ENGINEERS AUSTRALIA

ACCREDITATION BOARD

ACCREDITATION MANAGEMENT SYSTEM

EDUCATION PROGRAMS AT THE LEVEL OF

ENGINEERING TECHNOLOGIST

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Title Accreditation Criteria Guidelines

ENGINEERS
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1. INTRODUCTION

Engineers Australia, as the National competency authority responsible for the accreditation of engineering education programs in Australia, provides a range of documents within its Accreditation Management System. These documents provide a resource for both engineering educators and those responsible for the accreditation function. An index of the documents comprising the Accreditation Management System is provided in Reference 7,

'Engineers Australia – Accreditation Management System – List of Documents'.

This guideline document has been prepared as a supplement to Reference 1 which summarises the key criteria for accreditation. The accreditation criteria provide the basis for evaluation of engineering education programs and also provide, for engineering educators, a resource for the review and development of the teaching and learning environment, for the educational design and review tasks and for the processes of continuous quality improvement.

In this guideline document each criterion is developed more fully to clearly establish the key requirements for compliance and performance expectations.

The accreditation criteria are catalogued under the following section headings and the subsequent discussion is in accordance with this structure:

- Operating Environment
- The Academic Program
- Quality Systems

2. INTERPRETATION OF REQUIREMENTS

In this development of the criteria an attempt has been made to distinguish absolute requirements for accreditation from expected characteristics and performance levels and advice. Again the emphasis is on encouraging innovation and diversity in the educational design, delivery and quality processes. Statements variously employ the words **must** and **should**. Statements containing **must** denote absolute requirements for the program to be accredited. Statements containing **should** are not individually binding but for accreditation to be granted, it is expected that the program will meet a high proportion of them.

3. GUIDELINES TO THE CRITERIA

3.1. The Operating Environment

3.1.1. Identifiable Organisational Structure and Demonstrated Commitment to Engineering Education

There must be an identifiable organisational entity responsible for engineering education within the educational institution awarding the degree. Most commonly this will take the form of a division, faculty or school - a substantial organisational entity providing a key focus on and responsibility for engineering education and scholarship. In documents comprising the Accreditation Management System, the organisational entity responsible for engineering education is referred to as the ***engineering school***. Other forms of organisation may be acceptable but it is unlikely, for example, that an engineering program would be accredited if it were taught and managed in isolation by a handful of staff, primarily qualified and practising in a non-engineering discipline.

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It would normally be expected that the engineering school would have leadership responsibility – subject to the approval processes of the host educational organisation – for the educational design, delivery, support and management of the engineering programs, for the management of associated resources, and for the appointment and professional activity of staff. If this is not the case, the educational institution will need to demonstrate how sufficient engineering expertise is brought to bear on decisions in these areas.

The delegated accountability within the engineering school for the management and delivery of each engineering education program should be clearly specified.

There must be evidence that the host educational institution regards engineering education as a significant and long-term component of its activity, and has adequate arrangements for planning, development, delivery, and continuous quality improvement of engineering programs, and for supporting the associated professional activities of staff. This would most commonly be evident from an institution's mission statement and strategic plans, from the approved mission statement and strategic plans of the engineering school, perhaps from corporate responses to engineering school planning submissions or initiatives, and from the outcomes of formal reviews and performance evaluations.

The host organisation must have in place adequate policies and mechanisms for funding its engineering school and facilitating the generation of funds from external sources. Similarly there must be established policy and appropriate practices for attracting, appointing, retaining and rewarding well-qualified staff and providing for their ongoing professional development, and for providing and updating infrastructure and support services. The host institution must ensure that creative leadership is available to the engineering school through the appointment of highly-qualified and experienced senior staff in sufficient numbers.

There must be in place formal structures for the ongoing review and improvement of programs and for formal approval of new program proposals and program amendments.

3.1.2. Academic and Support Staff Profile

The teaching staff must be sufficient in number and capability to assure the quality of the engineering program and the attainment of its stated outcomes. As a guide, a viable engineering school would be expected to have a minimum of eight full-time-equivalent academic staff employed on a continuing basis, with reasonable gender balance, and would be expected to have not less than three full-time-equivalent staff with specialist engineering knowledge and experience in any field in which a designated degree or major is offered. Where a program has little or no overlap with other programs offered, more than three specialist staff members are likely to be necessary.

In no case should a major program be dependent on a single individual.

There should be an acceptable balance of staff appointments across the A - E Academic levels in order to provide appropriate academic leadership and at the same time providing the experience profile, the teaching expertise and student support appropriate to the program.

It is considered important that the staff should come from a diversity of backgrounds, embodying a mix of academic experience and engineering-practice experience in non-academic environments, preferably international as well as Australian. The school's research and/or professional activities should include vigorous interaction with industry and also community interaction.

In gauging the capabilities of staff, the Board will look at qualifications (both in engineering and in education), research and engineering practice activities, teaching experience, and contributions to the advancement of engineering knowledge, practice and education. Involvement in professional societies; chartered status and/or registration on the National Professional Engineers Register and effective participation in on-going professional development are also relevant indicators.

Staff development programs should aim at developing capabilities in educational design, the use of new delivery methodologies and in the development of learning quality management systems as well as professional standing within the specific engineering discipline.

As well as the full-time academic staff team, engineering schools are strongly encouraged to tap the expertise of practising professionals in engineering and related fields for guest lecturing or sessional delivery. There must also be sufficient qualified and experienced members of technical and administrative staff to provide adequate support to the educational program. There must be adequate arrangements for the supervision and guidance of both regular and sessional staff.

The Board will look for evidence that staff numbers and teaching loads are such as to permit adequate interaction with students and support for the range of learning experiences offered, with adequate opportunity available to staff for professional engagement outside of teaching. Arrangements for workload management, capacity and succession planning should support these objectives.

The engineering school and/or the educational institution must have sufficient staff and facilities to provide adequate levels of student counselling, support services, and interaction with relevant constituencies such as employers and graduates.

It is recognised that programs will increasingly be staffed and delivered in a variety of modes. Students will be supported to undertake learning activities at locations other than the 'host' campus through workplace and cooperative learning programs, distance delivery and through offshore arrangements. Educational institutions will form partnerships with both traditional and non-traditional providers to facilitate the delivery of engineering education. The educational institution/s awarding the degree will be considered responsible for assuring the capabilities of all staff involved, and the Board will require evidence of how this is achieved.

Academic staff must be aware of the need to address gender, cross-cultural, inclusiveness and equity issues. Staff development programs should reflect this need.

3.1.3. Academic Leadership and Educational Culture

The Board will look for evidence of a dynamic, innovative and outward-looking intellectual climate in the engineering school. In particular there should be an awareness amongst teaching staff of current educational thinking and development. There should be a pro-active attitude to the adoption of best practice.

There should be significant, ongoing involvement of teaching staff in the processes of setting educational outcome targets, detailed educational design, review and continuous quality improvement. A holistic approach requires for a particular program the full involvement of all teaching staff as a team and this should be evident to students. For each program there should be a clearly identified leader of the teaching team. Terms of reference, accountabilities and reporting obligations for the teaching team and program leader should be clearly defined and understood by all stakeholders.

The teaching team would be expected to meet regularly to consider input and feedback from the full range of constituencies, and use this in the on-going improvement of detailed learning strategies, structure, curriculum content and delivery. The teaching team should monitor, using declared performance criteria, the attainment of the targeted educational outcomes for the program as a whole as well as the delivery of the learning outcomes within individual academic units.

Staff should actively role-model the competencies defined in the appropriate National Generic Competency Standard and should be continually aware of their responsibility to do so.

Staff appointment, staff development, management and codes of practice in the school and the institution should address cultural, gender and equity issues and reflect an inclusive operating environment.

Through policy and operating practices there should be clear acknowledgment of the need to interlink research, industry and community interaction with teaching to enrich the experiences of students and facilitate the on-going professional development of staff.

3.1.4. Facilities and Physical Resources

For both on-campus and external students alike there must be adequate classrooms, learning-support facilities, study areas, library and information resources, computing and information-technology systems, and general infrastructure to fully support the achievement of the targeted learning outcomes for each specific program.

For all programs and associated implementation pathways, there must be adequate facilities for student-staff interaction. For distance, remote campus or offshore implementations there must be communication facilities sufficient to provide students with learning experiences and support equivalent to on-campus attendance.

Appropriate experimental facilities must be available for students to gain substantial experience in understanding and operating engineering equipment, of designing and conducting experiments and undertaking engineering project work. The equipment must be reasonably representative of modern engineering practice and facilitate sound learning design. Facilities need to support structured laboratory activities, experiments of an investigatory nature and more open ended project based learning. Access to modern analysis, synthesis, visualisation, simulation, planning, organisational and measuring tools in the engineering, sciences, business, communication and management domains is expected.

Where practical work is undertaken remote from the host campus, such as at another educational institution or in an industry environment, the arrangements must be such as to provide appropriate facilities, supervision and equipment access and an assured equivalence of learning outcomes.

Facilities and equipment access must be supportive of the development of the full range of educational outcomes defined for a specific program and allow students to explore beyond the formal dictates of the particular discipline of study where appropriate.

3.1.5. Funding

The funds provided through the host organisation, from all sources including government grant funds, fee income, and direct income earned through research and entrepreneurial activity, must be sufficient to adequately support the current engineering education programs and satisfy the resource aspects of the accreditation criteria. The strategic planning cycle and funding distribution models must ensure predicable levels of support and the on-going viability of the engineering programs/s.

3.1.6. Strategic Management of Student Profile

Resources provided to the engineering school are frequently dependent on student numbers. A criterion for viability is therefore a continuing level of demand for admission from adequately-qualified candidates in sufficient numbers to maintain the program. On-going viability should be monitored through rigorous demand analysis. Strategic decisions on program offerings should be taken systematically and on an appropriate time scale.

The admission system must adequately publicise the qualifications required for entry and ensure that only qualified candidates are admitted. Where advanced standing is offered, there must be clearly defined and rigorous processes for the analysis, assessment and verification of prior learning. The engineering school should be able to demonstrate a reasonable relationship between admission standards and student retention and graduation rates.

Determination of Honours must be based on a sound performance analysis rationale and reflect a standard of excellence commensurate with the performance criteria embedded within the educational outcomes specification and external benchmarks.

3.2. The Academic Program

3.2.1. Specification of Educational Outcomes

To ensure that a systematic approach is taken for the balanced development of graduates, each program submitted for accreditation must be supported by a published specification of educational outcomes tailored to the particular field(s) of practice and associated area(s) of specialisation. The educational outcomes specification should justify the inclusion or omission of any specialist title. External stakeholder input is critical to the development, review and attainment monitoring of these outcomes.

The Engineers Australia National Generic Competency Standards – Stage 1 Competency Standard for Engineering Technologist (Reference 4) provides a detailed generic description of the expected knowledge, capabilities and attributes expected of the graduate engineering technologist. The Competency Standard builds on and assures delivery of the original and brief generic attributes statement specified in the Accreditation Policy.

The Competency Standard develops detailed elements of competency and indication of performance under the headings of Knowledge Base, Engineering Ability and Professional Attributes. It provides an ideal, generic template or model for building a detailed educational outcome specification, customised for a particular education program in a nominated field of engineering practice.

The educational outcomes specification should include a statement of broad educational objectives as well as targeted graduate capabilities for the program in the specified field. The rationale for the specification of outcomes should be founded on the needs of industry and the community, trends in engineering practice and comparisons with programs of similar nature available nationally or internationally.

The statement of educational objectives should relate to the mission of the host institution and reflect the specialist technical focus, the anticipated career destinations of graduates, and the needs of appropriate external constituencies.

The educational objectives statement would also be expected to reflect the desired characteristics and/or capabilities and/or achievements of mature graduates within the first few years of their career following graduation.

The targeted capabilities for emerging graduates should be consistent with the Stage 1 – Competency Standard. Technical skills and knowledge and engineering application skills appropriate to the designated field of practice and/or specialisations should be clearly specified, supplementing the generic capabilities and attributes that are relevant to all fields of practice.

Targeted graduate capabilities should demonstrate a balanced and integrated development of enabling skills and knowledge, technical competence and engineering application skills, as well as personal and professional capabilities. Appropriate breadth and depth of competence must be clearly demonstrated in the technical domains comprising the field of practice and through high level knowledge and skills in nominated specialist areas.

Each graduate capability target should ideally include measurable performance indicators to provide a basis for monitoring the level of attainment. The multi-dimensional performance metric in each case is likely to involve quantitative and qualitative measures with inputs from a range of sources. Such measures would draw considerably on formal assessment processes from within academic units as well as from the feedback and direct input of various constituencies.

The specification of educational outcomes should provide a platform for subsequent educational design and review tasks and provide a key reference for tracking the aggregation of learning outcomes and assessment measures from individual academic units comprising the program.

3.2.2. Titles of Program and Award

To be eligible for accreditation, a program must include the word *engineering and/or technology* in its title and, unless the circumstances are exceptional, must lead to a degree which includes *engineering and/or technology* in its title.

An engineering technologist program must aim to deliver graduates with capabilities appropriate to a designated field of engineering practice. This will most commonly be reflected in the title of the program and/or degree, or cited as a major field of study in the academic transcript. It is not essential however for any nominated specialisation (whether it be advanced technical knowledge and capability in a particular area of technology application or knowledge and skills development in the management of technical operations) to appear in the title. The key requirement is that the program engages students with a coherent area of engineering application, providing an appreciation of current technical issues and developing competence in handling advanced technical/operations management problems.

Where a title denotes specialisation in a particular field of practice, the program must impart high level technical/operations management skills and knowledge in that specialisation. A program that omits coverage of substantial topics in the field implied by the title, in which a practitioner in that field could reasonably be expected to have competence, should not be accredited.

New program titles may be expected to arise in response to evolving industry practice (for example, as set out in the listings of engineering disciplines published from time to time by Engineers Australia and elsewhere). Programs may draw on several existing fields of specialisation, and may incorporate new knowledge or the application of knowledge in new practice environments. The Board does not wish to be prescriptive about titles, nor does it wish to encourage a proliferation of specialist titles that may have transitory lifetimes. It reserves the right to query a title or field of practice which it regards as inappropriate, or to decline to accredit.

Some of the fields of practice and specialisations already recognised in the titles of accredited engineering technology programs are listed in Reference 3.

3.2.3. Program Structure and Implementation Framework

The normal requirement of an accredited engineering technology program in Australia is three years of full-time-equivalent study, based on entry from a satisfactory level of achievement at Higher School Certificate level (twelve years of primary and secondary schooling) or equivalent. Programs offered via alternative implementation pathways (elective units and study sequences, workplace learning options, defined articulation routes, part-time attendance, distance mode, offshore and remote campus) must be demonstrably equivalent in terms of content, in the delivery of graduate outcomes as well as in the learning expectations of students.

The conventional academic year involves two semesters of formal study and examination, offering apparent scope for accelerated-progression utilising the remainder of the calendar year. In considering any program that offers completion in significantly less than three years, the Board will wish to be assured that it provides adequate opportunity for personal and professional skills development and the full equivalence of delivered outcomes.

Program durations exceeding the normal three years of full time study may be appropriate in some circumstances. Assessment will always be based on the assumed delivery of an appropriate standard of graduate outcomes, commensurate with the generic frame work of the Stage 1 Competency Standard and appropriate to the designated field of practice.

The curriculum must comprise an integrated set of tasks and structured learning experiences that lead to the delivery of the specified educational outcomes, and by implication, satisfactory attainment of the generic attributes. The necessary opportunities and support mechanisms must be provided.

The program structure must be appropriate to the development of in depth technical competence in the designated field of practice and in nominated specialist areas.

In accordance with the Accreditation Policy, a three-year engineering technologist program would be expected to include the following elements, the percentages denoting indicative proportions of the total learning experience measured in terms of student effort:

- mathematics, science, engineering principles, skills and tools appropriate to the discipline of study (not less than 40%),
- engineering design and projects (approximately 20%),
- an engineering discipline specialisation (approximately 20%),
- integrated exposure to engineering practice, including management and professional ethics (approximately 10%),
- more of any of the above elements, or other elective studies (approximately 10%).

These proportions are not mutually exclusive. Some relate principally to content, and others relate more to learning processes. A particular learning activity may consist of several of these component elements. Likewise a particular learning activity may concurrently contribute to various educational outcomes ranging through personal/professional, problem solving/design, enabling and specialist technical categories.

Substantial departure from these elemental proportions must be justified as consistent with the targeted educational outcomes for the program and thus the attainment of the Stage 1 competencies.

The structure should be sufficiently flexible to provide for any variance in the background and prior learning of students as well as for the differences in individual learning ability. The program structure must accommodate the curriculum requirements specified in section 3.2.4 below and should facilitate an integrated approach to:

- developing enabling skills and knowledge,
- developing in depth knowledge and understanding of a nominated field of technology and its applications,
- providing practical and laboratory learning, problem solving design and project based learning,
- developing personal and professional capabilities,
- exposing students to engineering practice.

The structure should also promote a graded transition of learning experiences from a structured beginning to a more independent learning approach as the program progresses.

A holistic approach to educational design will ensure that the individual learning outcomes and performance measures within each academic unit aggregate systematically to deliverer the educational outcomes targeted for the overall program.

3.2.3.1. Combined / Dual / Double Degrees

An emerging number of programs take the form of combined or dual or double degrees, combining an engineering outcome within a nominated specialist field with a second outcome in either another discipline altogether or in a second specialist field of engineering. In most instances, two individual degree testamurs are awarded, but sometimes a combined outcome is specified on a single testamur. Typically, the dual program occupies substantially less time than would the two degree programs taken separately. This is achieved by identifying content and learning experiences which may validly be counted towards both qualifications.

In all cases, for the accreditation of each engineering technologist program the Board will require the present policy and criteria to be met and demonstrated in full. The representative proportions of the learning experience, cited above, are to be interpreted as proportions of three full-time years, or their equivalent in other modes.

Where a combined / dual / double / degree program comprises two separate engineering outcomes, each in a designated specialist field, the policy and criteria must be satisfied for each individual outcome. Obviously there will be common development of some of the enabling skills and knowledge, as well as personal and professional capabilities, but for each of the two degree outcomes there will need to be evidence of the development of the appropriate depth of technical skills and knowledge, design and problem solving capability and appropriate exposure to engineering practice in the respective specialist field.

3.2.3.2. Alternative Implementation Pathways

Flexible delivery options are usually implemented as alternative implementation pathways within a single program definition. Such pathways can range from alternative academic units selected from a list of electives for a student studying on the home campus, major and minor elective sequences, optional cooperative modes, project and/or thesis options, workplace learning options, distance modes and various articulation routes right through to an offshore implementation of the program.

The program structure must accommodate such alternative pathways in such a way as to assure the equivalence of educational outcomes for every individual student. Reference 6 discusses in further detail the accreditation of alternative implementation pathways.

The early stages of the program should be tailored to the backgrounds of commencing students and should provide appropriate pathways for each group admitted. This should include special support programs for students admitted from disadvantaged or unconventional backgrounds, or with language difficulties.

3.2.4. Curriculum

The educational design and review process should be directed at an integrated curriculum delivering a balance of enabling or underpinning knowledge and skills, technical competence, engineering application skills and personal and professional capabilities. The curriculum must provide for the delivery of these outcomes in accordance with the requirements and explicit learning experiences specified below.

3.2.4.1. Enabling Skills and Knowledge Development

Enabling skills and knowledge in mathematics; physical, life and information sciences, and in engineering fundamentals must adequately underpin the development of high level technical and/or operations management capabilities, and engineering application work within the designated field of practice and selected specialisation(s).

Graduates should have an ability to work from first principles in tackling technically challenging problems and have an appreciation of the future need to apply fundamental knowledge to on-going developments in the nominated field(s) of technology as well as to new technologies relevant to the area of application or associated industry sector.

3.2.4.2. In Depth knowledge and understanding of a nominated field of technology and its applications

Engineering schools must make decisions on the breadth and depth of technical content within the foundation domains of the nominated engineering technology and in its applications, or of the technologies supporting the associated industry sector, as part of the educational design process. These decisions will be guided by external advisory mechanisms, benchmarking, and resources such as guidelines provided by professional engineering bodies. It is expected that students will however develop a knowledge of all aspects of an engineering technology including its broad application and/or of the technologies supporting a particular industry sector.

Graduates should be competent in applying mathematics, science and engineering science to the solution of representative problems, situations and challenges within the nominated technology field(s).

Graduates should have knowledge of relevant materials and resources and their properties and ability to select appropriate materials, resources and techniques for particular applications.

Graduates should have an ability to recognise results, calculations or proposals that may be ill-founded, to identify the source and nature of the underlying problem and take corrective action.

Advanced knowledge and capability development will be provided by pursuing - ***either*** - one or more specialist areas of application within the nominated field(s) of technology - ***or*** - the management of technical operations underpinning the nominated field(s) of technology or the associated industry sector. Either case will involve in-depth engagement with the specific body of knowledge and emerging developments and with problems and situations of significant technical complexity.

Where students develop advanced knowledge and skills through specialist application within the nominated field(s) of technology, this should be to a level that engages with current developments and practices as well as emerging issues. In this case, graduates should have ability to ensure that applications and extensions of the technology (technologies) are soundly based in theory and fundamental disciplines.

The Board will look for evidence that the technical knowledge and skill targets are commensurate with the range and depth expected by employers and consistent with international practice. The accreditation process will evaluate the steps taken in setting outcome targets such as the educational design process, the curriculum, the learning activities and student assessment processes in judging the adequacy of technological depth.

3.2.4.3. Personal and Professional Skills Development

The development of personal and professional skills should be addressed by the curriculum as a whole. An integrated and pervasive educational design approach will map the development of these skills through a wide range of learning activities spread throughout all stages of the program. The following list of personal and professional attributes along with associated performance and range indicators has been extracted from the Engineers Australia National Generic Competency Standards - Stage 1 – Competency Standard for Engineering Technologist (Reference 4).

Ability to communicate with the engineering team and the community at large and evidenced by:

- fluency in written and spoken English;
- an ability to make oral and written presentations to technical and non-technical audiences;
- a capacity to hear and comprehend others' viewpoints as well as disseminate information;
- effective discussion, debating and argument presentation skills;
- an ability to effectively represent the engineering profession to the community.

Information literacy and ability to manage information and documentation, demonstrated by:

- an ability to systematically and effectively source, analyse, evaluate and catalogue relevant information;
- an ability to assess the accuracy, reliability and authenticity of information;
- an ability to communicate through engineering drawings and sketches;
- fluency in the use of computer based communication and document preparation tools;
- skills in the creation, management and control of documents;
- skills in maintaining professional journals and records;
- skills in the preparation of progress reports, project reports, reports of investigations, proposals, designs, briefs and technical directions.

Creativity and innovation skills demonstrated by:

- a readiness to challenge technical practices from a non-technical viewpoint to identify opportunities for improvement;
- applying creative approaches to identify and develop alternative solutions;
- an awareness of other fields of engineering and technology with which interactions may develop and an openness to such interactions;
- seeking information from the widest practicable range of sources;
- engaging in wide ranging exchanges of ideas and being receptive to change.

Understanding of and commitment to ethical and professional responsibilities, including:

- Engineers Australia code of ethics;
- relevant legislation and statutory requirements;
- codes of practice and standards relevant to the nominated field(s) of technology and associated areas of application;
- sustainable and safe practices;

with:

- values, attitudes and conduct reflecting a social, cultural and environmental awareness.

Ability to function as an individual and as a team leader and member in multi-disciplinary and multi-cultural teams, and demonstrated by:

- managing time and processes and prioritising competing demands;
- achieving trust and confidence of colleagues through competent and timely completion of tasks;

- professional interaction with peers and other professionals to achieve a collective outcome;
- recognising the value of diversity, interpersonal and inter-cultural skills and effective network relationships that value and sustain a team ethic;
- mentoring others and the acceptance of mentoring;
- a capacity for initiative and leadership whist respecting others' agreed roles.

Capacity for lifelong learning and professional development, demonstrated by:

- recognising personal limits to knowledge and competence, seeking advice and undertaking research to supplement knowledge and experience;
- taking charge of own learning and development, self review and reflection, inviting peer review, personal benchmarking, identifying areas for personal development;
- developing a propensity to seek out, comprehend and apply new information;
- a commitment to the importance of being part of a professional and intellectual community: learning from its knowledge and standards, and contributing to their maintenance and advancement;
- building non-engineering knowledge and skills to assist in achieving engineering outcomes.

An appropriate professional attitude as evidenced by:

- presenting a professional image in all circumstances;
- a capacity for intellectual rigour and a readiness to tackle new issues in a responsible manner;
- demonstrating a sense of the physical and intellectual dimensions of projects and programs, and related information requirements, based on reasoning from first principles and on developing experience.

3.2.4.4. Engineering Application Experience

Engineering application activities should be pervasive to the curriculum and include complex problem solving, design and project work. It is expected that programs will embody at least one major engineering project experience, which draws on technical knowledge and skills, problem solving capabilities and design skills from several parts of the program and incorporate broad contextual considerations as part of a full project life cycle. Such project work may focus on the field(s) of technology and its applications or address the management of technical operations underpinning the field(s) of technology or the associated industry sector. Students should engage with complex, open-ended problems and work in both individual and team capacities. The curriculum should also develop engineering design capability, appropriate to the nominated field(s) of technology and the specialist focus of the program. Ideally a program will contain multiple design tasks, problem solving and project activities spread throughout the various levels.

Engineering application work should be representative of the field of practice and include both technical and non-technical considerations. A key objective should be to develop an appreciation of the interactions between technical systems and the social, cultural, ethical, legal, political, environmental and economic context in which they operate

The following lists some of the expected features and outcomes of engineering application activity.

Problem identification, formulation and solution

- Identifying the nature of a technical problem, formulating an approach to its solution, making appropriate simplifying assumptions, and achieving a solution.
- Quantifying significance of assumptions to the reliability of a solution.
- Investigating a situation, or the behaviour of a system, and identifying any underlying causes relevant to the field of specialisation.
- Recognising problems that have origins outside the area of specialisation and communicating them to an appropriately competent person.

Application and adaptation of the technology (technologies)

- Knowledge of the factors likely to be important in particular areas of application of the nominated technology (technologies) as well as understanding and managing them.
- Appreciating and managing the interactions between the technical and other parts of an overall system, defining operating interfaces with other technologies, equipment or systems, and ensuring that such interfaces function effectively.
- Adapting the nominated technology (technologies) to a variety of situations, understanding properties, possibilities and limitations of the technology (technologies).
- Identifying and solving effectively a wide range of practical problems arising from application of the nominated technology (technologies) in different contexts.

Engineering design using the nominated technology (technologies)

- Application of technical knowledge, design methodology, and appropriate tools and resources to design devices, components, systems, equipment, facilities or installations using the nominated technology (technologies).
- Developing competence in:
  - writing/interpreting functional specifications;
  - seeking advice from appropriate sources;
  - evaluating alternative approaches and justifying a recommended approach;
  - applying appropriate resources, tools and processes to the design task;
  - complying with appropriate standards and codes of practice;
  - ensuring integration of all functional elements;
  - validating the design solution against the engineering and functional specifications;
  - addressing reliability, maintainability, cost-effectiveness, product quality and value, and user friendliness issues.

Implementing and managing projects

- Developing skills in:
  - understanding and documenting the required outcomes of a project or program utilising the nominated technology (technologies);
  - evaluating and confirming the appropriateness of the proposed use of the nominated technology (technologies);
  - identifying, quantifying and managing risks, impacts and constraints;
  - developing specifications, using established engineering methods, standards

and codes of practice;
- undertaking a structured design task;;
- quantifying tasks, facilities and resources to implement a solution over a full project cycle;
- realising or prototyping a design solution;
- devising and implementing test, inspection, certification and compliance testing procedures;
- formal project management; and
- record keeping, reporting, presentation and documentation of outcomes.

Operating in a broad contextual framework

- Developing an ability to:
  - appreciate the interactions between technical systems and the social, cultural, environmental, economic and political context;
  - appreciate the imperatives of safety and of sustainability;
  - communicate the significance of nominated technology (technologies) and subsequent application in a particular context to other technical and non-technical stakeholders;
  - appreciate the nature of technical risk and also risk to clients, users, the community and the environment.

Appreciation of the business environment and the development of fundamental business and management skills

- Business skills development should be within an engineering technology framework and embrace:
  - the overall conduct and management of business enterprises and the structure and capabilities of the engineering workforce;
  - the commercial, financial, legal and marketing aspects of engineering projects and the requirements for successful innovation;
  - fundamental business principles and their significance;
  - cost consideration associated with a design or project and the task of managing within realistic constraints of time and budget.

3.2.4.5. Practical and 'Hands-On' Experience

There must be substantial hands-on practical experience manifested through specifically designed laboratory activities, investigatory assignments and project work. The specific learning contributions from practical work should be thoroughly understood, mapped and documented as an integral part of the learning design process within any particular academic unit. Practical learning experiences should engage students with the use of facilities, equipment and instrumentation reflective of current industry practice.

The learning outcomes from laboratory and other practical learning activities should aim to include the development of:

- an appreciation of the scientific method, the need for rigour and a sound theoretical basis;

- a commitment to safe and sustainable practices;
- skills in the selection and characterisation of engineering systems, devices, components and materials;
- skills in the selection and application of appropriate engineering resources tools and techniques;
- skills in the development and application of models;
- skills in the design and conduct of experiments and measurements;
- proficiency in appropriate laboratory procedures; the use of test rigs, instrumentation and test equipment;
- skills in recognising unsuccessful outcomes, diagnosis, fault finding and re-engineering;
- Skills in perceiving possible sources of error, eliminating or compensating for them where possible, and quantifying their significance to the conclusions drawn;
- skills in documenting results, analysing credibility of outcomes, critical reflection, developing robust conclusions, reporting outcomes.

3.2.5. Exposure to Engineering Practice

Exposure to engineering practice is a key element in differentiating an engineering technology degree from an applied science degree. Although the status of Chartered Engineering Technologist requires a substantial period of experiential formation in industry after graduation, it is clearly unsatisfactory for the student's perceptions of engineering to develop, over the first three critical years, in complete isolation from the realities of practice. There is obvious benefit in ensuring that at least an element of professional formation is interwoven with the academic curriculum, to provide a balanced perspective and relate academic preparation to career expectations.

Engineering practice exposure must be considered as an integral learning activity within the educational design process and make a significant and deliberate contribution to the delivery of educational outcomes. The objectives associated with each major episode of exposure need to be clearly understood by all constituencies and documented as a formal learning activity within a designated academic unit. There must be defined contributions from these activities to the specific learning outcomes of academic units and in turn to the educational outcomes of the program as a whole.

There should be a formalised tracking, monitoring and assessment of the learning outcomes associated with engineering practice exposure. This may for example be through a journal or portfolio system where students record and reflect on their experiences against the targeted graduate capabilities set for the program.

Engineering practice exposure must include some of the following:

- use of staff with industry experience,
- practical experience in an engineering environment outside the teaching establishment,
- mandatory exposure to lectures on professional ethics and conduct,
- use of guest presenters,
- industry visits and inspections,
- an industry based final year project,
- industry research for feasibility studies,
- study of industry policies, processes, practices and benchmarks,
- interviewing engineering practitioners,

- industry based investigatory assignments,
- direct industry input of data and advice to problem solving, projects and evaluation tasks,
- electronic links with practising professional engineers and/or engineering technologists and associates/officers, and
- case studies.

It is considered that there is no real substitute for first-hand experience in an engineering-practice environment, outside the educational institution. Engineers Australia strongly advocates that all engineering schools include a minimum of 8 weeks of such experience (or a satisfactory alternative) as a requirement for the granting of qualifications, in addition to the other elements suggested, and make strenuous effort to assist all students to gain placements of suitable quality. However it is recognised that this may not always be possible.

The requirement for accreditation is that programs incorporate a mix of the above elements, and others – perhaps offering a variety of opportunities to different students – to a total that can reasonably be seen as equivalent to at least 8 weeks of full time exposure to engineering practice in terms of the learning outcomes provided. In the same way as for other modes of learning, submitted documentation must explain how the various dimensions of engineering practice exposure contribute to the overall educational design.

Where practice exposure is incorporated within the three-year equivalent curriculum, it must embody assessable requirements comparable with other curriculum elements that attract similar credit. Where it consists of work experience in industry, not otherwise formally assessed, it should be counted in addition to the four-year academic requirement.

3.2.5.1. Cooperative and Workplace Learning

Some educational institutions offer programs in which students are required to gain substantial practical experience in industry, or other engineering-practice settings and interspersed with the academic program. These are generically known as co-operative education programs, involving cooperation between the education provider, the student, and one or more engineering employers.

Cooperative education programs would normally include the following features:

- an engineering-practice experience requirement taken in periods of sufficient duration for substantial work to be undertaken, and completed prior to the final academic semester;
- stated and assessed learning outcomes from this element of engineering practice experience;
- a formal requirement that the engineering practice experience be completed to a satisfactory standard, as a prerequisite for the award of the degree;
- comprehensive documentation of these requirements and how they are met;
- an office providing assistance to students in finding suitable practice experience placements.

The Board acknowledges these programs, and accredits them in the same way as any other engineering education program.

3.3. Quality Systems

Appropriate policy, processes and practices must be in place at all levels within the educational institution to assure the quality of engineering education. The dimensions of the educational quality system must embrace the following components.

3.3.1. Engagement with External Constituencies

Valid preparation of students for engineering practice requires interaction with industry on a continuing basis. There have been many messages *from* industry, often at the highest levels, that educational institutions have insufficient appreciation of the real needs of employment and must learn the real-world lessons of fitness for purpose, quality assurance and continuous interaction with clients. In short, education providers must "get closer to industry". Engineering schools are responding seriously to these injunctions, and the Accreditation Policy requires that they should. For the response to be effective, industry must make a serious commitment to the partnership in return. Some companies are exemplary in this regard; many more are needed for the relationship to be fully realised.

A specific requirement of the Policy is a formally-constituted advisory mechanism or mechanisms, involving program constituencies generally and industry in particular. The engineering school must secure the active participation of practising professional engineers/engineering technologists, graduates, professional bodies and leading employers of engineering graduates in defining, updating and evaluating educational outcomes for each program.

At least some members of the advisory body should be at senior level. In order for such involvement to be effective, the interactions must be well structured and well managed. The engineering school must present real issues for debate and must be seen to be responsive to comments made. Consultative dialogue should be bilateral or multilateral, involving active contributions and making use of the expertise of all constituent groups including students.

A senior industry advisory body would be mainly expected to operate at the strategic level in monitoring and analysing industry needs and trends as well as in the review and performance monitoring of the program objectives and graduate capability targets. The advisory body should have input to establishing performance standards and strategies for monitoring the development of technical competence, engineering application skills and personal and professional skills for each particular program. Depending upon organisation structures, there may be a case for a two tiered approach, to provide both strategic direction and advice as well as specific input to the educational design, review and performance monitoring at the individual program level. In some instances this may be achieved by a single advisory body with individual members or sub-groups accepting engagement to provide advice and assistance in learning design at a more detailed, operational level. Individuals may well also serve as adjunct staff or assessors of student performance.

An effective and productive industry engagement is also crucial for providing students with the necessary range of exposure to engineering practice as well as providing opportunity for collaborative project work and the professional development of staff.

3.3.2. Feedback and Stakeholder Input to Continuous Improvement Processes

There must be formal processes for securing specific and systematic feedback from constituencies such as students, graduates, employers of engineers and representatives of the wider community. There should be evidence of the systematic application of feedback in conjunction with other quantitative measures to setting, monitoring and reviewing outcomes at program and academic unit level.

Direct involvement of the student body as partners in the processes of continuous quality improvement is strongly encouraged. Staff-student consultation forums, focus groups and commissioned submissions can facilitate productive involvement as well as providing direct educational experiences for the student in the processes of quality assurance.

External stakeholder feedback and input should provide an important dimension in monitoring the delivery and attainment of program objectives and graduate capability targets.

3.3.3. Processes for Setting and Reviewing the Educational Outcomes Specification

There should be formal, documented processes for setting and reviewing the detailed educational objectives and graduate capability targets for each program as a whole. Reviews should be regular and on-going. These processes should ensure that the outcomes specification remains aligned with the Engineers Australia Stage Generic Competency Standards – Stage 1 Competency Standard for Engineering Technologist – (Reference 4), as well as external practices and specific industry needs. The specification of targeted graduate capabilities should cover enabling skills and knowledge, depth and breadth of technical competence, engineering application skills, as well as personal and professional capabilities. The Stage 1 Competency Standard provides a useful generic template for such an outcomes specification to which would need to be added technical outcomes appropriate to the designated field of practice and/or specialisation(s).

Systematic review processes should be inclusive of all staff engaged in the delivery of the program, and involve the on-going input of external constituencies as well as feedback and input from the student body.

3.3.4. Approach to Educational Design and Review

A systematic and holistic approach to educational design, review and continuous quality improvement must be evident.

Beginning with the specification of educational objectives and targeted graduate capabilities, a structured, ‘top-down’ approach to learning design should next determine the specific and measurable learning outcomes for each academic unit within the program.

At the academic unit level, the learning design process should continue by developing the appropriate learning activities and the formative and summative assessment approaches which monitor and measure the delivery of the learning outcomes. Closing the loop on learning outcomes, learning activities and assessment measures at the academic unit level should be a prime objective.

A mapping of the learning outcomes from individual academic units to the targeted graduate capabilities for the program as a whole should be a prime reference tool emerging from this process and underpin the outcomes based educational design. Subsequently, tracking this aggregation of learning outcomes and assessment measures from individual academic units to close the loop on delivery of graduate capabilities at the program level is a key component of the on-going review and improvement process.

Again, the educational design, review and continuous quality process should be inclusive of all program teaching staff through regular interactions, and involve the on-going input and feedback of the student body. Performance assessment at every level should involve a variety of measures as well as input from an appropriate range of stakeholders and drive the improvement cycle.

The overall goal of the learning design process is to ensure that the curriculum *as a whole* addresses the educational outcomes set for the program in a substantial, coherent and explicit way, emphasising contextual relationships. For example, in relation to communication skills development, it would not be sufficient to expect an adequate skill level to be established within one or two dedicated academic units at particular points in the program. Nor would it be sufficient to say that all or most of the academic units involve communication in one form or another, and no further explicit attention is necessary. As well as a pervading expectation of good communication practices, there should be a series of structured exercises (such as team projects and outreach activities) expressly requiring effective communication of an advanced order and using engineering issues as the vehicle, both at technical level between engineers engineering technologists and associates/officers, and at non-technical level with other professionals or with the community generally. Such exercises should involve both conveying complex intelligence, and receiving and responding to it. Multiple opportunities should be provided, for students with different temperaments and backgrounds.

3.3.5. Approach to Assessment and Performance Evaluation

The development of assessment and performance monitoring systems must be an integral part of the overall educational design process for any particular program.

There should be evidence that the assessment tools and evaluation processes within individual academic units are rigorously aligned with the designated learning outcomes for the unit.

At program level, assessment measures from within individual academic units along with a range of inputs, feedback and performance measures gleaned from the full range of constituencies will come together to provide multi-dimensional data appropriate for evaluating performance against the standards set for each of the targeted educational outcomes. Substantiating delivery of the prescribed outcomes in this way will validate satisfactory attainment of the Stage 1 competencies and thus ensure that the generic attributes specified in the Accreditation Policy are developed to a sufficient degree in all graduates.

Summative and formative assessment tools may include examinations, tests, quizzes, project reports, self, peer, and mentor appraisals, portfolios and journals, oral examinations and interviews and behavioural observations. Other sources of performance data at both the level of academic unit and for the program as a whole will include surveys, focus and discussion groups, questionnaires and professional interviews. Collectively these widespread measures will provide the inputs for performance evaluation and monitoring delivery of outcomes at all levels.

It is important that students be required to perform in at least one (and preferably several) assessable situations involving major and wide-ranging challenges, drawing on knowledge and capability from different subject areas.

There should be a documented system for setting, reviewing and monitoring the delivery of learning outcomes associated with engineering practice exposure.

The assessment regime should address the full range of graduate capabilities, including personal and professional skills development.

A rigorous moderation process should be in place to monitor and manage the assessment processes within academic units.

The processes for determination of honours should be clearly documented, and assure the performance standards of honours graduates is comparable with benchmark practice standards.

3.3.6. Management of Alternative Implementation Pathways and Delivery Modes

There must be rigorous processes for monitoring and managing alternative implementation pathways within a particular program definition, and for assuring the equivalence of educational outcomes for the program as a whole. Such alternative implementation pathways will range from specialised entry routes and elective academic units within an established home campus program right through to an offshore or remote campus offering of such a program.

3.3.7. Dissemination of Educational Philosophy

The educational design process should be properly documented and made available in appropriate form to each category of stakeholder. For students enrolled in a particular academic unit, this would mean a clear description of expected learning outcomes for the unit, the way in which learning activities will contribute to achievement of these outcomes and how performance against the target outcomes will be assessed. In addition such documentation should demonstrate how the academic unit learning outcomes are tracked to ensure these aggregate systematically to deliver the overall educational outcomes specified for the program. Dissemination of this holistic view of the educational design would normally be through published academic unit learning guides.

Systematic documentation of the educational design is crucial as educational institutions consider alternative implementation pathways to cover initiatives such as distance, workplace, cooperative and offshore delivery options and to provide for recognised articulation routes. Formalised mapping of unit learning outcomes against the targeted educational outcomes of a program and thorough learning design at the academic unit level provides an elemental breakdown of the learning processes. Such a breakdown facilitates the task of establishing the equivalence and validity of alternative implementation pathways. Examples could be the consideration of prior or concurrent learning in an industry setting or arguing the validity of alternatives to the traditional laboratory learning offered at a home campus.

3.3.8. Benchmarking

Engineering schools should engage in some form of comparative analysis to ensure that exit-level performance standards are comparable with national practice, and preferably international practice for the full range of graduate capabilities. Comparative analysis could include exchanges of teaching and assessment materials, discussion forums, visitation teams and/or the use of external examiners, if so desired. Beyond this, more systematic benchmarking could help in identifying best practices and specific directions for improvement. The accreditation process will evaluate program standards, but education providers should do so as part of the process of setting the performance criteria and monitoring targeted graduate outcomes, and not rely on the accreditation system for this.

3.3.9. Approval Processes for Program Development and Amendment

There must be formal approval processes associated with program and curriculum planning and review, with due reference to demand analysis, the input of external constituents, and quality management processes.

3.3.10. Student Administration

There must be an admissions system that ensures an acceptable standard of entry for students from appropriate educational backgrounds.

There must be policies and processes for the acceptance of transfer students, validation of formal prior learning and analysis of prior learning or concurrent learning in non-formal settings.

The admission system must adequately publicise the qualifications required for entry and ensure that only qualified candidates are admitted.

There should be formal policies and processes for tracking student progress, issuing advice and the provision of timely warnings to students at risk, systematic remediation, exclusion and appeal.

The records management system must enable auditing of the above processes at any time and provide confirmation of integrity.

4. REFERENCES

1 S02ET Accreditation Criteria Summary

2 P02ET Engineers Australia Policy on Accreditation of Professional Engineering Programs

3 G07ET Fields of Specialisation

4 P05ET Engineers Australia National Generic Competency Standard - Stage 1 Competency Standard for Engineering Technologist

6 G05ET Alternative Implementation Pathways

7 Engineers Australia, Accreditation Board Accreditation Management System, List of Documents