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A Methodology for Discipline-Specific Curriculum Development*

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A methodology and framework for discipline-specific curriculum development in a local context is described. These activities, as part of the Thailand-Australia Science and Engineering Assistance Project, were in response to a needs analysis for curriculum assistance to a number of publicly-funded Thai universities in the engineering priority area of Materials Processing and Manufacturing. The paper outlines a strategy for the delivery of a centralised curriculum development workshop for academic staff, follow-up visits and local curriculum activities with participating universities, and the presentation of technical short courses as guidance for such activity in other settings and/or discipline areas. This paper is part of a process of documentation so that others can apply the developed methodology and framework for curriculum development. While the paper is a report on curriculum activities in a particular setting, it is written in a manner that allows application of the methodology to other settings. The reader is advised that each curriculum activity needs to adopt a methodology and strategy to fit the particular circumstances being considered. To assist in applying this approach elsewhere, a description of the various steps in the curriculum process, and typical responses to some of the more global issues, have been presented. Full details are available in the various TASEAP reports prepared by the authors. Specific detail has been omitted where this detail does not provide any information for generalized consumption.

INTRODUCTION

THIS PAPER is based on the experiences of the authors in the AusAID funded Thailand Australia Science and Engineering Assistance Project (TASEAP). This program was to assist Thai universities in undergraduate education in both science and engineering for which a number of priority areas were identified, one of which in the engineering area was Materials Processing and Manufacturing (MP&M). This was in response to an identified need reported by Prince [1] who recommended that:

> TASEAP should conduct specialist seminar/workshops leading to the development of new curricula, in three of the engineering priority areas identified by the Thai universities, in a manner which serves to demonstrate systematic principles and procedure for generic curriculum development.

The paper describes a multi-faceted approach to providing assistance to academic staff from the participating Thai universities over a broad range of issues. These included curriculum review and development, the introduction of new teaching and assessment methodologies, and the updating of technical and professional skills. The approach adopted was in four parts: preliminary visits to the universities; the principal activity, the Curriculum Development (CD) workshop; follow-up visits several months later; and technical workshops. The majority of this paper reports on the design, planning and execution of a three day CD workshop for staff from departments of Industrial, Process, Chemical and Materials Engineering, and others, from universities participating in the MP&M program. This paper also includes insights gained by the authors during the follow-up CD activity that focused specifically on alternative teaching methods and on the methodology of applying a continuous improvement methodology to an academic curriculum in a real-world situation.

In preparation for the workshop and as follow-up several months later, a number of visits were made by the authors to the participating universities. The purpose of these, other than general familiarisation and fact-finding, was for the authors to meet, in their local environment, those academic staff who would be actively involved with the CD workshop and the technical presentations. This allowed a first-hand assessment of the status of the current undergraduate curriculum in each department and the skills and experience of staff. It also helped identify specific topics for inclusion in the technical workshops, which would be of future benefit to those attending.

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The CD workshop was designed to provide academic staff with a methodology and framework for curriculum development, as well as discipline-specific advice in the areas of metallurgy, materials science and manufacturing technology. Specialised assistance with the workshop was provided by Dr Kaya Prpic to whom the authors express their gratitude. This workshop, which had different appeal and relevance for the various staff attending, was a core element of an ongoing process of curriculum assistance—both review and development—provided by the authors from about mid-1998 to end 1999. Staff participating in the workshop were encouraged to continue work on their curriculums in the months following the workshop so that implementation of their new or revised curricula could be expedited.

The final stage of the program was a series of technical workshops in metallurgy, materials performance and welded fabrication. These served to impart technical information and demonstrate different strategies and approaches to teaching and learning, styles for preparation of course notes, and the use of visual aids to assist in the delivery.

CURRICULUM DEVELOPMENT WORKSHOP

Background

The workshop, held at Chulalongkorn University in December 1998, covered three full days. The first and second days were considered to be core activities for all participants, whereas the third day was optional. The workshop was designed to provide the framework for academic staff to establish new discipline-specific curricula and/or review existing curricula in undergraduate programs in the engineering priority area of Materials Processing and Manufacturing (MP&M).

The first day of the workshop dealt with the methodology of the curriculum development process and curriculum directions by considering the strengths and weaknesses of the various participating departments, and the opportunities and threats facing each department. Consideration was also given to the nature of the student intake, the required graduate outcomes, and teaching methodologies and assessment methods. Building on this, the second day led to the drafting of a Curriculum Framework for each program by considering the structure of the course, the streaming of areas of study and the scientific, technical and professional base of each degree course represented. The final day was optional for those academics (or departments) who had a specific need to deal with program/course documentation and subject development.

Attendance at the workshop was encouraged for all Thai academics with teaching and curriculum responsibility in Materials Processing and Manufacturing. It was emphasized that there was good scope for networking and wide sharing of ideas among all participants. In this way the final result for each would be much better than the result produced by the similar curriculum development exercise undertaken in isolation. Each participant was encouraged to work intensively and actively on curriculum development during the workshop. Most of the work was done in syndicates which were organized (and maintained for the duration of the workshop) based on the requirements, experience and expectations of the participants. At the conclusion of the various syndicate exercises (as described below), reports were given by representatives of each syndicate.

Full detail of the administrative arrangements for the workshop including its aims and expected outcomes of the workshop, proposed university participation, the workshop program and preliminary information sent to intending participants is available in the report prepared by Yeomans [2]. The complete proceedings of the workshop are contained in the TASEAP Working Paper '*Workshop on Curriculum Development in Materials Processing and Manufacturing*' compiled by Yeomans & Atrens [3]. In addition to the administrative documentation, the proceedings include explanatory notes, syndicate worksheets, curriculum planner, and examples of related course and subject descriptions from a number of Australian Universities (UNSW, UQ, UW and Monash). An extract from the IEAust Guidelines on Accreditation of Engineering Courses [4] was also included for reference.

Syndicate activities

For the duration of the workshop, the participants were grouped into four syndicates based on their common interests in metallurgy or materials engineering, industrial or process engineering, and other engineering disciplines such as food, chemical and civil engineering. After a series of brief presentations to introduce each topic or session, the syndicates were given exercises to complete as outlined below.

SWOT Analysis

To assist in the development of a strategic plan, each syndicate was tasked to identify the strengths and weaknesses of their department, and the opportunities and threats facing their department—a SWOT analysis.

For the strengths and weaknesses it was noted that while these are often dictated by internal factors, they might be significantly affected by outside pressures over which the staff and the department may have little control e.g. funding levels. The most commonly cited strengths were the tradition, name and prestige of the university, and the quality and experience of the teaching staff. Less common responses were the university's location, quality of student intake, good facilities, and links with industry. For weaknesses, the most common responses concerned lack of funding and resources, lack of staff, outdated equipment, lack of cooperation between staff and departments, and an unwillingness of staff to change, as well as low level teaching skills, lack of research focus, poor management and restrictive regulations.

On the issue of opportunities and threats, it was noted that while these largely come from external sources they might be precipitated from internal stresses where staff are non-responsive to the need for change. Commonly cited opportunities were improved cooperation with industry, new research programs, overseas collaboration and study, and improved efficiency. The most common threat was clearly seen as declining financial support (with all its ramifications on staff and facilities) along with increased competition, the inflexibility of staff and the system, and unwillingness to accept change.

Attributes of an engineering graduate

As background to this topic, the generic attributes of an engineering graduate as proposed by the IEAust [4] and listed below were discussed:

- ability to apply knowledge of basic science and engineering fundamentals;
- ability to communicate effectively, not only with engineers but also with the community at large;
- in-depth technical competence in at least one engineering discipline;
- ability to undertake problem identification, formulation and solution;
- ability to function effectively as an individual and in multi disciplinary teams with the capacity to be a leader or manager as well as an effective team member;
- understanding of the social, cultural, global, environmental and business responsibilities (including an understanding of entrepreneurship and the process of innovation) of the professional engineer, and the need for and principles of sustainable development;
- understanding of and a commitment to professional and ethical responsibilities;
- a capacity to undertake lifelong learning.

Further to this, a specific example of objectives of the Materials Engineering course at Monash University were examined from the perspective of the graduate's expected knowledge and understanding, professional skills, and attitudes and behaviour. A general statement of Course Objectives for Materials Engineering might be of the following form.

The graduate is expected to:

- have developed professional skills sufficient to advise on the analysis, use and development of engineering materials;
- be capable of independent design and research, with creative abilities in these areas fostered by the encouragement of initiative and originality;
- be prepared for eventual leadership in the profession of engineering and the community ar large.

Table 1. Summary of syndicate responses on attributes of graduates

What knowledge and understanding should they have?
• Knowledge of basic engineering
• Knowledge of chosen field of engineering
• Good understanding of engineering practice
• Appreciate relevance to other fields
• Possess technical knowledge
What professional skills should they have?
• Ability to apply knowledge
• Ability to communicate, both oral and written
• Be creative
• Possess problem solving skills
• Have aptitude for critical thinking
• Adaptability
• Have management ability
What attitudes should they have?
• Ethics
• Professionalism
• Desire for life-long learning
• Openness to new ideas

A summary of responses to the expected attributes of the Thai graduate is given in Table 1. As might be expected, it was noted that the graduate should have sound engineering knowledge and specific skills in their discipline. They should also be able to apply their knowledge and communicate effectively, as well as be ethical and professional and have a desire for lifelong learning.

Assessment of how one goes about measuring if an engineering graduate has these attributes is an important issue. This is dealt more fully in the section 'Quality Control and Continuous Improvement'. In summary, it is ensured that an engineering graduate has these attributes by a combination of:

1. Appropriate design and delivery of the curriculum to ensure each student has the appropriate mix of learning opportunities.
2. Assessment procedures congruent with the aims of each learning opportunity to ensure that each student has indeed achieved the stated leaning objectives in each case.
3. A framework for review, accreditation and continuous improvement.

The traditional assessment procedures at University ensure that a graduate has many of the attributes in the list proposed by IEAust [4] &/or in Table 1. The remainder require careful curriculum design.

Characteristics of students

To set the scene clearly within the local context, the syndicates were also asked to identify what they perceived to be the goals and aspirations of their students and what it is they bring to their studies. There was wide agreement here that the student's primary goal was to obtain a recognised, quality degree providing technical competence that would ensure their future through respected, long-term employment. Staff identified that the Thai student body was fairly uniform though coming

Table 2. Summary of syndicate responses on teaching methods

What are the traditional teaching methods?
• Classroom lectures, 'chalk and talk'
• Laboratory classes
• Homework
What are the drawbacks of traditional teaching methods?
• One-way transfer of subject content/material
• Teacher centered/focussed
• Boring for students
• Lack of involvement of students
• Promotes shallow learning and encourages cramming before examinations
• Poor learning environment
What is the role of the teacher as a facilitator
• To encourage the students in their own learning
• To pose questions, assist with discussion
• To coach the students and to expand the student's thinking

from a variety of backgrounds with different attitudes, skills and cultural flavour. The students are enthusiastic, with high hopes for the future and have high expectations of success.

Teaching methodology

Considerable time during the structured part of the workshop was spent on discussion of teaching methods. The presenters gave examples of different teaching styles which may be used in various settings and discipline areas, with a focus on learning outcomes. Syndicate responses to questions on traditional teaching methods and the role of the teacher as a facilitator are summarised in Table 2.

It was noted that tertiary level teaching methods are changing from the traditional methods of teacher centered delivery, e.g. 'chalk and talk', to much more student-centered, activity-based learning. Research has indicated that this transition in teaching methodology promotes improved learning outcomes, greater participation by the students in their education, a sense of ownership of the course and its contents by the students, and a sense of partnership with the teacher. Teacher-centered delivery is mainly a one-way process where large amounts of subject content are delivered with little opportunity for interaction between the teacher and the student, and thus little or no involvement of the student in the classroom. The obvious disadvantages of this are that the teaching is rigidly structured and inflexible, the teacher dominates the learning process, and it encourages lower level, i.e. shallow learning.

Student-centered learning on the other hand offers a number of significant advantages. In particular it helps develop problem-solving skills in the student and provides for higher level learning experiences. It also caters for different learning preferences and abilities for the students and more actively involves the students in the educational process, making the student more responsible for their own learning and thus their own success.

An integral part of this is the introduction of alternate teaching (i.e. delivery) modes. This offers many opportunities for flexibility and innovation in teaching delivery which may, if circumstances permit, allow the student to select the form of delivery most suited to their own needs. Clearly, this would further promote improved understanding of the subject content. Some alternate delivery methods, beyond traditional lecture and tutorial based teaching, include small group learning and self paced learning, problem based learning, and the use of case studies, seminars and guest lecturers. It would be anticipated that these methods would include the extensive use of computers, CDROMS and the Internet, as well as distance education and interactive learning.

Table 3. Summary of syndicate responses on assessment methods

Identify traditional assessment methods
• Examinations of many types (mid-term, final, quizzes, tests)
• Assignments (based on class activities) and homework (out-of-hours work)
• Term projects
• Laboratory exercises
• Student self-assessment and teacher assessment
Identify new or novel forms of assessment
• Case studies and group assignments
• Continuing assessment and evaluation, interim examinations
• Practical exercises mixed with lectures
• Student presentations (lectures, seminars) and group discussion (evaluation)
• Oral examinations and take-home examinations
• Project based assessment (participation and peer evaluation)
• Competency based assessment
Identify your usual assessment method
• Examinations (mid-term, final)
• Open book final exams
• Assignments and reports
• Term Projects (presentation, preparation and reporting)
• Case studies requiring student participation and presentations

Assessment methods

The workshop also explored the issue of the variety and appropriateness of different assessment methods. The traditional methods of assessment include examinations of many types, which may be closed book, open book, short answer, multiple choice or essay type examinations, as well as assignments, essays, tutorial papers, projects, and laboratory exercises. Other forms of assessment were noted to include group assignments, continuing assessment and ongoing evaluation, and practical exercises mixed with lectures. The involvement of the students in lectures and seminar presentations presents other opportunities. Grading can be either wholly by the teacher or may include some (or total) self-assessment by individual students and peer assessment. Project activities also allows student involvement in the assessment process and peer evaluation. Competency based assessment could also be used.

Table 3 gives a summary of syndicate responses on questions in this area and clearly indicates that most of the participants use only traditional forms of assessment based on examinations, assignments, reports, term projects and the like.

Quality control and continuous improvement

Quality control in modern enterprises has moved from the old paradigm of 'Quality Inspection' to a paradigm of 'Continuous Improvement'. Quality inspection can be described as the procedure by which it is ensured that a student does not graduate without fulfilling the course objectives. Continuous improvement, in contrast, requires a framework for course delivery and assessment in which feedback loops improve the various aspects of the whole course. Aspects of importance are the physical infrastructure and laboratory apparatus; the academic framework including the academic staff and faculty organisation and committees; sound understanding of the knowledge, skills and attitudes required for a graduate; an assessment framework congruent with course goals, and a feedback and review process for continuous improvement. The necessary elements for an undergraduate engineering degree include:

- Clearly articulated course objectives and graduate attributes.
- A course structure that ensures that each student has the appropriate mix of learning opportunities. This will usually involve a mixture of subject delivery modes to ensure that there are indeed appropriate learning modes for all course objectives and graduate attributes. For example, case studies, peer teaching, guided study and problem-based learning are generally acknowledged as good opportunities to develop attributes of independence and critical thinking. Lectures (traditional chalk and talk) are good methods of defining subject scope and furthermore often provide the most cost-effective use of scarce academic staff time.
- Assessment procedures congruent with the aims of each learning opportunity to ensure that each student has indeed achieved the stated learning objectives in each case.
- A framework within which the course can be reviewed and assessed as a whole and the individual parts also subjected to continuous improvement. This framework would be expected to include a teaching and learning committee, a process of peer review of different aspects of individual teaching, an environment that values and rewards innovations in teaching and learning, a formal procedure for the approval of course changes, and an accreditation process by which the Engineering Profession recognises the quality of the degrees awarded.

CURRICULUM FRAMEWORK

Course structure

To facilitate development of an academic framework for each course, a template was used. Table 4 presents this template completed for the Materials Engineering major at The University of Queensland. The template used at the workshop by each syndicate was an 'empty' version of Table 4, wherein each syndicate could enter the relevant streams of study and the corresponding subjects. The template was used at the workshop as an analysis tool to identify the various areas of study for each course across the years of each four-year degree program.

For this syndicate exercise, it was noted that engineering degrees, across a broad discipline base, generally comprise:

- mathematics, science, engineering principles, skill and tools appropriate to the discipline of study (about 40–50% of the total course content);
- engineering design and project activity (about 20%);
- integrated exposure to engineering practice, including management, ethics and industrial experience (about 10%);
- technical elective or general education components in other areas (balance of course).

Year 1 and to an extent Year 2 are formative years which establish the scientific base of all engineering courses. It is here that the building blocks in mathematics, physics, chemistry, general science and computer science (as may be appropriate) are developed from the minimum entry level of the students. Years 2 and 3 largely establish the technical base for the discipline by building on earlier year scientific foundations—often thought of as *engineering science*. If majors or streams apply to the degree program, these would generally commence in Year 3 and technical electives may become available at this time.

In broad terms, Year 4 is the *professional* year. It represents the conclusion of a structured degree program, possibly including majors and technical electives. It is the interface to the profession and the student would be exposed to high level discipline-specific subjects, as well as design, management, planning and like subjects. The student would also have acquired some industrial experience by this stage as further preparation for their professional engineering career.

In an extended exercise that involved considerable interaction between the presenters and the participants, each syndicate documented their course structures using the framework planner. A complete record of these is included in the report by Yeomans [2]. In Table 5, a broad summary is given of the continuity and range of prescribed areas or study (or streams) averaged over the nine curriculum frameworks completed. Table 6 presents a Materials Engineering curriculum at a leading Thai University and Table 7 presents an Industrial Engineering curriculum. The other seven curricula produced at the CD workshop are documented in [2].

While there was significant differences between the various courses, it was fairly clear that:

Table 4. Materials engineering at UQ

AREA OF STUDY	1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR
Engineering Science	• Applied Mechanics • Physics & Eng Materials • Applied Chemistry • Software Eng	• Minerals Processing • Structures & Materials • Mine Planning • Thermofluids		
Mathematics	• Calculus & Algebra • Calculus & ODEs	• Calculus & algebra		
Materials Engineering		• Materials Science • Manufacturing operations	• FE & Fracture • Materials characterisation • Polymers • Net Shape Manufacturing	• Materials selection • Corrosion • Light alloys
Design & thesis				• Advanced materials design • Thesis • Thesis
Professional Engin & Management	• Professional Engineering		• Engineering Management	
Electives or Minor	• Elective or minor (1)	• Elective or minor (1)	• Elective or minor (3)	• Elective or minor (2)

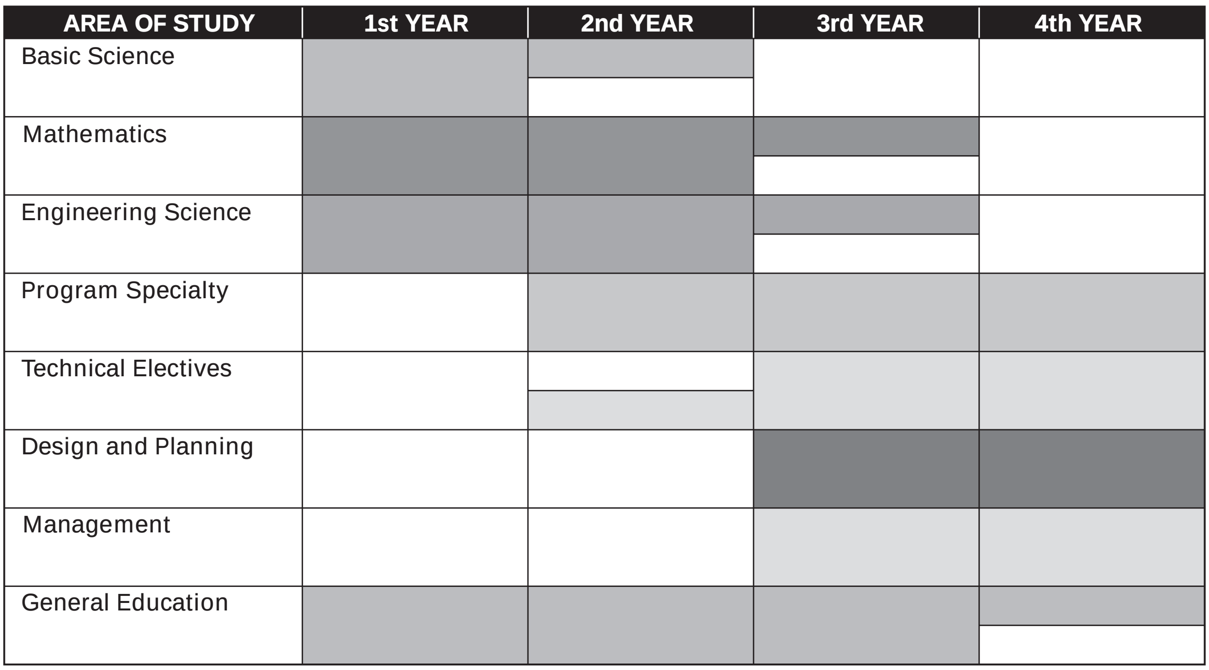
- the *sciences* dominate Year 1 and to an extent Year 2;
- the *engineering sciences* are mainly in Years 2 and 3,
- *program specialities* build from Year 2 into Years 3 and 4;
- *design, planning and management* are almost wholly in Years 3 and 4:
- *technical electives* are almost wholly in Years 3 and 4; while
- *general education/social science* subjects cover a range of years.

Subject profiles

On the final (optional) day of the workshop, after completion of the curriculum framework, attention turned to the detail of the preparation of a subject profile. It was explained that certain basic information would always be expected to appear in each profile including most of the following:

- subject name and unique identity code;
- a broad description of the subject, e.g. a handbook entry;

Table 5. Summary of course frameworks



Note: Split cells indicate possible extension into that year.

Table 6. A materials engineering curriculum at a leading Thai University

AREA OF STUDY	1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR
Engineering Science	• Engineering drawing • General chemistry & physics • Engineering materials • Computer programming	• Mechanics of materials • Engineering mechanics		
Mathematics	• Calculus	• Calculus • statistics		
Materials Engineering		• Materials Science • Thermodynamics • Transport phenomena	• Engineering materials • Mechanical behaviour • Materials characterisation	• Engineering materials • Materials forming • Materials Engineering Project
Other engineering electives		• Manufacturing processes	• Electrical engineering	
Professional Engin & Management			• Engineering economics • Engineering Management • Quality control	
General education	• English	• General education subjects		

- the level or year of the subject;
- whether it is core or elective;
- its credit rating and contact hours;
- if pre- or co-requisites are applicable;
- subject aims and expected outcomes;
- the method of delivery, e.g. lectures, laboratory, etc.;
- the detailed lecture content;
- the method of assessment, its relationship to subject aims and the assessment weighting;
- text and reference books required;
- the academic staff involved in the subject; and
- any other requirements, e.g. computers, calculators, drawing instruments etc.

Working closely with the presenters in small discipline-based groups, academic staff developed versions of subject profiles appropriate to their own teaching.

Table 7. An industrial engineering curriculum

AREA OF STUDY	1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR
Engineering Science	• Chemistry • Physics	• Physics		
Mathematics	• Mathematics • Calculus • Statistics	• Advanced Calculus • Differential equations		
Engineering basics	• Introduction to engineering • Computer programming • Workshop and drawing	• Engineering mechanics • Statistics • Electrical engineering • Fluid mechanics	• Mechanics of solids • Engineering practice • thermodynamics	• Mechanics of solids • Machine design • Industrial Eng project
Materials Manufacturing engineering		• Materials science	• Engineering metallurgy • Industrial automation • Manufacturing processes	• Foundry technology • Metal cutting • Applied computers • Welding technology • CAD/CAM
Industrial management		• Industrial management	• Operations research • Economics and quality control • Maintenance engineering • Industrial plant design	• Seminar
Technical electives				• Pollution control • Human resources • Cost budgeting • Value analysis
Social science	• Social science • Physical education • Language	• Language • Economics and business	• Social studies	• Social studies

Table 8. Summary of syndicate responses on future action

What now on curriculum development for your department?
- Encourage staff to accept need for change and think more openly
- Encourage staff participation in curriculum process
- Review existing curricula on ongoing basis (say every 4-5 years)
- Develop new curricula as needed
- Revise course content, subject sequence/streams
- Revise course/subject content and descriptions, pre-requisites
- Develop new technical electives, 'hot' topics, recent research
- Examine role/content of servicing subjects, involve servicing teachers
- Implement new or improved teaching methods, case studies, problem based learning
- Consider novel (non-traditional) assessment methods
- Put in place quality control systems, auditing of courses
- Establish Honours, Masters and PhD programs
- Obtain feedback from former students, surveys, questionnaires
- Establish new industry links, seek industry input
- Consider sandwich type or cooperative teaching programs
- Consider staff and student exchange programs
- Appropriate staff selection (knowledge, skills) based on needs of department

The next stage

At the end of the second day of the workshop after the curriculum frameworks had been compiled, each departmental group was asked to indicate what was seen as the next stage of their curriculum development process. A summary of the responses from each syndicate is given in Table 8. As might be expected, a universal response to the question 'what now?' was the need to proceed with the development of new subjects and the ongoing review of existing courses and subjects.

Another very common set of responses concerned the need to encourage all academic staff to accept the need for curriculum change where it had been identified; to think more outwardly about curriculum issues; and to participate in the curriculum process itself. For a variety of reasons, it does seem that some academic staff take the view that they have no role in CD, whereas others simply do not wish to be bothered with the process and so do not participate. In either case, this may lead to the unfortunate situation where some (perhaps many) staff in a department may in fact actively resist curriculum change to the detriment of the educational and academic value of the process.

A closely related matter, identified by some syndicates as a departmental weakness, was the lack of staff cooperation both within departments and between departments. This latter issue specifically concerns the role and function of academic staff from other departments teaching service subjects. Where there is limited staff cooperation and inflexibility and intransigence are entrenched, there is little opportunity for departments to act cohesively and the curriculum process becomes fragmented and piece-meal.

A final matter was the need for staff to implement new or improved teaching methods into the courses, and to recast their teaching more towards student-centered or problem based learning. Quite apart from the commitment in time and effort that is necessary to achieve this transition, convincing staff (perhaps older staff) of the value of this change and their involvement in the process is another matter entirely.

In summary, while the need to continue the CD process was clearly recognised and considerable progress will doubtless occur over the following months and years, it will require a change in 'culture' for the CD process to be widely embraced.

FURTHER CURRICULUM DEVELOPMENT ACTIVITY

It was clear from the outcomes of the workshop and the associated visits, that discipline-specific curriculum development activity needs to be targeted carefully to meet the actual needs of (Thai) academic departments and individual Academics. What was needed after the workshop was very specific curriculum assistance, not so much in the development of new courses and subjects, but rather in the refinement of existing curricula, the development of teaching skills, and the introduction of alternate modes of delivery.

It was also clear that staff at all levels need to be encouraged to participate in the curriculum process. For there to be a major impact on changing curriculum, it is necessary to involve not only those academic staff in the departments actively involved in the development of individual subjects and their delivery, but also senior academics to Head and Dean level who have overall curriculum responsibility. The enjoining of staff from servicing departments is also vitally important so that they are aware of the academic/practical constraints facing the engineering departments, and have empathy for the educational goals of the courses in which they teach. These issues touch on the very issue of inter-staff and inter-departmental cooperation (or lack thereof) which was highlighted in the syndicate activities.

It was thus decided that it was more appropriate for follow up activities to undertake individual visits to each university in the MP&M program and work directly with them on their specific needs. This in part involved:

- reviews of progress in curriculum review and development since the workshop;
- guidance in new curriculum issues and course development; and in some cases;
- specific assistance with the development of teaching skills and the introduction of new teaching and assessment methods.

In this way the follow-on activities could be tailored to suit individual needs of each department. This avoided the difficulties of repeating generic CD information when discipline-specific assistance was needed, avoiding the problems inherent in catering for those with different backgrounds, expertise and interests in joint activities, as well as creating a better environment for constructive work and curriculum progress within the workplace. With these outcomes in mind, the follow-on activity which occurred some 6–13 months after the CD workshop, comprised [6]:

- visits to each of the participating universities for discipline-specific curriculum development and curriculum delivery activities;
- presentation of a Bangkok-based series of three, two-day technical courses 'Selected Topics in Materials Engineering for Practising Engineers';
- a series of research, CD and instructional seminars/workshops at the host universities.

Short courses

In September 1999, a series of three two-day technical short courses were run at the Metallurgical Engineering Department, Chulalongkorn University, two of which were presented by Yeomans and one by Atrens. While the unifying theme was 'Selected Topics in Materials Engineering for Practising Engineers', the three courses were effectively stand-alone, discipline-specific courses to cater for those who could not attend for the full six days or who only wished to participate in certain topic areas.

The primary aim of the courses was to develop the technical skills of Thai academic staff and some industry partners in the areas of materials science, metallurgy, service performance, corrosion and welding. The technical content had direct relevance to a significant number of courses and subjects presently taught within the MP&M priority area. As such, the course material prepared by TASEAP for distribution to all participants was a valuable addition to the teaching resources particularly for the academic staff present.

A secondary outcome of these courses was to expose Thai academic staff to a 'methodology' for the preparation and presentation of technical short courses. One of the presenters (SY) has had considerable experience in this type of activity over more than 10 years, including the presentation of a number of professional development courses for engineers in several countries in SE Asia and elsewhere. Involvement in the short courses was thus a form of professional development for Thai academic staff.

The courses were detailed technical courses, presented entirely in English over 6 full days. Assessment, in the form of 3-hour short answer type written examination, some weeks after completion of the program was available to those who wished to have their mastery of the subject matter formally recognised. Brief details of the course contents are given below and full details are available in the TASEAP report of this activity [5].

- **Course 1:** Metallurgy and Materials (Associate Professor Stephen Yeomans): Metals as engineering materials. Nature of metals—structure and bonding, yielding and plastic flow, strengthening mechanisms. Metallurgy of steels—alloying, heat treatment, plain-carbon, alloy and tool steels, cast irons, stainless steels. Non-ferrous metals—aluminium alloys, copper alloys.
- **Course 2:** Service Performance of Engineering Materials (Associate Professor Andrejs Atrens): Product Performance, Fracture, Fatigue, Elements of Failure Analysis, Mechanical Testing, Materials Selection, Corrosion, Stress Corrosion Cracking, Steel Corrosion, Car Corrosion, Al Alloy Corrosion, Stainless steels, Electricity Generation, Atmospheric corrosion of Cu, Corrosion of Mg.
- **Course 3:** Welding in Engineering (Associate Professor Stephen Yeomans): The role of welding in engineering fabrication. Common welding processes. Welding metallurgy. Weldability of C-Mn steels, alloy steels, stainless steels. Welding of aluminium alloys. Testing of welds—destructive and non-destructive tests. Codes and Standards—operator and procedure qualification, defect assessment, quality assurance. Case studies.

The Short Course 'Service Performance of Engineering Materials' was repeated in November 1999 at Chiang Mai University and in December 1999 at Prince of Songkla University.

SUMMARY

The activities described here were a valuable opportunity for Thai academic staff, working in close association with Australian academic staff, to enhance their skills in curriculum development and curriculum review in the engineering priority area Materials Processing and Manufacturing. This process, hosted by TASEAP, involved a range of academic and technical activities commencing with a discipline-specific Curriculum Development Workshop and associated visits to various Thai universities in December 1998 and early January 1999. It culminated in the period July to December 1999 with follow-up visits to the participating universities to maintain the momentum of the curriculum processes being undertaken, and the presentation of a series of technical courses and seminars as staff development activities for Thai academic staff.

On completion of the first (workshop) stage of this activity, it was felt that the combination of further localised curriculum activities, tailored to the needs of the individual universities, was preferable to staging a centralized second CD Workshop. The visits to the universities provided the opportunity for this work to be progressed through personal and close contact with the academic staff involved, working in their own environment. Feedback from the participating universities verified that this approach provided valuable outcomes for all participants. Of most importance was that a new round of curriculum verification and curriculum change had been introduced, and was continuing, in a number of the departments participating in this program.

Finally, the series of short research seminars and the three two-day short courses presented an ideal opportunity to expose Thai academic staff to recent Australian research and teaching practices in metallurgy, materials science and materials engineering, and welded fabrication. The short courses in particular provided a significant quantum of teaching resource material which the Thai academic staff were free to include in their curricula and teaching materials as desired.

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