Second Draft

FACULTY OF ENGINEERING

UNIVERSITI KEBANGSAAN MALAYSIA

EFFORTS TOWARD OUTCOMES-BASED EVALUATION

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1. Background information

1.1 Degree Titles

The programmes under review are the degree of Bachelor of Engineering in Mechanical Engineering and Bachelor of Engineering in Manufacturing Engineering.

1.2 Program Modes

The only mode of instruction in which this programme is offered is a full-time day program.

There were about 370 students enrolled in the programmes during 2003/2004 session. Enrollment in the programmes for the first semester has been as shown below:

Session	2000/2001	2001/2002	2002/2003	2003/2004
Student Enrolment	340	296	306	372

2. Introduction

This report is prepared as a Self-Study Report to give an indication of what has been carried in Faculty of Engineering in order to fulfil Outcomes-Based Evaluation criteria. For this purpose the faculty has created Outcomes-Based Education and Curriculum Review (OBE-CR) Committee.

2.1 Outcomes-Based Education and Curriculum Review Committee

The committee at the faculty level is chaired by Professor Ir. Dr. Wan Hamidon Wan Badaruzzaman, Head of Civil and Structural Engineering Department and the members are as follows:

Professor Dr. Mohd. Marzuki Mustafa,
Deputy Dean (Development and Students Affair)

Professor Dr. Azah Mohamed,
Head of Electric and Electronic Engineering Department

Assoc. Prof. Ir. Dr. Abdul Wahab Mohamad,
Head of Chemical Engineering and Process Department

Assoc. Prof. Dr. Ahmad Kamal Ariffin Mohd. Ihsan,
Head of Mechanical Engineering and Material Department

Assoc. Prof. Ir. Dr. Riza Atiq O.K. Rahmat,
Chairman of the OBE and Curriculum Review Committee, Civil and Structural Engineering Department

2.1.4 Mechanical and Materials Engineering Department OBE-CR Committee

The committee is chaired by Assoc. Prof. Dr Che Hassan Che Haron, Head of Manufacturing Engineering Group and the members are as follows:

Prof Dr Jaafar Sahari
Assoc. Prof. Dr. Azmi Hassan
Assoc. Prof Dr Shahrir Abdullah
Assoc. Prof Dr Nordin Jamaluddin
Hj Baba Md Deros
Rohaizat Mat Tahir

The committee is formed to carry out the evaluation of the curriculum for the process of transformation from Curriculum Based Education (CBE) to the Outcomes Based Education (OBE) and to communicate with the major stakeholders. The stakeholders are the faculty, students, industries, alumni and parents. The entire communication process is shown in Figure 1.

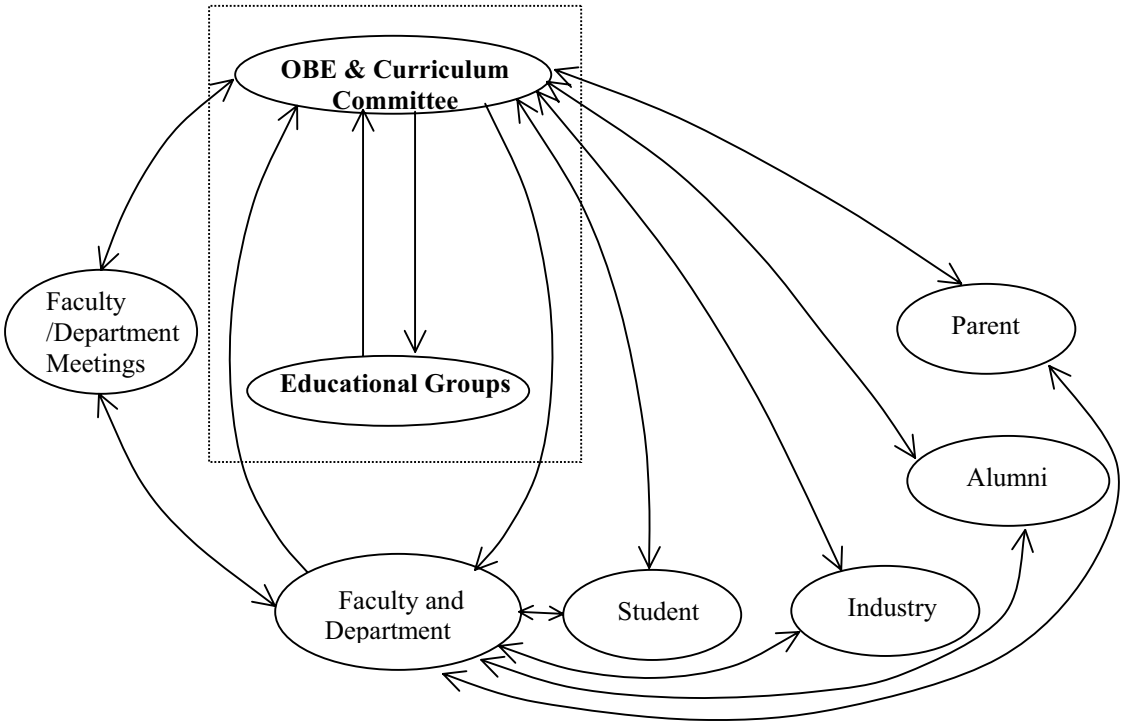


FIGURE 1 Communication with the stakeholders.

2.2 Process for Implementation of Program Educational Objectives and Outcomes Assessment

Following the need for increasing emphasis on assessment of program educational objective and outcomes the OBE and Curriculum Review Committee has adopted the two loops implementation process of the existing curriculum as shown in Figure 2 to ensure all the stipulated outcomes would be achieved by the majority of the student at the time of graduation. This process has been implemented successfully by University Illinois at Urbana-Champaign.

There are three main components of the entire processes, as indicated by the larger boxes labelled as PEO & Evaluation, Programs, and Outcomes Assessment. The driving element is the Program Educational Objectives (PEO), which we interpret to be the statements describing actions of the institution that would help students to accomplish their expectation during the first few years after graduation. The "Programs" box represents all the ingredients that pertain to the offering of the programs. The item Course G & IO refers to Course Goal and Instructional Outcomes. Program outcomes (PO) are the abilities acquired by our students by the time of their graduation, and the achievement of PO indicates that the students are equipped for the Program Educational Objectives to be achieved. Therefore, measuring the extent of expected success in achieving the objectives consists of assessing the actual program outcomes and comparing the results with the indicators of their achievement, as shown in the chart, or carrying out an equivalent action.

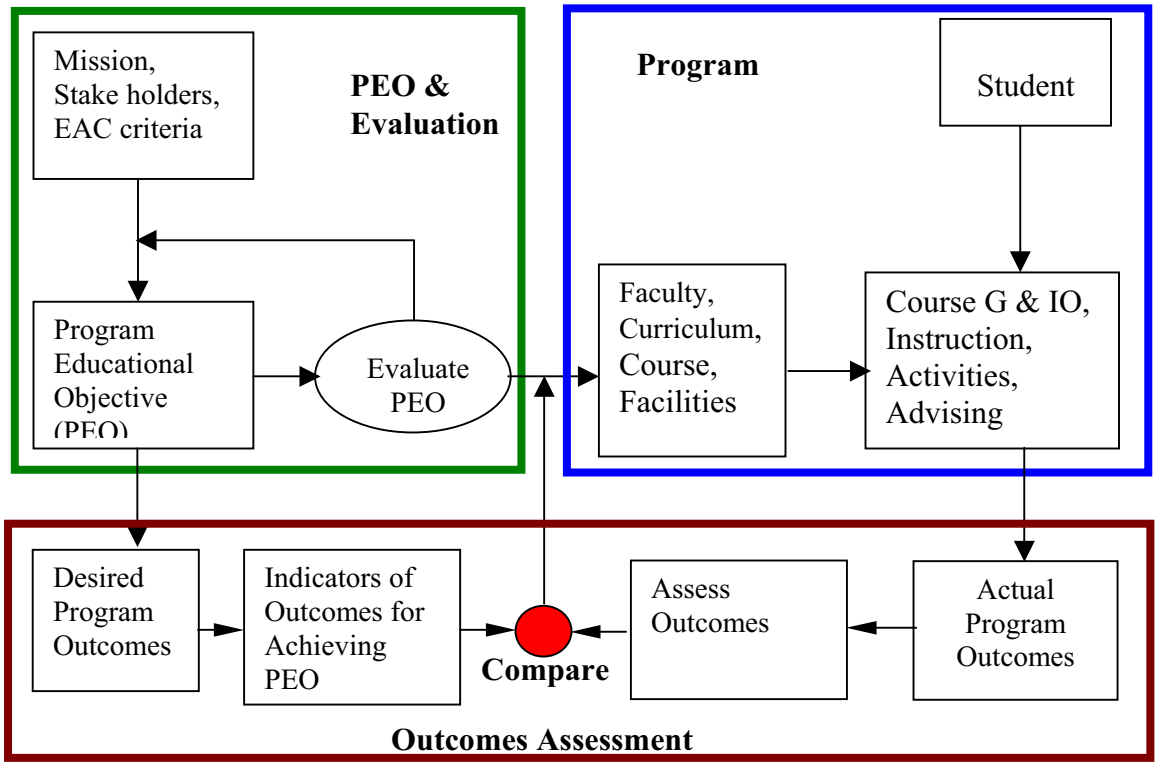


FIGURE 2 Implementation Process of The Curriculum

2.3 Faculty and Department Involvement in Curriculum Review

In the process of reviewing the curriculum to suite the outcome based education (OBE), the Department and faculty members are continuously and directly involved in developing and implementing the curriculum and contributing to the writing of this report. All Department and faculty members are involved by providing course outlines, assessment of course outcomes, and responding to surveys.

3. Program Educational Objectives

3.1 Process for Determination

The starting point for the determination of the program educational objectives (PEO) is the mission and objectives of UKM as well as the objectives of the department. Based on the objective and the needs of the stakeholders, the Outcomes Based Education and Curriculum Review Committee came up with six PEO. The committee has sent out a questioner survey to the industries and parents to seek their comments and advice to further improve the PEO.

3.2 UKM and Faculty Philosophy, vision, mission and objectives

UKM Philosophy

A combination of faith in Allah and beneficial knowledge and of theory and practice as the basis for the advancement of knowledge, the education of society and the development of the University.

UKM Vision

UKM is committed to be the leading university that pioneers innovations in creating a dynamic, knowledgeable and ethical society.

UKM Mission

To be the premier university that affirms and promotes the value of the Malay Language while globalising knowledge within the framework of the national culture.

UKM Aims

To become a leading and competitive centre of knowledge, enriched with technology that:

- Affirms and promotes the value of Malay as a language of learning;
- Builds a dynamic and ethical society;
- Internationalises UKM's image and contribution to the global community;
- Stimulates the development of technologies beneficial to society.

Faculty Vision

Towards producing dynamic, creative and ethical engineers

Faculty Mission

To be a centre of excellence of international standing, for the development of engineering knowledge

3.3 The Faculty Objectives

The program educational objectives are as follows:

1. A competent engineer with an understanding of the fundamental engineering knowledge.

2. An engineer with professional attitudes and ethics necessary in fulfilling his/her responsibilities towards the Creator, clients and the society

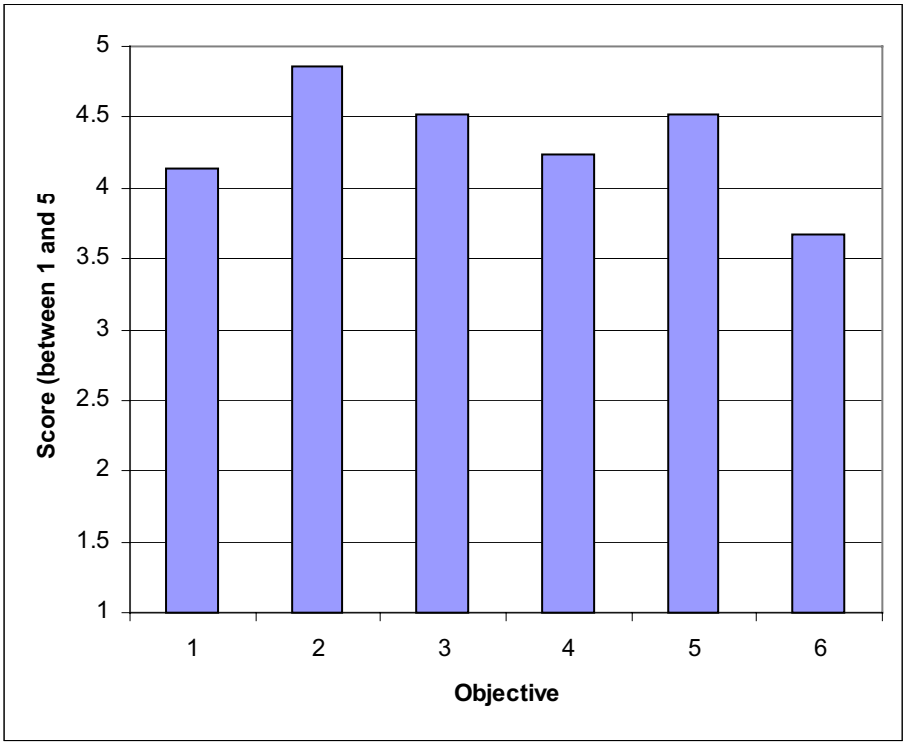
3. An engineer who will uphold the Malay Language as a language of knowledge in the engineering field and at the same time has the ability to communicate in English

4. An engineer who is able to adapt him/herself to the international/global work environment

5. An engineer who is able to lead an organisation based on knowledge of important current issues in engineering and experience

6. An engineer who is able to conduct research in his/her own organisation

A survey was conducted in May 2004 to industries and parents to seek their views and comment. A total 50 surveys were mailed to the parent and another 50 to the industries. 42% responses were received from parents and 36% responses form industries. The survey results are shown in Figure 3 and 4. The results indicate that all six objectives received scores well above 3.50 out of 5

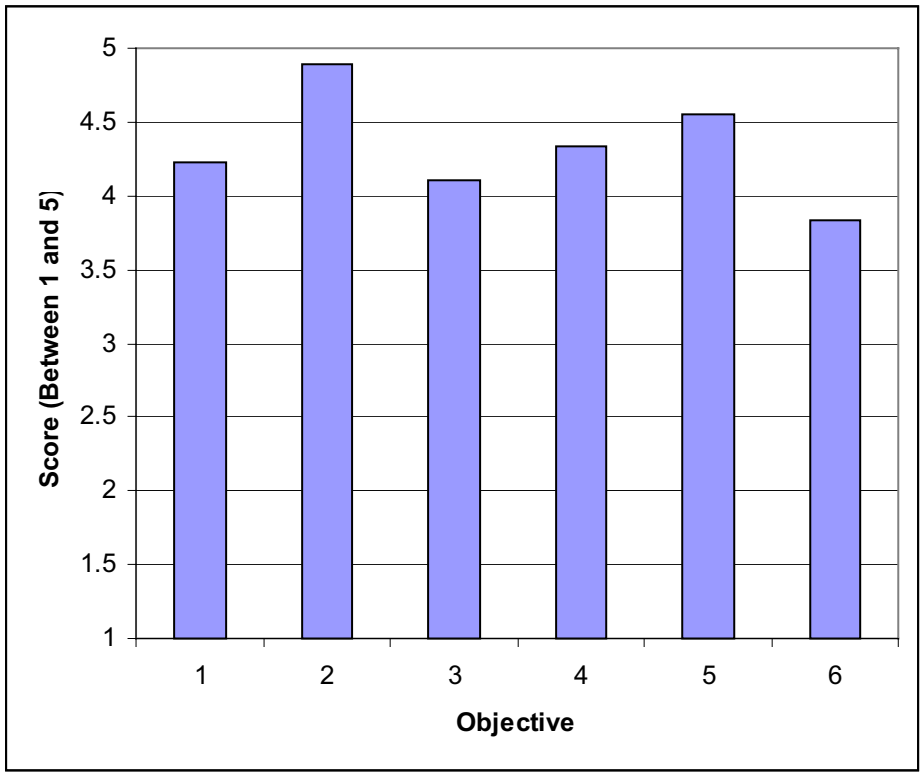


Average	4.14	4.86	4.52	4.24	4.52	3.67
standard Deviation	0.48	0.36	0.51	0.44	0.51	0.58

FIGURE 3 The importance of the objectives as perceived by parents

Some of the comment given by the parents are as follows:

- The students should be trained to have independent ability to carry out engineering duties
- The students should be trained to have confident in making important decisions
- The students should be trained to be able to communicate proficiently in English.



Average	4.22	4.89	4.11	4.33	4.56	3.83
Standard Deviation	0.95	0.38	0.82	0.53	0.58	0.49

FIGURE 4 The importance of the objectives as perceived by employers

3.4 Publication and Consistency with Objective and Curriculum

The PEO have been published widely. Here, we give some examples:

(a) Through the department's Web page.
http://pkukmweb.ukm.my/~jkmb/

(b) Publication in the Faculty of Engineering Programs of Study booklet.

3.5 Periodic Evaluation

Periodic evaluation consists of the same procedure employed for publicising the objectives to the stakeholders and seeking input. Examples are as follows:

Students: A handout containing a listing of the PEO is made available to the students along with the course schedule materials at the beginning of the semester. It is also posted on the Web.

Faculty: Faculty are continuously involved through departmental and faculty meetings and the department Curriculum Committee meeting.

Alumni: Input from alumni sought by sending a questionnaire directly to the alumni individuals.

Industry: Input sought from faculty members of the Mechanical & Materials Engineering Department Advisory Board. At the same time a questionnaire are directly sent to a number of selected the engineering companies.

3.6 Curriculum and Processes to Ensure Achievement

In addition to a solid foundation in mathematics and physics, the curriculum offers by the faculty includes sequences of related courses of increasing sophistication in the key areas of engineering. The course contents and instructional methods are reviewed by the OBE and Curriculum Review Committee as well as by the educational groups in the departments.

There are requirements in basic sciences, humanities, and mathematics and statistics as well as specific lectures in certain courses addressing professional issues such as management, law and ethics. All of these courses are administering by the faculty.

Student achievement is measured within a semester by regular examinations, problem sets, individual and group projects, laboratory assignments and extended design projects. Achievement in all of these areas is enhanced by recitation sessions or labs with teaching assistants, posted office hours of instructors, review sessions, and the posting of problem-set and exam solutions.

Achievement across semesters is also measured through a routine assessment of the ability and preparedness of students for subsequent courses in a sequence. When a course is a prerequisite for a follow-on course in a sequence, any deficiencies in the preparation of the students would be reported to both the department head for the prerequisite and brought to the attention of the relevant educational groups and the OBE & Curriculum Review committee. Periodic assessment at a coarser level is also undertaken by the OBE & Curriculum Review committee to validate and verify that the overall missions of the curriculum are met. This is done by assessment of the course content as well as the level of preparation the students demonstrate in subsequent courses in a sequence. If deficiencies are observed, then corrective action is taken through the curriculum committee and the relevant area committee.

4.7 Evaluation to Determine Achievement

Because Program Educational Objectives (PEO) have to do with students accomplishing things expected of them during the first few years after graduation, evaluation to determine achievement consists of two components:

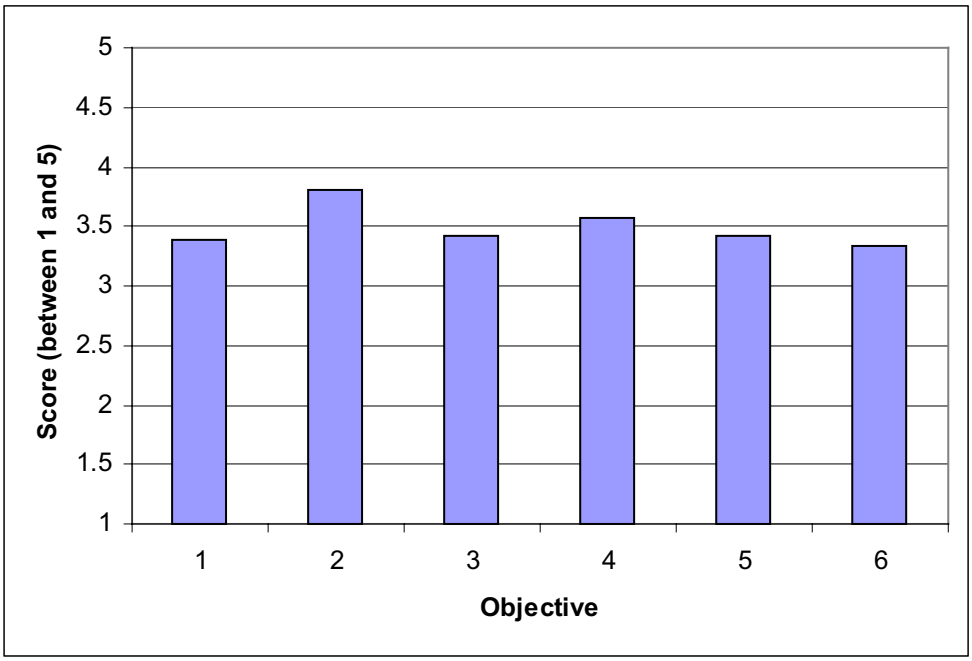
(a) Evaluation to determine success in preparing the students for achieving the program outcomes (PO). Because the PO are linked to the PEO, this is done through assessment of the outcomes.

(b) Evaluation to determine achievement through a direct process, involving a survey of our alumni.

(c) Evaluation to determine achievement through a direct process, involving a survey of companies who are employing hour graduates.

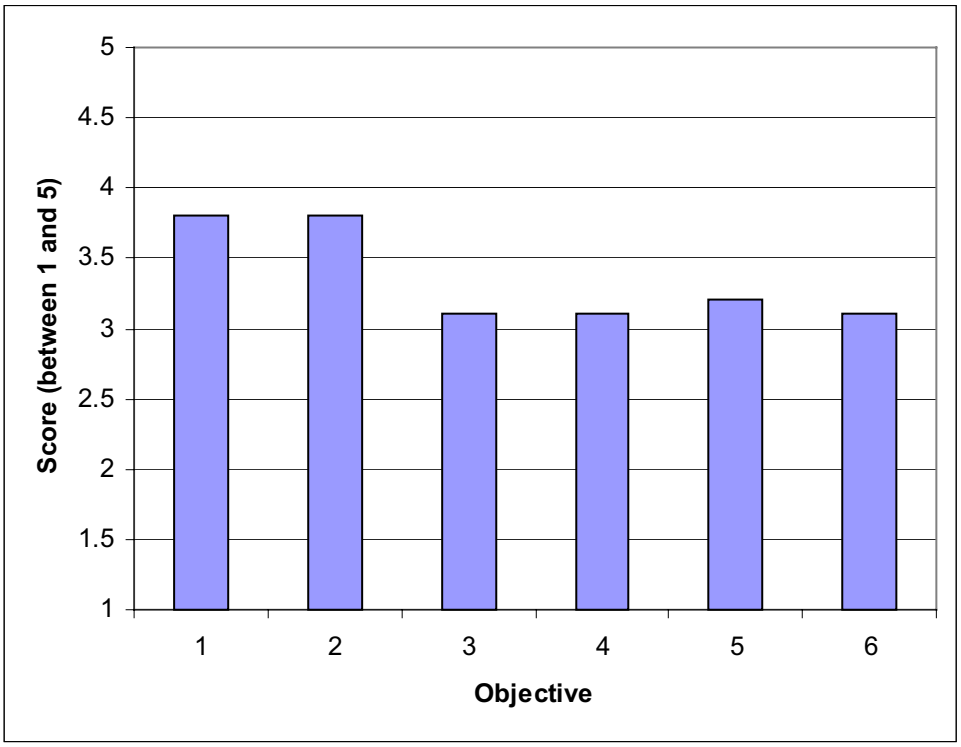
To carry out (b) and (c) above, a survey was mailed in May 2004 to Faculty of Engineering alumni and their employer who graduated between 1996 and 2002. The survey also included assessment of PO to carry out (a) above. A total of 50 surveys were mailed to the alumni, and 21 responses (42%) were received. Alumni had the option to respond by mail or electronically using e-mail.

The survey results are shown in Figure 5 and 6. The results indicate that all six objectives received scores well above 3.0 out of 5.



Average	3.38	3.81	3.43	3.57	3.43	3.33
Standard Deviation	0.50	0.40	0.75	0.60	0.51	0.73

FIGURE 5 Success of the department achieving the six objectives as perceived by the alumni who graduated between 1996 and 2002.



Average	3.80	3.80	3.10	3.10	3.20	3.10
Standard Deviation	0.42	0.42	0.88	0.88	0.63	0.57

FIGURE 6 Success of the department achieving the six objectives as perceived by employers of our graduates.

3.8 Use of Results to Improve Effectiveness of the Program

As illustrated in Figure 5 and 6, there are rooms to improve the effectiveness of the program makes use of the results of evaluation of Program Educational Objectives and assessment of program outcomes. The primary body that implements this process is the OBE & Curriculum Review Committee, which meets regularly to continuously evaluate the curriculum content and to initiate actions. This evaluation includes review of course requirements and curriculum hours, review of approved technical electives, analysis of periodic survey results, and review of new course proposals. In addition, the committee discusses faculty observations of student performance and course prerequisites.

4. Program Outcomes and Assessment

4.1 Statement of Program Outcomes

To prepare the students for the program educational objectives (PEO) achievement, a set of program outcomes (PO), that is, statements that describe what students are expected to know and are able to do by the time of graduation, have been adopted.

These outcomes are:

1. Ability to acquire and apply knowledge of basic science and engineering fundamentals.
2. Ability to communicate effectively, not only with engineers but also with the community at large.
3. Having in-depth technical competence in a specific engineering discipline
4. Ability to undertake problem identification, formulation and solution
5. Ability to utilise a systems approach to design and evaluate operational performance.
6. Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member
7. Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development.
8. Recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so
9. Ability to design and conduct experiments, as well as to analyse and interpret data
10. Ability to function on multi-disciplinary teams
11. Having the knowledge of contemporary issues

4.2 Relationship to Educational Objectives

The achievement of program outcomes indicates that the student is equipped for the program educational objectives to be achieved. Therefore, measuring the extent of success in equipping the students for achieving the educational objectives consists of

(a) linking the outcomes to the educational objectives and
(b) assessing the actual program outcomes and using the results for improvement of the program.

In this vein, the outcomes have been linked to the educational objectives, as shown in Table 2.

4.3 Course Goals (CG) and Instructional Outcomes (IO)

To facilitate instruction for the achievement of program outcomes and hence the program educational objectives, every academic stuff was asked to prepare course goals for each course he or she teaches. The course goals (CG) for a given course state succinctly the purpose of the course and its linkage, if any, to other courses.

The instructional outcomes (IO) for a given course are a list of specific statements, which together describe what the student is able to do as the course progresses, with each objective linked to a subset of the program outcomes (1) to (11), deemed appropriate by the faculty.

The course syllabi listings, included in Appendix I contain the course goals and instructional objectives.

TABLE 2 Program Outcomes and Links to Program Educational Objectives

	Outcomes	**Achievement of Education Objectives**					
		1	2	3	4	5	6
1	Ability to acquire and apply knowledge of basic science and engineering fundamentals.	√		√			
2	Ability to communicate effectively, not only with engineers but also with the community at large.			√			
3	Having in-depth technical competence in a specific engineering discipline.	√	√				
4	Ability to undertake problem identification, formulation and solution						√
5	Ability to utilise a systems approach to design and evaluate operational performance.				√		
6	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member.					√	
7	Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development.		√		√		
8	Recognising the need to undertake lifelong learning, and possessing/acquiring the capacity to do so				√		√
9	Ability to design and conduct experiments, as well as to analyse and interpret data						√
10	Ability to function on multi-disciplinary teams					√	
11	Having the knowledge of contemporary issues				√		

4.4 Relationship of Courses to Program Outcomes

To demonstrate that the curriculum prepares the student for the program outcomes to be achieved, we have prepared a chart relating the courses to the outcomes. This chart is shown in Figure 7. It illustrates the level of emphasis placed on a given program outcome, (1) to (11), in a given course, with the level ranging from very little or no emphasis to substantial emphasis. Thus, a glance at the entire chart indicates the

distribution of program outcomes in terms of emphasis level and breadth across the courses and hence across the curriculum.

4.5 Achievement of All Outcomes by All Students

To demonstrate that the curriculum prepares all students for all program outcomes to be achieved, we have prepared a chart relating the required courses to the outcomes. This chart is shown in Figure 8 and 9. Note that several outcomes are covered by many courses and each outcome is covered by at least a small number of courses.

FIGURE 7 Relationship of Mechanical & Materials Department courses to the Program Outcomes.

		Emphasis on the Program Outcomes										
Code	Course	1	2	3	4	5	6	7	8	9	10	11
KF1133	Introduction to the engineering	3										1
KF1153	Material Science	3										
KF1173	Engineering graphics	3	3									
KF1193	Ordinary Differential Equations	3		3			2					
ZT1012	Islamic Civilisation & Malaysian Studies I							3				
KF1043	Basic Applied Mechanics	3		2						2		
KF1063	Introduction to Electrical Engineering	3										
KF1083	Introduction to Thermodynamics	3										
KF1223	Linear Agebra & Vector Calculus	3			3		2					
KF1243	Computer Programming	3										
KF1131	Engineering Applications	3										
VH2073	English for Engineering		3									
KF2033	Engineering Statistics	3										
KJ2113	Basic Fluid Mechanics	3		2	3	2			1	3	3	3
KJ2513	Engineering Materials	4	1	2	3	1				1		
KL2073	Machine & Power Electronics	2		2	2	2				2		
KF2043	Complex analysis & Partial Differential eq	3										
KJ2323	Engineering Dynamics	3		2	2	1				1		
KJ2343	Mechanic of Materials	3		2		1						
KJ2723	Manufacturing Processes	2	1	3	1						1	2
KP2023	Manufacturing Processes I	4	1	2	3	1				1		
ZT1022	Islamic Civilisation & Malaysian Studies II							1				
KF3113	Numerical Analysis			3								
KJ3143	Engineering Thermodynamics	4		3	3	4				3	3	
KJ3313	Measurement and Instrumentation	3		2	2	1				2		
KJ3333	Dynamic Systems	3		2	2	2						
KJ3933	Machine Component Design	3		2	2	2				2	2	
KP3213	CAD/CAM	3	3	2	1	3	3		2	4	3	
KP3233	Fluid Power	3		3	3	3				3	2	

KP3413	Quality Control	3	4	2	3	1	3	2	3		3	2
KF3223	Technology and Civilisation			2								
KJ3123	Fluid Mechanics	3		3	4	3			2		1	3
KJ3163	Heat Transfer	4		4	4	3				4	3	
KJ3343	Control Engineering	3		2	2	2				2		
KJ3943	Systems Design	4		4	3	4	1			1	1	1
KP3023	Manufacturing Processes II	4	1	2	3	1				1		
KP3123	Machine Tools Technology	3		3	1	3		1		4	3	
KP3223	Automatic Control Systems	3		3	3	4				2		
KP3423	Facilities Planning & Materials Handling	2		3	3	4				4		
KF3065	Industrial Training	3						3			3	
KF4113	Management 1						2	2			3	2
KJ4013	Project 1	3	4	2	2	3	4	2	3	3	4	3
KJ4353	Mechanical Vibrations	3		2	2					2		
KJ4953	Design Project	3	3	1	3	3	3	2	2	1	1	1
KP4413	Industrial Project	3	4	2	2	3	4	2	3	3	4	3
KP4213	Automation and Robotics	2		3	3	3				3	2	2
KP4913	Project 1	3	4	2	2	3	4	2	3	3	4	3
KF4123	Management 2						2	2			3	2
KJ4023	Project 2	3	4	2	2	3	4	2	3	3	4	3
KP4423	Production Planning & Control	1	3		4	3				3	4	
KP4923	Project 2	3	4	2	2	3	4	2	3	3	4	3
KJ4113	Combustion and Thermal Systems	3		3	3	3			3			3
KJ4123	Utilisation of Natural Gas	3		3	3	3			4			
KJ4133	Efficient Use and Management of Energy	3		3	4	4				4	2	3
KJ4143	Air Conditioning and Refrigeration	3		2	3	3					3	
KJ4153	Solar Energy Technology	4	3	3	3	3			4	3	4	4
KJ4163	Computational Fluids Dynamics	3		4	3	3			4		2	4
KJ4173	Design of Thermal Systems – Fluid Syste,	3		3	4	4	2				3	3
KJ4183	Energy Conversion System	3		3	3	4			2	2	3	3
KJ4303	Non Desctructive Testing	3		2	2					2		
KJ4313	Basic Theory of Elasticity	2		2	2			2				
KJ4323	Advanced Control Engineering	3		2	2	2				2		
KJ4333	Basic Continuum Mechanics	2		2	2	1			2			
KJ4343	Acoustics	3		2	2	1			2	2		
KJ4363	Finite Elements Method	3		2	2	1			2	1		
KJ4373	Automotive Engineering	3		3	2	1			2	2		
KJ4383	Robotics	3		2	2	1				2		
KJ4393	Advanced Applied Mechanics	3		2						2		
KJ4513	Polymer Processing	4	1	2	3	1				1		
KJ4523	Corrosion and Corrosion Technology	4		4	4	1			1	1		1
KJ4533	Material Conservation	2	1	2	3	3	3				1	1
KJ4543	Tribology	4		3	3	2			3		3	

KJ4553	Mechanics of Polymer & Composite Matls	4		4	4	1			1	1		1
KJ4563	Metal Forming Theory	4	1	3	3	3		2		3		
KJ4573	Processing of Ceramics	1		2								
KP4013	Joining & Fnishing Technology	3	1	2	1	1				2		
KP4023	Contemporary Manufacturing Processes	3	2	1	2	1			2	2	2	3
KP4033	Machining Processes	2		3	3					3		3
KP4043	Casting & Powder Processes	4	1	2	3	1				1		
KP4053	Plastics Technology	2		3	2	2		1		3	1	1
KP4223	Artificial Intelligence in Manufacturing	3		3	4	4			3			
KP4233	Robot Analysis and Development	3		4	4	4				3		
KP4243	Design for Manufacturing	3	1	1	3	3	3	3	2	3	3	3
KP4253	Computer Numerical Control	3		3	4	4				3		
KP4263	Finite Element Analysis in Manufacturing	3		2	2	1			2	1		
KP4433	Manufacturing Ergonomics	3		4	3	3						
KP4443	Engineering Economics	1	1	2	2		1		2		1	1
KP4453	Manufacturing Project Management	2	1			3	3	3	2		3	3
KP4463	Planning & Control of Maintenance System	3		3	4	4				2		
KP4473	Management of Manufacturing Strategy	1	4		3		2				4	2

Key

	No emphasis
1	Very little emphasis
2	Some emphasis
3	Moderate emphasis
4	Substantial emphasis

FIGURE 8 Achievement of all outcomes by all students in relation of subjects in Mechanical Engineering program

Code	Course	Emphasis on the Program Outcomes										
		1	2	3	4	5	6	7	8	9	10	11
KF1133	Introduction to the engineering	3										1
KF1153	Material Science	3										
KF1173	Engineering graphics	3	3									
KF1193	Ordinary Differential Equations	3		3			2					
ZT1012	Islamic Civilisation & Malaysian Studies I							3				
KF1043	Basic Applied Mechanics	3		2						2		
KF1063	Introduction to Electrical Engineering	3										
KF1083	Introduction to Thermodynamics	3										
KF1223	Linear Agebra & Vector Calculus	3			3		2					
KF1243	Computer Programming	3										
KF1131	Engineering Applications	3										
VH2073	English for Engineering		3									
KF2033	Engineering Statistics	3										
KJ2113	Basic Fluid Mechanics	3		2	3	2			1	3	3	3
KJ2513	Engineering Materials	4	1	2	3	1				1		
KL2073	Machine & Power Electronics	2		2	2	2				2		
KF2043	Complex analysis & Partial Differential eq	3										
KJ2323	Engineering Dynamics	3		2	2	1				1		
KJ2343	Mechanic of Materials	3		2		1						
KJ2723	Manufacturing Processes	2	1	3	1						1	2
ZT1022	Islamic Civilisation & Malaysian Studies II							1				
KF3113	Numerical Analysis			3								
KJ3143	Engineering Thermodynamics	4		3	3	4				3	3	
KJ3313	Measurement and Instrumentation	3		2	2	1				2		
KJ3333	Dynamic Systems	3		2	2	2						
KJ3933	Machine Component Design	3		2	2	2				2	2	
KF3223	Technology and Civilisation			2								
KJ3123	Fluid Mechanics	3		3	4	3			2		1	3
KJ3163	Heat Transfer	4		4	4	3				4	3	
KJ3343	Control Engineering	3		2	2	2				2		
KJ3943	Systems Design	4		4	3	4	1			1	1	1
KF3065	Industrial Training	3						3			3	
KF4113	Management 1						2	2			3	2
KJ4013	Project 1	3	4	2	2	3	4	2	3	3	4	3
KJ4353	Mechanical Vibrations	3		2	2					2		
KJ4953	Design Project	3	3	1	3	3	3	2	2	1	1	1
KF4123	Management 2						2	2			3	2
KJ4023	Project 2	3	4	2	2	3	4	2	3	3	4	3
KJ4113	Combustion and Thermal Systems	3		3	3	3			3			3

KJ4123	Utilisation of Natural Gas	3		3	3	3			4			
KJ4133	Efficient Use and Management of Energy	3		3	4	4				4	2	3
KJ4143	Air Conditioning and Refrigeration	3		2	3	3					3	
KJ4153	Solar Energy Technology	4	3	3	3	3			4	3	4	4
KJ4163	Computational Fluids Dynamics	3		4	3	3			4		2	4
KJ4173	Design of Thermal Systems – Fluid Syste,	3		3	4	4	2				3	3
KJ4183	Energy Conversion System	3		3	3	4			2	2	3	3
KJ4303	Non Desctructive Testing	3		2	2					2		
KJ4313	Basic Theory of Elasticity	2		2	2			2				
KJ4323	Advanced Control Engineering	3		2	2	2				2		
KJ4333	Basic Continuum Mechanics	2		2	2	1			2			
KJ4343	Acoustics	3		2	2	1			2	2		
KJ4363	Finite Elements Method	3		2	2	1			2	1		
KJ4373	Automotive Engineering	3		3	2	1			2	2		
KJ4383	Robotics	3		2	2	1				2		
KJ4393	Advanced Applied Mechanics	3		2						2		
KJ4513	Polymer Processing	4	1	2	3	1				1		
KJ4523	Corrosion and Corrosion Technology	4		4	4	1			1	1		1
KJ4533	Material Conservation	2	1	2	3	3	3				1	1
KJ4543	Tribology	4		3	3	2			3		3	
KJ4553	Mechanics of Polymer & Composite Matls	4		4	4	1			1	1		1
KJ4563	Metal Forming Theory	4	1	3	3	3		2		3		
KJ4573	Processing of Ceramics	1		2								

Key

	No emphasis
1	Very little emphasis
2	Some emphasis
3	Moderate emphasis
4	Substantial emphasis

FIGURE 9 Achievement of all outcomes by all students in relation of subjects in Manufacturing Engineering program

Code	Course	Emphasis on the Program Outcomes										
		1	2	3	4	5	6	7	8	9	10	11
KF1133	Introduction to the engineering	3										1
KF1153	Material Science	3										
KF1173	Engineering graphics	3	3									
KF1193	Ordinary Differential Equations	3		3			2					
ZT1012	Islamic Civilisation & Malaysian Studies I							3				
KF1043	Basic Applied Mechanics	3		2						2		
KF1063	Introduction to Electrical Engineering	3										
KF1083	Introduction to Thermodynamics	3										
KF1223	Linear Agebra & Vector Calculus	3			3		2					
KF1243	Computer Programming	3										
KF1131	Engineering Applications	3										
VH2073	English for Engineering		3									
KF2033	Engineering Statistics	3										
KJ2113	Basic Fluid Mechanics	3		2	3	2			1	3	3	3
KJ2513	Engineering Materials	4	1	2	3	1				1		
KL2073	Machine & Power Electronics	2		2	2	2				2		
KF2043	Complex analysis & Partial Differential eq	3										
KJ2323	Engineering Dynamics	3		2	2	1				1		
KJ2343	Mechanic of Materials	3		2		1						
KP2023	Manufacturing Processes I	4	1	2	3	1				1		
ZT1022	Islamic Civilisation & Malaysian Studies II							1				
KF3113	Numerical Analysis			3								
KJ3313	Measurement and Instrumentation	3		2	2	1				2		
KP3213	CAD/CAM	3	3	2	1	3	3		2	4	3	
KP3233	Fluid Power	3		3	3	3				3	2	
KP3413	Quality Control	3	4	2	3	1	3	2	3		3	2
KF3223	Technology and Civilisation			2								
KJ3123	Fluid Mechanics	3		3	4	3			2		1	3
KP3023	Manufacturing Processes II	4	1	2	3	1				1		
KP3123	Machine Tools Technology	3		3	1	3		1		4	3	
KP3223	Automatic Control Systems	3		3	3	4				2		
KP3423	Facilities Planning & Materials Handling	2		3	3	4				4		
KF3065	Industrial Training	3						3			3	
KF4113	Management 1						2	2			3	2
KP4413	Industrial Project	3	4	2	2	3	4	2	3	3	4	3
KP4213	Automation and Robotics	2		3	3	3				3	2	2
KP4913	Project 1	3	4	2	2	3	4	2	3	3	4	3
KF4123	Management 2						2	2			3	2

KP4423	Production Planning & Control	1	3		4	3				3	4	
KP4923	Project 2	3	4	2	2	3	4	2	3	3	4	3
KP4013	Joining & Fnishing Technology	3	1	2	1	1				2		
KP4023	Contemporary Manufacturing Processes	3	2	1	2	1			2	2	2	3
KP4033	Machining Processes	2		3	3					3		3
KP4043	Casting & Powder Processes	4	1	2	3	1				1		
KP4053	Plastics Technology	2		3	2	2		1		3	1	1
KP4223	Artificial Intelligence in Manufacturing	3		3	4	4			3			
KP4233	Robot Analysis and Development	3		4	4	4				3		
KP4243	Design for Manufacturing	3	1	1	3	3	3	3	2	3	3	3
KP4253	Computer Numerical Control	3		3	4	4				3		
KP4263	Finite Element Analysis in Manufacturing	3		2	2	1			2	1		
KP4433	Manufacturing Ergonomics	3		4	3	3						
KP4443	Engineering Economics	1	1	2	2		1		2		1	1
KP4453	Manufacturing Project Management	2	1			3	3	3	2		3	3
KP4463	Planning & Control of Maintenance System	3		3	4	4				2		
KP4473	Management of Manufacturing Strategy	1	4		3		2				4	2

Key

	No emphasis
1	Very little emphasis
2	Some emphasis
3	Moderate emphasis
4	Substantial emphasis

4.6 Process for Achievement of Outcomes

For achieving the program outcomes, instruction is offered in accordance with course syllabi and the course goal (CG) and instruction outcomes (IO) documents. All individual course instructors are asked to complete an ***end-of-course self-assessment form*** prepared by the OBE & Curriculum Review Committee.

The form explicitly asks the course instructors to designate how much each course helped students in developing the attributes pertinent to the outcomes specified for that course. The form includes responses ranging from 1 (not at all) to 5 (a great deal). In addition, the form includes a request for comments that should be brought to the attention of the curriculum committee to improve the effectiveness of the course. Through this form, the OBE & Curriculum Review Committee receives continuous input from the faculty regarding their view of the achievement of outcomes.

4.7 Assessment of Program Outcomes and Results

Additionally, the outcomes are assessed by using a variety of assessment tools, and the results of assessments are used to implement changes in courses and the curriculum as needed for success in achieving the program objectives. The various assessment tools and the results of assessment are discussed next, followed by changes prompted by the assessment results.

4.7.1 Overview of Assessment Tools

Table 2 provides a summary of the various tools employed for assessment. In many cases, the PO are directly assessed by the constituents. In other cases, assessment is indirect, with the results providing useful information concerning the attributes of the graduates. Not included in Table 2 are routine every semester evaluations.

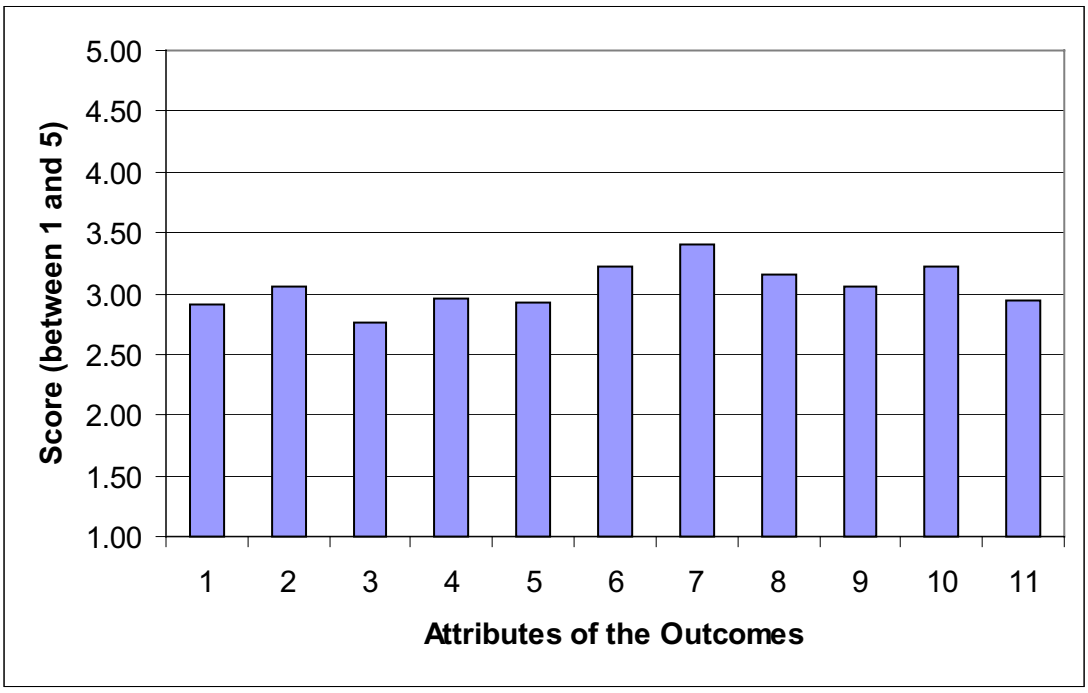
Table 2. Summary of Various Assessment Tools and Related Details

No.	Items Assessed	Assessment Tool	Administered by	When Administered
1	PO specific to courses	Self-evaluation	department	May 2004
2	PO achievement	Student Survey	department	May 2004
3	PEO	Parent	department	May 2004
4	PEO	Alumni survey	department	May 2004
5	PO, PEO achievement	Alumni survey	department	May 2004
6	PEO	Employer survey	department	May 2004
7	PO, PEO achievement	Employer survey	department	May 2004
8	Exiting competency	Senior exit survey	department	March 2004
9	Entry competency	First year student	department	May 2004

4.7.2 Student Surveys

To judge the department's success at helping students develop outcomes (1) to (11), undergraduate student of the department were surveyed at the end 2004/2005 session (June 2004), yielding a response rate of 73%. Also included in the survey are questions about demographics, goals of study.

The survey results are shown in Figure 10. Students rank the department higher in "soft" areas such as having the understanding of social, cultural, global and environmental responsibilities (outcome 7), effective individual in a group (outcomes 6), ability to function on multi-disciplinary teams (outcome 10) and communicate effectively (outcome 2).



Average	2.90	3.05	2.75	2.96	2.92	3.22	3.40	3.16	3.05	3.22	2.95
Std. deviation	0.73	0.76	0.85	0.77	0.88	0.90	0.81	0.71	0.70	0.79	0.83

FIGURE 10 Mean responses from undergraduates to the question *How much have the department (JKMB)help you develop the outcomes attributes of an engineer?*

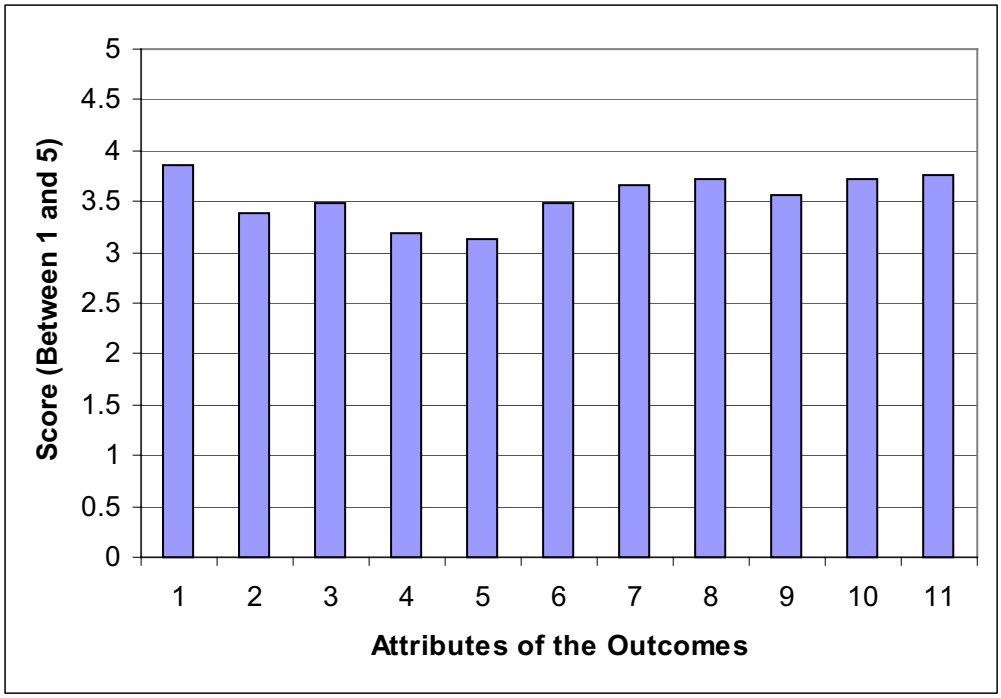
The May 2004 survey also revealed that exiting students rate the department more highly than lower first year students. Nevertheless, both groups agree that the department (and the university) does better in the hard areas.

4.7.3 Alumni Survey

A survey of the department alumni, who graduated between 1996 and 2002 was conducted in May 2000. A total of 50 surveys were mailed to the alumni and 21 responses (42%) were received. Alumni had the option to respond by mail or e-mail.

The survey also asked questions about employment status, educational influences at the department and the importance as well as their achievement of the program educational objective (PEO) in the careers of the alumni.

The survey results are shown in Figure 11. The results indicate that alumni rank the department more highly in "hard" areas such as applying basic knowledge, in-depth technical competence, designing experiments, and analysing data. Scores are significantly lower in "soft" areas such as communication, problem identification and systems approach.



Average	3.86	3.38	3.48	3.19	3.13	3.48	3.67	3.71	3.57	3.71	3.76
Std.Dev	0.48	0.67	0.51	0.75	0.60	0.51	0.48	0.46	0.60	0.46	0.44

FIGURE 11 Faculty of Engineering Alumni were asked to rate the department's performance at helping them develop the attributes of an engineer corresponding to outcomes (1) to(11).

4.7.4 *Senior Exit Survey*

The senior exit survey is administered in Mac 2004 to all graduating seniors. It is sent out by hand. Of the 87 graduating seniors, 47, or approximately 54% responded. The survey consists of items pertaining to choice of jobs and self-assessment of exiting abilities on several attributes stated in the program outcomes. In addition to numerical

ratings, the surveys also elicited open-ended responses to a question pertaining to improve future educational instruction of the department.

The self-assessment results from the surveys for the department graduates are presented in Table 3. The scores for the entering and exiting competencies are mean values for the entire group (approximately 100 in each year), on a scale of 1 to 5, with 1 representing very weak competency and 5 representing very strong competency. It can be seen that the exiting competencies in all attributes are higher than the corresponding entering competencies. In general, the increases in competencies in "hard" areas are greater than the increases in the "soft" areas.

TABLE 3 Self-assessment results from senior exit surveys and comparison with entering survey.

	Program Outcomes	Competency	
		Entering	Exiting
1	Ability to acquire and apply knowledge of basic science and engineering fundamentals.	2.90	3.81
2	Ability to communicate effectively, not only with engineers but also with the community at large.	3.05	3.63
3	In-depth technical competence in a specific engineering discipline.	2.75	3.70
4	Ability to undertake problem identification, formulation and solution	2.96	3.63
5	Ability to utilize a systems approach to design and evaluate operational performance	2.92	3.46
6	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member	3.22	4.16
7	Understanding of the social, cultural, global and environmental responsibilities of a professional engineer, and the need for sustainable development	3.40	4.23
8	Expectation of the need to undertake lifelong learning, and possessing/acquiring the capacity to do so	3.16	4.26
9	Ability to design and conduct experiments, as well as to analyse and interpret data	3.05	3.66
10	Ability to function on multi-disciplinary teams	3.22	4.26
11	Knowledge of contemporary issues	2.95	3.91

4.7.5 Employer Survey

The Department of Mechanical and Materials Engineering has mailed questionnaire to the industries who are employing our graduates to obtain their opinions regarding the quality of graduates in general and according to program outcomes. Among a list of 50 possible contacts 18 responded to the survey. The sample included a variety of industries, ranging from contractors, developers to consulting firms. The results of the

survey indicated that the employers satisfy with our graduate. All respondents rated the quality of the department graduates as above average with a rating between 3 to 4, on a scale of 1 to 5, with 1 being poor and 5 being excellent. The survey results are given in Table 4.

TABLE 4 the quality of the department graduates as perceived by employers

	Program Outcomes	Quality of graduates
1	Ability to acquire and apply knowledge of basic science and engineering fundamentals.	3.72
2	Ability to communicate effectively, not only with engineers but also with the community at large.	3.11
3	In-depth technical competence in a specific engineering discipline.	3.83
4	Ability to undertake problem identification, formulation and solution	3.61
5	Ability to utilize a systems approach to design and evaluate operational performance	3.50
6	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member	3.33
7	Understanding of the social, cultural, global and environmental responsibilities of a professional engineer, and the need for sustainable development	3.72
8	Expectation of the need to undertake lifelong learning, and possessing/acquiring the capacity to do so	3.67
9	Ability to design and conduct experiments, as well as to analyse and interpret data	3.56
10	Ability to function on multi-disciplinary teams	3.33
11	Knowledge of contemporary issues	3.61

4.8 Lecturer Survey and Use of Assessment Results

Summarizing the results presented for the various individual assessments, there is clear evidence that the preparation of our two undergraduate programs are strong in the "hard" areas, whereas some improvement may be needed in the "soft" areas.

Nevertheless, to quantify the need for attention to each attribute and thereby "close the loop," the OBE & Curriculum Review Committee surveyed the department academic staff in May 2004 to measure their effort for strengthening the curriculum with reference to student and alumni ratings for outcomes (1) to (11). This action is considered to be equivalent to setting indicators of achievement of PO and comparing the results of assessment with the indicators, as illustrated in Figure 2. The survey, administered electronically via email, elicited 17 responses. The academic staffs indicated to what degree they put their effort to achieve each of the department's 11 program outcomes, (1) to (11) for improvement in our curriculum. As they responded to this question, they could view results of past student surveys assessing the department's performance at helping them achieve each outcome.

The academic staffs were also asked to write freely their ideas for strengthening the outcomes in their particular courses and enhancing student awareness of the outcomes.

The survey results are shown in Figure 12, along with the results from the student and alumni surveys, from Figures 10 and 11. The alumni survey results were not available to the academic staffs at the time they responded to the survey. In a sense, the academic staffs ratings for (1) to (11) can be considered the inverse of the student and alumni ratings; that is, a low student rating (indicating poor departmental performance) should correspond to a high faculty rating (indicating need for improvement). In this vein, there appears to be broad agreement among the surveyed groups on outcomes (1), (3), (4), (5) and (9), with relatively low student and alumni ratings and relatively high staff ratings.

Accordingly the OBE & Curriculum Review Committee concluded that a focused attention was needed to address the situation with regard to these five outcomes, amid the continuous improvement of the overall curriculum in terms of all outcomes.

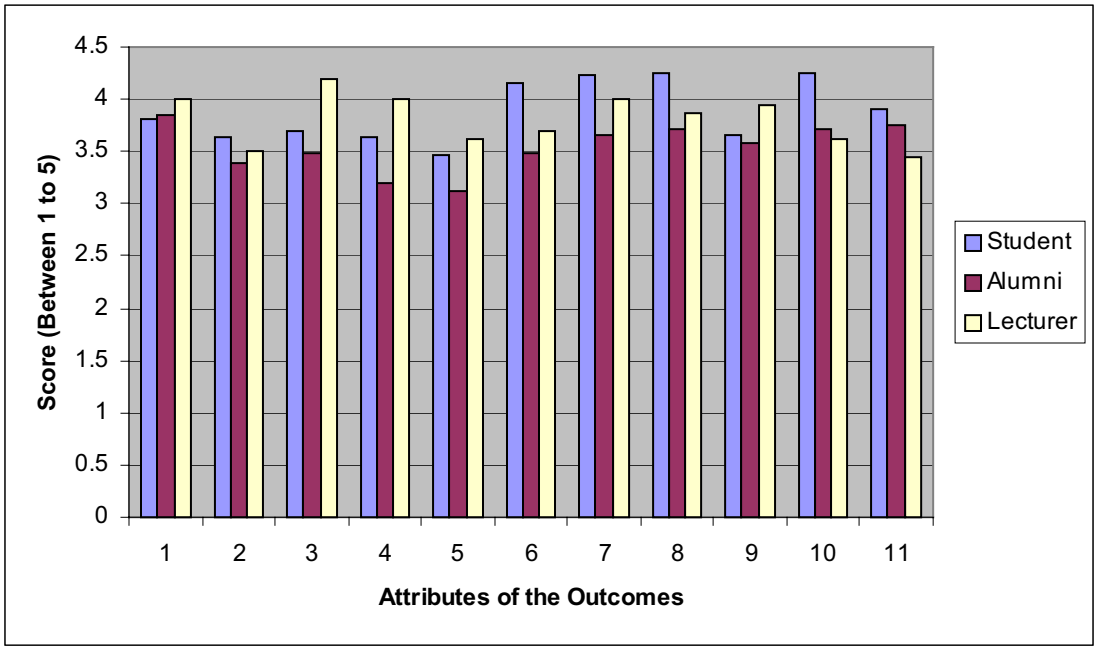


FIGURE 12 Ratings for outcomes (1) to (11) for three surveyed groups. All JKMB undergraduates (blue bars) were asked in May 2004 to assess how well the department had helped them develop the attributes of an engineer described in outcomes (1) to (11). Alumni who graduated between 1996 and 2002 (black bars) were asked in May 2004 to make the same assessment using the same scale. Academic staffs (yellow bars) were asked in May 2004 to assess the degree to which each outcome (1) to (11) they have given attention for improvement in the curriculum.

5. Consultation with stakeholders

To ensure that the programme offered is continually relevant, external assessments and reviews by specially invited external examiners are built into the assessment component of the programme. Every comment made by the external examiners, if found relevant and logical, is taken into account for improvement. In general, the curriculum is reviewed every 5 years. If it is felt necessary, the review is conducted earlier as and when needed.

The external examiners appointed for both the programmes offered by the Department of Mechanical and Materials Engineering are as follows:

1) Prof. Dr. Awaluddin bin Mohd. Shaharoun
   Faculty of Engineering
   Universiti Teknology Malaysia
   81310 UTM Skudai
   Johor Darul Ta'zim

2) Prof. Dr. Masjuki Hj Hassan
   Faculty of Engineering
   University of Malaya
   50603 Kuala Lumpur

3) Prof. Jasper L Styne
   University of Pretoria
   South Africa

Reports prepared by both the external examiners are given in Appendix 1. In addition, the Faculty is also in the process of appointing an Adjunct Professor for every department. They would also be members on the Faculty's Advisory Panel. For the Department of Mechanical and Materials Engineering, the appointed Adjunct Professor is Yang Berbahagia Dato' Kisai Rahmat, currently the Executive Director of Executive Director, Perusahaan Otomobil Nasional Berhad (PROTON), HICOM Industrial Estate, Batu 3, 40000 Shah Alam, Selangor.

At the departmental level, every department would have a Board of Studies with members consisting of representatives from the government and private sectors and also at least one former student. For the Department of Mechanical and Materials Engineering, the members are as follows:

1) Hj Jamaludin bin Hj Maarof
   General Manager
   Ingress Precision Sdn. Bhd.
   PT 2475-2476, Kawasan Perindustrian Nilai
   P.O.Box 45
   71807 Nilai
   Negeri Sembilan.

2) Nik Zainuddin bin Nik Ismail
   Hicom-Yamaha Manufacturing Malaysia Sdn. Bhd.

Lot 751, Persiaran Kuala Selangor, Seksyen 26
40000 Shah Alam
Selangor

3) Ir. Nasruddin bin Pawanteh
MOGC Engineers Sdn. Bhd.
No.3 Jln Suasana 3/3,
Bandar Tun Hussein Onn,
43200 Cheras,
Selangor

4) Khairul bin Dato' Hj Yusof
Hicom Teck See Manufacturing Sdn. Bhd
Lot 76&75A Jalan Sementa 27/91, Seksyen 27
40000 Shah Alam
Selangor

6. Faculty Plans & Commitment

The surveys that have been carried out by the departments shows that the alumni and employer have given their rating of less that 4.0 for all outcomes attributes as shown in Figure 13.

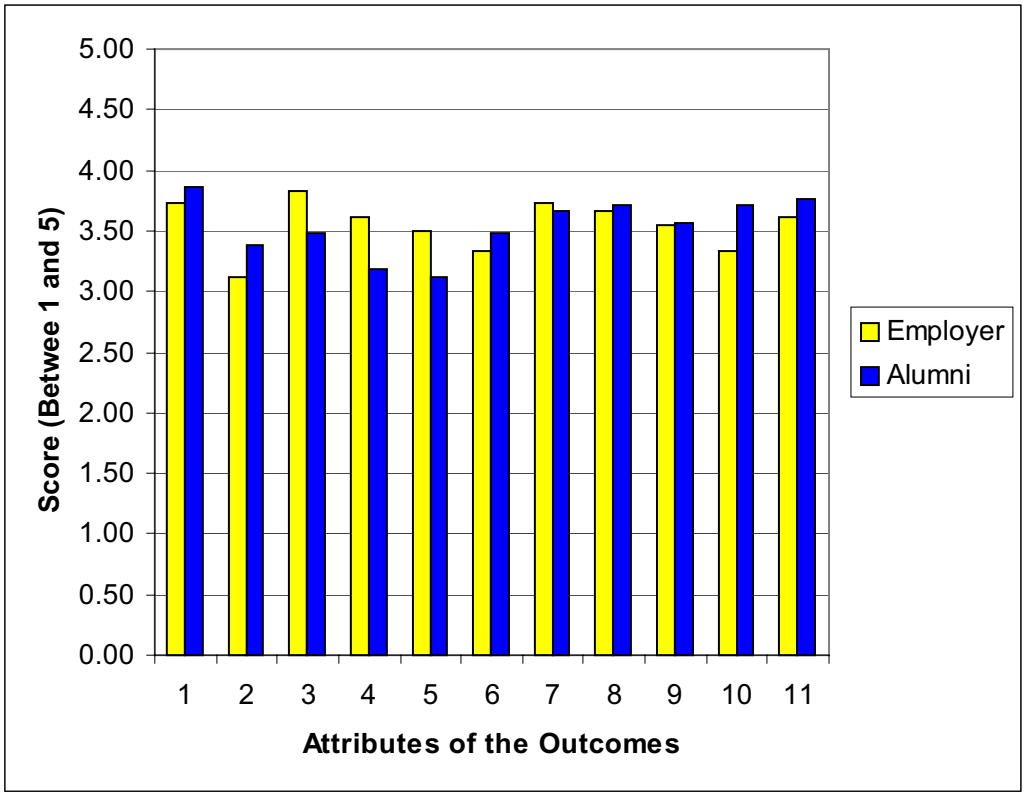


FIGURE 13 Ratings for outcomes (1) to (11) for employer and alumni surveyed groups.

The alumni group has given the rating of not greater than 3.5 for outcome 2 (ability to communicate), outcome 3 (in-depth technical knowledge), outcome 4 (ability to undertake problem identification, formulation and solution), outcome 5 (ability to utilise systems approach) and outcome 6 (Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member).

The faculty has sensed the deficiency of the graduated through unofficial comment of the alumni and employers before the survey exercise and took short term and long term correction measures. The survey confirms and indicates objectively the unofficial comments.

6.1 Short Term Correction Measures

The faculty has carried out some modifications in teaching process based on the existing curriculum. The modifications are as follows:

- Reducing classroom instructions.

- Encourage the use of e-learning process.
- Modify academic project or thesis to be more independent to train the student to be able to undertake problem identification, design and conduct research and interpret data.
- Re-align design-based courses to train the student to be more innovative.
- To encourage the students to form extra curriculum club to get hand-on experience on product design and realisation. The existing projects in the department are Solar Car and Robotic Projects.
- Intensify students presentation session for most the subjects where every student has to explain and defend his/her project.
- Link the final year project with on-going research project in the faculty.

The above components conceptionaly are shown in Figure 13.

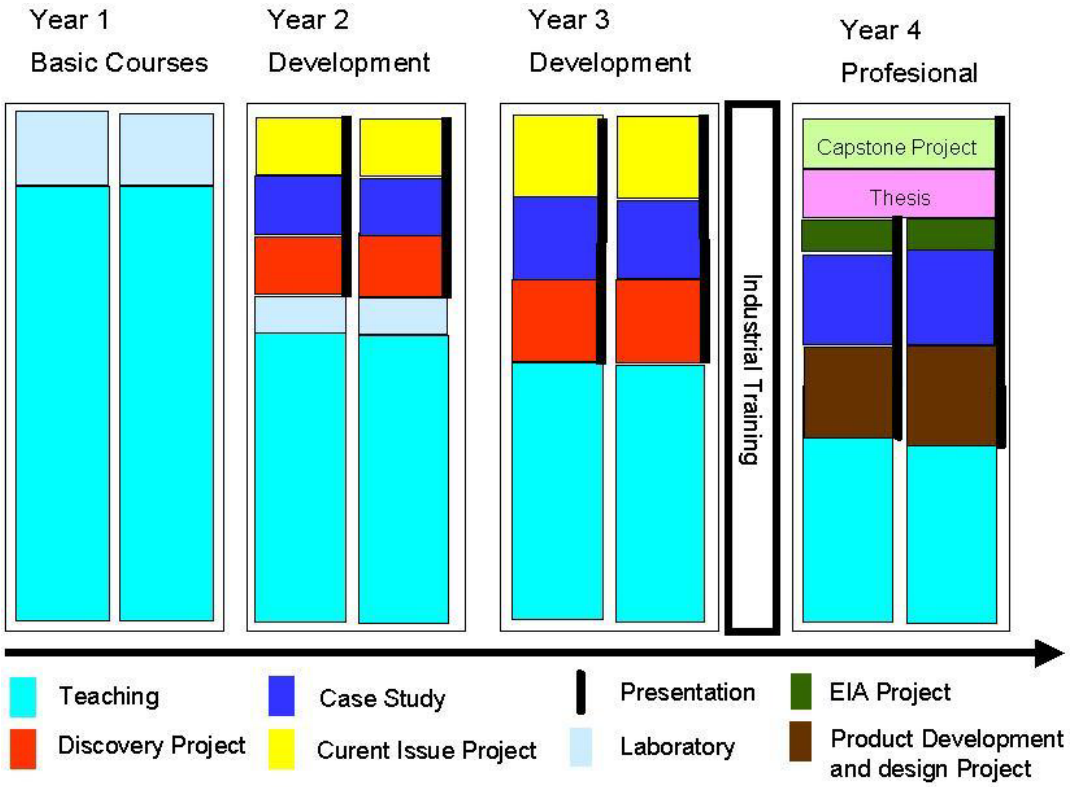


FIGURE 13 Basic components in the department curriculum

6.2 Long Term Correction Measures

The faculty is currently reviewing all course structure and syllabi. All aspects listed out for the short-term measures will be strengthened and new teaching process would be introduced in order to achieve the listed Outcomes.

The faculty is also strengthening its interaction with practitioners and employers. There are a number of academic staffs of Mechanical and Materials Engineering have some experience in industry before joining the department. Their experiences and connection with industrial practitioners establish the relation between the department to the industrial firm, consulting firm and various government agencies.

The department also establish a multi-disciplinary research and collaboration with number of national institutions (for e.g. SIRIM,) and international institutions (overseas universities, research partner etc).

The faculty is also encouraging its academic staffs to prepare themselves to sit for professional interview. Besides, the faculty is facilitating the academic staffs to participate in national and international innovative competition. Trough this program, the faculty has won several national and international award as given in Appendix II. The professional engineer and the innovative awards on top of academic qualification are giving good role model to the student.

APPENDIX I - Modified Existing Course Structure

Figure 14: New Structure for Mechanical Engineering Program

Figure 15: New Structure for Manufacturing Engineering Program

APPENDIX II - Awards

The outcome-based education (OBE) approach requires the university to ensure that the stated outcomes are met and that the programme objectives and quality are continually reviewed and improved. Since the Engineering Accreditation Council (EAC) first introduced this programme 3 years ago, it should be sufficient at this transitory stage for the universities to be able to demonstrate a certain minimum compliance. What is more important at this stage is that the universities show their early commitment towards OBE. At this point, the Faculty has taken some measures to comply with the OBE's requirement.

It has:

- Formed a task force to look into OBE at the Faculty and Departmental level.
- Sent some representatives to the 2nd ABET International Faculty Workshop on Continuous Program Improvement, Singapore, 9 – 11 November 2003.
- Organised a workshop on OBE on 30 December 2003.
- Formed a curriculum review committee to consider OBE in the syllabus with recommendation of a new matrix of programme outcomes to be achieved by each subject.
- Implemented an assessment and evaluation of the stated outcomes of the programmes. This includes a review of the contents of the final year project, final year design project, and industrial training to help student achieve the intended outcomes. An exit survey has also been distributed to the students to get some feedback of the achievement of the outcomes.
- Implemented new teaching approaches in order to achieve the stated outcomes of the programmes.
- Increased activities such as industrial visit and invited guest lecturers from industry to expose students to real engineering practice.
- Encouraged students to be involved in co-curriculum activities such as becoming student members of the Institution of Engineers Malaysia (IEM).
- Encouraged participation of students in conferences organised by faculty such as the 3rd International Conference ICAST held between 12 to 14 August 2003.
- In an effort to motivate students to excel in their academic and extra curricular performance, industries are solicited to sponsor various awards. The university itself offers various awards to students who excel.

Supplementary documents highlighting OBE activities at various stages of the students learning experience will be made available.