Board of Engineers, Malaysia
Institution of Engineers, Malaysia
Federation of Engineering Institution of Islamic Countries

Draft Final Report

The Engineering Technology Path

Blueprint for a highly competent engineering technical workforce

February 2003

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Foreword by Minister of Works, Malaysia

The Board of Engineers, Malaysia (BEM) has over the last 30 years managed to maintain a register of engineers in Malaysia with the objective of promoting professionalism amongst members of the engineering fraternity in the country. Engineers have contributed substantially to the development of the country and are expected to play a pivotal role in the future.

To support the country's entry into the knowledge age, Malaysia requires a strong engineering workforce. This study undertaken by BEM, IEM and FEIIC is timely in order to develop a highly competent engineering workforce in support of our country. I hope this report shall serve as a blueprint for the development of the engineering Technical Education and Vocational Training (TEVT) sector in our country.

I would like to encourage industry to support and more importantly, participate in these effort.

My ministry lends support the implementation of the recommendations of this report, so that Malaysia can benefit from the presence of a highly trained and competent workforce to support its development programmes as well as its entry into the k-economy.

Datuk Seri Samy Velu
Minister of Works, Malaysia

Foreword by Minister of Education, Malaysia

I would like to take this opportunity to congratulate the BEM, IEM and FEIIC for being very proactive and taking this bold initiative to study the needs of the engineering Technical Education and Vocational Training (TEVT) in the country. The country needs a highly competent engineering workforce to support our country's development programmes particularly in this knowledge age. Engineers can take pride in the various engineering achievements which marked our physical and economic landscape as well as world-class infrastructures and industries which have enhanced the quality of life in Malaysia.

The government in its Human Resource Plan stresses on the importance of producing highly competent manpower to support our migration to the k-economy. This study shall provide a basis for developing the programmes in this sector.

The Ministry of Education is establishing Community Colleges and Universiti Colleges in support of the Vocational Education and Training sector. MARA has set up Universiti Kuala Lumpur and a number of private institutions of higher learning are offering programmes in this area. It is therefore important for the country to coordinate a national qualification framework to ensure international mobility of our graduates.

It is my hope that the recommendations from this study can be used to further develop this sector.

Tan Sri Dato' Musa Mohammed
Minister of Education, Malaysia

Chairman's Statement

The Board of Engineers, Malaysia (BEM), Institution of Engineers, Malaysia (IEM) and Federation of Engineering Institution of Islamic Countries (FEIIC) have taken a bold step in initiating a study that enables us to understand the latest practices in engineering Technical Education and Vocational Training (TEVT) worldwide and propose a comprehensive and futuristic model for Malaysia in preparation for our entry into the global knowledge-based economy.

In trying to be competitive in the global labour market, Malaysia needs to leapfrog to the world of global educational solution providers, providing advanced technical education and vocational training which prepare students for the high technology and very competitive global marketplace. Malaysia must make a bold move to recognise the importance of this sector.

This model which is developed in Malaysia can also be adapted by other countries.

On behalf of the study team, I would like to record our appreciation to BEM, IEM and FEIIC for their support.

Ir. Prof. Abang Abdullah Abang Ali
Board of Engineers, Malaysia

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Terminologies and Abbreviations

AAS – Associate Applied Science
Abitur – equivalent to GCE A Level (Germany)
AC – Alternating Current
ADTEC – Advanced Technology Centre
Adv. – Advanced
AEng AMIEI – Associate Engineer of IEI
AET – Associate Engineering Technician
AICTE – All India Council for Technical Education
AMIEI – Associate Membership of IEI
AQF – The New Australia Qualification Framework
AScT – Applied Science Technologists
ASTT – Applied Science Technicians and Technologists
AT – Associate Engineering Technologist
BA – Berufsakademie
BAI – Bachelor Ab Initio
BE – Bachelor of Engineering
BEM – Board of Engineers, Malaysia
B.Eng. – Bachelor of Engineering
BEng.Tech. – Bachelor of Engineering Technology
Berufsschule – German dual system education post Haupschule and Realschule
BESA – British Equipment Suppliers Association
BI – Bahasa Inggeris (English Language)
BM – Bahasa Melayu (Malay Language)
BMI – British Malaysian Institute
BSc – Bachelor of Science
BTEC – Business and Technical Education Council
B.Tech. – Bachelor of Technology
BTS – Brevet de Technicien Supérieur
CAD – Computer Aided Design
CEAB – Canada Education Accreditation Board
Cégep – College of General and Vocational Education (French acronym), Canada
CEng – Chartered Engineer
CEng MIEI – Chartered Engineer of IEI
Cert – Certificate
CGPA – Cumulative Grade Point Average
CIAST – Centre of Instructor and Advanced Skill Training
CNC – Computer Numerical Control
CT – Certified Engineering Technologist
CTech – Certified Technician
DC – Direct Current
DEA – Diplôme d`Etudes Approfondies (postgraduate degree)
DESS – Diplôme d`Etudes Supérieures Spécialisées
DEUG – Diplôme d`études universitaires générales
DEUST – Diplôme d`études universitaires scientifiques et techniques
Dip – Diploma
Dip-Ing – Diplome Engineer
DUT – Diplôme Universitaire de Technologie
EAC – Engineering Accreditation Council

EDEXCEL – British Institution that offers BTEC HND
EDI – Entrepreneur Development Institute
Eng.Tech. – Engineering Technician / Engineering Technology
Eng.Tech. IEI – Engineering Technician of IEI
Facharbeiter – Skilled worker in Germany
FE – Fundamental of Engineering
FEANI – Federation Europeenne d'Association Nationales d'Ingenieurs (European Federation of National Engineering Associations)
FEIIC – Federation of Engineering Institution in Islamic Countries
FENTO – Further Education National Training Organisation
FH – Fachhochshule
FIT – Federal Institute of Technology
GCSE – General Certificate of Secondary Education
GMI – German Malaysian Institute
GNVQ – General National Vocational Qualification
Gesellenbrief – Certificate
Grundschule – Elementary school in Germany (grade 1 through 4)
Gymnasium – Post elementary school in Germany
Hauptschule – Post elementary school in Germany
HNC – Higher National Certificate
HND – Higher National Diploma
ICP – Individual Case Procedure
ICT – Information and Communications Technology
IEAust – The Institution of Engineers, Australia
IEI – The Institution of Engineers, Ireland
IEM – The Institution of Engineers, Malaysia
IIE – Indian Institute of Engineers
IKBN – Institut Kemahiran Belia Negara (National Youth Skill Institute)
IKM – Institut Kemahiran MARA (Mara Skill Institute)
ILP – Institut Latihan Perindustrian (Industrial Training Institute)
INPEX – International New Products Exhibition, US
IPTA – Institut Pengajian Tinggi Awam (Public Institutions of Higher Learning)
IPTS – Institut Pengajian Tinggi Swasta (Private Institutions of Higher Learning)
ITP – Institute Teknikal dan Perdagangan, Penang
IUP – Instituts Universitaires Professionnalisés (France)
JMTI – Japan Malaysian Technical Institute
JTR – Jabatan Tenaga Rakyat (Human Resource Department)
KPM – Kementerian Pendidikan Malaysia (Ministry of Education, Malaysia)
KUiTTHO – Kolej Universiti Institut Teknologi Tun Hussein Onn
KUKUM – Kolej Universiti Kejuruteraan Utara Malaysia
KUTKM – Kolej Universiti Teknikal Kebangsaan Malaysia
KUTKUM – Kolej Universiti Teknologi dan Kejuruteraan Malaysia
Licence – Degree awarded after the first year at the university (France)
Magistere – Degree awarded after the second year at IUP (France)
Maitrise – Degree awarded after the second year at the university (France)
MARA – Majlis Amanah Rakyat
MCED – Malaysian Council of Engineering Deans
Meister – Highly skilled craftsman in Germany
MEng – Master of Engineering
MEET – Malaysian Engineering Technology and Engineering Technicians

MFI – Malaysia France Institute
MGCC – Malaysian German Chamber of Commerce & Industry .
MIEI – Ordinary Membership of IEI
MLVK – Majlis Latihan Vokasional Kebangsaan (National Council of Vocational Training)
MOE – Ministry of Education
MRP – Mature Route Procedure
Mth – Month
NC – National Certificate
ND – National Diploma
NICET – The National Institute of Certified Engineering Technologist
NIOSH – National Institute of Occupational Health and Safety
NSPE – National Society of Professional Engineers
NVQ – National Vocational Qualification
NVQ3 – NVQ Level 3
PE – Practice of Engineering
PPE – Professional Practice Examination
Realschule – Post elementary school in Germany
SARTOR – Standard Routes to Registration
SET – Senior Engineering Technician
SKM – Sijil Kemahiran Malaysia (Malaysian Skill Certificate)
SPM – Sijil Pelajaran Malaysia (Malaysian Certificate of Education)
SSM – Sistem Saraan Malaysia
STPM – Sijil Tinggi Persekolahan Malaysia (Malaysian Higher Certificate of Education)
TAC/ABET – Technology Accreditation Commission of the Accreditation Board for Engineering and Technology
TAFE – Technical and Further Education
TATI – Terengganu Advanced Technical Institute
TC – Technical Certificate
TD – Technical Diploma
TechIEI – Technician Membership of IEI
TPUK – Trade Partner UK
TT – Technician Trainee
TVET – Technical Education and Vocational Training
UiTM – Universiti Teknologi Mara
UM – Universiti Malaya
UniKL – Universiti Kuala Lumpur
UNISEL – Universiti Industri Selangor
UPM – Universiti Putra Malaysia
UTM – Universiti Teknologi Malaysia
VET – Vocational Education and Training (VET)
Yrs – Years

Executive Summary

This report is the result of a joint BEM/IEM/FEIIC study on the Malaysian Engineering Technologist and Engineering Technician (MEET) profession. The study is focused on the national requirement for engineering technologists and engineering technicians. The study methodology involves the collection and analysis of information, documents and questionnaires as well as visits to local and overseas organizations and agencies involved in or related to the engineering Technical Education and Vocational Training (TEVT) sector. The education and training model, professional development route and career path for this route, which is termed ***"Engineering Technology Path"*** is proposed.

Acknowledging the importance of a highly skilled engineering workforce particularly in this knowledge age and globalization, Malaysia needs to further develop its TEVT system and it is recommended that the country:

- further develops the Malaysian TEVT sector with emphasis on practical and hands-on skills in advanced technology and ICT
- enhances participation of industry in education and training, and
- adopts new approaches to learning and nurtures entrepreneurship and a thinking culture amongst engineering students and the workforce.

It is further proposed that the Malaysian engineering qualifications framework and occupational grade be enhanced from three to four categories by the introduction of a new grade called engineering technologist and replacement of the technical assistant to engineering assistant grade as follows:

- Certificate - Technician
- Diploma - Engineering Assistant, replacing Technical Assistant.
- Bachelor of Engineering Technology – Engineering Technologist
- Bachelor of Engineering – Engineer.

The engineering TEVT model, professional development route and career pathway for students following the ***Engineering Technology Path*** in Malaysia is proposed.

1.0 Background and Methodology

After some fifty years of educating engineers in the country, Malaysian universities were forced by recent events to take a hard look at the Malaysian engineering education system. Comparison was made with engineering education models worldwide in order to produce engineers who can compete in the global engineering market as well as remaining competitive with the other professions in the country. Lacking in the global and humanistic skills, which are necessary for top management or leadership positions, engineers were often left out of leadership positions. Malaysian engineers lag behind scientists in research and development and have yet to be active in business on a global scale. A study on the Malaysian engineering education model (MCED/IEM, 2000) has shown that engineers need to be technically competent as well as having the interpersonal skills to deal with the public effectively. A stronger emphasis on engineering science is envisaged and training in various industrial skills such as communication, management, law, politics and environment is important preparation for the young engineer.

The creation of an alternative path to conventional engineering qualification involving Engineering Technology and Engineering Technician programmes, is envisaged by the Board of Engineers, Malaysia (BEM) and the Institution of Engineers, Malaysia (IEM), as complementing qualifications to the regular engineering degree. With the Washington, Sydney and Dublin Accords trying to regulate training standards in participating countries, the time has come for Malaysia to develop a comprehensive and up-to-date education and training system for its engineering workforce.

There is a very high demand for engineering TEVT today, with clear emphasis on the need to produce workers with more hands-on skills and experience for the competitive job market in a dynamic industrial sector. Industry is demanding a higher education and training standards and requiring graduates with specific as well as generic skills. The industry is looking for multi-skilled workers as well as people with new skills for the ever-changing business environment.

A number of national initiatives have been taken in other countries to improve their TEVT system. This ranges from a change in education and learning approaches to government support in the establishment of special colleges and national qualifications to cater for the high demand for highly skilled and competent workforce.

The study on Malaysian Engineering Technologist and Engineering Technician (MEET) aims to develop the engineering Technical Education and Vocational Training (TEVT) sector for the Malaysian job market. The study shall propose model curricula, a professional development route and career path for these engineering personnel. This entails an education and training structure as well as final progression to the Professional Engineer status.

The work involves the collection and study of available information and documents, a survey and visits to local and overseas organisations and agencies involved in or related to the TEVT sector. The study methodology is similar to that of the Malaysian Engineering Education Model study (Megat Johari et al., 2002). Several countries that have been visited during the study period were Ireland, Germany, United Kingdom, United States, Australia, Canada, Turkey, France and India. Other relevant overseas information was obtained via the respective web sites. A study team workshop was held in Malacca on 13 – 15th February 2002, where the findings of the respective study team members were presented. Gaps in the study were identified and the framework for the study was rationalised.

A national colloquium entitled *The Engineering Education and Training - Second Route* was held on the 16th July 2002 in Putrajaya, to present the preliminary findings and obtain feedbacks from nearly 200 representatives of the engineering TEVT sectors and the industry. An advisory committee also gave their feedbacks to refine further the findings of the study.

The local and overseas organizations and agencies or representatives visited or met during the study period are as shown in Table 1.0.

The survey that was conducted as part of the study aimed at providing deeper insights into the needs of the Malaysian engineering Technical Education and Vocational Training. The survey questionnaire addresses issues on receptiveness of Malaysian engineers to the possibility of creating a path for those in the TEVT sector to obtain professional status.

Generally, the questionnaire covers the respondent and company background, the importance of professional engineering status in his/her organisation, the role and functions of the engineering personnel. It also seeks the opinion of the respondent in the development of a certification route for the supporting engineering personnel and the importance of creating a professional engineering path for these personnel. The survey also explored the possibility of having certified engineering technologist or engineering technician status, as a form of recognition and acknowledgement for their contribution to the engineering field.

The questionnaires were sent to related engineering and manufacturing organisations as well as the Institution of Engineers Malaysia council members and the board members of Board of Engineers Malaysia.

Table 1.0: Organisations and agencies or representatives visited or met

Malaysia	Advanced Technology Centre (ADTEC), Melaka
	Politeknik Kota Kinabalu, Sabah
	German Malaysian Institute (GMI), Cheras
	British Malaysian Institute (BMI), Gombak
	Politeknik Kuching, Sarawak
	Malaysia France Institute (MFI), Bangi
Germany	Fachhochschule Rosenheim
	Fachhochschule Augsburg
	Fachhochschule Nuernburg
	Fachhochschule Munich
United Kingdom	Association of Colleges (AOC)
	Further Education National Training Organisation (FENTO)
	British Council
	British High Commission
	University of Birmingham
	Trade Partner UK (TPUK)
	British Equipment Suppliers Association (BESA)
	Warwickshire and Crawley Colleges
Australia	TAFE Directors
	Northern Australia TAFE
	Southern Australia TAFE
	Institution of Engineers Australia, Victoria Division
	University of Melbourne
	Victoria TAFE
	World Congress of Colleges & Polytechnics 2002
	TAFE Sunshine Campus, Victoria University of Technology
	New South Wales TAFE
Canada	American Society of Engineering Education Annual Conference 2002
	LabVolt, Quebec
Turkey	Institution of Engineers, Istanbul
	Istanbul Technical University
	Bogazhi University
India	Madras Institute of Technology
United States	INPEX, Pittsburgh

2.0 Engineering Technical Education and Vocational Training

2.1 Introduction

As the world moves from the agricultural to industrial, IT and then knowledge ages, Malaysian industries, which have been predominantly Manufacturing, Agricultural and Construction and rely heavily on cheap labour, may move into the high-tech arena. Malaysia may give more emphasis on R&D, innovation and the production of high technology goods ahead of the other countries. This calls for the education and training of highly skilled engineers and technicians as opposed to those engineers who were trained in the conventional way. These highly skilled engineers are sometimes known as engineering technologists. Subsequently, there is a need for high technology personnel such as engineering technician that can support the work of both engineering technologists and engineers. This requires a discussion on the qualification framework within the engineering fraternity.

Engineering qualification framework refers to the policy framework that satisfies both the national and international recognised qualifications. It comprises of titles and guidelines, together with principles and protocols covering articulation and issuance of qualifications and statements of attainment. Elements of qualification framework indicate the achievement for each qualification titles. It will also provide progression routes for all the graduates in the engineering fields. In addition the framework sets the benchmark for all engineering programmes. It enables international recognition and student/graduate mobility especially with the advent of the Washington, Dublin and Sydney Accords.

Washington Accord (2003) is an agreement between accrediting bodies for engineering degree programmes of signatories countries. It recognizes the substantial equivalency of programmes accredited by these bodies, and recommends that graduates of accredited programmes be recognized as having met the academic requirements or entry to the practice of engineering in these countries. The Accord covers professional engineering undergraduate degrees. According to the Accord graduates of accredited engineering programmes are expected have attributes including the ability to:

- Apply mathematics, science and engineering science for the design, operation and improvement of systems, processes and machines
- Formulate and solve complex engineering problems
- Understand and resolve the environmental, economic, societal implications of engineering work
- Communicate effectively
- Engage in lifelong learning and professional development
- Act in accordance with the ethical principles of the engineering profession
- Function in contemporary society

The Sydney Accord is for engineering technologist, an agreement signed by Australia, Canada, Hong Kong, Ireland, New Zealand, South Africa and the United Kingdom. The Dublin Accord is a similar agreement signed by countries that acknowledge the equivalency at engineering technician level.

In the qualification framework, training and qualification of engineering programmes have to be assessed in terms of suitability. The issue to be addressed includes the credit versus outcome-based qualification systems. It also includes the time-served or competency-based training system. The training conducted could also be more client focused or training provider focused. The learning should be made flexible so that students do not have to complete their programmes based on a specified time but based on their own pace and capabilities. In the age of ICT, e-learning could possibly be the mode of delivery where students can study using virtual facilities.

The other issues that need to be highlighted are the streams and routes. The stream for the purpose of the report include the:

- Engineering
- Engineering Technology

In addition, three levels of engineering qualifications, namely, certificate, diploma and degree levels, have to be investigated for the two streams. The possible routes for the streams include:

- Academic – Diploma, Degree
- Technical Education and Vocational Training (TEVT) – Certificate, Diploma, Degree
- Examination – for example, The Board of Engineers, Malaysia (BEM) / The Institution of Engineers (IEM) or the Engineering Council UK Part I, Part II and Part III examinations

The term engineering and technology have always been confused. Engineering in fact encompasses theories relating to research, development, design and operations whereas **t**echnology primarily focuses on hands-on, application of the theories and principles of engineering and science to every day operations such as manufacturing, electronics and medicine, marketing, field testing, design, and customer service.

In order to distinguish between engineering and engineering technology, a technological spectrum, as shown in Figure 2.1 is used to illustrate the differences. Generally, in an organization engineers would most likely work in the design and development fields while technologists, technicians and craftsmen would be more inclined to work in manufacturing and production line. The engineers role are more towards the left of the spectrum while the technologists are more towards the right of the spectrum although the main activities of both engineers and technologist are in the center of the spectrum (Cheshier, 1998).

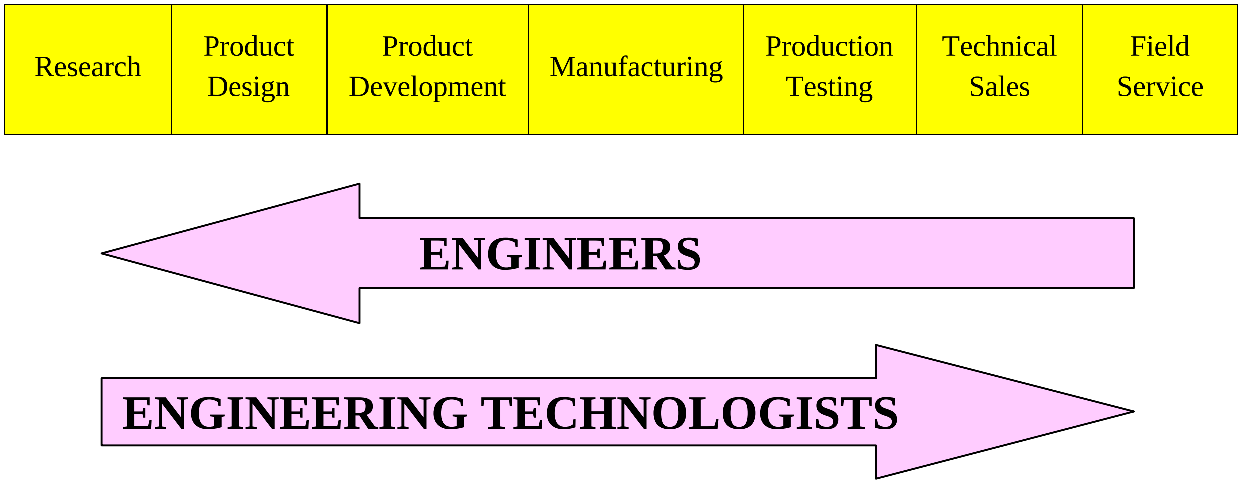


Figure 2.1. The Engineering and Technology Spectrum (Adapted from Cheshier, 1998)

According to Cheshier (1998), Engineering is defined as:

> *The profession in which knowledge of* ***advanced mathematical and natural sciences*** *gained by higher education, experience, and practice is devoted to the* ***creation of new technology*** *for the benefit of humanity. Engineering education for the professional* ***focuses primarily on the conceptual and theoretical aspects of science and engineering*** *aimed at preparing graduates for the practice of engineering closest to the* ***research, development, and conceptual design functions***.

The same author also defines Engineering Technology as:

> *The profession in which knowledge of the* ***applied mathematical and natural sciences*** *gained by higher education, experience, and practice is devoted to* ***application of engineering principles*** *and the benefit of humanity. Engineering technology education for the professional* ***focuses primarily on analyzing, applying, implementing, and improving existing technologies*** *and is aimed at preparing graduates for the practice of engineering closest to the* ***product improvement, manufacturing and engineering operational functions***.

According to Cheshier (1998) the US Accreditation Board for Engineering and Technology defines engineering and engineering technology, respectively, as follows:

> ***Engineering*** *is the profession in which knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.*
>
> ***Engineering Technology*** *is that part of the technological field that requires the application of scientific and engineering knowledge and methods combined*

with technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer.

The distinction between engineering and engineering technology emanates primarily from differences in their educational programmes. Engineering programmes are geared toward development of conceptual skills, and consist of a sequence of engineering fundamentals and design courses, built on a foundation of complex mathematics and science courses. These programmes also provide their graduates a breadth and depth of knowledge that allows them to function as designers.

Engineering technology programmes on the other hand, are oriented towards application. They provide students with introductory courses on mathematics and science, and qualitative introduction to engineering fundamentals.

From the previous definitions the distinction between the engineering disciplines has to be highlighted. Table 2.1 shows the qualification framework for engineering, engineering technology, engineering assistant and engineering technician professions for selected countries. The job specifications for the four group of profession are also highlighted. As can be seen, these four groups are categorized based on the qualification obtained. The groups are as follows:

- Engineers
- Engineering Technologists
- Engineering Assistants
- Engineering Technicians

The role of an engineer is to be a leader and coordinator in design, research and development using the knowledge of mathematics and natural sciences gained by study, experience, and practice, applied with judgment, to develop ways to economically utilize the materials and forces of nature for the benefit of mankind. Since engineering involves a wide spectrum of activities extending from the conception, design, development and formulation of new systems and products, engineers often work closely with engineering scientists in developing new technology via research projects.

Complementary to the engineers, the engineering technologist implement engineering works by applying engineering and scientific knowledge combined with technical skills to support engineering activities. Their areas of interest and education are typically application oriented, while being somewhat less theoretical and mathematically oriented than their engineering counterparts. They typically concentrate their activities on the applied design, using current engineering practice. Technologists play key roles on the engineering team; they are typically involved in product development, manufacturing, product assurance, sales, and programme management.

The third and fourth qualification namely diploma and certificate will produce engineering assistant and technician, respectively. It is good to note that engineering assistant known in countries like Australia is similar to Malaysian Technical Assistant. These engineering assistants are the supervisors of engineering work while the technicians are mainly the doers.

Table 2.1: Qualification Framework for Engineering and Engineering Technology of Selected Countries

Qualification	**Profession**	**Job specs**	**UK**	**Germany**	**France**	**USA**	**Canada**	**India**	**Ireland**	**Australia**	**Turkey**	**Japan**
Engineering Degree (4/5 years)	Engineer	Leader and Coordinator in Design, R&D and Teaching	*MEng*	*Dipl-Ing Dipl-Ing (FH)*	*Dipl-Ing/ DESS/DEA Matrise*	*BS*	*BSc*	*BEng/ BTech*	*BE/BEng/ BSc(Eng)/ BAI*	*BE/BEng*	*BSc*	*BEng*
Engineering Technology Degree (3/4 years)	Engineering Technologist	Implementer of engineering works	*BSc/BEng*	*Dipl-Ing (BA)*	*Magistere/ License*	*BEngTech*	*BEngTech*	-	*BTech*	*BTech/ BEngTech*	-	*NA*
Diploma	Engineering Assistant	Supervisor	*HND*		*DUT/BTS/ DEUG/ DEUST*	*AAS/AET*	*Diploma of Tech*	*Diploma*	*ND/TD*	*Adv Diploma/ Diploma*	*Diploma*	*Diploma*
Certificate	Technician	Doers	*HNC/Adv GNVQ/ NVQ3*	*Meisterbrief / Gesellenbrief*		*Certificate*	*Certificate*	*Certificate*	*NC/TC*	*Certificate*	*Certificate*	*Certificate*

NA: not available

2.2 Malaysian EngineeringTEVT

The era of globalisation plays a crucial role in influencing the current trend in the engineering TEVT. With the Washington, Sydney and Dublin Accords, the Engineering Institutions in various countries are taking up the challenge not only to gain international recognition for their engineering degrees, but also widening the scope of engineering recognition to include engineering technologists and technicians.

There is a need to rethink engineering priorities in the light of global event and the changing needs of the market place. As technology becomes more sophisticated, employers continue to look for technicians who are skilled in the new technology and require a minimum of additional training. The engineering technician level will be more in demand as this is the area of greatest skill shortages.

A study of the TEVT system and the recognition path for TEVT in Malaysia provides some insight to the trends of engineering TEVT in Malaysia. A survey on the requirements of the industries on the type of engineers in Malaysia was also conducted to provide more information in developing a path for the Malaysian engineering fraternity.

2.2.1 Malaysian Education System

The education system in Malaysia starts at preschool level. This is followed by six years of primary education, 3 years of lower secondary and 2 years of upper secondary. For post secondary education, students have a choice of continuing the academic line by attending the sixth form in either the government or private schools for 2 years or matriculation programmes either in private, public colleges or matriculation centers. Some students continue their studies by taking two to three years diploma programmes either at government polytechnics or private colleges, while some continue taking certificate programmes either at polytechnics or colleges.

The tertiary education level in engineering normally takes four years to complete. A typical student completes his/her studies in 16 or 17 years before graduating with a degree.

To become an industrialised nation, the country requires more scientists and engineers to propel its growth. Based on the 1994 National Survey of Research and Development conducted by the Malaysia Science and Technology Centre, the number of scientists and engineers for every 10,000 population is extremely low. The national ratio was 7 compared to 82 in Japan, 76 in USA, 66 in Singapore and 26 in Taiwan**.** To increase the number of scientists and engineers, the Government must provide greater opportunities and facilities for students to embark on science and technology courses.

Currently, there are 17 public universities and university colleges and an almost equal number of private universities. All universities offer bachelor degree while a few offer diploma levels as well. There are 13 polytechnics in Malaysia and three new ones are under construction. By 2005 the number of polytechnics in Malaysia is expected to double (Mahat, 2001). These polytechnics offer courses at certificate and diploma levels.

The need to cater for the growing population in education and coupled with limited places in public universities, has spurred the growth of private colleges and universities. In 1992, the number of private institutions of learning was 156, increased by 127% to 354 in 1996 and in 2000, there were 470 registered institutions. A total of 17 Community Colleges are already in operations and over the next several years, one Community College will be built in every parliamentary constituency (Mahat, 2001). It provides an alternative route to students who do not enter the existing institutional set-up.

In the area ofTEVT, there are four main players, namely, Ministry of Education (MOE), Majlis Amanah Rakyat (MARA), Jabatan Tenaga Rakyat (JTR) and Ministry of Youth and Sports. The MOE offers engineering diplomas and certificate courses at its polytechnics, engineering diploma courses at public universities and diploma in technological areas at some public university colleges. Several educational institutions under MARA such as British Malaysian Institute, Malaysian France Institute, and German Malaysian Institute offer diploma levels related to technical and vocational education and certificate levels in its skill institutes (IKM). The JTR Industrial Training Institutes under the Ministry of Human Resource provides systematic training programmes to produce highly skilled workers in technical areas for SPM school leavers at diploma and certificate levels. The curriculum for these programmes are designed to fulfill the requirement set by the National Council of Vocational Training (MLVK). Table 2.2 illustrates the relationship between the training skills at different training institutions under the Manpower Department, Ministry of Human Resource and their qualification levels. The Ministry of Youth and Sports are currently adding more training institutes (IKBN) that provide skills training.

A summary of some Bachelor, Diploma and Certificate courses in technical related areas offered in Malaysia, which include their entry requirements, duration and course distribution is shown in Tables 2.3 a, b, c and d**.** Details of selected established colleges offering these programmes are found in Appendix 2.

Table 2.2: Relationship between occupational categories and qualifications at different Malaysian Manpower Department training institutes (source: JTR, ___)

Occupational Category	Qualification	Training Centres	Training Duration
Management	SKM Level 5 Diploma in Advanced Technology	JMTI	1 Year
Supervisory	SKM Level 4 Diploma Technology	JMTI ADTEC	1 Year
	SKM Level 3		1 Year
Operations	SKM Level 2	ILP	1 Year
	SKM Level 1	ILP	

Table 2.3a: Selected Certificate Programmes in Malaysia

Name of Institution	Polytechnic	EDI
Name of Qualification	Cert. of Eng.	Cert. of Eng.
Entry Qualification	SPM 3 credit with pass BM & BI	SPM Minimum of 2 credit
No. of years No. of semester	2 4 semester	1 3 semester
Academic System	2 semester/year 18-week/semester	3 semester/year 15-week/semester
Total credit hour	51	54
Scientific Skills (%)	12 (23.5)	8 (14.8)
Technical Skills (%)	33 (64.7)	34 (62.9)
Generic Skills (%)	6 (11.8)	12 (22.2)
Industrial training	Credit not given	None

Table 2.3b: Selected Diploma Programmes at Government-backed Institutions

Name of Institution	KUiTTHO	GMI	MFI	IKM (MARA-UTM)
Name of Qualification	Diploma in Engineering Technology	Industrial Diploma	Diploma in Technology	Diploma in Technology
Entry Qualification	SPM, Polytechnic Certificate or equivalent or MLVK Level 2	SPM 4 credits or MLVK Level 2 and Pass Interview	SPM 4 credits UiTM Pre-Science CGPA >2	SPM Minimum of 5 Credit or IKM Technology Certificate
No of years No of semester	3 6 semesters	3 6 semesters	3 6 semesters	3 6 semesters
Academic system	2 sem/year 15-week/sem	2 sem/year 20-week/sem	2 sem/year 18-week/sem	2 sem/year 22-week/sem
Total credit	97	105	100	91
Scientific Skills (%)	17 (17.5)	6 (5.5)	7 (7.0)	18 (20.0)
Generic Skills (%)	16 (16,5)	35 (32.1)	26 (26.0)	19 (21.0)
Technical Skills(%)	58 (60.0)	63 (57.8)	57 (57.0)	42 (46.0)
Industrial training (%)	6 (6.0)	12 weeks	10 (10.0)	12 (13.0)

Table 2.3c: Selected Diploma Programmes at Private Institutions

Name of Institution	Kolej Damansara Utama	EDI	FIT	ITP Lebuh Victoria	TATI
Name of Qualification	Dip Eng	Dip Eng	City & Guild	City & Guild	BTEC HND
Entry Qualification	SPM 1 credit +	SPM 2 credit +	SPM 5 pass STPM 2 P	SPM 2 credit +	STPM 3 P Tahun Asas TATI 2.0 CPA
No of years No of semesters/ modules/terms	2 6 semesters	2 6 semesters	2 16 modules	2 6 terms	2 4 semester
Academic System	3 sem/year 14-week/sem	3 sem/year 15-week/sem	8 modules/year 5 wks/module	3 term/year 5 modules/ term 3 wks/module	2 sem/year 15-week/sem
Total credit hour	94	102	94	93	81
Scientific Skills (%)	20 (21.0)	11 (10.8)	28 (29.8)	12 (12.9)	10 (12.3)
Generic Skills (%)	12 (13.0)	17 (16.7)	10 (10.6)	9 (9.7%)	12 (14.8)
Technical Skills (%)	62 (66.0)	62 (60.7)	56 (59.6)	72 (77.4)	59 (72.9)
Industrial training (%)	None	12 (11.8)	None	None	None

Table 2.3d: Selected Bachelor Degree Programmes at Public and Private Institutions

Name of Institution	UM	UPM	KUiTTHO	UniKL (MFI)	KUiTTHO (GMI)
Name of Qualification	Bachelor of Engineering	Bachelor of Engineering	Bachelor of Engineering	Bachelor of Engineering Technology	Bachelor of Technology
Entry Qualification	Matriculation STPM	Matriculation STPM Diploma	Matriculation STPM Diploma	STPM Diploma	Diploma in Technology + 1 year industrial experience
No of years No of semester	4 8 semester	4 8 semester	4 8 semester	4 8 semester	3 6 semester
Academic system	2 sem/year 15-week/sem	2 sem/year 14-week/sem	2 sem/year 15-week/sem	2 sem/year 18-week/sem	2 sem/year 20-week/sem
Total credit	120	133	128	159	149
Scientific Skills (%)	17 (14.0)	18 (13.5)	16 (12.0)	21 (13.2)	10 (6.5)
Generic Skills (%)	17 (14.0)	28 (21.0)	27 (21.0)	33 (20.8)	29 (20.0)
Technical Skills (%)	78 (65.0)	76 (57.0)	69 (54.0)	88 (55.3)	101 (68.0)
Industrial training (%)	None	5 (4.0)	6 (5.0)	7 (4.4)	None
Project work (%)	8 (7.0)	6 (4.5)	10 (8.0)	10 (6.3)	9 (5.5)

2.2.2 Professional Training

The number of professional engineers registered with the Board of Engineers, Malaysia, as of December 2001 is 10,528 and graduate engineers are 29,584. The BEM listed 93 disciplines, where the most engineers registered as professional and graduate engineers are in Civil (5490 and 11938), followed by electrical (2110 and 4630), mechanical (2028 and 6512) and chemical (284 and 1796). The number of professional engineers registered with the Board of Engineers of other disciplines had mostly double and single digit registrant.

A graduate in engineering can register with BEM as a graduate engineer and after 4 years of practical experience, sit for the professional interview conducted by the Institution of Engineers, Malaysia (IEM). After passing the professional interview, the applicant applies to the BEM for professional engineer (P.Eng) status. Those without any degree can obtain the P.Eng. status by sitting for the Part 1 and 2 papers and currently, a part 3 has been introduced in line with the Engineering Council UK move to bring the Examination to C.Eng degree status.

At present, there is no formal registration for the existing engineering assistants, technologists or technicians nor is there a prescribed pathway where those with such qualifications can become professional engineers. The increase in the enrolment at diploma and certificate levels (Appendix 3) and the important roles these groups of engineering fraternities play to ensure successful engineering endeavors calls for an urgent need for such registration.

2.2.3 Career Path

Engineers

Graduates of Bachelor in Engineering at the moment are appointed as engineers in the J41 (previously J3 in SSB) category in the government new SSM scheme. Engineering graduates who join universities with relevant masters degree are appointed as lecturers in the DS45 category in the SSM scheme. Those graduates who wish to be teachers in the technical education service are appointed as technical teachers in schools or lecturers in polytechnics, and they are placed in the DG41 category.

In the private sector the pathway is less clear but graduate engineers can be employed as engineers upon graduation. The positions held by such graduates are process engineers, project engineers, design engineers, or research engineers. Eventually they will progress to the position of senior engineers or chief engineers. Engineers who have been in the industry for a long time normally end up in the managerial positions such as engineering managers, senior plant managers or production managers. Normally engineering graduates will register for Professional Engineer status and then start their own consulting practice or engineering related business after acquiring enough experience and networkings in the industry.

Engineering Assistants

Engineering Assistants are semi-professionals and their tasks are to assist the engineers. Engineering Assistants are diploma holders in engineering or technology. Engineering Assistants involve and/or assist in the supervision of installation, maintenance and operation. In the government SSM scheme of service they are placed in J29 category. In the manufacturing industry they work as production supervisors, line leaders or quality supervisors. In the field of civil engineering they may be clerk of works or site supervisors. Engineering Assistants can become engineers through taking a degree course in engineering, or taking the IEM/BEM examinations.

Engineering Technicians

Engineering Technicians are certificate holders, and are usually from the Ministry of Education Polytechnics. They have the skills in specific areas and are doers of engineering tasks. As an example, air conditioning and refrigeration certificate holders from the Ministry of Education Polytechnics are skilful in installation, maintenance and operations in air conditioning and refrigeration systems.

In the private sectors, they are given designation according to their job function, for example, maintenance technicians, quality control technicians and test technicians. In the government SSM scheme they are placed in the J17 category. Technicians can become engineers through taking a degree course in engineering or taking the IEM/BEM examinations.

Since the Bachelor degree in Engineering Technology is not currently offered in Malaysia, the post of engineering technologist has not been created. The post of technologists (such as food technologists) is not under the J category.

The existing career path for a bachelor, diploma and certificate holders in engineering in different sectors is shown in Table 2.4.

Table 2.4: Pathways for Engineering Careers in Malaysia

	Government	University	Polytechnic	Industry	Research Institute
Bachelor in Engineering	Engineer (J41)	With Masters degree – Lecturer (DS 45)	Lecturer (DG41)	Engineer	Researcher (Q41)
Diploma in Engineering	Technical Assistant (J29)	Technical Assistant (J29)	Instructors (DG29)	Assistant Engineer	Assistant Researcher (Q29)
Certificate in Engineering	Technician (J17)	Technician (J17)	Skill Teacher (DG17)	Technician	Research Technician (Q17)

2.2.4 MEET Survey Report

To enhance and provide greater insight to the needs of institutions and industries in Malaysia for engineering technologists and technicians, and to consider establishing some form of recognition for the important role of engineering technologists and technicians in supporting the work of engineers a survey was conducted.

The respondents were required to indicate their level of agreement for each statement using a 5-point Likert scale, with 1 indicating as least important to 5 as most important.

A total of 100 questionnaires were posted to various organizations. A total reply of 25 was received. Most of the respondents (88%) are engineers in the various fields, especially Mechanical and Civil engineering. The companies are consultancy firms, manufacturing firms, contractors and also involved in plantations. The engineers required in the firms surveyed are mostly Mechanical and Civil.

Survey Results and Discussion

1. Importance of Professional Engineers.

Importance of Professional Engineers	3.12

The survey result showed that the status in Professional Engineers (PE) is not important.

2. Roles of engineering workforce perceived in the industry

Engineers	4.00
Technicians	3.40
Engineering Technologists	2.62
Professional Engineers	2.0

The respondents perceive engineering workforce in the order of importance as engineers (4.00), technicians (3.4), engineering technologists (2.62) and professional engineers (2.0).

3. Main role of engineers in the industry

Apply proven techniques and procedures	3.72
Supervisory roles	3.70
Operation Managers	3.67
Designing	3.48
Forefront in developing engineering technology	3.45
Research and development	2.92

The question seeks to identify what are the main roles of the engineering workforce in the company. It was found that the main roles are applying proven techniques and procedures (3.72) followed by supervisory roles (3.70), operation managers (3.67), designing (3.48), forefront in developing engineering technology (3.45) and least of all in research and development (2.92).

4. Characteristics of engineers the company is looking for

'Hands on' engineers	4.56
Adequate knowledge of the job	4.52
Have the necessary skills	4.4
Ability to do design work	3.88
Company needs more qualified technicians than engineers	3.79
Highly qualified (academic) engineers	3.32
Duration of study more than 3 years	3.29
Prefers to hire technicians that can be upgraded through training	3.00
Ability to do research and development	2.20

The most important characteristics that the companies are looking for are the ability to carry out the jobs or 'hands on' engineers (4.56), followed by having adequate knowledge of the job (4.52), having the necessary skills (4.4), ability to do design work (3.88), and the company needs more qualified technicians than engineers (3.79). Having highly qualified (academic) engineers (3.32) and duration of study more than three years (3.29), the company prefers technicians that can be upgraded through training (3.0) and ability to do research and development (2.2) are relatively unimportant characteristics.

5. Training required for engineers

Specific technical needs of the company	4.20
Supervisory	3.86
Operations	3.72
Management	3.17

The most important training required identified by the respondents are specific technical needs of the company (4.2) followed by supervisory (3.86), operations (3.72) and management (3.17).

6. Type of Engineering Personnel : ROUTE 1 or ROUTE 2

Route 1 (academic engineer)	50%
Route 2 (engineering technologists and technicians)	50%

The companies are equally divided on the type of engineering personnel required. However, more than 80% of the respondents agree that an accreditation programme be developed for engineering technology and engineering associates programmes. The majority of the respondents also agreed that a path/route be developed for these programmes to enable the Route 2 engineers be registered as engineering associates and 92% agreed that a suitable pathway be developed for Route 2 engineers to articulate from one membership category to another in Malaysia.

In conclusion the survey shows that:

- The roles of engineers, characteristics of the engineers in the industries and the training described, indicate that the companies require engineering technologists and technicians more than professional engineers.
- The respondents agreed that a path be created to enable engineering technologists and technicians to be given due recognition.

2.3 Global Trend

This section discusses on the global status of engineering and engineering technology education and the progression route to professional status.

2.3.1 Education Systems

Education system differs from country to country in terms of the number of years spent at primary and secondary schools. However many countries nowadays provide a well-balanced education system so that students will later able to choose any areas they are interested in at tertiary education level.

The United States in particular, offers both public and private elementary and secondary schools in which every child in America receives at least 11 years of education. In many states, junior or community colleges offers programmes at certificate and associate degree (diploma) levels to those interested in hands-on curriculum. These colleges provide a bridge between high school and four-year Bachelor of Engineering Technology programmes for some students (Rosnah, 2002).

Canada (Noordin, 2002), Japan (Osman, 1999) and Turkey (Jaafar, 2002) share almost similar system with the US in which children have to undergo at least 11 years of schooling from year 6 before being able to continue their tertiary education. Students may continue to a four-year professional engineering degree or a two-year Diploma in Engineering programme after high school. Those with diploma qualification may continue to degree programme if they achieved certain standard, or join the work force as engineering technicians. College of General and Vocational Education in Canada like Community Colleges in the US, offers two years of general or three years of technical education between high school and university (Noordin, 2002).

Unlike the US, Germany offers three-tier general schooling (elementary, lower secondary level and upper secondary) and dual vocational training system. Children in Germany start school at the age of 6, and from grades 1 through 4 attend elementary school *(Grundschule)*, where the subjects taught are the same for all. Then, after the 4th grade, they are separated according to their academic ability, and attend one of three different kinds of schools: *Hauptschule*, *Realschule* or *Gymnasium*. Beyond the *Haupschule* and *Realschule* lies the *Berufsschule* (dual system), combining part-time academic study and apprenticeship. The successful completion of an apprenticeship programme leads to certification in a particular trade or field of work (Megat Johari et. al, 2002)

Australia on the other hand requires at least 12 years of schooling. Technical and Further Education (TAFE) system in Australia has been developed so that the qualifications are more in tune with industry needs. This is a system of vocational education and training at tertiary level. TAFE qualification includes Advanced Diploma, Diploma courses, Certificate courses, Apprenticeship training and Traineeships (Mariun, 2002).

Like Australia, children in India generally go through 12 years of school education. There are two basic post-school technical education institutions in India. The polytechnics and colleges of engineering offered engineering programmes in diploma and certificate level while Universities, Technical Universities and Indian Institutes of Technology offer Bachelor and higher degrees.

There are three types of engineering institutions in India, i.e. academic University, University of Technology and Institute of Technology. In addition to these institutions, there are also state universities, which offer degrees in Engineering and also affiliated colleges known as Colleges of Engineering or Colleges of Technology which offers degree in Engineering, affiliated to either a state or federal universities. The degrees in Engineering awarded are Bachelor in Engineering in the academic University and Bachelor of Technology in the University of Technology as well as in the Institute of Technology (Hasan, 2002).

In a UK education system students have to undergo 10 years of schooling and 2 years of A-Level before entering University education. Based on the A-Level achievement, students will continue for either Higher National Diploma (HND), 3-year Bachelor of Engineering leading to Incorporated Engineers, or 4-year Bachelor of Engineering leading to Chartered Engineer status.

2.3.2 Engineering Technology Curricula

It should be noted that the title of qualification i.e. Bachelor of Engineering or Bachelor of Engineering Technology are not consistently used globally, as shown in Table 2.5. Universities in India, for example the Indian Institute of Technology, name the degree as Bachelor of Technology. The UK universities use Masters of Engineering (M. Eng), whereas in the US universities Bachelor of Science (Engineering). In Malaysia the qualification is known as Bachelor of Engineering. As such, the curricula comparisons among the programmes offered in this report, are not based on the title of the qualification, but on the contents, course durations, entry qualifications and the path towards professional engineering qualifications.

Engineering technology programme may be defined as a programme that prepares graduates who are able to work with/assist to complement professional engineers. The graduates are exposed to almost similar courses with those of the engineering curricula, except that the distribution of theories and practicals are different. Lahndt (1998) said "Hands-on design happens when students work on realistic, or preferable real-life, design problems with outcomes going beyond drawings and reports, to involve presentation of working prototypes". The Open Polytechnics, Australia states that Bachelor of Engineering

Technology has been designed for people with an aptitude for mathematics and science who would like to work as technologists, in complementary with professional engineers.

Table 2.5: Programme of Study for Bachelor of Engineering and Bachelor of Engineering Technology

Country	B. Eng or its equivalent / duration	Entry (years of education)	B. Eng. Tech. or its equivalent / duration	Entry (years of education)
Australia	B.Eng or BSc. (Eng) / 4 years	HSC (13)	*BSc. (Technology) / 3 years	HSC (13)
U.K.	M. Eng. or B.Eng / 4 years or 3 years	A Level with 24 or 18 UKAS points (13)	*BSc / 3 years	A Level/ AS Level (13)
U.S.A	BSc. (Eng) / 4 years	SAT (12)	B. Eng. Tech./ 4 years	SAT (12) / Assoc. Degree
New Zealand	B.Eng or B.Tech / 4 years	NA	*BSc. (Technology) / 3 years	A level : 3 passes incl. 1C (13)
Malaysia	B. Eng. / 4 years	STPM (13)	Not available	Not Available

NA: information not available.
* Considered as equivalent according to Sydney Accord.

The trend of education in Europe (other than UK) is leaning towards more technical approach. Students who have high academic achievement may choose or are attracted to technical institutes instead of the academic universities due to its good job-placement rates. In Germany, for example, training is aimed at providing a highly skilled workforce through a variety of institutions such as applied science university (fachhochschulen), vocational academies and technical trade schools. These institutions have different levels of entrance requirements, duration of study and alliance with industry. The average duration to graduate from the fachhochschulen is 4.5 years and it is an important institution in training engineers in Germany. In Badenburg, Germany there are also other technical training institutions known as Berufsakademie that integrate practical training in industry with theoretical education in local universities.

Engineering technology students receive an education that stresses the practical application of engineering principles. In the USA, the Bachelor of Engineering Technology takes similar duration (4 years) with those of the Bachelor of Science (Engineering). The subjects covered however, differs in terms of practical and theoretical aspects. Students who entered the Bachelor of Engineering Technology programmes in the USA normally require lower entry academic requirement or achievement. Premier engineering universities such as Stanford, Purdue, Michigan or MIT do not offer the programmes. The programmes are only offered by “secondary universities” such as Michigan University of Technology or community colleges attached to the premier universities. Similar trends can also be found in the UK, Australia and New Zealand where the premier universities do not normally offer the Bachelor of Engineering Technology.

Examples of curricula from selected universities in various countries are shown in Table 2.6 through Table 2.11 for different disciplines for both degree and diploma levels. Comparison between these curricula indicates that the engineering technology degree in the USA requires an additional year due to the presence of basic sciences subjects such as physics, chemistry and mathematics and also non-engineering subjects which include communication, languages and humanities.

It can be seen from Table 2.6 that the technical content for Civil Engineering Technology programmes between these universities are comparable and almost similar. The Australian university may produce engineering technologist who are very competent, but they may not be well rounded as compared to the engineering technology graduates of the US universities due to lack of generic skills. The Australian engineering technology programme is usually at diploma level and vocationally orientated. The programmes provides students with the knowledge and skills that are necessary to obtain employment as an engineering technologist and to be admitted as an Engineering Technologist with the Institution of Engineers, Australia. It provides students with a core of basic analytical and communication skills, common to all branches of engineering, and then permits students to undertake in depth study in specialized areas. In addition, students are equipped with a basic knowledge of the industrial and social environments in which they will function as engineering technologists.

Similar to Civil Engineering Technology programme, technical content for both Mechanical and Electronics in various countries are comparable and almost similar, as shown in Table 2.7 and 2.8 respectively. The US programmes, however, emphasise more on scientific competencies and generic skills with a sizable amount of professional courses. The UK system on the other hand, focuses more on the technology part by providing more professional courses. The Australian system opts for a moderate combination of scientific, generic and professional courses.

Like Bachelor of Engineering Technology programmes, the Diploma of Engineering technology programmes show similar trends in term of courses offered. Countries like the USA and Canada provide more broad-based (See Tables 2.9 through 2.11 for examples of courses for Diploma of Engineering Technology in Civil, Electronics and Mechanical respectively) contents ranging from fundamental mathematics and science courses to professional and generic courses. However, UK systems still focus more on the professional courses even though the duration of the programme is two years for all selected countries.

Table 2.6: Example of Courses for B.Eng.Tech.(Civil) in Australian and American Universities

University	Queensland University of Technology, Australia (Anon, 2003h)	Central Connecticut State University, USA (Anon, 2003a)	Metropolitan State College of Denver, USA (Anon, 2003b)
Programme (Duration – Credits/Units)	Bachelor of Technology (Civil) (3 Years [2 semester + 1 trimester/year] – 288 credits)	Bachelor of Science in Civil Engineering Technology (4 Years – 130 Credits)	Bachelor of Science in Civil Engineering Technology (4 Years – 128 Credits)
Scientific Skills	Eng. Mathematics 1, 2 &3, Eng. Computing, Statics, Material Science, Environmental Science.	Trigonometry, Calculus I & II, Statistics, Introduction to Engineering Technology, University Physics I and II, Chemistry I and II, Applied Mechanics – Statics and Dynamics, Strength of Materials	Chemistry Physics I & II, Physics Laboratory Calculus I & II Mechanics I & II Technical Programming Mechanics of Materials Thermodynamics
Generic Skills	Engineering Drwg Interpretation, Eng. Graphics, Computer Aided Drafting, Drafting steelwork, Drafting RC structures, Reports Presentation, Writing Workplace Documents, Drafting Roads and Pipelines	Writing Composition, Public Speaking, Technical Writing Introduction to CAD General Education Studies (44 Credits)	Public Speaking Technical Drawing I & II Economic Principles Structural Drawing Technical Writing Engineering Economy General Studies
Professional Skills	Strength of Materials, Quality Concepts, Planning Estimating and Costing, Construction Techniques A&B, Environment Engineering, Load Analysis, Geometric Roads Design, Survey,Stormwater Drainage, Project Management, Civil Estimating, Civil Eng. Computer Applications, Structural Engineering, Geotechnical Engineering, Hydraulic Engineering, Water and Wastewater Eng., Municipal Design, Professional Studies, Investigation Project	Introduction to Surveying Applied Fluid Mechanics Structural Analysis Soil Mechanics and Foundation Transportation Engineering Structural Steel and Concrete Design Hydrology and Storm Drainage Materials of Construction Computer Programming Construction Documents Advanced Electrical Circuits Applied Thermodynamics Environmental Technology	Intro. Structural Analysis Fluid Mechanics I&II Environmental Technology Construction Methods Civil Technology Construction Surveying Concrete Design I&II Steel Design I&II Timber Design Route Surveying Construction Estimating Construction Law

Table 2.7: Example of Courses for B.Eng.Tech.(Electronics) in various countries

University	University of South Queensland, Australia (Anon, 2003c)	Kansas State University, USA (Anon, 2002m)	Sheffied Hallam University, UK (Anon, 2002n)
Programme (Duration – Credits/Units)	BEngTech in Electrical and Electronic Engineering (3 years – 24 units)	B.Sc in Electronics Engineering Technology (4 years – 127 credits)	BEng (Hons) in Electronic Engineering (3 years)
Scientific Skills	Foundation Mathematics, Engineering Problem Solving I and II, Engineering Materials, Computer Engineering	College Algebra, Plane Trigonometry, Introduction to PC Software, Analytical Geometry, Calculus I, General Physics I, Applied BASIC Programming, Chemistry Advanced Mathematics	Engineering Principles, Mathematics Computing, Introduction to Programming, Computer Modeling and Math for Electronic
Generic Skills	Principles of Professional Engineering and Surveying, Technology and Society, Engineering Management	Expository Writing I and II, Public Speaking, Technical Writing, Science Elective, Humanities or Social Sciences (15 credits), Business Elective	Industrial Studies and Professional Development, Professional Engineering Formation
Professional Skills	Electronics Circuits, Electrical Technology, Introduction to Engineering Design, Electrical Measurement and Analysis, Telecommunication Principles, Embedded System Design, Electronic Workshop and Production, Electronics Systems, Control and Instrumentation, Electrical Plant, Electronic Measurement, Power Electronics Principles and Applications, 4 other professional electives	Direct Current Circuits, Alternating Current Circuits, Semiconductor Electronics, Electronic Intrumentation and Measurement, Linear Circuit Design, Electronic Manufacturing I and II, Digital Logic, CAD Applications in Electronics, RF Communication System, Microprocessor Fundamentals, Electric Motors and Controls, Applications in C for Eng. Tech, Industrial Electronics, Technical Elective (6 credits), Telecommunication Systems, Advanced Network Analysis, Digital Circuits and Systems, Electronic Communication, Electronic Design Lab, Advanced Data Communication	Professional Engineering Formation, Electrical Principles, Electronic Engineering I, II and III, Signal and Systems, Computer System Engineering, Option Courses (2), Professional Development and Project Planning, Project, Optoelectronics, Microelectronics, System Applications

Table 2.8: Example of Courses for B.Eng.Tech.(Mechanical) in various countries

University	University of South Queensland, Australia (Anon, 2002o)	Kansas State University, USA (Anon, 2002d)	Nottingham Trent University, UK (Anon, 2000e)
Programme (Duration – Credits/Units)	BEngTech in Mechanical Engineering (3 years – 24 units)	B.Sc in Mecahnical Engineering Technology (4 years – 128 credits)	BSc(Honours) in Engineering (Mechanical) (3 years)
Scientific Skills	Foundation Mathematics, Engineering Problem Solving I and II, Engineering Materials, Engineering Statics, Thermodynamics, Introduction to Fluid Mechanics.	College Algebra, Applied Plane, Trigonometry, Introduction to PC Software, Analytical Geometry, Calculus I &II, General Physics I, Applied BASIC Programming, Chemistry I, Advanced Mathematics, Statics, General Physics I, Fluid Mechanics I, Basic Electronics	Engineering Principles, IT and Communications, Engineering Mechanics
Generic Skills	Principles of Professional Engineering and Surveying, Technology and Society, Engineering Management	Expository Writing I and II, Public Speaking , Technical Writing, Science Elective, Humanities or Social Sciences (15 credits), Business Elective, Principles of Macroeconomics	The Engineer Today, Organisation and Business
Professional Skills	Introduction to Engineering Design, Mechanical Drafting, Manufacturing Process, Electrical Technology, Machine Stress, Machine Dynamics, Design of Machine Elements, System Design Materials Technology, Engineering Management Science, Production Engineering, 2 other professional electives	Technical Graphics, Manufacturing Methods, Mechanical Detailing, CNC Machine Processes, Physical Materials and Metallurgy, Materials Strength and Testing, Automated Manufacturing Systems I &II, Dynamics of Machines, Machine Design Technology I &II, Sophomore Design Project, Computer Aided Solid Modeling, Elements of Mechanisms, Applications in C, Programming for Engineering Technology, Advanced Materials Science, Fluid Mechanics II, Advanced CAD/CAM, Electric Power and Devices, Industrial Instrumentation and Controls, Senior Design Project I &II, Tool Design for Manufacturing, Thermodynamics and Heat Transfer	Design and CAD, Engineering Projects, Power and Control, Engineering Design, Manufacturing and Materials, Major Project, Design Project, Thermofluids, Applied Mechanics, Control System Design, Applied Engineering Option

Table 2.9: Example of Courses for Diploma Eng.Tech.(Civil) in various countries

University	Fanshawe College, Canada (Anon, 2002p)	Ethio-Swedish Institute of Building Technology (ESIBT), Adis Ababa , Etophia (Anon, 2002q)	Victoria University, Australia (Anon, 2002r)
Programme (Duration – Credits/Units)	Civil Eng. Technology Diploma (3 Years)	Building Technology Diploma (3 Years)	Advanced Diploma of Engineering Technology (Civil) (2 Years)
Scientific Skills	Basic Autocad, , Fundamentals of computation, Mathematics in Technology I&II, Calculus, Mechanics of Materials, Statistics	Chemistry for Bldg. Engineers, Physics 1&2, Mathematics I & 2, Building Materials 1&2, Engineering Mechanics, Strength of Materials 1 & 2	Engineering Mathematics, Geoscience Geology, Statics, Civil Eng. Materials 1, Intro to Strength of Materials,
Generic	Language & Communication Skills 1,2&3, Workplace legislation, Computer operations, Intermediate Autocad	College English 1 & 2, Building Drawing 1&2, Comp. Application for Building, Sophomore English	Workplace Communication, Engineering Computing, Eng. Graphic, CAD A&B,
Professional Skills	Highway Design Fundamentals, Civil Eng. Drawing, Static, Electronic Surveys, Survey Camp, Fluid Mechanics, Theory of Structures, Building Science, Construction Materials, GIS, Intro. to Plane Surveying, Construction Methods, Highway Technology I & 2, Soil Mechanics Hydrology, Storm and Sanitary Drainage Design, Economics of Civil Eng., Steel Design & Drawings, Contract Administration, Quantities, Municipal Engineering, RC Design, Foundations, Civil Eng. Computer Application, Environmental Drafting, Environmental Technology	Surveying and Setting Out 1 & 2, Building Construction 1 & 2, Building Workshop 1 & 2, Arch. Planning & Design 1&2, Theory of structures, Soil Mechanics & Foundation, Environmental Water Supply & Sanitary, Road Construction, Technical Report writing, Building Con. Management, Fund. of Structural Design, Quantity Surveying & Specification, Building Road Construction, Building Site Supervision,	Load Analysis, Drafting RC, Drafting Roads, Drafting Steelwork, Hydraulics Mechanics, Introduction to Road Engineering, Survey Compilation, Survey Measurement 1&2, Occupational Health & Safety, Eng. Organization, Poject Management, RC Design 1&2, Beam & Column Analysis, Civil Construction Techniques, Civil Estimating, Foundation 1&2, Steel Design, Timber Design, Site Investigation, Civil Eng. Computer Application, Civil Eng. Projects, Planning/Estimating, & Costing,

Table 2.10: Example of Courses for Diploma Eng.Tech.(Electronics) in various countries

University	Kwantlen University College, Canada (Anon, 2002t)	Salina College, Kansas State University, USA (Anon, 2002m)	Sheffield Hallam University, UK (Anon, 2002n)
Programme (Duration – Credits/Units)	Diploma in Electronics Engineering Technology (2 years)	Associate Degree in Electronics Engineering Technology (2 years – 68 credits)	Higher National Diploma in Electronic Engineering (2 years)
Scientific Skills	Computer Applications, Engineering Mathematics I and II, Applied Physics I and II, Differential Equations, C++ Programming	College Algebra, Plane Trigonometry, Intro to PC Software, Analytical Geometry and Calculus I, General Physics I, Applied BASIC Programming, Chemistry	Engineering Principles, Mathematics Computing, Introduction to Programming, Computer Modeling and Math for Electronic Engineering
Generic Skills	Business and Technical, Communication, Engineering Economics I and II	Expository Writing I, Technical Writing, Humanities or Social Sciences (3 credits)	Industrial Studies and Professional Development, Professional Engineering Formation
Professional Skills	Electric Circuits I and II, CAE Graphics and Fabrication, Electronics Circuits I, II and III, Digital System I and II, Communications I, II and III, Signal and Systems, Electrical Machines, Advanced Microprocessors, Control Systems, Work Project	Direct Current Circuits, Alternating Current Circuits, Semiconductor Electronics, Electronic Intrumentation and Measurement, Linear Circuit Design, Electronic Manufacturing I and II, Digital Logic, CAD Applications in Electronics, RF Communication System, Microprocessor Fundamentals	Electrical Principles, Electronic Engineering I, and II, Signal and Systems, Computer System Engineering, Option Courses (1), System Applications

Table 2.11: Example of Courses for Diploma Eng.Tech.(Mechanical) in various countries

University	Swinburne University of Technology, Australia (Anon, 2003f)	Kansas State University(Salina), USA (Anon, 2002s)	Southampton Institute, UK (Anon, 2003g)
Programme (Duration – Credits/Units)	Advanced Diploma of Engineering Technology (Mechanical Engineering) (2 years – 27 modules)	B.Sc in Mecahnical Engineering Technology (2 years – 68 credits)	BTEC HND Mechanical Engineering (2 years – 18 units)
Scientific Skills	Calculus, Engineering Mathematics, Materials Science, Engineering Computing, Introductory Dynamics, Fluid Mechanics 1, Thermodynamics 1, Introduction to Strength of Materials, Static	College Algebra, Applied Plane Trigonometry, Analytical Geometry, Calculus I, General Physics I, Applied BASIC Programming, Chemistry I, Static, General Physics I, Fluid Mechanics I, Basic Electronics	Engineering Science, Mechanical Principles, Analytical Methods of Engineers
Generic Skills	Presenting Reports	Expository Writing I, Technical Writing, Science Elective, Humanities or Social Sciences (3 credit)	Business Management Techniques, Quality Assurance and Management
Professional Skills	CAD, Engineering Graphics, Engineering Drawing, Mechanical Drive Components, Workshop Practices (Fabrication), Workshop Practices (Machining), Manufacturing Processes, Drafting Mechanical – Drive Systems, Materials Engineering, Advanced Machine Design, Dynamics of Industrial Machines, Machine Design, Thermodynamics 2, Fluid Mechanics 2, Advanced Dynamics, Advanced Strength of Materials	Technical Graphics, Manufacturing Methods, Mechanical Detailing, CNC Machine Processes, Physical Materials and Metallurgy, Materials Strength and Testing, Automated Manufacturing Systems I , Dynamics of Machines, Machine Design Technology I, Sophomore Design Project	Digital and Analog Devices, Manufacturing Processes, Further Analytical Methods, Design for Manufacture, Robot Technology Advanced machine Tools, Project Management, Materials Engineering Control Systems and Automation, Project, Engineering Applications

2.3.3 Characteristics and Outcomes

Table 2.12 summarises the expected to have attributes/ability for graduates of accredited engineering and engineering technology programmes ([1] Washington Accord, 2003; [2] IEAust, 2001a; [3] IEI, 2000; [4] ABET, 2001; [5] IEAust, 2001b).

Table 2.12 Attributes/Ability of Engineering and Engineering Technology Graduates

Engineering	Engineering Technology
• apply mathematics, science and engineering science for the design, operation and improvement of systems, processes and machines [1, 2, 3]	• an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines [4, 5]
	• an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology [4]
• formulate and solve complex engineering problems [1, 2, 3]	• an ability to identify, analyze, and solve technical problems [4]
	• an ability to conduct, analyze, and interpret experiments and apply results to improve processes [4]
	• an ability to apply creativity in the design of systems, components, or processes appropriate to Programme objectives [4]
	• an ability to function effectively in teams, [4, 5]
• communicate effectively [1, 2, 3]	• an ability to communicate effectively [4, 5]
• engage in lifelong learning and professional development [1, 2, 3]	• a recognition of the need for, and an ability to engage in lifelong learning [4, 5]
• act in accordance with the ethical principles of the engineering profession [1, 2, 3]	• an ability to understand professional, ethical, and social responsibilities [4, 5]
• function in contemporary society [1, 3] • understand and resolve the environmental, economic, societal implications of engineering work [1, 2, 3]	• respect for diversity and a knowledge of contemporary professional, societal, and global issues [4, 5]
	• a commitment to quality, timeless and continuous improvement [4]

As a whole the engineering technology curricula are to educate and train individuals for industrial positions requiring a sophisticated, but applied technical orientation. Graduates will be capable of solving design and applied engineering problems, as well as performing managerial, business and sales function.

2.3.4 Professional Status

In the United Kingdom, it is the Engineering Council that sets the standard for registration as professional engineer or technician as:

- Chartered Engineer (CEng)
- Incorporated Engineer (IEng)
- Engineering Technician (EngTech)

To become a chartered engineer, the graduate must follow a 4-year academic study (e.g. accredited MEng degree) or 3-year accredited BEng (Hons) degree plus one year of 'matching section' such as an integrated programme of work and study known as the Integrated Graduate Development Scheme. Graduates from a 3-year academic study (e.g. 3-year degree accredited for IEng status or, the 2-year HND plus a 1-year 'matching section') can only register for IEng. There is no pathway for them to becoming a chartered engineer except through the Engineering Council examination (Part I, II and III). Registration as a Chartered Engineer is only possible after having completed a professional review including interview. As a guideline, four to five years of post qualification engineering or technical experience with at least two years in a substantive post is expected to provide sufficient evident of competency.

.The Institution of Engineers, Australia (IEAust) on the other hand recognizes four occupational categories in the engineering team in Australia:

- Professional Engineer
- Engineering Technologist
- Engineering Associate
- Engineering Technician

The academic qualification that leads to the Professional Engineer category is a four-year Bachelor of Engineering degree gained after 12 years of schooling or equivalent. In order to be an Engineering Technologist, a three-year Bachelor of Technology gained after 12 years of schooling or equivalent is required. A two-year Diploma of Engineering gained after 12 years of schooling or equivalent is required to be an Engineering Associate. However, Engineering Technologist and Engineering Associate can proceed to the Professional Engineer path through a matching section by taking additional courses from an approved list of courses of the IEAust.

In Germany, graduates from University, Fachhochschule (FH) and Berufsakademie (BA) are recognised as Professional Engineers by both public and private sectors in Germany. The qualification from Universities and Fachhochshulen as well as Berufsakademie meet different needs of the industry. Graduates from Universities are more research oriented while graduates from FH's and BA’s are application oriented. The BA’s and FH's are more preferred by industry.

All engineering graduates are accepted as fully qualified engineers upon graduation as stipulated in Germany's University Education Law. The law only allows approved universities to conduct engineering programmes. The law also specifies the syllabus and curriculum that are to be followed for a particular engineering degree.

In the USA licensing laws vary from state to state and are exclusively under the control of the individual state legislatures. But generally, the licensure laws for professional engineers require graduation from an accredited, four-year engineering curriculum followed by approximately four years of responsible engineering experience, and finally the successful completion of a written exam.

Generally a candidate for engineering licensure take the Fundamental of Engineering (FE) Examination during the senior year, start work in an engineering position immediately after graduation, and begin to accumulate qualifying engineering experience in order to take the Principles and Practice of Engineering (PE) Examination at the earliest opportunity.

In some states it is possible for non-engineering graduate to obtain the PE licensure by providing certain number of years of experience to substitute for each number of year of education.

The National Institute of Certified Engineering Technologist (NICET), which is a division of the National Society of Professional Engineers (NSPE) provides nationally-applicable voluntary certification programmes covering several broad engineering technology fields and a number of specialized subfields. This certification does not entitle the certificant to practice engineering, which is regulated by the state licensing board.

The Engineering Technologists Certification Programme is awarded at two grades, the Associate Engineering Technologist (AT) and Certified Engineering Technologist (CT). The certification criteria require graduation from an engineering technology bachelor’s degree programme accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC/ABET) coupled with the relevant work experience and endorsement from qualified individuals. The AT grade is available upon graduation and the CT grade requires a minimum of five years work experience (Rosnah, 2002).

In India graduates from the 4-year engineering programme can join the Indian Institutes of Engineers (IIE) as graduate member upon graduation. The next grade of membership is Associate Member, which can only be awarded after ten years of experience while the highest membership grade is Fellow member, which is awarded 5 years after obtaining the Associate Member status. Graduates can practice engineering upon completing their studies.

Engineering graduates in Turkey are required to register with the Association of Engineers before they can join the workforce. They would require a minimum of five years of experience before they are allowed to register as full member, whence they can own their own engineering practice. A further seven years is required before they can sit for examination to be full professional engineers. (Jaafar, 2002)

In Canada the academic requirements needed to become a professional engineer are to meet education standards (4-year programme of 124 credits) established by Canadian Engineering Accreditation Board (CEAB) or its equivalence established by each state professional engineer society. Alternatively, a series of at least 20 three-hour examinations can be taken to gain entry to the profession, and normally done in industry. They must also pass the Professional Practice Examination (PPE) on engineering law and ethics, and meet engineering experience requirements. There is no engineering technologist professional certification despite some universities offering bachelor degree in engineering technology. Most of the engineering technology programmes are at diploma and certificate levels and conducted at various colleges.

In Ireland, those applying for the prestigious registered professional titles of Chartered Engineer (CEng MIEI), Associate Engineer (AEng AMIEI) or Engineering Technician (Eng Tech IEI) must also undergo a Professional Review following some years of engineering work experience. However, The Institution recognises that individuals may acquire and develop engineering skills and knowledge in various ways, both within and outside an educational institution. Therefore, consideration is given for those who meet the appropriate criteria as a result of holding alternative qualifications and/or learning gained from experience.

Holders of engineering-related qualification in such disciplines as physics, technology or computing and who can demonstrate they have suitable knowledge and expertise in a branch of engineering over a period of two or more years (three for MIEI), may apply under the “Individual Case Procedure” (ICP).

Applicants with some or no qualifications in engineering, who can demonstrate suitable knowledge and expertise in a branch of engineering over a significant number of years, and have a proven track record of functioning at a professional engineering level, may apply via the “Mature Route Procedure”(MRP).

Alternatively, it is possible to qualify for Ordinary Membership through the IEI Examination, provided applicants meets specified entry standards. The curriculum, which is based on a programme, which allows a limited choice of subjects to cater for different engineering specializations, involves two levels - Part 1 and Part 2. By holding other technological qualifications, applicants could be entitled to exemptions from certain subjects (Megat Johari, 2002).

The professional engineering experience and training expected by the professional institutions is similar to that stipulated by FEANI include the following (Anon, 2003g):

- The soulution of problems requiring the application of engineering science in the fields such as research, development, design, production, construction, installation, maintenance, engineering sales and marketing, and
- Management or guiding of technical staff, or
- The financial, economical, statutory or legal aspects of engineering tasks, or
- Industrial and/or environmental problem solving

2.3.5 Para Professional Status

In the UK, EdExcel National Certificates and diplomas or Advanced GNVQs are required in order to become Engineering Technicians. With these qualifications, students can also gain access to Higher National Diploma (HND) and later degree course. Alternatively, at least one A-level or appropriate GSEs are required to enter HND courses in engineering

In Germany, student that has less academic performance (e.g *Hauptschule, Realschule*), will opt for apprentice training through dual system training. The system is called 'dual' because vocational training takes place both in the company and in part-time vocational school. The company provides the apprentice mostly with practical training.

Graduate from apprenticeship training obtained *Facharbeiter* (a skilled worker) certificate that allows them to work as a skilled worker/technician of the trade. After obtaining a certification, the person is allowed to work by law in their respective trades. For example, a person that wants to work in motor mechanics must obtain the apprenticeship qualification. After 2 to 3 years of industrial experience, the skill worker/technicians can go for further education to obtain *meister* certification.

The *meister* qualification allows the person to become a trainer in dual-system in industry. Graduate from the vocational training (Fachaibeiter certificate) or meister qualification may pursue academic study at FH to obtain Dipl-Ing. after obtaining a university entrance certification called *Fachhochshulreife.* This certification can be obtained through full-time studies between 1-2 years at the Fachobershule.

The engineering technician certification programme is based on job-task competency and general knowledge-based. The job-task competency programme requires the candidate to have relevant experience to the desired certification, a written examination, supervisor evaluation of On-the-Job performance and recommendation from a qualified individual. It is awarded at 4 levels, each level representing a certain level of performance capabilities. The general knowledge-based certification is designed to evaluate the knowledge acquired by graduates of an engineering technology associate degree programme. Certification is awarded at four grades as follows:

- Technician Trainee (TT)
- Associate Engineering Technician (AET)
- Engineering Technician (ET) and,
- Senior Engineering Technician (SET)

The certification criteria are relevant work experience, a written examination which involves a Part A (fundamentals) and on a Part B (discipline specific), and recommendation from a qualified individual. The TT grade also does not require any work experience if possesses an appropriate associate degree, otherwise a minimum of two years are required. The ET and SET grades require passing of the Part A and B of the examination.

Diploma and Certificate in Engineering in India are only offered by polytechnics, colleges of engineering and Colleges of Technology, with 3-year duration of study. The diploma graduates are considered as assistant engineers and certificate holders are technicians. Diploma holders with good diploma can proceed to university but will have to start from year one, with no credit transfer. Technicians can also become engineers by passing Part A and B examination conducted by IIE (Hasan, 2002).

In Canada certified engineering technicians and technologist is generally classified in 3 categories. These are Certified ASTT, Associate, and Graduate Technologist/Technicians. The Applied Science Technicians and Technologists (ASTT) Act recognises two professional group as follows:

- *Applied Science Technologists (AScT)* – persons who have completed an acceptable programme of studies (usually a Diploma of Technology or academic equivalent) and who have at least two years of current practical experience (minimum one year Canadian experience) in a position of responsibility that reflects a technologist level of education.

- *Certified Technician (CTech)* – persons who have completed an acceptable programme of studies (usually a Certificate of Technology or academic equivalent), and who have at least two years of current practical experience (minimum one year Canadian experience) in a position of responsibility and that reflects a technician level of education.

Persons who are employed or practice but have only Grade 12 education and lack of full academic required for certification are classified as associates. Alternatively, those with full academic qualification but have not yet satisfied the experience requirement can also be classified as Associate.

Persons who have completed accredited technologist or technician programme but have not yet satisfied the experience requirement for certification are classified as graduate technologist/technician.

The Board of Examiners who evaluates application requires that a person provide evidence of attaining a minimum of two years of acceptable, relevant, progressive, accumulated experience, verified by acceptable references. (Noordin, 2002)

2.3 Summary

Basically, the education system in the countries reviewed require between 11 to 13 years of schooling before pursuing higher education at certificate, diploma and degree levels. The review on the existing global trend of the engineering programmes indicates a myriad of approaches to the way the curricula are formulated. The content of the syllabus, mode of delivery and assessment method are the major elements in ensuring and differentiating appropriate level of education. There may not be a significant difference in the content of the syllabus but the depth of the subjects could be different between curricula.

Table 2.13 shows the percentage distribution of the three categories of the curriculum, namely, scientific, professional and generic for some higher institutions. This categorisation is based on the Malaysian Engineering Education Model study (MCED/IEM, 2000) with the generic category referring to global and strategic, industrial, and humanistic skills. The summary provides a basis for comparing the emphasis given in each category by the institutions.

There is a trend of increasing demand for engineering technologists globally. Engineering technologists play a complementary role for engineers and they are a vital component of the workforce for a nation to be industrialised. They are heavily involved in implementing engineering works and applying engineering and scientific knowledge, combine with technical skills to support engineering activities. There is a subtle difference in the definition between engineers and engineering technologists, but their roles are distinct, as reflected in Table 2.12. Engineering technologists are the closest to the engineers in the occupational spectrum as shown in Figure 2.1.

Diplomas and certificates in engineering and engineering technology and bachelor in technology are already established. However, Malaysia needs to enhance her engineering technology sector by providing programmes at Bachelor’s level in engineering technology. As such the engineering technologists will complement the work of traditional engineers. To establish and formulate the Bachelor of Engineering Technology (B.Eng.Tech.) in Malaysia, it requires input from the engineering model characteristics and the global practices, as well as the industry needs. Taking all these factors into consideration, the proposed B.Eng.Tech. model by the study which is expected to meet the needs of the industry and the country as a whole, and should be embraced by the institutions of higher learning.

A summary of the percentage distribution for the three categories in the curriculum at different levels of engineering technology programmes, offered in the various countries, is given in Table 2.14. The generic skills are essentially none in some certificate and undergraduate engineering programmes. However, the generic skills such as communication skills are desirable for a worker to function effectively in an organization and to progress to higher level or promotion.

Table 2.13: Percentage Distribution of Scientific, Professional and Generic Categories in Engineering Technology Curricula at some Higher Institutions

Certificate								
	Cert. of Eng. Government Polytechnic, Malaysia	Cert.3 in Mechanical Eng., Victoria UT, Australia (TAFE, 2002)	Surveying Cert., Columbus State Comm. College, US (Anon, 2002a)	Mech Technical Prep Cert, Humber College, Ontario Canada (Anon, 2000a)	Robotics Cert., Humber College, Ontario Canada (Anon, 2000b)	Cert in Applied Tech (Automotive Eng,) Waikato Inst of Tech, New Zealand (Anon, 2002b)	HND Elect & Manuf Eng – Comp Tech, U of East London, UK (Anon, 2002d)	HND Eng – Mechatronics, U of Glasgow, UK (Anon, 2002e)
Scientific Skills (%)	23.5	10	19	14	0	0	0	9
Professional Skills(%)	64.7	90	70	86	100	100	100	91
Generic Skills (%)	11.8	0	11	0	0	0	0	0
Diploma								
	Dip. In Technology GMI Malaysia	AAS, Virginia Community College, US (Kauffman and Lewis, 2002)	EngTech Delaware Tech & Community College,US (Al-Hajeri and Al-Anezi, 2002)	EngTech, Erie Community College, US (Al-Hajeri and Al-Anezi, 2002)	EngTech, Kuwait (Al-Hajeri and Al-Anezi, 2002)	Dip in Mech Eng Tech – Automated Manuf, Conestoga College, Canada (Anon, 2002c)	Dip in Electronics (Broad-based), Swinburne University of Technology, Australia (Anon, 2002k)	Adv. Dip Eng Tech Civil, Box Hill Inst., Australia (Anon, 2002l)
Scientific Skills (%)	5.5	9	29	30	6	6	8	6
Professional Skills(%)	57.8	69	56	58	78	82	92	91
Generic Skills (%)	32.1	22	15	12	16	12	0	3
Degree								
	Bac. Engineering Technology, MFI Malaysia	BS EIET, U of Northern Iowa, US (Pecen et al., 2002)	BS ET, Penn State Colleges & Universities, US (Kliewer, 2002)	BSc in Automotive Design Technology, University of Bardford, UK (Anon, 2002f)	BSc(Hons) Engineering (Mechanical), The Nottingham Trent University, UK (Anon, 2002g)	B.S. (EET), Pensylvania College of Technology UK (Anon, 2002h)	B.S(EET), Kansas State, US (Anon, 2002i)	B of Electronic Tech, Latrobe, Australia (Anon, 2002j)
Scientific Skills (%)	13.2	17	21	11	6	18	25	24
Professional Skills(%)	66	39	58	86	94	63	52	76
Generic Skills (%)	20.8	44	21	3	0	19	23	0

Table 2.14: Summary Percentage Distribution of Categories in the Engineering Technology Curriculum

Certificate (US, UK, Canada, Australia, Canada, New Zealand)	
Scientific Skills (%)	10-20
Professional Skills(%)	70-100
Generic Skills (%)	Almost nil
Diploma (US, UK, Canada, Australia, Kuwait)	
Scientific Skills (%)	5-30
Professional Skills(%)	60-80
Generic Skills (%)	10-20
Degree (US, UK, Australia)	
Scientific Skills (%)	5-25
Professional Skills(%)	40-90
Generic Skills (%)	0-40

In order to be aligned with global practices and satisfying the industry needs, it is essential that the vision of engineering workforce be enhanced to include the engineering technology component of the engineering fraternity. Engineering technologists and technicians should be given due recognition to their contributions to engineering work. In most countries, engineering technologists and technicians are given recognition as specialists by certified bodies in their fields. Opportunities to be professional engineers are also provided in some countries, as opposed to making engineering technology as an independent stream, which cannot progress further or be promoted within the engineering qualification framework.

3.0 A Vision for the Engineering Workforce

A complete engineering fraternity consists of a spectrum of technical know-how from the competencies in engineering design to highly skilled technical workforce. This spectrum calls for a comprehensive vision to technical education and training.

The engineering profession revolves around the development of practical solutions to industrial problems. Many countries have reinvented the skill development processes and make them more relevant to the needs of industry. Instead of entering a “time-served” training and education systems, students may gain different competencies at different rates and through various routes, leading to a more flexible learning system. Technical education and training in many countries are now more competency-based and flexible, leading to a nationally accredited qualification, and offering wider choices. Employers also prefer a nationally accredited qualification while employees want a portable qualification.

In the effort to remain competitive and relevant in this globalised knowledge-based world, Malaysia has to further develop its technical education and training or the engineering TEVT sector and ensure that her workforce is sufficiently trained and competent to support the diversifying economy. The engineering TEVT sector in Malaysia has to respond to the needs of the government, industry and communities in a rapidly changing world, influenced by globalisation and the latest advances in technology. There is a need for the country to produce and promote the growth of various levels of engineering skills and competencies, apart from the traditional engineering professionals, in the local engineering industry and commerce. The country needs to identify a suitable composition of professional engineers to other engineering categories.

Technicians and the engineering technologists share similar roles such that they make the prototypes that are designed engineers, and then test and make suggestions about redesign and modification about the prototypes and supervise the manufacturing of products. The hands-on ability of the technicians and engineering technologists make them easily to adapt to new processes quicker (30-60 days) than engineers (1 year).

Recognising the importance of highly competent engineering workforce, particularly in this knowledge age and globalisation, there is a need to further develop a Malaysian engineering education and training system, also known as the Malaysian Engineering Qualification Framework (MEQF). This system should include engineering technology component that:

- produces competent engineering workforce that fits the requirement of the country and the global demand.
- encompasses new approaches to learning with greater industry participation.
- nurtures highly competent engineering workforce with thinking culture that provides continuous and flexible opportunity for upward movement. This demands a

comprehensive structure of education and training that leads ultimately to the Professional Engineer status

- produces competent engineering workforce that are adaptable to the advanced and changing technology in the knowledge-economy era
- includes basic fundamentals in religious studies and ethics to produce workforce with high morals and sense of responsibilities

The Malaysian engineering qualification framework together with the occupational grade should be enhanced to include the whole spectrum of the engineering fraternity.

Hence, the vision for the Malaysian Engineering Qualification Framework (MEQF) shall be:

"To develop a highly competent engineering workforce for the global market".

With this vision, it is thus appropriate that an Engineering Technology path, which complements the existing engineering workforce, be introduced in Malaysia. The attributes of graduates in engineering technology, be it bachelor or diploma level, should encompass the followings:

- sufficient knowledge in mathematics and science to analyse, implement and/or improve existing technologies
- apply engineering principles for product improvement, manufacturing and/or operational function.
- ability to work in teams and communicate effectively
- act in accordance with professional ethics and moral and undertake social responsibilities
- committed to lifelong learning
- sufficient knowledge in environmental and global issues
- commitment to quality

As the duration of the course is too brief (usually 12 months) for certificate level, there is a need to focus more on skill development, and thus less emphasis is expected on the generic quality.

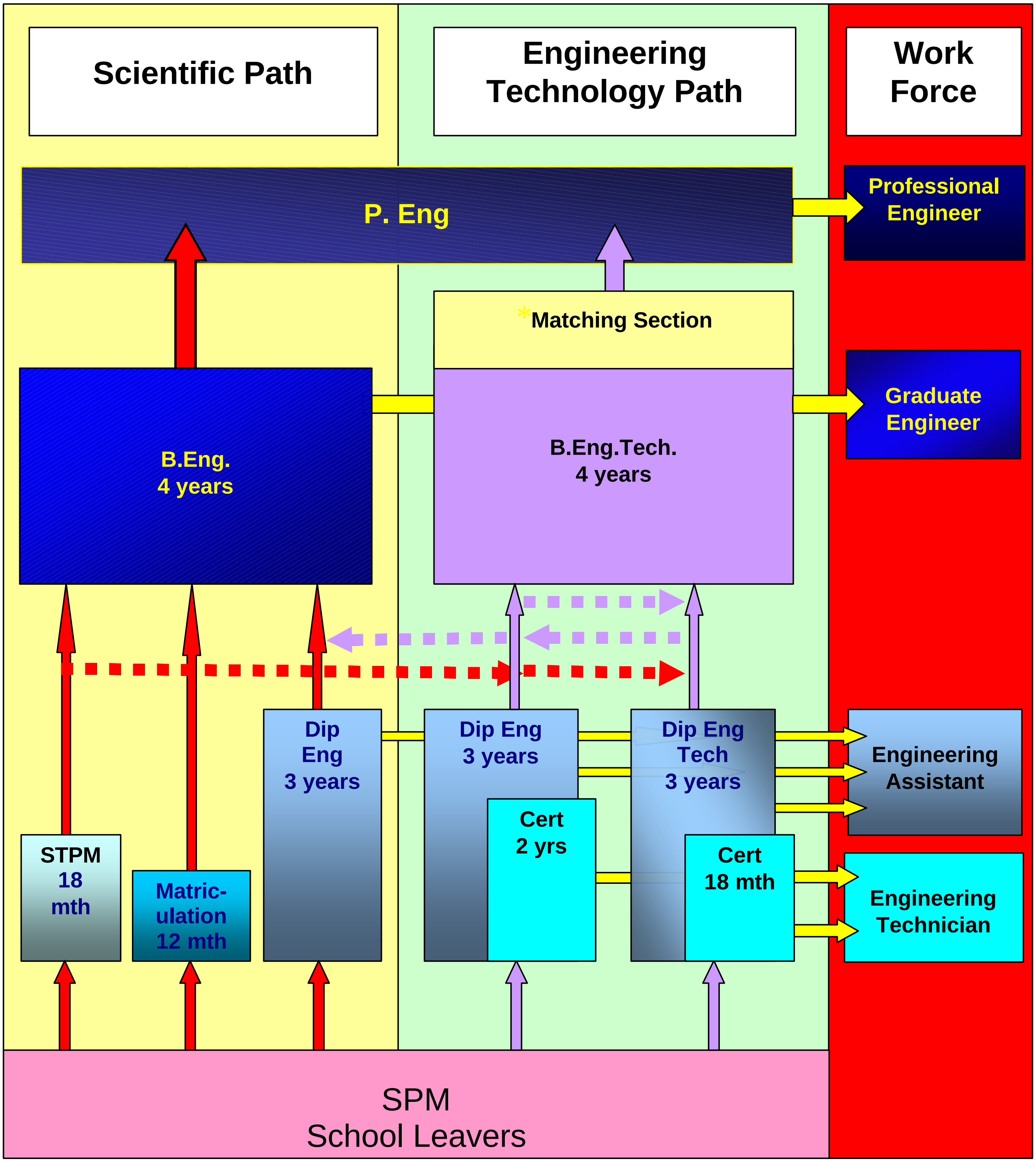
4.0 Proposed Engineering Technology Path

4.1 Education, Training and Professional Development Route

Figure 4.1 shows the education, training and professional development routes. The standard qualification to register as a professional engineer in Malaysia is an accredited engineering degree at the undergraduate level. This has been the major route for all these years, while a small percentage comes from those passing the IEM/BEM graduate examination (Part I and II). The four-year undergraduate engineering degree has its main feeder from STPM and Matriculation apart from the diploma holders. Those taking the Part I and II examinations are usually holders of unrecognised engineering degree, recognised science degree, recognised and unrecognised engineering diploma, and those who have been working in the discipline without any tertiary academic qualification. Part I exemption is usually given to recognized diploma qualification upwards.

The figure also shows that the minimum number of years to graduate with an undergraduate engineering degree is five years, for those going through the matriculation channel. Those with a diploma may graduate within six years, if a two-year exemption is given, as practiced at few local universities and university colleges. A minimum of four years of working experience in the respective disciplines would qualify a person to apply for registration with the Board of Engineers, Malaysia for the status of a professional engineer. This route has always been regarded as the academic route or the scientific path as defined by the Malaysian engineering education model report (MCED/IEM, 2000). Details of the competencies and skills required for this route has been discussed in the report, which comprises the following:

- Global and strategic – skills which enable students to adapt easily within the borderless world which is experiencing rapid expanding knowledge
- Industrial – skills that goes beyond the scientific and professional and which are necessary in the advance phase of the graduate's career, such as, management, law, environment, communication, finance and economics
- Humanistic – skills that help create a balanced engineer with high ethical and moral standards
- Practical – skills that enable students to be directly involved with hands-on activities or real-life situations, thus providing the basis for integrating the intra and inter engineering and non-engineering knowledge
- Professional – skills that cover technical competency aspects, which are required to perform specific engineering tasks including design of components or systems
- Scientific – skills that enable students to have a firm foundation in engineering science, thus enabling them to realign themselves with the changes in emphasis in the scientific field, and to develop an interest in R&D and design



*Matching section varies according to the candidate's academic and professional achievements, for example one year of final year BEng programme courses

Fig 4.1 MEET Education, Training and Professional Development Routes

The IEM/BEM graduate examination route has its roots from the Engineering Council (EC), UK Part I and II examinations, which are currently undergoing a transformation to include a Part III. With the introduction of the Part III, it is expected that those who have completed all the examinations would qualify as equivalent to the MEng degree holder. The IEM/BEM examination is also being expanded into three parts but does not include the project work as required by the EC, UK. This report does not intend to include this route in its discussion on the path to professional engineering status. It will still remain as an alternative route to the scientific route, until a detailed study is conducted to re-evaluate its equivalency and effectiveness.

The growing interest in developing an alternative route to the scientific route that has been termed as "hands-on" engineering or engineering technology, triggered the need to consider them in a proper perspective. This is beyond the existing three-year engineering programmes, which had its roots from the twinning programmes with overseas universities, mostly from the UK. The Board of Engineers Malaysia does not recognise any three-year programmes since the acceptance of the Malaysian engineering education model. Despite the situation, interest in the three-year programme is still there, especially in the private institutions of higher learning. This is motivated mainly by the costs and the degree awarded which has the overseas label. Those graduated from a three-year programme may possibly progress further through a matching section. However, it is not within the scope of the study to provide the input of the matching section required since a different rational would be required in dealing with the three-year engineering programmes.

"Hands-on" has been loosely defined as the education and training method that would equip graduates with necessary technical skills, ready to undertake the responsibilities in industries. The "hands-on" or "learning by doing" is expected from the inclusion of the basic machining workshop skills and the industrial placement in the curriculum. Programme labels such as Technology and Engineering Technology are being used or proposed to connote the "hands-on" element.

The global engineering education comparison to this group of programmes indicates a resemblance of the German model of the Fachoschulen (university of applied sciences) or the polytechnics degrees of the UK, prior to them being chartered as universities. The American equivalent is the Engineering Technology programmes which have their roots from the World War II by interested parties who had been involved in the war industries to continue their study. This has evolved into a two-year Associate degree. Presently, the two-year Associate degree holder is allowed to progress into a four-year Engineering Technology degree programme with a two-year exemption. The Australian equivalent is the three-year Bachelor of Technology programme which incorporates the "hands-on" skills. The entrance requirement for all these global programmes is an equivalent of the A-levels or the Arbitur. This is very much different from the Malaysian Engineering Technology programme where the programme is expected to draw its pool of students mostly from the certificate and diploma holders. However, as shown in Figure 4.1, students from the STPM and Matriculation can also opt for the Engineering Technology programme, but the migration into this alternative path would be relatively minimal. Those having gone through the diploma programme with greater emphasis on the “hands-on” components could also migrate into the scientific path if qualified to do so.

It is expected that students with lower academic qualification than those entering the scientific path would be drawn into these Engineering Technology programmes. As such, there is a need to package the programme to consider the entry requirement, the need of the industry and the changing emphasis of the engineering works. This report does not include the Technology programme in its discussion as the engineering components are negligible, and thus falls out of the engineering scope. However, Technology programmes that satisfy the definition and/or requirements of the engineering category are considered as engineering programmes.

A four-year Engineering Technology programme is proposed as an alternative path for the progression into the professional route, after reviewing the trends in the global and local engineering education and training, and the entry requirement. Students are expected to be given more practical skills and greater exposure to laboratory type work. This emphasis would mean greater contact hours but lower credit allocation given to them, unlike the traditional lectures where one hour is equivalent to a credit hour. A credit is equivalent to two to three hours of practical or laboratory works, as defined in the MCED/IEM earlier study. Despite a lower credit loading for the programme, the contact hours or duration of the study would be equivalent to that of a degree programme of the scientific path. More basic sciences subjects would be required in this programme as the entry requirement is more lenient, in order to ensure that students are able to grasps the required technical understanding. The breadth and depth of a programme are influenced by the limitation of the programme duration and the entry qualification. As such, a reduction of the scientific and/or the professional components of the programme are needed to make way for the basic sciences content.

In order to allow progression into the professional engineers route, graduates of the Engineering Technology programme is required to do a matching section. In the matching section, courses from the scientific and professional components, an equivalent of one-year study duration would be required to bring the Engineering Technologists at par to the engineering graduates from the scientific path. However, a Masters programme in engineering or engineering technology could be considered as an equivalent matching section for progression to the professional route. Graduates in Engineering Technology can, however, join the workforce as engineers but cannot progress to become professional engineers without going through the matching section, even with the work experience.

The Engineering Technology programme is expected to produce competent workers that would complement the engineers from the scientific path, with each having slightly different traits but both having the minimum academic exposure to function as an engineer. As a whole, the study supports the creation of the alternative path, the Engineering Technology, which should be allowed to progress further into the professional route, instead of being a terminal degree. This would ensure the continual upgrading of the knowledge and competencies of engineers. Any indication to limit the progression of engineering technologists into the professional route should be seen as a step backward and creating a second-class professional in the engineering sector.

Those who progressed through the engineering technology route must also abide by the training requirements of the Board of Engineers Malaysia in order to be considered for the professional engineer status. The duration of training period would be the same, i.e. four years, and applicants must satisfy the other requirements of the Board.

The engineering technology diploma and certificate graduates are also allowed to crossover to the scientific route provided they satisfy the academic requirements of the scientific path. Such integration of the engineering routes would facilitate transfer between the paths based on the recognition of the qualification levels of both paths.

The creation of the alternative path is also in line with the global trend of having engineers, engineering technologists and engineering technicians. The Engineering Technology programme would also be able to gain recognition among the Sydney Accord signatories with regard to the duration of the programme. However, efforts to ensure the equivalence or higher level standard, as stipulated by the Accord must be exhibited in order to gain the recognition. The mobility of engineering technologists would thus be enhanced with the recognition.

4.2 Engineering Technology Curricula

In curricula development the entry requirement, content of the syllabus, mode of delivery and assessment method are the major elements in ensuring appropriate and effective learning, as well as providing a means of evaluation. A lower entry requirement indirectly determines the structure of a curriculum. This may require the reintroduction of foundation subjects, such as mathematics and basic sciences. As such, it may extend the duration of the programme.

There may not be a significant difference in the content of the syllabus but the depth of the subject could be different between curricula. The mode of delivery may be through lectures, laboratory works, tutorials and group works, with some taking more problem-oriented approach rather than the traditional teacher-student approach. The assessment may be in the form of traditional examination and coursework.

It is through the variation of these elements that the engineering and engineering technology programmes are differentiated in the study. The study, however, does not aim to be prescriptive such that the creativity and innovativeness of a programme are restricted.

Figure 4.2 illustrates the breadth and depth of the MEET bachelor curriculum proposed as compared to the traditional engineering curriculum. It is expected that the Engineering Technology curriculum would cover less of the scientific category and at lesser depth (to include the basic science and mathematics) than the traditional engineering. The depth of the professional category is expected to be higher for engineering technology since it is “area focused”, and thus limits the breadth of coverage of subject area. The traditional engineering on the other hand has greater breadth and lesser depth. Similarly there is a greater breadth on the generic category with the engineering curriculum, unlike that of engineering technology. The lesser breadth of the engineering technology is the result of the “area focused” and the inclusion of the fundamental courses (basic science and mathematics), as well as the longer duration of the industrial training, which limit the number of courses that can be introduced. The traditional engineering has minimal industrial training, which is normally held during the vacation period.

As highlighted in chapter two, the existing global trend of engineering programmes indicates numerous approaches in the way curricula are developed. This is further supported by the data shown in Table 2.13, which shows the percentage distribution of the three categories of subjects, namely, scientific, professional and generic, which vary among institutions and countries. The generic skills are virtually none in some certificate programmes, which is acceptable if aimed at producing skilled workers. However, the communication skill is still desirable as a worker cannot function effectively in an organization without it. Similarly, for the purpose of progression to higher levels or promotion, the non-technical capabilities would become important criteria for consideration. Surprisingly, there still exist undergraduate engineering programmes that are devoid of the generic skills.

The proposed engineering technology curricula at bachelor, diploma and certificate levels, also known as the Malaysian Engineering Technologist and Engineering Technician (MEET) model, are shown in Table 4.1 a, b and c, respectively. The bachelor's level programme is compared with the Bachelor of Engineering programme based on the Malaysian Engineering Education Model characteristics, whereas, the categorisation of the diploma and certificate programmes are based on the three major groups, namely, scientific, professional and generic (comprising global and strategic, industrial, and humanistic) skills. Since Engineering Technology is more "hands-on" oriented, the mode of delivery is expected to be different from the scientific engineering path. The delivery is more practical based and problem-oriented with assessment mainly through coursework and group work.

Table 4.2 shows the comparison of a typical Bachelor of Civil Engineering Technology programme with the requirements of the Malaysian Engineering Accreditation Council (EAC) and the Malaysian Engineering Education Model (MEEM). It is observed that in the engineering technology curriculum, the professional courses are built around specialisations, and there is less coverage in other categories.

The curricula for engineering technology require considerable applied experience in industrial processes. Substantial supporting laboratories are required in conducting the engineering technology programme. The curriculum elements are directed toward development of the ability to apply pertinent knowledge through the solution of practical problems in the graduates' specialty. Hands-on training provides the student with significant real world experience. Fundamental courses in basic science and mathematics are required to supplement the programme, and supported also by courses in communications and humanities.

Table 4.3 a, b and c, Tables 4.4 a, b and c, Tables 4.5 a, b and c, and Tables 4.6 a, b and c provide the calibration for four major disciplines of engineering technology, namely, civil, electronic, electrical and mechanical engineering.

At bachelors level, graduates of Civil Engineering Technology are to assist professional engineers in a wide variety of projects, among others, from transportation, to sewer and water supply, to environmental solutions. The programme has a strong foundation in mathematics and science and reinforced with communication, computers, and area focused electives.

The Electronic Engineering Technology programme gives graduates the skills required to design and troubleshoot electronic systems in such industries as oil and gas, telecommunications, computer systems, manufacturing, biomedical, and industrial instrumentation and control. The programme includes analog and digital electronics, computer programming and interfacing, industrial electronics and troubleshooting techniques. The first semester of this programme is usually common with Electrical Engineering

Technology. The Electrical Engineering Technology programme focus on handling electrical machines and power systems, including high energy systems. Students enrolling in these programmes must be prepared to undertake a demanding and intensive Programme of study that is comprehensive and highly technical in content.

Mechanical Engineering Technology focuses primarily on analysing, applying, implementing, and improving existing technologies and is aimed at preparing graduates for the practice of engineering closest to the product improvement, manufacturing, and engineering operational functions. The field of Mechanical Engineering Technology includes: mechanical design, manufacturing processes, energy utilisation, building air conditioning and the economics of these activities. Lectures emphasise applied engineering and are supplemented by extensive laboratory experience.

It can be seen that the curricula contents are similar with the traditional engineering courses. However the differences are on the mode of deliveries and the breadth and depth of the subjects offered within the specific curricula. Figure 4.2 illustrates the relative composition of the subject categories for both engineering and engineering technology programmes.

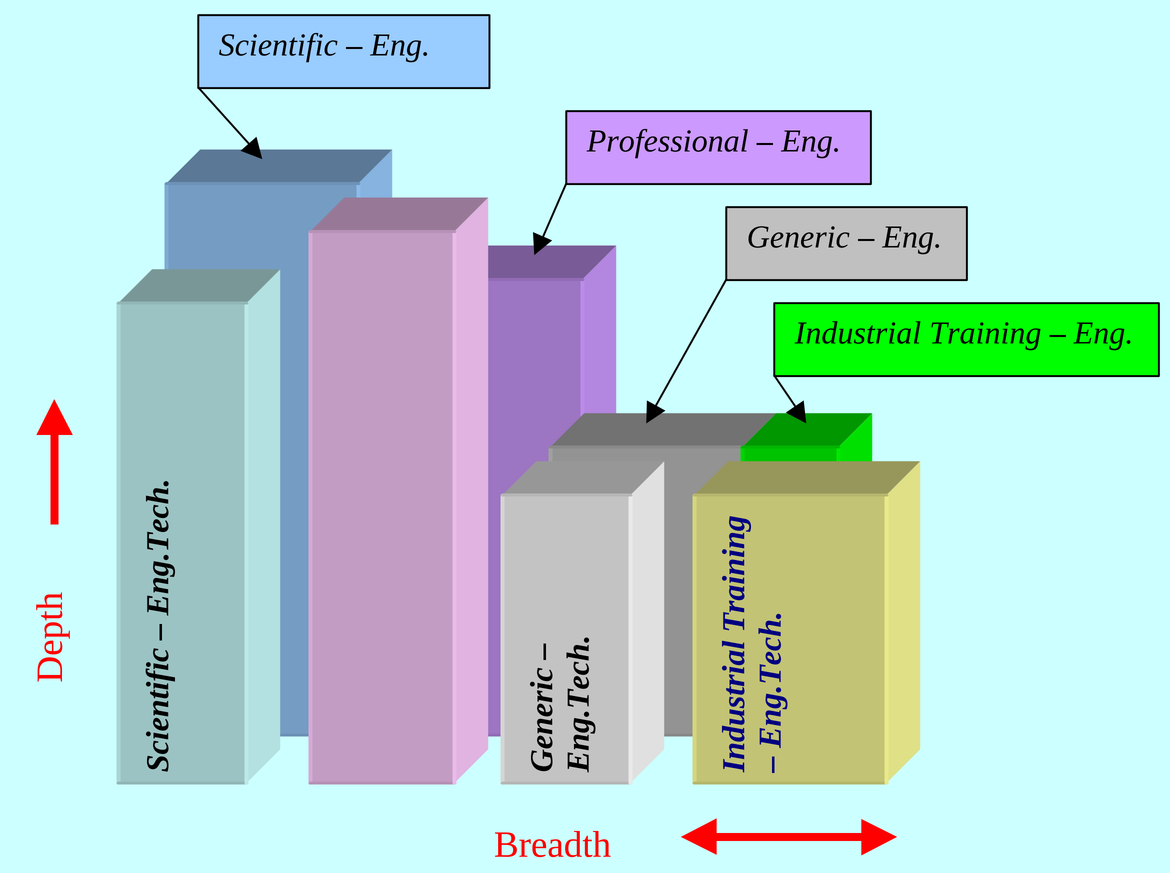


Figure 4.2: Breadth and Depth Relationships between Engineering (Eng.) and Engineering Technology (Eng.Tech.) at Bachelor Degree

Table 4.1a MEET Education and Training Model for Bachelor Degree

<table>
<tr><th>Category</th><th>Malaysian Engineering Education Model Percentage Distribution (130 credits*)</th><th>MEET Engineering Technology Proposed Percentage Distribution (120 credits)</th><th>Summary Percentage Distribution from Selected Countries (From Table 2.14)</th></tr>
<tr><td>Qualification</td><td>B.Eng.</td><td>B.Eng.Tech.</td><td>-</td></tr>
<tr><td>Professional Skills</td><td rowspan="2">50 – 35 %
(65-45)</td><td rowspan="2">65 – 75 %
(78-90)</td><td rowspan="2">40 – 90 %</td></tr>
<tr><td>Practical Skills</td></tr>
<tr><td>Scientific Skills</td><td>20 – 35 %
(25-45)</td><td rowspan="2">15 – 20 %
(18-24)</td><td rowspan="2">5 – 25 %</td></tr>
<tr><td>Basic Science and Math Skills</td><td>-</td></tr>
<tr><td>Global and Strategic Skills</td><td rowspan="3">30 %
(40)</td><td rowspan="3">15 – 20 %
(18-24)</td><td rowspan="3">0 – 40 %</td></tr>
<tr><td>Industrial Skills</td></tr>
<tr><td>Humanistic Skills</td></tr>
<tr><td>Delivery/Assessment (Theory : Practical)</td><td>80 : 20**</td><td>50 : 50**</td><td>-</td></tr>
</table>

NB: Entry requirements into these programmes varies.
* EAC minimum total credit is 120.
** Ratio of contact times.

Table 4.1b MEET Education and Training Model for Diploma

Qualification	Diploma in Engineering (based on MEEM)	Diploma in Engineering Technology	Summary Percentage Distribution from Selected Countries (From Table 2.14)
Total Credit	90	90	-
[1] Professional Skills	65-75%	50-60%	60-80%
[2] Scientific Skills	15-20%	25-30%	5-30%
[3] Generic Skills	15-20%	15-20%	10-20%
Delivery (Theory : Practical)	70 : 30	50 : 50	-

Table 4.1c MEET Education and Training Model for Certificate

Qualification	Certificate in Engineering	Certificate in Engineering Technology	Summary Percentage Distribution from Selected Countries (From Table 2.14)
Total Credit	50	50	-
[1] Professional Skills	65-75%	65-75%	40-90%
[2] Scientific Skills	15-25%	15-25%	5-25%
[3] Generic Skills	10-15%	10-15%	10-20%
Delivery (Theory : Practical)	70 : 30	50 : 50	-

[1] Professional skills : covers professional and practical courses
[2] Scientific skills : covers basic sciences and scientific courses
[3] Generic skills : covers global & strategic, industrial and humanistic courses

Table 4.2: MEET curriculum for Bachelor of Civil Engineering Technology in comparison with the requirements of the Engineering Accreditation Council (EAC) and Malaysian Engineering Education Model (MEEM)

Bachelor of Engineering (BEM, ___)		Bachelor of Engineering (Megat Johari et. al., 2002a)		MEET Bachelor of Engineering Technology	
Skills & Competencies	EAC Requirement	Skills & Competencies	Malaysian Engineering Education Model	Skills & Competencies	Civil Engineering Technology Curriculum
Engineering Sciences and Principles	Strength and Properties of materials, Static and Dynamics, Structural Analysis and Design, Fluid mechanics and Hydraulics, Soil mechanics, Geotechnical Engineering and Geology, Water resource and Environmental engineering, Highway and Transportation Engineering, Surveying and Construction.	Professional	Structural Design 1 and 2, Foundation Eng., Hydraulics and Hydrology 1, Water and Wastewater Eng., Eng. Geomatic, Survey Camp, Eng. Traffics, Highway Eng., Project Management, Technical Electives (min. 4 subjects e.g. Retaining and Earth Structures, Water Supply and Sewerage, Hydraulics & Hydrology II, Public Health Engineering, Pavement Analysis and Design, Traffic Safety and Analysis, Advanced Concrete and Steel Design)	Professional	Civil Technology, Mechanics of Materials, Structural Analysis, Environmental Technology, Construction Surveying, Concrete Design I&II, Steel Design I&II, Route Surveying, Infrastructure Design and Construction, Construction Methods, Construction Estimating, Construction Law, Hydrology and Hydraulics, Applied Hydrology, Road Design and Location, Construction Engineering, Municipal Services, Engineering Practice for Soil & Water Engineering, Civil Eng. Materials, Soil Mechanics and Foundation
Practical – Engineering Applications	Industrial practice and Final Year Project – Materials, Design and Construction	Practical	Workshop Management and Practice, Final Year Academic Project, Engineering Design	Practical	Structural & Civil Eng. Drawing, Industrial Training*, Design Projects, Workshop Technology
Mathematics and Computing	Computer aided analysis and design, Economics analysis, Databases and IS, OR, Business Management systems, Numerical Methods	Scientific	Eng. Mathematics 1 and 2, Eng. Statistics, Numerical Methods, Eng. Mechanics, Strength of Materials, Structural Analysis 1 and 2, Soil Mechanics 1 and 2, Fluid Mechanics, Eng. and Construction Materials, Eng. Statistics, Comp. Programming and Application, Electronic and Electrical Technology	Scientific	Technical Programming, Chemistry, Physics I & II, Calculus I & II, Mechanics I & II, Fluid Mechanics
General	Communication skills, Humanities and ethics	Global and Strategic	English for Academic Purposes, Writing for Academic Purposes, Interactive Speaking, Creative Thinking, Introduction to Environmental Eng.	Global and Strategic	Technical Writing, Communication
-	-	Industrial	Principles and Practice in Communication, Engineering and Society, Financial Management in Construction Project, Construction Law and Contract, Economic Principles		Engineering Economy, Engineers and Society
Humanistic	Tamadun Islam, Tamadun Asia, Kenegaraan	Humanistic	Islamic Civilization, Asian Civilization and Malaysian Nationhood		Islamic Civilization, Asian Civilization and Malaysian Nationhood

* Industrial training for MEET B.Eng.Tech. is recommended to be conducted for one semester

Table 4.3a: MEET Calibration for B.Eng.Tech.(Civil) compared with MEEM's B.Eng.(Civil)

BACHELOR OF ENGINEERING (MEEM)			**BACHELOR OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (130 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (120 credits Total)	Courses
Professional Practical	35 – 50 % (45-65)	Structural Design 1 and 2, Foundation Eng., Hydraulics and Hydrology 1, Water and Wastewater Eng., Eng. Geomatic, Survey Camp, Eng. Traffics, Highway Eng., Project Management, Technical Electives (min. 4 subjects e.g. Retaining and Earth Structures, Water Supply and Sewerage, Hydraulics & Hydrology II, Public Health Engineering, Pavement Analysis and Design, Traffic Safety and Analysis, Advanced Concrete and Steel Design). Workshop Management and Practice, Final Year Academic Project, Engineering Design	Professional	65 – 75 % (78-90)	Civil Technology, Mechanics of Materials, Structural Analysis, Environmental Technology, Construction Surveying, Concrete Design I&II, Steel Design I&II, Route Surveying, Infrastructure Design and Construction, Construction Methods, Construction Estimating, Construction Law, Hydrology and Hydraulics, Applied Hydrology, Road Design and Location, Construction Engineering, Municipal Services, Engineering Practice for Soil & Water Engineering, Civil Eng. Materials, Soil Mechanics and Foundation, Structural & Civil Eng. Drawing, Industrial Training, Design Projects, Workshop Technology
Scientific	20 – 35 % (25-45)	Eng. Mathematics 1 and 2, Eng. Statistics, Numerical Methods, Eng. Mechanics, Strength of Materials, Structural Analysis 1 and 2, Soil Mechanics 1 and 2, Eng. and Construction Materials, Fluid Mechanics, Eng. Statistics, Comp. Programming and Application, Electronic and Electrical Technology	Scientific	15 – 20 % (18-24)	Technical Programming, Chemistry, Physics I & II, Calculus I & II, Mechanics I & II, Fluid Mechanics
	-		Basic Science and Mathematics		
Global and Strategic Industrial Humanistic	30 % (40)	English for Academic Purposes, Writing for Academic Purposes, Interactive Speaking, Creative Thinking, Introduction to Environmental Eng. Principles and Practice in Communication, Engineering and Society, Financial Management in Construction Project, Construction Law and Contract, Economic Principles, Islamic Civilization, Asian Civilization and Malaysian Nationhood	Generic	15 – 20 % (18-24)	Technical Writing, Communication, Engineering Economy, Engineers and Society, Islamic Civilization, Asian Civilization and Malaysian Nationhood

Table 4.3b: MEET Calibration for Dip.Eng.Tech.(Civil) compared with a typical Dip.Eng.(Civil) Curriculum

DIPLOMA OF ENGINEERING			DIPLOMA OF ENGINEERING TECHNOLOGY (MEET)		
Skills & Competencies	% Distribution (90 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (90 credits Total)	Courses
Professional Practical	65-75 % (55-60)	Mechanics of Materials, Structural Analysis and Design 1 and 2, Soil Mechanics and Foundation Eng., Fluid Mechanics, Hydrology, Water and Wastewater Eng., Engineering Geomatic, Survey Camp, Highway and Traffic, Civil and Structural Engineering Drawing, Engineering Workshop, Industrial Training	Professional	50-60% (45-55)	Intro. to Plane Surveying, Electronic Surveys, Survey Camp, Highway Design Fundamentals, Highway Technology I & 2, Civil Eng. Drawing, Construction Materials and Methods, Contract Administration and Quantities, Hydrology, Storm and Sanitary Drainage Design, Theory of Structures, RC, Steel Design & Drawings, Foundations, Environmental Technology, Engineering Workshop, Industrial Training
Scientific Basic Science and Mathematics	15-20 % (15-20)	Calculus, Physics, Chemistry, Mechanics, Eng. and Construction Materials, Comp. Programming and Application, Electronic and Electrical Technology	Scientific Basic Science and Mathematics	25-30 % (25-30)	Mathematics in Technology I&II, Calculus, Mechanics, Trigonometry, Algebra, Physics, Chemistry, Soil Mechanics, Mechanics of Materials, Fundamentals of Computation, Fluid Mechanics
Global and Strategic Industrial Humanistic	15-20 % (15-20)	Language & Communication Skills 1,2&3, Engineering Drawing, Intermediate Autocad, Workplace legislation	Generic	15-20 % (15-20)	Language & Communication Skills 1,2&3, Engineering Drawing, Intermediate Autocad, Workplace legislation

4.3c: MEET Calibration for Cert.Eng.Tech.(Civil) compared with a typical Cert.Eng.(Civil) Curriculum

CERTIFICATE OF ENGINEERING			**CERTIFICATE OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (50 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (50 credits Total)	Courses
Professional	65-75 % (33-36)	Engineering Drawing, Intermediate Autocad, Civil Eng. Drawing, Surveying, Highway Technology I & 2, Construction Materials and Methods, Hydraulics and Hydrology, Mechanics of Materials, Soil Mechanics, Engineering Workshop.	Professional	65-75 % (33-36)	Engineering Drawing, Intermediate Autocad, Civil Eng. Drawing, Surveying, Highway Technology I & 2, Construction Materials and Methods, Hydrology, Storm and Sanitary Drainage Design, Mechanics of Materials, Soil Mechanics, Engineering Workshop.
Practical					
Scientific	15-20 % (7-14)	Trigonometry, Algebra, Calculus, Physics, Chemistry	Scientific	15-20 % (7-14)	Trigonometry, Algebra, Calculus, Physics, Chemistry
Basic Science and Mathematics			Basic Science and Mathematics		
Global and Strategic	10-15 % (7-14)	Language, Tamadun Islam, Moral, Enterprises,	Generic	10-15 % (7-14)	Language, Tamadun Islam, Moral, Enterprise
Industrial					
Humanistic					

4.4a: MEET Calibration for B.Eng.Tech.(Electronic) compared with MEEM's B.Eng.(Electronic)

BACHELOR OF ENGINEERING (MEEM)			**BACHELOR OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (130 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (120 credits Total)	Courses
Professional Practical	35 – 50 % (45-65)	Intro to Electronics, DC and AC Circuit Fundamental, Circuit Analysis, Semiconductor Devices, Analog Devices and Circuits, Digital Concepts, Operational Amplifier, Digital Logic, Digital Systems, Network Analysis, Microcontrollers, Linear System Analysis, Microprocessor Systems, Communication Systems and Analysis and Design Analog Integrated Circuits and Final Year Project	Professional	65 – 75 % (78-90)	Intro to Electronics, DC and AC Circuit Fundamental, Circuit Analysis, Semiconductor Devices, Analog Devices and Circuits, Digital Concepts, Operational Amplifier, Digital Logic, Digital Systems, Network Analysis, Microcontrollers, Linear System Analysis, Microprocessor Systems, Communication Systems and Analysis and Design Analog Integrated Circuits. and Final Year Project.
Scientific	20 – 35 % (25-45)	Differential and Integral Calculus, Statistics, Differential Equations, and Advance Applied Mathematics	Scientific	15 – 20 % (18-24)	Algebra, Trigonometry, Differential Calculus, Integral Calculus, Physics, and Applied Differential Equations
	-		Basic Science and Mathematics		
Global and Strategic Industrial Humanistic	30 % (40)	**Global & Strategic**: Public Speaking, English Composition, and Technical Report Writing. **Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.	Generic	15 – 20 % (18-24)	**Global & Strategic**: Public Speaking, English Composition, and Technical Report Writing, **Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.

4.4b: MEET Calibration for Dip.Eng.Tech.(Electronic) compared with a typical Dip.Eng.(Electronic) Curriculum

DIPLOMA OF ENGINEERING			**DIPLOMA OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (90 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (90 credits Total)	Courses
Professional	65-75 % (55-60)	Semiconductor Devices, Circuit Analysis, Analog Devices and Circuits, Digital Logic, Operational Amplifier, Intro to Microcontroller, Electronics, DC and AC Circuit Fundamental, Computer Organization and Practical Training	Professional	50-60% (45-55)	Semiconductor Devices, Circuit Analysis, Analog Devices and Circuits, Digital Logic, Operational Amplifier, Intro to Microcontroller, Electronics, DC and AC Circuit Fundamental, and Computer Organization and Practical Training.
Practical					
Scientific	15-20 % (15-20)	Trigonometry, Algebra, Beginning C Programming, Analytical Geometry and Differential Calculus	Scientific	25-30 % (25-30)	Trigonometry, Algebra, Beginning C Programming, Analytical Geometry.
Basic Science and Mathematics			Basic Science and Mathematics		
Global and Strategic	15-20 % (15-20)	**Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.	Generic	15-20 % (15-20)	**Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.
Industrial					
Humanistic					

4.4c: MEET Calibration for Cert.Eng.Tech.(Electronic) compared with a typical Cert.Eng.(Electronic) Curriculum

CERTIFICATE OF ENGINEERING			**CERTIFICATE OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (50 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (50 credits Total)	Courses
Professional Practical	65-75 % (33-36)	Semiconductor Devices, Circuit Analysis, Analog Devices and Circuits, Digital Logic, Operational Amplifier, Intro to Microcontroller, Electronics, DC and AC Circuit Fundamental, Semiconductor Devices Lab, Circuit Analysis Labs, Analog Devices and Circuit Lab, Logic Lab, Operational Amplifier Lab, Microcontroller Lab, Electronics Lab, and DC and AC Lab	Professional	65-75 % (33-36)	Semiconductor Devices, Circuit Analysis, Analog Devices and Circuits, Digital Logic, Operational Amplifier, Intro to Microcontroller, Electronics, DC and AC Circuit Fundamental, Semiconductor Devices Lab, Circuit Analysis Labs, Analog Devices and Circuit Lab, Logic Lab, Operational Amplifier Lab, Microcontroller Lab, Electronics Lab, and DC and AC Lab
Scientific Basic Science and Mathematics	15-20 % (7-14)	General Physics, Trigonometry, Algebra, Beginning C Programming	Scientific Basic Science and Mathematics	15-20 % (7-14)	General Physics, Trigonometry, Algebra, Beginning C Programming
Global and Strategic Industrial Humanistic	10-15 % (7-14)	Preparation for Employment, Tamadun Islam, Kenegaraan, Moral Studies and Kemahiran Kemanusiaan	Generic	10-15 % (7-14)	Preparation for Employment, Tamadun Islam, Kenegaraan, Moral Studies and Kemahiran Kemanusiaan

4.5a: MEET Calibration for B.Eng.Tech.(Electrical) compared with MEEM's B.Eng.(Electrical)

BACHELOR OF ENGINEERING (MEEM)			**BACHELOR OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (130 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (120 credits Total)	Courses
Professional Practical	35 – 50 % (45-65)	Introduction to Electrical and Electronics Technology, DC and AC Circuit Fundamental, Circuit Analysis, Semiconductor Devices, Analog Devices and Circuits, Digital Concepts, Digital Logic, Digital Systems, Network Analysis, Electromagnetic Field and Waves, Control and Automation System, Measurement and Instrumentations, Microcontrollers, Linear System Analysis, Microprocessor Systems, Power System, Power Electronics, and Final Year Project	Professional	65 – 75 % (78-90)	Introduction to Electrical and Electronics Technology, DC and AC Circuit Fundamental and Analysis, Semiconductor Devices, Analog Devices and Circuits, Digital Logic and Systems, Network Analysis, Electromagnetic Field and Waves, Microcontrollers, Control and Automation System, Measurement and Instrumentations, Microprocessor Systems, Power Electronics, Electrical Power Systems and Electrical Machines and Drives. DC and AC Circuit Fundamental Lab, and Final Year Project.
Scientific	20 – 35 % (25-45)	Differential and Integral Calculus, Statistics, Differential Equations, and Advance Applied Mathematics	Scientific	15 – 20 % (18-24)	Algebra, Trigonometry, Differential Calculus, Integral Calculus, Physics, and Applied Differential Equations
	-		Basic Science and Mathematics		
Global and Strategic Industrial Humanistic	30 % (40)	**Global & Strategic**: Public Speaking, English Composition, and Technical Report Writing. **Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.	Generic	15 – 20 % (18-24)	**Global & Strategic**: Public Speaking, English Composition, and Technical Report Writing. **Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.

4.5b: MEET Calibration for Dip.Eng.Tech.(Electrical) compared with a typical Dip.Eng.(Electrical) Curriculum

DIPLOMA OF ENGINEERING			**DIPLOMA OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (90 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (90 credits Total)	Courses
Professional Practical	65-75 % (55-60)	Introduction to Electrical and Electronics Technology, DC and AC Circuit Fundamental, Analog Devices and Circuits, Digital Electronics, Industrial Electronics Control and Automation System, Measurement and Instrumentations, Microcontroller and Microprocessor Systems, Electrical Installation and Wiring, Power System, Electrical Machines and Drives, and Practical Training	Professional	50-60% (45-55)	Introduction to Electrical and Electronics Technology, DC and AC Circuit Fundamental, Analog Devices and Circuits, Digital Electronics, Industrial Electronics Control and Automation System, Measurement and Instrumentations, Microcontroller and Microprocessor Systems, Electrical Installation and Wiring, Power System, Electrical Machines and Drives, and Practical Training
Scientific Basic Science and Mathematics	15-20 % (15-20)	Trigonometry, Algebra, Intoduction to C Programming, Analytical Geometry and Differential Calculus	Scientific Basic Science and Mathematics	25-30 % (25-30)	Trigonometry, Algebra, Introduction to C Programming, Basic Geometry and Calculus.
Global and Strategic Industrial Humanistic	15-20 % (15-20)	**Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.	Generic	15-20 % (15-20)	**Industrial**: Quality Assurance and Reliability, Business and Management **Humanistic**: Civilization, Islamic and Moral Studies.

Table 4.5c: MEET Calibration for Cert.Eng.Tech.(Electrical) compared with a typical Cert.Eng.(Electrical) Curriculum

CERTIFICATE OF ENGINEERING			**CERTIFICATE OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (50 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (50 credits Total)	Courses
Professional Practical	65-75 % (33-36)	Introduction to electrical technology, Electrical wiring and installation, Electrical machines maintenance and trouble shooting.	Professional	65-75 % (33-36)	Introduction to electrical technology, Electrical wiring and installation, Electrical machines maintenance and trouble shooting,
Scientific Basic Science and Mathemathics	15-20 % (7-14)	General Physics, Trigonometry, Algebra, Computer Skills and Applications	Scientific Basic Science and Mathematics	15-20 % (7-14)	General Physics, Trigonometry, Algebra, Computer Skills and Applications
Global and Strategic Industrial Humanistic	10-15 % (7-14)	Preparation for Employment, Tamadun Islam, Kenegaraan, Moral Studies and Kemahiran Kemanusiaan	Generic	10-15 % (7-14)	Preparation for Employment, Tamadun Islam, Kenegaraan, Moral Studies and Kemahiran Kemanusiaan

Table 4.6a MEET Calibration for B.Eng.Tech.(Mechanical) compared with MEEM's B.Eng.(Mechanical)

BACHELOR OF ENGINEERING (MEEM)			**BACHELOR OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (130 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (120 credits Total)	Courses
Professional	35 – 50 % (45-65)	Manufacturing Process, Automation, Composite Material Technology, Engineering Economics and Cost Accounting, Total Quality Control, Engineering Design, Industrial Training, Final Year Project	Professional	65 – 75 % (78-90)	Manufacturing Process, Manufacturing Automation, Composite Material Technology, Engineering Economics and Cost Accounting, Total Quality Control, Engineering Design, Industrial Training, Final year Project
Practical					
Scientific	20 – 35 % (25-45)	Engineering Mathematics, Engineering Mechanics, Engineering Material, Engineering Drawing and CAD, Strength of Material, Fluid Mechanic, Electric and Electronics Technology, Thermodynamics, Computer Programming and Application, Applied Fluid Mechanics, Engineering Statistics, Applied Strength of Material, Control Engineering, Applied Dynamics	Scientific	15 – 20 % (18-24)	Engineering Mechanics, Engineering Material, Engineering Drawing CAD, Strength of Material, Fluid Mechanic, Electric and Electronics Technology, Thermodynamics, Computer Programming and Application, Applied Fluid Mechanics, Engineering Statistics, Applied Strength of Material, Control Engineering, Applied Dynamics, Physics, Mathematics
	-		Basic Science and Mathematics		
Global and Strategic	30 % (40)	**Global & Strategic**: Languages, IT, **Industrial**: Industrial Management, Accounting, Health and Safety, Communication Skills, Law **Humanistic**: Civilazation, Islamic studies, Morals	Generic	15 – 20 % (18-24)	**Global & Strategic**: Languages, IT, **Industrial**: Finance and Accounting, Management Communication Skills, Law, **Humanistic**: Civilazation, Islamic studies, Morals
Industrial					
Humanistic					

Table 4.6b MEET Calibration for Dip.Eng.Tech.(Mechanical) compared with a typical Dip.Eng.(Mechanical) Curriculum

DIPLOMA OF ENGINEERING			**DIPLOMA OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (90 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (90 credits Total)	Courses
Professional Practical	65-75 % (55-60)	Metrology, Manufacturing Technology Design, Automation, Quality and Manufacturing System, Design and CAD, Concurrent Engineering, Information Technology, Control and Instrumentation, Quality and System, Manufacturing Process, Engineering Management, Project, Industrial Training	Professional	50-60% (45-55)	Manufacturing Process, Material Removal Processes, Computer Aided Manufacturing, Tool Design, Production Engineering Management, Production Planning, CNC Lathe Programming, Statistical Quality Control, Manufacturing projects, Material Joining Process, Metrology, Control and Instrumentation, Total Quality Management, Project, Industrial Training
Scientific	15-20 % (15-20)	Electrical Science, Mechanics, Materials, Engineering Graphics, Computer Studies, Thermodynamics, Fluid Mechanics, Applied Mechanics, Electrical Engineering, Mechanic of Machine, Mathematics	Scientific Basic Science and Mathematics	25-30 % (25-30)	Electrical Science, Mechanics, Materials,Engineering Graphics, Computer Studies, Thermodynamics, Fluid Mechanics, Applied Mechanics, Mechanics of Machine, Mathematics, Physics, Calculus
Global and Strategic Industrial Humanistic	15-20 % (15-20)	Language, Tamadun Islam, Moral,	Generic	15-20 % (15-20)	Language, Tamadun Islam, Moral,

Table 4.6c: MEET Calibration for Cert.Eng.Tech.(Mechanical) compared with a typical Cert.Eng.(Mechanical) Curriculum

CERTIFICATE OF ENGINEERING			**CERTIFICATE OF ENGINEERING TECHNOLOGY (MEET)**		
Skills & Competencies	% Distribution (50 Credits Total)	Courses	Skills & Competencies	Proposed % Distribution (50 credits Total)	Courses
Professional Practical	65-75 % (33-36)	Metrology, Control and Instrumentation, Manufacturing Technology, Design and IT, Automation, Quality and Manufacturing Systems, Design and Engineering Graphics, Management Studies	Professional	65-75 % (33-36)	Metrology, Control and Instrumentation, Manufacturing Technology, Design and IT, Automation, Quality and Manufacturing Systems, Design and Engineering Graphics, Management Studies
Scientific Basic Science and Mathematics	15-20 % (7-14)	Electrical Engineering, Engineering Science, Mechanics, Materials, Engineering Graphics, Computer Studies, Thermodynamics, Fluid Mechanics, Applied Mechanics, Computer Studies, Mathematics	Scientific Basic Science and Mathematics	15-20 % (7-14)	Electrical Engineering, Engineering Science, Mechanics, Materials, Engineering Graphics, Computer Studies, Thermodynamics, Fluid Mechanics, Applied Mechanics, Computer Studies, Mathematics
Global and Strategic Industrial Humanistic	10-15 % (7-14)	Language, Tamadun Islam, Moral,	Generic	10-15 % (7-14)	Language, Tamadun Islam, Moral

4.3 Career Pathway

As highlighted earlier, engineering technologists assist engineers in various areas and sectors. They can be positioned in manufacturing or production, practice-oriented design and development of new products, field engineering and maintenance, resource management, quality control, and technical sales and service. Graduates eventually may become executives of companies. Typical job titles of the graduates are: field engineer, surveyor, planning engineer, production supervisor, systems engineer, manufacturing engineer, electronics/electrical engineer, process engineer, plastics engineer, maintenance supervisor, quality control supervisor, inspection supervisor, project manager, project engineer. Hence, engineering technologists are practicing engineering and should be considered as "engineers".

Engineering TEVT is expected to produce such a balance workforce, i.e., between theory and skills, and also facilitates the immediate establishment of skilled and competent manpower. This is the likely effect with the introduction of engineering technology programme, particularly Bachelor of Engineering Technology. As such, it necessitates the creation of an alternative career path within the engineering fraternity.

Table 4.7 shows the proposed career pathways which include engineering technology. As lecturers in universities they will be in the same category, whether they are engineers or engineering technologists. Engineering technologists in government agencies, polytechnics and research institutes have been proposed to be in the same respective category but at P1T2 unlike engineers at P1T4. The higher scale, P1T2 for engineering technologists as compared to the other J41 category jobs such as quantity surveyors is justified as the duration of the programme is four years for engineering technology as oppose to three for the others.

Table 4.7: MEET Career Pathways for Engineering Fraternity in Malaysia

	Government	University	Polytechnic	Industry	Research Institute
Bachelor in Engineering	Engineer (J41 – P1T4)	Lecturer with at least an MS degree (DS 45)	Lecturer (DG41 – P1T4)	Engineer	Researcher (Q41 – P1T4)
Bachelor in Engineering Technology	Engineering Technologist (J41- P1T2)	Lecturer with at least an MS degree (DS 45)	Lecturer (DG41 – P1T1)	Engineering Technologist	Researcher (Q41 – P1T2)
Diploma in Engineering	Technical Assistant (J29)	Technical Assistant (J29)	Instructors (DG29)	Engineering Assistant	Assistant Researcher (Q29)
Certificate in Engineering	Technician (J17)	Technician (J17)	Skill Teacher (DG17)	Technician	Research Technician (Q17)

5.0 Recommendations

The global engineering technical education and vocational training sector is currently faced with unprecedented challenges requiring government, industry, students and communities to identify and develop new ways of working together in an effort to produce highly skilled manpower for the global knowledge-based marketplace. Many countries have reinvented the skill development processes in order to make them more relevant to the needs of industry. Instead of entering a "time-served" training and education system, students gain competencies in their own way and at their own time from wherever they live, leading to a more flexible learning system. Employers prefer a nationally accredited system for education and training while employees wanted a portable qualification. Technical Education and Vocational Training (TEVT) in many countries are now more competency-based and flexible, leading to a nationally accredited qualification, offering provider choice. Flexible-learning and e-learning are current buzz words in the TEVT industry today.

In its effort to remain competitive in this globalised knowledge-based world, Malaysia has to further develop its engineering TEVT sector and ensure that its workforce is sufficiently trained and skilled to support its diversifying economy. The engineering TEVT sector in Malaysia has to respond to the needs of the government, industry and communities in a rapidly changing world, influenced by globalization, ICT and the latest advances in technology. There is a need for the country to produce and promote the growth of the Engineering Technologist, Engineering Assistant and Technician grades in the local engineering industry and commerce. From the study of the TEVT sector in selected countries and resolutions of the Washington, Sydney and Dublin Accords, these grades are being accorded more importance in the engineering fraternity. Engineering qualifications frameworks overseas tend to regard them as important members of the engineering profession.

An engineering vocational education system, which is termed ***"The Engineering Technology Path"*** comprising of a comprehensive engineering education and training curriculum model, professional development route and career pathway is proposed. Acknowledging the importance of a highly skilled workforce particularly in this knowledge age and impending globalization, Malaysia need to further develop its engineering Technical Education and Vocational Training (TEVT) system and it is recommended that the country:

- further develop the Malaysian TEVT sector with emphasis on practical and hands-on skills in advanced technology, ICT and quality
- enhance participation of industry in education and training and
- adopt new approaches to learning and nurture entrepreneurship and a thinking culture amongst students and the workforce.

Table 5.1: MEET Education and Training Model for Bachelor Degree

	Malaysian Engineering Education Model (MEEM)	Malaysian Engineering Technology & Engineering Technician (MEET) Model	EAC requirements	Summary % Distribution (from Table 2.14)
Qualification	B. Eng	B. Eng. Tech	B. Eng	B. Eng.Tech. / B. Tech
Duration	4 years	4 Years	4 years	4 / 3 years
Total Credit	130	120	120	90 - 130
Professional Skills & Competencies	35 - 50% (45-65 credits)	65-75% (78-90 credits)*	67% (Minimum. 80 credits)	40 –90%
Practical Skills & Competencies				
Scientific Skills & Competencies	20-35% (25-45 credits)	15-20% (18-24 credits)		5 – 25%
Basic Science and Mathematics Skills & Competencies	Not Counted		Not Counted	
Global and Strategic Skills & Competencies	30% (40 credits)	15-20% (18-24 credits)	33% (40 credits)	0 – 40%
Industrial Skills & Competencies				
Humanistic Skills				

*Include a semester of industrial training

Table 5.1 shows the proposed MEET model in comparison with the other two established engineering models in Malaysia, namely, MEEM and the EAC requirements as well as the summary percentage distribution adopted from Table 2.14. It can be observed that the distribution of skills is comparable with those established models and the summary distribution. The main difference of the MEET model from the established models is on the contents i.e., presence of basic sciences and mathematics courses, whereas there is none for the established models. In addition, there is one whole semester of industrial training for the MEET model. The mode of delivery for the MEET model is more practical and "hands-on" oriented and the assessment is coursework oriented instead of the typical examination oriented assessment. The breadth and depth of courses for the MEET model is different from the conventional engineering model and hence, the role they play in the industry will be different.

It is further proposed that the Malaysian engineering qualification framework and occupational grade be enhanced from three to four categories by the introduction of a new grade called engineering technologist and replacement of the technical assistant to engineering assistant nomenclature in the public sector as follows:

Table 5.2: MEET Qualification Framework and Occupational Grade

Qualification	**Occupation**	**Job Specification**	**Public Service Grade**
B.Eng.	Engineer	Leader & Coordinator in Design, R&D, Teaching	J41 – P1T4
B.EngTech.	Engineering Technologist	Implementor in engineering works	J41 – P1T2
Dip.Eng.	Engineering Assistant	Supervisor	J29
Certificate	Technician	Doers	J17

References

1. ABET. 2001. ABET 2001-2002 Criteria for Accrediting Engineering Technology Programs.
2. Al-Hajeri, M.H. & Al-Anezi, A.A. 2002. Engineering Technology Education in Kuwait (Comparison Study). Proc. of the 2002 American Society for Engineering Education Annual Conference & Exposition. Canada, June 16-19th 2002. Session 2649.
3. Anon. 2000a. http://www.cecal.humberc.on.ca/manumech/mtpc.htm, Mechanical Technical Preparation Certificate Program 042.
4. Anon. 2000b. http://www.cecal.humberc.on.ca/manumech/robotc.htm, Robotics Certificate Program 390.
5. Anon. 2002a. http://www.cscc.edu/DOCS/civileng.htm**,** Civil Engineering Technology Associate Degree Surveying Certificate.
6. Anon. 2002b. http://www.wintec.ac.nz/progregs/CertATAuto.htm, Certificate in Applied Technology.
7. Anon. 2002c. http://www.conestogac.on.ca/programs/metra.html, Mechanical Engineering Technology - Robotics and Automation (Co-op).
8. Anon. 2002d. http://www.uel.ac.uk/electrical-engineering/courses/crs_hnc-hnd-comp-tech.htm, Electrical and Manufacturing Engineering HNC/HND Computer Technology.
9. Anon. 2002e. http://www.glasgow -nautical.ac.uk/courses/engineering/telecoms/hndmechatronics.htm, HND Mechatronics.
10. Anon. 2002f. http://www.eng.brad.ac.uk/new/admissions/b_adt.php, BSc Automotive Design Technology – UOB.
11. Anon. 2002g. http://www.domme.ntu.ac.uk/Courses/BSEng/content.html, B Sc Honours Degrees in Engineering.
12. Anon. 2002h. http://www.pct.edu/degrprog/BET.shtml, Electronics Engineering Technology Bachelor of Science Degree (B.S.) Degree Pensylvania College of Technology.
13. Anon. 2002i. http://www.sal.ksu.edu/eet/curric/eetbs.htm, KSU-Salina Electronic Engineering Technology Bachelor's Degree, 2002.
14. Anon. 2002j. http://www.Latrobe.edu.au/handbook/scitech/courses-26.htm, Faculty of Science, Technology and Engineering.
15. Anon. 2002k. http://www.tafe.swin.edu.au/cee/electron/bbased/bbased.htm. Subject Details.
16. Anon. 2002l. http://www.bhtafe.edu.au/bhi/Courses/NCE31.htm, Advanced Diploma of Engineering Technology – Civil, 2002.
17. Anon. 2002m. http://www. sal.ksu.edu/eet/curric/eetbs.htm, 2002.
18. Anon. 2002n. http://www.2.shu.ac.uk/prospectus/op_uglookup1.cfm?id_num+ENG006
19. Anon. 2002o. http://www.usq.edu.au/handbook/2002/engineer/programs/bachegtech/index.htm
20. Anon. 2002p. http://www.fanshawec.on.ca/
21. Anon. 2002q. http://www.telecom.net.et/~aaufot/BldgDept..html
22. Anon. 2002r. http://www.vu.edu.au/Tafe/Schools
23. Anon. 2002s. http://www. sal.ksu.edu/met/curriculum.html,.
24. Anon. 2002t. http://www.kwantlen.bc.ca/calender/eltnprg.html
25. Anon. 2003 The Eur Ing designation, FEANI Register and Index http://www.feani.org/euring.html
26. Anon, 2003a. www.technology/ccsu/edu/programs/information/et_civ_index.html
27. Anon. 2003b. www.mscd.edu/~cet/program/degree.shtml
28. Anon. 2003c. http://www.usq.edu.au/handbook/2003/content BETC
29. Anon. 2003d. http://www. sal.ksu.edu/met/curriculum.html
30. Anon. 2003e. http://facct.ntu.ac.uk/Students/coursedetails.asp?ProgrammeID=191
31. Anon. 2003f. http://dominao.swin.au/cd31.nsf…/aa4c64841e5528daca25690e00034c39?OpenDocumen
32. Anon. 2003g. http://www.solent.ac.uk/courses/coursinfo.asp?courseid=626
33. Anon. 2003h. http://www.qut.edu.au
34. BEM (____) Engineering programme accreditation manual.
35. Cheshier, S.R. 1998. Studying Engineering Technology, Discovery Press, Los Angeles, pp. 36-37.
36. Hasan, S. 2002. Brief Notes on Indian Engineering Education in Proc. MEET Study Team Workshop, Melaka, 13-15th Feb. 2002, pp.44-45
37. IEAust. 2001a The Institution of Engineers Australia Chartered Professional Engineers.
38. IEAust. 2001b The Institution of Engineers Australia, Chartered Engineering Technologists.
39. IEI. 2000. Accreditation of Engineering Degrees, May 2000, Institution of Engineers of Ireland (IEI)
40. Jaafar, M.S. 2002. Brief Notes on Engineering Education in Turkey in in Proc. MEET Study Team Workshop, Melaka, 13-15th Feb. 2002, pp.41-43
41. JTR (____) Brosur Jabatan Tenaga Rakyat.

42. Kauffmann, P. & Lewis, V.W. 2002. General Engineering Technology – A Broader Spectrum of Student Needs. Proc. of the 2002 American Society for Engineering Education Annual Conference & Exposition. Canada, June 16-19th2002. Session 2247
43. Kliewer, R.M. 2002. Continuous Improvement in Engineering Technology Programs. Proc. of the 2002 American Society for Engineering Education Annual Conference & Exposition. Canada, June 16-19th,2002, Session 1648.
44. Lahndt, L. 1998. Industry mentored engineering and engineering technology curricula. The Technology Interface (Spring)
45. Mahat, A.R., 2001. Trends and Development of Technology And Vocational-Technical Education In Malaysia: Meeting The Global Challenges Of Globalisation And K-Economy. in Int. Conference on Technology and Vocational -Technical Education. November 12-13. Residence Hotel, UNITEN, Kajang. Selangor, Malaysia.
46. Malaysia, 2001. Department of Statistics, Social Statistics Bulletin Malaysia, November 2001.
47. Malaysia, 7th Malaysia Plan, 1996-2000.
48. Malaysia, 8th Malaysia Plan, 2001-2005.
49. Mariun, N. 2002. Technical and further education graduates pathway for professional recognition in Australia. in Proc. MEET Study Team Workshop, Melaka, 13-15th Feb. 2002.
50. MCED/IEM. 2000. Malaysian engineering education model – Educating future industry leaders. MCED/IEM Report.
51. Megat Johari Megat Mohd Noor, Abang Abdullah Abang Ali & Mohd Saleh Jaafar (2002a) Civil Engineering Curriculum at Universiti Putra Malaysia. In Proc. Engineering Education, Training & Policy. 2nd World Engineering Congress. 22-25 July 2002. Sarawak, Malaysia. Universiti Putra Malaysia Press. pp 100-103.
52. Megat Johari, M.M.N. 2002. Engineering and Technology Programmes Accreditation in Ireland in in Proc. MEET Study Team Workshop, Melaka, 13-15th Feb. 2002, pp.21-28
53. Megat Johari, M.M.N., Abang Abdullah, A.A., Osman, M.R., Sapuan, M.S., Mariun, N., Jaafar, M.S., Ghazali, A.H., Omar, H., Rosnah, M.Y. 2002. A New Engineering Education Model for Malaysia. Int. J. Engng Edu. Vol 18 No 1. pp.1-8
54. Noordin, N.K. 2002 Engineering Technicians and Technologists in Canada in in Proc. MEET Study Team Workshop, Melaka, 13-15th Feb. 2002, pp.32-34
55. Osman, M.R. 1999. Engineering Curriculum Review for Japan in Proc A Review of Engineering Curricula. Pp 31-43.
56. Pecen, R., Hall, T. & Ahmad, J. 2002. A Curriculum Update from Electromechanical to Electrical and Information Engineering Technology at the University of Northern Iowa. Proc. of the 2002 American Society for Engineering Education Annual Conference & Exposition. Canada, June 16-19th 2002. Session 2650.
57. Rosnah M.Y. 2002. Professional Engineers, Engineering Technologists and Engineering Technicians in The United States of America in Proc. MEET Study Team Workshop, Melaka, 13-15th Feb. 2002, pp.29-31
58. TAFE. 2000. TAFE Division, Department of Mechanical Manufacturing & Civil Engineering. Engineering (Certificate I-III)[New Apprenticeships] Victoria University of Technology Brochure.
59. Washington Accord. 2003. Guidelines and Application For Provisional Status in the Washington Accord, http://www.washingtonaccord.org/wash_accord_trans.html

Bibliography

1. IEM/BEM (1996) An enquiry on the formation of engineers in Malaysia – Towards the engineering vision.
2. Mohd Sapuan Salit, Mohd Rasid Osman,Megat Johari Megat Mohd Noor, Desa Ahmad (1999) A review of engineering curricula. UPM.
3. Abang Abdullah Abang Ali (2001) Trends in world engineering education. Paper presented at the Forum on Accreditation of engineering programmes. BEM.
4. The Institution of Engineers of Ireland, Accreditation of Engineering Degrees, May 2000
5. The Institute of Highway Incorporated Engineers, Membership & CPD, 2001
6. Standards and Routes to Registration (SARTOR) 3rd Edition
7. Engineering BTec NVQs, Ed Excel
8. Accredited Academic Courses (AACL) Institution of Incorporated Engineers, UK.
9. ABET, Accreditation Policy and Procedure Manual, 2001-2002

10. ABET, Criteria for Accrediting Engineering Technology Programmes, 2001-2002
11. Bluefield State College, Civil Engineering Technology
12. SUNY Canton, Construction Engineering Technology
13. Oxford Brookes University, Civil Engineering Course Handbook 1999/2000
14. IEAust, Australian Engineering Technology Programmes Accredited by The Institution of Engineers Australia, 2002
15. IEAust, Manual for the Accreditation of Professional Engineering Programmes, 1999
16. TAFE Directors Position Paper: Training Packages, 2001
17. TAFE Directors Position Paper: Skilling Australians for the Future – Role of TAFE in an Innovative Australia.
18. Suhaimi Badrul Jamil, Halimah Ahmad, Abang Abdullah. Report of an APEX/AOC Visit on Vocational Education and Training (VET) in the United Kingdom, February 2002.
19. Abang Abdullah Abang Ali, Megat Johari Megat Mohd Noor. *Report of 2nd World Congress of Colleges & Polytechnics and Technical Visit*, Melbourne, Australia, March 2002.
20. Napsiah Ismail. Report on Study Visit to Germany, October 2001.
21. Megat Johari Megat Mohd Noor, Mohd Rasid Osman, Norkamariah Noordin, Rosnah Mohd Yusof, Napsiah Ismail. *Proceedings MEET Study Team Workshop*. April 2002.
22. Australia National Training Authority, Australian Quality Training Framework – Web Page, 2001
23. FENTO, National Occupational Standards for Management in Further Education, 2001.
24. FENTO, Standards for Teaching and Supporting Learning in Further Education in England and Wales, 2000
25. QCA, Qualifications and Curriculum Authority Publications Catalogue, September 2001
26. QCA, Arrangements for the Statutory Regulation of External Qualifications in England, Wales and Northern Ireland, 2000
27. Engineering Skills Training Board (Vic), Cadetships, Apprenticeships, Traineeships – Careers in the Manufacturing and Engineering Industry, 2001
28. TAFE Directors Australia, Annual Report, 2001
29. TAFE Directors Australia, Skilling Australians for the Future – The Role of TAFE in an innovative Australia – 2001 Position Statement
30. Australian National Training Authority, Australian Quality Training Framework – Standards for Registered Training Organisations, 2001
31. Australian National Training Authority, Evidence of High-skilled VET Practitioners and High-performing VET Organisations, July 2001
32. Australian National Training Authority, A Bridge to the Future.
33. Australian National Training Authority, Implementing Training Packages, 2000
34. Australian National Training Authority, High-skilled High-performing VET, March 2001.

APPENDIX I

Engineering Disciplines and Careers

1.0 Introduction

The engineering profession in general defines a professional engineer as a person who is "competent by virtue of his/her fundamental education and training to apply the scientific method and outlook to the solution of problems and to assume personal responsibility for the development and application of engineering science and techniques especially in research, designing, manufacturing, supervising, and managing. The person is qualified by aptitude, education, and experience to perform engineering functions."

The Engineering Council UK defines professional or chartered engineers as "those who are concerned primarily with the progress of technology through innovation, creativity and change. They develop and apply new technologies, promote advanced designs and design methods, introduce new and more efficient production techniques and marketing and construction concepts, and pioneer new engineering services and management methods. They may be involved with the management and direction of high-risk and resource intensive projects. Professional judgement is a key feature of their role, allied to the assumption of responsibility for the direction of important tasks, including the profitable management of industrial and commercial enterprises."

The Engineering Council UK associates another group of engineering fraternity, known as Incorporated Engineers, as "exponents of today's technology and they maintain and manage applications of current and developing technology at the highest efficiency. They exercise independent technical judgement and management in the field. They provide, independently and as leaders, a significant influence on the overall effectiveness of the organization in which they work, often in key operational management roles". This group of engineers is also known as Engineering Technologists in some countries.

Both categories of engineers have been in co-existence, complementing each other in their pursuit of directing the great sources of power in nature for the use and convenience of man. The engineering assistants and engineering technicians are those who are involved in the application of proven techniques and procedures in solving practical problems. They conduct a measure of supervisory and technical responsibility and are competent to within defined field of technology. They are the support group of the engineers, and often working directly under the direction of engineering technologists or incorporated engineers.

2.0 Engineering Disciplines

The following are typical engineering disciplines that are being practiced worldwide:

- Civil Engineering
- Mechanical Engineering
- Electrical Engineering
- Electronic Engineering
- Chemical Engineering
- Manufacturing Engineering
- Aerospace Engineering

- Computer Engineering
- Agricultural Engineering
- Bio-Medical Engineering
- Electronics and Telecommunication Engineering
- Environmental Engineering
- Industrial Engineering
- Instrumentation Engineering
- Marine Engineering
- Mining Engineering
- Petroleum Engineering

However, these engineering disciplines can be categorised into four major disciplines, namely, civil, mechanical, electrical and electronic, and chemical engineering.

2.1 Civil Engineering

Civil engineers plan, design and supervise the construction of facilities essential to modern life. Projects range from high-rise buildings to mass transit systems, from airports to water treatment plants, from space telescopes to off-shore drilling platforms.

a. Structural engineering involves design all types of structures; bridges, buildings, dams, tunnels, tanks, power plants, transmission line towers, offshore drilling platforms and space satellites. The primary responsibility of a structural engineer is to analyse the forces that a structure would encounter and develop a design to withstand those forces. A critical part of this design process involves the selection of structural components, system and materials that would provide adequate strength, stability and durability. Structural dynamics is a specialty within structural engineering that accounts for dynamic forces on structures, such as those resulting from earthquakes.

b. Transportation engineering is concerned with the safe and efficient movement of both people and goods. Involved in design of highways and streets, harbours and ports, mass transit systems, airports and railroads. Transportation engineers are also involved in the design of systems to transport goods such as gas, oil and the commodities.

c. Environmental engineers are responsible for controlling, preventing and eliminating air, water and land pollution. Involved in the design and operation of water distribution systems, wastewater treatment facilities, sewage treatment plants, garbage disposal systems, air quality control Programmes, recycling and reclamation projects, toxic waste cleanup projects, and pesticide control Programmes.

d. Water resources engineering focuses on water-related problems and issues. The work of engineers in this area includes the operation of water availability and delivery systems, the evaluation of potential new water sources, harbour and river development, flood control, irrigation and drainage projects, costal protection and the construction and maintenance of hydroelectric power facilities.

e. Geotechnical engineering includes the study of the properties of soil and rocks over which structures and facilities are built. Geotechnical engineers are able to predict how the ground material which would support or otherwise affect the structural integrity of the planned facility. Their work is vital to the design and construction of earth structures, foundations, offshore platforms, tunnels and dams. Geotechnical engineers also evaluate the settlement of buildings, stability of slopes and fills, seepage of ground water and effects of earthquakes.

f. Surveying involves mapping out construction sites and their surrounding areas before construction can begin. Surveyors locate property lines and determine right-of-ways, while also establishing the alignment and proper placement of the buildings to be constructed. Current surveying practice makes use of modern technology, including satellites, aerial and terrestrial photogrammetry, and computer processing of photographic data.

g. Construction involves both technical and management skills to plan and build facilities such as buildings, bridges, tunnels and dams. These engineers are responsible from estimating construction costs, determining equipment and personnel needs, supervising the construction and once completed, operating the facility until the client assumes responsibility. Knowledgeable about construction methods and equipment, as well as principles of planning, organizing, financing, managing and operating construction enterprises.

2.2 Mechanical Engineering

mechanical engineers design tools, engines, machines and other mechanical equipment. They design and develop power-producing machines such as internal combustion engines, steam and gas turbines, and jet and rocket engines. They also design and develop power-using machines such as refrigeration and air-conditioning systems, robots, machine tools, materials handling systems and industrial production equipment.

a. Mechanical system involves the design of structures and motion of mechanical systems, and design of automobiles, trucks, tractors, trains, airplanes and even aerospace vehicles. The engineers design lathes, milling machines, grinders and drill presses in the manufacture of goods. They design copying machines, faxes, computers and medical devices and systems.

b. Manufacturing is a process of converting raw materials into a final product. Manufacturing engineers design and manufacture machines that make machines; designing the manufacturing processes, including automation and robotics, to help make the production of manufactured goods as efficient, cost-effective and reliable as possible. Industrial engineers determine the most effective ways for an organization to use its various resources-people, machines, materials, information and energy to make a process or product. They also design and manage the quality control Programmes that monitor the production process at every step. They are also involved in facilities and plant design, along with plant management and production engineering. The most distinguishing characteristic of industrial engineers is their involvement with the human and organisational aspects of systems design; hence their description as “the people-oriented engineering profession”.

c. Energy involves the production and transfer of energy, as well as the conversion of energy from one form to another. The engineers design and operate power plants, study the economical combustion of fuels, design processes to convert heat energy into mechanical energy and create ways to put that mechanical energy to work.

d. Materials engineers are responsible for improving the strength, corrosion resistance, fatigue resistance, and other characteristics of frequently used materials. They are also involved in selecting materials with desirable mechanical, electrical, magnetic, chemical, and heat transfer properties that meet special performance requirements. Metallurgical engineers deal specifically with metals in one of the three main branches of metallurgy; extractive, physical and mechanical.

2.3 Electrical & Electronic Engineering

Electrical engineers are involved with electrical devices and systems and the used of electrical energy. Their work can be seen in the entertainment systems in our homes, in the computers used, in numerically-controlled machines used by manufacturing companies, and in the early warning systems used by the government.

a. Electronic Engineering deals with the design of circuits and electrical devices to produce, amplify, detect, or rectify electrical signals. Advances in microelectronics, transistors, semiconductors and integrated circuits (ICs) and semiconductors.

b. Computer Engineering is concerned with firmware (the microcode that controls processors) and hardware (processors, as well as the entire computer system).

c. Communications comprise a broad spectrum of applications from consumer entertainment to military radar. These include communication systems, video-conferencing, lasers, fibre optics and wireless networks.

d. Power involves the generation, transmission and distribution of electric power. Power generation systems include hydroelectric, steam, nuclear as well as sustainable sources such as solar, wind and fuel cells. Power engineers are involved in transmission lines, electric motors and generators.

e. Control engineers design systems that control automated operations and processes.

f. Instrumentation involves the use of electronic devices – transducers to measure such parameters as pressure, temperature, flow rate, speed, acceleration, voltage and current.

2.4 Chemical Engineering

Chemical engineers combine their engineering training with knowledge of chemistry to transform the laboratory work of chemists into commercial realities. Involved in design and operations of chemical production facilities and manufacturing facilities that use chemicals or chemical processes in their production of goods. Products include plastics, building materials, food products, pharmaceuticals, synthetic rubber, synthetic fibers and petroleum products. Chemical engineers also play a major role in keeping our environment clean by creating ways to clean up the problems of the past, prevent pollution in the future and extend our shrinking natural resources. Many play equally important roles in helping to eliminate world hunger by developing processes to produce fertilizers economically.

3.0 Engineering Careers

Engineering careers among others include analysis, design, development and testing, research, teaching, consulting, management and sales.

3.1 Analysis, Design, Development and Testing

a. Analysis – mathematical modeling of physical problem.

b. Design – converts concepts and information into detailed plans and specifications that dictate the development and manufacture of a product. Creativity and innovation, along with an analytic mind and attention to detail, are important.

c. Development – involves the development of products, systems or processes. Intermediary between design and test engineers. Turning concepts into actual products or applying new knowledge to improve existing products.

d. Testing – responsible for developing and conducting tests to verify that a selected design or new product meets all specifications. Tests for structural integrity, performance or reliability. Test engineers also conduct quality control checks on existing products.

3.2 Research

Engineering researchers apply knowledge to engineering practices and principles. Research engineers explore mathematics, physics, chemistry and engineering sciences in search of answers or insights that will contribute to the advancement of engineering.

3.3 Teaching

The engineering professor has three main functions; teaching, research and service.

3.4 Consulting

Consulting engineers performs services for a client on a contractual basis and includes investigations and analyses; preplanning, design and design implementation, research and development; construction management.

3.5 Management

Managing an organization as well as project management.

3.6 Sales

Sales engineering is the liason person between the company and the customer. Sales engineers must possess strong communication skills and related “people” skills in addition to technical knowledge.

APPENDIX II

Local Organizations and Institutions Involved With TEVT

1.0 Ministry of Education

In the technical and vocational training, government polytechnics and some community colleges under the Ministry of Education (MOE) are offering engineering diploma and certificate courses. In addition, public universities offering engineering diploma courses are:

- Universiti Teknologi Mara (UiTM)
- Universiti Teknologi Malaysia (UTM)
- Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO)
- Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKEM)

At the same time, a few public universities are offering diploma in technological areas. Those offering them are

- Kolej Universiti Teknologi Tun Hussein Onn (KUiTTHO)
- Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKEM).
- Kolej Universiti Teknolgi dan Kejuruteraan Malaysia (KUTKUM)
- Kolej Universiti Kejuruteraan Utara Malaysia (KUKUM)

UTM also has some on-going franchise programmes with a number of government and private technical training institutes awarding diploma in technology programmes. Some of the institutions use Malaysian Skill Certificate (SKM) as their basic qualifications and provide students with enough theoretical background to enable their graduates to further their education either locally or overseas.

Private colleges are also offering engineering diploma programmes but most of their graduates will continue their studies either locally or overseas. The majority of them completed their studies in overseas universities as part of the agreed twinning programmes.

2.0 MAJLIS AMANAH RAKYAT

Majlis Amanah Rakyat (MARA) is actively involved with technical and vocational training since inception. Presently MARA has several educational institutions related with technical and vocational education. Institutions offering equivalent engineering diploma and technology courses include British Malaysian Institute (BMI), German Malaysian Institute (GMI) and Malaysian French Institute (MFI). These institutes will be the anchor institutes for the future Universiti Kuala Lumpur.

2.1 German Malaysian Institute (GMI)

GMI was launched in 1991 and started with its first intake of trainees in July 1992.The founders of GMI are MARA and the Malaysian German Chamber of Commerce & Industry (MGCC).

The main objective of GMI is to support Malaysia's industry by qualifying highly skilled manpower capable of combining theoretical know-why with practical know-how in design, manufacture, maintenance, fault analysis and repair of complex production plant, machinery, equipment, tools product and efficiently use modern technology notable in the manufacturing and engineering industries.

GMI's training is intended to produce technologists that have not only specialists knowledge but also able to see on their own, problems posed by complex work in a technical environment which is a process of constant and rapid change. They must also be capable of implementing their tasks in cooperation with other employees. GMI training will thus produce competent technologists. This competency involves three basic elements that are inculcated during the training Programme, namely technical competency, learning competency and social competency.

2.2 Malaysia France Institute (MFI)

MFI is a cooperation project between France and Malaysia. It is an advance technical training center in the field of engineering specialising in automation, electrical, mechanical and maintenance. The institute insists on the importance of the work related training.

The curriculum designed for the Programmes offered is based on the French National Diploma adapted to the Malaysian standard and forms the survey results of the local industry needs. Important aspects integrated in the curriculum building are:

- Good foundation in Engineering and Technology needed by students upon graduation
- Skills in work management and supervisory
- Communication (Bahasa Melayu, English and French)
- Basic fundamentals in Religious Studies as to have persons with high morals and sense of responsibilities.
- General knowledge, as to produce technologists who are sensitive to the development and advancement of other areas apart from engineering.

To ensure that MFI delivers a course reflecting the French technology, workshops are equipped with French state of the art machines. To deliver the courses, the tea teaching staff consists of Malaysian lecturers trained on the method of training in France.

2.3 British Malaysian Institute (BMI)

BMI is the result of a partnership between the Malaysian and British government. On the Malaysian side, MARA provides the infrastructure and the staff: the British provides support and expertise from companies such as, among others BAE Systems, British Airways, Rolls Royce, Malayan Cement and Standard Chartered Bank. This combination of Malaysian desire to learn and British expertise to share their vast knowledge has created a center for engineering and technical education, not found elsewhere.

BMI was formerly known as Tuas Polytechnic, which was established on 1 September 1983. Its first premise was at the Medan MARA building. In December 1993, it moved to its temporary location at Taman Shamelin Perkasa, Cheras. In 1997 it changed its name to BMI in line with the government's vision of transferring foreign technologies to Malaysian industries. It is now located in a new green campus in Gombak.

Presently BMI is offering 6 full time courses in Electrical Engineering, Electronic Engineering, Medical Electronics Engineering, Telecommunication Engineering, Engineering and Computing and Engineering and Business Information Engineering. It is offering Pre HND and HND in those areas mentioned. After HND, students can either continue their degree studies in the UK, BMI other local IPTA/IPTS or enter employment.

2.4 Institut Kemahiran MARA (IKM)

At certificate level, MARA is offering courses through its Skill Institutes (IKM). Basically these institutes are training school leavers in skills related to trades in the job market. Presently there are 12 IKMs in the whole of Malaysia. Some IKM are also offering Programmes at diploma level. At the IKM Jasin the courses that are offered at Diploma levels are:

- Diploma in Mechanical Engineering Technology (Automotive)
- Diploma in Electrical Engineering Technology.

The certificate level Programmes offered are:

- Mechanical Engineering Technology (Drawing and Design)
- Mechanical Engineering Technology (Manufacturing)
- Mechanical Engineering Technology (Machine Maintenance)
- Automobile Engineering Technology
- Automobile Engineering Technology (Heavy Machines)
- Vehicle Body Repair Technology
- Electrical Engineering Technology (Industrial and Domestic)
- Welding Technology and Fabrication.

The duration of study for certificate level is 3 semesters (18 months) and for diploma is 6 semesters (36 months). Students graduating with IKM certificates can either work in the industries or continue their studies at BMI, GMI, MFI or other equivalent institutes.

3.0 Ministry of Human Resource

Jabatan Tenaga Rakyat (JTR) of the Ministry of Human Resource provides a systematic training programme for SPM/SPMV school leavers. The programmes aim to train highly skilled workers in technical areas. The curriculums are organised to fulfill the requirement set by the National Council of Vocational Training (MLVK). There are five levels of training ranging from Level 1 to Level 5.

There are four different training centres under the JTR namely:

- Institut Latihan Perindustrian (ILP)
- Pusat Latihan Teknologi Tinggi (ADTEC)
- Institut Teknikal Jepun-Malaysia (JMTI)
- Pusat Latihan Pengajar dan Kemahiran Lanjutan (CIAST)

ILP has 14 centres in the country and offers five main technical areas. They are divided into five sections called Mechanical and Manufacturing, Electrical and Electronic, Civil and Building, Printing and Non-metallic Materials Sections. The Mechanical and Manufacturing has 15 different programmes that include Industrial Mechanics, Machining-CNC, Automotive, Metal Fabrications and Gas Pipe Installation. The Electrical and Electronic

Section has 12 programmes, which includes Air-condition, Industrial Instrumentation, Industrial Electronic Technology and Computer Maintenance. The Civil and Building Section has 6 programmes, which includes Building-CADD, Building Construction and Furniture Technology. The Printing and Non-metallic Sections have one programme each i.e. Printing Technology and Plastic Technology, respectively.

Most programmes conduct 12-month training, which cover the MLVK Level 1 and Level 2. The one-year period covers two semesters of 22 weeks for each semester. Most programmes at ILP require minimum qualification at SPM level. Some programmes require only a pass in Bahasa Malaysia (e.g. Industrial Mechanics and General Machining), while some programmes require a credit in Mathematics and Physics/Science (e.g. CNC Machining and Fabrication of Moulds and Cutting Tools).

ADTEC has four centres in the country, which are located in Melaka, Batu Pahat, Kedah and Shah Alam. They offer Diploma in Engineering Technology, which are related to Mechanical and Electronic Technologies. There are five programmes under the Mechanical i.e. Welding, Manufacturing, Machining, Quality Assurance and Mechatronics. There are also five programmes under the electrical and Electronic i.e. Power, Electronic, Telecommunications, Information Technology and Data Processing and Cooling and Air-conditioning. The entry requirements are either from SPM with credits in Mathematics and Science plus passes in Bahasa Malaysia and English, or the relevant certificates of Level 2. Students from SPM and Level 2 entries require 3 years and 2 years, respectively, to complete the Diploma programmes.

JMTI was established based on the “Record of Discussion” between the Malaysian and Japanese Governments in 1997. The institute is located in Seberang Prai and offers programmes leading to Diploma and Advanced Diploma in Engineering Technology. There are four main programmes offered in the institute that are Computer Engineering Technology, Electronic Engineering Technology, Mechatronic Engineering Technology and Manufacturing Engineering Technology. The entry to Diploma programme requires a minimum of 5 credits in SPM, which includes Bahasa Malaysia, English, Mathematics, Physics/Science and one other subject. Both Diplomas from ADTEC and JMTI covers the MLVK Level 3 and 4. It is believed that JMTI is preparing to offer Advanced Diploma Programme that satisfies the MLVK Level 5 requirement.

CIAST is a centre to train instructors in advanced training skills. The entry requirement is SPM/SPMV with credits in Bahasa Malaysia, Mathematics and Physics/Science, plus a pass in English. CIAST awards Teacher Vocational Diploma, which require 3 years for direct entry from SPM and 2 years for the Level 2 entry.

The academic year in all training institutes are divided in two semesters consisting of 22 weeks for each semester. The training modules consists of 70% Practical and 30% Theory. Certificates for each level will only be awarded if all modules in the chosen programmes are satisfactorily completed. Students from these institutes are awarded two certificates for each level i.e. one from MLVK and the other from the institute itself. Certificate from the institutes will carry detailed transcripts of the students’ achievement.

The concept of training provided by the institutes are ‘hands on’. It is worth noting that the programmes at the JTR institutes have value added courses that enhance the training programmes. The additional courses have been included to provide extra training in the respective areas and levels. Examples of courses include Languages, Management and also advanced subjects in the respective technical disciplines. It is also worth noting that the semester is a 22-week session and the class period is during a normal office hours. This indicates that the students may be given enough practical exposure to compensate for the lack of training in the theoretical aspects.

Detailed study on the curriculum and its structure is required to assess if the training provided by the institutes are equivalent to the conventional ‘academic’ provided by most Public Institutions of Higher Learning as claimed.

4.0 Ministry of Youth, Culture and Sports

The Ministry of Youth, Culture and Sports have also established a number of technical training institutions awarding diploma and certificates in industrial technology. These institutions are called Youth Skill Training Institutes or Institut Kemahiran Belia Negara (IKBN). There are also a number of IKBNs, which provide advance training in technology. This advance technology training centres are equipped with advanced machineries and instructors to provide high technology training to youths in Malaysia.

Appendix III

Enrolment, Projected Increase of Engineeers and Projected output of Engineers at Bachelor, Diploma and Certificate Levels.

The Table A3a given is extracted from Tables 4-6 and 4-7 of the 8th Malaysian Plan 2001-2005, which showed the enrolment and output for first degree, diploma and certificate courses from local public educational institutions and local public higher educational institutions. The courses have been categorized into arts (Arts & humanities, economic & Business, law, science (Medicine & Dentistry, Agriculture & Related sciences & others) and Technical (Engineering, architecture, town Planning & Survey & others). The percentage shown is the percentage for each category to total enrolment and output. Percentages for engineering enrolment and output have been calculated for each level.

The student enrolment in the technical courses in 1995 was 16.7% of the total enrolment for first degree programmes and then increased to 23% in 2000 and projected to increase to 28.1% in 2005. Based on the figures given, the percentage of total enrolment for first degree courses in engineering in 1995 was 12.8% and increased to 18.4% in 2000 and projected to increase to 23.5% in 2005.The output of first degree engineers is expected to be 53,822 after the 8MP compared to 16,980 after the 7MP. This constitutes an increase of 18.4% from 12.5% after the 7MP of all first degree output from local universities. The 5-year increase from the 7MP to the 8MP is 216% or an average of 43% each year (2000-2005).

The engineering diploma level showed a similar trend. In 1995, engineering diploma holders constitute 25% of the total diploma enrolment, increasing to 29.7% in 2000 and projected to dip slightly to 29% in 2005. The output of diploma holders is 16.4% after the 7MP and expected to increase to 23.3% after the 8MP for all diploma output. The engineering certificate level constitutes 76% of all certificate enrolment, decreasing to 72% in 2000 and 2005. The output of certified level engineers is only at 11.6% after the 7MP and 10.8% after the 8MP.

Table A3b shows the number of polytechnics and enrolment, number of first degree engineering students and graduates in engineering for each respective year. The figures showed that the enrolment in polytechnics decreases in 1996 and 1997, increasing at a greater pace in 1998 to 2000. This is in line with the number of polytechnics, which increased from only 6 in 1995 to 12 in 1999. However, the enrolment of engineering first degree students rose steadily from 8,557 in 1994 to 22,950 in 1998.

Table A3a: Enrolment and Output for first Degree Courses, Diploma and Certificates From Local Public Educational Institutions, 1995-2005 (Source: Extracted from 8th Malaysia Plan 2001-2005)

		Enrolment			**Output**	
		1995	**2000**	**2005**	**7MP**	**8MP**
Degree	Technical	12,652 (16.7%)	39,305 (23%)	68,784 (28.1%)	22,765 (16.7%)	66,007 (22.6%)
	Engineering	9,756	31,494	57,684	16,980	53,822
Diploma	Technical	15,744 (33.9%)	35,410 (38.4%)	69,119 (46.7%)	19,636 (25.8%)	39,603 (32.3%)
	Engineering	11,513	27,419	42,879	12,466	28,608
Certificate	Technical	10,675 (78.7%)	20,821 (73.9%)	65,304 (73.5%)	2,582 (26.0%)	2,610 (14.6%)
	Engineering	10,320	20,396	64,516	1,163	1,935
Total enrolment and output for all courses	Degree	75,709	170,794	244,527	136,003	292,378
	Diploma	46,480	92,304	148,025	76,159	122,734
	Certificate	13,556	28,154	88,848	9,949	17,874

Table A3b: Number of students in Polytechnics and Universities (Technical and Engineering) 1994-2000

Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
Number of Polytechnics	-	6	7	8	10	12	12
Number of Students in Polytechnics	-	19,230	18,434	17,365	20,257	26,788	39,027
Number of Engineering students in Universities	8,557	9,988	12,665	17,590	22,950	-	-
Number of engineering Graduates in Universities	1,173	1,214	1,306	1,798	2,376	-	-

Source: Extracted from Social Statistics Bulletin Malaysia. Department of Statistics. November 2001

Appendix IV

Outcomes or Attributes/Ability of Engineering and Engineering Technology Graduates

Table A4.1: Attributes/Ability of Engineering and Engineering Technology Graduates According to Washington Accord and ABET

Engineering (Washington Accord, 2002)	**Engineering Technology** (ABET, 2001)
• apply mathematics, science and engineering science for the design, operation and improvement of systems, processes and machines	• an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines
	• an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology
• formulate and solve complex engineering problems	• an ability to identify, analyze, and solve technical problems
	• an ability to conduct, analyze, and interpret experiments and apply results to improve processes
	• an ability to apply creativity in the design of systems, components, or processes appropriate to Programme objectives
	• an ability to function effectively in teams,
• communicate effectively	• an ability to communicate effectively
• engage in lifelong learning and professional development	• a recognition of the need for, and an ability to engage in lifelong learning
• act in accordance with the ethical principles of the engineering profession	• an ability to understand professional, ethical, and social responsibilities
• function in contemporary society • understand and resolve the environmental, economic, societal implications of engineering work	• respect for diversity and a knowledge of contemporary professional, societal, and global issues
	• a commitment to quality, timeless and continuous improvement

Table A4.2: Attributes/Ability of Engineering and Engineering Technology Graduates According to IEAust.

Engineers (IEAust, 2001a)	**Engineering Technologists** (IEAust, 2001b)
• Ability to apply knowledge of science and engineering fundamentals.	• Same
• Ability to communicate effectively not only with members of the engineering team but also with clients, customers, stakeholders,suppliers, regulators and the community at large.	• same
• Ability to undertake problem identification, formulation, and solution through *the development of new and innovative engineering practices.*	• Ability to undertake problem identification, formulation, and solution through *the adaptation of standard engineering practices and procedures.*
• Ability to utilise a whole systems approach to design and operational performance.	• Ability to utilise a systems approach to design and operational performance while modifying and/or adapting existing practice.
• Ability to function effectively as an individual and in multi disciplinary and multicultural teams with the capacity to be a team leader or manager as well as an effective team member.	• Ability to function effectively as an individual and in multi disciplinary and multicultural teams with the capacity to be a team leader as well as an effective team member.
• Understanding and application of social, cultural, global, environmental and business responsibilities (including an understanding of entrepreneurship and the process of innovation) and the need to employ principles of sustainable development.	• same
• Understanding of and commitment to professional and ethical responsibilities.	• same
• A capacity to undertake lifelong learning.	• same

Table A4.3: Attributes/Ability of Engineering According to IEI

• An ability to recognise, delineate, analyse and solve in a professional and practical way the problems, technical and otherwise which are susceptible to engineering treatment.
• An ability to apply pertinent knowledge to the practice of engineering in an effective and professional manner.
• Flexibility in the practice of engineering.
• An appreciation of the national and global needs for sustainable development, where appropriate.
• An appreciation of the professional engineer’s responsibility regarding the environment.
• An appreciation of the need for the highest ethical standards in professional engineering.
• An ability to work in a team.
• An ability to communicate effectively.
• An appreciation of the importance of continuing professional development.
• A sensitivity to the impact on society of engineering concepts, developments and works.