METHODOLOGY FOR CURRICULUM DEVELOPMENT

Various models have been presented in the engineering educational literature for the development of curricula for study programs in engineering. The model suggested here is a simple three-stage model that effectively encapsulates most features inherent in a logical and structured approach to curriculum design. The model has been adapted from that described by Grayson (1978). Essentially the model identifies the following stages in the design and development of a curriculum:

Stage 1: Problem definition
Stage 2: Structuring the curriculum
Stage 3: Implementation
Each stage has a set of inputs which must be evaluated and then analyzed to produce the output from that stage. The output from one stage serves as one of the inputs to the next stage. However, the process is not linear as this would suggest but is highly iterative with multiple secondary interactions and revisions before moving on to the next stage. The process is illustrated in the block diagram above.

**Stage 1 Problem Definition**

The inputs to stage 1 are:

**The Mission Statement.** This should be a part of the strategic planning and quality management procedures of the Department and it provides overall guidance of the purpose of the Department.

**Industry Needs.** These can be difficult to obtain but should include a measure of manpower requirements and the skills, knowledge and competencies employers expect of graduate engineers.

**Societal needs.** The role that the engineer will play in the national development, the engineer's responsibilities to society, society's expectations and the impact of technology on society are necessary inputs to the curriculum design process.

**Professional needs.** This input includes criteria set for the initial registration of professional engineers, criteria for continued registration, and criteria for educational program as set by the professional societies.

**Evaluation of an Existing Curriculum.** Feedback from the existing curriculum, if any, can be used to determine how well the existing curriculum satisfies the educational goals. This information will help in improving the curriculum.

The outputs from stage 1 are:

A broad statement of the educational objectives of the engineering education program. These educational goals reflect the philosophy of the Department and, as seen from above, are based on the current and future needs of society, the profession and industry.

A qualifications profile (Program outcomes) which is a list of the knowledge, skills and attitudes that a graduate from the program must possess.

**Stage 2 Structuring the Curriculum Elements**

The inputs to stage 2 are:

The educational objectives and program outcomes from stage 1.

The domain of knowledge for the engineering discipline. This represent the area of the knowledge that can be identified as being fundamental to the particular discipline, including the basic sciences and mathematics on which the engineering principles and practice are based. Advances in engineering sciences and in technology will result in modifications to the curriculum if the knowledge of graduates is to be up-to-date.

**Student characteristics.** Course designers are able to better accommodate the needs of the "clients" if they have an understanding of the prior education, experience, learning habits, motivation and numbers of the students entering the program.
Accrediting body. The criteria and accrediting procedures of the relevant authority must be met in the final curriculum design. Criteria often include topics to be covered, time to spend on each section of the curriculum, minimum length of course and staff qualifications, for example see the ABET 2000 criteria.

Resources. The resources available to the Department to be used in delivering the curriculum include: library facilities, laboratories, computer systems, staff qualifications, experience and interests, funding, classrooms, access to resources outside the department and so on. It may be necessary to plan the upgrading of some of these resources as part of the continuous improvement in the quality of the program. The effectiveness of the use as well as the actual quantity of the resources needs to be considered.

Teaching and Learning Methods. An awareness of the theories of learning can provide some insight into understanding how university students learn. This in turn will reflect on the design of the curricula, the teaching methods, the assessment procedures to adopt and educational technology to be used. These considerations become more important when one is involved in the fine details of curriculum design, that is in the design of the syllabus to achieve the learning outcomes of each subject.

Stage 2 consists of two steps:

1. Organizing the main structural elements of the curriculum. The objective of this step is to make decisions about the broad structure of the course: the length of study, the percentage of the course devoted to each study area (i.e. Basic Science, Mathematics, Engineering Science, Design and so on), the major subjects and their sequence, mandatory courses and elective courses. The difference between what students know on entry to the course and what is expected of them at the end of the course as expressed in the program outcomes provides the basis for making the appropriate decisions. Accreditation criteria can provide good guidelines on this, as can reference to international educational practice.

   **Sequencing** of material is important. Students must learn to apply the fundamentals to increasingly difficult problems over the duration of the program. Topics may be treated at a fundamental level initially and at advanced levels in later years.

   **Integration** of material is also important. For example, in the study of mathematics it is good practice if students learn to apply to their chemical engineering science subjects what is being taught in mathematics as it is being taught or soon after. That is, knowledge should not be developed in isolation in individual courses.

2. Detailed structuring of the course. This is the development of the content and learning activities within each subject area. Subject specialists provide the main input at this stage. Reference to the “domain of knowledge” or “program criteria” as defined by ABET 2000, for example, can assist in defining topics that should be included in the subject area. However, experience is a major factor here, especially with respect to allocating time to each topic within a subject, deciding on teaching methodology and assessment criteria, allocating time to lectures, tutorials, laboratory work, independent learning and setting homework assignments.

It is recommended that specific objectives are set for each subject, the learning outcomes are defined and that criteria by which a student's knowledge and skills can be assessed against these outcomes be established – these topics will be discussed in a later session of this course.
The selection of content and the emphasis to be given to it in the delivery of the course can then be made on a logical basis. Note that according to the learning outcomes approach, the curriculum must be concerned with both content to be learned and the behavior (skills, abilities, attitude) to be developed. If the course designed is too concerned with content only, the resulting course may be overloaded and although a lot of material is taught only a fraction of it will be learned.

Guiding principles for organizing the content are:

- Exposition of content should proceed from the simple to the complex
- Material for presentation should be ordered according to prerequisite knowledge
- Material should be presented from the practical to the abstract.
- Material should be presented from the part to the whole, that is individual elements should be mastered before complex systems or mechanisms are studied.

The selection of learning activities is the final step in this part of the curriculum design process. Modern educational practice indicates that student-centred learning models are the preferred method. The problem for the course designer is to select the types of learning experiences that will most efficiently result in the previously determined learning outcomes.

The output from stage 2 will be the structured at the macro-level and at the detailed level. This curriculum must then be implemented and evaluated.

However, before the new or modified curriculum is implemented it would undergo some validation process. For a curriculum developed at the Department level this would most likely involve being reviewed by a Curriculum Review committee at the Faculty and/or University level and then submitted to an accreditation body for approval. The development of a new curriculum must also be incorporated within the total quality management system of the Department and the University.

### Stage 3 Implementation and Evaluation

The curriculum developed and approved at stage 2 must now be implemented and evaluated. ABET 2000, for example, requires that Departments have a documented assessment process which demonstrates that the objectives of the program are being measured and achieved, and that the results of this outcomes assessment are being applied to the continuous improvement of the study program.

Evidence that could be gathered as part of this assessment process would include: students' results, students' project and design outputs, nationally (or internationally) referenced subject content examinations, alumni surveys, career developments of former students, graduate employment, employer satisfaction surveys and program accreditation results.

Individual subjects can be evaluated by getting feedback from students, by observing the quality of students' output in designs, tests or examinations, by observing student performance in subsequent courses and by comparing class performance with that in previous years or for similar courses.

It takes time to build up a full evaluation process as inputs to the assessment framework are accumulated over the years that the curriculum is in operation.

**REFERENCE**

ON A METHODOLOGY FOR CURRICULUM DESIGN

(From the paper by Lawrence P Grayson On a Methodology for Curriculum Design
Engineering Education: December 1978 p 285 -295)

The design of a curriculum to meet present and future requirements for engineering manpower is not an easy task. Technological advances, increases in knowledge, changes in national priorities, funding patterns and social conditions, as well as changes in the profession itself combine affect the demand and requirements for engineering services. This in turn has direct implications for the type of education that engineers receive.

Curricula, in all subjects and at all levels of education, have been developed more as an art than a science. That is most of what is done in schools and colleges, has come about more from experience in the practical affairs of operating colleges and from outside pressures than from well-developed theories of how material should be organized to achieve certain objectives or that are based on principles of teaching and learning. Outside demands or crises often result in new topics or new courses being added to existing curricula without a clear definition of how this affects other courses or how it changes the goals and objectives on which the curricula should be based. As a consequence, engineering curricula have grown by an additive process and are largely the result of changes in technology or industrial pressures.

The changes in engineering programs that have occurred to date have been largely due to perceptive individuals who could anticipate the changing needs for engineering services and who were in a position to modify the curricula. The changes, for the most part, have been in content, e.g., a course in atomic physics replaces a course in electrical machines, although there have been a few notable changes in the types of activities in which a student is engaged, such as the introduction and subsequent development of laboratory work and the introduction of project-based activities. These modifications have not been based on a scientific, methodological approach to curriculum design, but have come about by traditional, empirical and intuitive methods.

This process is in sharp contrast to applications of science and engineering, where developed theories direct practices and explain phenomena and relationships. While theories are modified by research, they also direct much of technological development. It is the recognition of the importance of this interplay between theory and practice that has guided the development of the methodology presented here.

For our purposes, a curriculum is defined as a plan for the education of students during their enrollment in a given school. It provides a structured series of intended outcomes for learning, usually within a given field of study, that guides instruction and is used to develop teaching strategies. Defined in this way, a curriculum relates to what students should learn, rather than what they should do, and allows methodologies of curriculum design to be developed that relate to principles of teaching and learning.

In the past, curriculum developers focused on what students were to know, to the exclusion of how they learned. This was because our knowledge of the human learning process was insufficient. Recent advances in the teaching-learning sciences, however, are providing a basis for changing curricula to account for the learning process as well as the content. Certain principles have evolved which, if followed, will increase the amount a student learns and remembers. We now know, at least partially, how to organize curricula so that learning is reinforced and becomes easier and more meaningful for the student. This does not mean that we are at a point where a model or recipe can be presented which, if assiduously
followed. will provide an optimum curriculum. This is not the case. Rather, we know certain
principles, which if applied in the development of a curriculum, will increase the knowledge
and skills of a student in the content area.

A study of curriculum design practice shows certain common logical steps that can be
followed, the identification and analysis of which lead to a methodology of design. The steps
in this methodology include an analysis of needs for technical manpower; the setting of
specifications that identify qualification profiles or specify desired characteristics in skills,
training and knowledge that the graduate is to possess; the selection and structuring of the
content; and the validation and evaluation of the curriculum as it is used.

The methodology, shown graphically in figure 1, is a systematic sequential progression
through three stages: Problem definition; synthesis or structuring the curriculum, which has
been divided into two parts- a structuring of the major elements and a fine tuning; and
implementation and evaluation. Each stage involves an interactive procedure, the output of
which is evaluated before being used as part of the input to the next stage. For convenience,
the methodology is presented in the figure as if it were a linear flow, whereas in practice it is
a highly iterative process, which depends heavily on previous developments and involves
multiple secondary interactions. As with almost any development procedure based on
human involvement it requires for its successful application the frequent injection of
individual and collective expertise, enthusiasm and criticism.

Problem Definition

The first stage in the design procedure is to define clearly the problem the curriculum is to
address. Engineering curricula must be designed with a view towards the future, when
graduates will be employed. As a result, the curriculum designer must develop an idea of
what the major national problems and priorities will be, how engineering can contribute to the
solution to the problems, what types of jobs will have to be filled, and what types of training
and skills will be necessary for those jobs. In short, the designer must obtain or perform an
analysis of technical manpower needs and identify the skills, knowledge and competencies
required to develop engineering personnel with the desired attributes and abilities. This
analysis provides the basis for setting the goals and objectives upon which the curriculum is
structured.

An adequate analysis of the needs for future engineering manpower is difficult, as can be
readily appreciated when one realizes there are almost no data on how well past graduates
met past needs, or even on how well engineering graduates met the expectations and needs
of their first employers. The data that exist usually either describe gross characteristics of the
labor market, e.g., the types of jobs that do and are projected to exist in the years ahead, or
the numbers of new graduates that will be needed in various specialties-or are gathered
classically, as from surveys of past graduates to determine their present occupational
responsibilities, income, job satisfaction and specific courses that did or could have benefited
the graduates during their careers. All these data, however are either too gross, incomplete
or unreliable to give an accurate picture of how well past curricula have met present needs
or what types of curricula are necessary to meet future needs. They give at best an
indication that must be tempered with the good judgement of the curriculum designer.

In addition to the needs of industry and society, the requirements of the profession are very important
consideration that can affect the design of a curriculum Professional requirements can often be
identified in terms of the criteria established for initial registration and for the continued registration of
practicing professional engineers. Further, professional bodies, such as the Engineers’ Council for
Professional Development, establish minimum criteria that all engineering curricula must satisfy if they
are to receive the recognition and sanction of the profession.
The design of an undergraduate curriculum is also influenced by the degree of reliance placed on graduate programs. If the first engineering degree is viewed as a terminal degree, careful consideration must be given to how much and what kind of information should be included in the curriculum to best prepare the graduate to practice. If, however, one expects that the student will undertake graduate programs, then one can concentrate at the undergraduate level on teaching a broader range of knowledge, leaving for the graduate programs the task of specialization.

Following the initial attempts to identify needs, the information obtained must be analyzed and assessed in an attempt to define clearly the problem or problems the curriculum will address. At this point, certain boundaries may be set on the spectrum of problems that confront industry and society, and requirements for additional, specific information may be identified. This is obviously a cyclic process which can be undertaken formally or informally by an individual or a team. In any event, the overall process usually requires a considerable commitment by a number of experts to assure that a valid and realistic problem statement results.

**Statement of Goals and Qualifications**

Setting goals that are unambiguous and achievable is the first and most important step in curriculum design, but all too often is the most neglected. What the student learns is specified by the goal set and the objectives derived from them. After they have been specified, all other arts of the design process follow them and should be concerned with their achievement.

Goals are broad statements that describe the general outcomes to be achieved. They express the professional obligation that the school has towards society and the importance in places on the development of the student as an individual. The goals are a direct reflection of the educational philosophy of the college, and are based on the current and future needs of society and the profession.

The Grinter Report, for example, proposed two broad goals- one technical and the other social- for engineering education. The first was the preparation of the student to perform analysis and creative design, or construction, production or operation, where a full knowledge of the analysis and design of the structure, machine or process is essential. The second goal was to develop an understanding of the evolution of society and of the impact of technology on it, an acquaintance with an appreciation of the heritage of other cultural fields, and the development of both a personal philosophy, which will ensure satisfaction in the pursuit of a productive life, and a sense of moral and ethical values consistent with the career of a professional engineer. These very broad goals were established at a national level to guide the future development of engineering education.

Goals are a matter of choice, and therefore they are value judgements by those responsible for developing the curriculum or by the leaders of the college or the profession. However, a knowledge of the needs of the professional and of society and a conscious philosophy of education can aid in selecting the goals. The goals are very important, for ultimately they are the basis for selecting the specific objectives to be achieved, the materials and instructional types of examinations and tests that will be given.

In some cases a statement of broad goals may suffice to proceed with the design. In other situations, a much more detailed definition of the qualifications desired for the graduate may be required. In the latter case it may be found advantageous to create a profile of desired qualification in terms of the knowledge, skills and attitudes the graduate must possess to
practise a given field of engineering. Certain of the attributes that are specified will be global and apply to all engineers; others will vary according to the specific field of engineering described. In all cases, however, the qualifications profile forms a list of specifications or desired outcomes that can be used to organize and evaluate the curriculum.

The validation of the qualifications profile concludes the problem definition stage and is an important element in the iterative process leading to the final problem statement. It involves checking not only the conclusions in detail, but also the process by which they were reached and the data on which they were based. The method of validation of the profile will relate to the way in which the problem statement has been produced. A national curriculum proposal may result in a paper circulated throughout the profession for discussion, whereas a local proposal may be submitted only to a validation committee prior to further development. Experience suggests that at this stage a constructive dialogue between those responsible for producing the problem statement and an appropriate and expert group of assessors is of considerable value in arriving at a definite and realistic statement of goals on which the second stage of curriculum design procedure can be based.

**Structuring the Curriculum Elements**

Curricula may be organized or structured at two levels. The first approach may be at the broad or macro-level, in which decisions are made about the type of courses to be offered, the amount of time to be developed to each, the way they will be arranged over the program of study and so forth. Second, the particular content elements and learning activities can be selected and organized to optimize the knowledge gained by the student. This latter approach usually deals with material within and the relationship between courses and can be based on certain principles of teaching and learning and of curriculum design. The two types of organization may be compared to the adjustment made in tuning a mechanism or instrument: first, gross adjustments are made, then fine tuning is carried out.

Designers of engineering curricula usually restrict themselves to the first part of the process, i.e., the organization of the main structural elements of the curriculum. Design at the macro-level is usually begun by analyzing, in the light of the problem statement, the gap between the starting knowledge of the entering student and the curriculum goals or profile in order to identify the knowledge that must be taught.

With this information, engineering colleges often specify the structure of a curriculum at the broadest level in terms of the number of credit hours that must be completed in several fields of study, such as humanities, social sciences, engineering sciences and so forth. Next, the departments identify certain courses to be taken within that broad framework and usually specify how the courses are sequenced in terms of prerequisite courses. Individual teachers then develop the content within their course offerings. In this way the curriculum is developed as a series of refining steps.

In structuring the curriculum, the courses should be examined to determine their relationships both over time and from one subject area to another, in order to increase the cumulative effect of the educational experiences proposed. This examination may be facilitated by certain organizing factors that can aid in the selection of content and learning activities. These factors include: continuity, sequence and integration.

*Continuity* refers to the reiteration over time of the major points to be learned, that is, to the recurrence of certain concepts or skills in several courses. If for example, an objective is to develop a working knowledge of Newton’s first law of motion, then it is necessary that opportunities to apply the first law to a variety of problems occur again and again.
Sequence is related to, but goes beyond continuity. If a curriculum element recurs many times, but always at the same level of difficulty, there is no progressive development of understanding or skill. Sequence emphasizes the importance of having each successive experience build on the proceeding one, but going more broadly and deeply into the matters involved. For example, sequential development of Newton’s first law might begin with the student’s learning to recognize the equation for it and being able to recall it when asked, then being able to apply the law to the solution of variety of simple problems in mechanics, and finally to recognize physical situations governed by the law. Sequence emphasizes higher levels of treatment with each successive learning experience, rather than duplication. Integration refers to the relationship of curriculum experiences within courses not connected in a hierarchical arrangement. The organization of these experiences should be such that they help the student increasingly to get a unified view of the content and to unify his behaviour in relation to the elements studied. In developing skills in calculus, for example, it is important to consider ways it which these skills can be effectively used in mechanics, electric circuits, fluid flow and other content areas, so they are not developed as isolated knowledge to be used in a single course, but are increasingly part of the total capability of the student to be used in many situations. Some authors refer this concept as generality, since it is an attempt to teach knowledge in one course that can be used in others.

In identifying the organizing factors, it is necessary to realize that they apply to the experiences of the learner and not to the way in which the subject matter is viewed by the teacher or expert in the field. Continuity, for example, refers to the recurring emphasis in the learner’s experience with these elements and not to the logical organization as viewed by the teacher.

After the material has been broadly organized into courses and the courses arranged in a suitable pattern, study time or credits are assigned to each course and consideration is given to the availability of teaching staff and resources. In addition, decisions are made on matters such as which areas of study should be mandatory and which elective; the balance that must be attained between technical and humanistic studies; the extent to which students can select their own programs and will follow a coherent course of study; and the desirability of assuring it given amount of practice or industrial experience, as through cooperative or sandwich courses. All of this is done within the broad goals or qualification profiles that have been established, with due consideration of the student, as well as of the academic and resources constrains of the institution.

In considering the constraints that students place on the design, one must assess the quantity, qualifications, experience and motivation of prospective students. An attempt should be made to determine the reaction of current and past student to curriculum content, choice, total study effort required, number of concurrent studies specified and the teaching and evaluation methods used. The academic constrains which must be considered include information on admission requirements, length of study, academic standards and so forth, while the resources that must be accounted for include academic staff, support equipment and facilities (e.g., laboratories, shops and specialized equipment, and institutional resources, such as the library and computer centre. Dealing with the resources is one aspect of the curriculum design process that can be proceduralized to a major extent and for which the appropriate data can reliably be quantified. This is not, of course, just a matter of quantity, but is also a function of how effectively the available resources can be used.

While all this is occurring, a continuous evaluation should be conducted to assure that the goals are being met within existing constraints. The end result of the macro-level structuring is that the curriculum will be defined as a syllabus, a timetable, an idea of the teaching approaches (lecture, laboratory, seminar, etc.) to be used, and perhaps by the type, timing and importance of examinations.
Tuning the Curriculum

After the major curriculum elements have been designed, it is possible to perform a more detailed structuring. The procedure to be presented is based on the formulation of specific objectives and desired learning outcomes for each course, and on the selection of both content and learning activities to achieve the objectives. At this level, the selection process can be rooted in finding derived from the psychology of teaching and learning, and certain organizing principles can be applied to assist in the arrangement of content and activities.

Most developers of engineering curricula conclude their designs after they have structured the major elements. In the past they have not gone to the detail described here. Perhaps, because of the rapidity with which curricula change, they have not found it necessary; or perhaps it is because they have not been familiar with techniques that would allow the fine adjustments to be made. The procedure to be discussed is valuable, however, because it can be applied to the curriculum as a whole, or to a group of courses, or even to a single course. In that sense, the techniques can be used by a single instructor teaching in one course, or by a team of people developing a curriculum for an entire school.

Formulation of Objectives

The first step is to define specific objectives for each of the desired outcomes of the learning. These objectives are much more precise than — but are usually based on — the goals developed for the total curriculum. The goals are broad statements of what is to be achieved. Objectives on the other hand, are specific ends to be attained in the overall accomplishment of the goals. They specify the desired outcomes of particular learning activities in terms of the desired knowledge methods of thinking, attitudes and skills the students are to achieve as a result of their learning experiences. Objectives must confirm with conditions intrinsic to the learning process, and thus a knowledge of the psychology of learning is helpful in selecting them. This knowledge will allow one to distinguish objectives that are feasible from those that will take a long time or are impossible to achieve, and will help in deciding about the appropriateness of particular objectives at given points in the sequence of educational programs.

The formulation of objectives is a critical step in curriculum development, for objectives provide the basis for carrying out all the other activities of the curriculum designer. Clear and precise objectives are useful as a guide in selecting content, for suggesting learning activities, for deciding on the kinds of teaching procedures to follow, and for evaluating how well the student is progressing.

Stating objectives in a form that makes them useful in selecting learning activities and in guiding the teaching is not a difficult task, although they are often stated in unsatisfactory ways. Objectives, for example are sometimes stated as things the instructor is to do. If education is viewed as the process of changing a student's behavior, that is, his or her actions, attitudes or responses to certain situations or stimuli, objectives given in this form do not state the ends to be achieved. The difficulty with objectives that are stated as activities to be carried out by the instructor is that there is no way to guarantee that these specific teacher activities will bring about the desired learning by the students. For the curriculum designer, this form of objective does not provide a satisfactory guide to further steps of selecting materials and devising teaching procedures for the curriculum.

A second unsatisfactory form is for the objective simply to list the elements of content, such as the topics, concepts, generalizations and so forth, that are to be treated in the course. While objectives stated in this way indicate the content to be covered, they do not specify
what students are expected to do with the content or how they are to respond. A statement such as “linear, second-order differential equations” is not useful as an objective because it does not allow one to determine if the student is to: derive a second-order equation from an appropriate physical system; give illustration of physical situations that are described by a given equation; solve such questions, and if so, under what conditions and by what techniques; or learn something entirely different. Objectives stated as content headings are poor guide to the development of curricula.

A more useful way to state objectives is to express them in terms that identify both the kinds of content to be developed and the behaviors to be exhibited. For instance, a major objective for a course in mechanics might be that the student should develop force balance equations that describe a variety of physical static structures. By putting together the two aspects of the behavior and content that are sought, it is possible to specify the materials, the particular ideas, and the kinds of situations or activities to be used in connection with each of the objectives. A useful criterion for judging the adequacy of an objective is to determine if, from the statement one can both specify the kind of behavior the student is expected to acquire and have a basis for recognizing such behavior when it occurs.

It is useful to classify the behavioral components of the objectives according to a scheme, as in the work of Bloom, Krathwohl and their colleagues, that varies from simple to complex behaviors, with the more complex encompassing the simpler, since this provides convenient framework for analyzing and specifying the behaviors to be learned by the students. Since the scheme has a hierarchical nature, the designer can assure that simpler skills which form the prerequisites are learned before the more encompassing complex behavior, and can judge the difficulty of the curriculum according to the amount of simple and complex behaviors to be learned.

**Principles of Learning**

A psychology of learning is important to the curriculum designer, for it will aid in determining the conditions necessary to achieve certain objectives. The psychology that is adopted should include specific findings (e.g., trying to learn simultaneously or in immediate succession two bodies of similar but distinct material may cause mutual interference), and ideally should provide a unified theory of learning which would explain the nature of the learning process, how it takes place, under what conditions and so forth. There is, however, no single theory of learning. Moreover, the particular theory adopted will considerably influence the determination of how objectives are to be stated and even what kinds of statements are to be viewed as objectives.

Thorndike, Pavlov, Skinner and others have formulated theories of learning that involve the idea that learning consists of building up connection between specific stimuli and specific responses. Learning, according to these theories, is taken to be similar to habit formation, with the result that objectives tend to be highly specific and numerous. On the other hand, there are theories that treat learning as the development of generalizations and modes of attack on problems, and modes of reacting to generalized types of situations. Under these theories, objectives are stated in more general terms and, tend to be fewer in number. An objective in accord with these theories might be to have the student apply the principles of linearity in explaining a variety of actual phenomena.

Each of the many theories of learning explains certain types of learning under certain conditions. No one has yet drawn specific relationships between the principles that have been developed from the study of learning and the design of curricula for engineering students. This implies that one should carefully note the conditions under which the various principles have been derived and be aware of their limitations as they are applied to the development of curricula.
From the point of view of learning theory, a curriculum designer should also be aware of the characteristics of adults and how these affect the ways students learn.

Most engineering students are in the 18-25 age range – that is, they are young adults. As student mature, sharp contrasts develop between their present and their childhood learning styles. These differences occur in motivation, in learning skills, in amount and variety of knowledge, in desires for learning, in self-concept, and in need for immediacy of application. It is probable that there are greater differences in abilities between the childhood and adult stages, in the same person’s life than among all the children in a typical elementary school classroom. Yet, until recently, little effort had been made to identify the unique characteristics of adults as learners and to determine how these should affect the methods used in their education.

As an adult, the self-concept of an engineering student is changing from one of a self-directed human being. As a child, his or her whole life was managed by adults. However, on entering adulthood, he or she becomes more aware of personal abilities and limitations and becomes more self-directing. At that point, students are willing to manage their own lives, to make decisions and accept the results. Adults tend to resist learning under conditions that are incongruous with their self-concept as autonomous individuals.

A second difference between children and adults is their perception of time and the need to see how they can make use of what they are learning. Children are willing to postpone the application of knowledge, viewing most of what is learned as preparation for the next level of schooling. Adults, in contrast, prefer immediate application. (Engineering students often view their subjects as important to their performance in their first jobs following graduation and respond to the pressures they feel are generated by the demand of their chosen areas of specialization.) The result is that children are subject-oriented, while adults are more problem-centered. That is, adults do not perceive knowledge as an end in itself, but rather as a means to achieving other things that are more important to them.

Another characteristic of adults is that they have a broader and deeper range of experience than children. This resource of experience allows adults to contribute to the learning of others, and acts as a basis upon which to relate new learning. At the same time, experience often brings with it fixed habits and thought patterns so that adults can be less open-minded than children.

Educational research has shown that people, both adults and children, learn best those things necessary for them to advance from one stage of development to the next. Thus at any point in a person’s development he or she may be ready to learn certain things, but not yet ready for others. When seeking a job, for instance, adults are concerned about those skills necessary to get a job. Later, these will become less important and they will be concerned with learning the special things necessary to keep the job and to get along with their fellow workers. At a later stage, they will become interested in learning those skills, such as supervision, that are necessary to advance to a higher level position. If this readiness to learn is to be taken advantage of, then curricula should be structured so that each type of material is presented at the right time in the student's development. This becomes a fourth organizing principle for curriculum design, perhaps even more important than using the logical sequence of the subject matter.

It should be recognized that learning is an individual process involving the personality, motivation and ability of the student, whereas curriculum design is a mechanistic process primarily concerned with the selection and structuring of material. The relationship between these activities is not easily recognized and defined, although motivation as related to proper sequencing of material is a highly important factor in designing an effective curriculum.
Defining the relationship between teaching and learning methods and curriculum design is a difficult and complex task, for which no facile and general solution is likely to emerge in the near future. However, this definition is an important aspect of curriculum design, and further studies could lead to the formulation of more specific guide lines to augment a curriculum methodology.

**Selection of Content**

In engineering, curricula are often presented as lists of content which fit into a logical framework. As specified by the objectives, however, a curriculum should be concerned with both the behaviors to be developed and the content to be learned. Any approach to curriculum design, therefore, should treat both aspects.

Engineering teachers have used a variety of conceptual frameworks to organize their subject matter. Often these are based on properties of the system or phenomena dealt with, so that curricula may be organized from the viewpoint of a continuous system or a discrete system; from linear to non-linear; from deterministic to probabilistic; from macro to micro; from concrete to abstract; from specific to general; and, more often than not, from a combination of viewpoints.

All teachers know they have at their disposal more material than they can deal with in a given time. Hence, they must selectively choose the content to be presented. Too often, content is selected on the basis of tradition, availability on a textbook, or an instructor’s familiarity with it, without a consideration of other factors. When there are alternative samples of material that satisfy the overall objectives of the curriculum and that relate logically to the basic conceptual framework, then it is possible to make choices in accordance with other criteria.

Different samples of material can be used to illustrate the same idea. If there are no clear objectives to determine what is important and relevant, the tendency is to cover everything in the field in order not to omit anything of importance. Identification of fundamentals and the provision of alternative samples of material allow the teacher to determine what content is important for students at a given time. Thus, content can be chosen that is most likely to be understood in terms of previous experience. Where choice is possible, that content should be selected which offers the possibility of achieving the greatest number of objectives.

Two major criteria that can be used to select content are relevance and significance. Relevance, in one sense, implies a close connection between the content and the objectives it is intended to serve. Content is relevant, therefore, if it promotes the outcomes to be achieved. If the content does not fit the objectives, it should be rejected.

A second aspect of relevance is the degree to which the subject matter is current. Knowledge, particularly in the engineering and technical areas, changes very rapidly, so that there is a possibility of obsolescence of the subject matter. Not only do the facts become dated, but the concepts, theories and techniques which organize, interpret and use the facts become obsolete. Any particular body of knowledge is likely to be of only temporary significance, and it should be updated regularly.

The second criterion for selecting content relates to the significance of the material chosen. Significance usually increases if the content is deemed to be fundamental, to be generalizable, or to cut across boundaries and be used in an interdisciplinary way for several subjects. Field theory, for instance, is useful in many subject areas, including electromagnetic, fluid flow, aerodynamics, heat transfer and acoustics, and thus can be labeled significant.
In addition to relevance and significance, there are other lesser criteria that may be applied in the selection of content. These criteria may include the availability of existing material, the extent of the teacher’s knowledge, the students’ background and levels of development, the needs and interests of the students, the organization and sequence of the content, developments in the field of knowledge, how applicable the content is to a wide range of objectives, the number of outcomes to be achieved, and how useful it is to the students in solving problems now.

Organizing the Content

After the content has been selected it should be organized in a manner that will facilitate the learning of it by the student. At this stage it is necessary to identify the elements of the curriculum that can serve as organizing threads, which, in engineering, are often concepts, percepts and skills. That is, engineering educators have identified certain concepts so basic that they become elements of major importance and must be developed early and carried through the curriculum. The principle of conservation of energy in a closed system is such a concept. It can be presented first in a freshman physics course and later developed into a deeper and broader concept in upper-level engineering courses.

Percepts refer to information and experience that is gained through perception of actual phenomena. It is one thing to describe the effects of an acid solution on litmus paper; it is quite another to see the paper turn red as a drop of acid is placed on it. A skill might be cognitive, such as an ability to solve linear differential equations by the separation of variables technique, or physical, such as the correct use of an oscilloscope. Skills and percepts also may be developed at relatively low levels initially, and then can become increasingly deeper and more sophisticated as the learner progresses through the curriculum.

In addition to the organizing principles discussed for structuring the major elements of a curriculum, which can also be applied at the micro-level, experience in the design and teaching of engineering curricula have resulted in the identification of several additional principles for dealing with specific subject matter. The first of these principles is that the exposition of content should proceed from the simple to the complex. In electronics, for instance, single-stage amplifiers should be treated before multi-stage amplifiers. Second, material should be ordered for presentation according to prerequisite knowledge. This principle is often followed in subjects largely consisting of laws and principles, such as geometry and physics, in which various portions of the content have a logical relationship to one another and are best learned in that relation.

A third principle is that material should be presented from the practical to the abstract. A demonstration or referral to direct experience should precede the development of generalized principles. This allows the learner to relate new items to old learnings. Finally, material should be presented from the part to the whole. In mechanics, for example, the various elements should be studied before complex mechanisms involving those components are considered.

The result is that the organization of the content for an engineering curriculum or course often begins with a list of content elements. These are then structured to fit into a logical pattern, building from the simple to the complex, with consideration given to the interdependence and prerequisite nature of the elements.
Selection of Learning Activities

The final step in the fine tuning of a curriculum is the selection of particular learning activities to achieve the given objectives. Learning takes place through the learners' experiences, that is through their reactions to the activities in which they are engaged. This view of learning implies that students are active participants in the learning process – it is what the students do that determines what they learn, not what the teacher does. Thus in planning an educational program to achieve given objectives, the teacher’s responsibility is to provide appropriate experiences by setting up an environment and structuring situations to stimulate the desired types of reactions.

Two students in the same class, however, may have different experiences and thus learn different matter. The teacher must therefore set up situations with a number of facets sufficient to promote the desired learning in all students. The activities must be varied so that some of them will be significant to each student. Consequently, the problem of selecting learning activities is the problem of determining the kinds of experiences likely to produce given types of learning as specified by the objectives.

In making the selection, the designer must provide opportunities for students both to practice the behavior and to deal with the content specified by the objectives. The activities must be such that the responses desired are within the range of the student's present abilities and that each student receives satisfaction from carrying out the required behaviors. Further, the designer must recognize that there are many particular activities and experiences that can be used to bring about the same learning. For instance, if a student is to learn how an electrical circuit consisting of a resistor and capacitor respond to a variety of inputs, the student can test the circuit, in the laboratory, simulate it on a computer, or solve the describing differential equation. This means that the teacher has a wide range of possibilities at his or her disposal when planning particular work. Thus, it is not necessary for the curriculum to provide only certain limited or prescribed learning activities in order to ensure that the objectives are achieved.

In contrast, a single learning experience will often bring about several outcomes. When students test a signal amplifier in the laboratory, they learn more that the response of a particular circuit, for they also learn about the physical characteristics of amplifiers, about signal generators and oscilloscopes, and about experimental techniques. On the positive side, this allows a well-planned set of activities to satisfy several objectives simultaneously and thus achieve economy of time. Negatively, it requires that the teacher must be on the lookout for undesirable outcomes that may develop from a learning activity planned for some other purpose.

The process of selecting learning activities is not a mechanical method of setting down definitely prescribed activities for each objective. Rather the process is creative, as the teacher must consider the desired objectives and reflect upon both the kinds of activities that might be carried out and the materials that can be used.

Implementation and Evaluation

After a curriculum has been designed, it still must be put into operation and evaluated. Both of these aspects are highly critical to the successful use of a curriculum, and if not done properly can cause a curriculum to be totally ineffective, not matter how well it was designed initially. On the other hand, properly conducted evaluations can overcome many deficiencies in the initial design. The steps discussed to structure the major elements and tune the curriculum make the design process appear to be a linear flow with one step following another. In reality, the design process is highly interactive and iterative. Evaluations performed at various points in the process assess the effectiveness and validity of what has
been developed, and provide information that can be used in a feedback process to modify what has been developed.

Implementation also is a very critical stage. Even though a curriculum may be well designed and validated. It will never have the desired effects and achieve its goals if it is not implemented, or is implemented in spite of the resistance and hostility of the faculty. In order to be most useful, steps to implement and evaluate the curriculum must begin at the very start of the design process, that is, at the time that the goals are being decided on.

**A Procedure for Evaluation**

Evaluation is essentially the process of determining to what extent the educational goals and objectives are being met by the curriculum. Depending on its purpose and when it is applied in the process, evaluation may be referred to by different terms. If its purpose, for example, is to assess the relevance and accuracy of the problem statement, it may be called validation. If it is used as part of the development procedure to determine the appropriateness and effectiveness of particular segments of material as they are developed, it is referred to as formative evaluation. If it is used to determine how well the curriculum satisfies its goals, it is termed vetting or summative evaluation.

Whatever its purpose and however it is called, certain things can be said about evaluation. In the first place, evaluation involves the appraisal of the behavior of the students since the purpose of education is to change these behaviors. In the second place, an evaluation must involve more than one appraisal. Since comparisons are made to measure change, appraisals are necessary at both an early point to provide base or reference data, and a later point. Further, colleges are often concerned with the permanence of what has been learned, so that it is often necessary to make at least a third appraisal at some time after the instruction is completed.

There is no unique or even agreed upon way to evaluate the effectiveness of a curriculum, and almost any means for gathering valid evidence about the desired goals and objectives can be an appropriate method of evaluation. A course, for instance, may be evaluated by paper and pencil tests, by observing the products of students engaged in design, by seeing how well the students do in succeeding courses, or by comparing their performance with that of other students from previous years who were at the same point in the curriculum. Observations, interviews, questionnaires and survey of former students are all valid ways to collect information about the learners or graduates.

The goals and objectives that served as a basis for planning the learning experiences also provide a basis for planning the evaluation. Each objective specifies both a type of behavior, which should be assessed to see how far that behavior has developed, and the content to be evaluated. Based on the objectives, an evaluation instrument should be constructed and situations identified that will not only permit but encourage a student to evoke the desired behavior. If, for instance, an objective is to have students learn to adjust the horizontal and vertical gain controls on an oscilloscope, then the students may be asked to use an oscilloscope to measure a series of waveforms of various amplitudes and durations. Although this appears to be simple, many problems are involved in finding situations sufficiently under the control of the instructor or evaluator to allow them to assess the types of behavior the students are developing.

Third a means must be devised to obtain a record of student behavior in the test situation. The students, for example, may be asked to write down the measurements of the waveforms obtained from the oscilloscope, or they may be required to take photographs of the oscilloscope screen when each waveform is properly displayed.
In developing an evaluation instrument, it is also necessary to decide upon the measures or units that will be used to record student behavior. When the evaluation instrument is an objective test, the record is usually a numerical or letter grade. If the objective, however, is to have students become self-learners, or if it is to have them make use of libraries and reference sources, then the usual grading schemes may not be appropriate. In the latter case, an appropriate measure might be the number of times a student goes to the library, or the number of different books that he or she checks out. If the objective is to develop creativity or originality, or the ability to do research, then appropriate measures become more difficult and subjective. Yet it is the latter type of objectives that often form the broad objectives or goals of the curriculum.

One measure of the effectiveness of an engineering curriculum is whether or not it receives accreditation. The Engineers’ Council for Professional Development, which grants accreditation, will form a team consisting of engineers from industry and from other engineering colleges, and send the team to the college whose curriculum is to be evaluated. The team will study extensive reports about the institution prepared by the college. During that time the team may scrutinize the catalogue of courses, meet with teachers, administrators and students, inspect the facilities, check course notes and examinations and look into other aspects of the college that may give it a better understanding of the curriculum, how well it is being implemented and how effective it is. Finally, the team members will discuss their findings and come to a consensual judgement on whether or not to recommend accreditation.

In developing any evaluation scheme consideration should be given not only to appraising how well the curriculum, course or instructional unit satisfies its objectives, but also to how it can provide information useful in improving the curriculum. The granting of accreditation by an outside agency is clearly a summative evaluation, since it indicates that the graduates are prepared to enter the profession. The evaluation reports, however, can also be used by the institution, even if it is granted accreditation to improve the curriculum and remove any deficiencies that are noted.

The nature of the curriculum evaluation will vary with the type of engineering curriculum proposed, the extent to which it is being changed, and the degree to which it is being used. A detailed and stringent evaluation, however, should not only improve a curriculum, but should increase the credibility accorded to it and hence encourage its acceptance and implementation.

**Problems of Implementation**

The implementation of a curriculum requires a great deal of commitment, planning and dedicated effort. The degree of difficulty encountered is directly related to the proportion of the existing system involved in the change. Most higher education systems can easily accommodate the changes created by an individual faculty member in one course. When an entire department or college proposes to implement a significant change in its operation, however, the effect on the entire difficulties and resistance to the proposed change increase dramatically.

All institutions that involve the combined efforts of a large number of people are inherently complex and are usually stable. It is almost a truism that the founders of a new organization will attempt to create a functional system that will be easy to operate. As the organization develops and expands, however, procedures that allow it to function in a workable manner become a complex network of interdependent and interactive forces, which not only ensures smooth operation for the system, but protects it from disruption. And change, whether for better or worse, is disruptive.
An analysis of the problems associated with instituting a change in any system is essentially an analysis of the existing conditions and their mismatch with current needs and trend. A necessary first step, therefore, in the implementation of change is to develop a clear understanding of the difference between what now is and what is proposed to be.

A major hindrance to implementing change lies in the established managerial and operational structure of the traditional educational system. Budgeting by a central administration, for example, often is based primarily on minor extrapolations of prior activities, and thus encourages the maintenance of the existing system. Very few institutions are provided with funds that permit any investment in research and development on their academic processes, or have any formal means within their budget structures for promoting the development of faculty and programs. Further central administrations often consider the budgetary needs of an engineering department to be similar to those of a humanities department, making it difficult to justify the additional expenditure for laboratory space and equipment.

Although universities are being asked to be accountable for the efficiency and effectiveness of their processes, their management systems often are not organized to ensure cost effectiveness, nor are their administrators chosen for their managerial ability. Administrators in higher education generally are selected from the faculty ranks as a reward for outstanding professional and academic achievement rather than for their administrative or managerial effectiveness.

Another problem arises because the characteristics of the traditional organization of instruction are basically incompatible with the characteristics of the new approaches in education. The existing system in higher education, for instance, is notably lacking in educational technology. Yet most recent innovations in education are highly dependent on the implementation of new techniques in educational technology. The existing system also emphasizes professional competence of faculty members in their disciplines, without requiring them to be proficient or competent in teaching and learning techniques. Faculty members are not required to have any training in instructional methods nor any supervised teaching experience, so that they approach teaching as an empirical art, learned by observing experienced, but similarly untrained, teachers.

Since the reward system is based principally on professional achievement in an academic discipline, there is little incentive for either the faculty or the administration to include teaching improvement programs in the academic process. If any activities are undertaken to improve the teaching expertise of the faculty, these are often informal, voluntary and minimal. The implementation of new educational techniques that require an upgrading of the expertise of the faculty will require that an in-service faculty training system be instituted, which is not in accord with present practice in many institutions.

Curriculum design is an extremely laborious and tedious process, usually conducted through compromise. Individual faculty members and administrators of various departments temper their beliefs that their courses should be included in the final curriculum only by the desire to meet the overall requirements of accreditation and conventionality and those imposed by a central agency. The unit of exchange in this process is the individual course, with little or no attempt to negotiate the content of the course in curriculum development, or for a department to accept courses offered by another department in place of its own. Departmental autonomy often overrides any attempt towards interdepartmental cooperation in the development of new curricula.

The conflicts in curriculum development that occur between the demands of the traditional curriculum and the demands for the inclusion of an ever-increasing amount of new, relevant...
subject matter are not easy ones to resolve. The problems are further complicated by the industrial climate and the opportunities that exist for employment in the various specialties or disciplines, and by compromises that must be reached on the amount of balancing or complementary studies that should be included in the curriculum.

There also are many hindering factors created by available resources. These include the availability of academic staff, technical and administrative support staff, laboratory space and equipment, and the cost to implement the change, to retrain faculty members, to abandon old procedures and forms and generate new ones, to restructure learning spaces, to relinquish out-of-date equipment, to develop new course materials, and so on. Further, the needs of students enrolled in existing curricula must be considered, and means for a transition or for dual systems must be developed.

Perhaps the greater barrier to innovation is the natural resistance of all individuals to abandon comfortable, convenient and well-known procedures. Major changes in a curriculum inevitably realign responsibility and authority, and create threats to the political structure of the institution. New lines of power and authority may be established, and new political leverages must be developed. The threat to individual autonomy, of exposure by evaluation procedures, and of new and unfamiliar criteria for reward and advancement all imply that any successful implementation must take time and be based on a well organized plan.

**Final Comments**

There are many ways to approach curriculum design. Some are heuristic, others are analytical. Not all are equally effective, and not all present equal difficulty in their implementation.

Although engineering educators have paid little attention to sound principles of curriculum design, except in the most general and intuitive sense, the procedures they have followed have been relatively successful. Engineering schools have been graduating engineers for almost 200 years and, for the most part, these graduates have led productive lives and have served the changing needs of the nation very well.

It is becoming more difficult, however, to design an effective curriculum. The rapidity with which knowledge is expanding and with which technological developments are taking place – and the increasing demands to apply engineering to social problems – are causing engineering curricula to remain in an almost constant state of revision. More formal, less intuitive, ways are and should be used to design engineering curricula.

Study of the curriculum design procedures used by several nations with various economic, social, political and educational systems reveals that the various procedures contain certain common logical steps, the identification of which can be used to define a methodology of curriculum design. The procedure discussed in this article has been developed from an attempt to identify and expand upon those common steps.

The methodology presented is simple and straightforward, yet lends itself to as much precision and detail as desired. Many of the steps proposed are self-evident and, when conducted on a gross level, may already be carried out by most people who engage in curriculum design. The methodology, however, can be rooted in the principles of teaching and learning and can be made as detailed as desired, with the cost of implementation directly related the amount of time and effort the designer wishes to put into the process.
The methodology should be viewed as a model for a process to be followed, rather than a recipe for curriculum design. Too many variations exist among institutions to permit a fixed formula to be followed, and many factors will influence the detailed procedure to be adopted in a particular case. Despite all the variations that will occur, it is believed that the flexibility and adaptability of this methodology will make it useful to most people concerned with the development of engineering curricula.
ASSURING THE QUALITY OF CURRICULUM DEVELOPMENT

Nirwan Idrus

There are many models of curriculum development. A simple one adapted from Grayson (1978) is depicted in Figure 1 below where essential inputs to each of the three stages are shown on the left.
ASSURING QUALITY

Quality is achieved when the customers’ needs are met by the product or service, because there is a fitness for purpose perceived by the customers.

The achieving of Quality in turn is due to the assurance of that fitness for purpose. That is, Quality is achieved when all the steps towards this achievement are guaranteed or in other words assured.

How do we assure the quality steps?

In the case of curriculum development, the final quality is assured when the curriculum team or individual charged with developing the curriculum, follows all the steps as outlined in the Figure in the previous page according to a quality formula, such as the one shown on the next page in tabular form.

However, it is not enough for the curriculum team or individual to simply perfunctorily carry out the steps. S/he must be continually referring whether consciously or unconsciously to the needs of the students, and that s/he must also always attempt to procedure the best possible result from his/her endeavor at each one of those steps.

Quality is produced not because of the SUM of the individual element’s quality but of their PRODUCT. That is,

\[
Q \neq \Sigma q_i, \text{ BUT} \\
Q = \Pi q_i, \quad \text{where } q = \text{element and } 1 < I < n
\]

Thus even with 90% quality of the elements, and depending on the number of elements involved, the overall Quality, Q is going to be a lot less than 90%

Hence, to keep the overall Quality high, it is not enough to simply do the steps required, but to them with the utmost care and consciousness.

Various tools of Quality should be applied at each of the steps whenever possible to ensure that the highest level of quality is achieved at every point on the way to the overall Quality. These may included simple tools such as brainstorming, data gathering and analysis, survey of the needs of the students, monitoring of the students’ satisfaction in an ongoing manner, carry out corrective action, review and do it all over again.

The PLAN – DO – CHECK – ACT cycle is well known within the Quality circle and this cycle has to be practiced at each step and also at the overall systems level, in order to maintain the fitness for purpose as required by the customer or student in case.
<table>
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<tr>
<th>STAGE</th>
<th>ELEMENTS OF STAGE</th>
<th>STEPS TO DO TO ASSURE QUALITY</th>
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</table>
| 1. Problem Definition | a. Mission Statement | - Does the institution have a Mission Statement?  
- Is this Mission Statement accepted and supported by all staff and students of the institution?  
- Does the Study Program or curriculum being proposed for development support this Mission statement?  
- Does the Study Program or curriculum being proposed for development fall within this and the spirit of the Mission Statement?  
- Is there a documented system for checking that the above question are actually asked and corrective or follow up actions determined? If yes, please produce the documented system for further analysis and audit by the QA Team. |
|               | b. Industry Needs | - Does the university or faculty have an industry liaison?  
- Is this activity part of the university’s or faculty’s Strategic plan?  
- Is this activity documented?  
- Is there an industry liaison person appointed for this purpose?  
- Is this person a lecturer or an administrative person?  
- Is this person appointed full or part time? If part-time, state the number of hours per week the person is involved in industry liaison.  
- For the curriculum or study program proposed for development, has the appropriate industry been consulted? If yes, please explain HOW and whether the consultation was documented and analyzed in detail.  
- Does any member of the industry sit in any committees of the university or faculty? If yes, which committees and how active, e.g. as Chairman or Deputy Chairman of the committees etc.  
- Are the inputs from industry properly analyzed to show an unbiased support for the study program being proposed for development? |
|               | c. Societal Needs | - Does the industry liaison mentioned in (b) if exists in the university or faculty, also consult with and research the requirements and limitation imposed but the society, e.g. through enacted laws say on environmental protection, occupational health and safety.  
- If not, does the university or faculty have an appointed person (either full time or part time) to scan the education environment on a regular basis to keep management of the university or faculty about social development in the local, national and global scenes including demography? |
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<th>STEPS TO DO TO ASSURE QUALITY</th>
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<td>If yes, how often is the <em>environmental scanning</em> done and who makes use of the analysis; Top Management, Deans, Heads of departments?</td>
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<td></td>
<td>Are these <em>environmental scanning</em>, analysis and use documented?</td>
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<td>Are data obtained through <em>environmental scanning</em> used by management for planning purposes? If so, HOW?</td>
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<td>d.</td>
<td>Professional Needs</td>
<td>Does the university or faculty have a good relationship with the relevant professional bodies?</td>
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<td></td>
<td></td>
<td>Does the university or faculty liaise with these bodies on a regular and synergistic manner?</td>
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<td>Are there any representatives from these bodies in any committees of the faculty or university?</td>
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<td>Do they hold any office position within committees (e.g. Chairman and/or Deputy Chairman)?</td>
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<td>In developing the study program or curriculum under question, has the professional bodies made any inputs as to the relevance of the study program to the profession?</td>
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<td>In the opinion of the university or faculty, have the professional bodies kept themselves up to date with the requirement of the profession, given the rapid development of technology?</td>
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<td>Has the university or faculty taken into consideration the inputs from these bodies to the development of the curriculum or study program? If not, why not?</td>
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<tr>
<td>2.</td>
<td>Structuring the Curriculum</td>
<td>Does the proposed curriculum or study program fall within the level of knowledge appropriate for a university study?</td>
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<td></td>
<td>a. Domain of Knowledge</td>
<td>How is this determined?</td>
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<td>Are the benchmarks used to determine the above appropriate? How do you prove this?</td>
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<td>Is the amount of knowledge to be imparted to the students taking this study program or curriculum considered adequate given any pre-requisites for the study program or subjects within the study program?</td>
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<td></td>
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<td>How is this determined?</td>
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<td></td>
<td>Are the benchmarks used to determine this appropriate? How do you prove this?</td>
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<td></td>
<td>Does the study program or curriculum fall within the scope of knowledge required for the graduates to be competent in the area of the study program?</td>
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<td></td>
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<td>How is this determined?</td>
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<td>Are the benchmarks used to determine this appropriate? Ho do you prove this?</td>
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<td></td>
<td>b. Student Constraints</td>
<td>Has the university or faculty determined and analyzed the probable difficulties faced by students in enrolling in this study program?</td>
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<td></td>
<td>Has the university or faculty decided on a corrective action in view of these probable difficulties? What are they?</td>
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<td>In assisting students through these difficulties, has the university or faculty taken a traditional solution?</td>
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<td>STAGE</td>
<td>ELEMENTS OF STAGE</td>
<td>STEPS TO DO TO ASSURE QUALITY</td>
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<td>❑ In assisting, student through these difficulties, has the university or faculty taken a non-traditional solution? What are they?</td>
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<td>❑ In assisting, student through these difficulties, has the university or faculty assumed the role of a “coach”: and thus empowering the students to work out the solution that suits themselves best?</td>
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<td></td>
<td></td>
<td>❑ In assisting, student through these difficulties, has the university or faculty taken a paternal approach, i.e. spoon feeding the students</td>
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<tr>
<td>c.</td>
<td>Accrediting Body</td>
<td>❑ Has the university or faculty prepared the study program or curriculum in accordance with the requirements of the appropriate accrediting body?</td>
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<td></td>
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<td>❑ Has the university or faculty tested the resultant study program or curriculum against the criteria of the accrediting body?</td>
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<td></td>
<td>❑ Has the university or faculty corrected any points or items that do not meet the criteria of the accrediting body?</td>
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<td>❑ In the final analysis, has the corrected version of the curriculum and study program achieved the initial aims and objectives of the program while satisfying the requirements of the accrediting body?</td>
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<td>❑ Has the university or faculty submitted the curriculum of study program to the accrediting body for accreditation?</td>
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<td>d.</td>
<td>Resources</td>
<td>i) Human Resources</td>
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<td></td>
<td>❑ Is there sufficient number of lectures available who are knowledgeable and skilled to teach the study program?</td>
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<td>❑ Is this number of lectures determined according to an acceptable formula, e.g. Students-Staff ratio.</td>
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<td>❑ Is their knowledge and skills determined according to an acceptable selection criteria?</td>
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<td>❑ Are the selection criteria documented and known to all applicants for the job?</td>
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<td>❑ Is the system of lecturers approved by the management of the university as a general policy and practiced accordingly?</td>
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<td>❑ Has a review system been set up to monitor and review the human resources requirements, effectiveness and efficiency for this program?</td>
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<td>ii) Financial Resources</td>
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<td></td>
<td>❑ Has a budget been prepared for the commencement of the proposed study program?</td>
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<td>❑ Has a budget been prepared for the continuation of the study program throughout its first full length of execution time?</td>
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<td></td>
<td>❑ Have these budgets included A.L.L requirements for a quality Study program, e.g. including computer and equipment requirements, consumables for practical, library books and journals, etc in addition to buildings, rooms, lecture theatres etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>❑ Have these budgets been discussed at and approved by management?</td>
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<tr>
<td>STAGE</td>
<td>ELEMENTS OF STAGE</td>
<td>STEPS TO DO TO ASSURE QUALITY</td>
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<td>Have funds been allocated to cover these approved budgets by management?</td>
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<td></td>
<td>Has a financial control system been approved and set up?</td>
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<td></td>
<td>Has a review system been set up to monitor and review the financial resources expenditures and budgets?</td>
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<td></td>
<td>Has this review system also included a corrective action system as well?</td>
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<td></td>
<td>iii) Technology Resources</td>
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<td></td>
<td>Does the planning for the study program or curriculum include an analysis of technological development that may impact on the study program or curriculum during its first full run, during its second full run etc?</td>
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<td></td>
<td>Has the above plan also taken into account the method of delivery of the study program and / or curriculum?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Have these been budgeted for?</td>
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<tr>
<td></td>
<td></td>
<td>Have these been taken into account in the purchase and establishment of supporting laboratories and workshops for this study program or curriculum?</td>
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<tr>
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<td></td>
<td>Have methods of technology acquisition been explored discussed and approved by management?</td>
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<tr>
<td></td>
<td>e. Teaching and Learning Methods</td>
<td>Does the university or faculty have a section or unit that scans possible new ways of teaching and learning effectively in a continual basis?</td>
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<tr>
<td></td>
<td></td>
<td>Does this unit liaise constantly with the teaching/learning departments?</td>
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<td></td>
<td>Does this unit have its own budget to test and try out new ways of effective teaching and learning?</td>
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<td>Does this unit organize a regular workshop to update and upgrade the teaching and learning methods within the university?</td>
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<td></td>
<td>Does management encourage the trying out and experimenting with new ways of teaching and learning.</td>
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<tr>
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<td></td>
<td>Does management do this by providing a budget for these?</td>
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<td></td>
<td>Does management do this by providing staff development time for these purposes?</td>
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<tr>
<td></td>
<td></td>
<td>Does management do this by bringing in teaching and learning expert from outside the university to share their experience with all teaching staff at the university, either through lectures, workshop?</td>
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<td></td>
<td></td>
<td>Do teaching staff themselves suggest alternative methods of teaching and learning generally?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do teaching staff themselves suggest alternative methods of teaching and learning for this particular curriculum or study program?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Have the teaching staff analyzed the needs of the proposed curriculum or study program for curriculum or study program for the most appropriate alternative teaching and learning methodology that will improve effectiveness and efficiencies or learning.</td>
</tr>
<tr>
<td>STAGE</td>
<td>ELEMENTS OF STAGE</td>
<td>STEPS TO DO TO ASSURE QUALITY</td>
</tr>
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</tbody>
</table>
|       |                   | ❑ Has either the university and faculty or teaching staff planned for a monitoring and review system of the teaching and learning methodologies?  
|       |                   | ❑ How often is a review of teaching and learning methodologies planned? |
| 3. Implementation and Evaluation | a. Advisory Board | ❑ Does the university or faculty have advisory boards whose members include representatives from industry, students and professional bodies?  
| |       | ❑ Is there an Advisory Board for the development of the proposed curriculum or study program, whose members include representatives from industry, students and professional bodies?  
| |       | ❑ Do Advisory Board have documented aims and objectives as well as selection criteria for membership?  
| |       | ❑ Does the university or faculty have a monitoring and review system by which the Advisory Boards are reviewed on their aims, objectives, memberships and achievements?  
| |       | ❑ If so, how often is this done?  
| |       | ❑ If so, what follow-up actions are in place in order to effect continuous improvement in the Advisory Boards? |
| | b. External Examiners | ❑ Does the university and/or faculty use external examiners for new as well as on-going examinations?  
| |       | ❑ Does the proposed curriculum and study program plan to use external examiners in its subject examinations?  
| |       | ❑ Is the policy of using external examiners documented, monitored and reviewed regularly?  
| |       | ❑ Is the selection for an external examiner well documented, actioned, reviewed and monitored by management?  
| |       | ❑ Does the university or faculty keep a record of all external examiners’ recommendations, results and comments?  
| |       | ❑ Does the university or faculty carry out corrective actions on the basis of these external examiners’ recommendations, results and comments? |
| | c. Feedback from Industry | ❑ Does the university or faculty have a policy of soliciting feedback from industry and seriously act on these feedback?  
| |       | ❑ Does the university and the faculty have a feedback plan to ensure that proper and well considered feedback from industry is obtained, analyzed and acted upon to continually improve the curriculum and study program?  
| |       | ❑ Is a feedback plan included in the development of the proposed study program and curriculum? |
| | d. Outcomes Assessment | ❑ Does the university and faculty operate on the basis of outcomes orientation where the outcomes cover all possible aspects that impact on the proposed curriculum and study program?  
| |       | ❑ Do the proposed study program and curriculum have and outcomes assessment plan? |
STAGE ELEMENTS OF STAGE STEPS TO DO TO ASSURE QUALITY

- Does the outcomes assessment plan clearly state how the assessment is to be carried out, what will be assessed and the actions that will be taken depending on the results of the outcomes assessment?
- Have previous outcomes assessment plans worked to the satisfaction of the customers, the organization and the public?
- Is there a properly established recording system to facilitate decision-making based on outcomes?
- Does the university and faculty have documented system and procedures to dismount a study program or a subject within a study program?
- Does the university and faculty have documented system and procedures to create a perpetual or continual improvement in the proposed study program and curriculum?
- Does the university and faculty have a documented system of evaluating the corrective actions carried out as a result of outcomes assessments?

Instruction on the use of the Table of Checks List for Quality Assured Curriculum Development

- There are 101 questions in the check list Table.
- Put a “þ” for a yes or positive answer to each question in the last column.
- Put a “ý” for a no or negative answer to each questions in the last column.
- Note down on a separate sheet of paper any qualified answer, i.e. a “þ” or a “ý” but with some explanation, or that the answer is not exactly a yes or a no.
- Where documented evidence is asked for and your answer is a yes, note down on the side of the tick the short-form of the document, e.g. AB for Academic Board, MT for Management Team etc.
- For each no or “ý” answer, ask the following question and carry out the most appropriate actions as listed in the second column.

<table>
<thead>
<tr>
<th>Questions to Ask</th>
<th>Possible Answer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is it “ý” because we have not established the system?</td>
<td>❑ Start creating the system. This may involve discussing immediately with the Head of Department, Dean and/or Rector about the need for the system.</td>
</tr>
<tr>
<td></td>
<td>❑ Check why the system had not been established and plug the gaps that caused this inadequacy in the first place.</td>
</tr>
<tr>
<td></td>
<td>❑ Get help from the best source, to set up the system. Help can be at any level of the organization and can come from Consultants as well as motivated internal staff.</td>
</tr>
<tr>
<td>2. Is it “ý” because there is no control on the system or on some undocumented system?</td>
<td>❑ Check what sorts of controls are needed, remembering that the best control is self-control by those involved. Hence must create a system that encourages self-assessment and self-control, but the staff will need training.</td>
</tr>
<tr>
<td></td>
<td>❑ Plan training for self-assessment and self-control.</td>
</tr>
</tbody>
</table>
### Questions to Ask

<table>
<thead>
<tr>
<th>Possible Answer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan the on-going control of the system through self-control of the staff.</td>
</tr>
<tr>
<td>Action the plan by first disseminating the objectives of the system and gain cooperation from the staff.</td>
</tr>
</tbody>
</table>

3. Is it “☒” because there is no on-going overt monitoring of the progress of the system?

<table>
<thead>
<tr>
<th>Possible Answer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check what needs to be monitored, how often, what method, who should be involved.</td>
</tr>
<tr>
<td>Create a plan of monitoring that covers all the above and any other inputs from those impacted by this decision. This plan should also have a review and corrective action plans.</td>
</tr>
<tr>
<td>Put an action plan into place and start the actions.</td>
</tr>
<tr>
<td>Repeat all the above steps.</td>
</tr>
</tbody>
</table>

4. Is it “☒” because while the action plan is implemented, no result or progress is forthcoming?

<table>
<thead>
<tr>
<th>Possible Answer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check if there was an Action Plan with details as to the people involved, their obligations and responsibilities, line of accountabilities and the actioning at the top of this accountability structure.</td>
</tr>
<tr>
<td>Check if there was any regular reviews of the Action Plan as well as a corrective action plan and system.</td>
</tr>
<tr>
<td>If no to both checks, start creating the appropriate system(s) as in (1) above.</td>
</tr>
</tbody>
</table>

5. Is it “☒” because of insufficient resources to carry out the tasks involved to do them properly?

<table>
<thead>
<tr>
<th>Possible Answer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check if this was caused by the lack of budgeting and budget approval system, and if so, draw up a budget in detail and discuss or present to top management for approval and support.</td>
</tr>
<tr>
<td>Check if this was caused by the lack of top management support, and if so, top management must be alerted to it and corrective action be implemented straight away.</td>
</tr>
<tr>
<td>Check if this was caused by the lack of human resources. If so, re-check the qualifications and experiential requirements and officers involved, to see if these requirements are difficult to fulfil. If so, review the requirements again and if proven to be unnecessarily high, change them. However, do not change them if this action is only to accommodate a lower level of requirement standards.</td>
</tr>
</tbody>
</table>

- As a general indicator,
  - 10 < “☒” < 20 can be acceptable if they do not involve systems problems. Corrective actions required.
  - 20 < “☒” < 40 is getting serious especially since this will be inevitably involve systems problems. A check by a Quality Audit person or team required before any other further actions are taken. Corrective actions are definitely required and a review after corrections should be done.
  - “☒” > 40 unacceptable. A Quality Audit consultant is required to carry out an audit on the university and faculty management systems.
There is always a tendency to compromise the QA of any system including the curriculum development system. The 101 items listed in this Check List are not stringent and neither exhaustive. That is, there are many more questions that can be asked to ensure that the system complies with QA requirements. Some of these hard questions have not been asked here. So compromising the situation will dilute the ability of the university and faculty to do a proper job on curriculum development.

Quality and Quality Assurance or Total Quality Management will only work properly when the management, the people, the resources, the documentation, the procedures and the various regulations involved exist towards continually improving the product or services that the client want. This means that at every level of management, people should be trying to continually improving themselves (some through official training scheme and professional development plans) and continually improving the system.

Nirwan Idrus
July 1999
CURRICULUM DEVELOPMENT

INTRODUCTION

Sessions 3.1 to 8.8 are concerned with the development of a curriculum for a program of study in an engineering discipline. In these sessions the methodology of Grayson (1978) will be used as a guideline to the curriculum development process. Essentially, with this model the curriculum development process is divided into three stages, the inputs for each stage are identified and information obtained on each input. Decisions are made at each stage of the model before moving on to the next stage. However, the process is an iterative one and earlier decisions may have to be revised in the light of later analysis.

The ABET 2000 accreditation and evaluation model will be used as reference material for the purposes of accreditation requirements. This model has a significant influence on the mutual recognition of first degree qualifications in an international context. Some time is devoted to explaining this model so that participants will be aware of its implications for curriculum design.

A series of activities have been developed for these sessions of the workshop. These activities are concerned with developing some of the inputs required for curriculum design before undertaking the development of a curriculum in a specific discipline of engineering. Within the time constraints of this workshop it is not feasible to source and analyze all the inputs that are necessary for the development of a curriculum. For example, the needs of industry, of society or the qualifications and expectations of students cannot be ascertained within the confines of the workshop. It is expected that participants will contribute information from their own experience and knowledge of these sources. Some information on selected inputs will be provided, however, but the participants will be expected to develop others such as program educational objectives in the activities.

REFERENCE

INTRODUCTION TO ABET 2000

OBJECTIVE

To familiarize participants with the philosophy and methodology of the ABET 2000 accreditation system

BACKGROUND

In many overseas countries the National accreditation and evaluation systems for engineering studies are established and operated by the Professional engineering societies. The requirements of these professional accrediting bodies have a significant impact on the design of the engineering curriculum to be followed in the educational institutions. For reasons to be outlined below, the accreditation system of the USA is becoming more influential as a model for many countries and this together with the internationalization of engineering practice and the move towards the mutual acknowledgement of engineering qualifications by different countries means that educational program designers must take an international perspective when designing engineering curricula.

The American model will be discussed extensively in this and the next few sessions. We will refer to it as the ABET model and use its approach to assist in the development of engineering curricula. It should be noted at the outset that the ABET model incorporates continuous quality improvement philosophy and is focussed on the outcomes of the educational process.

The Accreditation Board for Engineering and Technology (ABET) is a federation of professional societies in the USA which has over 60 years of experience in the evaluation and accreditation of engineering education programs. ABET was previously called the Engineering Council for Professional Development.

Since 1991 ABET has become more active in its international activities and has conducted consultative evaluations (not accreditation) of engineering education programs in countries in Asia, the Middle East, Eastern Europe, Central and South America and USSR. The result is that the ABET model has become increasingly significant for the international recognition of engineering qualifications from different countries and has been proposed as an approach to accreditation and evaluation of engineering and engineering technology programs in Indonesia.

In this session, participants are to become familiar with the ABET model, the ABET criteria and how engineering programs are evaluated under that model. This will be achieved by the presentation of four topics on different aspects of the ABET model and one activity. For Session 3.1 particular emphasis is placed on the ABET Criterion 4. This criterion is concerned with the "Professional Component" of an engineering education program, that is, it relates to the structure of the curriculum and the broad areas of knowledge covered in an engineering program.
INFORMATION ON ABET 2000 MODEL

An overview of ABET and its activities is given in the attached document.

THE ABET 2000 CRITERIA

ABET accredits engineering programs at two levels (1) the Basic level and (2) the Advanced level.

There are eight criteria for accrediting programs at the Basic level. These are listed below and commented on briefly. Each criterion will be examined in more detail in later sessions.

Criterion 1. Students
The quality and performance of students and graduates are important considerations in the evaluation of an education program. Sources of information on the quality of students would include examples of examinations, homework assignments, laboratory work, reports and design project work. Since ABET emphasis outputs in its evaluation, it is essential that the quality of students and graduates be monitored to determine if programs are meeting the stated objectives.

Criterion 2. Educational Objectives
The need to have written objectives and documented process for determining if the objectives are achieved is covered by this criterion.

Criterion 3. Outcomes and Assessment
This criterion effectively states the generic attributes expected of graduates from an accredited engineering degree program. ABET gives eleven characteristics that students should possess on graduating from the study program. The abilities listed cover technical and engineering skills and knowledge, communication, teamwork, life skills and skills for professional practice. The necessity of having a documented assessment process that has relevant measures of outcomes is highlighted.

Criterion 4. Professional Component
Course content is covered by this criterion. Specific courses are not prescribed but required areas of knowledge are identified, design experience is stressed and a general education component that complements the technical content is included.

Curriculum Elements
The curriculum in Engineering is made up of the following elements:

- Basic Sciences and Mathematics
- Engineering Topics
  - Engineering sciences
  - Engineering design
- General Education Component

The “General Education” component is not specified in detail but it should "complement the technical content of the curriculum and [be] consistent with the program and institute objectives". In the previous ABET model this was described as the "Humanities and Social Sciences" component and acceptable subjects and topics for this component of the curriculum were described.
Criterion 5. Faculty
The role of the staff and the qualifications and competencies expected of them are specified under this criterion.

Criterion 6. Facilities
This criterion deals with classrooms, laboratories, equipment, computing and information infrastructure.

Criterion 7. Institutional Support and Financial Resources
The role of the institution (University) in supporting the engineering program, the staff and other resources is specified.

 Criterion 8. Program Criteria
The program criteria are an integral part of the accreditation criteria. They cover the requirements in specified disciplinary areas of engineering. There are 23 disciplines in the current list of program criteria including Architectural Engineering, Chemical Engineering, Civil Engineering, Electrical and Electronic Engineering, Mechanical Engineering and Environmental Engineering.

In addition to the eight basic level criteria noted above there are two further criteria:

Cooperation Education Criterion
This covers courses where students undertake a period of full-time employment as part of the degree requirements.

Advanced Level Programs
For advanced level programs the criteria are the same as above with the following additions: one extra year of study beyond the basic level and an engineering project or research activity resulting in a report that demonstrates both mastery of the subject matter and a high level of communication skills.

Essentially the criteria state that to be accredited a program must have a course content that gives a graduate sufficient knowledge of and exposure to an engineering discipline to begin practice in that discipline, the student's learning experience must be supported by quality teaching staff, adequate teaching resources - laboratory, library and information technology, a faculty and an institution committed to the program.

REFERENCE MATERIAL

The following ABET documents:

These and other ABET documents may be found at the ABET web site:
- [http://www.abet.org](http://www.abet.org)

MATERIAL FOR SESSION

A copy of the National Curriculum should be available for reference. Copies of the ABET documents.
ACCREDITATION BOARD FOR ENGINEERING AND TECHNOLOGY

VISION

ABET will provide world leadership to assure quality and stimulate innovation in engineering, technology and applied science education.

MISSION

ABET serves the public through the promotion and advancement of engineering, technology and applied science education. ABET will:

- Accredit engineering, technology and applied science programs.
- Promote quality and innovation in engineering, technology and applied science education.
- Consult and assist in the development and advancement of education in engineering, technology and applied science.
- Inform the public of activities and accomplishments.
- Manage operations and resources to be responsive and relevant to the needs of the organization and its stakeholders.

ABET ... What It Is

The Accreditation Board for Engineering and Technology (ABET) is primarily responsible for monitoring, evaluating, and certifying the quality of engineering, engineering technology, and engineering-related education in colleges and universities in the United States. ABET develops accreditation policies and criteria and conducts a comprehensive program of evaluation of degree programs. Programs that meet the prescribed criteria are granted accredited status. ABET participates in general areas of higher education, especially those that impact on the engineering profession. ABET initiates and sponsors studies, conferences, and seminars, and co-sponsors projects in cooperation with organizations with common interests.

Accreditation...How It Started

The present system of engineering accreditation was developed by The Engineers Council for Professional Development (ECPD), now known as ABET, in 1932. With input from the engineering community and its seven organizing societies (American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, American Institute of Electrical Engineers, Society for the Promotion of Engineering Education, American Institute of Chemical Engineers, National Council of State Boards of Engineering Examiners), ECPD developed criteria for accrediting undergraduate engineering degree programs. In 1936, ECPD implemented the process of evaluating engineering degree programs against these criteria and awarding recognition (accreditation) to programs which met the required minimum standards. Using the same developmental procedure, ECPD developed criteria for engineering technology programs, and accreditation of those programs began in 1946. Prior to the establishment of ECPD, there was no national system for evaluating engineering and engineering technology programs in all the engineering disciplines.
Accreditation...Objectives

To serve the public, industry, and the profession generally by stimulating the development of improved engineering education; including encouraging curricular improvement in existing programs and helping to develop educational models for the establishment of new programs. To identify for prospective students, student counselors, parents, potential employers, public bodies and officials, engineering, engineering technology, and engineering-related programs that meet the ABET criteria for accreditation.

Accreditation...What It Provides

Through a process of direct on-site visitation, ABET provides schools with a means to have their programs formally evaluated against criteria that have been set by educators and practitioners in the profession. Programs that meet the criteria are awarded a term of accreditation lasting up to six years. As a result, students in an ABET-accredited engineering, engineering technology, or engineering-related program have a definite assurance that their investment in a collegiate education is protected. The accreditation process has a number of positive effects on the quality of engineering education in the United States. Individual college/university engineering departments benefit from an impartial expert team's vital feedback, the opportunity for self-appraisal, and an intensive curriculum review. Another important value to engineering educators is the overall perspective that ABET gains from its continuing investigations of engineering education. Often ABET is able to identify general trends within engineering education of which individual institutions may not be aware.

Accreditation...A Passport

A degree from an ABET-accredited program is like a passport because it is quality tested. Graduates from ABET-accredited programs have a high degree of job mobility due to the wide recognition of the accreditation system in the world engineering community.

The Accreditation Commissions

ABET's three accreditation commissions perform the accreditation function and determine accreditation actions. The Engineering Accreditation Commission is responsible for engineering programs, the Technology Accreditation Commission is responsible for engineering technology programs, and the Related Accreditation Commission for engineering-related programs. All commission members who chair the on-site visit teams are qualified evaluators and are thoroughly knowledgeable of accreditation procedures, policies, and criteria. Programs are identified as accredited by the Engineering Accreditation Commission of ABET (EAC/ABET), the Technology Accreditation Commission of ABET (TAC/ABET), or the Related Accreditation Commission of ABET (RAC/ABET).

Accreditation...The Process

First, a school requests accreditation for a particular program in engineering, engineering technology, or an engineering-related field.

Second, a team of experienced professional educators and/or practitioners is assembled to visit the school. Equipped with various documents, including a detailed self-evaluation
questionnaire completed by the school beforehand, the team conducts an on-site campus visit to consult with administrators, faculty, students, and departmental personnel. The ABET team examines the academic and professional qualifications of the faculty, adequacy of laboratories, equipment, computer facilities, library facilities, and more. It also looks at the quality of the students' work as evaluated on the basis of interviews with students and the assessment of current examination papers, laboratory work, reports and theses, models or equipment constructed by students, and other evidence of the scope of their education. In addition, the team performs a qualitative and quantitative analysis of program content to ensure that it meets the criteria for mathematical foundations, basic sciences, engineering sciences, engineering design and synthesis, and humanities and social sciences (which ABET requires to complement the technical education of the student).

Third, the team chair prepares a preliminary report with input from the program evaluators. Officers of the appropriate accreditation commission (Engineering Accreditation Commission, Technology Accreditation Commission, or Related Accreditation Commission) review and edit the report and send it to the institution for its due process review and comment. This procedure allows the institution to correct any errors of fact or observation. The institution's response is reviewed by the originator of the preliminary report to determine whether changes are warranted.

Fourth, the preliminary report, the analysis of the institution's response, and other related materials are presented to the respective full commission for its review and action. The commission may grant (or extend) accreditation of a program for a period of up to six years, or it may deny accreditation altogether.

Who Recognizes ABET?

ABET's legal recognition comes from two sources. First, the U.S. Department of Education periodically reviews ABET's operations and formally recognizes ABET's exclusive jurisdiction for accreditation of engineering, engineering technology, and engineering-related education. Second, state licensing authorities, either by specific statute or by long-standing practice, generally recognize ABET-accredited engineering programs for full educational credit toward satisfaction of state Professional Engineer licensure requirements.

ABET has many constituencies but it ultimately derives its standing from its parentage the engineering community. It serves the public interest on behalf of the engineering community, it derives its expertise from the engineering community, and it nurtures its vitality and technical currency from the continuing support of the engineering community.

Who Governs ABET?

ABET is governed by twenty-two Participating Bodies that are the major technical and professional engineering societies in the United States. They are represented on ABET's Board of Directors and accreditation commissions by individuals who encompass the private, public, and academic sectors of a wide range of engineering disciplines. Along with six Affiliate Bodies, these societies represent more than 1.8 million individual engineers. Membership figures are as of September 1994.

All members of the ABET Board of Directors and accreditation commissions are volunteers who contribute their time and effort to the accreditation process. ABET also relies on the volunteer services of an extensive network of top-ranking educators and practitioners who serve on the visiting evaluation teams.
Definition of Engineering

Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.

Definition of Engineering Technology

Engineering technology is that part of the technological field that requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer.

Definition of Engineering-Related Programs

Engineering-related programs in higher technical education are mathematics-and-science-based programs that do not fit the strict definitions of either engineering or engineering technology, but have close practical and academic ties with engineering. With appropriate participation of societies representing specific engineering-related professional disciplines, engineering-related programs may be structured to prepare graduates for entry into professional practice in a discipline that is neither engineering nor engineering technology.
ABET 2000

OBJECTIVE

To familiarize participants with the concept of an outcomes focused accreditation philosophy with clearly defined, documented and controlled processes.

BACKGROUND

In this session, ABET criteria other than those related to program content will be considered in more detail. This will give participants a wider view of the meaning of curriculum and highlight the importance of other inputs to the curriculum development process. It is to be noted that modern accreditation procedures are outcomes focused i.e. are based upon what students learn in their studies and not on what is presented. Institutions must have clearly stated educational objectives and employ outcome assessment techniques to determine to what degree the goals and objectives are being obtained. Each program must have an assessment process with documented results. These results must then be applied to the further development and improvement of the program. This session will focus on the educational objectives of a curriculum. Outcomes assessment and the writing of learning objectives will be considered in detail in the session on Syllabus Development.

The ABET criteria that deal with curriculum elements other than course content will be considered and their relationship to curriculum design explained. A simple model of one approach to curriculum design is then presented. This model will be the basis of the methodology to be adopted in this workshop for curriculum design.

ABET Criterion 1. Students

The quality and performance of the students and graduates is an important consideration in the evaluation of an engineering program. The institution must evaluate, advise, and monitor students to determine its success in meeting program objectives.

This criterion would require that tertiary educational institutions maintain detailed and accurate records on entrance standards of each student, monitor a student's progress through the course and provide advise on academic and professional development matters to all students. The performance of students must be related back to the program objectives.

ABET Criterion 2. Program Educational Objectives

Each engineering program for which an institution seeks accreditation or reaccreditation must have in place
(a) detailed published educational objectives that are consistent with the mission of the institution and these criteria
(b) a process based on the needs of the program’s various constituencies in which the objectives are determined and periodically evaluated
(c) a curriculum and process that ensures the achievement of these objectives
(d) a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.
Items listed under criterion 2 will be met by implementing a total quality management program in a University. As part of its quality assurance procedures, an Institution should have a clearly defined mission statement from which educational objectives are derived and procedures established to compare measured performance against standards and initiate corrective action when necessary.

**ABET Criterion 3. Program Outcomes and Assessment**

Engineering programs must demonstrate that their graduates have
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program, including those listed above, are being measured. Evidence that may be used includes, but is not limited to the following: student portfolios, including design projects; nationally-normed subject content examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys; and placement data of graduates.

Each engineering department must be able to demonstrate that its graduates possess the attributes and abilities listed under this criterion. Evidence must be gathered and recorded on the performance of students in their undergraduate studies, the professional accomplishments and careers of graduates, employment data and employer satisfaction. Systematic documentation of the assessment process is required and the outcomes related to the mission of the University and the objectives of the particular educational program.

**ABET Criterion 4. Professional Component**

The professional component requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The engineering faculty must assure that the program curriculum devotes adequate attention and time to each component, consistent with the objectives of the program and institution. Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic; environmental; sustainability;
manufacturability; ethical; health and safety; social; and political. The professional component must include:
(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline
(b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student’s field or study
(c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

ABET Criterion 5. Faculty

The faculty is the heart of any educational program. The faculty must be of sufficient number; and must have the competencies to cover all of the curricular areas of the program. There must be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students.

The faculty must have sufficient qualifications and must ensure the proper guidance of the program and its evaluation and development. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and registration as Professional Engineers.

A competent, qualified and forward-looking staff is necessary to give the program an overall scholarly atmosphere and to provide appropriate role models for students. This criterion is concerned with the knowledge, teaching skills, professional engineering experience and attitude of staff. In addition, the extent of student-staff interaction and the role of staff in guiding the academic progress and professional growth of students are considered.

ABET Criterion 6. Facilities

Classrooms, laboratories, and associated equipment must be adequate to accomplish the program objectives and provide an atmosphere conducive to learning. Appropriate facilities must be available to foster faculty-student interaction and to create a climate that encourages professional development and professional activities. Programs must provide opportunities for students to learn the use of modern engineering tools. Computing and information infrastructures must be in place to support the scholarly activities of the students and faculty and the educational objectives of the institution.

The accreditation body expects that the engineering program will be supported by adequate physical facilities such as classroom space, laboratories and workshop facilities that are suitable for the programs objectives and scope.

Libraries should include the necessary technical and non-technical books, journals and other reference material. Computer-accessible information centers and inter-library loan services can extend the range of information sources available to staff and students.

Computer facilities should be sufficient to cover the use of computers for technical calculations, problem solving, data acquisition and processing, process control, computer-
aided design, computer graphics and other applications as appropriate to the particular engineering discipline.

Laboratory facilities must reflect the requirements of the engineering educational program and be supported by equipment and instruments to ensure the adequate functioning of the laboratory. The Department should also have a plan for the maintenance, on-going replacement, modernization and support of the laboratory equipment and related facilities.

**ABET Criterion 7. Institutional Support and Financial Resources**

Institutional support, financial resources, and constructive leadership must be adequate to assure the quality and continuity of the engineering program. Resources must be sufficient to attract, retain, and provide for the continued professional development of a well-qualified faculty. Resources also must be sufficient to acquire, maintain, and operate facilities and equipment appropriate for the engineering program. In addition, support personnel and institutional services must be adequate to meet program needs.

Essentially this criterion looks at the organizational structure of the institution and how the overall administration of the institution relates to the engineering department and helps it to achieve its educational objectives.

**ABET Criterion 8. Program Criteria**

Each program must satisfy applicable Program Criteria. Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. Requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set of Program Criteria; however, overlapping requirements need to be satisfied only once.

The program criteria are an integral part of the accreditation criteria. They cover the requirements in specified disciplinary areas of engineering. There are 23 disciplinary areas in the current list of program criteria. These include Architectural Engineering, Chemical Engineering, Civil Engineering, Electrical and Electronic Engineering, Mechanical Engineering and Environmental Engineering.

**ABET General Advanced Level Programs**

Criteria for advanced level programs are the same as for basic level programs with the following additions: one year of study beyond the basic level and an engineering project or research activity resulting in a report that demonstrates both mastery of the subject matter and a high level of communication skills.

Please note that Criterion 8 will be discussed in Session 5.7 in which the educational programs for specific engineering disciplines will be examined.
CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS

Effective for Evaluations During the 1999-2000 Accreditation Cycle

Incorporates all changes approved by the ABET Board of Directors as of November 1, 1998

αβχ

Engineering Accreditation Commission

Accreditation Board for Engineering and Technology, Inc.
111 Market Place, Suite 1050
Baltimore, MD 21202

Telephone: 410-347-7700
Fax: 410-625-2238
E-mail: accreditation@abet.org
Website: http://www.abet.org
ENGINEERING CRITERIA 2000

CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS

Effective for Evaluations during the 1999-2000 Accreditation Cycle

I. GENERAL CRITERIA FOR BASIC LEVEL PROGRAMS

It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program meets the following criteria.

Criterion 1. Students

The quality and performance of the students and graduates are important considerations in the evaluation of an engineering program. The institution must evaluate, advise, and monitor students to determine its success in meeting program objectives. The institution must have and enforce policies for the acceptance of transfer students and for the validation of courses taken for credit elsewhere. The institution must also have and enforce procedures to assure that all students meet all program requirements.

Criterion 2. Program Educational Objectives

Each engineering program for which an institution seeks accreditation or reaccreditation must have in place:

(a) detailed published educational objectives that are consistent with the mission of the institution and these criteria
(b) a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated
(c) a curriculum and processes that ensure the achievement of these objectives
(d) a system of ongoing evaluation that demonstrates achievement of these objectives and uses the results to improve the effectiveness of the program.

Criterion 3. Program Outcomes and Assessment

Engineering programs must demonstrate that their graduates have:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
Each program must have an assessment process with documented results. Evidence must be given that the results are applied to the further development and improvement of the program. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the program, including those listed above, are being measured. Evidence that may be used includes, but is not limited to the following: student portfolios, including design projects; nationally-normed subject content examinations; alumni surveys that document professional accomplishments and career development activities; employer surveys; and placement data of graduates.

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(a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline
(b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study
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The faculty must have sufficient qualifications and must ensure the proper guidance of the program and its evaluation and development. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and registration as Professional Engineers.

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Classrooms, laboratories, and associated equipment must be adequate to accomplish the program objectives and provide an atmosphere conducive to learning. Appropriate facilities must be available to foster faculty-student interaction and to create a climate that encourages professional development and professional activities. Programs must provide opportunities for students to learn the use of modern engineering tools. Computing and
information infrastructures must be in place to support the scholarly activities of the students and faculty and the educational objectives of the institution.

**Criterion 7. Institutional Support and Financial Resources**

Institutional support, financial resources, and constructive leadership must be adequate to assure the quality and continuity of the engineering program. Resources must be sufficient to attract, retain, and provide for the continued professional development of a well-qualified faculty. Resources also must be sufficient to acquire, maintain, and operate facilities and equipment appropriate for the engineering program. In addition, support personnel and institutional services must be adequate to meet program needs.

**Criterion 8. Program Criteria**

Each program must satisfy applicable Program Criteria (if any). Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. Requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set of Program Criteria; however, overlapping requirements need to be satisfied only once.

**II. COOPERATIVE EDUCATION CRITERIA**

Should the program include as a part of the professional component a cooperative work element, this element of the program may be examined as a separate entity and reported as part of the accreditation action.

**III. GENERAL CRITERIA FOR ADVANCED LEVEL PROGRAMS**

Criteria for advanced level programs are the same as for basic level programs with the following additions: one year of study beyond the basic level and an engineering project or research activity resulting in a report that demonstrates both mastery of the subject matter and a high level of communication skills.
GENERIC COMPETENCIES REQUIRED OF ENGINEERS

OBJECTIVE

To make participants aware of the concept of national generic competency standards for engineers.

BACKGROUND

In many countries the professional engineering institutions have the major responsibility for establishing accreditation standards and evaluation procedures for engineering education programs and thus set the entry-level qualifications to the profession. The signatories of the Washington Accord, for example, were the professional engineering institutions or National Councils formed from the professional institutions in each country. In this session, the concept of "Professionalism" will be discussed, the role of professional engineering societies examined and one approach to national generic competency standards (that of the Institution of Engineers, Australia) will be presented.

Professional requirements are one of the inputs to Stage 1 of the curriculum development methodology and the published criteria for initial registration and continued registration of professional engineers are one source of information for this input. The generic competency standards that IEAust requires for the registration of professional engineers in Australia have a significant impact on the design of engineering undergraduate courses and courses for continuing professional development.

NOTES ON PROFESSIONALISM, THE ROLE OF A PROFESSIONAL ENGINEERING SOCIETY AND COMPETENCY STANDARDS.

Professionalism

The Institution of Engineers Australia defines the occupational category of Professional Engineer as follows:

Professional Engineer: The benchmark is the graduate from an IEAust accredited four year professional engineering course, or recognized equivalent. Professional Engineers develop and apply newly developed engineering practices on a regular basis. They have the capacity to apply performance-based procedures, which demand the reliable application of fundamental principles to problems which lie outside their prior experience. They have leadership and management qualities which, when combined with knowledge of mathematics, science and technology, enable the marshalling of human, physical and financial resources to meet community, commercial and social needs. Through their education and formation they can synthesize a wide range of information to solve diverse problems, and do advanced design, taking an overall systemic view and holistic approach in the pursuit of engineering opportunities and outcomes.

Thus, to be an effective professional engineer, an individual must be competent in the areas of:

- Engineering practice
- Engineering design
- Self-management in the Engineering workplace.
In addition, an individual would need to possess other skills that reflect the particular requirements for the practice of engineering in his or her employment situation. Some of these activities would not necessarily be specific to the work of a professional engineer but would be necessary to make the individual effective in the performance of his or her engineering activities. Such skills would include some general management skills, communication skills and skills related to the business function of the organization.

### The Role of a Professional Engineering Society

A professional engineering society is essentially a representative body for its members. The society exists to serve its members, to promote engineering and to facilitate the practice of engineering for the benefit of the community. A Professional Society would seek to:

- Promote and advance the science and practice of engineering;
- Ensure that the community is well served by its engineering resources;
- Encourage the development of the nation's technological capacity in a way that ensures sustainability and maximizes its contribution to national economic growth;
- Encourage the professional development of its members.

To achieve these goals, the professional society undertakes a diverse range of activities which may include:

- Accrediting engineering education programs;
- Self-regulation of the profession;
- Setting standards for the practice of engineering and the recognition of professional engineers;
- Maintaining a register of professional engineers and engineering technologists;
- Operating programs of continuing education and professional development for its members;
- Maintaining a publishing and conference program;
- Being involved in community debate on relevant national issues;
- Promoting the profession to schools, the community and government;
- Representing the interests of its members in the internationalization of engineering practice;
- Providing other services and benefits for members (e.g. employment services, career advice, scholarships and awards, professional networks).

While all these activities represent the genuine interests of members of a profession, in the context of this workshop on curriculum development we are primarily interested in the roles that relate to accrediting engineering education programs and setting competency standards for professional practice as these roles directly affect the curriculum for education programs.

ABET has already been discussed as an example of a modern approach to accreditation and evaluation of education programs by a professional organization. We will now consider the National Competency Standards adopted in Australia by the Institution of Engineers as an illustration of one Professional Society’s procedures for defining standards that aim to ensure world class practice from its members.

### Competency Standards

The generic competency standards for Professional Engineers in Australia are a part of the National Competency Based Assessment System. The competency standards are the foundations upon which other parts of the system are built. The primary function of the
competency standards is their assessment role, that is they are a standard against which an individual engineer can be assessed for entry to or to move upwards within an occupational category. However, competency standards also have an important role as a guide to curriculum development. For example, they would be an important input to stage 1 of the curriculum development methodology discussed earlier.

In Australia the generally accepted definition of Competency is:

Competency is the ability to perform activities in an occupational category or function to the standard expected in employment.

The IEAust Professional Engineering Competency Requirements

IEAust applies the above definition of competency to the practice of engineering and has determined a set of engineering competency units that focus on the engineering function together with those business functions that are most closely related to the achievement of engineering outcomes. The competency units cover the major areas of activity described under Professionalism above as core competency standards. There are also elective competency standards to cover related engineering activities.

The professional engineer core competency standards are:

1. Engineering Practice
   1.1 Presents and develops a professional focus
   1.2 Pursues continuing professional development
   1.3 Integrates engineering with other professional input
   1.4 Develops innovative engineering solutions
   1.5 Identifies constraints on potential engineering solutions

2. Engineering Design
   2.1 Interprets and scopes design requirements
   2.2 Prepares concept proposals
   2.3 Implements planning and design process
   2.4 Reviews the design to achieve acceptance
   2.5 Prepares and maintains documentation during the design process
   2.6 Reviews design outcomes in operation

3. Self Management in the Engineering Workplace
   3.1 Manages self
   3.2 Works effectively with the team
   3.3 Manages work priorities and resources
   3.4 Facilitates and capitalizes on change and innovation
   3.5 Establishes and maintains business relationships with customers/stakeholder/supplier/regulator

The professional engineer elective competency standards are:

1. Engineering Business Management
2. Engineering Project Management
3. Engineering Operations
4. Materials / Components / Systems
5. Environmental Management
6. Investigation and Reporting
7. Research and Development and Commercialization
Within each of these Elective Units of competency there are a number of elements (varying from four to eight). Engineers must demonstrate competency on a subset of these elements in each unit but some elements are mandatory. Engineers seeking recognition as chartered professional engineers must be competent in all three Core Units and in two of the seven Elective Units. Some Elective Units are mutually exclusive e.g. Engineering Business Management cannot be selected with Engineering Project Management.

It should be noted that these competency standards are generic in the sense that they apply to all engineering disciplines. Also the standards apply to a professional engineer seeking assessment for the Stage 2 Professional Engineer status. Briefly, the levels of recognition of a Professional Engineer in Australia are:

**Professional Engineer Stage 1** - essentially a graduate engineer or person with recognised equivalent qualifications at entry level to the profession. People at this stage would work on tasks of limited scope and complexity under the guidance of a more experienced person.

**Professional Engineer Stage 2** - an experienced engineer seeking recognition as a Chartered Professional Engineer. The professional development of the engineer achieved following certification at Stage 1 is assessed against the core and elective competency standards. People at this level are expected to be able to work independently on normal engineering work. For more complex or critical work they would have limited guidance from a more experienced engineer.

**Professional Engineer Advanced** - at this level the engineer exercises full professional autonomy and demonstrates a capacity for leadership of change, innovation and creativity in professional engineering work. The person demonstrates an ability to appreciate the wider context of engineering in social, organizational and economic terms. Skills in the business functions, planning and supervising the use of all resources and management of personnel and industrial relations issues are evident.

The competency standards for Stage 1 are the same as for Stage 2 but in applying the standards the IEAust recognizes that candidates seeking entry to the Professional Engineer occupational category have not undergone the formation process of an experienced engineer. Thus it is not expected that entry level candidates will exhibit the increase in knowledge, understanding, problem-solving and practice skills that come with professional experience. People graduating from IEAust accredited courses are deemed to have the Stage 1 competencies.

**ACTIVITY**

*Develop a set of generic competency standards for engineers in Indonesia*

Participants will be divided into 10 groups – each group to consider one generic competency unit. Division need not be according to engineering discipline since the competency standards to be developed are generic; that is, they apply to all the disciplines. To expedite the activity each group will work on one Unit following the IEAust division into 10 Units – three core Units and seven elective Unit. Within a Unit, a group should examine the Elements that make up the Unit and the associated Performance Criteria. Participants should formulate alternative elements and criteria that are applicable to the practice of engineering in Indonesia.
REFERENCE MATERIAL
Information on the IEAust Generic Competency Standards will be provided.

MATERIAL FOR SESSION
Extracts from the IEAust National Competency Standards.
KOMPETENSI, PROFESI DAN PROFESIONAL

KOMPETENSI
Kemampuan untuk melaksanakan (secara profesional) suatu kegiatan dalam kategori/fungsi praktek keprofesian sesuai dengan baku-bakuuan yang disyaratkan dalam dunia kerja nyata.

PROFESI
Pekerjaan yang mensyaratkan latihan dan pendidikan tinggi kepada para penyandangnya.

PROFESIONAL
Tampilan tindakan dan kelakukan yang dihargai sebagai standar yang tinggi dari dan oleh suatu profesi.

PERSATUAN INSINYUR INDONESIA (PII)

- Sarjana Teknik (S.T.)
  Gelar akademik untuk tamatan program S-1 perguruan tinggi teknik.
- Insinyur (Ir.)
  Sebutan untuk penyandang gelar Sarjana Teknik (S.T.) atau Sarjana Pertanian yang memiliki dasar pengetahuan profesi keinsinyuran.
- Insinyur Profesional (IP):
  Insinyur yang memiliki kompetensi profesional, berpengalaman praktek keinsinyuran (engineering), dan mempraktekan keinsinyuran sebagai profesinya sehari-hari.

CIRI-CIRI INSINYUR PROFESIONAL

- memegang teguh kode etik profesi
- pekerjaan = “hobi”
- keahlian awet, segar, dan mutakhir
- berupaya mencapai standar hasil yang lebih baik
- senantiasa berupaya memperbaiki diri, mempertahankan integritas, dan bekerja ke arah kesempurnaan
- cakap dalam prakarsa, kreativitas, kearifan, dan kedewasaan
- berketrampilan tinggi dalam melakukan perhitungan-perhitungan perancangan dan evaluasi.

IKLIM YANG MENDORONG PROFESIONALISME

- Kode etik dipegang teguh.
- Prestasi individu tak terpupuskan oleh citra kelompok.
- Ada “award” dan “reward”.
- Tiap pelaku profesi terdorong untuk:
  - berperan aktif dalam perkembangan teknologi, dan
  - tak terbuai pengalaman dan “yang praktis-praktis”
PRODUK AKHIR IKLIM PROFESIONALISME

Terwujudnya pemanfaatan dan penguasaan teknologi dan sains secara mantap dan dinamik.
⇒ kunci penentu daya saing dan pertumbuhan ekonomi bangsa!

YANG BERTANGGUNGJAWAB MENCIPATKAN IKLIM PROFESIONALISME

- Himpunan Profesi (PII + Badan-badan Kejuruan)
- Majikan: industri (barang/jasa) dan pemerintah
- Perguruan Tinggi: (BKS-BKS)
KODE ETIK INSINYUR INDONESIA

“Catur Karsa Sapta Darma Insinyur Indonesia”

EMPAT KAIDAH DASAR

1. Mengutamakan keluhuran budi.
2. Menggunakan pengetahuan dan kemampuan untuk kepentingan kesejahteraan umat manusia.

TUJUH SIKAP

1. Insinyur Indonesia senantiasa mengutamakan keselamatan, kesehatan, dan kesejahteraan masyarakat.
2. Insinyur Indonesia senantiasa bekerja sesuai dengan kompetensinya.
3. Insinyur Indonesia hanya menyatakan pendapat yang dapat dipertanggungjawabkan.
4. Insinyur Indonesia senantiasa menghindari terjadinya pertentangan kepentingan dalam tanggung jawab tugasnya.
5. Insinyur Indonesia senantiasa membangun reputasi profesi berdasarkan kemampuan masing-masing.
6. Insinyur Indonesia senantiasa memegang teguh kehormatan, integritas, dan martabat profesi.
7. Insinyur Indonesia senantiasa mengembangkan kemampuan profesionalnya.
BAKUAN KOMPETENSI-KOMPETENSI GENERIK
PERSATUAN INSINYUR INDONESIA - PII

UNIT KOMPETENSI WAJIB:
3. Perencanaan dan Perancangan Keinsinyuran.

UNIT KOMPETENSI PILIHAN:
1. Pendidikan dan Latihan
2. Penelitian, Pengembangan dan Komersialisasi
3. Konsultasi Rekayasa dan/atau Konstruksi/Instalasi
4. Produksi / Manufaktur
5. Bahan Material dan Komponen
6. Manajemen Usaha dan Pemasaran Teknik

Tiap insinyur yang menghendaki sertifikasi sebagai insinyur profesional harus kompeten dalam keempat Unit Kompetensi Wajib dan dua dari tujuh Unit Kompetensi Pilihan.

BAKUAN KOMPETENSI-KOMPETENSI GENERIK
IEAUSST

CORE COMPETENCY STANDARDS:
1. Engineering Practice
2. Engineering Design

ELECTIVE COMPETENCY STANDARDS:
1. Engineering Business Management
2. Engineering Project Management
3. Engineering Operations
4. Materials / Components / Systems
5. Environmental Management
6. Investigation and Reporting

Tiap insinyur yang menghendaki sertifikasi sebagai insinyur profesional harus kompeten dalam ketiga "core competency standards" dan dua dari tujuh "elective competency standards".
DOKUMEN

PERSATUAN INSINYUR INDONESIA (PII)

BAKUAN KOMPETENSI

Dokumen di atas ditulis pada berkas yang terpisah
CONSTRAINS ON CURRICULUM IN INDONESIA

Cuplikan

Keputusan Menteri Pendidikan dan Kebudayaan tentang Kurikulum Nasional untuk Program Sarjana Ilmu Teknik untuk Program Studi:

• Teknik Mesin
• Teknik Elektro
• Teknik Kimia
• Teknik Industri
• Teknik Sipil
• Arsitektur

Surat Keputusan tersebut dicuplik untuk menjadi bahan kajian pada Teaching Improvement Workshop
KEPUTUSAN
MENTERI PENDIDIKAN DAN KEBUDAYAAN
REPUBLIC INDONESIA
NOMOR 02181U/1995
TENTANG
KURIKULUM YANG BERLAKU SECARA NASIONAL
PROGRAM SARJANA ILMU TEKNIK

MENTERI PENDIDIKAN DAN KEBUDAYAAN,


b. bahwa kurikulum yang berlaku secara nasional Program Sarjana ditetapkan oleh Menteri Pendidikan dan Kebudayaan;

c. bahwa sehubungan dengan itu dipandang perlu menetapkan kurikulum yang berlaku secara nasional Program Sarjana Ilmu Teknik.

Mengingat : 1. Undang-Undang Nomor 2 Tahun 1989;
2. Peraturan Pemerintah Nomor 30 Tahun 1990;
3. Keputusan Presiden Republik Indonesia
   a. Nomor 44 Tahun 1974;
   b. Nomor 15 Tahun 1984, sebagaimana telah beberapa kali diubah terakhir dengan Keputusan Presiden Republik Indonesia Nomor 2 Tahun 1995;
4. Keputusan Menteri Pendidikan dan Kebudayaan :
   a. Nomor 0222c/0/1980;
   b. Nomor 088/0/1983;
   c. Nomor 0686/U/1991;
   d. Nomor 036/U/1993;


MEMUTUSKAN

Menetapkan : KEPUTUSAN MENTERI PENDIDIKAN DAN KEBUDAYAAN REPUBLIK INDONESIA TENTANG KURIKULUM YANG BERLAKU SECARA NASIONAL PROGRAM SARJANA ILMU TEKNIK.
Pasal 1

(1) Tujuan Program Sarjana Ilmu Teknik adalah untuk menghasilkan warga negara yang:

a. memiliki integritas kepribadian yang tinggi sebagai Sarjana Ilmu Teknik;
b. memiliki pengembangan kepemimpinan, dan penumbuhan rasa etika profesional;
c. memiliki kemampuan bekerja atau meneruskan pendidikan ke jenjang pendidikan lebih tinggi setelah menyelesaikan pendidikan sarjana;
d. mampu menghadapi situasi-situasi yang baru dalam profesi yang berdasarkan prinsip-prinsip fundamental secara mandiri, disertai percaya diri dan pertimbangan yang mantap;
e. mempunyai motivasi untuk mengikuti perkembangan ilmu pengetahuan secara intelektual, sosial, dan kultural;
f. mampu menyelesaikan masalah dengan menerapkan prinsip-prinsip dasar dalam teknik ke pemikiran analitis yang tertib dalam merumuskan masalah, menyederhanakan masalah tanpa kehilangan sifat kekhususannya.

(2) Penyelenggaraan kegiatan untuk mencapai tujuan sebagaimana dimaksud dalam ayat (1) berpedoman pada:

a. tujuan pendidikan nasional;
b. kaidah, moral dan etika ilmu pengetahuan;
c. kepentingan masyarakat, serta memperhatikan minat, kemampuan dan prakarsa pribadi.

Pasal 2

Program Ilmu Teknik merupakan program pendidikan akademik terdiri atas 23 (dua puluh tiga) Program Studi sebagai berikut:

a. Teknik Mesin;
b. Teknik Perkapalan;
c. Teknik Sistem Perkapalan;
d. Teknik Elektro;
e. Teknik Kimia;
f. Fisika Teknik;
g. Teknik Industri;
h. Teknik Nuklir;
i. Teknik Penerbangan;
j. Teknik Material;
k. Teknik Informatika;
l. Teknik Sipil;
m. Teknik Kelautan;
n. Teknik Geodesi;
o. Arsitektur;
p. Perencanaan Wilayah dan Kota;
q. Teknik Lingkungan;
r. Teknik Geologi;
s. Teknik Geofisika;
t. Teknik Perminyakan;
u. Teknik Pertambangan;
w. Eksplorasi Tambang.
Pasal 3

(1) Kurikulum yang berlaku secara nasional Program Sarjana Ilmu Teknik paling sedikit 75 satuan kredit semester (sk) terdiri atas:

a. Mata Kuliah Umum (MKU) 10 sks;
b. Mata Kuliah Dasar Keahlian (MKDK) 33 sks;
c. Mata Kuliah Keahlian (MKK) 32 sks.

(2) Kurikulum lokal program Sarjana Ilmu Teknik ditetapkan oleh masing-masing pimpinan perguruan tinggi paling banyak 85 sks.

Pasal 4

(1) Kurikulum yang berlaku secara nasional Program Studi Teknik Mesin meliputi:

a. Mata Kuliah Umum (MKU) 10 sks;
b. Mata Kuliah Dasar Keahlian (MKDK) 57 sks;
c. Mata Kuliah Keahlian (MKK) 32 sks.

(2) Mata Kuliah Umum terdiri atas mata kuliah dengan jumlah sks sebagai berikut:

a. Pendidikan Agama 2 sks;
b. Pendidikan Pancasila 2 sks;
c. Pendidikan Kewarganegaraan (Kewiraan) 2 sks;
d. Pilih dua mata kuliah diantara mata kuliah di bawah ini:
   1) Ilmu Budaya Dasar 2 sks;
   2) Ilmu Sosial Dasar 2 sks;
   3) Bahasa Indonesia 2 sks;
   4) Bahasa Inggris 2 sks;
   5) Falsafah Ilmu Pengetahuan 2 sks;
   6) Olah Raga 2 sks.

(3) Mata Kuliah Dasar Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:

a. Kalkulus 8 sks;
b. Fisika Dasar 6 sks;
c. Kimia Dasar 2 sks;
d. Matematika Teknik 6 sks;
e. Menggambar Teknik 2 sks;
f. Menggambar Mesin 2 sks;
g. Statika Struktur 3 sks;
h. Mekanika Kekuatan Material 3 sks;
i. Material Teknik 3 sks;
j. Metalurgi Fisik 3 sks;
k. Proses Produksi 6 sks;
l. Kinematika dan Dinamika 4 sks;
m. Termodinamika Dasar 3 sks;
n. Mekanika Fluida Dasar 3 sks;
o. Perpindahan Panas Dasar 3 sks.

(4) Mata Kuliah Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:

a. Elemen Mesin 9 sks;
b. Getaran Mekanis 2 sks;
c. Praktikum Fenomena Dasar Mesin 1 sks;
d. Praktikum Prestasi Mesin 1 sks;
e. Mesin Konversi Energi 3 sks;
f. Pemilihan Bahan dan Proses 2 sks;
g. Pengukuran Teknik 2 sks;
h. Teknik Tenaga Listrik 2 sks;
i. Teknik Pengaturan 2 sks;
j. Manajemen industri 2 sks;  
k. Kerja Praktik 1 sks;  
l. Tugas Akhir/Skripsi 5 sks.

Pasal 7

(1) Kurikulum yang berlaku secara nasional Program Studi Teknik Elektro paling, sedikit 95 sks meliputi:
   a. Mata Kuliah Umum (MKU) 12 sks;  
   b. Mata Kuliah Dasar Keahlian (MKDK) 50 sks;  
   c. Mata Kuliah Keahlian (MKK) 33 sks.

(2) Mata Kuliah Umum terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Pendidikan Agama 2 sks;  
   b. Pendidikan Pancasila 2 sks;  
   c. Pendidikan Kewarganegaraan (Kewiraan) 2 sks;  
   d. Pilih dua mata kuliah di antara mata kuliah di bawah ini:
      1) Ilmu Budaya Dasar 2 sks;  
      2) Ilmu Sosial Dasar 2 sks;  
      3) Bahasa Indonesia 2 sks;  
      4) Bahasa Inggris 2 sks;  
      5) Falsafah Ilmu Pengetahuan 2 sks;  
      6) Olah Raga 2 sks.

(3) Mata Kuliah Dasar Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Kalkulus 8 sks;  
   b. Fisika Dasar 8 sks;  
   c. Matematika Teknik 6 sks;  
   d. Dasar Teknik Elektro 2 sks;  
   e. Dasar Komputer dan Pemrograman 2 sks;  
   f. Medan Elektromagnetik 3 sks;  
   g. Rangkaian Listrik 3 sks;  
   h. Dasar Elektronika 2 sks;  
   i. Dasar Telekomunikasi 2 sks;  
   j. Dasar Konversi Energi Elektrik 2 sks;  
   k. Pengukuran Besaran Listrik 2 sks;  
   l. Dasar Sistem Kontrol 2 sks;  
   m. Sistem Linier 3 sks;  
   n. Probabilitas dan Statistik 2 sks.

(4) Mata Kuliah Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Konsentrasi : Teknik Energi Listrik
      1) Mesin-mesin Elektrik 6 sks;  
      2) Gejala Medan Tinggi 2 sks;  
      3) Sistem Proteksi 3 sks;  
      4) Elektronika Daya 2 sks;  
      5) Analisis Sistem Tenaga 3 sks;  
      6) Sistem Distribusi 2 sks;  
      7) Pembangkitan Energi Elektrik 2 sks;  
      8) Transmisi Daya Elektrik 3 sks;  
      9) Peralatan Tegangan Tinggi 2 sks;  
     10) Termodinamika 2 sks;  
     11) Kerja Praktik 2 sks;  
     12) Tugas Akhir/Skripsi 4 sks.
b. Konsentrasi : Teknik Telekomunikasi
   1) Saluran Transmisi 3 sks;
   2) Jaringan Telekomunikasi 3 sks;
   3) Antena dan Propagasi 3 sks;
   4) Kinerja Sistem Telekomunikasi 3 sks;
   5) Sistem Transmisi Telekomunikasi 3 sks;
   6) Pengolahan Sinyal Digital 3 sks;
   7) Elektronika Analog 3 sks;
   8) Elektronika Telekomunikasi 3 sks;
   9) Rekayasa Trafik 3 sks;
  10) Kerja Praktik 2 sks;
  11) Tugas Akhir/Skripsi 4 sks;

c. Konsentrasi : Teknik Kontrol
   1) Perancangan Sistem Digital 2 sks;
   2) Sistem Kontrol Optimal 3 sks;
   3) Sistem Kontrol Multivariabel 3 sks;
   4) Arsitektur Sistem Komputer 3 sks;
   5) Sistem Kontrol Digital 3 sks;
   6) Elektronika Analog 3 sks;
   7) Optimasi 3 sks;
   8) Komponen Sistem Kontrol 3 sks;
   9) Sistem Pemrosesan Sinyal 3 sks;
  10) Sistem Mikroprosesor 3 sks;
  11) Kerja Praktik 2 sks;
  12) Tugas Akhir/Skripsi 4 sks;

d. Konsentrasi : Teknik Elektronika
   1) Sistem Instrumentasi Elektronika 3 sks;
   2) Perancangan Sistem Digital 2 sks;
   3) Teknologi Rangkaian Terintegrasi 3 sks;
   4) Devais Mikroelektronika 3 sks;
   5) Perancangan Sistem Elektronika 3 sks;
   6) Sistem Mikroprosesor 3 sks;
   7) Elektronika Analog 3 sks;
   8) Elektronika Digital 3 sks;
   9) Arsitektur Sistem Komputer 3 sks;
  10) Sistem Pemrosesan Sinyal 3 sks;
  11) Kerja Praktik 2 sks;
  12) Tugas Akhir/Skripsi 4 sks;

e. Konsentrasi : Teknik Sistem Komputer
   1) Komputasi Numerik dan Simbolik 2 sks;
   2) Perancangan Sistem Digital 2 sks;
   3) Sistem Cerdas 3 sks;
   4) Pemodelan dan Simulasi 2 sks;
   5) Teori Informasi 2 sks;
   6) Algoritma dan Struktur Data 3 sks;
   7) Teori Antrian dan Keandalan 2 sks;
   8) Sistem Operasi 2 sks;
   9) Sistem Pemrosesan Sinyal 3 sks;
  10) Arsitektur Sistem Komputer 3 sks;
  11) Elektronika Analog 2 sks;
  12) Sistem Mikroprosesor 3 sks;
  13) Kerja Praktik 2 sks;
  14) Tugas Akhir/Skripsi 4 sks.
Pasal 8

(1) Kurikulum yang berlaku secara nasional Program Studi Teknik Kimia meliputi:
   a. Mata Kuliah Umum (MKU) 10 sks;
   b. Mata Kuliah Dasar Keahlian (MKDK) 44 sks;
   c. Mata Kuliah Keahlian (MKK) 39 sks.

(2) Mata Kuliah Umum terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Pendidikan Agama 2 sks;
   b. Pendidikan Pancasila 2 sks;
   c. Pendidikan Kewarganegaraan (Kewiraan) 2 sks;
   d. Pilih dua mata kuliah di antara mata kuliah di bawah ini:
      1) Ilmu Budaya Dasar 2 sks;
      2) Ilmu Sosial Dasar 2 sks;
      3) Bahasa Indonesia 2 sks;
      4) Bahasa Inggris 2 sks;
      5) Falsafah Ilmu Pengetahuan 2 sks;
      6) Olah Raga 2 sks.

(3) Mata Kuliah Dasar Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Kalkulus 6 sks;
   b. Fisika Dasar 6 sks;
   c. Kimia Dasar 3 sks;
   d. Kimia Fisika 4 sks;
   e. Kimia Organik 4 sks;
   f. Kimia Analisis 4 sks;
   g. Matematika Teknik Kimia 6 sks;
   h. Termodinamika Teknik Kimia 5 sks;
   i. Azas Teknik Kimia 6 sks.

(4) Mata Kuliah Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Pengendalian Proses 3 sks;
   b. Proses Industri Kimia 3 sks;
   c. Utilitas 3 sks;
   d. Perancangan Pabrik Kimia 4 sks;
   e. Operasi Teknik Kimia 2 sks;
   f. Teknik Reaksi Kimia 6 sks;
   g. Kerja Praktik 2 sks;
   h. Tugas Akhir/Skripsi 6 sks.

Pasal 10

(1) Kurikulum yang berlaku secara nasional Program Studi Teknik Industri terdiri atas:
   a. Mata Kuliah Umum (MKU) 10 sks;
   b. Mata Kuliah Dasar Keahlian (MKDK) 42 sks;
   c. Mata Kuliah Keahlian (MKK) 53 sks.

(2) Mata Kuliah Umum terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Pendidikan Agama 2 sks;
   b. Pendidikan Pancasila 2 sks;
   c. Pendidikan Kewarganegaraan (Kewiraan) 2 sks;
   d. Pilih dua mata kuliah di antara mata kuliah di bawah ini:
      1) Ilmu Budaya Dasar 2 sks;
      2) Ilmu Sosial Dasar 2 sks;
3) Bahasa Indonesia 2 sks;
4) Bahasa Inggris 2 sks;
5) Falsafah Ilmu Pengetahuan 2 sks;
6) Olah Raga 2 sks.

(3) Mata Kuliah Dasar Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Kalkulus 8 sks;
   b. Fisika 6 sks;
   c. Kimia 4 sks;
   d. Menggambar Teknik 2 sks;
   e. Mekanika Teknik 3 sks;
   f. Pengetahuan Bahan 3 sks;
   g. Proses Produksi 6 sks;
   h. Elemen Mesin 2 sks;
   i. Teknik Tenaga Listrik 2 sks;
   j. Pemrograman Komputer 2 sks;
   k. Pengantar Teknik Industri 2 sks;
   l. Pengantar Ekonomi 2 sks.

(4) Mata Kuliah Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Statistik Industri 6 sks;
   b. Analisis dan Perancangan Kerja 4 sks;
   c. Ekonomi Teknik 3 sks;
   d. Akuntansi dan Biaya 3 sks;
   e. Psikologi Industri 2 sks;
   f. Perencanaan dan Perancangan Produk 2 sks;
   g. Manajemen Sumber Daya Manusia 2 sks;
   h. Penelitian Operasional 6 sks;
   i. Perencanaan dan Pengendalian Produksi 3 sks;
   j. Pengendalian Kualitas 2 sks;
   k. Perencanaan Tata Letak Pabrik 3 sks;
   l. Manajemen Perusahaan Industri 2 sks;
   m. Pemodelan Sistem 3 sks;
   n. Sistem Produksi 3 sks;
   o. Analisis Kelayakan Pabrik 2 sks;
   p. Kerja Praktik 2 sks;
   q. Tugas Akhir/Skripsi 5 sks.

Pasal 15

(1) Kurikulum yang berlaku secara nasional Program Studi Teknik Sipil terdiri atas:
   a. Mata Kuliah Umum (MKU) 10 sks;
   b. Mata Kuliah Dasar Keahlian (MKDK) 46 sks;
   c. Mata Kuliah Keahlian (MKK) 44 sks.

(2) Mata Kuliah Umum terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Pendidikan Agama 2 sks;
   b. Pendidikan Pancasila 2 sks;
   c. Pendidikan Kewarganegaraan (Kewiraan) 2 sks;
   d. Pilih dua mata kuliah di antara mata kuliah dibawah ini:
      1) Ilmu Budaya Dasar 2 sks;
      2) Ilmu Sosial Dasar 2 sks;
      3) Bahasa Indonesia 2 sks;
      4) Bahasa Inggris 2 sks;
      5) Falsafah Ilmu Pengetahuan 2 sks;
      6) Olah Raga 2 sks.
(3) Mata Kuliah Dasar Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Kalkulus 12 sks;
   b. Fisika Dasar 2 sks;
   c. Kimia Dasar 2 sks;
   d. Statistika dan Probabilitas 2 sks;
   e. Bahasa Komputer 2 sks;
   f. Mekanika Rekayasa 12 sks;
   g. Menggambar Rekayasa (Struktur Bangunan) 2 sks;
   h. Mekanika Tanah 4 sks;
   i. Mekanika Fluida dan Hidrolika 4 sks;
   j. Rekayasa Hidrologi 2 sks;
   k. Bahan Bangunan 2 sks.

(4) Mata Kuliah Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Struktur Beton 4 sks;
   b. Struktur Baja 4 sks;
   c. Struktur Kayu 2 sks;
   d. Rekayasa Pondasi 2 sks;
   e. Pengembangan Sumber Daya Air 2 sks;
   f. Irigasi dan Bangunan Air 3 sks;
   g. Drainase Perkotaan 2 sks;
   h. Rekayasa Lingkungan 2 sks;
   i. Sistem Transportasi 2 sks;
   j. Rekayasa Jalan Raya (Geometrik dan Pengerusan) 3 sks;
   k. Rekayasa Lalu Lintas 2 sks;
   l. Pelabuhan 2 sks;
   m. Lapangan Terbang 2 sks;
   n. Pemindahan Tahan Mekanis/Alat-alat Berat 2 sks;
   o. Manajemen Konstruksi 2 sks;
   p. Ilmu Ukur Tanah 2 sks;
   q. Kerja Praktik 2 sks;
   r. Tugas Akhir/Skripsi 4 sks.

Pasal 18

(1) Kurikulum yang berlaku secara nasional Program Studi Arsitektur terdiri atas:
   a. Mata Kuliah Umum (MKU) 10 sks;
   b. Mata Kuliah Dasar Keahlian (MKDK) 40 sks;
   c. Mata Kuliah Keahlian (MKK) 50 sks.

(2) Mata Kuliah Umum terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Pendidikan Agama 2 sks;
   b. Pendidikan Pancasila 2 sks;
   c. Pendidikan Kewarganegaraan (Kewiraan) 2 sks;
   d. Pilih dua mata kuliah di antara mata kuliah di bawah ini:
      1) Ilmu Budaya Dasar 2 sks;
      2) Ilmu Sosial Dasar 2 sks;
      3) Bahasa Indonesia 2 sks;
      4) Bahasa Inggris 2 sks;
      5) Falsafah Ilmu Pengetahuan 2 sks;
      6) Olah Raga 2 sks.

(3) Mata Kuliah Dasar Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
   a. Matematika 2 sks;
   b. Matematika Teknik 4 sks;
   c. Teknologi Bahan 2 sks;
   d. Fisika Bangunan 4 sks.
e. Utilitas 2 sks;
f. Pengantar Arsitektur 2 sks;
g. Estetika Bentuk 4 sks;
h. Teknik Komunikasi Arsitektural 2 sks;
i. Teori Arsitektur 6 sks;
j. Perkembangan Arsitektur 6 sks;
k. Metoda Perancangan 4 sks;
l. Perancangan Tapak 2 sks.

(4) Mata Kuliah Keahlian terdiri atas mata kuliah dengan jumlah sks sebagai berikut:
a. Studio Perancangan Arsitektur 20 sks;
b. Struktur dan Konstruksi 16 sks;
c. Kota dan Permukiman 2 sks;
d. Arsitektur Kota 2 sks;
e. Kerja Praktik 2 sks;
f. Tugas Akhir/Skripsi 8 sks.

Pasal 27
1. Silabus buku bacaan wajib dan anjuran, disusun oleh masing-masing perguruan tinggi sesuai dengan ketentuan yang berlaku.

2. Pimpinan perguruan tinggi menetapkan kurikulum pendidikan tinggi sebagai pengembangan kurikulum yang berlaku secara nasional atas usul senat/pertimbangan Dekan Fakultas/Ketua Jurusan.

Pasal 28
Penilaian kurikulum yang berlaku secara nasional dilaksanakan secara berkala.

Pasal 29
Perguruan tinggi wajib melaksanakan kurikulum yang berlaku secara nasional, yang diatur dalam keputusan ini selambat-lambatnya 2 (dua) tahun scjak berlakunya keputusan ini.

Pasal 30
Semua ketentuan yang mengatur tentang kurikulum yang berlaku secara nasional yang telah ada pada saat berlakunya keputusan ini dinyatakan tidak berlaku.

Pasal 31

Ditetapkan : di Jakarta
pada tanggal : 25 Juli 1995

MENTERI PENDIDIKAN DAN KEBUDAYAAN,

ttd.

Prof. Dr.-Ing. Wardiman Djojonegoro
VISI, MISI, RENCANA STRATEGIS & TAKTIS DALAM PERGURUAN TINGGI

Oleh: Sukisno

1. Pendahuluan.

Pengelolaan suatu sistem lembaga / badan dengan penerapan manajemen kualitas memerlukan suatu pedoman kerja yang memberikan pengarahan atas hasil kerja atau tujuan aktivitas yang diharapkan, secara kuantitas maupun kualitas. Pengarahan ini akan memberikan orientasi yang seragam bagi setiap elemen atau sub sistem dalam lembaga tersebut sehingga terbentuk kesatuan kerja yang efektif clan kompak dalam usaha lembaga menuju hasil kerja yang di harapkan. Setiap elemen sub sistem, pimpinan clan anggotanya mengetahui dengan jelas arah pengembangan lembaga tempat kerjanya.

2. Pengertian VISI, MISI

Visi adalah suatu pernyataan tentang gambaran keadaan clan karakteristik yang ingin di capai oleh suatu lembaga pada jauh dimasa yang akan datang. Banyak interpresi yang dapat keluar dari pernyataan keadaan ideal yang ingin dicapai lembaga tersebut. Visi itu sendiri tidak dapat dituliskan secara lebih jelas menerangkan detail gambaran sistem yang ditujunya, oleh kemungkinan kemajuan Clan perubahan ilmu serta situasi yang sulit diprediksi selama masa yang panjang tersebut. Pernyataan Visi tersebut harus selalu berlaku pada semua kemungkinan perubahan yang mungkin terjadi sehingga suatu Visi hendaknya mempunyai sifat / fleksibel. Untuk itu ada beberapa persyaratan yang hendaknya dipenuhi oleh suatu pernyataan Visi:

- Berorientasi pada masa depan;
- Tidak dibuat berdasar kondisi atau tren saat ini;
- Mengekpresikan kreativitas;
- Berdasar pada prinsip nilai yang mengandung penghargaan bagi masyarakat;
- Memperhatikan sejarah, kultur, clan nilai organisasi meskipun ada perubahan terduga;
- Mempunyai standard yang tinggi, ideal serta harapan bagi anggota lembaga;
- Memberikan klarifikasi bagi manfaat lembaga serta tujuan-tujuannya;
- Memberikan semangat clan mendorong timbunnya dedikasi pada lembaga;
- Menggambarkan keunikan lembaga dalam kompetisi serta citranya;
- Bersifat ambisius serta menantang segenap anggota lembaga (Lewis & Smith 1994)

Misi adalah pernyataan tentang apa yang harus dikerjakan oleh lembaga dalam usahanya meng-ujud-kan Visi. Dalam operasionalnya orang berpedoman pada pernyataan misi yang merupakan hasil kompromi interpretasi Visi. Misi merupakan sesuatu yang nyata untuk dituju serta dapat pula memberikan petunjuk garis besar cara pencapaian Visi.
Gambar 1. Posisi sekarang yang dituju serta kemungkinan lintasan pelaksanaan rencana strategis

Pernyataan Misi memberikan keterangan yang jelas tentang apa yang ingin dituju serta kadang kala memberikan pula keterangan tentang bagaimana cara lembaga bekerja. Mengingat demikian pentingnya pernyataan misi maka selama pembentukannya perlu diperhatikan masukan-masukan dari anggota lembaga serta sumber-sumber lain yang dianggap penting. Untuk secara langsung pernyataan Misi belum dapat dipergunakan sebagai petunjuk bekerja. Interpretasi lebih mendetail diperlukan agar pernyataan Misi dapat diterjemahkan ke langkah-langkah kerja atau tahapan pencapaian tujuan sebagaimana tertulis dalam pernyataan Misi.

Untuk memberikan tekanan pada faktor komprehensif dari pernyataan misi maka pernyataan tersebut hendaknya mampu memberikan gambaran yang menjawab pertanyaan sbb (Lewis & Smith 1944):

- Keberadaan lembaga adalah untuk berbuat apa
- Apa produk atau jasa yang utama dari lembaga
- Apa yang bersifat unik dari lembaga
- Siapa konsumen utama dari lembaga
- Mengapa mereka merupakan konsumen utama
- Pihak lain mana yang berkepentingan dengan lembaga dan mengapa
- Apa "Core Values" / nilai dasar lembaga
- Apa yang berbeda pada lembaga 5 th yang lalu dan sekarang
- Mengapa berbeda
- Apa yang berbeda pada lembaga saat sekarang dan 5 th dari sekarang
- Mengapa hal itu akan menjadi beda
- Apa produk atau jenis jasa yang akan diberikan lembaga di masa depan
- Apa yang harus dikerjakan lembaga untuk menyiapkan produk baru tersebut
- Apakah jawaban pertanyaan-pertanyaan di atas merefleksikan Visi lembaga?
  Bila tidak, pertanyaan mana yang harus ada dan apa jawabannya
1. Vision Statement Example:

a. By 2025 my institution will have 500 thousand active students from nine continents of the world studying in a virtual campus about many cultures of the world as well as the latest sciences and technology. Graduates of my institution will bring and encourage peace to the world as a result of their involvement with my institution and will find the means to help those who are unfortunate enough not to have been a graduate of my institution in order to improve their living and intellectual conditions.

b. Quality Vision Statement of Eastern Iowa Community College District: Eastern Iowa Community College District is committed to meeting or exceeding Customer needs and expectations through Continuous Quality Improvement.

2. Mission Statements of

a. Otago Polytechnic:
To Equip its students with the capability for self development, thus empowering them to become useful, productive, efficient, responsive and proactive citizens who will make a positive contribution to the needs of the country in an environment of continuous social, economic and technological change.

b. Solikull College (U.K.) Approved in 1995:
The College is here to meet the present and future education and training needs of the whole community. It aims to be open, accessible and supportive and to seek excellence in all that it does.

c. Swinburne University of Technology (from its strategic plan 1996 - 2000):
Swinburne University of Technology's mission is to be a leading, intersectoral university offering high quality education, training, research and consultancy focussed on the needs of industry, business, government and the local, National and International communities.

3. Core Values of Swinburne University of technology

1. Quality, Integrity, equity and continuous improvement in all our activities.
2. A culture which encourages scholarship, critical enquiry, a plurality of views, creativity and initiative.
3. The pursuit of learning and the acquisition of knowledge and skills as life-long activities.
4. Research and development which provide innovative and practical solutions for the needs and expectations of our clients.
5. The provision of equitable and flexible educational opportunities and pathways from apprenticeships to doctorates in a supportive, responsive and friendly institution.
6. Developing highly employable graduates who are effective citizens with a sense of responsibility, respect for others and teamwork.
7. The development of the potential of our staff, the encouragement of teamwork, the provision of effective leadership, and the delivery of efficient and accountable management.
8. Participation in the International community of scholars.
9. Strong partnerships with industry, business and the community.
3. Rencana Strategis & Taktis

Rencana Strategis (Strategic Plan) adalah rencana langkah demi langkah yang setelah lengkap pada akhirnya akan membawa lembaga mencapai tujuan akhir sesuai dengan tujuan yang tersirat dalam pernyataan Visi dan misi suatu rencana strategis hendaknya bersifat fleksibel secara rasional guna dapat menampung kemungkinan adanya hal-hal yang tak terduga di lain pihak rencana strategis bersifat dinamis, dapat berubah setiap saat sesuai dengan kebutuhan saat itu tanpa mengubah tujuan akhir.

Kebutuhan utama dari pembentukan suatu rencana strategis akan mencakup hal-hal berikut:

- Suatu pernyataan dan diskusi tentang Visi dan Misi lembaga
- Penilaian skenario sekarang yang hendaknya mengandung faktor-faktor internal maupun eksternal
- Alasan perubahan kondisi sekarang dengan kondisi pada 5 atau 10 tahun yang akan datang, misalnya mengapa bertambah atau mengapa tetap
- Identifikasi serta penilaian oleh adanya gap antara saat sekarang dan saat akhir yang diinginkan
- Suatu (Beberapa) rencana disusun dengan objektif untuk menutup gap tersebut dalam suatu waktu tertentu
- Bermacam-macam rencana diikuti untuk memperoleh keterangan keluaran / kebutuhan finansial ataupun non finansial.

Untuk mencapai target-target sebagaimana dinyatakan dalam rencana strategis maka dibuat orang suatu rencana taktis (tactical plan) yang berupa pentahapan dan siasat dalam rangka pelaksanaan rencana strategis mengingat pentingnya faktor Rencana Strategis maka RenStra disusun dengan melibatkan unsur-unsur pimpinan lembaga (Senat, Rektor, Komisi RenStra, Dekan, Staf, dll) teknik atau siasat pelaksanaan guna mewujudkan rencana strategis secara efisien dan tepat. Rencana taktis ini yang selanjutnya dilaksanakan, dikelola, dinilai serta diperbaiki sehingga memberikan hasil akhir sesuai dengan rencana yang telah di sepakati bersama (lihat gambar 1).

Kelak, di tengah pematangan bahkan ditengah implementasinya, Rencana Taktis juga bersifat terbuka untuk mengalami perubahan. Perubahan Rencana Taktis diperlukan bagi penyesuaianannya dengan keadaan saat itu, trend saat itu atau keadaan lain agar Rencana Taktis mengikuti sifat Rencana Strategis yang hendaknya juga bersifat fleksibel secara terbatas dan dinamis sehingga selalu meningkat performasinya.

4. Pengaruh pernyataan Misi atas Organisasi lembaga clan cara kerjanya

Pandang bahwa lembaga tersebut adalah suatu perguruan tinggi. Sistem perguruan tinggi terbentuk dari sub-sistem seperti misalnya sub sistem fasilitas laboratorium, perpustakaan, bangunan kelas dan alat bantu, staf, unit riset, unit pengabdian masyarakat, dll. Kinerja perguruan tinggi tersebut ditentukan oleh hasil kerja bersama dari segenap sub sistemnya. Adanya kepincangan pada salah satu sub-sistem akan dapat mempengaruhi unjuk kerja perguruan tinggi tersebut secara keseluruhan. Sub-sistem tersebut dapat di pandang sebagai sebuah sistem kecil yang memberikan keluaran tertentu untuk suatu masukan tertentu.

Untuk suatu tugas atau fungsi tertentu dari perguruan tinggi, masing-masing subsistem harus menata diri atau ditata sedemikian sehingga membentuk suatu sistem dengan karakteristik tertentu sesuai dengan tugasnya sebagaimana tersirat dalam pernyataan misi perguruan tinggi.
Penataan dari sub-subsistem mencakup pengaturan intensitas kerja, kecepatan, kualitas dll, serta masukan yang sepadan yang diatur oleh organisasi yang dibentuk. Hal ini ekivalent dengan pengaturan cara kerja lembaga perguruan tinggi tersebut.

Gambar 2. Penataan organisasi dan cara kerja guna mengemban misi tertentu dari lembaga

Pernyataan misi sangat penting dalam menentukan bentuk organisasi lembaga dan cara erjanya guna menjamin tercapainya tujuan misi serta kerja yang efisien dari lembaga. Sebagai contoh dapat di berikan beberapa pernyataan misi :

1. Menghasilkan sejumlah lulusan dalam perioda tertentu
2. Menghasilkan lulusan sebanyak-banyaknya dalam perioda tertentu
3. Menghasilkan lulusan yang bermutu tinggi dengan jumlah & dalam perioda tertentu

Untuk ketiga macam misi tersebut, diperlukan penataan yang berbeda atas sub-subsistem dalam sistem perguruan tinggi serta dengan perioritas kerja, beban biaya dll yang berbeda pula.

Untuk misi 1 : Fasilitas kelas, laboratorium, kurikulum, staf dapat dianggap cukup memadai, tak ada persyaratan kualitas lulusan yang diminta ; dll.

Untuk misi 2 : Diperlukan penambahan jumlah staf, kelas, waktu kerja laboratorium, dll. Terdapat konsekuensi tambahan biaya investasi maupun operasi perguruan tinggi yang bersangkutan.

Untuk misi 3 : Diperlukan program peningkatan kualitas staf, peralatan, laboratorium, sarana kelas, kurikulum, dll. Mutu lulusan merupakan sesuatu yang dituntut oleh pernyataan Misi ini. Hal ini membawa konsekuensi biaya investasi, kerja pengelolaan, keahlian staff & peralatan serta penyusunan kurikulum baru.

Demikian dengan misi berbeda maka mode kerja clan organisasi kerja perlu dibedakan pula.

Perubahan mode kerja tidak hanya disebabkan oleh kebijakan pimpinan lembaga saja namun bisa pula oleh adanya faktor dari luar, misalnya adanya perubahan kebijakan pemerintah (Swa kelola lembaga perguruan tinggi, ada dana bantuan khusus dll), peningkatan tajam clan suatu teknologi yang berpengaruh besar dll. Dalam hal seperti ini perubahan harus dilakukan melalui prosedur yang sama sewaktu proses penyusunan awal.
STAF

PENGAJAR

Dokumentasi

Sylabus & rencana perkuliahan

Analisa

<table>
<thead>
<tr>
<th>Peremuan ke</th>
<th>Pertemuan 1: Absensi &amp; Materi kuliah</th>
<th>Pertemuan 2: Permulaan Kuliah</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Kehadiran Mahasiswa &gt;50%, 60%, 70%, 80%</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td></td>
<td>Persepsi Mahasiswa &gt; Materi sesuai silabus &gt; Jelas diterangkan &gt; Menarik &gt; Dosen siap kuliah</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
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<tr>
<td>7</td>
<td></td>
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<tr>
<td>8</td>
<td>Mid Test: Materi mid tes &gt; Soal yang jelas &gt; Waktu yang cukup &gt; Nilai</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Kehadiran Mahasiswa &gt; Materi sesuai jadwal &gt; Jelas diterangkan</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>13</td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td>Akhir kuliah: Materi kuliah sesuai jadwal &gt; Perspeksi mahasiswa &gt; Terhadap perkuliahan</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Ujian akhir: Materi ujian &gt; Soal yang jelas &gt; Nilai Ujian / kelulusan</td>
<td></td>
</tr>
</tbody>
</table>

Gambar 3. Monitoring Perkuliahan (contoh)
APAKAH :

- Ada responsi praktikum sebelumnya
- Responsi diberikan oleh pengajar yang bersangkutan
- Ada test awal sebelum praktikum
- Tiap anggota group praktikum aktif
- Ada tugas seselesai praktikum
- Asisten praktikum dosen yunior / mahasiswa senior / karyawan
- Waktu pelaksanaan praktikum cukup / kurang
- Peralatan praktikum bekerja baik / ada kekurangan

Monitoring Pelaksanaan Praktikum
(Contoh)

5. Kesimpulan

Pernyataan misi, mengingat pengaruh yang tinggi terhadap organisasi serta cara kerjanya, dibuat oleh suatu tim kemudian disetujui dan diresmikan setelah melalui tahapan-tahapan dirapatkan - menerima kritik dan masukan - diperbaiki - disetujui oleh staf lain, pengelola, konsumen, asosiasi alumni d.l.l.


Gambar 3. Merupakan contoh dari kegiatan mikro sistem pengelolaan dengan penerapan manajemen kualitas, berupa kegiatan pengawasan kegiatan rencana taktis untuk meningkatkan kualitas lulusan misalnya.

Pengawasan dapat didasarkan atas prosedur kegiatan, materi oengajaran, urutan materi, jumlah kuliah/ topik materi, literatur/ diktat/petunjuk praktikum d.l.l.

Kepustakaan :

PROGRAM OUTCOMES AND ASSESSMENT

Background

Assessment is an ongoing process aimed at understanding and improving student learning. It involves making our expectations explicit and public; setting appropriate criteria and high standards for learning quality; systematically gathering, analyzing and interpreting evidence to determine how well performance matches those expectations and standards; and using the resulting information to document, explain and improve performance. [Angelo, 1995].

Assessment of any learning activity requires a clear statement of goals and objectives. As we move from considerations of the national education level, to the university level, through the department level and finally to the level of individual courses, the goal statements and objectives become more specific, and in most instances more easily measured. Thus depending on what level we are addressing, objectives may be stated in general or specific terms. Usually we can identify a hierarchy of objective specificity from the less specific goals or outcome statements of an educational institution to the very specific objectives of a lecture or teaching session.

Hierarchy of Objective Specificity

- General objectives of program [less specific]
- Specific Objectives of a Course (Unit of Study)
- Instructional Objectives: Lesson-specific [more specific]

ABET 2000 Assessment Philosophy

ABET 2000 considers what students learn in the course of their program of studies, as opposed to what is presented to them in the curriculum.

Academic institutions are required to employ outcomes assessment techniques to determine the degree to which program goals and objectives are being attained.

There are two criteria in ABET2000 which are directly concerned with the assessment of outcomes at the program level.

Criterion 2 Program Educational Objectives
This criterion requires detailed published educational objectives, a process by which these objectives are determined and periodically evaluated, demonstrated achievement of objectives and continuous improvement of the teaching and learning program.

A program educational objective is a statement which describes one aspect of what the department or institution intends to achieve with its educational program.

Criterion 3 Program Outcomes and Assessment
This criterion gives a list of attributes of graduates from engineering programs and requires a documented process that demonstrates that the graduates from a program possess these attributes.
A program outcome is a statement which describes one element of what the department or institution intends the graduates to know, to think or to be able to do when they have completed the program of study.

The determination of the Programs Educational Objectives has already been considered in Stage 1 of the Curriculum Development Model - see notes from this morning's session. There it was pointed out that this could be done by considering the mission of the Department and the needs of the various program constituents (industry, society, profession). In practice following procedure might be used: each staff members can propose a list of appropriate goals taking those factors into account, and then a curriculum or assessment committee could consolidate the suggestions into a concise set of Program Objectives.

An engineering department must be able to demonstrate that its graduates possess the attributes listed under Program Outcomes. Evidence must be gathered and recorded for this purpose. Typical evidence would be the performance of students in their undergraduate studies, the professional accomplishments and careers of graduates, employment data, employer satisfaction and graduate satisfaction. Systematic documentation of the data and the assessment process would be essential and the results of the assessment are applied to improving the educational program.

Assessment Tools

The following is a list of the typical assessment tools (or outcome indicators) that can be used to evaluate an educational program at the curriculum level.

- Exit interviews with graduating students
- Survey of graduating students
- Alumni surveys
- Student employment status after graduation
- Employer surveys
- Professional entrance examinations
- Student portfolios - work samples, accomplishments
- Student records and transcripts - courses attempted, grades achieved
- Course evaluations using standard questionnaires
- Feedback from External Advisory Body (eg Industry Advisory Board)
- Records of accreditation reviews and reports
- External reviewers
- Benchmarking of the academic program

Thus it is seen that there is a diversity of assessment measures that may be applied to the set of program objectives. No single assessment device will be suitable for all the educational objectives expected of a modern engineering educational program. Furthermore, each objective should be assessed by two or three measuring devices. There is a need from a matrix of measures from which to choose those measures most suitable for our particular requirements.
Selecting the Criteria

For each assessment method we will need to select a set of criteria by which we can judge whether or not we have met the Program Outcome at a satisfactory level. For example, suppose we are considering the Program Outcome "Engineering graduates will have the ability to function on multi-disciplinary teams" [ABET2000 Criterion 3 d]. We wish to assess this outcome using the Alumni survey and the Employer survey. We could apply the following criteria:

Criterion 1
In Alumni surveys, at least 90% of respondents will "agree" or "strongly agree" that the S1 program provided adequate preparation in multi-disciplinary teamwork, computing and communication.

Criterion 2
In Employer surveys, at least 90% of respondents will "agree" or "strongly agree" that graduates have adequate depth of education, preparation for life-long learning and the ability to use their education.

The following table [adapted from Leonard and Scales, 1997] gives some example formats for criteria statements and possible values for the criteria. In setting values for the criteria, the program developers would need to arrive at a realistic value, a figure that is a challenge to both students and staff but not unreasonably high.

<table>
<thead>
<tr>
<th>Examples of Formats for Criteria Statements</th>
<th>Example Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>In an employment survey of recent graduates, X% will successfully find employment or continue on to graduate study within six months of graduation.</td>
<td>X = 90</td>
</tr>
<tr>
<td>X% of the graduates who are working will agree that the program provided adequate preparation for their current job.</td>
<td>X = 90</td>
</tr>
<tr>
<td>X% of the graduates are currently working in professional engineering practice</td>
<td>X = 70</td>
</tr>
<tr>
<td>In Employer surveys, X% of respondents will &quot;agree&quot; or &quot;strongly agree&quot; that graduates have adequate depth of education, preparation for life-long learning and the ability to use their education.</td>
<td>X = 90</td>
</tr>
<tr>
<td>Longitudinal student portfolios will demonstrate integration of design through the curriculum and an understanding of professional and ethical issues</td>
<td></td>
</tr>
<tr>
<td>The number of job offers per student will be greater than X</td>
<td>X = 2</td>
</tr>
<tr>
<td>X% of the program graduates are registered professional engineers within ten years of graduation.</td>
<td>X = 50</td>
</tr>
</tbody>
</table>
EXAMPLE

The following example has been adapted from the Self-Study Report for Chemical Engineering Georgia Institute of Technology.

Mission Statement

The Mission of the School of Chemical Engineering is to prepare students for the practice of their profession through generation and dissemination of knowledge related to chemical engineering, and through the advancement of the science and technology that form the basis of chemical engineering.

Educational Objectives

1. Educate and train students in the principles and methods essential to modern chemical engineering.
2. Broaden perspectives of students regarding social issues and responsibilities, ethics and professionalism.
3. Recognise graduate students for excellence and selection for top industrial, academic and government positions.
4. Contribute to a literature supportive of the needs of chemical engineering.
5. Facilitate growth of professionals through continuing education.

Program Outcomes

(a) Graduates will have an understanding of the impact of technology and specifically chemical technology on society.
(b) Graduates will have the ability to integrate fundamental concepts in physics, chemistry and engineering into the solution of chemical engineering problems.
(c) Graduates will have the ability to formulate and solve problems in chemical engineering practice.
(d) Graduates will have the ability to integrate fundamental and practical knowledge and creativity into the solutions of unique problems for which the solution procedure is not clearly documented. They will have the ability to design experiments to identify the solutions to such problems.
(e) Graduates will be able to design systems to carry out unit operations and to synthesise unit operations into a complete process design. They will have a working knowledge of state-of-the-art design software.
(f) Students will have an opportunity to enhance their understanding of their profession through required laboratory courses, co-op experiences and undergraduate research.
(g) Graduates will have had training and experience in team concepts, and oral and written communication.
## Strategies to Assure Program Outcomes

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design the curriculum to address the specific Program Outcomes occurrence X X X X X X X</td>
<td></td>
</tr>
<tr>
<td>Provide laboratory experience in selected topics</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Promote the London and Oxford study abroad program</td>
<td>X X X</td>
</tr>
<tr>
<td>Design the curriculum to accommodate co-op programs</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Provide opportunities for undergraduate research</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Establish minimum performance standards for students</td>
<td>X X X X</td>
</tr>
<tr>
<td>Supply access to software and hardware to enhance classroom instruction</td>
<td>X X X X</td>
</tr>
<tr>
<td>Implement direct faculty advising of undergraduate students</td>
<td>X X X X</td>
</tr>
<tr>
<td>Support AIChE Student Chapter program</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Support AIChE Tutoring program</td>
<td>X X X X</td>
</tr>
<tr>
<td>Seek curriculum input from External Advisory Board</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Offer seminars and other special events to strengthen the interface between the classroom environment and the world of professional practice</td>
<td>X X X X X X</td>
</tr>
</tbody>
</table>


## Assessment Methods

<table>
<thead>
<tr>
<th>Assessment Method</th>
<th>Program Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exit interview with randomly selected graduating students (annual)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Exit survey of all graduating students (annual)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Alumni survey (as needed)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Course evaluations using standard questionnaires (quarterly)</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Feedback from External Advisory Board (annual)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>National Rankings (annual)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Level of scholarship aid to students (annual)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>ABET accreditation reviews (every six years)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Graduate employment record (annual)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Graduate school enrolments of new graduates (annual)</td>
<td>X X X X X</td>
</tr>
<tr>
<td>Number of students participating in study abroad programs (annual)</td>
<td>X</td>
</tr>
<tr>
<td>Number of students participating in undergraduate research (annual)</td>
<td>X</td>
</tr>
<tr>
<td>External awards won by AIChE students chapter (annual)</td>
<td>X</td>
</tr>
<tr>
<td>Classroom/laboratory renovations and upgrades (annual)</td>
<td>X X X X X X X</td>
</tr>
<tr>
<td>Number of students participating in co-op (annual)</td>
<td>X</td>
</tr>
<tr>
<td>Number of publications and presentations co-authored by undergraduates (annual)</td>
<td>X</td>
</tr>
<tr>
<td>Benchmarking (as needed)</td>
<td>X X X X X X X</td>
</tr>
</tbody>
</table>

Examples of:

- Alumni Survey Form
- Employer Survey Form
FACTORS IN CURRICULUM DESIGN

Objective:
To investigate factors that impose constraints on the practical design of the curriculum and the courses within it.

Background:
Several major factors must be taken into consideration when it comes to structuring a curriculum. Forces outside the department control many of these factors. These factors include:

Accreditation requirements: Does the proposed curriculum include those academic areas, credits, and courses required by the institution or by external professional associations? ABET or National Curriculum requirements are to be considered. ABET, for example, requires a minimum time in the areas of Basic Sciences and Mathematics and on Engineering Topics. The National Curriculum specifies subject names and credit values (sks).

Credit restrictions: Can the proposed program fit within the number of credit hours required for the degree involved? How is "credit hours" specified for a course? Are there restrictions on minimum or maximum credit hours in a course or on sections of a program?

Fiscal and staff constraints: Is the proposed curriculum feasible? Can it be staffed? Do we have staff who have the knowledge and experience to teach the proposed courses. If new positions and new facilities are required, can the needed fiscal resources be found? For example, if class size is to be reduced to permit oral presentations or group projects, can the course be staffed?

Effectiveness of existing courses and programs: If some elements of an existing curriculum are to be used, are they effective and do they meet the needs for which they have been selected?

The National Curriculum for engineering should be discussed with respect to flexibility in the present system, what is specified, what can be determined by the individual department, how useful is it, what constraints or problems these cause for curriculum development in Indonesia. These points should be raised to stimulate discussion for the activity of this session.

Activity:
List factors to be considered in S1 curriculum design.

The activity requires the participants to produce a list of factors that affect the practical design of a curriculum. The class should work in groups in their respective disciplines for this activity and each group can produce a list of factors. The results should then be discussed with the entire class and a final list developed, for example, on the whiteboard.

Reference Material:
National Curriculum for Engineering
ABET 2000
NON-TECHNICAL TOPICS IN THE CURRICULUM

Objective:
To understand why non-technical topics are included in an engineering curriculum and to decide which topics should be included in a specific course

Background:
In the Professional Component - Criterion 4 of ABET 2000 "a general education component that complements the technical content of the curriculum" is required. Similarly, accreditation guidelines from other countries specify the inclusion of courses on management, economics, communication, humanities and social sciences. What role do these course play in an engineering program? How much time should be allocated to them? How do we prioritize them? How do we ensure that the content in such subjects "complements the technical content" of the engineering subjects? The purpose of this session is to raise these concerns with the participants and to get them to write and discuss a list of those non-technical topics that they consider should be included in their curriculum. The educational objectives developed in Session 10 and the analysis of "Professionalism" from Session 12 will be useful here.

The introduction of studies in management, the humanities and social sciences followed from an analysis of what society and industry expected from engineers and what was actually being taught in the educational institutions. In the developed countries, many studies and surveys have been done on the education of engineers during the past 40 years. Often it was reported that while engineering programs developed strong technical skills and problem-solving abilities, graduates were lacking in communication skills, had little understanding of the business or commercial environment and did not appreciate the societal or environmental impacts of engineering. To address these deficiencies, subjects outside the technical science and engineering domain of knowledge were introduced into undergraduate engineering courses. In North America, for example, subjects from the Humanities and Social Sciences - the Liberal Arts - were included in engineering curricula whereas in the United Kingdom courses such as The Engineer in Society, Management Economics, The Business and Social Environment, The History of Technology and similar were introduced. Courses on Communication, Technical Writing and English language were common features of engineering programs in both North America and UK. The IEAust Manual for the Accreditation of Professional Engineering Courses requires that 10% of the total course content be an "integrated exposure to professional engineering practice (including management and professional ethics" but makes no reference to Humanities or Social Sciences.

The teaching of non-technical subjects in an engineering program must be purposeful and seen to be so by the student. The topics selected, the way the subjects are incorporated into the curriculum design and the delivery of such subjects must be consistent with the educational objectives of the program.

Activity:
List non-technical topics to be considered in S1 curriculum design.

The activity requires the participants to produce a list of non-technical topics that could be included in the "general education component" of Criterion 4 of the ABET 2000 model. Participants should be able to justify their choice of topic or subject and could also consider how much time or credit value should be given to the subject in the overall curriculum. An attempt is to be made to prioritize the different topics.
Reference Material:
National Curriculum
Pengertian

QA untuk industrial needs adalah proses untuk menjamin agar identifikasi kebutuhan industri dalam pengembangan kurikulum sudah dilakukan dengan prosedur yang lengkap, jelas dan benar.

Prosedur

1. Susun penjelasan dari program studi dalam satu bentuk publikasi singkat /brosur, yang berisi kedudukan dari program studi, sejarah pembentukan dan pengembangan program studi, dan informasi lain yang dimaksudkan untuk memperkenalkan program studi ke masyarakat, dalam hal ini untuk dijelaskan kepada dunia industri

2. Tetapkan jenis industri yang akan dijadikan responden untuk mengetahui kebutuhan industri, serta tetapkan secara proporsional jumlah industri setiap jenis yang akan dijadikan sampel (yang akan diberikan kuesioner atau wawancara), misalnya :
   a. Industri mesin
   b. Industri logam
   c. Industri Produk elektrik
   d. Industri kertas, pulp dan barang dari kertas
   e. Industri energi dan penyediaan sumber daya
   f. Industri Jasa teknis
   g. Bank
   h. Industri karet, plastik dll.
   i. Industri makanan dan minuman
   j. Industri kimia
   k. Pendidikan dan penelitian
   l. Lainnya

   (disesuaikan dengan jenis program studi)

3. Identifikasi variabel yang akan dijadikan subyek informasi :
   a. Kesesuaian antara kemampuan sarjana yang dihasilkan program studi dengan tuntutan industri
   b. Tuntutan akan spesialisasi atau generalisasi dari sarjana yang dihasilkan
   c. Tuntutan keterampilan teknis
   d. Tuntutan pengetahuan (knowledge)
   e. Tuntutan kemampuan (know-how)
   f. Tuntutan kebijaksanaan (wisdom)
   g. Tuntutan sikap / perilaku
   h. Tuntutan kemampuan non-teknis
   i. Kebutuhan latihan tambahan setelah sarjana diterima sebagai karyawan
4. Susun daftar pertanyaan (lihat contoh)

5. Tetapkan metoda pengumpulan informasi (kuesioner, wawancara, seminar)

6. Lakukan pengumpulan informasi (paling jarang untuk setiap 5 tahun sekali)

7. Lakukan pengolahan informasi untuk mendapatkan:
   a. Tuntutan yang menjadi modus (paling banyak dituntut oleh industri)
   b. Tuntutan yang mempunyai prioritas tinggi untuk ditanggapi oleh perguruan tinggi dalam pengembangan kurikulum
   c. Tuntutan yang mempunyai prioritas tinggi, tetapi akan diberikan oleh industri sendiri
Contoh Kuesioner:

DAFTAR PERTANYAAN UNTUK MENGETAHUI INDUSTRIAL NEEDS

Program Studi : ____________________________

Pengantar

Untuk mengetahui kebutuhan dari industri yang menggunakan lulusan program studi kami, berikut kami ajukan sekumpulan pertanyaan untuk saudara jawab sebagaimana penilaian saudara pada lulusan kami. Atas jawaban yang saudara berikan, kami mengucapkan terima kasih.

1. Apakah perusahaan/ institusi saudara mempekerjakan sarjana lulusan program studi kami ?
   G Ya  G Tidak
   Bila saudara menjawab ya, silakan lanjutkan dengan pertanyaan berikut:

2. Secara umum, apakah lulusan kami memenuhi tuntutan / kebutuhan perusahaan?
   a. Pengetahuan (knowledge) : G ya  G tidak
   b. Kemampuan (Skill) : G ya  G tidak
   c. Sikap (Attitude) : G ya  G tidak
   d. Kebijaksanaan (Wisdom) : G ya  G tidak

3. Manakah yang lebih saudara tuntut sebagai kemampuan lulusan kami, dan apa yang menjadi pertimbangan atas jawaban saudara ?
   a. Sebagai seorang spesialis, karena tugas-tugas di perusahaan kami memerlukan kekhususan yang tinggi dalam setiap bidang
   b. Sebagai seorang generalis, karena disamping tugas-tugas yang khusus kami menuntut pula kemampuan lain yang bersifat umum
   c. Jawaban lain : .................................................................

4. Pengetahuan (knowledge) dan kemampuan aplikasi (know-how untuk memecahkan masalah) apakah yang saudara butuhkan dari lulusan kami ? Mohon saudara urutkan berdasarkan tingkat kepentingannya :
   a. ____________, urutan ______
   b. ____________, urutan ______
   c. ____________, urutan ______
   d. ____________, urutan ______
   e. ____________, urutan ______
   f. ____________, urutan ______
   g. ____________, urutan ______
   h. ____________, urutan ______
5. Keterampilan teknis apakah yang diharapkan dari lulusan kami? Dapatkah saudara susun dalam urutan prioritas?
   a. Komputer, urutan __________
   b. Automation, urutan __________
   c. Sistem mutu, urutan __________
   d. Maintenance, urutan __________
   e. __________, urutan __________
   f. __________, urutan __________
   g. __________, urutan __________

6. Keterampilan/kemampuan non teknis apakah yang diharapkan dari lulusan program studi kami? Harap saudara urutkan menurut tingkat kepentingan perusahaan saudara.
   a. Bahasa Inggris, urutan __________
   b. Kepemimpinan, urutan __________
   c. Ekonomi, urutan __________
   d. Teamwork, urutan __________
   e. Hubungan manusia, urutan __________
   f. Negosiasi, urutan __________
   g. Presentasi, urutan __________
   h. Business, urutan __________
   i. __________, urutan __________
   j. __________, urutan __________

7. Sikap yang bagaimanakah yang saudara harapkan dimiliki lulusan kami yang berkaitan dengan persepsi terhadap masalah, sikap diri sebagai sarjana, sebagai anggota organisasi perusahaan dan sebagai individu pada umumnya?
   a. __________
   b. __________
   c. __________
   d. __________
   e. __________
   f. __________
   g. __________

8. Kemampuan apakah yang akan saudara kembangkan sendiri dari sarjana lulusan kami setelah mereka bekerja, karena perguruan tinggi tidak dapat mengisi kebutuhan yang terlalu spesifik?
   a. __________, urutan __________
   b. __________, urutan __________
   c. __________, urutan __________
   d. __________, urutan __________
   e. __________, urutan __________
   f. __________, urutan __________
   g. __________, urutan __________
   h. __________, urutan __________
9. Apakah saudara menilai bahwa lulusan S-1 yang (akan) saudara pekerjakan membutuhkan pendidikan lanjutan (S-2)? Bila ya, mengapa dan dalam bidang apakah akan dikembangkan?

   G ya  G tidak

   Bila ya, akan dikembangkan untuk bidang pendidikan, ________________

Demikian jawaban kami,
Terima Kasih.
QA UNTUK PROFESSIONAL NEEDS

Pengertian

QA untuk professional needs adalah proses untuk menjamin agar identifikasi tuntutan dunia profesi dalam pengembangan kurikulum sudah dilakukan dengan prosedur yang lengkap, jelas dan benar.

Prosedur

1. Susun penjelasan dari program studi di perguruan tinggi ybs dalam satu bentuk publikasi singkat / brosur, yang berisi kedudukan dari program studi, sejarah pembentukan dan pengembangan program studi, kondisi aktual dan tuntutan masyarakat terhadap program studi serta informasi lain

2. Tetapkan kalangan profesional yang akan dijadikan responden untuk mengetahui tuntutan dunia profesi (yang akan diberikan kuesioner atau wawancara atau akan diundang untuk acara pertemuan informal, seminar atau diskusi khusus), misalnya :
   a. Asosiasi profesi
   b. Ikatan alumni
   c. Kadin
   d. Ikatan konsultan dalam program studi ybs
   e. Kelompok eksekutif dari industri
   f. Birokrat, dll

3. Identifikasi variabel yang akan dijadikan subyek informasi :
   a. Norma yang harus dianut dalam menjalankan profesi keteknikan
   b. Keyakinan-keyakinan yang perlu ditanamkan
   c. Tata nilai yang harus dimiliki
   d. Sikap yang perlu dibentuk
   e. Perilaku yang harus diwujudkan
   f. Etika yang dibangun
   g. Tuntutan akan kemampuan-kemampuan sosial
   h. Tuntutan akan pekerjaan multi disiplin / teamwork

4. Susun bentuk pertanyaan yang akan dibahas (lihat contoh daftar materi diskusi)

5. Tetapkan metoda pengumpulan informasi (seminar, loka karya, diskusi, temu alumni)

6. Laksanakan pengumpulan informasi (paling jarang untuk setiap 5 tahun sekali)
7. Lakukan pengolahan informasi untuk mendapatkan:

   a. Tuntutan yang menjadi modus (paling banyak dituntut oleh kalangan profesi)
   b. Tuntutan yang mempunyai prioritas tinggi untuk ditanggapi oleh perguruan tinggi dalam pengembangan kurikulum
Contoh :

DAFTAR MATERI DISKUSI
UNTUK MENGETAHUI PROFESSIONAL NEEDS

Program Studi : __________________________

Pengantar

Untuk mengetahui tuntutan dari kalangan profesi, berikut adalah sekumpulan pertanyaan untuk didiskusikan dalam lokakarya, diskusi, temu alumni, seminar

1. Apakah sarjana lulusan program studi telah mempunyai sikap yang secara umum memenuhi persyaratan ?
2. Secara umum, sikap manakah yang paling mengecewakan ? Bila banyak, bagaimana urutannya ?
4. Manakah yang lebih lebih dituntut sebagai sikap dominan dari lulusan, dan apa yang menjadi pertimbangan atas jawaban yang muncul ?
   G Sebagai seorang spesialis, karena tugas-tugas umumnya harus mencirikan spesialisasi keahlian
   G Sebagai seorang generalis, karena tuntutan pekerjaan saat ini sudah semakin multi disiplin
   G Jawaban lain : __________________________
5. Norma apakah yang harus dianut oleh lulusan dalam menjalankan pekerjaannya, yaitu dalam melaksanakan profesi keteknikannya ?
6. Keyakinan-keyakinan apa yang perlu ditanamkan di kelas agar nanti pada waktu bekerja dapat membentuk sikap yang positif ?
7. Tata nilai apa yang perlu dimiliki untuk menjalankan pekerjaan secara etikal ?
8. Sikap apa yang perlu dibentuk di perguruan tinggi dan bagaimana mengintegrasikan kemampuan ini dengan kemampuan teknis ?
9. Kemampuan sosial apakah yang diperlukan oleh lulusan dalam menjalankan keprofesianya yang dapat menunjang pekerjaan dan karirnya ?
10. Apakah ada kemampuan khusus yang lain dikaitkan dengan aspek globalisasi, perubahan lingkungan yang cepat dan dunia profesi yang semakin menuntut profesionalisme ?
Pengertian

QA untuk societal needs adalah proses untuk menjamin agar identifikasi tuntutan masyarakat umum dalam pengembangan kurikulum sudah dilakukan dengan prosedur yang lengkap, jelas dan benar.

Prosedur

1. Susun penjelasan dari program studi di perguruan tinggi ybs dalam satu bentuk publikasi singkat / brosur, yang berisi kedudukan dari program studi, sejarah pembentukan dan pengembangan program studi, kondisi aktual dan tuntutan masyarakat terhadap program studi serta informasi lain

2. Tetapkan perwakilan masyarakat umum yang akan dijadikan responden untuk mengetahui tuntutan societal (yang akan diundang untuk acara pertemuan informal, seminar atau diskusi khusus), misalnya:
   a. Pemerintah pusat/daerah
   b. Lingkungan pemerintahan setempat di lokasi perguruan tinggi
   c. Lingkungan keagamaan, budaya setempat
   d. LSM
   e. Perwakilan masyarakat umum
   f. Ikatan Orang tua mahasiswa

3. Identifikasikan variabel yang akan dijadikan subyek informasi :
   a. Sikap dan perilaku umum lulusan program studi
   b. Kepedulian sosial
   c. Perilaku sosial yang dituntut
   d. Integritas dengan masyarakat umum
   e. Semangat kerjasama
   f. Toleransi
   g. Partisipasi sosial
   h. Kepemimpinan masyarakat
   i. Keteladanan dalam masyarakat
   j. Transferability kemampuan, manfaat

4. Susun bentuk pertanyaan yang akan dibahas (lihat contoh daftar materi diskusi)

5. Tetapkan metoda pengumpulan informasi (seminar, loka karya, diskusi, pertemuan)

6. Lakukan pengumpulan informasi (paling jarang untuk setiap 5 tahun sekali)

7. Lakukan pengolahan informasi untuk mendapatkan informasi tuntutan masyarakat
Contoh :

DAFTAR MATERI DISKUSI
UNTUK MENGETAHUI PROFESSIONAL NEEDS

Program Studi : ____________________________

Pengantar

Untuk mengetahui tuntutan dari masyarakat umum, berikut adalah sekumpulan pertanyaan untuk didiskusikan dalam lokakarya, diskusi, pertemuan.

1. Apakah sarjana lulusan program studi telah mempunyai sikap yang secara umum sejalan dengan harapan masyarakat?
2. Secara umum, sikap manakah yang paling mengecewakan? Bila banyak, bagaimana urutannya?
4. Manakah yang lebih diutamakan dari lulusan program studi dalam masyarakat, diurutkan sesuai dengan harapan paling diinginkan?
   a. Sebagai pemimpin masyarakat,
   b. Sebagai contoh keteladanan,
   c. Sebagai anggota masyarakat biasa yang partisipatif,
   d. Sebagai ahli yang dapat dimanfaatkan,
   e. Sebagai __________________________, 
   f. Sebagai __________________________,

5. Sikap dan perilaku umum yang bagaimanakah yang ditutut dari program studi oleh masyarakat pada umumnya?
6. Bentuk kepedulian sosial yang bagaimanakah yang diharapkan dari lulusan program studi?
7. Jelaskanlah sifat-sifat yang ditutut dari lulusan berkaitan dengan hal-hal berikut:
   a. Integritas dengan masyarakat umum
   b. Semangat kerjasama
   c. Toleransi
   d. Partisipasi sosial
   e. Kepemimpinan masyarakat
   f. Keteladanan dalam masyarakat
   g. Transferability kemampuan, manfaat

(Perlu dilengkapi dengan contoh-contoh yang dapat digali dari masyarakat)
CURRICULUM DEVELOPMENT OF AN S1 PROGRAM

**Objective:**
To develop skills in curriculum analysis and design.

**Background:**
These five sessions will be used for curriculum development practice based on the framework set up over the previous sessions. Session 4.7 will start with a review of ABET Criteria, the non-technical topics to be included in the curriculum and other relevant factors. The final curriculum framework should be developed with the participants. This will then be followed by the major activity for the rest of session 4.7 and the following 4 sessions. By Session 5.3 participants should have developed a curriculum for their discipline and each group should be able to present their curriculum to all participants and address any comments that may arise.

**Activity:**
*Develop S1 Curriculum from the Framework*

When carrying out the activity the session leader will need to discuss the progress of the different groups from time to time. Problems will arise in developing the curriculum and participants should be encouraged to voice their concerns and openly discuss such problems. Is the problem specific to one group or is it relevant to all? Devise alternative solutions but encourage each group to solve the problem in its own way.

**Reference Material:**
ABET documents:
ENGINEERING CRITERIA 2000
PROGRAM CRITERIA

PROGRAM CRITERIA FOR ARCHITECTURAL
AND SIMILARLY NAMED ENGINEERING PROGRAMS
Submitted by the American Society of Civil Engineering
(Lead Society in cooperation with The American Society of Heating, Refrigerating,
and Air-Conditioning Engineers, Inc.)

These program criteria apply to engineering program including “architectural” and similar modifier in their titles.

1. Curriculum

The program must demonstrate that graduate have: proficiency in mathematics through
differential equations, probability and statistics, calculus-based physics, and general chemistry;
proficiency in statics, strength of materials, thermodynamics, fluid mechanics, electric circuits,
and engineering economics; proficiency in a minimum of two (2) of three (3) basic curriculum
areas of structures, building mechanical, and electrical system, and construction/construction
management; engineering design capabilities in at least two (2) of the three (3) basic
curriculum areas of architectural engineering, and that design has been integrated across the
breadth of program; an understanding of architectural design and history leading to
architectural design that will permit communication, and interaction, with the other design
professionals in the execution of building projects.

2. Faculty

Program faculty must have responsibility and sufficient authority to define, revise, implement,
and achieve program objectives.

The program must demonstrate that faculty teaching courses that are primarily engineering
design in content are qualified to teach the subject matter by virtue of professional licensure,
or by education and design experience. It must also demonstrate that the majority of faculty
teaching architectural design courses are qualified to teach subject matter by virtue of
professional licensure, or by education and design experience.
PROGRAM CRITERIA FOR CHEMICAL AND SIMILARLY NAMED PROGRAMS
Submitted by the American Institute of Chemical Engineers

These program criteria apply to engineering programs including "chemical" and similar modifiers in their titles.

1. Curriculum

The program must demonstrate that graduates have: thorough grounding in chemistry and a working knowledge of advanced chemistry such as organic, inorganic, physical, analytical, materials chemistry, or biochemistry, selected as appropriate to the goals of the program; working knowledge, including safety and environmental aspects, of material and energy balances applied to chemical processes; thermodynamics of physical and chemical equilibria; heat, mass, and momentum transfer; chemical reaction engineering; continuous and stage-wise separation operations; process dynamics and control; process design; and appropriate modern experimental and computing techniques.

PROGRAM CRITERIA FOR CIVIL AND SIMILARLY NAMED ENGINEERING PROGRAMS
Submitted by the American Society of Civil Engineers

These program criteria apply to engineering programs including "civil" and similar modifiers in their titles.

1. Curriculum

The program must demonstrate that graduates have: proficiency in mathematics through differential equations; probability and statistics; calculus-based physics; and general chemistry; proficiency in a minimum of four (4) recognized major civil engineering areas; the ability to conduct laboratory experiments and to critically analyze and interpret data in more than one of the recognized major civil engineering areas; the ability to perform civil engineering design by means of design experiences integrated throughout the professional component of the curriculum; an understanding of professional practice issues such as: procurement of work; bidding versus quality based selection processes; how the design professionals and the construction professions interact to construct a project; the importance of professional licensure and continuing education; and/or other professional practice issues.

2. Faculty

The program must demonstrate that faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The program must demonstrate that it is must not be critically dependent on one individual.
PROGRAM CRITERIA FOR ELECTRICAL, COMPUTER, AND SIMILARLY NAMED ENGINEERING PROGRAMS
Submitted by The Institute of Electrical and Electronics Engineers, Inc.

These program criteria apply to engineering programs which include electrical, electronic, computer, or similar modifiers in their titles.

1. Curriculum

The structure of the curriculum must provide both breath and depth across the range of engineering topics implied by the title of the program. The program must demonstrate that graduates have: knowledge of probability and statistics, including applications appropriate to the program name and objectives; knowledge of mathematics through differential and integral calculus, basic sciences, and engineering sciences necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components, as appropriate to program objectives.

PROGRAM CRITERIA FOR INDUSTRIAL AND SIMILARLY NAMED ENGINEERING PROGRAMS
Submitted by the Institute of Industrial Engineers, Inc. (TC "Industrial Engineering" \13)

These program criteria apply to engineering programs using industrial or similar modifiers in their titles.

1. Curriculum

The program must demonstrate that graduates have the ability to design, develop, implement and improve integrated systems that include people, materials, information, equipment and energy.

The program must include in-depth instruction to accomplish the integration of systems using appropriate analytical, computational and experimental practices.

2. Faculty

Evidence must be provided that the program faculty understand professional practice and maintain currency in their respective professional areas. Program faculty must have responsibility and sufficient authority to define, revise, implement, and achieve program objectives.
PROGRAM CRITERIA FOR MECHANICAL AND SIMILARLY NAMED ENGINEERING PROGRAMS
Submitted by The American Society of Mechanical Engineers

These program criteria will apply to all engineering programs including using "mechanical" or similar modifiers in their titles.

1. Curriculum

The program must demonstrate that graduates have: knowledge of chemistry and calculus-based physics with depth in at least one; the ability to apply advanced mathematics through multivariate calculus and differential equations; familiarity with statistics and linear algebra; the ability to work professionally in both thermal and mechanical systems areas including the design and realization of such systems.

2. Faculty

The program must demonstrate that faculty responsible for the upper-level professional program are maintaining currency in their specialty area.