they ranked the overall priority of the perceived importance of the generic skills categories in the order of problem-solving, communication, management and other ‘generic-type’ skills categories. The same ranking outcome resulted from the engineering managers who had spent years working in industry. Sixty-seven percent of the graduate engineers and 66% of the engineering managers rated a ‘High Priority’ for problem-solving skills. There were virtually no differences between these two groups in their ratings in this category. In the category of communication skills, the percentage of the graduate engineers and the engineering managers rated ‘High Priority’ as 65% and 64%, respectively. The ‘High Priority’ percentage ranking for both problem-solving and communication skills categories were very close.
In the other two categories, 39% of the graduate engineers and 37% of the engineering managers rated management skills as a 'High Priority' and 26% of the graduate engineers and 33% of the engineering managers rated the other 'generic-type' skills categories as 'High Priority'. Proportionally, less graduate engineers and engineering managers rated as low priorities the management and the other 'generic-type' skills categories.

4.2.2 Communication skills

A summary of the comparison of the ratings of the graduate engineers and the engineering managers for the perceived 'Importance' and the 'Adequacy' in the communication skills category is shown in Table 4.1. Detailed descriptions of the statements of Q1 to Q4 are listed in Table 4.1.

Table 4.1 Summary of comparison of the importance and the adequacy of communication skills category: graduate engineers and engineering managers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng %</td>
<td>Mgr %</td>
</tr>
<tr>
<td>Section 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1. Communicate effectively in English</td>
<td>57</td>
<td>71</td>
</tr>
<tr>
<td>Q2. Communicate effectively in Putonghua</td>
<td>40</td>
<td>27</td>
</tr>
<tr>
<td>Q3. Communicate effectively in written Chinese</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>Q4. Communicate effectively with a range of cultural divergent</td>
<td>42</td>
<td>35</td>
</tr>
<tr>
<td>Overall, knowledge and skills relevant to communication are adequate</td>
<td>58</td>
<td>61</td>
</tr>
</tbody>
</table>

Figure 4.2 shows a summary of the direct comparison (bar chart) format of the ratings
of the importance and the adequacy of the communication skills category, perceived by the graduate engineers and the engineering managers. The far right-hand column of Figure 4.2 shows the percentages for different levels of adequacy (A = Adequate, L/A = Less Adequate) for each statement in this category rated by both the graduate engineers and the engineering managers.

**Figure 4.2** Comparison of the importance and the adequacy of communication skills: graduate engineers and engineering managers

<table>
<thead>
<tr>
<th></th>
<th>Grad Engr</th>
<th>Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>56%</td>
<td>39%</td>
</tr>
<tr>
<td>Q2</td>
<td>29%</td>
<td>24%</td>
</tr>
<tr>
<td>Q3</td>
<td>46%</td>
<td>57%</td>
</tr>
<tr>
<td>Q4</td>
<td>35%</td>
<td>49%</td>
</tr>
</tbody>
</table>

The results indicated that 57% of the graduate engineers and 71% of the engineering managers rated ‘High Importance’ for Q1 ‘communicate effectively in English’. Forty percent of the graduate engineers and 27% of the engineering managers rated ‘High Importance’ for Q2 ‘communication in Putonghua’. However, when it came to the evaluation of the graduate engineers’ adequacy in communication skills, only 39% of the engineering managers rated that the graduate engineers as ‘Adequate’ in English
and 24% rated them as ‘Adequate’ in Putonghua.

In the ‘Adequacy’ Column in Figure 4.2, it can be seen that the comparison of the ratings of the graduate engineers and the engineering managers shows different percentages of Adequate (A) vs. Less Adequate (L/A) for all statements in this communication skills category: ranging from 5% to as high as 17%. Only 39% of engineering managers perceive that the graduate engineers communicate well in English. However, graduate engineers had a different perception of their communication skills in English. Fifty-six percent of the graduate engineers believed that they had adequate skills to communicate in English with a difference of 17%. In the effective communication in Putonghua statement, only 29% of the graduate engineers and 24% the engineering managers indicated that the graduate engineers do have requisite skills to communicate in Putonghua. On the statement of Q4 ‘communicate effectively with a range of culturally diverse people’, 35% of the graduate engineers rated themselves as adequate while 49% of engineering managers rated the graduate engineers as adequate; a difference of 14%. The result indicated that both groups understood the importance of working well with all different kinds of members in an organization. For future engineering leaders, cultural diversity or working well with different kinds of people may be crucial to the success of business. There was also a 11% differences between responses to the statement of Q3 ‘communicate effectively in written Chinese’ between the graduate engineers and the engineering managers.

Table 4.2 shows the summary of the differences of the graduate engineers’ and engineering managers’ perception of the importance and their performance of the communication skills category. The gap differences of the graduate engineers are
ranging from 1% to 17% while the engineering managers’ perception of the importance and their views of the graduate engineers are ranging from 3% to 32%.

**Table 4.2** Graduate engineers’ and engineering managers’ summaries of the importance and the performance of communication skills category

**Graduate Engineers**

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Communicate effectively in English</td>
<td>57</td>
<td>56</td>
<td>+1</td>
</tr>
<tr>
<td>2. Communicate effectively in Putonghua</td>
<td>40</td>
<td>29</td>
<td>+11</td>
</tr>
<tr>
<td>3. Communicate effectively in written Chinese</td>
<td>29</td>
<td>46</td>
<td>-17</td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural divergent</td>
<td>42</td>
<td>35</td>
<td>+7</td>
</tr>
</tbody>
</table>

**Engineering Managers**

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Communicate effectively in English</td>
<td>71</td>
<td>39</td>
<td>+32</td>
</tr>
<tr>
<td>2. Communicate effectively in Putonghua</td>
<td>27</td>
<td>24</td>
<td>+3</td>
</tr>
<tr>
<td>3. Communicate effectively in written Chinese</td>
<td>20</td>
<td>57</td>
<td>-37</td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural divergent</td>
<td>35</td>
<td>49</td>
<td>-14</td>
</tr>
</tbody>
</table>

In last section of the communication skills category, the graduate engineers and the engineer managers are requested to answer only ‘Yes’ or ‘No’ to the following
For graduate engineers: 'Overall, my knowledge and skills relevant to communications skills learned at university are adequate' and

For engineering managers: 'Overall, my rating of graduate engineers on communication skills category is adequate'.

Figure 4.3 shows the results of a comparison of the overall adequacy of communication skills expressed as percentages as perceived by the graduate engineers and the engineering managers.

**Figure 4.3** Comparison of the overall adequacy of communication skills perceived by graduate engineers and engineering managers

The majority of the engineering managers believed that the graduate engineers have the ability to communicate 'reasonably' well in their workplaces. Sixty-one percent of the surveyed engineering managers rated the graduate engineers as adequate in the communication skills category. Similarly, 58% of the graduate engineers rated themselves as adequate in the knowledge and skills relevant to communication skills learned at university. This indicator shows that university courses did provide some support and training for graduate engineers with the communication skills in university engineering education. Nonetheless, there were still 40% of the graduate engineers (and engineering managers) that indicated that they did not have adequate
skills in the communication category. The 40% of 'inadequate' in communication skills rated by the graduate engineers should be of concern to university educators.

A Chi-square test of significance was deemed appropriate to be applied to the frequency data used to construct Figure 4.3. Table 4.3 shows the actual summary data obtained from the graduate engineers and the engineering managers.

**Table 4.3** Raw summary comparison of data used for a Chi-square test of the overall adequacy of communication skills perceived by graduate engineers and engineering managers

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate engineers</td>
<td>43</td>
<td>31</td>
<td>74</td>
</tr>
<tr>
<td>Engineering managers</td>
<td>32</td>
<td>20</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>51</td>
<td>126</td>
</tr>
</tbody>
</table>

The results of a 2 x 2 Chi-square analysis revealed; \( p > 0.05; \) and \( \chi^2 = .149.\)

There was no statistically significant difference between the overall adequacy of the communication skills as perceived by the graduate engineers and the engineering managers.

**4.2.3 Problem-solving skills**

A summary of the comparison of the opinions of the graduate engineers and the engineering managers for the perceived 'Importance' and the 'Adequacy' of the problem-solving skills category is shown in Table 4.4. Detailed descriptions of the statements of Q5 to Q9 are also listed in Table 4.4.
Table 4.4  Summary of comparison of the importance and the adequacy of problem-solving skills: graduate engineers and engineering managers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Section 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eng</td>
</tr>
<tr>
<td>Q5.</td>
<td>Knowledge of global outlook and engineering practice</td>
<td>53</td>
</tr>
<tr>
<td>Q6.</td>
<td>Creative and diversified thinking</td>
<td>57</td>
</tr>
<tr>
<td>Q7.</td>
<td>Effective analysis of different types of data</td>
<td>66</td>
</tr>
<tr>
<td>Q8.</td>
<td>Effective evaluation of engineering options, and selection of the optimum solution</td>
<td>53</td>
</tr>
<tr>
<td>Q9.</td>
<td>Using technology effectively in the workplace</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Overall, knowledge and skills relevant to problem-solving are adequate</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.4 shows a summary of the direct comparison in a graphical (bar chart) format of the ratings of the importance and the adequacy of the result of the problem-solving skills category as perceived by the graduate engineers and the engineering managers. The far right-hand column of Figure 4.4 represents the percentage of each group’s rating of the adequacy of the survey statements (A = Adequate, L/A = Less Adequate).
The results indicated that engineering managers perceived Q8 ‘effective evaluation of engineering options, and selection of the optimum solution’ (73%) and Q9 ‘using technology effectively in the workplace’ (69%) are the most high important statements in this category. However, the graduate engineers’ ratings of the ‘High Importance’ in this problem-solving skills category were somewhat different. Graduate engineers perceived Q7 ‘effective analysis of different types of data’ (66%) and Q6 ‘creative and diversified thinking’ (57%) were the most high important statements. All graduate engineers rated all statements as being of ‘High Importance’ (range from 51% to 66%).
A further descriptive summary of the 'High Importance' and their major differences between graduate engineers and engineering managers for the problem-solving skills category statements is shown in Table 4.5.

Table 4.5  Percentage differences between graduate engineers and engineering managers of three statements rated as 'High Importance'

<table>
<thead>
<tr>
<th>Statement</th>
<th>Graduate engineers' rating of 'High Importance' (%)</th>
<th>Engineering managers' rating of 'High Importance' (%)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q8</td>
<td>53</td>
<td>73</td>
<td>20</td>
</tr>
<tr>
<td>Q9</td>
<td>51</td>
<td>69</td>
<td>18</td>
</tr>
<tr>
<td>Q5</td>
<td>53</td>
<td>39</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 4.5 shows the comparison of the results expressed as percentage for the graduate engineers and the engineering managers on statements Q8 'effective valuation of engineering options, and selection of the optimal solution', Q9 'using technology effectively in the workplace' and Q5 'knowledge of global outlook and engineering practice'. It was found that there were quite large perceived differences of 20%, 18% and 14%, respectively, for these three statements. The engineering managers rated statements Q8 and Q9 much higher than the graduate engineers. While on statement Q5, graduate engineers rated 14% higher than the engineering managers. These results indicated different opinions between these two groups in the areas of decision making and technology application processes. For the remaining other two statements of Q6 'creative and diversified thinking' and Q7 'effective analysis of different types of data', the results show little variation between graduate engineers’ and engineering managers' ratings.
The Adequacy Column in Figure 4.4 indicates that the graduate engineers generally perceived that they had adequate skills and perceived that they were able to perform reasonable well in solving operations issues in their workplaces. The graduate engineers’ perceptions were also agreed by their engineering managers. However, engineering managers had different ratings of the graduate engineers’ adequacy in the problem-solving skills category.

In the Adequacy column shown in both Table 4.4 and Figure 4.4, the statement Q7 ‘effective analysis of different types of data’, indicated a difference for ‘adequacy’ of 12% between the ratings of the graduate engineers and the managers. For statement Q6 ‘creative and diversified thinking’, the difference was 9%. In both statements, graduate engineers rated themselves higher in percentage terms of their ‘adequacy’ than did the managers. These different ratings between the graduate engineers and the engineering managers probably indicated their different backgrounds, working experiences, and their exposures to their working environments.

Table 4.6 shows the summary of the differences of the graduate engineers’ and engineering managers’ perception of the importance and their performance of the problem-solving skills category. The gap differences of the graduate engineers are ranging from 0% to 7% while the engineering managers’ perception of the importance and their views of the graduate engineers are ranging from 6% to 22%.
Table 4.6  Summary of comparison of the importance and the performance of problem-solving skills: graduate engineers and engineering managers

Graduate Engineers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q5. Knowledge of global outlook and engineering practice</td>
<td>53</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>Q6. Creative and diversified thinking</td>
<td>57</td>
<td>50</td>
<td>+7</td>
</tr>
<tr>
<td>Q7. Effective analysis of different types of data</td>
<td>66</td>
<td>61</td>
<td>+5</td>
</tr>
<tr>
<td>Q8. Effective evaluation of engineering options, and selection of the optimum solution</td>
<td>53</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>Q9. Using technology effectively in the workplace</td>
<td>51</td>
<td>58</td>
<td>-7</td>
</tr>
</tbody>
</table>

Engineering Managers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q5. Knowledge of global outlook and engineering practice</td>
<td>39</td>
<td>51</td>
<td>-12</td>
</tr>
<tr>
<td>Q6. Creative and diversified thinking</td>
<td>57</td>
<td>41</td>
<td>+16</td>
</tr>
<tr>
<td>Q7. Effective analysis of different types of data</td>
<td>65</td>
<td>49</td>
<td>+14</td>
</tr>
<tr>
<td>Q8. Effective evaluation of engineering options, and selection of the optimum solution</td>
<td>73</td>
<td>51</td>
<td>+22</td>
</tr>
<tr>
<td>Q9. Using technology effectively in the workplace</td>
<td>69</td>
<td>63</td>
<td>+6</td>
</tr>
</tbody>
</table>
In the last section of the problem-solving skills category, the graduate engineers and the engineering managers are requested to answer only “Yes” or “No” to the following statement:

For graduate engineers: “Overall, my knowledge and skills relevant to problem-solving skills learned at university are adequate” and

For engineering managers: “Overall, my rating of graduate engineers on problem-solving skills category is adequate”.

Figure 4.5 shows a direct comparison of the overall evaluation of the adequacy (as %) of problem-solving skills, perceived by the graduate engineers and the engineering managers. Both groups were requested to answer “Yes” or “No” to the following statement:

For graduate engineers: “Overall, my knowledge and skills relevant to problem-solving skills learned at university are adequate” and

For engineering managers: “Overall, my rating of graduate engineers on problem-solving skills category is adequate”.

Figure 4.5  Comparison of the overall adequacy of problem-solving skills perceived by graduate engineers and engineering managers

![Comparison chart]

Perceived adequacy (%)
The results indicated that 67% of the graduate engineers rated their knowledge and skills relevant to problem-solving learned at university as adequate, while 69% of the engineering managers rated graduate engineers as adequate in this generic skills category. A majority of both groups perceived that the graduates could resolve problems effectively and the graduate engineers indicated their problem-solving skills were acceptable. It is important to note, however, that 41% and 49% of engineering managers rated graduate engineers low on statements Q6 ‘creative and diversified thinking’ and Q7 ‘effective analysis of different types of data’ respectively. Even for the other two statements Q5 ‘knowledge of global outlook and engineering practice’ and Q8 ‘effective evaluation of engineering options, and selection of the optimum solution’, only 51% of the engineering managers rated the graduate engineers as adequate on these two statements. In general, engineering managers were more inclined to evaluate all options before making the final decision, while graduate engineers perhaps jumped to an ‘optimal’ conclusion too soon.

A Chi-square test of significance was deemed appropriate to be applied to the frequency data used to construct Figure 4.5. Table 4.5 shows the actual summary data obtained from the graduate engineers and the engineering managers.

Table 4.7 Raw summary comparison of data used for a Chi-square test of the overall adequacy of problem-solving skills perceived by graduate engineers and engineering managers

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate engineers</td>
<td>49</td>
<td>25</td>
<td>74</td>
</tr>
<tr>
<td>Engineering managers</td>
<td>36</td>
<td>16</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>85</td>
<td>41</td>
<td>126</td>
</tr>
</tbody>
</table>
The results of a 2 x 2 Chi-square analysis revealed: $p > 0.05$ and $\chi^2 = .126$.

There was no statistically significant difference between the overall adequacy of problem-solving skills as perceived by the graduate engineers and the engineering managers.

### 4.2.4 Management skills

In this category, there were ten statements (Q10 to Q19) which included deemed to be important generic-type management skills, such as teamwork, managing conflict, leadership and time management. Both graduate engineers and engineering managers were requested to rate their perceived importance and their adequacy of the ten statements related to the generic-type management skills category. Their ratings are summarised in Table 4.8. The detailed description of each statement (Q10 to Q19) in this management skills category is also shown in Table 4.8.

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng %</td>
<td>Mgr %</td>
</tr>
<tr>
<td><strong>Section 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q10. Effective member of a group or a working team</td>
<td>58</td>
<td>71</td>
</tr>
<tr>
<td>Q11. Resolving work-based conflicts</td>
<td>50</td>
<td>37</td>
</tr>
<tr>
<td>Q12. Effective organizing and coordinating tasks to achieve project goals.</td>
<td>71</td>
<td>67</td>
</tr>
<tr>
<td>Q13. Co-operate and collaborate with colleagues</td>
<td>74</td>
<td>80</td>
</tr>
<tr>
<td>Q14. When and where appropriate, demonstrate leadership skills among colleagues</td>
<td>42</td>
<td>37</td>
</tr>
<tr>
<td>Q15. When a problem occurs, be prepared and</td>
<td>71</td>
<td>76</td>
</tr>
</tbody>
</table>
engaged with others to help to seek solutions

<table>
<thead>
<tr>
<th></th>
<th>50</th>
<th>43</th>
<th>+7</th>
<th>26</th>
<th>41</th>
<th>-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q16. Effective control of budget</td>
<td>78</td>
<td>69</td>
<td>+9</td>
<td>54</td>
<td>43</td>
<td>+11</td>
</tr>
<tr>
<td>Q17. Effective management of time</td>
<td>45</td>
<td>41</td>
<td>+4</td>
<td>58</td>
<td>43</td>
<td>+15</td>
</tr>
<tr>
<td>Q18. Effective administration and record keeping</td>
<td>57</td>
<td>51</td>
<td>+6</td>
<td>56</td>
<td>45</td>
<td>+11</td>
</tr>
<tr>
<td>Q19. Independently explore new information and solutions to workplace problems</td>
<td>65</td>
<td>61</td>
<td>+4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, knowledge and skills relevant to management are adequate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.6 shows a direct comparison of the perceived importance and the adequacy of management skills category by the graduate engineers and the engineering managers in a bar chart format. In the far right-hand column of Figure 4.6, it shows the percentage of the graduate engineers’ and the engineering managers’ ratings of the adequacy (A = Adequate) and less adequate (L/A = Less Adequate) with respect to the statements in the management skills category.
Figure 4.6  Comparison of the importance and the adequacy of management skills: graduate engineers and engineering managers
The results in both Table 4.8 and Figure 4.6 indicated the statement Q13 'co-operate and collaborate with colleagues' had the highest percentage of graduate engineers' and engineering managers' ratings of 'High Importance'. Seventy-four percent of the graduate engineers and 80% of the engineering managers indicated this rating. Teamwork is a must in any organization, which is the reason why this statement was likely rated as one of the highest percentages by the engineering managers. Seventy-four percent of the graduate engineers made a similar observation when they rated this statement. The graduate engineers realized that in order to complete a task, they have to work with various departments and other colleagues to gain their collaboration and support.

The second highest rated percentage of 'High Importance' for both groups was for statement Q17 'effective management of time'. Seventy-eight percent of the graduate engineers and 69% of the engineering managers indicated that they rated this statement as 'High Importance'. There is no doubt in the business world that time means money and is of great importance. Effective time management is one of the key success factors in an organization and engineering managers are fully aware of this factor. The work environment and culture have led as many as 78% of the graduate engineers to rate statement Q17 'effective management of time' as being of 'High Importance'. Students usually did not pay much attention to 'time' when they studying at university. However, when graduate engineers enter the workforce, they realized that time management is an important issue in their workplace. This shows a good example of different expectation between the recent university graduates and the work requirements of industry.
The third statement rated as being of 'High Importance' is statement Q15 'when a problem occurs, be prepared and engaged with others to help to seek solutions'. Seventy-six percent of the engineering managers' responses and 71% of the graduate engineers rated this statement to be of 'High Importance'. The reason is relatively simple: No matter whether they are engineering managers or graduate engineers, their jobs are to work together as teams and to achieve a final goal in a given time.

The results from the management skills category show some commonality between graduate engineers' and engineering managers' ratings but there also appear to be some major differences in their perceptions in the rating of the 'High Importance' for some statements.

For statement Q10 'effective member of a group or a working team', there was a difference of opinion of 13% in the 'High Importance' rating, between the graduate engineers and the engineering managers. Seventy-one percent of the engineering managers rated this statement as 'High Importance' while only 58% of the graduate engineers did so. However, for statement Q11 'resolving work based conflicts', there was also a difference of opinion of 13% for the 'High Importance' rating between these two groups. This time, 50% of the graduate engineers rated this statement as 'High Importance', while only 37% of the engineering managers rated as 'High Importance'. The variation of perception between the graduate engineers and the engineering managers on these two statements can be explained. For statement Q10 'effective member of a group or a working team', engineering managers expect their co-workers to collaborate and work as teams with other stakeholders to drive forward the vision or objective of the organization. That might be the main reason why 71% of the managers rated statement Q10 as 'High Importance'.
For statement Q11 ‘resolving work-based conflicts’, only 37% of the engineering managers rated this statement as ‘High Importance’, probably because managers expect that operational issues should be resolved by their co-workers. Resolving work-based conflicts is a part of the co-workers’ responsibilities. However, 50% of the graduate engineers rated this statement as a ‘High Importance’, because graduate engineers believed resolving work-based conflicts is an important activity. Besides the foregoing explained statements, there were not relatively wide variations between graduate engineers’ and engineering managers’ ratings on other statements of ‘High Importance’. The variations there ranged only from 4% to 9%.

A further descriptive summary of the percentage differences between the graduate engineers and the engineering managers for their ratings of the “High Importance” statements in the management skills category are shown in Table 4.9.

The (-) sign of the difference column indicated that engineering managers provided a higher rating of the ‘High Importance’ of the statement than graduate engineers.

**Table 4.9** Major ranked difference between graduate engineers and engineering managers on their ratings of statements as of ‘High Importance’

<table>
<thead>
<tr>
<th>Statement</th>
<th>Graduate engineers</th>
<th>Engineering managers</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q10—effective member of a group or a work team</td>
<td>58</td>
<td>71</td>
<td>-13</td>
</tr>
<tr>
<td>Q11—Resolving work-based conflicts</td>
<td>50</td>
<td>37</td>
<td>13</td>
</tr>
<tr>
<td>Q17—Effective management of time</td>
<td>78</td>
<td>69</td>
<td>9</td>
</tr>
<tr>
<td>Q16—Effective control of budget</td>
<td>50</td>
<td>43</td>
<td>7</td>
</tr>
<tr>
<td>Q13—Demonstrate leadership skills among colleagues</td>
<td>74</td>
<td>80</td>
<td>-6</td>
</tr>
<tr>
<td>Q19—Independent explore new information and solutions</td>
<td>57</td>
<td>51</td>
<td>6</td>
</tr>
</tbody>
</table>
workplace problems

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
<th>% Adequate</th>
<th>% Adequate Engaged</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q15</td>
<td>When a problem occurs, be prepared and engaged with others to help to seek solutions</td>
<td>71</td>
<td>76</td>
<td>-5</td>
</tr>
<tr>
<td>Q14</td>
<td>When and where appropriate, demonstrate leadership skills among colleagues</td>
<td>42</td>
<td>37</td>
<td>5</td>
</tr>
<tr>
<td>Q12</td>
<td>Effective organizing and coordinating tasks to achieve project goals</td>
<td>71</td>
<td>67</td>
<td>4</td>
</tr>
<tr>
<td>Q18</td>
<td>Effective administration and record keeping</td>
<td>45</td>
<td>41</td>
<td>4</td>
</tr>
</tbody>
</table>

The far right-hand column of Figure 4.6 shows the percentage of the graduate engineers’ and the engineering managers’ ratings of ‘Adequacy’ with respect to the statements in the generic management skills category. The results here also indicated some wide variations in the perceptions of adequacy between the graduate engineers and the engineering managers. Graduate engineers were rated as ‘Adequate’ by the lowest percentage of engineering managers for the management skills category.

Thirty-five percent of the graduate engineers indicated that their management skills learned at university were not adequate. Graduate engineers rated themselves low on the adequacy on statements, such as Q16 ‘effective control of budget’ (26% rated as adequate), Q13 ‘demonstrate their leadership skills among colleagues’ (44% as adequate) and Q11 ‘resolve work-based conflicts’ (46% as adequate). The same message was echoed by the engineering managers. The engineering managers also indicated a reasonably low perception of the adequacy of the graduate engineers on statements Q14 ‘demonstrate their leadership skills among colleagues’ (35%), Q11 ‘resolve work-based conflicts (35%), Q16 ‘effective control of budget’ (41%), Q17 ‘effective management of time’ (43%), Q18 ‘effective administration and record
keeping' and Q19 'independently explore new information and solutions to workplace problems'. Generally speaking, the engineering managers perceived the graduate engineers were not well equipped by their university training for skills in the management area.

In summary, less than 50% of the engineering managers rated the graduate engineers as being not currently adequate on the following statements:

- Q11 ‘resolving work based conflicts’ 35% (46%)
- Q14 ‘when and where appropriate, demonstrate leadership skills among colleagues’ 35% (44%)
- Q16 ‘effective control of budget’ 41% (25%)
- Q17 ‘effective management of time’ 43% (54%)
- Q18 ‘effective administration and record keeping’ 43% (58%)
- Q19 ‘independently explore new information and solutions to workplace problems’ 45% (56%)

(Figures in brackets indicate the graduate engineers’ data)

There were only 3 statements on which less than 50% of the graduate engineers rated themselves as adequate. They were:

- Q16 ‘effective control of budget’
- Q14 ‘when and where appropriate, demonstrate leadership skills among colleagues’
- Q11 ‘resolving work based conflicts’

These somewhat wide percentage variations tended to demonstrate the perception that the graduate engineers might lack training in at least some important generic-type
management skills during their university education. The reason why so few (26%) graduate engineers rated themselves as 'adequate' on statement Q16 'effective control of budget' is probably because of the lack of financial courses in the engineering discipline. Of course, in the workplace, it may be difficult for graduate engineers to demonstrate their leadership skills among colleagues due to lack of experience. This might be that the reason why only 35% of the engineering managers rated graduate engineers as being 'adequate' for statement Q14 'when and where appropriate, demonstrate leadership skills among colleagues'.

Table 4.10 shows a summarized table to indicate the differences of the graduate engineers' and engineering managers' perception of the importance and their performance of the management skills category. The gap differences of the graduate engineers are ranging from 1% to 24% while the engineering managers' perception of the importance and their views of the graduate engineers are ranging from 2% to 25%.

**Table 4.10** Summary of comparison of the importance and the performance of management skills: graduate engineers and engineering managers

<table>
<thead>
<tr>
<th>Graduate Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td><strong>Management type skills</strong></td>
</tr>
<tr>
<td>10. Effective member of a group or a working team</td>
</tr>
<tr>
<td>11. Resolving work based conflicts</td>
</tr>
<tr>
<td>12. Effective organizing and coordinating tasks to achieve project goals</td>
</tr>
<tr>
<td>13. Co-operate and collaborate with</td>
</tr>
<tr>
<td>Item</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>10. Effective member of a group or a working team</td>
</tr>
<tr>
<td>11. Resolving work based conflicts</td>
</tr>
<tr>
<td>12. Effective organizing and coordinating tasks to achieve project goals</td>
</tr>
<tr>
<td>13. Co-operate and collaborate with colleagues</td>
</tr>
<tr>
<td>14. When and where appropriate, demonstrate leadership skills among colleagues</td>
</tr>
<tr>
<td>15. When a problem occurs, be prepared and engaged with others to help to seek solutions</td>
</tr>
<tr>
<td>16. Effective control of budget</td>
</tr>
<tr>
<td>17. Effective management of time</td>
</tr>
</tbody>
</table>

**Engineering Managers**
In the last section of the management skills category, the graduate engineers and the engineering managers are requested to answer only ‘Yes’ or ‘No’ to the following statement:

For graduate engineers: ‘Overall, my knowledge and skills relevant to management skills learned at university are adequate’ and

For engineering managers: ‘Overall, my rating of graduate engineers for management skills category is adequate’.

Figure 4.7 shows a comparison of the overall adequacy of management skills (expressed as a percentage) as perceived by the graduate engineers and engineering managers.

![Perceived adequacy (%)](image)

The results indicated that 61% of the engineering managers rated the graduate engineers as adequate on the management skills category, and 65% of the graduate engineers rated their knowledge and skills relevant to the generic-type management.
skills learned at university as 'adequate'. The survey results show that both graduate engineers and engineering managers generally were only partially satisfied with the adequacy with the graduates' management skills in their workplaces. Survey results indicated that about 2 out of 5 of the graduate engineers were perceived to be lacking the generic-type management skills. It was a perception that was also held by most of their employers. In general, the other 39% of engineering managers rated graduate engineers as 'inadequate' and 35% of graduate engineers rated themselves as 'less adequate' demonstrated that university should spend more time and effort to enhance management type skills training for graduates.

A Chi-square test of significance was deemed appropriate to be applied to the frequency data used to construct Figure 4.6. Table 4.11 shows the actual summary data obtained from the graduate engineers and the engineering managers.

Table 4.11 Raw summary comparison of data used for a Chi-square test of the overall adequacy of management skills perceived by the graduate engineers and the engineering managers

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate engineers</td>
<td>48</td>
<td>26</td>
<td>74</td>
</tr>
<tr>
<td>Engineering managers</td>
<td>32</td>
<td>20</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>46</td>
<td>126</td>
</tr>
</tbody>
</table>

The results of a 2 x 2 Chi-square analysis revealed: p > 0.05; χ² = .146.

There was no statistically significant difference between the overall adequacy of the management skills as perceived by the graduate engineers and the engineering managers.
4.2.5 Other ‘generic-type’ skills

There were 5 statements (Q20 to Q24) listed in the other ‘generic-type’ skills category. These skills included variables such as their general attitude towards work, adaptability to change, professional ethics and integrity. Both the description of the statements and their ratings are summarised in Table 4.12.

Table 4.12 Summary of a comparison of the importance and the adequacy of ‘other-type generic’ skills: graduate engineers and engineering managers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eng</td>
<td>Mgr</td>
</tr>
<tr>
<td>Section 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q20. Relevant engineering knowledge and skills</td>
<td>38</td>
<td>61</td>
</tr>
<tr>
<td>Q21. Adapt to change (e.g. new ideas, technologies, procedures or job demands)</td>
<td>67</td>
<td>69</td>
</tr>
<tr>
<td>Q22. Project an enthusiasm and positive attitude towards fellow workers and work environment</td>
<td>63</td>
<td>49</td>
</tr>
<tr>
<td>Q23. Possess integrity and act according to a high ethical standard</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>Q24. Adhere to the type of standard set by the engineering professional body (e.g. Hong Kong Institute of Engineers)</td>
<td>24</td>
<td>33</td>
</tr>
<tr>
<td>Overall knowledge and skills relevant to others types are adequate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.8 shows a detailed direct comparison of the results of the importance and the adequacy of the other ‘generic-type’ skills category perceived by the graduate engineers and the engineering managers in a graphical bar chart format. The far right-hand column of Figure 4.8 shows the percentage of their ratings of the adequacy.
(A = Adequate, L/A = Less Adequate) with respect to the statements in the other 'generic-type' skills category.

Figure 4.8 Comparison of the importance and the adequacy of other 'generic-type' skills category: graduate engineers and engineering managers

In this category, both graduate engineers and engineering managers were requested to rate the importance and the adequacy of statements related to the other 'generic-type' skills. The highest percentage rating for 'High Importance' for the graduate engineers and the engineering managers was for the statement Q21 'to adapt to change (e.g. new ideas, technologies, procedures or job demands)'. Sixty-seven percent of graduate engineers and 69% of the engineering managers provided this rating. Change is part
of our lives in this society, and the survey data from graduate engineers and engineering managers supported statement Q21 'to adapt to change' as the statement most frequently rated as of 'High Importance' in this category.

The second statement most commonly rated as of 'High Importance' was statement Q22 'project an enthusiasm and positive attitude towards fellow workers and work environment'. Sixty-three percent of the graduate engineers and 49% of the engineering managers rated this statement as such. Graduate engineers rated this statement 14% higher than engineering managers, showing its relative higher importance for them.

For the statement Q20 'relevant engineering knowledge and skills', 61% of the engineering managers rated it of 'High Importance' but only 38% of the graduate engineers did so. Engineering managers rated this statement 23% higher than graduate engineers' rating. Both groups had a wide different perspective on the 'relevant engineering knowledge and skills'. Engineering managers had a much higher expectation about graduate engineers' engineering knowledge and skills for application in their daily activities.

Although the overall assessments showed the engineering managers were satisfied with the adequacy of the graduates, there were some concerns indicated in relation to other statements. However, on these statements such as Q20 'relevant engineering knowledge and skills', Q22 'project an enthusiastic and positive attitude towards fellow workers and work environment', and Q23 'possess integrity and act with high ethical standard', their results showed there were between group differences here of 23%, 14% and 14%, respectively. Engineering managers rated statement Q20 higher than did the graduate engineers and the graduate engineers rated statements of Q22
and Q23 higher. These differences raise concerns for educators in Hong Kong and these concerns are part of the issues presently being addressed in the Hong Kong educational reform (EMB, 2000).

The far right-hand column of Figure 4.8 shows the percentages of the graduate engineers' and the engineering managers' ratings of the adequacy for each statement in the other 'generic-type' skills category. Graduate engineers generally reported that they had adequate skills in managing the variables or statements of the other 'generic-type' skills category, except that they had issue on statement Q24 'adhere to the type of standard set by the engineering professional body (e.g. Hong Kong Institute of Engineers)'. Only 46% of the graduate engineers indicated that they had 'adequate' skills in dealing with this issue. However, the engineering managers had a different view. Only 41% of the engineering managers rated graduate engineers as adequate on statement Q22 'project an enthusiastic and positive attitude towards fellow workers and work environment'. Even among the graduate engineers, only a little more than half, rated themselves as adequate in this statement. For statement Q20 'relevant engineering knowledge and skills', only half of the engineering managers rated the graduate engineers as 'Adequate'.

Table 4.13 shows the summary of the differences of the graduate engineers' and engineering managers' perception of the importance and their performance of the other 'generic-type' skills category. The gap differences of the graduate engineers are ranging from 5% to 22% while the engineering managers' perception of the importance and their views of the graduate engineers are ranging from 8% to 26%.
Table 4.13  Summary of comparison of the importance and the performance of the other ‘generic-type’ skills: graduate engineers and engineering managers

### Graduate Engineers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q20. Relevant engineering knowledge and skills</td>
<td>38</td>
<td>56</td>
<td>-18</td>
</tr>
<tr>
<td>Q21. Adapt to change (e.g. new ideas, technologies, procedures or job demands)</td>
<td>67</td>
<td>57</td>
<td>+10</td>
</tr>
<tr>
<td>Q22. Project an enthusiasm and positive attitude towards fellow workers and work environment</td>
<td>63</td>
<td>58</td>
<td>+5</td>
</tr>
<tr>
<td>Q23. Possess integrity and act according to a high ethical standard</td>
<td>57</td>
<td>63</td>
<td>-6</td>
</tr>
<tr>
<td>Q24. Adhere to the type of standard set by the engineering professional body (e.g. Hong Kong Institute of Engineers)</td>
<td>24</td>
<td>46</td>
<td>-22</td>
</tr>
</tbody>
</table>

### Engineering Managers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q20. Relevant engineering knowledge and skills</td>
<td>61</td>
<td>49</td>
<td>+12</td>
</tr>
<tr>
<td>Q21. Adapt to change (e.g. new ideas, technologies, procedures or job demands)</td>
<td>69</td>
<td>53</td>
<td>+16</td>
</tr>
<tr>
<td>Q22. Project an enthusiasm and positive attitude towards fellow workers and</td>
<td>49</td>
<td>41</td>
<td>+8</td>
</tr>
</tbody>
</table>
The results of an overall evaluation of the perceived adequacy of the other ‘generic-type’ skills category perceived by the graduate engineers and the engineering managers is shown in Figure 4.9 and Table 4.14.

Figure 4.9 shows a comparison of the overall adequacy of the other ‘generic-type’ skills expressed as percentages as perceived by the graduate engineers and the engineering managers. Both groups were requested to answer ‘Yes’ or ‘No’ to the following statement:

For graduate engineers: ‘Overall, my knowledge and skills relevant to the other ‘generic-type’ skills learned at university are adequate’ and

For engineering managers: ‘Overall, my rating of graduate engineers on the other ‘generic-type’ skills category is adequate’.

Figure 4.9  Comparison of the overall adequacy of other ‘generic-type’ skills perceived by graduate engineers and engineering managers

<table>
<thead>
<tr>
<th>work environment</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Q23. Possess integrity and act according to a high ethical standard</td>
<td>43</td>
<td>69</td>
</tr>
<tr>
<td>Q24. Adhere to the type of standard set by the engineering professional body (e.g. Hong Kong Institute of Engineers)</td>
<td>33</td>
<td>55</td>
</tr>
</tbody>
</table>

Perceived adequacy (%)
For the overall assessment, 82% of the engineering managers indicated perceived adequacy for the other ‘generic-type’ skills category for their graduate engineers. However, 67% of the graduate engineers rated the relevant knowledge and skills learned in this category as adequate. Engineering managers rated the overall adequacy 15% higher than the graduate engineers’. Their result indicated generally that the engineering managers were more satisfied with the behaviours and ethics of the graduate engineers.

A Chi-square test of significance was deemed appropriate to be applied to the frequency data used to construct Figure 4.9. Table 4.6 shows the actual summary data obtained from the graduate engineers and the engineering managers.

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate engineers</td>
<td>49</td>
<td>25</td>
<td>74</td>
</tr>
<tr>
<td>Engineering managers</td>
<td>41</td>
<td>11</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>36</td>
<td>126</td>
</tr>
</tbody>
</table>

The results of a 2 x 2 Chi-square analysis revealed: \( p > 0.05 \); and \( \chi^2 = 0.24 \).

There was no statistically significant difference between the overall adequacy of the other ‘generic-type’ skills as perceived by the graduate engineers and the engineering managers.
4.2.6 Evaluation by graduate engineers of the learned knowledge at university

There was one extra section (Section 3) in the graduate engineers' questionnaire. The graduate engineers were requested to indicate their agreement with statements about the adequacy and usefulness of the knowledge learned at university. This section was specially designed for the graduate engineers. The researcher wanted to identify any difficulties or issues about teaching and learning facing graduate engineers during their university education. The findings from this section should help to further improve teaching and learning in engineering courses at university. The results indicated that the majority of the responses from the graduate engineers agreed with the statements stated in the questionnaire and indicated that their learned knowledge at university was perceived to be useful. The outcomes of this section are shown in Figure 4.10.
Figure 4.10  Percentage distribution of the perceived relevance and usefulness of the learned university knowledge

<table>
<thead>
<tr>
<th>Question</th>
<th>U</th>
<th>L/U</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.a</td>
<td>76%</td>
<td>24%</td>
</tr>
<tr>
<td>21.b</td>
<td>72%</td>
<td>28%</td>
</tr>
<tr>
<td>21.c</td>
<td>44%</td>
<td>56%</td>
</tr>
<tr>
<td>21.d</td>
<td>64%</td>
<td>36%</td>
</tr>
<tr>
<td>21.e</td>
<td>56%</td>
<td>44%</td>
</tr>
<tr>
<td>22</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>23</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>24</td>
<td>76%</td>
<td>24%</td>
</tr>
<tr>
<td>25</td>
<td>76%</td>
<td>24%</td>
</tr>
<tr>
<td>26</td>
<td>68%</td>
<td>32%</td>
</tr>
<tr>
<td>27</td>
<td>80%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Legend:

- **Agree**
- **Disagree**

**Perceived Agreement (%)**

Q2.1.a = Content was relevant to my career needs

Q2.1.b = Content was substantial and useful

Q2.1.c = Content had a coherent sequence and well-structured

Q2.1.d = Teaching material was adequate and useful

Q2.1.e = The course provided adequate practical application

Q2.2 = My classmates and I frequently engaged and collaborated together on academic tasks or projects

Q2.3 = I was encouraged to learn actively both inside and outside of the classroom

Q2.4 = I was engaged in team building and collaborative learning

145
Q2.5 = I was provided adequate resource to support my learning
Q2.6 = Teachers provided adequate support and feedback
Q2.7 = Teachers encouraged students to learn independently (e.g. from library, or other means)

U = Useful
L/U = Less than Useful

The three statements Q2.1b ‘content was substantial and useful’, Q2.4 ‘I was engaged in team building and collaborative learning’ and Q2.7 ‘teachers encouraged students to learn independently (e.g. from library, or other means)’ that were rated proportionally highest agreement by the respondents. Ninety percent of the graduate engineers agreed with these statements.

The statements with least agreement were Q2.1.c ‘content had a coherent sequence and well-structured’, Q2.3 ‘I was encouraged to learn actively both inside and outside of the classroom’ and Q2.5 ‘I was provided adequate resource to support my learning’, Both statements Q2.1.c and Q2.3 indicated 70% graduate engineers’ agreement while statement Q2.5, scored only 65% of agreement by the graduate engineers. These results indicated that the graduate engineers were less satisfied with the teaching material, activities and the teaching structure of certain subjects in their engineering course.

The far right-hand column in Figure 4.10 shows ratings of the perceived ‘usefulness’ for each of the identified statements provided in this part of the questionnaire. Graduate engineers perceived different degrees of usefulness as indicated in Figure 4.10. The results shown there should provide certain indications to academic staff members to improve the teaching and learning process.
The statements, Q2.2 ‘my classmates and I frequently engaged and collaborated together on academic tasks or projects’, Q2.3 ‘I was encouraged to learn actively both inside and outside of the classroom’ and Q2.7 ‘teachers encouraged students to learn independently (e.g. from library, or other means)’ were rated proportionally highest by the respondents. Eighty percent of the graduates indicated that they agreed with these statements and perceived that they were ‘useful’. Graduate engineers indicated that statements Q2.1.c ‘content had a coherent sequence and well-structured’ and Q2.1.e ‘the course provided adequate practical application’ were rated as useful by only 44% and 56% respectively. These two results indicated that relatively large proportions of the graduate engineers found certain subjects where the teaching content material did not have a good coherent sequence and was not well-structured as it could have been (statement Q2.1c). The course was also perceived by some (25%) not to provide adequate practical application (statement Q2.1e).

4.3 Questionnaire open-ended questions

There were open-ended questions on both questionnaires for the graduate engineers and the engineering managers. The main purpose of the open-ended questions was to invite graduate engineers and engineering managers to provide personal comments in addition to the check-lists in the questionnaire. These optional open-ended questions requested individuals to identify their positions, provide their organizations’ products or services, their training programs if any and suggestions to improve engineering education in Hong Kong. The majority of the respondents provided their position and the products or services of their organization. Some even provided some recommendations for future improvements in engineering education.
4.3.1 Graduate engineers' responses on open-ended questions

The survey results here indicated that graduate engineers worked at various industry sectors after their graduation. However, they can be classified into the following main sectors:

1. Manufacturing sector (75%) and could further breakdown into:
   - Plastic
   - Electronic
   - Electro-mechanic
   - Metal

2. Service sector (23%) and could further breakdown into:
   - Logistics
   - Purchase
   - Quality audit

3. Others (2%):
   - Self-employed

The results also indicated that the majority of the graduate engineers would like to further develop their generic-type skills after graduation. Some would prefer to continue their studies for postgraduate degrees and some would like to work for their professional qualifications. Lifelong learning seems to have become part of many graduate engineers’ ongoing activities.

Some graduate engineers provided suggestions for their own further development and reflections on their university education:
• "Undergraduate engineering degree is just a stepping stone to enter the job market. I need to continue my postgraduate study on a part-time basis to further my career".

• "Some promotion may depend on professional courses taken by individuals. Continuing education is a must after graduation".

• "There is no training program in my organization, but I think lifelong learning is a process of continuing to upgrade my own knowledge and skills, and I have to do it by myself".

• "Students should take advantage of any chances to seek opportunities to speak to any native English-speaking exchange students at university. The university language centre is also a great place to explore and practise English".

Some recommendations were provided by the graduate engineers to improving engineering education in Hong Kong:

• "I have a concern with some instructors who teach in Chinese-style English (aka "Chinglish")). This kind of teaching should be eliminated. All courses (except Chinese) should be taught clearly in proper English".

• "Professors should use more real case studies to support the learning process. Problem-based learning is a good approach. More actual problem-based case studies in management subjects, and students should be given opportunities to express their findings with reasons".

• University should emphasise writing, reading, listening and speaking English and Putonghua, and should encourage practising these skills even after lectures".

• "During my university education, there were only two English subjects in the undergraduate courses at Year 1, and I believe that the courses were not really helpful for my job. Now I have managed to overcome the communication issue
by talking with overseas customers and reading more reference books and fictional story books by myself. More complementary English subjects should be added in university”.

Graduate engineers provided positive feedback on how to improve the engineering education in Hong Kong. These suggestions will be further analysed later together with the recommendations.

4.3.2 Engineering managers’ responses to open-ended questions

The majority of the engineering managers had been working in industry for more than 10 years and they had usually been through various engineering ranks before being promoted to their current management positions. They were the decision-making groups and fully aware of their business direction and how to achieve their goals. In general, their businesses involved the following categories:

1. Manufacturing sector (75%) which could be divided into:
   - Plastic
   - Electronic
   - Electro-mechanic
   - Metal

2. Service sector (20%) which could be divided into:
   - Logistics
   - Purchase
   - Quality audit

3. Management Consultant: (5%).

Honesty and integrity emerged as a natural expectation of the managers. These values
reflected how managers manage and deal with their businesses and clients. Engineering managers also suggested that the university courses should provide more practical courses to improve students' overall generic-type skills.

- "Some graduate engineers are lacking in the positive and pro-active attitude to solve problems. If graduate engineers have the 'desire-to-learn' attitudes, and seek advice from their superiors, they should not have any issues in solving problems”.

- "Graduate engineers do not read a lot of journals or books to improve their knowledge. By not reading journals or business magazines they will limit their abilities to improve their knowledge and language skills. May be university should encourage students to read more books outside their own disciplines”.

- "Invite guest speakers from business or industry to complement some engineering topics to enhance students' exposure to industry, particularly some case studies. I am willingly to share my experience with students”.

- "Summer jobs provide a great opportunity to learn problem-solving skills. Engineering students should be encouraged to work in factories if possible during the summer term, and they should try to find a solution first before seeking support from their mentors”.

Engineering managers provided very constructive feedback on how they could help and further suggestions on how to improve the engineering curriculum design in engineering education in Hong Kong. Their suggestions here will be further explored and be linked to later recommendations.

4.4 Qualitative results (from interviews and discussions)

In order to have more depth and focus in the discussion of the generic skills among
graduate engineers, engineering managers and academic staff after the main survey results became available, some selected graduate engineers, engineering managers and academic staff were invited to attend focus group discussions or interviews. The focus group discussions and interviews served as an open forum to these three groups to air issues related to the open-ended questions in the questionnaire and also served as a forum to clarify any issues related to the results obtained.

Twenty graduate engineers accepted the offer and agreed to share their personal experiences about the application of generic skills that are required in their day-to-day operations. Graduate engineers were divided into two groups based on their availability on two separate Saturday afternoons. Eleven graduate engineers attended the first focus group discussion and 9 attended the second meeting. Most of the graduate engineers interviewed were graduates in the industrial engineering discipline but they all worked in different sectors in industry after graduation. This phenomenon verified that a first undergraduate degree for students is just the foundation base for entry into the engineering workforce.

Fifteen engineering managers accepted the invitation for an individual interview in their office. These managers, all graduated in engineering disciplines, had been working in industry for more than 10 years. Most of these targeted engineering managers had worked as engineers before being promoted to their current positions as engineering managers. These managers had experience in operations and understood the skills required to be successful in their own businesses.

A combination of discussion forum and individual discussions were used with academic staff members because of their daily activities. Five engineering academic
staff from the Department of the Industrial and Systems Engineering (ISE) of the Hong Kong PolyU attended the 'discussion forum' and 3 other ISE engineering academic staff accepted the invitation for a one-to-one 'individual discussion'. Presenting the full survey result summary for both graduate engineers and engineering managers to academic staff provided an opportunity for academic staff members to understand the current issues relating to generic skills and the different opinions between industry and the academic world as well as the current approaches to teaching and learning at university.

4.4.1 Findings on communication skills

Graduate engineers

The majority of the graduate engineers from Hong Kong universities should communicate reasonably well in English. They have practised English both in writing and speaking, at different levels since primary schools. However, when they deal with customers from foreign countries, they have to be especially good in both oral and written English.

During the focus group interview, one graduate interviewee said it loudly and clearly:

• "There is not enough training in business English at university".

Other key comments are summarised as below:

• "Communication (verbal and written) skill is the most important skill in any business. I spent about fifty percent of time in meetings; listening and responding to questions are keys to my success in my job. I have to master listening and presentation skills".
• "I am weak in listening particularly to clients with strong accent (e.g. Indian, and Malaysian). Sometimes, I have to ask my client to repeat the same statement twice. I have had no exposure to their accents".

• "I work at the IT department of an Electronic Component Company. I have to deal with overseas customers in Europe, Japan and Korea and communicate with them in English. Because I spent one year in England as an exchange student during my undergraduate studies in university, my English communication skill is acceptable. Since the manufacturing facility is located in Mainland China, I have to communicate with my co-workers in Putonghua. After speaking Putonghua for 3 years, I feel confident in speaking Putonghua now. The technique is more practice".

Engineering managers

All of the engineering managers claimed that problem-solving and communication skills were the number one priorities among the generic-type skills categories. Verbal and written communication skills were seen as ‘must haves’ for any business. During the interviews, engineering managers expressed their concerns about the fluency of the communication of the graduate engineers in English and Putonghua. Generally, engineering managers were satisfied with graduate engineers’ communication skills but they preferred graduate engineers to have a much better understanding of the language, particularly in English. Managers would like graduate engineers to present their ideas in a precise and concise way so that other senior management who were not with engineering background can understand. Managers also suggested that graduate engineers use less engineering jargon when they present their designs and that they should have some basic understanding of the financial issues of their projects. The following are some key comments from engineering managers:
• "Generally, graduate engineers may possess adequate skills in communication in technical ideas, but not in the general business sense. Presenting an idea in a precise and concise manner in business terms is a real challenge to graduate engineers. Some ideas proposed by graduate engineers are very superficial; they need to think more as a "whole" system in a business sense".

• "Graduate engineers must master communication and problem-solving skills effectively if they want to be promoted to the next higher positions in any organization. Graduate engineers need to master English and Putonghua".

• "Time and experience can improve management skills. Communication is also part of the management skills. By communicating well with management on issues, management can help engineers to resolve conflicts".

The engineering managers generally thought that graduate engineers do possess adequate skills in communicating technical ideas but need to improve their business skills and knowledge. Communication skills can be trained. The researcher observed that business graduates have better communication skills than engineering graduates. This is due to different approaches to teaching and learning at university. Usually, business students have more opportunities to present themselves in class. Perhaps, as some engineering managers suggested, engineering students should take some courses from the School of Business. Engineering managers also recommended that graduate engineers should take time to read more business journals to broaden their knowledge and language skills. To be current, graduate engineers need to read more technical journals and business magazines to broaden their general knowledge and they should attend conferences related to their disciplines to strengthen their professional knowledge.
4.4.2 Findings on problem-solving skills

Graduate engineers

During the two interviews with graduate engineers, there seemed to be no major issues with the basic contents of the engineering subjects. The major challenges for graduate engineers appeared to lie in the application of this engineering content into the solution of real problems. In the problem-solving skills category, the majority of the graduate engineers were concerned about lacking experience in dealing with the human aspects of management and managing the flow of information. The problem-solving techniques taught in engineering courses are very similar: these techniques are problem identification, problem analyses, solution proposal and proposal implementation. The problem case-studies in university are well structured and there is usually one correct answer. But in reality, the problem is dynamic, involves people, and there may be more than one solutions.

Graduate interviewees aired their comments on the problem-solving skills category with these issues:

- "I have problems in searching certain information and, sometimes, information overflow makes it difficult for me to make decision".
- "I have difficulties in time management, I do not have enough time to follow up with certain activities that co-workers promised but not able to deliver".
- "I work as a project engineer and deal with a team from marketing, sales and engineering. This group of people has great experience in various fields and I learned lots from them. They helped to make the final decision on new product introduction".
- "I have difficulties in dealing with problems that involve people. This problem is so obvious in the workplace. I start to learn this technique in the job-related
activities. Organization/department should build up a co-operative culture and share the successful events”.

Problem-solving skills are broad ways of thinking and acting which involve lots of techniques and common sense. Graduate engineers indicated that they should have no major issues in identifying problems. They did not fully understood that solving a problem requires a critical thinking process, resources and time and sometimes solving one problem may create another problem(s) which impacts on other functions. Breaking down a problem, understanding its impact on other functions and seeking alternatives are the best ways of dealing with problems. However, graduate engineers indicated that they were lacking in the skill of providing more than one alternative.

Graduate engineers suggested that university should substantially incorporate more real case studies into the curriculum design and provide more real-life cases or problem-based learning in lectures or tutorials. They thought that improved problem-based learning in their university education could help them to improve the problem-solving skills in their own workplaces. In dealing with people, the majority of graduates thought the best solution was to listen to the issues of all sides before making the final decision and they believed that they did not pay much attention or listen ‘attentively’ to lectures during their university education.

**Engineering managers**

During the interview with engineering managers, the managers reiterated that the number one generic skill in business is problem-solving. Managers suggested that problem-solving skills involve a systematic approach to a problem. This systematic approach means that all ‘peripheral’ or related (macro view) issues and impacts should be identified first, then the next step is to select the one with the optimal
solution. The execution of the solution should be followed through until the problem has been resolved completely. One engineering manager aired his frustration about a project initiated by a graduate engineer but that had to be completed by the management at the final stage due to its time urgency. They suggested that the lack of time management in problem-solving and the attitude of graduate engineers, might be perhaps partly the result of their habits of 'lateness' in submitting their assignments during their university education.

Some key comments from engineering managers are noted.

- "Graduate engineers do have the ability to solve basic technical problems. However, graduate engineers prefer to initiate projects, but do not like to follow through until the projects are completed".

- "Graduate engineers do have the following deficiencies in solving problems:
  - They do not know how to approach problem solving systematically and do not have the ability to look for more alternative ways solving problems;
  - They do not have the ability to analyse and look beyond the current situation; and
  - They do not follow through an issue until it is completely resolved."

- "Engineering students usually have narrow minds in looking for solutions to problems. Engineering students are good at finding out optimum solutions (through equations or other means) but not their impacts".

The engineering managers generally thought that the graduate engineers do possess adequate skills to solve basic technical problems but if graduate engineers want to be a success in business, they need to think beyond the current situation or to use an 'out-of-the-box' approach. Another suggestion by an engineering manager was to get
the graduate to assume that they were manager. Then, if they were manager, how would they resolve the problem and evaluate the impact in both technical and business perspectives? One of the key problem-solving processes is also effective communication. This communication technique involves presentation (speaking and listening) of ideas and gaining support from others.

4.4.3 Findings on Management skills

Graduate engineers

In this category, graduate engineers made many comments: Some of these were legitimate, as graduate engineers have to go through the learning process in order to gain these skills. The followings are some of the typical key concerns from graduate engineers:

- "I have difficulties in managing experienced staff and convincing them to support my projects. Particularly staff across different departments".
- "I do not have enough time in managing my task at work. Usually I stay behind to complete my task".
- "I do not quite fully understand cultures of overseas co-workers or customers".
- "During university education, I was more concerned about my examination grades than the actual understanding of the process and procedures on acquiring management skills".

Teaching 'Engineering Management' courses helped the researcher to understand the learning attitudes of Hong Kong students, and the focus group comments from the graduate engineers also extended and validated the earlier perception of the learning attitude of some students. Graduate engineers thought the development of management skills presently taught is not considered a major activity in the
engineering curriculum design and Faculty members expect students to learn by themselves. The graduates indicated that many students believe a management subject is an easy subject to get a ‘passing’ grade and they believe students’ seldom fail in this subject as long as they memorised some theories or some notes from the lecturer. They assume they are future engineers and will only deal with technical issues, such as design and analysis. They do not understand activities in an organization have to be involved and integrated with all the other functions of the organization. As one graduate engineer stated:

“I did not acquire the actual management skills during my university education and I pay for it now”.

The graduates thought that time management is another key issue in management skill which they never “treasured” while studying in university. One graduate engineer explained that in university education, the majority of students usually expect to submit their assignments or reports at the end of the semester and they thought they have time to complete them. Even if they were late in submitting their assignments or reports, the penalty is minimal. But in industry the completion of a project is subjected to the requirements of the customer and based on the commitment of an organization. The time interval leading to the delivery could be very short. An organization could not afford to miss the customer’s deadline and management have to deliver as per the customer’s contract. Graduate engineers indicated that they started to realize the importance of time management. The response from the focus group interview of the graduate engineers indicated that the university should modify the curriculum design to include more on management skills, time management and professional practice.
Engineering managers

The engineering managers believed that the graduate engineers should seek opportunities to broaden their skills during their early employment stage. They should have career plans for their career paths for five years or ten years. Pay is not the only factor in evaluation for employment. Future opportunity, so they thought, should be the first priority in looking for employment.

- “Some ‘big’ companies in Hong Kong are ‘family’ owned. Some managers may be appointed by the owners and usually the owner or the boss will dictate the direction and the process and teamwork is only applied on a small scale. However, there are some large organizations operated in Mainland China, and graduate engineers should be encouraged to seek employment opportunities in these large organizations in China to broaden their management skills”.

- “In this competitive society, graduate engineers change jobs quite frequently, often with little, if any, increase in pay. This reflects that graduate engineers do not know exactly what they want and where they should go. This lack of clear direction will limit their growth in their career paths”.

- “Graduate engineers have drive and can learn very fast, yet they need to improve their attitudes towards work deadlines. Deadlines are extremely important to any business”.

Other managers commented:

- “If an engineer has his will to complete the task, nothing can stop him from doing it. This kind of ‘can do’ attitude is what industry needs”.

- “Nowadays teamwork is more important than ever, and everyone has to deal with people. Even if an engineer doesn’t come face to face with customers, he/she
needs to deal with people of all different languages and cultures. Engineers need to be aware of these changes”.

- “Graduate engineers should read more books (both technical and novel). Technical magazines help to update the technical knowledge and novels relax the mind”.

**4.4.4 Findings on other ‘generic-type’ skills**

**Graduate engineers**

All of the graduate engineers interviewed indicated a belief that ‘honesty and integrity’ are two very important values and that all engineers should possess these values. The graduate engineers expressed concerns about their abilities to cope with change. Taking responsibility and being in charge of change, they indicated could force the graduate engineers out of their ‘comfort zones’ and this industrial learning process speed up the experience and maturity of graduate engineers. Graduate engineers also recommended that they have to pro-actively step forward and assume responsibility.

Further typical comments were as follows:

- “University does not provide 100% subjects related to workplace. However, some subjects should have direct links to some professional organizations, and university should help final year students to join some engineering institutions as student members to get exposure to the professional institutions”.

- “Honesty and integrity are the two very important values that all engineers should have”.

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• “Besides subjects learned from university, students should broaden their knowledge by reading more books outside their curriculum. Students should learn how to adapt to changes and be part of changes”.

In the interviews with graduate engineers, the researcher observed that the graduate engineers shared the importance of ‘honesty and integrity’ in their workplaces. The values of honesty and integrity are difficult to teach in university and graduate engineers have to gain these values by practising them at their workplaces. All professional institutions have their own ‘code of ethics’. Before individuals become professional engineers, they must have to pass the ‘ethics for professionals’ examination. That the graduate engineers appear to understand and treasure their values of ‘honesty and integrity’ is a great reward to academic staff.

The researcher found that the two focus group interviews with graduate engineers were informal and constructive. All of the graduate interviewees discussed actual issues honestly about their limited working experience. The graduate interviewees also said they would like to share their experiences with engineering students at university about the importance and application of the generic-type skills.

Most of the graduate interviewees had taken some courses to upgrade themselves outside their working hours. These courses tended to be job-related or profession-related. This demonstrated that the graduate engineers were eager to learn and would like to upgrade themselves over time. As one graduate engineer stated:

• “Promotion may depend on professional courses taken by the individual. Continuous education is a must after graduation”.

Some graduate engineers are engaged in lifelong learning. They indicated that the
working environment is quite different from their parents' generation. They need to seek to acquire a broad set of marketable skills and lifelong learning is way to go.

**Engineering managers**

All of the engineering managers expressed the belief that all employees (including the graduate engineers) must have 'good' personalities and high levels of integrity that follow the codes of ethics of business and professional bodies. No matter how good the problem-solving and communication skills that the graduate engineers possess, if they do not have the appropriate temperament, integrity and the natural willingness to follow a code of ethics, they will never become good leaders. As one manager commented:

- "Integrity and ethics issues play a most important role in my organization. 'Knowledge' and 'technology' can be 'purchased' in an organization. However, business ethics and an individual's integrity are the fundamental components of a successful organization".

Another manager commented:

"I will employ graduate engineers who have a positive attitude towards work and life, even they may not score the best academic results at university".

The establishment of the Hong Kong Independent Commission Against Corruption (ICAC), an organization committed to fighting corruption through effective law enforcement, education and prevention in Hong Kong, helps all graduate engineers to have a better understanding of the corruption rules in Hong Kong and makes further demands on the ethics of all professionals.
As one manager stated in the discussion: the most desirable and most wanted graduate engineer is the one equipped with the best brains of a analytical, detail oriented, strategic, passionate, intuitive, creative, expert but was also versatile and possessed the skills of communication, problem-solving, management and other 'generic-type' skills.

The researcher observed another issue during the interviews with the managers. In Hong Kong, the majority of engineering managers have to work long hours (more than 10 hours per day), and they expect their subordinates to do the same. This long working time, however, will limit young graduate engineers from furthering their studies and updating themselves. The researcher hopes that this trend will change as the business environment is improving.

4.5 Academic focus group discussion and interviews

A combination of focus group interview and individual interview was used with academic staff members because of their daily activities. The academic review was scheduled as the last component of the study. Presenting the full survey result summary for both graduate engineers and engineering managers to academic staff provided an opportunity for academic staff members to understand the current issues relating to generic skills and the different opinions between industry and the academic world as well as the current approaches to teaching and learning at university. It was thought that the different opinions might even trigger academic staff members to re-evaluate or re-develop the curriculum contents of the engineering subjects in the near future in order to cope with the change.
The researcher planned one ‘discussion forum’ and 5 academic staff members attended the forum and 3 academic staff members accepted the invitation for a one-to-one interview because of their teaching schedules.

The followings were the major issues and concerns recorded in the discussion forum and the individual interviews with academic staff. The researcher observed that a wide variety of opinions surfaced from the academic staff such as:

- “University students should be mature enough to be self-motivated, and they should learn as much as they want. Learning is not limited in the classroom. Students should explore these generic skills through their extra curriculum activities during their studies at university”.

- “In each subject, there are certain guidelines and outcomes for teaching staff to follow. It may be difficult for teaching staff to ‘add’ the generic skills to a particular subject. My teaching load is so heavy that I do not even have enough lecture time to teach the technical topics - how do I have extra time in class to include the teaching of generic skills?”

- “We do not teach English subjects for engineering students in our department. Students should have the basic knowledge of the language. If they want to further their language skills, they should practise in the English Centre at the university”.

- “Graduate engineers should ‘think outside one’s own box’ in any business decision making. Activities or project work in any organization will involve more than one individual or department, such as finance, marketing, sales, or design manufacturing. If graduates understand other professionals’ requirements, they will become ‘all-rounded’ leaders. Engineering students should be encouraged to take some other courses outside the engineering curriculum. This
approach will provide a better understanding of other professions’ requirements. Sometimes, a double degree course may be the solution to help students to enhance their problem-solving skills”.

Academic staff members’ concerns about their workload and limitations of implementing generic skills to the curriculum and the students’ learning attitudes are legitimate issues. University students are supposed to be mature students and they should know what they want. But in Hong Kong, the situation is somewhat different. One academic staff commented that some university students are ‘well’ protected by their parents and less independent and their general attitudes are passive and not that active. A lot more needs to be done to encourage students to be active participants in interactive learning. As one academic staff commented:

- Many Hong Kong university students are well ‘protected’ and ‘spoiled’. They cannot make decisions by themselves. Even some simple issues, they had to consult their parents.

Some of the concerns made by academic staff members may be due to the immaturity of some of the Hong Kong university students. Nevertheless, academics do have certain obligations and responsibilities to provide an environment that encourages students to interact and to learn. Sometimes, a change of teaching approach can introduce the learning of generic skills to students indirectly through case studies or mini-project work. Applications of computer-based education can relieve some teaching workloads. For example, at Queensland University of Technology (QUT) in Australia, the Teaching and Learning Plan for 1998 – 2000 sets the quantitative target that ten percent of all first-year undergraduate contact hours should be delivered through computer-based education. This new approach should reduce the spoken
lecture and face-to-face classes for the academic staff. Another option is the ‘Self-learning’ module. Students can learn at their own paces. Both “Computer-based education” and ‘Self-learning’ modules can train students to be more independent and to have better time management.

Some academic staff aired their general concerns and frustrations about the Hong Kong higher education system. The following are comments recorded from academic staff:

- “Based on the current education systems in Hong Kong, examinations (assessments) play a very important role in determining students’ accessibility to the next level of studies because of fierce competitions for higher education. The system applies from kindergarten to secondary school to university entries. This system makes Hong Kong students more concerned about their ‘marks’ in any examinations and their ‘promotions’ to the next level. Thus, in a student’s mind, the examination will determine his/her ‘fate’. Doing well in examination is a must no matter at what cost. In any subjects which carry marks, students will work hard for them. With any complementary subjects not needing to be graded, students typically seldom attend. The current education system will encourage students to gain the short-term goal (high marks) rather than the long-term benefit (actual understanding and the application of the contents). To change this culture, a major education reform is required”.

- “Responsibility and accountability cannot be measured by ‘marks’. How does university measure generic skills for students during these three years of higher education? The greatest pedagogical difficulty will be to overcome engineering students’ reluctance to take a long-term view of world of work skills
development. They need to understand that it is worthwhile to work now on skills at university before they enter the workforce”.

The interviewed academics articulated their concerns and frustrations about the current engineering education system clearly. Their concerns are very valid issues and may suggest a number of things. The first of these are the budget cut and resource constraints applied to all universities with larger class size, more lectures and workload for academics. A second explanation may lie in the quality of students. With more entertainment facilities in Hong Kong, such as video games (NDS, PSP, etc.), karaoke and mobile communication, students have more attractive activities than just studying. Some students consider a pass grade to be sufficient for them. There is an old Chinese saying: ‘It takes ten years to grow a tree, but requires one-hundred years to educate a person’. Education is considered to be a more complex issue and academics are part of the education system, so they should find ways to improve the education system.

One academic staff member explained his own view that the university teaching staff members can roughly be divided into two groups. One group specializes in research (active researcher) and most of these joined the teaching profession directly after graduating from university (e.g. B.Eng, M.Eng, and PhD). The second group joined the teaching profession with academic qualifications, plus a certain number of years of industrial experience. The first group usually prepares teaching materials from text books, while the second group prepares teaching materials in terms of books plus their own industrial experience. He provided the following suggestions:

• “Academic staff specializing in research should do more consultation work with industry, or take time off and work in industry in areas related to their
specialisms. This will help them to have a better understanding of the industry needs”.

- “Teaching staff with both academic qualifications and experience should apply more real life examples in their teaching materials, as this will help students to have better understanding of the real issues when they graduate and work in industry”.

The comment was supported by another academic staff member who indicated that some academic staff members were lacking in practical experience in the engineering field. He suggested academics, besides attending conferences and publishing papers, should consider providing consultation services to industry as it provides an excellent opportunity to upgrade oneself. Academic staff should get out of the ‘ivory tower’ and make close contact with industry. The close contact with industry would enable staff to have a better understanding of what real problems are being faced and what industry wants. The ‘problems’ and ‘wants’ from industry could then serve as real case studies in the engineering courses and help to improve the curricula.

Some academic staff provided some constructive comments to improve relevant generic-type skills of students through teaching and learning:

- “In order to improve students’ communication skills, students should take some courses outside their own curricula. Engineering courses should include more opportunities for students to make presentations, as do Business students. If university believes English and Putonghua are important communication skills, it should encourage students to speak these two languages publicly at university campus”.
• "Real business operations are not run only by engineering discipline; the whole operation involves other professionals in areas such as finance, marketing, sales, design and manufacturing. Instead of developing courses on problem-solving, management, engineering students should be encouraged to take some business courses to enhance their generic skills. A 'double-degree' course (Engineering and Business) may be the solution to help students to enhance their problem-solving and management skills”.

• "Project work in industry provides an excellent opportunity for students to gain experience in the actual work environment. Summer placements and final-year projects (FYP) for engineering-discipline students should be conducted in workplaces. The FYP should provide students with better understanding of the actual work environment and how an operational system functions”.

• "Problem-based learning is an excellent approach for students to learn. All subjects should include case studies. The same approach as in the medical professions”.

The researcher tends to agree with the suggestions of practising English and Putonghua in the university campus, as only practice makes perfect. The industrial-based final year project can help students to have a better understanding of engineering operations. This experience definitely improves students’ abilities to cope the working environment when they enter into the workforce.

The discussion forum and individual interviews with academic members indicated that academic staff had a wide range of opinions and perceptions of the generic-type skills that should be taught or further improved at university. Both positive and negative remarks were recorded. Some staff members were concerned about their
busy schedules involving teaching, publishing papers and consulting, while others were concerned about the current education systems in Hong Kong. It is important to note, however, that one of the key missions of university education is to produce graduates to be the future professional leaders and academics have a key role to play. University education should be as described by Margetson (1994, p.5):

“The general aims of a program in higher education includes the development of students’ intellectual and imaginative powers, their understanding and judgement; their problem-solving skills and their ability to communicate”.
Chapter 5 Conclusions and Discussion

5.1 Introduction

This study provided an evaluation of the generic skill outcomes of the Hong Kong graduate engineers by both themselves and the engineering managers. It provided an overview of the perceptions and indicators of the adequacy of generic skills of the newly graduate engineers in Hong Kong. It was concluded that generic skills are seen to be a key success factor in industry and business by both graduate engineers and their managers. However, the study results indicated that a university education did not necessarily provide adequate training for graduates to gain and later practise the basic relevant generic-type skills before they enter the workplace.

It must be noted, however, that overall engineering managers were generally satisfied with the general performance of graduate engineers on the overall knowledge and skills in the areas of problem-solving, communication, management (e.g. team work, leadership, motivation and time management) and the other ‘generic-type’ skills variables examined here (e.g. adaptation to change, honesty, integrity and engineering ethics), nevertheless, the engineering managers were concerned about the performance of graduate engineers, specifically in areas of effective communication in English and Putonghua, problem-solving, creative thinking and effective analysis of different types of data and demonstrating a leadership role and a positive attitude towards co-workers and work environment.

The results from this study may help academics to have a better understanding of the overall generic skills of the graduate engineers working in industry, in term of providing an opportunity to review the teaching and learning process to enhance the
requirements of generic skills as required by the engineering students and industry in Hong Kong. No longer does it appear to be sufficient to educate engineering students only in technical engineering subjects. The non-technical generic skills as the results of this study have shown, are perceived to be as significant to an effective graduate engineer as the traditional technical areas.

5.2 Perception of the importance of generic skills categories

One of the major objectives of this study was to identify the perceived importance of certain key generic-type skills by graduate engineers and engineering managers and to evaluate the workplace adequacy of such skills by the current graduate engineers, and to compare the results with their work-related engineering managers.

The results of this study indicated, on average, that the graduate engineers ranked problem-solving skills as the 'most important' generic skill among all of the generic-type skills categories examined. This result reflected a general requirement of business and industry. The key responsibilities of the engineers and the managers are to resolve work-related problems and to deliver solutions (products or services) on schedule in order to satisfy customers' requirements. The second ranking as the 'most important' generic skill category by graduate engineers was effective communication skill. The third was generic-type management skill and this was followed by the other 'generic-type' skills category.

Engineering managers also ranked problem-solving skills category as the top priority in terms of the perceived overall importance of the generic-type skill categories. This was followed by their second priority of the communication skills category. Their third priority of importance was the management skills category and the fourth
priority was the ‘other’ generic-type skills category. There were less than a 2% difference between the graduate engineers and the engineering managers on the ratings of the perceived importance in the generic-type skills of problem-solving, communication and the management skill areas. The results demonstrated quite positively, that the graduate engineers, even though with less work experience, shared the same priority here in the working environment as the experienced engineering managers. However, in the evaluation of the adequacy of specific areas in each skill category, the graduate engineers, on average, indicated that they appeared to be somewhat deficient in many areas such as effective communication in English and Putonghua, problem-solving skill, ability to resolve work-related conflicts and demonstration of leadership and these deficiencies were also concurred with by their managers. More detailed conclusions now follow for each generic-type skill category examined.

5.3 Problem-solving skill

Both the graduate engineers and the engineering managers rated the problem-solving skills category as being of ‘top importance’ when compared to the other generic skill categories in this study. Of the five statements listed in the problem-solving category, more than 6 in 10 of the graduate engineers considered the effectiveness of analysing different types of data and making decisions as the most important statement in this problem-solving skills category. This was followed by the ability to think creatively in solving problem, which was rated as of the second highest importance by more than half of the graduate engineers.

When the engineering managers evaluated the statements in this category, however,
about three-quarters of the engineering managers rated the ability to evaluate different engineering options and select the optimal solution as of the highest importance and 7 in 10 of them, rated the application of new technology in the workplace as the second highest important statement. These results indicated somewhat different perceptions on the importance of underlying issues related to problem-solving skills, between the graduate engineers and the engineering managers. Their different perceptions and differences on the ratings might be due to their positions, work experiences and exposure to the working environment in the industry. The graduate engineers were more concerned about their daily operational problems, while the engineering managers, besides being concerned about the day-to-day operational problems, were also concerned about how to maximize their resources (capital) to resolve the actual causes of various operation problems.

The graduate engineers’ survey results were similar to qualitative information obtained from their focus group discussions. The focus group discussion results indicated that the graduate engineers had certain difficulties with problem-solving skills. Some graduate engineers commented that they had problems in resolving work-based conflicts. Some said that they had difficulties in dealing with mass of information to make a sound decision. Some even had difficulties in prioritizing their activities to meet the tight schedules. It appears to be quite normal for new graduate engineers to experience these difficulties in managing problem solving techniques in the workplace.

When graduate engineers are assigned tasks in their workplace, they have to search for the background information. Generally, they are overwhelmed by the vast amount of information and data, and they do not know how to select the most appropriate
information or documents to solve a problem. In order to make ‘right’ decisions, graduate engineers have to go through many documents and analyze the data before making the final decision. Their lack of experience in choosing the best relevant information for evaluating the text, or even asking the ‘right’ questions in the first place, makes them feel uncomfortable about making a decision. The engineering managers, however, with their working experience, have to consider all options related to their business, based on the availability of resources, the stability of technology and the direction and strategy of the organization before they make the final decision.

Some engineering managers commented that the graduate engineers usually have a narrow focus in looking for solutions to a problem. One manager indicated that the graduate engineers are good at finding the optimum solutions but lack the ability to consider other alternatives, beyond the quick focus solution and the potential impact of the solution to the business. Bateson (2000), a trained anthropologist in the United States, studied the view of the culture of man, stated that the most important task today is, perhaps, to learn to think in the new way, and how to think creatively.

The ‘adequacy’ rating of the knowledge and skills of each statement in the problem-solving skills category indicated that the graduate engineers and the engineering managers sometimes had widely different perceptions. The results indicated that 6 in 10 of the graduate engineers rated themselves as ‘adequate’ in the effective analysis of different types of data to make decision, but less than half of the engineering managers rated the graduate engineers as adequate on that statement. The perceived difference of opinion in this statement between them was strong. Half of the graduate engineers indicated that they had the ability to think creatively and solve
work-related problems, but only 4 in 10 (less than half) of the engineering managers perceived this to be so. The higher ratings of the adequacy in this category by the graduate engineers indicated the limited experience and exposure of the graduate engineers to a workplace environment.

There are other studies the results of which are in support of the results found in the present study. A study conducted by Brumm (2006) in the United States on workplace competencies indicated that the employers rated the ‘ability to identify, formulate and solve engineering problems’ as the high important in workplace competencies (score of 4.4 on a 5-point scale). Another study conducted by Comer (1987) in the United States on the generic skills of graduate engineers, indicated that both engineering managers and engineers rated problem-solving skill as a first priority issue in the industry today. However, Comer’s study indicated that 34% of the graduate engineers had difficulties with problem-solving techniques. Some graduate engineers even had problems with the application of basic theory to the solution of real problems in the workplace. It also was found that sometimes graduate engineers did not even know where to start when facing a new problem.

Dearing’s study (1997) in the United Kingdom on general fresh graduates’ skills indicated that ‘communication skill’ and ‘capacity to make decisions and solve problems’ were ranked by employers as their first and second priorities respectively among a range of other generic-type skills. Although Dearing’s study indicated that communication skills was the first priority and decision making was the second, the report did stress that problem-solving skill is critical in successful business and industry. In order to solve problems, graduates must have good communication skills to identify problems and present solutions to various audiences to gain their support.
for the implementation of the solution. The inter-relationship between communication and problem-solving skill is very close and they are integral components of basic generic skills.

In Hong Kong, a study conducted by the Education and Manpower Bureau (EMB, 2006) on the skills of new graduates (all from different academic disciplines) working in business and industry indicated that only 34% of employers were satisfied with the analytical and problem-solving skills of graduates in Hong Kong. Boeing’s (Magee, 2003) attribute (generic skills) test for new engineers indicated that new engineers received low-level grade of C- on ‘systems thinking’ and ‘decision making. All of these previous studies plus the present study results, indicate that problem-solving is important in all businesses, however, the majority of graduates have difficulties in applying successful problem solving skills.

Needless to say, all managers realised that their key objective was to support their operations and resolve any problems that hinder the delivery of their products or services. The managers also expected their employees to fulfil the same requirement. Problem-solving, data-managing and critical-thinking skills are the basic tools for good management. Good managers should possess these analytical skills, before they can be promoted to any supervisory or management level. Graduate engineers have new ideas, energy and drive. However, sometimes their new ideas may not be practical or in alignment with the organization’s strategy and objectives. With their limited experience, as long as they find one solution, they believe that they have completed the task. In order to find the optimal solutions, graduate engineers need to be able to define an issue and to choose and sort through the relevant data available and select the best solution.
Some problems facing the industry, of course, may not relate directly to what graduate engineers learned at university. Most of the organizations targeted in this study were under tremendous pressure from local and foreign competition. These organizations often need to reduce intervals of time-to-market for their new product design and to increase the productivity through creativity and innovation. Of course, managers expect graduate engineers to work with them and solve all work-related problems. Therefore, it would be highly desirable if graduate engineers had stronger generic skills in this area and the ability to apply any ‘transferable skills’ that they might have learned in university engineering subjects to solve industrial work-based problems.

5.4 Communication skill

In the communication skills category, the majority of the managers (7 in 10), while half of the graduate engineers, rated communication in English as being of ‘top importance’ and a ‘must have’ in any business. The focus group discussion with the graduate engineers and the interviews with the engineering managers also reflected the view that effective communication in English is very important in Hong Kong. Yet, half of the engineering managers surveyed had great concern about the adequacy of the effectiveness in communication in English and Putonghua of their graduate engineers and only 4 in 10 of the engineering managers indicated that their graduate engineers had adequate skills for dealing with work concerned with a range of diverse cultures.

The engineering managers rated the graduate engineers’ overall learned knowledge and skills relevant to the communication skills category generally as adequate and graduate engineers also rated themselves had adequate for their overall learned
knowledge and skills relevant to this category, but both groups had concerns about specific areas in the communication skills category. The graduate engineers were concerned about their fluency in speaking English and Putonghua. Two thirds of the graduate engineers indicated that they were weak in communication in English and more than half of the graduate engineers indicated that they were weak in communication in Putonghua. In addition, the results indicated that only about one third of the graduate engineers considered themselves to be adequate in written Chinese and only slightly over half indicated that they had adequate skills to deal with a range of divergent cultures.

The results also reflected the voices of the graduate engineers about their communication skills. In the focus group discussions, conducted with the graduate engineers, they stated that communication (verbal and written) and problem-solving skills were considered important generic skills in their workplaces. Some of them regretted that they had not paid much attention to improve these skills during their university education. More than one graduate engineer commented that he was weak in listening skills, particularly with clients who had strong accents, either in English and Putonghua. Some graduate engineers suggested that engineering education should provide more emphasis on the writing, reading, listening and speaking of English and Putonghua. The speaking of English and Putonghua should be encouraged and practised even after classes/lectures are finished. However, both groups understood the importance of working well with all different kinds of staff members in an organization.

The results from the communication skill category ratings in this study were comparable with other previous studies of communication skills in engineering and in
other workplaces. Many previous studies have also indicated that graduate engineers were weak in communication skills. A report by Brumm (2006), after assessing the workplace competencies of university graduates in the United States, indicated the importance of the workplace competency of ‘ability to communicate effectively’. The Society of Manufacturing Engineers in the United States named the lack of communication skill for graduate engineers as one of the top ‘competency gaps’ in engineering education (Rogers, 1999). Comer’s (1987) study also indicated that one of the main deficiencies found for engineering graduates in North America was communication skill in that 59% of the respondents indicated that the graduate engineers had communication problems, whilst 18% rated the graduate engineers as not able to present their ideas or information clearly in meetings.

Dearing’s (1997) study of the university graduates’ generic skills in UK indicated that ‘communication skill’ was ranked by employers as a first priority among other generic skills. More recently, Magee’s (2003) study of new graduate engineers working at Boeing Aircraft Company in the United States found that they received a grade C- on their communication skill. Some time before, the Board for Engineering and Technology (ABET, 2000) in the United States had recommended that any engineering curriculum should include communication skill as one of the key components of the knowledge requirements for all engineering programmes and on graduation, all graduates should possess the ability to communicate effectively. The U.S. Congress’ Office of Technology assessment report (1988) listed communication skill as one the key qualitative skills vital to the employment environment that needs to be developed. In Canada, the Conference Board of Canada (2000) developed an extensive scheme of employability skills, placing communication skill as an important element.
Kelly (2001) outlined the key broad goals of education and specified that communication skill is one of the eight essential skills that students should possess in New Zealand. A report by Todd, Sorensen, and Magleby (1993) also identified one of the areas of concern for engineering graduates was weak in communication skills.

In Asia, the Employment and Manpower Bureau survey on Manpower Training and Job Skills Requirements (2000) in Hong Kong SAR, indicated that employers had great concerns about the decline of the language proficiency of their staff, that graduated in Hong Kong, especially in spoken English and Putonghua. Another survey conducted by the Hong Kong Economic Journal (May 2007) for 8 university graduates in Hong Kong, found that the graduates from the Hong Kong PolyU scored low (only 6 in a 10-point scale) and were ranked the 6th among the 8 universities on English and Chinese proficiency survey.

Apparently, overseas findings in this area are now at least in part, replicated by the results of this study for Hong Kong graduates. With the inadequacy in communication skill in both English and Putonghua for the Hong Kong graduate engineers, the best solution might be to integrate communication skills into subjects, where there would be a context in which these skills could be further developed in the engineering education. The other solutions to help Hong Kong engineering students, would be to add formal writing and presentation courses to the engineering curriculum, such as does occur at McGill University in Canada. Both written and presentation skills can only be achieved through practice and feedback.

The Hong Kong SAR government also has recognized that Hong Kong students generally are deficient in communication skills. Recently, the Putonghua language has become a part of the curriculum for primary and secondary schools and for
universities in Hong Kong. The new Education Chief, Suen Ming-yeung has set the goal of reversing the controversial mother-tongue (Chinese) education introduced in 1997 and has allowed secondary schools to place equal weighting on Chinese- and English-language teaching in schools from 2008. These changes, hopefully, should eventually enhance the overall skill level in both oral and written communication for all graduates in English and Putonghua.

Some possible reasons for the Hong Kong graduate students’ weaknesses in communicating in English and Putonghua appear to be:

• Although the graduate engineers have learned both English and Putonghua in their secondary schools and universities, without further practices and applications, they have difficulties in perfecting these communication skills.

• Graduate engineers’ lack of reading and speaking of English and lack of practice in communicating in Putonghua.

• Since 2003, the Education Department has stipulated that a language teacher (English and Putonghua) is required to have either a Bachelor of Education degree majoring in the relevant language subject or any degree majoring in the relevant language subject, plus a teacher training qualification. From 2004 onwards, language teachers that did not have the appropriate qualifications or training had three to five years to acquire a postgraduate diploma or certificate in education. But it was found that 42% of language teachers at primary and secondary level still lack the proper language level qualification (Lai, 2008).

• In 1997, the Hong Kong SAR implemented mother-tongue Chinese (e.g. Cantonese) teaching in the majority of the secondary schools. All subjects except English will be taught in Cantonese. Thus the opportunity to speak and practise English publicly were dramatically reduced for the majority of secondary school
students - even in English lessons, some Cantonese is used, for example, for giving some explanations.

- The majority of the Hong Kong engineering graduates work in the Chinese operated factories or organizations located in Hong Kong and/or in the Shenzhen areas. The daily communication language is Cantonese in the Hong Kong office and Putonghua and Cantonese if they visit their factory in Shenzhen area.

To improve the effectiveness of the graduate engineers’ communication with a culturally diverse range of people, graduate engineers, whenever possible, should work and socialize with co-workers from different countries, or from different provinces in China with different cultures and dialects. Hong Kong is a multi-national city, engineering managers and graduate engineers should have the ability to communicate well both in English and Putonghua and also work well with all kinds of different nationalities. For future engineering leaders, communicating well and working well with different kinds of people will be crucial to the success of their business.

5.5 Management and the other generic-type skills categories

Both the graduate engineers and the engineering managers rated the management and the other ‘generic-type’ skills categories as the third and fourth priority respectively, among the four basic generic skills categories in this study. The results here indicated that relatively fewer of the graduate engineers and the engineering managers rated ‘management skills’ (37% and 39%, respectively) and all of the ‘other generic-type skills’ listed (26% and 33%, respectively) as important engineering generic skills, when compared to problem-solving and communication skills.
Nevertheless, both the graduate engineers and the engineering managers (8 in 10) ranked the ability to co-operate and collaborate with other colleagues and to work as a team to solve problems as a most important issue in the management skills category. As well, about 7 in 10 of the engineering managers, indicated that the graduate engineers did not have adequate skills for resolving work-based conflicts in the workplace and about half of the graduate engineers agreed that they did not have adequate skills in this area.

In the other ‘generic-type’ skills category, more than 7 in 10 of the graduate engineers and the engineering managers rated the ability to adapt to change as of highest importance. Only about half of the engineering managers indicated that the graduate engineers had the ability to adapt to change. A similar number of the graduate engineers, indicated the same view. The interviews revealed that both the graduate engineers and the engineering managers saw honesty and integrity are as the two most important values that all engineers should have.

Team work, honesty and integrity are considered to be the fundamental requirements for all employees in any organization. In an engineering workplace, usually activities are not conducted by one individual but often require team members to work together and to collaborate to achieve the final goal. In fact, teamwork is a ‘given’ in any organization. Chang (2005) stated that all successful engineers need to be proactive and practise their people skills and to be able to work equally effectively as team leaders or as team members. In Hong Kong, for example, Dragon Airlines has a policy for all its members to be good team members. If individuals are not team players, they will not be hired. In the Nortel Network in Canada, one of the key objectives for every employee is to co-operate and collaborate with others and the outcome is evaluated against its
objective in the annual performance evaluation.

McMasters (2003) stated that engineering is usually practised in a broad context and requires all other individuals, who possess different skill sets, to work as a team and to integrate their skills and complete the task in a professional manner. One interviewed engineering manager commented: integrity and ethical issues play an important role in his organization, whereas ‘knowledge’ and ‘technology’ can be ‘purchased’ in an organization. It was seen that business ethics and an individual’s integrity are the fundamental components of a successful organization. However, the results here indicated that the graduate engineers did not have completely adequate skills in the management and the other ‘generic-type’ skills categories. These inadequacies included the ability to resolve conflicts, particularly in dealing with people and a lack of positive attitude towards the work environment. One engineering manager said he would prefer to employ graduate engineers who possessed a positive attitude towards work and life.

It appeared that the ‘whole person’ development in university education had not kept up with the trend towards more teamwork in industry. This view was put forth by Forestier (2006) who stated that schools should not operate in isolation but had to work with many stakeholders in preparing their students as individuals and as team leaders.

The concern about the graduates’ ability to work in teams and resolve work-based conflicts are real challenges for university and industry. The results of this study are supported by other studies. A study conducted by Magee (2003) on the assessment of attributes (generic skills) for the new graduate engineers working at Boeing Aircraft Company in the United States, indicated that the new graduate engineers were rated grade D on teamwork and leadership skills and grade D- on the application of
‘domain-specific knowledge’ and experience. These relative low scores, exposed the lack of the basic generic skills of many graduate engineers to carry out their activities effectively in the United States.

In the current higher education system in Hong Kong, the assessment system and the grading criteria create a system that rewards competitive, individual results and continually encourages students to work alone. The current ‘work-alone’ attitude of students might be difficult to change unless the students are encouraged further to develop team-people skills at university. To promote the co-operative and collaborative spirit among students in university, perhaps certain curricula, could be modified so that more assignments are conducted in group environments. Students performances could then be assessed in two components: one as an individual mark, the other as a group project mark. Group projects, hopefully, could help students to develop their abilities to interact with others and work together to achieve group project goals.

The survey results of this study indicated that both the graduate engineers and the engineering managers perceived the ability to adapt to change to be an important factor in the workplace. However, the results also indicated that both the graduate engineers and engineering managers were concerned about the present inadequacy of this skill among recent graduates. With globalization and the advances in technology, change is unavoidable and is a part of everybody’s life. As Chambers (Bryne, 2000) stated, companies that are successful will have cultures that thrive on change, even though change makes most people uncomfortable. Creating positive changes in organizations is not an easy task. Change involves complexity, uncertainly, anxiety, and risk.
More than one academic staff members commented during interview, indicated that the majority of the graduates nowadays in Hong Kong appeared not to have the positive attitudes and the ability to easily adapt changes. These comments coincided with the outcome of one study conducted by the Hong Kong Youth Society in Hong Kong (Gan, 2006), whose findings indicated that more than half of the employers (in retail, finance and services) in Hong Kong were not satisfied with new graduates in the areas of ‘self-discipline’ and in the areas of ‘work under pressure’. Similar comments were also received from engineering managers. Another interviewed manager stated that the lack of a ‘can do’ attitude might hinder graduate engineers’ future career advancement. They believed that ‘self-discipline’ and a ‘can do’ attitude are a key to future success.

5.6 The general adequacy of the generic skills of the graduate engineers

Both the graduate engineers and the engineering managers were requested to answer one question in the affirmative or the negative, regarding the general adequacy of the overall knowledge and skills at the end of each generic skill type category.

The results indicated, on average, that about 60% to 70% of the graduate engineers perceived that they had adequate overall knowledge and skills in the generic skill categories of communication, problem-solving and management. Less than half of the graduate engineers, however, perceived that they had adequate overall knowledge and skills in the other ‘generic-type’ skills category in performing their duties in their workplaces.

The results also indicated that the engineering managers perceived that the graduate
engineers, on average, generally had adequate overall knowledge and skills relevant to these basic generic skills categories. Six in 10 of the engineering managers rated the graduate engineers as having adequate overall knowledge and skills in communication, 7 in 10 of them thought that they were adequate on problem-solving, with 6 in 10 for the management skills categories. The engineering managers rated the perceived adequacy of the graduate engineers higher in the other ‘generic-type’ skills category. Here 8 in 10 of the engineering managers indicated that the graduate engineers were adequate on these overall knowledge and skills.

Although the engineering managers and over half of the graduate engineers had indicated a ‘Yes’ rating for the overall adequacy on the knowledge and skills over the majority of the generic-type skill categories, yet, graduate engineers and engineering managers indicated that they had concerns about specific areas in each category. As previously explained, the engineering managers and the graduate engineers often had concerns about the current graduate engineers’ ability to communicate effectively in both English and Putonghua, their problem-solving skill, their ability to make sound decisions, demonstrating their leadership and having a positive attitude towards co-workers and work environment.

The majority of previous studies (Brumm, 2006, Comer, 1987, Dearing, 1997, EMB, 2000, Hong Kong Economic Journal, 2007, Gan, 2006 and McMaster, 2003) on generic skills indicated only the employers’ view of the adequacy of the graduates’ performance in their workplace but in those studies there was no evidence from the graduates’ own view. In this study, the researcher attempted to identify the perceived adequacy from both groups’ viewpoints (employers and the graduate employees) and this allowed the perceived adequacy of the graduate engineers’ overall knowledge and
skills to be tested against that of their managers.

The graduate engineers' perceived their adequacy of the overall knowledge and skills in the generic skills categories, might be due to limited exposure and experience to the complexity of engineering problems in the real working environment.

Possible reasons for the engineering managers' perception of the overall somewhat poorer perceived adequacy of the generic skills of the graduate engineers could be because:

- All the graduate engineers had gone through the interview process before they were hired for their jobs. These graduate engineers might be hired by their managers and their managers then believe that these graduate engineers should be the better candidates when compared to those who failed the interview.

- As the graduate engineers are junior staff in the organization, as long as they have completed given tasks assigned by their supervisors, managers usually consider them to have accomplished the task, even if the task was not perfectly executed. Managers usually do not consider the time and support they provide to graduate engineers to complete a task.

- Since the majority of the graduate engineers work under the supervision of their engineering managers and are considered as 'under training' in their organization, their managers should have a better understanding about their strengths, weaknesses and future potential. For the majority of these graduate engineers, as long as they work 'reasonably' well in their workplace, the engineering managers may consider that their performances are acceptable and will therefore, rate them as satisfactory in their positions.
The results of this study indicated the engineering managers in Hong Kong appeared 'courteous towards' and 'tolerant' of the graduate engineers' limited ability in performing their duties. The comments of the engineering managers towards the graduate engineers reflect a typical Chinese upbringing and culture: Chinese people seldom point out others mistakes in front of others in social functions. Therefore, when engineering managers were requested to rate the overall adequacy of the knowledge and skills of the graduate engineers in their workplaces, the results indicated the engineering managers tended to rate their graduate engineers as 'satisfactory' on their overall assessment for the four basic generic skill categories. This, however, was not necessarily the case, when they rated the adequacy of each of the specific generic skill categories. The researcher believes that when engineering managers assess their individual graduate engineer's annual work performance, they may highlight all their individual graduate engineer's generic skill deficiencies in the report as they did when they assessed the specific generic skills of the graduate engineers.

5.7 Perception of adequacy and usefulness of the learned knowledge and skills of the graduate engineers

In this study, the second major objective was to identify the perceived adequacy and usefulness of the graduate engineers' university learned knowledge and skills. This objective related to the graduate engineers only. The majority of the surveyed graduate engineers thought that all of their academic, personal development, enterprise skills and their generic skills had improved since starting their university education and they perceived that they had adequate generic skills basically to cope with the activities in their workplace.
The results reported here, indicated that the graduate engineers’ learned knowledge and skills, acquired over the three years of university, on average, were perceived to be ‘adequate’ to support their workplace operational requirements. The graduate engineers tended to have positive attitudes towards their learning outcomes, assessment and the teaching quality of their university course in general. Nine out of 10 of the graduate engineers, indicated a high degree of agreement with the statements about encouragement ‘to learn independently as an individual’, to ‘engage in team building and collaborative learning’ and that the ‘subject content was substantial and useful’.

When graduate engineers were requested to indicate the usefulness of the university learned knowledge and skills, 8 out of 10 of the graduate engineers indicated that their teachers’ encouragement for them to learn independently and individually was very useful later in the workplace. This demonstrated that the universities do try to encourage students to work as a team as well as also to learn independently as an individual. More than three-quarters of the graduate engineers surveyed indicated that both the subject material and their engagement in team building and collaborative learning had been deemed to be substantial and useful in the workplace. After working in industry for two to three years, these graduate engineers actually realized the importance of the university study areas that supported their activities in the workplace. For example, the training from learning independently at university later helped them to work independently in the workplace.

However, some of the graduate engineers were critical of certain aspects of their engineering educational experience. Some of their dissatisfaction could be associated with the part-time teaching staff and the changes of teaching methods. Only two-fifths
of the graduate engineers indicated that that material taught was adequate in certain of their university subjects. For example, the application of technology to work-related operations. The inadequacy of practicing engineering in the workplace by graduate engineers was also echoed by the engineering managers in the interview. Only 4 in 10 of the engineering managers perceived that the graduate engineers had the relevant engineering knowledge and skills for performing their duties in the problem-solving skills category.

Employing part-time teaching staff would save resource and money for the university, but obviously it provided graduate engineers with an impression of less feedback or contacts. It was suggested that in future, each subject should have one full-time academic staff as the subject leader to co-ordinate the teaching activity. If more than one teaching staff member (either part-time or full-time) is assigned to a subject, the subject leader should co-ordinate with the teaching team to work out the teaching material and develop the subject teaching plan. The subject teaching plan could then be discussed with the students at the first lecture. This simple proposal could greatly improve the teaching and learning process for the students.

Another concern expressed by the graduate engineers in this study was about the adequacy of the subject content applications, particularly in the applications of product design, jigs and tools design. Some of the manufacturing subjects were eliminated due to changes in the Hong Kong local economy. Instead, new technical subjects, such as Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM) were added to the program. These new technical subjects provide more theory than the traditional practical ‘paper and pen’ approaches. The introduction of computer-based learning packages is another change in learning methods. The lack of
actual practical applications of the learned CAD/CAM tools in real industrial environments may be difficult for students to later apply these tools in the workplace. However, if students had the opportunity to take part in the summer placement or internships in industry, they would surely benefit more than just learning using a computer. It would be most desirable for the university to work together with industry and seek support from industry for summer placements or internships for engineering students so that they can have opportunities to be exposed to and gain working experience using the actual operational procedures in industry.

Specific variables from the so called other ‘generic-type’ skills category, such as adaptation to change and ethics however, are not usually taught in class. Polytechnic University in Hong Kong, currently, is more focused on engineering professional ethics and the global changes that affect the employment of its engineering graduates. For example, in a course called ‘The Society and the Engineer’, a team consisted of four engineering students were challenged with the application of profession practice on a work-related project, at the end of the course, students were required to produce a report with recommendation based on their analysis of the engineering ethics of their chosen work-related project. The revision of the teaching method of this course could help engineering students to have a better understanding of the practice and ethics issues in the workplace. It also helped to develop essential skills such as team working – skills highly valued by the employers.

Some of the concerns raised by the graduate engineers in this study cannot be solved by simply increasing curriculum content but require new approaches to teaching, learning and assessment. Some topics related to problem-solving, communication, time management, professional ethics, productivity and efficiency cannot be taught
just in lecture rooms but can only best be experienced in a real working environment. The importance of these topics must be reinforced and practised during the entire university educational process. Summer training, work-integrated education and sandwich courses could help to serve the purpose of practical applications.

Graduate engineers’ general technical knowledge, such as numeracy skills, computing and writing skills, is heavily influenced by the subjects they had studied. The highest levels of improvement in the skills, traditionally highly valued by employers, took place among those graduate engineers most in need of them: the new labour-market entrants. Thus, graduate engineers’ generic skills, which will equip them not only for a specific workplace but for a working life, should progress as a result of their experience in higher education and lifelong learning. Some of the graduate engineers commented that they needed to continue their postgraduate study on a part-time basis to further their career and to continue their professional development after graduation. Brahrami (1992) advises employees from the point of view of the employer, that they own their career and that employers should provide them with future learning opportunities.

Engineering managers indicated in this study, that some graduate engineers were lacking the positive and pro-active attitudes required to solve problems. These engineering managers indicated that the graduate engineers would later need to take up leadership roles and face any challenges put in front of them. Some engineering managers offered their time or would be prepared to share their industrial experience and talk to university students and some even offer summer job placements so that engineering students could have opportunities to face the real challenges in the actual industrial environment. The positive support offered by the engineering managers in
this study if tapped, perhaps could help to bridge the generic skill gaps between university education and industry requirements even while these young people are still at university. During the academic individual interviews, academic staff also commented that students certainly needed to further develop their curiosity and eagerness to acquire generic skills, particularly in areas and topics which cannot be taught directly. To create this curiosity and eagerness to learn requires the efforts of both academic staff and students. Self-learning, problem-based learning and group project modules are some excellent examples of teaching approaches that it has been shown, can change students' learning attitudes and improve their analytical skills, teamwork and problem-solving abilities (Nakavachara, 2001; Soden, 1994).

A university education surely is not only about transmitting technical knowledge and skills to engineering students. This education should also provide students with general generic-type skills and valued professional attitudes so that they can face the challenges of the workplace. The Vice President of the City University of Hong Kong (Clem, 2004), has stated that the depth of knowledge in a specific discipline remains important but it is no longer sufficient. A university needs to prepare students for worldwide employability. He noted that generic skills that cut across disciplines are the key, especially the ability and motivation to learn. The generic marketable skills learned at university will enable graduate engineers to be more flexible in the employment market and further improvement in generic skills is the route to achieving further marketable skills and career advancement.
5.8 Approaches to enhance the generic skills of the graduate engineers

Another but lesser objective of this study, was to develop a list of recommendations for changes in engineering curriculum design in Hong Kong, to help to improve the teaching and learning process in the generic-type skills area. Many of the generic skills that have been considered in this study such as communication, problem-solving, management, team building, ethics, attitude and value are considered as non-technical in engineering education. The development of these generic skills is often compromised in favour of technical or science-based skills.

Indeed, in order to promote and improve the basic generic skills to students in Hong Kong, the Hong Kong Education Commission (2000), suggested that generic skills should be part of the tertiary education system and should be included in the curriculum design to achieve all-round education and lifelong learning. To respond to the Commission’s suggestion, the Hong Kong Polytechnic University, for example, has modified its engineering course curriculum design to help students work on whole-person development, besides gaining technical knowledge. The subject syllabi of these courses have been modified to include the expected learning outcomes of the generic skills based on the PolyU’s set of generic skills. These include global outlook; critical and creative thinking; social and national responsibility; cultural appreciation; lifelong learning; biliteracy (English and Chinese), trilingulism (English, Putonghua and Cantonese) and entrepreneurship and leadership.

To enhance communication in English for all university students, PolyU also developed a complementary subject (no credit bearing) to improve communication in English in the English Centre. All engineering students have to take the
university-developed Graduating Students’ Language Proficiency Assessment (GSLPA) test in Chinese and English as the required language proficiency exit test before graduation. In other places, universities, such as the State University at Buffalo in the United States and McGill University in Montreal, Canada have also developed credit electives courses to address the topics of ‘Technical Communication for Engineers’, ‘Problem-solving and Decision Making’ and ‘Empowering Your Technical Language’.

Some universities in Australia have also taken a lead and have made changes in their engineering programmes to include generic skills as part of the graduate attributes. For example, Griffith University has developed a toolkit to help academic staff with practical strategies for embedding generic skills such as communication, problem-solving, information literacy and teamwork into the engineering curriculum design. The University of Queensland has developed statements of graduate attributes for all its undergraduate engineering programmes to ensure graduates will be able to communicate ideas more clearly and effectively, be able to learn and work independently and have the ability to make decisions. The University of South Australia even goes one step further and requires the curriculum documentation to indicate what component of student time per subject will be allocated to the development of certain generic skills.

The University of Technology, Sydney (UTS) identified generic skills (communication, analytical, problem-solving skills) within the discipline of engineering and introduced them into the curriculum for a whole-degree programme. The communication and the analytical skills were part of the generic skills built into the project assignments. For example, the UTS engineering students need to analyse a
given problem for an assignment, prepare a proposal and present the solution and recommendation in front of a panel (academic staff and industrial representatives) and answer any queries from the panel judge. These types of built-in generic skills in the engineering curriculum design should enhance a graduate student’s generic skills before he/she joins the workplace. This new learning experience, it is hoped, will create a new generation of graduate engineers, who are technical competence, continuous their learning interests and nurture their personal values with positive attitudes towards work and life.

5.9 Engineering education needs support from industry

Concerns regarding the inadequacy of generic skills of the graduate engineers were raised by managers from the industry in this study, yet the industry too can help to narrow these skill gaps by providing opportunities for students to work in placements in their organizations. Companies should also realize that here they are part of the solution. Motorola Asia Pacific Manager of University Relations in Hong Kong (Kir, 2004), Kir stated that with the future of the Asia-Pacific region pointing to growth, universities are keys to sourcing the top talent in the market. Development and upgrading of the skills of graduates should also be the responsibilities of industry. Industry must work together with universities to assure that the mutual needs are met to cope with changes arising from Hong Kong’s economic development and progress. The individual interviews with engineering managers in this study also echoed the view that at least some parts of the industry would like to support engineering education and help to enhance students’ learning experience during their university education. Industry could offer its support and provide more opportunity for:

- Industrial-based Final Year Project
Work-Integrated Education (WIE)

Sandwich Programs

The Integrative Studies in Product Design or Enterprise Systems and Management

Guest speakers

Industrial visits

Some corporations in Hong Kong and China have already started to offer their support in engineering education by offering job-related placements for engineering students, either in terms of industrial-based projects, summer placements or sandwich programmes. The same exist in Australia, Canada, Germany, the Netherlands, Sweden, the UK and the US. These industrial-related programmes, such as work-integrated education (WIE) and sandwich programmes, expose students to the real working environment (in a factory, or an engineering department for engineering disciples) for a certain period of time and provide invaluable practical experience in their study-related field with an insight into business and a better understanding of how it operates. Some other supports, such as providing industrial scholarships, guest speakers or mentors of students and inviting students to visit their manufacturing facilities, could definitely help engineering students to become more familiar with the current processes and the general industrial requirements. These suggestions were included in the responses made by the graduate engineers, engineering managers and the academics in their focus group discussions/interviews in this study.

5.10 Concluding comments

The main objectives of this study were the identification of the importance of the key generic skills of the graduate engineers and the engineering managers and their
perceived degree of the adequacy of the learned knowledge and skills of the graduate engineers. A list of recommendations for changes in engineering curriculum design for further enhancement were also proposed to improve the teaching and learning in university engineering education. Most of the graduate engineers surveyed in this study had studied previously in the Department of Industrial and Systems Engineering (ISE) of the Hong Kong Polytechnic University and they had been working in various industrial sectors for the last two to three years in Hong Kong or in Mainland China. Given the limited sample size used for both graduate engineers and engineering managers, it was not possible to generalize to a wider population with confidence.

The majority of the previous studies on the graduate engineers’ generic skills were results from surveys of the employers, very few had addressed the views of the current employed graduate engineers themselves. This study attempted to measure the feedback from both the graduate engineers and managers in their workplaces. The general consistency of the responses across all of these two groups (except the different perceptions of the importance and the adequacies of generic skills) was an encouraging sign that it would likely be worthwhile to assess the broader applicability of this survey’s results in other places or in other countries.

In general, most graduate engineers appeared to have gained a great deal from their time in higher education. They had been exposed to a wide range of experiences, which they valued. The majority of the graduate engineers generally indicated that their learned knowledge and skills at university were useful in the workplace. Of course, the graduate engineers also quickly became aware of their deficiencies after employment and understood that they needed to be ready to meet the future challenges related to the application of new technologies as well as further enhancing
relevant generic skills. To be successful in their futures, some graduate engineers stated that they would continue a learning process to upgrade their knowledge and skills. Some will continue their postgraduate study on a part-time base to further their careers. The positive attitudes of the graduate engineers in this study, overall demonstrated great future career opportunities for them. In this lifelong learning society, continuous learning is a must. As an old Chinese idiom says that 'Learning is just like rolling a boat against the current of the Yangtze River; if it does not move forward, it will move backward'.

Chang (2005) suggested that graduate engineers must acquire the minimum survival generic skills for the current century. These include marketable skills to offer value above and beyond what other engineers and managers elsewhere can offer, demonstration of leadership, in both technology and management planning and perspectives with global orientation, maintaining good networks and being effective in problem-solving and communication skills. Therefore, lifelong learning is a must for the graduate engineers to enhance both their technological and generic skills.

Chang’s minimum generic skills kit for graduate engineers was echoed by the Hong Kong engineering managers in this study. It was indicated by the majority of the engineering managers in this study, that they would prefer to have graduate engineers with: (a) A good education – preferably a relevant first or second degree and qualifications for engineering and management disciplines. A willingness to continue education and desire for lifelong learning; (b) An ability to adapt to different working roles with a far-sighted view of career and ambitions; (c) Good interpersonal skills for both internal and external customers and the ability to be team players; (d) Communication skills, especially English, Cantonese and Putonghua and presentation
skills. International awareness and cultural knowledge and (e) The highest standard of professionalism and ethics.

With the new education reforms in Hong Kong, future graduate engineers both here and in China, will need to equip themselves with the required generic skills to better meet industry needs. The skills and knowledge that graduate engineers gain at university must help them to serve the business and industrial sectors as well as improve Hong Kong’s engineering competitiveness in a globalized society.

We are living in a period of accelerating change. The changes affect the employability of graduate engineers and universities must take a leading role and design their curricula to satisfy new requirements. It is clear that business and industry seek to employ graduates who have the technical knowledge and skill as well as a variety of generic skills and personal attributes. Enhancing generic skills through higher education not only improves the quality and employability of graduate engineers but also supports the new requirements of the 21st century.

5.11 Recommendations for further studies

This study is an attempt to have better understand of the perceived importance of the generic skills by both the graduate engineers and their managers. The study also allowed the graduate engineers to evaluate their own adequacy of the generic skills in their workplaces by comparing them with their supervisors (engineering managers) perceived adequacy of their performance at work. This study can be enriched and strengthened by further research in the following areas.
1. Extend the study to all manufacturing and industrial graduate engineers from other Hong Kong universities.

There are eight universities in Hong Kong with five of these universities offering manufacturing and industrial engineering degree programmes. A future survey should cover all graduate engineers graduated in those five universities. The result could provide more extensive overall view of the perceived importance and the adequacy of all graduate engineers in Hong Kong. This would be especially important for the Hong Kong Education and Manpower Bureau (EMB) for designing and developing a blue-print for further development of engineering education in Hong Kong.

2. Extend the study to all engineering disciplines of graduate engineers (civil, mechanical, electrical and others) in Hong Kong. The sample size and resource requirements here would be enormous. The study could be conducted with the support of Hong Kong EMB.

3. Compare the study of graduate engineers in Hong Kong with a study of graduate engineers in other countries. Such a study could compare the general generic skills outcomes of graduate engineers in various countries to demonstrate the relevance and applicability of engineering curriculum design in the various engineering disciplines.

4. A study of the cultural influences on engineering graduates in their working environment.
References


Accreditation Board of Engineering and Technology (ABET) 2000, Engineering Criteria: Criteria for Accrediting Programs in Engineering in the United States.


Australian National Training Authority 2003, National Centre for Vocational Education Research Ltd (NCVER), Adelaide, SA5000.


Beck L 2006, Graduate discover the real world doesn’t rely on theories, South China Morning Pos, Hong Kong, July 8, pg. E4.


Bennett, N., Dunne, E & Carre, C 2000, Skills development in higher education and employmen, Open University Independent International publisher.

Beresford, J 2003, Developing students as effective learners: The student conditions for school improvement, School Effectiveness and School Improvement, vol. 14 no. 2, pg. 121 -158.

Biggs, J 1992, Why and how do Hong Kong students learn, The Faculty of Education, University of Hong Kong Press.


Chan, M 2004, A liberal helping of life skills, *South China Morning Post, Hong Kong*.  

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Chang, L 2004, Structural reform overdue but wisdom of new tests is doubtful, *South China Morning Post, Hong Kong*, November 27, pg. E5.

Cheng, J 2005, Hong Kong's university challenge, *South China Morning Post, Hong Kong*, June 17, pg A19.


Comer, J. J 1987, An investigation into the skills necessary for the success of newly graduated engineers in industry, PhD Thesis, University of Illinois at Urbana-Champaign.

Conference Board of Canada 2000, *Employability skills 2000+*, Canada, 


Cremer, J 2005, Profession faces challenging times: Firms must build links with academic world, *South China Morning Post, Hong Kong*, Nov 26, Pg 14.


Davis, C 2005, Experience helps to win that first job, *South China Morning Post, Hong Kong*, Feb 19, Pg S13.


Editor, 2004, Education shake-up must be made to work, *South China Morning Post, Hong Kong*, Oct 21, pg. A14.


Forestier, K 2006, Educators warned to be aware of new role, *South China Morning Post*, Hong Kong, June 24, pg. E3.


Fullan, M 2004, Creating leaders is true measure of leadership, *South China Morning Post*, Hong Kong, Sept 25, Pg E4.


Griffith Institute for Higher Education (1994), Evaluation subjects and Teaching to
Improve Student Learning: A Quick Guide with Selected Questionnaires and Item Banks for Obtaining Student Feedback. Nathan: GIHE.

Gyopos, S 2005, Secrets of good leadership, *South China Morning Post, Hong Kong*, September 3, pg. 56.


Heron, L 2004, A single exam to cut back on stress, *South China Morning Post, Hong Kong*, Nov 27, Pg. E5.

Heron, L 2005, Degrees get flexible with a 'pick and mix' approach, *South China Morning Post, Hong Kong*, March 5, Pg. E3.

Heron, L 2005, Universities take a global approach, *South China Morning Post, Hong Kong*, November 12, Pg. E3


HKSAR (various years). Census and Statistics Department, Quarterly survey of employment and vacancies.


Humphrey, P 2005, Ethical differences carry risks, *South China Morning Post, Hong Kong*, September 3, pg. 42.


Kelly, F 2001, *Definition and selection of key competencies in New Zealand*, Retrieved from


Kir, G 2004, Motorola finds key partner in academia, *South China Morning Post*, Hong Kong, July 3, pg. 42.


Lau, L 2004, Inauguration speech, Chinese University of Hong Kong, *South China Morning Post*. Hong Kong.


Lee, W.B 2004, *Future of Engineering Education in Hong Kong Forum*, The Hong Kong Polytechnic University, Faculty of Engineering (unpublished paper).

Leung, T. P 2005, *Education quality work: The Hong Kong experience*, Education Development Centre, The Hong Kong Polytechnic University, Hong Kong.


Macdonald, R and Wisdom, J 2002, Academic and educational development, Kogan
Page Ltd., Publisher.
industrial/academe perspective. Int. J. Engineering Education, vol. 20, no. 3,
pg.341-352.
Man, W. K 2007, Outcome-based education, Sing Tao Daily News, Hong Kong, May
2, pg. F2.
Margetson, D 1994, Current education reform and the significance of problem-based
Martin, D 2006, Culture holds the key to an engaged staff, South China Morning Post,
Hong Kong, January 14 pg. 24.
Martin, J. M 1993, The successful engineer: Personal and professional skills - a
Metcalfe, T 2005, Smart business needs smart staff, South China Morning Post, Hong
Kong, Nov 26, pg. 7.
McMaster, J. H ,2003, Influencing engineering education: One (aerospace) industry
Mgangira, M. B 2003, Integrating the development of employability skills in a civil
engineering core subject through problem-based learning approach, Int. J.
outcomes in a software engineering problem-based learning course, Int. J.
Mok, K H 2006, Education reform and education police in East Asia, Routledge,
Milton Park, Abingdom, Oxon OX14 4RN.
Morgan, C and Morris, G. 1999, Good teaching and learning: Pupils and teachers
speak, Buckingham, Philadelphia, Open University Press.
Morgan, D 2006, Upgrading skills is crucial to your career, South China Morning
Post, Hong Kong, June 3, pg. 36.
Nakavachara, C 2001, Facilitating learning and teaching in engineering education: A
problem-based approach, PhD Thesis, Graduate School of Vanderbilt University,
Nashville, Tennessee.
Naples, L. M 1996, Outcomes-based evaluation for educational program in
engineering: A focus on the construction industry’s needs, PhD Thesis,
Engineering & Public Policy Department, Carnegie Mellon University,
Pittsburgh, Pennsylvania.
National Research Council (NRC), 1985, *Engineering education and practice in the United States – Foundations of our techno-economic future*, Published by NRC.

Nedeljkovic, Z 2006, Shortage of talent hinders growth, *South China Morning Post, Hong Kong*, January 14 pg. 23.


The Organization for Economic Co-operation and Development (OECD), 2005, Education Ministers.


Foundation.
Rodwell, R 2005, Broadening their horizons, South China Morning Post, Hong Kong, Nov 26, pg. 42.
Shea, J. E 1997, The role of industry and university, South China Morning Post, Hong Kong, July 3, pg. 42.
Smith, C. K 2004, Rethinking an engineer’s education, Electronic Engineering Times, Apr 5, 1315; ProQuest computing, pg. 59.
Sun, Q 2001, Internet-based distributed collaborative environment for engineering
education and design, PhD Thesis, Graduate Faculty, the University of Oklahoma, Graduate College.


Todd, R.H., Sorensen, C.D and Magleby, S.P 1993, Designing a capstone senior course to satisfy industrial customers, *Journal of Engineering Education*, vol. 82, no. 2, pg. 92 - 100.

Tong, N 2006, Funding fears for night classes, *South China Morning Post, Hong Kong*, April 1, pg. E3.


Tong, N 2007, Decline in English standards ‘alarming’, *South China Morning Post, Hong Kong*, May 5, pg. E3.


Winkelman, P 2001, Beyond Science: An Exploration of Values in Engineering Education and Practice, PhD thesis, Department of Mechanical and Manufacturing Engineering, University of Calgary, Calgary, Alberta, Canada.

Wong, C 2007, Four-year programme seen as a bonus, *South China Morning Post, Hong Kong*, March 20, pg. S2.


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Appendix 1 Invitation letter and questionnaire for the graduate engineers

Faculty of Education
City campus Broadway
PO Box 123
Broadway NSW 2007 Australia

Dear .............,

My name is Raymond Wong, and I am a Doctor of Education Degree student at the University of Technology, Sydney, Australia.

I am conducting a study to better understand the importance of the generic skills in industry, and the adequacy of the learned knowledge at university for engineering graduates. I am seeking your support for this research. The questionnaire will take no more than 15 minutes to complete.

If you are interested in participating, I would be grateful if you would complete the questionnaire, and return to Raymond Wong either by fax, or email.

You are under no obligation to participate in this study.

Thank you very much in advance for participating in this study. If you have any concerns about this study, please feel free to contact the undersign or the Hong Kong local independent contact: *A/Prof. Chi-Kwong Li, The Hong Kong Polytechnic University, Email: enckli@polyu.edu.hk, Phone: (852) 2766-6218.

*(Dr. Li is an independent local contact person not affiliated with the University of Technology, Sydney).

Yours sincerely,

Research Student:
Raymond Wong,
Email: mfrwong@polyu.edu.hk
Tel: (852) 2766-6593
Fax: (852) 2362-5267

Principal Supervisor:
A/Prof. R. Pithers,
email: bob.pithers@uts.edu.au
Tel: 61 2 9514 3819
Fax: 61 2 9514 3939

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the research, you may contact the Ethics Committee through the Research Ethics Office (ph:61 2 9514 9615, Research.Ethics@uts.edu.au) and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

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Questionnaire for Engineering Managers

On the following pages are a number of questions about the general generic skills in industry. Based on your observations and knowledge, please give your view that would apply to your situation in your organization.

Your answers are ANONYMOUS and CONFIDENTIAL.

Instructions:
In the following Section (1), you will see a series of short statements grouped into a particular category.

You are requested to respond to each of this statement into two criteria:
First you are requested to rate the importance of each statement of the generic skills in your workplace in Column A. Then, you are asked to rate the adequacy of these generic skills of your graduate engineers (engineers graduated in 1 or 2 years) in your organization in Column B.

Please circle in each statement of the number of your preferred response in Column A and the letter of your preferred response in Column B.

Section (1)

Assessment of the Importance of Generic Skills

In Column A, to what extent do you rate the importance of the generic skills needed in your workplace?

1 – Low importance (L)
2 – Moderate importance (M)
3 – High importance (H)

In Column B, to what extent do you rate the adequacy of the generic skills of your graduate engineers (engineers graduated in 1 or 2 years) in your organization?

A – Adequate (A)
L – Less than Adequate (L)
**Communication skills:**

<table>
<thead>
<tr>
<th></th>
<th>Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Communicate effectively in English</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>2. Communicate effectively in Putonghua</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>3. Communicate effectively in written Chinese</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural diversity people</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
</tbody>
</table>

**Overall, my rating of graduate engineer on communication skills category is adequate.**

---

**Problem-solving skills:**

<table>
<thead>
<tr>
<th></th>
<th>Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Knowledge of global outlook and engineering practice</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>6. Creative and diversified thinking</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td>7. Effective analysis of different types of data</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td>8. Effective evaluation of engineering options, and selection of the optimal solution</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>9. Using technology effectively in the workplace</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
</tbody>
</table>

**Overall, my rating of graduate engineer on problem-solving skills category is adequate.**

---

**Management type skills:**

<table>
<thead>
<tr>
<th></th>
<th>Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Effective member of a group or a working team</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>11. Resolving work based conflicts</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>12. Effective organizing and coordinating tasks to achieve project goals</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>13. Co-operate and collaborate with colleagues</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
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<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>15. When a problem occurs, be prepared and engaged with others to seek solutions</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>16. Effective control of budget</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>17. Effective management of time</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>18. Effective administration and record keeping</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
<tr>
<td>19. Independently explore new information and solutions to workplace problems</td>
<td>1 2 3</td>
<td>A L</td>
</tr>
</tbody>
</table>
Overall, my rating of graduate engineer on management skills category is adequate. ......................................... Yes No

Other type competency skills:
20. Relevant engineering knowledge and skills.. ............ 1 2 3 A L
21. Adapt to change (e.g. new ideas, technologies, procedures or job demands). ................................. 1 2 3 A L
22. Project an enthusiasm and positive attitude towards fellow workers and work environment. ............... 1 2 3 A L
23. Possess integrity and act with high ethical standard. ... 1 2 3 A L
24. Adhere to the type of standard set by an engineering professional body (e.g. Hong Kong Institute of Engineers). .................................................... 1 2 3 A L

** Overall, my rating of graduate engineer on others skills category is adequate. ........................................... Yes No

Now considering your work from Section (1), rank the priority into 1, 2, 3, 4 (1 = lowest, 4 = highest) of the perceived importance of the following categories.

Communication skills; ........................................... __________
Problem-solving skills; .................................... __________
Management related skills; ............................... __________
Other type competency skills.............................. __________

Section (2)

Please answer the following questions.

1. Your position and major products or services provided by your organization.

__________________________________________________________________________

2. Based on your observation and knowledge of graduate engineers (engineers graduated 1 or 2 years) in your organization, what generic skills do the graduate engineers need in order to be successful in industry?

__________________________________________________________________________

__________________________________________________________________________
3. Any training programs in your organization for graduate engineers to improve their generic skills?  
   Yes  No  
   If Yes (List below):

   ________________________________
   ________________________________
   ________________________________

4. Any recommendations to the design of engineering curriculum for future engineering education?

   ________________________________
   ________________________________
   ________________________________
   ________________________________

Any questions should be forwarded to:

Raymond Wong,  
The Hong Kong Polytechnic University,  
Hung Hom, Kowloon, Hong Kong.  
Email: mfrwong@polyu.edu.hk  
Phone: (852) 2766-6593  
Fax: (852) 2362-5267

Hong Kong independent contact:

* A/Prof. Chi-Kwong Li,  
The Hong Kong Polytechnic University,  
Hung Hom, Kowloon, Hong Kong.  
Email: enckli@polyu.edu.hk  
Phone: (852) 2766-6218  
Fax: (852) 2362 8439

*(Dr. Li is an independent local contact person who is not affiliated with the University of Technology, Sydney)*
Appendix 2  Invitation letter and questionnaire for the graduate engineers

Faculty of Education
City campus Broadway
PO Box 123
Broadway NSW 2007 Australia

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If you are interested in participating, I would be grateful if you would complete the questionnaire, and return to Raymond Wong either by fax, or email.

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Yours sincerely,

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Questionnaire for Graduate Engineers

On the following pages are a number of statements about the general generic skills that may be useful when working in the industry. Some or all of these may have been taught during your university courses.

Based on your observations and knowledge in the workplace and your university course, please give answers that would apply to you in your own work situation.

Your answers will be completely ANONYMOUS and CONFIDENTIAL.

Instructions:
In the following Section (1) and (2), you will see a series of short statements grouped into a particular category.

You are requested to respond to each of two criteria placed next to each statement: First in Column A, you are requested to rate the importance of each statement about the generic skills useful in your workplace. Then in Column B, you are asked to rate the adequacy of how well this concept or skill was taught at university.

For each statement, please circle the number of your preferred response in Column A and then the letter of your preferred response for Column B.

Section (1)

Assessment of the Importance of Generic Skills

In Column A, rate the importance of the generic skills in your work place in terms of the following:

1 – Low or of no importance (L)
2 – Moderate importance (M)
3 – High importance (H)

In Column B, rate the adequacy of your learning at university:

A – Adequate (A)
L – Less than Adequate (L)
## Section (1)

Knowledge or Skill (required in your present job)

<table>
<thead>
<tr>
<th>Communication skills:</th>
<th>Col A</th>
<th>Col B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Importance</strong></td>
<td>L</td>
<td>M</td>
</tr>
<tr>
<td>1. Communicate effectively in English.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
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<td>1 2 3</td>
<td>A</td>
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<td>A</td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural divergent people</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td><strong>Overall, my knowledge and skills relevant to communication learned at university are adequate.</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem-solving skills:</th>
<th>Col A</th>
<th>Col B</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Knowledge of global outlook and engineering practice.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td>6. Creative and divergent thinking.</td>
<td>1 2 3</td>
<td>A</td>
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<td>7. Effective analysis of different types of data.</td>
<td>1 2 3</td>
<td>A</td>
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<td>8. Effective evaluation of engineering options, and selection of the optimum solution.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
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<td>9. Using technology effectively in the workplace.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td><strong>Overall, my knowledge and skills relevant to problem-solving learned at university are adequate.</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Management type skills:</th>
<th>Col A</th>
<th>Col B</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Effective member of a group or a working team.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td>11. Resolving work based conflicts.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td>12. Effective organizing and coordinating tasks to achieve project goals.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td>13. Co-operate and collaborate with colleagues.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
<tr>
<td>14. When and where appropriate, demonstrate leadership skills among colleagues.</td>
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<td>A</td>
</tr>
<tr>
<td>17. Effective management of time.</td>
<td>1 2 3</td>
<td>A</td>
</tr>
</tbody>
</table>
18. Effective administration and record keeping. .......... 1 2 3 A L
19. Independently explore new information and solutions to work place problems. ......................... 1 2 3 A L
** Overall, my knowledge and skills relevant to management learned at university are adequate. ................. Yes No

Other type competency skills:

20. Relevant engineering knowledge and skills. .......... 1 2 3 A L
21. Adapt to change (e.g. new ideas, technologies, procedures or job demands). ......................... 1 2 3 A L
22. Project an enthusiasm and positive attitude towards fellow workers and work environment. ................. 1 2 3 A L
23. Possess integrity and act according to a high ethical standard. ......................... 1 2 3 A L
24. Adhere to the type of standard set by the engineering professional body (e.g. Hong Kong Institute of Engineers). ......................... 1 2 3 A L
** Overall, my knowledge and skills relevant to the other skills learned at university are adequate. ................. Yes No

Now considering your work from Section (1), rank the priority into 1, 2, 3, 4 (1 = lowest; 4 = highest) of the perceived importance of the following categories.

Communication skills; .............................................
Problem-solving skills; .............................................
Management related skills; .............................................
Other skills; .............................................
Section (2)

Evaluation of the Learned Knowledge at University.

In Column A, to what extent do you agree or disagree with each of the following statements about learned knowledge as a result of your studying at university. Use the following scale criteria:

1 – Disagree (DA)
2 – Agree (A)

In Column B, to what extend do you rate the usefulness your learned knowledge at university. Use the following scale criteria:

U – Useful
L/U – Less than useful

<table>
<thead>
<tr>
<th>Col A</th>
<th>Col B Usefulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>A</td>
</tr>
<tr>
<td>1. Overall, in my university course:</td>
<td></td>
</tr>
<tr>
<td>a. Content was relevant to my career needs. ............ 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>b. Content was substantial and useful. .................... 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>c. Content had a coherent sequence and well-structured. ........................................ 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>d. Teaching material was adequate and useful. .......... 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>e. The course provided adequate practical application.</td>
<td>1 2 U L/U</td>
</tr>
<tr>
<td>2. My classmates and I frequently engaged and collaborated together on academic tasks or projects. ... 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>3. I was encouraged to learn actively both inside and outside of the classroom. ............................ 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>4. I was engaged in team building and collaborative learning. ............................................. 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>5. I was provided adequate resource to support my learning. .................................................... 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>6. Teachers provided adequate support and feedback. .... 1</td>
<td>2 U L/U</td>
</tr>
<tr>
<td>7. Teachers encouraged students to learn independently. (e.g. from library, or other means). .................. 1</td>
<td>2 U L/U</td>
</tr>
</tbody>
</table>
Section (3)

Please answer the following questions.

1. What major product or service is provided by your organization?

2. Do you have any future plans to attend any specific training programs to improve the sort of knowledge and skill listed in Section (1) (i.e. the generic skills)?
   Yes  No
   If Yes (List below):

3. Do you have any recommendations about engineering education in the future?

Any questions should be forwarded to:

Raymond Wong,
The Hong Kong Polytechnic University, OR The Hong Kong Polytechnic University,
Hung Hom, Kowloon, Hong Kong. Hung Hom, Kowloon, Hong Kong.
Email: mfrwong@polyu.edu.hk Email: enckli@polyu.edu.hk
Phone: (852) 2766-6593 Phone: (852) 2766-6218
Fax: (852) 2362-5267 Fax: (852) 2362 8439

*(Dr. Li is an independent local contact person not affiliated with the University of Technology, Sydney)
Appendix 3 Prepared interview questions for the managers

Engineering managers:

Following is a brief outline of the statements and questions posed to managers at the interview.

Opening statement:

"During a recent survey for engineering managers regarding the generic workplace skills for Graduate engineers, the following findings were identified. I would like to seek your opinion about those findings".

In the engineering managers' questionnaire feedback;

1. Communication skills category

"Engineering managers indicated that communication skills in English and Putonghua are "very important", but that not many graduate engineers employed in industry have adequate generic skills in communication in either English or Putonghua";

Please comment on:

(1.1.) How important are these skills in your industry and why?

(1.2.) How might these skills be improved at university?

2. Problem-solving skills category

"About fifty percent of the engineering managers indicated that graduate engineers did not possess adequate generic skills in solving problems in the work-place";

Please comment on:

(2.1.) Do you agree with the above captioned statement? Can you describe what are the major problems facing your industry?

(2.2.) How can the problem-solving skills be taught at university?
3. Management skills category

"About forty percent of engineering managers indicated graduate engineers' abilities relevant to general management skills learned at university were not adequate".

Please comment on:

(3.1.) What is your opinion about the above results?

(3.2.) Which are the weakest areas of management skills with Graduate Engineers in your work-place?

(3.3.) Does your organization provide training for Graduate Engineers to enhance their management skills?

(3.4.) How can university and industry work together to develop these skills?

4. Other-generic-type skills category

"Engineering managers indicated that the adaptability of changes and projection of positive attitude are very important in the engineering business, yet about fifty percent of engineering managers said they believe that graduate engineers do not have adequate skills to deal with these issues";

Please comment on:

(4.1) Are these skills and the temperament factors important to your industry and why?

(4.2.) How can these skills be taught at university?

5. Any other comments?

(5.1) Are there any other types of generic skills or competencies (like those just discussed but NOT technical knowledge skills) which you think graduate engineers should possess?
Appendix 4  Prepared focus group discussion questions for the graduate engineers

Graduate Engineers

“Based on the graduate engineers’ questionnaire feedback, in the communication skills category, many of the graduate engineers indicated that good communication skill in both English and Putonghua are ‘very important’ in the workplace”;

“How important are these skills in your day-to-day operations and why?”

“How can these skills be improved at university?”

Similar question format would apply to the problem-solving skills, management skills and other-generic-type skills categories.

Other questions were:

In the graduate engineers’ questionnaire feedback;

1. Communication skills

“Many of the graduate engineers indicated that good communication skills in both English and Putonghua are “very important” in the workplace”;

(1.1.) How important are these skills in your day-to-day operations and why?

(1.2.) How can these skills be improved at university?

2. Problem-solving skills

“More than 40% of graduate engineers believe that they do not possess adequate skills in solving problems in the workplace”;

(2.1.) What are the major problems facing you in your daily operations?

(2.2.) Why are problem-solving skills important to you in achieving your objectives?

(2.3.) How can these problem-solving skills be taught or be improved at
university?

3. Management skills

"About 35% of graduate engineers indicated that their learned management skills at university are not adequate";

(3.1.) Can you explain the reason why?

(3.2.) Have you taken any actions to improve these skills?

4. Other-generic-type skills

"More than 70% of graduate engineers indicated that the adaptability of changes and projections of positive attitude are very important, yet more than 40% of them believe that they do not have adequate skills to make changes";

(4.1.) Are these skills and temperament factors important to you and why?

(4.2.) How can these skills be improved through university teaching?

5. Any other comments?

Are there other types of generic skills or competencies (like those just discussed but NOT technical knowledge skills) which you think graduate engineers should possess?
## Appendix 5  Focus group discussion with the graduate engineers

<table>
<thead>
<tr>
<th>Graduate Engineer</th>
<th>Year of Graduation</th>
<th>Title</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2003</td>
<td>Quality Engineer</td>
<td>Plastic Company.</td>
</tr>
<tr>
<td>2</td>
<td>2004</td>
<td>Operation Adm.</td>
<td>Healthcare Products Company</td>
</tr>
<tr>
<td>3</td>
<td>2004</td>
<td>General Manager</td>
<td>(Self employed) Logistics Co.</td>
</tr>
<tr>
<td>4</td>
<td>2003</td>
<td>Mould Design Engineer</td>
<td>Mould Design Company in Shenzhen, China</td>
</tr>
<tr>
<td>5</td>
<td>2004</td>
<td>Marketing Support Engineer</td>
<td>Electro - Component Company</td>
</tr>
<tr>
<td>6</td>
<td>2003</td>
<td>Product Executive</td>
<td>New Product Development Company</td>
</tr>
<tr>
<td>7</td>
<td>2004</td>
<td>Project Engineer</td>
<td>Electronic Component Co.</td>
</tr>
<tr>
<td>8</td>
<td>2004</td>
<td>Industrial Engineer</td>
<td>Toy Manufacturing Company</td>
</tr>
<tr>
<td>9</td>
<td>2003</td>
<td>Project Engineer</td>
<td>Manufacturing Company</td>
</tr>
<tr>
<td>10</td>
<td>2004</td>
<td>New Product Engineer</td>
<td>Appliance Manufacturing Co.</td>
</tr>
<tr>
<td>11</td>
<td>2004</td>
<td>Engineer</td>
<td>Logistics Company</td>
</tr>
<tr>
<td>12</td>
<td>2004</td>
<td>R &amp; D Engineer</td>
<td>Toy Manufacturing Company</td>
</tr>
<tr>
<td>13</td>
<td>2003</td>
<td>Process Engineer</td>
<td>OEM Company</td>
</tr>
<tr>
<td>14</td>
<td>2003</td>
<td>R &amp; D Engineer</td>
<td>Manufacturing Company</td>
</tr>
<tr>
<td>15</td>
<td>2003</td>
<td>Mfg Engineer</td>
<td>Manufacturing Company</td>
</tr>
<tr>
<td>16</td>
<td>2004</td>
<td>Logistics Engineer</td>
<td>Modern Terminal</td>
</tr>
<tr>
<td>17</td>
<td>2003</td>
<td>Quality Engineer</td>
<td>ASM Mfg company</td>
</tr>
<tr>
<td>18</td>
<td>2003</td>
<td>Industrial Engineer</td>
<td>Plastic Co.</td>
</tr>
<tr>
<td>19</td>
<td>2004</td>
<td>Mfg Engineer</td>
<td>ACE Mould Company</td>
</tr>
<tr>
<td>20</td>
<td>2004</td>
<td>QA Engineer</td>
<td>Software Development Company</td>
</tr>
</tbody>
</table>
## Appendix 6  Summary of the graduate engineers’ survey results

<table>
<thead>
<tr>
<th>Item</th>
<th>Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Communicate effectively in English</td>
<td>57 32 11 56 44</td>
<td></td>
</tr>
<tr>
<td>2. Communicate effectively in Putonghua</td>
<td>40 40 20 29 71</td>
<td></td>
</tr>
<tr>
<td>3. Communicate effectively in written Chinese</td>
<td>29 42 29 46 54</td>
<td></td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural divergent</td>
<td>42 51 7 35 65</td>
<td></td>
</tr>
<tr>
<td><strong>Communication skills</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, my knowledge and skills relevant to communication learned at university are adequate</td>
<td>Yes 58 No 42</td>
<td></td>
</tr>
<tr>
<td>5. Knowledge of global outlook and engineering practice</td>
<td>53 40 7 53 47</td>
<td></td>
</tr>
<tr>
<td>6. Creative and diversified thinking</td>
<td>57 39 4 50 50</td>
<td></td>
</tr>
<tr>
<td>7. Effective analysis of different types of data</td>
<td>66 32 7 61 39</td>
<td></td>
</tr>
<tr>
<td>8. Effective evaluation of engineering options, and selection of the optimum solution</td>
<td>53 41 6 53 47</td>
<td></td>
</tr>
<tr>
<td>9. Using technology effectively in the workplace</td>
<td>51 42 7 58 42</td>
<td></td>
</tr>
<tr>
<td><strong>Problem-solving skills</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, my knowledge and skills relevant to problem-solving learned at university are adequate</td>
<td>Yes 67 No 33</td>
<td></td>
</tr>
<tr>
<td>10. Effective member of a group or a working team</td>
<td>58 38 4 67 33</td>
<td></td>
</tr>
<tr>
<td>11. Resolving work based conflicts</td>
<td>50 49 1 46 54</td>
<td></td>
</tr>
<tr>
<td>12. Effective organizing and coordinating tasks to achieve project goals</td>
<td>71 26 3 56 44</td>
<td></td>
</tr>
<tr>
<td>13. Co-operate and collaborate with colleagues</td>
<td>74 26 0 71 29</td>
<td></td>
</tr>
<tr>
<td>14. When and where appropriate, demonstrate leadership skills among colleagues</td>
<td>42 50 8 44 56</td>
<td></td>
</tr>
<tr>
<td>15. When a problem occurs, be prepared and engaged with others to help to seek solutions</td>
<td>71 25 4 65 35</td>
<td></td>
</tr>
<tr>
<td>16. Effective control of budget</td>
<td>50</td>
<td>32</td>
</tr>
<tr>
<td>17. Effective management of time</td>
<td>78</td>
<td>19</td>
</tr>
<tr>
<td>18. Effective administration and record keeping</td>
<td>45</td>
<td>49</td>
</tr>
<tr>
<td>19. Independently explore new information and solutions to workplace problems</td>
<td>57</td>
<td>37</td>
</tr>
<tr>
<td>Overall, my knowledge and skills relevant to management learned at university are adequate</td>
<td>65</td>
<td>35</td>
</tr>
<tr>
<td>20. Relevant engineering knowledge and skills</td>
<td>38</td>
<td>54</td>
</tr>
<tr>
<td>21. Adapt to change (e.g. new ideas, technologies, procedures or job demands)</td>
<td>67</td>
<td>29</td>
</tr>
<tr>
<td>22. Project an enthusiasm and positive attitude towards fellow workers and work environment</td>
<td>63</td>
<td>30</td>
</tr>
<tr>
<td>23. Possess integrity and act according to a high ethical standard</td>
<td>57</td>
<td>40</td>
</tr>
<tr>
<td>24. Adhere to the type of standard set by the engineering professional body (e.g. Hong Kong Institute of Engineers)</td>
<td>24</td>
<td>57</td>
</tr>
<tr>
<td>Overall, my knowledge and skills relevant to others learned at university are adequate</td>
<td>67</td>
<td>33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perceived importance</th>
<th>Hi %</th>
<th>Mi %</th>
<th>Lo %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication skills</td>
<td>65</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>Problem-solving skills</td>
<td>67</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>Management related skills</td>
<td>39</td>
<td>47</td>
<td>14</td>
</tr>
<tr>
<td>Other type competency skills</td>
<td>26</td>
<td>14</td>
<td>60</td>
</tr>
</tbody>
</table>
### Section (2)

<table>
<thead>
<tr>
<th>Evaluation of the learned knowledge at university</th>
<th>DA</th>
<th>A</th>
<th>U</th>
<th>L/U</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overall, in my university course:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.a. Content was relevant to my career needs</td>
<td>27</td>
<td>73</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>1.b. Content was substantial and useful</td>
<td>18</td>
<td>82</td>
<td>72</td>
<td>28</td>
</tr>
<tr>
<td>1.c. Content had a coherent sequence and</td>
<td>27</td>
<td>73</td>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>well-structured</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.d. Teaching material was adequate and useful</td>
<td>31</td>
<td>69</td>
<td>64</td>
<td>36</td>
</tr>
<tr>
<td>1.e. The course provided adequate practical</td>
<td>47</td>
<td>53</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>application</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. My classmates and I frequently engaged and</td>
<td>36</td>
<td>64</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>collaborated together on academic tasks or</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I was encouraged to learn actively both</td>
<td>38</td>
<td>62</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>inside and outside of the classroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I was engaged in team building and</td>
<td>36</td>
<td>64</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>collaborative learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I was provided adequate resource to support</td>
<td>33</td>
<td>67</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>my learning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Teachers provided adequate support and</td>
<td>36</td>
<td>64</td>
<td>68</td>
<td>32</td>
</tr>
<tr>
<td>feedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Teachers encouraged students to learn</td>
<td>18</td>
<td>82</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>independently. (e.g. from library, or other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>means)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix 7  Summary of the engineering managers’ survey results

<table>
<thead>
<tr>
<th>Item</th>
<th>Percentage distribution %</th>
<th>Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 1 Importance Adequacy</strong></td>
<td></td>
<td>3 2 1</td>
<td>A L</td>
</tr>
<tr>
<td>1. Communicate effectively in English</td>
<td></td>
<td>71 27 2</td>
<td>39 61</td>
</tr>
<tr>
<td>2. Communicate effectively in Putonghua</td>
<td></td>
<td>27 45 28</td>
<td>24 76</td>
</tr>
<tr>
<td>3. Communicate effectively in written Chinese</td>
<td></td>
<td>20 45 35</td>
<td>57 43</td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural divergent</td>
<td></td>
<td>35 47 18</td>
<td>49 51</td>
</tr>
<tr>
<td><strong>Communication skills</strong></td>
<td></td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>5. Knowledge of global outlook and engineering practice</td>
<td></td>
<td>39 59 2</td>
<td>51 49</td>
</tr>
<tr>
<td>6. Creative and diversified thinking</td>
<td></td>
<td>57 41 2</td>
<td>41 59</td>
</tr>
<tr>
<td>7. Effective analysis of different types of data</td>
<td></td>
<td>65 31 4</td>
<td>49 51</td>
</tr>
<tr>
<td>8. Effective evaluation of engineering options, and selection of the optimum solution</td>
<td></td>
<td>73 24 2</td>
<td>51 49</td>
</tr>
<tr>
<td>9. Using technology effectively in the workplace</td>
<td></td>
<td>69 31 0</td>
<td>63 37</td>
</tr>
<tr>
<td><strong>Problem-solving skills</strong></td>
<td></td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>10. Effective member of a group or a working team</td>
<td></td>
<td>71 24 4</td>
<td>57 43</td>
</tr>
<tr>
<td>11. Resolving work based conflicts</td>
<td></td>
<td>37 59 4</td>
<td>35 65</td>
</tr>
<tr>
<td>12. Effective organizing and coordinating tasks to achieve project goals.</td>
<td></td>
<td>67 31 2</td>
<td>53 47</td>
</tr>
<tr>
<td>13. Co-operate and collaborate with colleagues</td>
<td></td>
<td>80 18 2</td>
<td>55 45</td>
</tr>
<tr>
<td>14. When and where appropriate, demonstrate leadership skills among colleagues</td>
<td></td>
<td>37 57 6</td>
<td>35 65</td>
</tr>
<tr>
<td>15. When a problem occurs, be prepared and engaged with others to help to seek solutions</td>
<td></td>
<td>76 20 4</td>
<td>61 39</td>
</tr>
<tr>
<td>16. Effective control of budget</td>
<td></td>
<td>43 45 12</td>
<td>41 59</td>
</tr>
<tr>
<td>Question</td>
<td>Hi %</td>
<td>Mi %</td>
<td>Lo %</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Communication skills</td>
<td>64</td>
<td>26</td>
<td>10</td>
</tr>
<tr>
<td>Problem-solving skills</td>
<td>66</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>Management related skills</td>
<td>37</td>
<td>47</td>
<td>16</td>
</tr>
<tr>
<td>Other type competency skills</td>
<td>33</td>
<td>12</td>
<td>55</td>
</tr>
</tbody>
</table>
## Appendix 8  
Comparison of the survey results between the graduate engineers and the engineering managers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Section 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eng %</td>
<td>Mgr %</td>
</tr>
<tr>
<td>1. Communicate effectively in English</td>
<td>57</td>
<td>71</td>
</tr>
<tr>
<td>2. Communicate effectively in Putonghua</td>
<td>40</td>
<td>27</td>
</tr>
<tr>
<td>3. Communicate effectively in written Chinese</td>
<td>29</td>
<td>20</td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural divergent</td>
<td>42</td>
<td>35</td>
</tr>
<tr>
<td>Overall, knowledge and skills relevant to communication are adequate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

|                                                                      | Problem-solving skills |          |
|                                                                      |                 |          |
|                                                                      | 5. Knowledge of global outlook and engineering practice | 53 | 39 | +14 | 53 | 51 | +2 |
|                                                                      | 6. Creative and diversified thinking                   | 57 | 57 | 0   | 50 | 41 | +9 |
|                                                                      | 7. Effective analysis of different types of data        | 66 | 65 | +1  | 61 | 49 | +12|
|                                                                      | 8. Effective evaluation of engineering options, and selection of the optimum solution | 53 | 73 | -20 | 53 | 51 | +2 |
| Overall, knowledge and skills relevant to problem-solving are adequate |      |    |        | 67   | 69  | -2   |

<p>|                                                                      | Management type skills |          |
|                                                                      |                           |          |
|                                                                      | 10. Effective member of a group or a working team      | 58 | 71 | -13 | 67 | 57 | +10 |
|                                                                      | 11. Resolving work-based conflicts                      | 50 | 37 | +13 | 46 | 35 | +11 |
|                                                                      | 12. Effective organizing and coordinating tasks to achieve project goals. | 71 | 67 | +4  | 56 | 53 | +3 |
|                                                                      | 13. Co-operate and collaborate with colleagues        | 74 | 80 | -6  | 71 | 55 | +16|
|                                                                      | 14. When and where appropriate, demonstrate leadership skills among colleagues | 42 | 37 | +5  | 44 | 35 | +9 |
|                                                                      | 15. When a problem occurs, be prepared and             | 71 | 76 | -5  | 65 | 61 | +4 |</p>
<table>
<thead>
<tr>
<th>Skill Description</th>
<th>Eng</th>
<th>Mgr</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engaged with others to help to seek solutions</td>
<td>50</td>
<td>43</td>
<td>+7</td>
</tr>
<tr>
<td>Effective control of budget</td>
<td>78</td>
<td>69</td>
<td>+9</td>
</tr>
<tr>
<td>Effective management of time</td>
<td>45</td>
<td>41</td>
<td>+4</td>
</tr>
<tr>
<td>Effective administration and record keeping</td>
<td>57</td>
<td>51</td>
<td>+6</td>
</tr>
<tr>
<td>Independently explore new information and solutions to workplace problems</td>
<td>65</td>
<td>61</td>
<td>+4</td>
</tr>
<tr>
<td>Overall, knowledge and skills relevant to management are adequate</td>
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<tr>
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<td>38</td>
<td>61</td>
<td>-23</td>
</tr>
<tr>
<td>Adapt to change (e.g., new ideas, technologies, procedures, or job demands)</td>
<td>67</td>
<td>69</td>
<td>-2</td>
</tr>
<tr>
<td>Project an enthusiasm and positive attitude towards fellow workers and work environment</td>
<td>63</td>
<td>49</td>
<td>+14</td>
</tr>
<tr>
<td>Possess integrity and act according to a high ethical standard</td>
<td>57</td>
<td>43</td>
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<tr>
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<td>Communication skills</td>
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<td>Problem-solving skills</td>
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<td>Management-related skills</td>
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<tr>
<td>Other types of skills</td>
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Appendix 9  Comparison of the survey results of importance and performance of skills between graduate engineers and engineering managers

Graduate Engineers

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
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<tbody>
<tr>
<td><strong>Section 1</strong></td>
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<td></td>
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<tr>
<td>1. Communicate effectively in English</td>
<td>57</td>
<td>56</td>
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<tr>
<td>2. Communicate effectively in Putonghua</td>
<td>40</td>
<td>29</td>
<td>+11</td>
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<tr>
<td>3. Communicate effectively in written Chinese</td>
<td>29</td>
<td>46</td>
<td>-17</td>
</tr>
<tr>
<td>4. Communicate effectively with a range of cultural divergent</td>
<td>42</td>
<td>35</td>
<td>+7</td>
</tr>
<tr>
<td><strong>Section 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Knowledge of global outlook and engineering practice</td>
<td>53</td>
<td>53</td>
<td>0</td>
</tr>
<tr>
<td>6. Creative and diversified thinking</td>
<td>57</td>
<td>50</td>
<td>+7</td>
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<tr>
<td>7. Effective analysis of different types of data</td>
<td>66</td>
<td>61</td>
<td>+5</td>
</tr>
<tr>
<td>8. Effective evaluation of engineering options, and selection of the optimum solution</td>
<td>53</td>
<td>53</td>
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<tr>
<td>9. Using technology effectively in the workplace</td>
<td>51</td>
<td>58</td>
<td>-7</td>
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### Section 3

<table>
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<th>10. Effective member of a group or a working team</th>
<th>11. Resolving work based conflicts</th>
<th>12. Effective organizing and coordinating tasks to achieve project goals</th>
<th>13. Co-operate and collaborate with colleagues</th>
<th>14. When and where appropriate, demonstrate leadership skills among colleagues</th>
<th>15. When a problem occurs, be prepared and engaged with others to help to seek solutions</th>
<th>16. Effective control of budget</th>
<th>17. Effective management of time</th>
<th>18. Effective administration and record keeping</th>
<th>19. Independently explore new information and solutions to work place problems</th>
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<td>58</td>
<td>67</td>
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<td>56</td>
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<td>-2</td>
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<td>+6</td>
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<td>26</td>
<td>+24</td>
<td>78</td>
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### Section 4

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<th>21. Adapt to change (e.g. new ideas, technologies, procedures or job demands)</th>
<th>22. Project an enthusiasm and positive attitude towards fellow workers and work environment</th>
<th>23. Possess integrity and act according to a high ethical standard</th>
<th>24. Adhere to the type of standard set by</th>
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<tbody>
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<td>38</td>
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<td>+10</td>
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<td></td>
<td>24</td>
<td>46</td>
<td>-22</td>
<td>24</td>
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</table>
the engineering professional body  
(e.g. Hong Kong Institute of Engineers)

**Engineering Managers**

<table>
<thead>
<tr>
<th>Item</th>
<th>High Importance</th>
<th>Adequacy</th>
<th>Difference % (Gap)</th>
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<tr>
<td><strong>Section 1</strong></td>
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<tr>
<td>1. Communicate effectively in English</td>
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<tr>
<td>2. Communicate effectively in Putonghua</td>
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<td>4. Communicate effectively with a range of cultural divergent</td>
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<td><strong>Section 2</strong></td>
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<td>5. Knowledge of global outlook and engineering practice</td>
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<td>6. Creative and diversified thinking</td>
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<td>7. Effective analysis of different types of data</td>
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<tr>
<td>8. Effective evaluation of engineering options, and selection of the optimum solution</td>
<td>73</td>
<td>51</td>
<td>+22</td>
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<tr>
<td>9. Using technology effectively in the workplace</td>
<td>69</td>
<td>63</td>
<td>+6</td>
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<tr>
<td>10. Effective member of a group or a working team</td>
<td>71</td>
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<td>+14</td>
</tr>
<tr>
<td>11. Resolving work based conflicts</td>
<td>37</td>
<td>35</td>
<td>+2</td>
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<td>12. Effective organizing and coordinating tasks to achieve project goals</td>
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<td>+14</td>
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<tr>
<td>13. Co-operate and collaborate with colleagues</td>
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<td>14. When and where appropriate, demonstrate leadership skills among colleagues</td>
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<tr>
<td>15. When a problem occurs, be prepared and engaged with others to help to seek solutions</td>
<td>76</td>
<td>61</td>
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</tr>
<tr>
<td>16. Effective control of budget</td>
<td>43</td>
<td>41</td>
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<td>19. Independently explore new information and solutions to work place problems</td>
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<tr>
<td>22. Project an enthusiasm and positive attitude towards fellow workers and work environment</td>
<td>49</td>
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<tr>
<td>23. Possess integrity and act according to a high ethical standard</td>
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<tr>
<td>24. Adhere to the type of standard set by</td>
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<tr>
<td>the engineering professional body (e.g. Hong Kong Institute of Engineers)</td>
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