Report of the External Assessor 2007

prepared by

Taylan Altan, PhD
Professor & Director
Engineering Research Center for Net Shape Manufacturing
The Ohio State University
339 Baker Systems / 1971 Neil Avenue
Columbus, Ohio 43210-1271 / U.S.A.

E-mail: altan.1@osu.edu

for

Mechanical and Manufacturing Engineering Programme
Department of Mechanical and Materials Engineering
Faculty of Engineering
Universiti Kebangsaan, Malaysia (UKM)
March 19-21, 2007

ACKNOWLEDGEMENTS

This report was prepared as a result of my 3 days stay at UKM (March 19-21, 2007). I would like to thank the Administration of UKM and especially Dean of the Faculty of Engineering, Professor Hassan Basri for inviting me to do this programme review. During my visit the Chairman of the Department of Mechanical and Materials Engineering, Professor Ahmad Kamal Ariffin Mohd. Ihsan, was extremely helpful in making sure that I had access to all the relevant information and had the opportunity to meet with the lecturers and professors of the department as well as with a group of students. He also made sure that my stay at UKM was socially pleasant and interesting.

Associate Professor Norhamidi Muhamad maintained the correspondence with me and made sure that all the logistics of my visit were perfect and I had an enjoyable and productive time at UKM. All the lecturers of the department whom I met were extremely cooperative and provided any information I needed.

My sincere thanks for all this pleasant and extremely helpful support.

Taylan Altan
March 26, 2007

FOREWORD

The preparation of this report included:

A. The review of the following documents:

1. The "ABET Self Study Report (2005-2006) for the Mechanical Engineering (ME) Program", submitted by The Ohio State University (OSU) to the Engineering Accreditation Commission, June 2005.

This review was useful and illustrated that the ME Program of OSU is quite similar to that of UKM and some of the issues addressed in the OSU-ABET report were helpful in reviewing UKM's program.

2. Reports to External Assessor 2007 on both the Mechanical Engineering Program and the Manufacturing Engineering Program of the Dept. of Mechanical and Materials Engineering.

3. Supplementary document submitted to Engineering Accreditation Council – Board of Engineers Malaysia, May 2004, entitled "Efforts Towards Outcome-Based Approach in Engineering Education".

B – Meetings and discussions during the 3 day visit (March 19 thru March 21, 2007), according to the following agenda:

Day 1 – Initial discussions / Introduction to the Department by the Head of Department / Review and evaluation of engineering syllabus / laboratory visits / (lecturers and technicians standing by)

Day 2 – Continue of review and evaluation of engineering syllabus / meeting with eight students / meeting with lecturers on design projects and 4 year design project.

Day 3 – Preliminary oral review report / discussion with all lecturers and suggestions on quality improvement / seminar and discussion on engineering education (1 – Engineering education – a perspective from USA / 2 – international cooperation and student exchange in metal forming research).

Following the significant aspects of all these discussions, this brief report is structured as follows:

1. INTRODUCTION / GENERAL COMMENTS

The review of the available documents (item A in Foreword) already illustrated that the contents of the mechanical engineering programs at Ohio State and at UKM are quite similar with one major difference that the first year UKM students have a stronger background in high school chemistry and physics and also probably in mathematics. Thus, UKM's program does not need basic courses in chemistry and physics.

The philosophy, vision, mission, aims and Programme Educational Objectives (PEO) of UKM and of the faculty of engineering are outstanding. Nevertheless, some of the PEO's of the Dept. of Mech. and Materials Engineering are quite ambitious and may have to be evaluated with certain tolerance. Specifically, the following PEO's and Learning Outcomes (LO) are quite challenging:

- PEO- 4 – "A graduate who is able to adapt him/herself to the international/global work environment"
- PEO-5 – "A graduate who is able to lead an engineering organization based on knowledge of important current issues in engineering and experience"
- LO-2 – "Ability to communicate effectively, not only with engineers but also with community at large"
- LO-11 – "Having the knowledge of contemporary issues in mechanical/manufacturing engineering"
- LO-12 – "Ability to use techniques, skills, and modern engineering tools necessary for mechanical/manufacturing engineering practice"

These PEO's and LO's should be considered as "objectives" to be achieved "as much as possible".

The academic qualifications of the UKM's lecturers (lecturer, Associate Professor, Professor) are excellent. However, a large majority of the lecturers do not have much industrial experience or exposure. This is quite similar to the situation that exists at Ohio State and in most U.S. engineering departments. This situation may not be very critical in the U.S. environment because U.S. has a large industrial infrastructure. Furthermore, many companies and most U.S. engineering colleges have extensive "cooperative study" programs that allow students to spend one or more quarters (or semesters) in industry even though as a result the "four year" program may take 5 or more years.

The discussion with students as well as with lecturers indicates that there is a need for more "practice or industry oriented" activities. This observation is made in reviewing and discussing several aspects of the program such as: a) laboratory experiments, b) length of industrial training, c) content of the majority of the class projects, d) content of the 4^{th} year projects (or thesis), and e) workshops on machining during intersession. These issues will be discussed further.

2. LABORATORY EXPERIMENTS

The following topics include suggestions and observations made by the students:

2.1 Access to lab equipment and tests. Often a group of 5 to 8 students have to conduct a lab experiment. However, in reality only 1 to 3 may work hands-on while the others may have to "watch". This situation is due to limited resources and is similar in nearly all other engineering colleges.

A possible remedy may be to develop computer and animation based "virtual lab experiments" that the students must review before coming to the lab session (most students are quite computer-savy and had computers since the start of high school and they like computer simulation). The virtual lab would not replace the physical lab but rather prepare the students.

Development of "virtual labs" could be done by 3rd year students as "design projects".

2.2 Scheduling and contents of lab experiments. It is desirable, although this is often difficult to do, that a given lab experiment is scheduled after the fundamentals of that topic have been covered in class. (Here the virtual lab may help.)

Furthermore, it would be great to reconfigure some of the experiments to incorporate "practical" or industry-type issues/problems.

2.3 Maintenance of lab equipment, as pointed out by some students, is critical and may need some attention. Non functional lab equipment causes the students to miss a significant learning experience.

2.4 Exam on lab tests. To make sure that all the students have thoroughly understood the labs, it may be useful to introduce a test. Apparently, turning in the lab reports is not always sufficient to evaluate the quality of learning in the labs.

3. INDUSTRY CONTACTS

There is a general consensus (students and lecturers) that increasing industrial contacts would have a positive effect on the overall engineering education as follows:

3.1 Industrial Training (10 to 12 weeks) is too short and should be 4 to 6 months (one semester or more). Furthermore, it is desirable for students to have a "meaningful" industrial experience compatible with their experience and interests. However, this is very difficult to achieve because a) not many companies may be willing to participate in this program, and b) extending the industrial training/experience requires additional time or extension of the study period.

Both issues may have to be handled at an institutional level, at least from the faculty and Dean's level.

3.2 Increase of Industrial Contacts. There is an Industrial Advisory Board and there are Adjunct Professors from industry. A major effort by the department and faculty may be necessary to increase industry contacts and establish mutual understanding between industry and UKM. Possible actions to achieve this objective may be:

3.2.1. Increase the size and effectiveness of the Industrial Advisory Board by (a) selecting seriously interested industry representatives, and (b) assuring that they interact or at least meet with the lecturers.

3.2.2 Explore how to utilize existing research cooperation with industry to additional interactions.

3.2.3 Maintain and update an alumni list since these individuals may be potential points of contact and cooperation.

3.2.4 Invite occasionally speakers from industry to give seminars to students and lecturers on industry perspective and activities.

3.2.5 Arrange for occasional field trips (one or more days) to various companies with lecturers and students.

3.2.6 Explore whether some of non-critical industrial problems could be incorporated into class projects and/or 4^{th} year thesis projects.

Some of these activities, listed above, may already be taking place.

An observation was made that companies prefer to hire graduates of foreign universities. It may e useful to find out why? Furthermore, it is interesting to know which companies hire graduates from which countries?

Finally, increasing industrial contacts would also facilitate the job search for graduating students since, most probably, their advisors with contacts could assist them. Alternatively students may have already made some industrial contacts while working on their thesis project.

4. INTERSESSION/MACHINE SHOP TRAINING

All engineering students are now required to go thru this training. Observations by students (also by some lecturers) indicate that this training is not achieving its objectives because the resources are limited. Students may have to "wait" for their turn and are "bored" since the time is not used effectively.

Is it possible to a) require only the Mech. and Manuf. Engr. Students to take this training (this would considerably reduce the work load), or b) cooperate with another organization (trade school or alike) that has the resources to take over this task.

5. ASSESSSMENT OF PROGRAMME OUTCOMES AND RESULTS

Several tools are available and are used at various levels of effectiveness.

5.1 Course evaluation. There is a procedure for students to evaluate individual courses via the internet. Questions are: a) is there a follow up? (b) is there a procedure to assist a lecturer who needs to improve his/her teaching skills?

5.2 Student survey. This was administered in 2004. For the ME students, the scores on eleven PO (Programme Outcomes) are mixed, in the range of 2.5 to 3.5 (max 5.0) (Fig. 7 of OBE report).

5.3 Alumni Survey, also done in May 2004, for the entire faculty of engineering gives a higher rating on all eleven PO's (between 3 and 3.5).

5.4 Senior exit survey of May 2004 was not available for Mech. Engr. Department.

5.5 Employers Survey results were not available for Mech. Engr. Department.

5.6 Industrial Training Employers Survey gives reasonably well results. However, compared with other observations made on industrial training (too short, positions are not always best for student's interest, etc.) these results may need re-evaluation.

The senior exit survey is generally considered to be very valuable. At Ohio State, this survey is used as a major indicator to determine the overall teaching capabilities of the Mech. Engr. Department.

6. DESIGN PROJECT AND THE 4TH YEAR THESIS PROJECT

Several courses (KKK J3933 / KKK J3943 / KKK J 3343 / KKK J4953) include projects or project-like assignments. In addition there are 2 courses entirely devoted to 4th year thesis (KKK J4013 / KKK J4023). Design is probably the most important discipline in mechanical engineering and it is one of the most difficult subjects to teach. This observation is valid in most engineering colleges and definitely at The Ohio State University. At the last ABET review at Ohio State, design was identified as one of the issues to improve.

It is desirable to include into design projects (as part of a course assignment), including the 4th year design thesis, design problems that have practical and/or industrial relevance. This is not easily done and requires contacts with industry and knowledge of the industrial issues and problems. This knowledge takes time and industry cooperation to obtain.

Conservations with lecturers responsible for design and with students revealed some very interesting points.

6.1 The students find overall the design projects very useful. They believe to have very good support from the lecturers and advisors. They wish projects could be made more practical and industry related (this issue of practicality came up again and again). Ideally, students would like to work with industry on industry-related projects. In some cases this happens; a student contacts (with support by his/her advisor) the Human Resources Manager of a company to initiate contact and identify design projects.

6.2 It may be possible (this is probably done already in some cases) to integrate some of the design projects with ongoing post-graduate research. Thus, (a) the project has some "usefulness", (b) an MS or PhD student may advise the undergraduate student, jointly with the lecturer. This is a great experience for the graduate student.

6.3 Are students using state of the art software (that is used in industry) for mechanical design (solid modeling, etc.) and are there sufficient number of licenses and terminals for access by the students? Auto CAD alone may not be sufficient.

6.4 Is it possible to include the "architectural or industrial design" aspects into mechanical design? This question, from a student, appears to be influenced by the design work done by the architectural students.

7. SUMMARY AND RECOMMENDATIONS

7.1 Lecturers The educational background and the academic qualifications of the faculty are excellent. With very few exceptions, all the lecturers received their PhD or equivalent degree from well known good universities in U.K. (in most cases), USA, Japan or Germany. Similar to comparable departments in U.S. and U.K., the majority of the lecturers do not have any industry experience. However, there seems to be considerable interest as well as encouragement from the engineering faculty administration to increase interaction and cooperation with industry.

7.2 Students. The educational background, as well as the English language competency of the students, appears to be good. This quality of the incoming students, in addition to the quality of the lecturers, is an essential ingredient for having an excellent university and department.

7.3 Teaching/Courses The overall impression received from discussions with students and lecturers indicate that the academic content, examinations and teaching of the courses in general is quite good.

7.4 Student Interests Based on the conversation with a very small sampling of students, it is very clear that the students are very eager to learn and they like the laboratory sessions and design projects. However, they would like to see all these activities more oriented to practical world problems and industry related issues.

7.5 Laboratories The laboratories could be improved mainly in: a) making sure that all the students, within small groups assigned for a specific lab test, have a good understanding of the experiment; b) lab equipment is well maintained an is always functional; c) whenever possible, specific labs are scheduled after the lab topic is covered in the lecture, and d) whenever possible, the lab experiments are related to real-world problems

One possible improvement would be to have (a) virtual lab experiments that would prepare the students (not to replace the lab experiments) and (b) to give a test on the specific experiments to assure that everyone (and not only 2 of 3 of a group of 5 to 8) are familiar with the experiments. Furthermore, it may be possible to develop the "virtual labs" as class projects in appropriate lectures.

7.6 Industry Contacts. Increasing contacts and cooperation with industry is one of the major goals of the department because cooperation with industry would positively affect many activities including: a) industrial training (which is now too short, 8 to 10 weeks, and may be expanded to 4 to 6 months which is desirable); (b) selection of design projects; (c) industrial training; (d) increase of job opportunities for graduates, and (e) in the long run, assistance in research support (with funds provided by industry or government sources).

To improve industry contacts, it is recommended to a) increase the size and effectiveness (selection of members) of the industrial advisory board; b) selection/increase of adjunct professors; c) keeping contact (as much as possible) with alumni, and d) increase the number of field trips to industry (time permitting).

7.7 Machine Shop Training. It is understandable that this activity will be limited because the students are to learn how machining affects engineering and design. They are not expected to be "good machinists". Nevertheless, the effectiveness of this activity needs to be increased. However, time and resources are problems. It may be useful to consider: a) cooperation with another educational institution that has more equipment and offers machinists training, or b) providing machine shop training only to mechanical and manufacturing engineering students.

7.8 Assessment of Programme. The Programme Outcomes need to be continuously evaluated. This is being done through course evaluations, student surveys, alumni surveys and employer surveys. Serious follow up on the results of these surveys are essential for high quality programme assessment. Thus, the interest of all beneficiaries of the programme, mainly students and employers, would benefit from continuous improvement.

Furthermore, some of these surveys would help in increasing the relations with the industry, which is one of the major goals of the department.

7.9 Design Projects. Design projects associated with relevant lectures as well as the fourth year design project would benefit by including practical and industrial considerations. This is already being done but additional efforts seem to be advisable to make design projects more interesting and useful to students' learning. Here again, increase interaction with industry will help.

Involving BS students in graduate research, with some supervision by MS and PhD students (in addition to supervision by the lecturer) would be beneficial to all the students (undergraduate and graduate). This is being done to some extent and could be further expanded as resources are available.