Educating the Engineer of 2020: Malaysian Scenario

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Abstract: The role of the future engineer in these technically developed societies is becoming more challenging because of the globalization of industry and engineering practices. Our society today faces significant challenges including international competition, the global environment, an increasingly diverse population, and a rapid growth in the population. Hence, there will be a fierce challenges and competition growth for engineers. As a result, the engineering education system for the future (2020) should be broad-based engineering programs for easy mobility, flexibility and adaptability to the new changing technology and environment. Thus, a more dynamic curriculum for the engineering education is needed. Realizing the importance of producing a highly competence engineers of the future, the Malaysian Ministry of Higher Education (MOHE) has put a considerable pressure to the universities to produce engineers who are competitive in the marketplace. This paper discusses the universities' response towards the assignment of developing a highly competent engineer to accommodate the future needs and the growing realization among the engineering educators in Malaysia that a new vision for the engineering education is needed, a vision based upon the needs of engineering of the 2020. It examines how a university charts its route towards this direction through its implementation of engineering education. This paper also investigates the needs for the new engineering education, the main drivers for the change, main obstacles or barriers towards the change, desired characteristics of the graduates for 2020 and programs emphases to develop these characteristics. A key conclusion of this research is that Malaysian universities need to evaluate its engineering education strategies, identify model of change through which change might occur and identify the role of academic staff development towards achieving the much desired improvement in the new engineering education system in the country.

1.0 Introduction

The current and rising challenges in engineering such as climate change, sustainability, energy, water, security and increasing internationalisation and global integration demand engineers who are well prepared to provide innovative solutions in important areas. As a result, higher education today, faces new challenges in preparing the engineers for the status of an industrialised nation by 2020 as envisaged in VISION 2020.

2.0 Drivers for the Changes

The main drivers or motivator for the change are divided into four main area; global challenges, nature and operating environment of industry, socio-technological challenges and the changing roles of the future engineers.

Global Challenges

Globalisation is a term and a phenomenon which is on the mind of policy makers, academics and professionals in any sector or discipline, and this is no exception in education especially

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engineering education. The role of education, particularly post-secondary education, as both agent and reactor to globalisation is a critical area of debate and study. Globalisation is defined as "the flow of people, culture, ideas, values, knowledge, technology, and economy across borders facilitating a more interconnected and interdependent world" [1]. Globalisation affects each country in a different way due to a nation's individual history, traditions, culture and priorities. It is a multifaceted process and can impact countries in a vastly different ways, economically, culturally and politically.

There will be fierce challenges and competition growths for engineers. At current suitability rates and pace of engineering demand, the supply of engineers for the globe could be constrained by 2015 [2]. To accommodate these new challenges and needs, Universiti Teknologi Malaysia (UTM), being the premier university in engineering and engineering education in Malaysia, should capitalise these opportunities and challenges. It is essential for UTM to enhance the engineering education in order to produce ***"The engineers of 2020"*** with has strong analytical skills, creativity, practical ingenuity, communication skills, professionalism and leadership. Hence, inline with the enhancement in the education system, UTM graduates should be able to adapt to the new and global marketplace.

Due to global challenges and international competition, job markets, companies, and supply chains have become much more international. Engineering services are often out-sourced to the countries that can provide the best value or to the lowest cost countries [2][3][4]. Industry, government agencies, and educational institutions all have important roles in meeting these challenges. Higher education, such as UTM, has the role of providing the professional preparation for the next generation of business leaders, technical professionals, government officials, and educators at all levels.

In addition to analytic skills, which are well provided by the current education system, companies need engineers with passion, systems thinking, the ability to innovate, to work in multicultural environments, to understand the business context of engineering, and to adapt to changing conditions. Engineers 2020 should have interdisciplinary skills, communication skills, leadership skills, and an eagerness for life-long learning [2][3][4]. Thus, due to these new global requirements for the engineers, the engineering education system needs changes.

Nature and Operating Environment of Industry

The nature and operating environment of industry today is based on knowledge and human capital. They have become the key driving forces in a global economy. The culture of engineering education must change from traditional discipline into the need of multi-inter-and-trans discipline, to fit into the global need for different cultures and community [2][3][4].

The current engineering education in Malaysia practices science and engineering fundamentals. For future challenges and competitions, new engineering education model must include science and engineering fundamental, technical skills and specialization, professional practice, humanities, soft skills and social sciences. The development of engineering education is essential for the creation of the skills and knowledge needed. This will also drive the expansion of industry-academia linkages, and thus develop the linkages that are vital for the efficient operation of universities.

Socio-technological Challenges

According to a study made by the National Academy of Engineering [5], the following societal challenges that require effective solutions by engineering ingenuity are identified: (a) decaying of physical infrastructures in urban settings, (b) assuring the growth and performance of the newly developing critical communication and information infrastructures, their maintenance, management and protection, (c) concerns related to the environment and climate change, (d) destruction and depletion of natural resources and non-renewable source of energy, (e) aging of industrialized societies, (f) population growth and socio-economic tensions in the developing world.

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The same study also identified opportunities inherent in the emergence and growth of: (a) information and communication technologies, (b) bioengineering, biotechnology and biomedical technology, (c) micro-and-nanotechnologies, (d) smart materials and systems, to help address the listed challenges.

However, how we may take advantage of these opportunities for effectively responding to the challenges listed above is yet unresolved. Factors such as industrialization, urbanization, and environmental degradation, socio-political tensions around the world, rising concerns regarding the social implications of rapid technological advance, the growing diversity of the workforce, an increased focus on managed risk and assessment with a view to public security, privacy, and safety are additional parameters that effect how engineering education need to be re-engineered and make full advantage of technology to address the above listed challenges.

Hence, the leveraging of technology has to be in context with the speed of technological change and the explosion in the amount of data and information that is becoming available, the globalisation of industry and engineering practice, the shift of engineering employment from large companies to small and medium-sized companies and the growing emphasis on entrepreneurial, the growing share of engineering employment in non-traditional, less-technical engineering work (e.g., management, finance, marketing, policy), the shift to a knowledge-based "service" economy, and, the increasing productivity gains by using technology in the work, education and continuing education of the engineer [2][4][6].

Changes in the Roles of Engineers

The role of the future engineer in these technically developed modern societies is becoming more challenging because of the globalisation of industry and engineering practice. In order to solve future problems, engineers will need to acquire much more advanced core knowledge as well as technical skills and soft skills to acquire the growing share or engineering employment in non-traditional, less-technical engineering work and knowledge-based "services" economy [2][3]. With this rapid changing nature of modern technology (information technology, nano-scale biomedical and medical sciences, as well as the societal, cultural, economic and geopolitical issues) preparation for the engineering program will extend to the interdisciplinary education and commitment to self-continuing-education.

Engineering education needs to be re-engineered taking into account the emerging trends in the inputs, the output requirements, the environment or ambience, and the strategic goals [4][7]. The new millennium paradigm for engineering education is emerging as a multi-disciplinary, multi-mode, multi-media, and multiple partner enterprise. The next generation of engineers will be challenged to find holistic solutions to population, energy, environment, food, water, terrorism, housing, health, and transportation problems. Engineering education, in particular, will have a central role in our increasingly technologically-based society. The education of engineers must prepare them for the full disciplinary nature of the problems they will face.

3.0 Desired Characteristics of our Graduate for the 2020

Within the context of the changing national and global landscape, we enunciated a set of aspirations for our graduate engineers in 2020 [2]. These aspirations set the bar high but are believed attainable if a course of action is set to reach them. We took the aspirations a step further by setting forth the attributes needed for the graduates of 2020 to reach them. These include such traits as:

- ability to apply knowledge of mathematics, science, and applied sciences
- ability to design and construct experiment, as well as to analyze and interpret data.
- ability to formulate or design a system, process or program to meet desired needs.
- ability to function on multidisciplinary teams.
- ability to identify and solve engineering problems

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- an understanding of professional and ethical responsibility.
- ability to communicate effectively.
- a broad education necessary to understand the impact of solutions in global and societal context.
- the recognition of the need for, and an ability to engage in real life-long learning.
- the knowledge of contemporary issues.
- ability to use technique, skills, and modern scientific and technical tools necessary for professional practice.
- strong analytical skills
- practical ingenuity, creativity
- business, management skills and leadership skills
- dynamic/agile/resilient/flexible
- ability to put problems in their socio-technical and operational context.

4.0 Identifying Strategies Necessary to Develop the Characteristics of the Engineers of 2020

The following section identifies the activities and initiatives should be undertaken by Malaysia and UTM in particular in developing the characteristics of the engineers 2020. Five key themes are explored: the universities, the infrastructure and facilities, academician, quality assurance, and the curriculum.

Universities

In Malaysia, MOHE [8] with the cooperation of the local universities formulate and create action plans for reforming engineering education in preparation for the professional expectations of the future. As a result, the universities are urged to act and play a leadership role in improving the engineering education.

Interaction with local and overseas industries should also be increased. This will facilitate more realistic and relevant joint projects for students and industry professionals [5][7]. Through this interaction, universities will face a variety of real-world multi-disciplinary problems that are similar to the business operational problems locally and internationally. These problems can be used as test cases for solution approaches. Engineering students could form interdisciplinary collaborative teams to develop effective solutions to such problems. As a result, the desired attributes for the future engineers, for example, the ability to function on multidisciplinary team, the ability to identify and solve engineering problems, the ability to understand the professional and ethical responsibility and the ability to communicate effectively can be achieved.

Infrastructure and Facilities

Universities need to establish consensus on relevancy of a set of a new fundamental for engineering education [2][4][5][7]. This may include information technology, bio-engineering, nano-skill-technologies, skills and understanding necessary for effectively leading multidisciplinary-teams, the challenges of framing and addressing large-scale system-of-systems problems, sustainability, lifecycle management of systems, risk-based asset management, and the need of lifelong learning, globalisation, demographic realities and need for diversity.

We have to formulate a road map for constructing a highly flexible global core curriculum for the futures global engineers, including sufficient examples for the minimum delivery standards and associated pedagogical tools that are required for its successful mastery given the differences in the culture and college preparation of current and future students at various parts of the world. Together with this curriculum, we have to formulate how we may successfully prepare tomorrow's engineering

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educators. This set of a new fundamental for engineering education must balance between the core subject for engineering and the liberal subjects.

Academician

The pedagogy of engineering education must be changed. According to Felder [9][10] many students in the United States fail to excel with only the support of traditional method used in teaching engineering. Engineering students prefer active teaching method [9][10][11][12].Therefore, the traditional teaching engineering model must be changed to a new teaching model inline with the engineers of the 21st century. The future engineering education program should include the use of ICT (Information Communication Technology). This idea suggested by many undergraduate engineering students [11]. The ICT genre involves the use of all tools in the forms of software, on-line program and resources to create new and improved conditions for learning, for example the use of e-learning, email, word processor, and web resources (both static information and dynamic interactive information).

Traditional engineering classrooms run courses where professors spend a great deal of class time lecturing on the basic facts, formulas, and problem-solving algorithm that comprise the course material, giving assignments and tests to the students to demonstrate their ability to recite the facts, do not encourage students to participate much in the process of teaching and learning in the classroom. Teaching engineering model where students are presented with problems before they are told everything they need to know to determine the solutions are much desired [9][11]. The professor will only become a facilitator providing information and guidance, but formal instruction would only occur when the students had established a need to know something to progress with their work.

Bransford, et al.[12], stated that the traditional lecture-homework-test paradigm of engineering education is simply ineffective. The alternative effective teaching methods for future engineering education suggested by him based on approaches such as active learning, cooperative learning and problem based learning. Practical training, industrial attachment, job rotation, internship, externship can be adapted to achieved these effective teaching methods. The way engineering education is conducted is important to the future of the engineering profession in the context of the growing gap between the need for well-trained engineers and the ability of universities to produce such engineers, the following are some ideas that can be implemented:

- Involvement of practicing and successful engineer in curriculum design and delivery.
- Involvement of industry leaders in the academic oversight process
- Pursuit of a national commitment to education
- Design of a homogeneous curriculum, encompassing a good foundation in general education to provide students with comprehensive skills so that they can adapt to the changing world.
- Provision of basic infrastructure (physical and otherwise) to implement the curriculum.

Quality Assurance of Engineering Programme

Accreditation provides quality control for engineering education. It assures that graduates of accredited programmes are prepared for professional practice. The accreditation criteria is becoming prescriptive, inhibiting development of innovative programmes to reflect changing needs of practice. In response, ABET and its stake holders developed revised criteria, Engineering Criteria 2000 [13], which emphasize learning outcomes, assessment, and continuous improvement rather than detailed curriculum specification. This criterion, together with international agreements among engineering accrediting bodies facilitates mobility of the increasingly global profession.

Curriculum

The recommendations for the key attributes of future engineers listed earlier shows that there is a need for a new curriculum or programme. A new education paradigm is needed and must head in new direction [7][14]. The new curriculum should balance in the applications with fundamentals core

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knowledge and it should be an interdisciplinary education between traditional engineering departments and across schools engineering, management, and social sciences. This will summons the management and leadership activity, creativity, skill and persistence of an engineer. Beside the curriculum content, good infra-structure, lecturers or academicians as well as facilities are also needed. The recommended programmes for implementation in achieving the desired characteristics of the future engineering graduates are shown in Table 1.

Table 1. Desired Characteristics of Future Engineering Graduates and Possible Programmes for Implementation

Desired Characteristics	Recommended Programmes
Strong analytical skills	▪ Science and Mathematics with focus on applications involving analytical objectives of several technical courses that would develop strong reasoning skills rather than memorization.
Practical ingenuity	▪ Laboratory requirements – well coordinated laboratories and lectures ▪ Application oriented projects that require connection with local industry
Creativity	▪ Introduce research work – the undergraduate research work that incorporate the applied science and engineering materials ▪ Special innovations and inventions courses
Communication skills	▪ Team work and individual presentations of reports and papers
Business and management	▪ Include the technology management faculty in developing suitable courses in management to enhance not only the 'manufacturing' component of the curriculum but also contribute to management skills development ▪ Introduce accounting course.
Leadership	▪ Regular seminars on engineering topics and presentation by invited speakers from industry, business and academia. ▪ Leadership experience from the projects conducted – student become project leader ▪ Conduct special courses on leadership or topics in selected courses.
High ethical standard and professionalism	▪ Conduct courses on ethics for the engineers and professionals or ethical topics in selected courses.
Flexibility, agility, resilience, and dynamism	▪ Good curriculum design- the curriculum is not too narrow and only specialization oriented. ▪ Introduce essentials engineering skills necessary to adapt and adjust in future.
Lifelong learners	▪ Introduce mandatory self-study projects during the year in the university. ▪ Undergo intensive research and professional literature study in the library (not just the web site).

5.0 The Proposed Model of Malaysian Engineering Education 2020

The vision for Malaysian Engineers as stated by IEM [15] is, "Engineers shall be technically competent and well-respected professionals spearheading technology and wealth creation in Malaysia". In order to realise the vision there is a need for Malaysia to formulate its own engineering education model which can prove to be dynamic and benefited to the development and progress of engineering in Malaysia. Engineering education in Malaysia must cater for the future 2020 needs and must ensure that both universities and industries can benefits mutually for the progress and sustainability of the nation.

The nature of engineering profession revolves around the practice of engineering science and technology and is firmly rooted in fundamental science [3]. Therefore, engineers must demonstrate good scientific knowledge with the development of general skills, such as those related to self-directed knowledge acquisition, so that engineers will be able to cope with the rapidly expanding of new knowledge. Engineering graduates must equipped with management and related skills to ensure

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better chances to reach top management post in the industry. They must be able to adapt with the changing emphasis in scientific fields, for instance in information technology and bioengineering.

World without boundaries, globalisation, knowledge-based economies and service industries are the emerging terms in the context of the global village [2]. Engineers must be able to practice abroad and therefore, engineers must be equipped with knowledge that can cater for the needs of global village [4]. We need a well-respected engineers who are not only technically competent but also maintain a certain level of ethical standard, acquire leadership, management skills and the ability to deal with people at all levels [16]. Completeness in the training of engineers is necessary in preparing engineers who are capable of performing useful functions in the industry, and these include emphasising communication, management and innovative thinking skills [4][6].

In adopting the engineering education model for 2020, Malaysia and UTM particularly considered three basic elements. There are the input, output and formation elements [7][8][17][18]. This model adopted outcome-based education (OBE). The implementation of OBE in the engineering education in Malaysia has been initiated and driven by the Quality Assurance Department, MOHE. It is set to be an essential requirement for all local universities in Malaysia [18].

The input refers to entrance qualification, quality and quantity of the students entering the engineering programme and shall determine the level of education to be provided. The output shall define the curriculum requirements; type of engineers needed with these five characteristics: possessing scientific strength, professional competency, multi-skills, well respected and potential industry leadership skills and moral and ethical soundness. The formation process refers to the stage at the university where students are trained to become engineers. The programme must be learning-based, and the experience must be practice-oriented, and the programme must demand active involvement of the student [17][18]. Such learning-based programme is problem based education. It must become a norm of engineering programme, where the acquisition of knowledge is driven by the need to solve the problems. It has to impart knowledge as a substance, and as a process, students must learn how to think and how to learn. Skills and competences are considered necessary in preparing engineering students for their professional training upon graduation to develop their professional development requirement and needs. Those who have completed the formation process should be able to acquire these six skills and competencies: global and strategic skills, industrial skills, humanistic skills, practical skills, professional competency and scientific competency.

The proposed model is for a four year programme, with strong emphasis in scientific competencies which will build the global and strategic industrial, humanistic, practical and professional skills and competencies. Our suggested model satisfies ABET, the Federation of Engineering Institutions of South East Asia and the Pacific (FEISEAP) and BEM [19]. At UTM, the whole organization, are committed to the changes needed to make this model a reality, we have partially started the programme.

6.0 Implementing Strategies in Developing the Characteristics of the Engineers of 2020

In implementing strategies in developing the characteristics of the engineers 2020, the involvement of the university management, faculty and the students are required. The implementations are as follows:

Business Process Re-engineering (BPR)

Improvement of administrative, research and teaching and learning activities are essential BPR is being used in a number of UK Higher Education Institutions as a change management strategy. Whilst focusing on re-engineering administrative services, there are also tentative attempts to redesign teaching and learning [20].

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UTM must seek managerial tools for maintaining efficiency, effectiveness and economy of the new Engineering Education 2020 Model. Central databases are encourage to becoming more process oriented and eliminate redundant and non-value adding practices. BPR focus on utilising IT solutions to link business processes that cut across functional boundaries and the re-engineering could ensure that practices in various departments become more similar as departments are working with the integrated information system.

Realign Engineering Education

Our goal to ensure effective engineering education should be pursued within the context of a comprehensive examination of all relevant aspects of the interrelated systems of engineering education, engineering practice and the global economic system. Engineering education must be realigned to promote attainment of the characteristics desired in practicing engineers, and this must be done in the context of an increased emphasis on the research base underlying conduct of engineering practice and engineering education. This will require that action be taken by key stakeholders, particularly engineering faculty and the engineering professional societies.

Curriculum Structure and Course Innovation

There is a need to address the issues of curriculum structure and course innovation in order to meet the expectations of industry, research, students and the professions with regard to engineering graduates of the coming decade. The curriculum should be inline with the aspiration of The National Higher Education Action Plan Malaysia (2007-2010) [8][18] which addresses five pillars necessary for strong higher education institutions which are: governance, leadership, academia, teaching and learning, and research and development to ensure that the foundation for a rejuvenated higher education system remains solid in the years to come. Role of the modern engineer as technical specialist, systems integrator and change agent are also an important considerations.

The engineering education system for 2020 should be broad-based engineering programmes. A new engineering education paradigm in conjunction with profound cultural changes should provide the environment for the new curriculum. Our goal is to reengineer engineering education that focuses on outcome based education to make it more effective, flexible and simpler [8][18][20]. The desired outcome should include an enhanced educational experience and opportunities to pursue engineering as a liberal education that provides the diversity and breadth needed for engineering and non-engineering marketplace. It should also depict engineering education that develops the motivation, capability and the knowledge base for lifelong learning.

The current engineering instruction typically relies upon large lectures, highly structured problem assignments, and structured examinations for assessment The process of engineering education should change to use more effective pedagogical approaches and to engage students more effectively in the educational enterprise [20]. Such emerging technologies, including multimedia, computer-based simulation and computer aided engineering, can be important components in the educational process along with collaborative learning, team projects and other student centred modes [11]. Also, changes must provide improved learning environments such as active learning; collaborative learning; modular learning; research, development and practice experience for undergraduate; new physical environments, distance learning; hands-on learning; and integrative learning [9][10][11].

The universities, accreditation bodies and industries should collaborate in setting the accreditation criteria [21][22]. Traditional methods of assessment such as student survey of course quality, accreditation processes, and the market demand for graduates should be augmented with new approaches The university should take new responsibility for promoting technological literacy and leadership role in holistic approach by integrating curriculum elements across disciplines.

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Academic Staff Development

The role of academic staff is to keep pace with the rapid technological development, internationalisation of enterprises and globalisation of world economy, so that they can produce the best engineers [2][23][24]. They must establish an integrated system to support professional development of engineers that will cover engineering education, training and practise, professional certification and continuing professional development nationally and internationally.

New Vision for Teaching and Learning in Engineering Education

Teaching and learning centres at the institutional level should be established with the stated objective of improving the quality of teaching and education [20][22][25][26].This can be done by creating a national and international partnership to facilitate staff and faculty development. The aims are to target quality of delivery pedagogical and curriculum development of university.

The educational literature has been transformed from the concept of absolutist to constructivist. Lecturers' main responsibility is now to create an empowering learning environment and to act as a facilitator, guiding students in their learning process. Teaching is not about covering the course content, but about enhancing student learning. In order to put this teaching concept into practise it is necessary to create support from faculty members. It is essential that the university developed a training programme for the faculty members.

Colet [27] devised three different models for faculty development, namely the up-front, interactive and distributed models. The up-front model focuses on improvement of the individual lecturer. Staff development is central with the development of a series of certified programme. The interactive model focuses on the development of the system and therefore involve both counselling and curriculum development project. The interactive model is built more on interaction between staff/faculty developers and the ordinary lecturers. The distributed model focuses on creating a new system and culture referred to as a community of learning. This model is based upon a research-based faculty development in order to facilitate action research project run by faculty developers and staff and involves counselling regarding curriculum project. We adopt the distributed model as it is more appropriate to enhance the progression of staff development in engineering education.

Technology and Pedagogy

Technology and communication will focus on how to teach effectively through technology, how technology affects students' learning, how technology can be changed to improve students' learning [25]. Quantitative and qualitative research on student learning and learning environments focusing on the abilities and skills of the engineering students need to be developed. This is to assure the success of the students at each stage of their academic careers and beyond.

Future engineering curriculum should be built around developing skills and not around teaching available knowledge. Focus must be made on shaping analytic skills, problem-solving skills, and design skills based on teaching the methods and not the solutions. This will nurture the future engineers to be creative and flexible, to be curios and imaginative. Future engineers must understand and appreciate the impact of social/cultural dynamics on a team environment. They must appreciate the power of a team relative to the importance of each individual's talent. They must know to communicate effectively and how to think globally.

New Vision for Research and Discovery in Engineering Education

The emphasis on research productivity in the faculty incentive and reward system is justified by the claim that research enhances teaching and has the potential to support teaching in practice [28]. Within the field of engineering education, the scholarship of discovery, the scholarship of integration,

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and the scholarship of teaching are all relevant and seamlessly bound [25]. The scholarship of teaching has come to mean more than the knowledge gained from preparing for and participating in one's classes and the earning of a reputation for excellence in the classroom, it does not reflect the breadth of scholarly activity that occurs under the engineering education umbrella. As a result, university must initiate new school of engineering education that involved in scholarly activities that include but are not limited to:

- Dissemination of research results to a wide variety of audiences including engineering, math, science, and technology educators and policy makers.
- Preparation of the next generation of faculty and professionals wishing to pursue work in the field of engineering education.
- Seeking and securing funding to support research activities.

There is a growing realization among engineering educators that a new version of research for the engineering educators, a vision need based upon the needs of engineering of the 2020.The research is not only based on the engineering problem but also includes pedagogy research [24][28]. It includes research on teaming, motivation, self-beliefs, learning environments, collaborative learning, diversity issues, teaching design across the engineering curriculum, and development of interventions, such as supplemental instruction and service learning.

7.0 Barriers to Change

Human Attitude

The main barrier is to deal with the human attitude. Some people are not willing to change and not willing to learn new things in their life. People are rigid to changes because they are complacent with the situation. This is influence by their understanding of the problem and by the knowledge and the ability to evaluate courses of action and others very well.

Miscommunication

Rapid technical change tends to abbreviate engineering careers, bringing additional pressure to shift to other occupations- primarily to management – in the working life of many engineers. As a result of branching into inter-disciplines may impede communication since interpretation of terms and knowledge can vary significantly. Misinformation is exacerbated by vague definitions. This resulted misinformation in the transfer of knowledge, standards setting and global business communication.

Faculties' cooperation

The success of the engineering education for 2020, can be achieved through an integrated system approach. The management of the university should eliminate the barriers caused by departmental boundaries. Fostering integration between engineering and other technical and non-technical field can eliminate these barriers. This also requires cooperation among faculties.

Academician

Reward and incentives promoting and valuing the constitution of all faculties should be implemented to recognise the contribution of teaching, advising, research, and service. Academicians are not fully trained in educational engineering research and interaction with specialists in pedagogy and assessment of learning are minimal, resulted less awareness in human subjects. Problem like less incentive in doing research, few opportunities to get grants, unable to utilise graduate students, and could not publish engineering educational research studies that count when promotion and tenure decisions are made.

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Curriculum

The needs for innovative curriculum in engineering education are required. Appropriate concepts and principles with a wide range of contexts should be included within the four years programme. An interactive engineering education and problem based learning and open ended design projects should be incalculated in the courses. Issues about transparency and consistency of the curriculum must be overcome. Assessments and plans for the future engineering curriculum are to be planned including the development of the curriculum design, pedagogy and teaching materials.

Lack of Cooperation and Interaction of Engineers in Industry and University

Reengineering of the engineering education requires the interaction of engineers in industry and the university. These two parties must be considered so that the change made result in an effective system such as providing better educational needs of the student. This understanding enables the student to succeed in the current and future global multi-disciplinary world.

8.0 Conclusion

The engineering education system for 2020 should be broad-based engineering programmes that focuses on outcome based education and it should be more effective, flexible and simpler. The desired outcome should include an enhanced educational experience and opportunities to pursue engineering as a liberal education that provides the diversity and breadth needed for engineering and non-engineering marketplace. It should also depict engineering education that develops the motivation, capability and the knowledge base for lifelong learning.

Engineers for 2020 are expected to project their image and profession. They should appreciate the profound impact of the engineering profession on social-cultural systems, the full spectrum of career opportunities accessible through an engineering education. Engineers should remain well grounded in the basics of math and sciences, humanities, social sciences, and economics. The engineering profession should have the creativity, invention, cross-disciplinary and interdisciplinary and should lead, making public policy and be the administrator of government and industry.

Engineering educators and practicing engineers must be proactive to prepare engineering education to address global challenges, socio-technological challenges and the roles of engineer. They should reconstitute engineering curriculum and related educational programmes for future, rapid pace of change in the world and unpredictability. The curriculum should be responsive to the disparate learning styles to accommodate young persons to be creative and productive. Global accreditation is required to guarantee quality and public accountability in the educational system, encouraging trust on behalf of students, parents, employers, education administration and society in general. As we enter the year 2020, we can expect a continuing change in the engineering education paradigm.

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