

The EPC Engineering Graduate Output Standard

Output standards and
professional body accreditation

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The Engineering Professors Council

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Executive Summary

The framework of the Engineering Professors' Council (EPC) Engineering Graduate Output Standard takes the form of 26 'Ability to...Statements' that are expressed in generic non-discipline-specific terms and are based on the procedures carried out by an engineer in solving an engineering problem and delivering a solution.

Following publication of the Output Standard, the EPC commissioned five linked sub-projects. One of these dealt with the relationship of the Output Standard to the accreditation of engineering programmes by Engineering Professional Bodies on behalf of the Engineering Council. This report outlines the main areas discussed by the Professional Bodies Working Group (PBWG), the outcomes from these discussions, and recommendations. The membership of the PBWG represented eight Professional Bodies, and all of the other Professional Bodies licensed by the Engineering Council to accredit programmes were engaged as corresponding members.

Accreditation is the process by which an Engineering Professional Body assesses whether or not an engineering academic programme meets the requirements for initial registration of Engineers and Technicians in the Engineering Council's Register. This process is carried out in accordance with the guidance set down in the Engineering Council's policy document Standards and Routes to Registration, third edition (SARTOR 3). The first task of the Working Group was to review the practice of accreditation in the UK. It appears that all of the Professional Bodies represented on the PBWG adopt the same approach to accreditation, which is based on a careful assessment of both input and output measures by a peer review process. In general there are transparent codified criteria for the input measures. However decisions on whether or not graduates meet required output standards are based largely on the principle of connoisseurship. Most Professional Engineering Bodies do not use explicit exemplar benchmarks and do not attempt to compare the actual output being achieved against benchmarked standards. The PBWG believes that the use of benchmarks would allow decisions to be made in a much more explicit manner. The PBWG is of the opinion that on the whole the accreditation process was robust, but all agreed that the assessment of graduate output could be improved by the use of a standard such as the EPC Output Standard.

An attempt was made by the PBWG to map current accreditation practice on to the EPC Output Standard. Whilst the comparison showed a close correlation with the requirements of SARTOR 3, difficulties were experienced in devising benchmark statements which suited the wide range of programmes that Professional Bodies are invited to accredit. It was thought that an alternative approach would be to express a standard in terms of the complexity and open-ended nature of the tasks that graduates were expected to undertake, and that benchmarking a portfolio of exemplar tasks in these terms might be worth exploring.

The PBWG reviewed the accreditation processes of non-UK professional bodies and the role of Output Standards of other relevant UK professions. EU and American professional-body activity was included, and the UK professions of Medicine, Nursing, Law and Accountancy were covered. It is observed that professional bodies in the UK are attempting to assess the ability and capability of graduates through a greater focus being placed on the assessment of output.

The PBWG also took into account the Academic Standards produced by the Quality Assurance Agency (QAA) for both Engineering and Computing together with the report from the Joint EPC/QAA Compatibility Working Group which establishes the compatibility of the QAA Academic Standard – Engineering and the EPC Output Standard. This report concludes that the

QAA and EPC standards do not contradict each other but say very similar things, although in different formats. The report observes that opportunities will arise, in the not too distant future, for the principal stakeholders to determine whether the standards, including SARTOR 3, should be co-ordinated in some formal manner, or whether the retention of these different, but compatible perspectives for characterising what is expected of a graduate engineer provides opportunity and flexibility. The PBWG agrees that in any review of output standards all three documents should be considered but takes the view that, in the long term, harmonisation of the three approaches to output standards would in fact be very helpful to the accreditation process.

The PBWG observes that whilst the current approaches to academic programme accreditation are robust, there is room for improvement particularly in the assessment of graduate output. This improvement could be achieved through the acceptance of the following five recommendations:

- 1 The Engineering Council is urged to instigate a dialogue between itself, QAA, EPC and the Professional Engineering Bodies with a view to harmonising the three approaches to output standards so as to allow accreditation committees to make sound judgements using output criteria.

[**ACTION:** Engineering Council]

- 2 Professional Engineering Bodies are encouraged to move away from a concentration on the assessment of input to a more explicit use of agreed output criteria where appropriate and possible.

[**ACTION:** Professional Bodies]

- 3 Professional Engineering Bodies are urged to work on a mapping exercise to produce appropriate exemplar benchmarks and/or attributes to support the accreditation process in the assessment of graduate output.

[**ACTION:** Professional Bodies]

- 4 The Professional Engineering Bodies should work together through DABCE and JAB in order to harmonise the various accreditation processes used. This is of particular importance as the shift towards the assessment of graduate output occurs.

[**ACTION:** DABCE and JAB]

- 5 The EPC should monitor the progress on the four recommendations and report progress to its annual Congress in 2003.

[**ACTION:** EPC]

1 Background

In December 2000 the Engineering Professors' Council (EPC) published Occasional Paper Number 10 entitled 'The EPC Engineering Graduate Output Standard' [1]. This paper was the outcome of Phases 1 & 2 of the EPC Output Standard Project and defined a methodology for describing engineering graduate output standards. The framework established takes the form of 26 'Ability to...statements' that are expressed in generic non-discipline-specific terms and are based on the procedures carried out by an engineer in solving an engineering problem and delivering a solution.

In early 2001 EPC approved Phase 3 of the project. Phase 3 comprises five linked sub-projects with one of these sub-projects dealing with the relationship of the EPC Standard to the accreditation of courses on behalf of the Engineering Council by the Engineering Professional Bodies, see Annex 3. An accredited academic programme meets the requirements for initial registration of Engineers and Technicians in the Engineering Council's Register.

This report outlines the main areas discussed by the Professional Bodies Working Group (PBWG), the outcomes from these discussions, and recommendations. The overall aim is to encourage the peer review of benchmarks by the Professional Bodies in relation to the EPC Engineering Output Standard and to explore the benefits to those bodies of a single standard applicable across all engineering disciplines.

As the work of the PBWG was progressing the report, in its draft form, was read by a number individuals and groups from outside the membership of the PBWG but who had a professional interest in accreditation and the assessment of output. Quotes from two of these individuals, Professor Jim McQuaid and Professor Ernest Shannon, have been included in the body of the report as their contributions were considered to add significantly to the discussions and focus of the Working Group.

Professor Jim McQuaid is a Fellow of the Royal Academy of Engineering. He is currently a Royal Academy of Engineering visiting professor at the University of Ulster in Engineering Design and Sustainable Development. Until recently he was Director of Science and Technology at the Health and Safety Executive, London.

Professor Ernest Shannon is a Fellow and Vice President of the Royal Academy of Engineering, a past President of the IMechE and a past president of the Institution of Gas Engineers. He is an Executive Board Member of FEANI and is the FEANI representative on ESOPE.

Appendix 1 presents the rationale and terms of reference for the PBWG and Appendix 2 gives a list of working group members. In total 6 meetings were held.

2 Academic Programme Input and Output Measures

Throughout this report the terms 'input' and 'output' are extensively used. For the purposes of this report input refers to such things as the student entry qualification profile, the curriculum, detailed syllabi and stated learning outcomes, the learning resource base used in the delivery of an academic programme, the quality of the staffing base and their research, industrial involvement and industrial consultancy activities.

Similarly output refers to the ability and capability of the students who graduate from an academic programme.

As such, input can be assessed from the documents provided by Universities to the accreditation bodies for accreditation purposes supplemented by a panel visit, whereas output is much more difficult to assess. If output is to be assessed against a standard then achievements need to be compared with exemplar benchmarks, established in the standard, to determine the level of attainment. ‘Learning Outcomes’ are now used by many universities and Professional Bodies to assess what a graduate is expected to be able to do having studied a particular module or the complete academic programme. After much discussion the PBWG agreed that the identification of learning outcomes should be considered to be an input as these are specified by academic programme planners at the design stage. They do however, offer a language for expressing output achievements of students and hence student achievement can be judged against them.

“The distinction I would draw is that an output can be directly measured ie solving linear differential equations – a prescriptive structure – whereas an outcome has to draw on collateral evidence of fulfilment ie an ability to apply knowledge of mathematics – a goal setting structure – with solving equations as one of many possible exemplar tasks.”
Professor Jim McQuaid

3 Review of Accreditation Practice in the UK

3.1 Overview of SARTOR 3 and the role of Professional Engineering Bodies in the Accreditation Process

The Engineering Council’s policy document Standards and Routes to Registration, third edition (SARTOR 3) [2] sets out the criteria which all engineering degree courses must meet to gain accreditation. An academic programme will be accredited by one or more of the Professional Engineering Bodies, acting as agents of the Engineering Council, provided that the academic programme is deemed to have met the criteria identified in SARTOR 3 and is therefore considered to be ‘fit for purpose’. Accreditation then, features an assessment process, followed by a decision about fitness for purpose.

The criteria established in SARTOR 3 relate to both inputs and outputs. In the former category, much of the attention has focused on the cohort admissions standards requirements which courses must meet. However there are other important input-related criteria which concern course content and structure (such as the need for MEng programmes to include a group project) and the need to set learning in the context of engineering applications.

Of more interest in the context of the work of the PBWG are the outcome statements which SARTOR 3 sets out for accredited degrees. These cover the knowledge, understanding, awareness and abilities which graduates from different types of degree courses should achieve. They are derived from the competencies which SARTOR 3 ascribes to Chartered and Incorporated Engineers and which candidates for registration must demonstrate at professional review. These competence statements are set out in SARTOR 3 Part 2, Sections 2.1.1 and 2.2.2, and the accreditation criteria are set out in Sections 4.1.1 and 4.1.2. Professional Engineering Bodies accredit courses in accordance with these generic criteria, which they have contextualised to their individual disciplines.

Professional Engineering Bodies are licensed by the Engineering Council to accredit academic programmes at Chartered Engineer or Incorporated Engineer level. Appendix 3 gives a list of licensed Professional Engineering Bodies. All members of the Working Group, who represented eight Professional Engineering Bodies, were asked to explain the accreditation procedures used by their individual Professional Bodies and to identify what they consider to be good practice. In particular they were also asked to explain if and how they assessed graduate

output and the reasons for refusing to accredit. To enable informed discussion to take place all the Professional Bodies provided the Working Group with copies of their full range of accreditation documentation including copies of submission documents, check lists used by visiting teams and copies of visit report pro-forma used to present the outcomes of accreditation visits. They also outlined their disclosure policy. What follows is a summary of these discussions.

3.2 Accreditation Process

All the Professional Bodies represented on the PBWG adopt essentially the same approach to accreditation. They all produce guideline documents based on their interpretation of SARTOR 3, which are published and sent to university departments [3, 4, 5, 6, 7, 8]. They all require academic departments to complete a submission document which is used as the basis for accreditation and arrange for a team to visit the department. In all cases the team produces an assessment pro-forma and after the visit a report is written on the basis of the completed pro-forma for approval by an Accreditation Committee. In some cases the final report is confidential to the Accreditation Committee and in other cases the final report is sent to the university as a formal record of the outcome of the accreditation process.

Submission documents are required in advance of a visit and the adequacy of the documentation and the academic programme that it describes is formally assessed. For example the IMechE requires documentation at least six weeks ahead of a visit and this is reviewed by three Committee members. Inadequate documentation or programme specification can result in the process being suspended and no visit taking place.

Although there is a default format for the visit, most Professional Bodies will tailor a visit to suit the particular needs of the academic programme and to enable the visiting team to address concerns that are identified by the documentation. Generally the visiting team meets with senior university staff that will include the Head of Department and may include the Vice Chancellor, but always they will meet with teaching staff and students. They will inspect individual and group project work and coursework and will visit laboratories, design studios and other areas that support student learning, such as learning resource centres which generally include library provision.

3.3 Assessment of input and output by the Professional Bodies

All the Professional Bodies have established guidelines, developed from SARTOR 3, which identify how they believe an accreditation team should judge an academic programme based on an evaluation of both input and output measures. In all cases, input is assessed through a study of the documentation provided to the Professional Body's accreditation committee by the university, supplemented by the panel visit. Output is assessed through a study of examination papers, group and individual project reports, design and laboratory reports, external examiners reports and student feedback. In all cases discussions take place with staff and students during the accreditation visit and in some cases the accreditation team may also meet with employers of graduates from the academic programme.

"If a way has been found to rigorously assess university education on output standards then this should be adopted. For me the whole point of such an exercise is to give individuals and those who employ them some means of establishing competence to practice engineering at or above an agreed standard." Professor Ernest Shannon

In all cases the assessment described above is based on a peer review process, which is a well-tried and trusted method of judgement and is accepted by both parties as an appropriate method

when applied with due care and professionalism. The assessment is based on the codification of the criteria and the transparent use of these criteria in coming to a judgement. Generally it is supported by the careful selection, training and probation of accreditors. Under these conditions the Professional Engineering Bodies believe that it is possible to undertake accreditation on the grounds that they can establish, through peer assessment, whether or not the criteria have been met.

Decisions on whether or not graduates meet required standards are based largely on the principle of connoisseurship - where the decision relies on the judgement of expert assessors. As far as one can tell, most Professional Engineering Bodies do not use explicit exemplar benchmarks and do not attempt to compare the actual output being achieved against benchmarked standards. However the use of benchmarks would allow decisions to be made in a much more explicit manner based on judgement.

“The basis of the judgement should be more explicit and not be mere declaration in which case, it is opinion rather than judgement. After all art and wine connoisseurs are nowadays expected to explain their judgements eg nose - what aromas; taste - what flavours; finish - does it linger, etc. Not sufficient to say 'I like it' if you declare you are a wine expert. The wine experts use benchmark exemplars eg blackberries, leather, etc or comparators eg this Chilean red is reminiscent of St Emillion. Engineering 'connoisseurs' need to develop their own language.” Professor Jim McQuaid

However, in spite of the imperfect nature of some of the aspects of accreditation identified above, members of the PBWG were of the opinion that on the whole the process was robust, but all agreed that the assessment of graduate output could be improved by the use of a standard such as the EPC Output Standard.

3.4 Approaches to Accreditation by the Professional Bodies

Since the introduction of SARTOR 3 Professional Bodies have been busy developing accreditation procedures that are designed to be more innovative and flexible, whilst at the same time having regard for the input and output standards set out in SARTOR 3. The rapidly changing nature of engineering has been an important driver of this process and the perceived need by some Professional Bodies to assess output in a more explicit way rather than an over-emphasis on input. The Professional Bodies have clearly developed methodologies for attempting to assess both input and output. This section describes some of the innovations that have been developed for attempting to assess output.

The Institute of Marine Engineering, Science and Technology (IMarEST) has carried out a significant amount of work to establish output criteria and has produced a matrix of ‘Ability to...Statements’ linked to SARTOR 3 requirements which differentiates between the levels of attainment required for different degree awards. However they have not yet moved to the stage where they invite programme providers to show how they meet the criteria set out in the matrix. The matrix has a large number of quite complex statements, which raises an important issue that all standards have in common. A compromise is required between the detail required to express the standard accurately and the need to keep it comprehensible and manageable by those who will need to use it.

The British Computer Society (BCS) uses seven major criteria in making a judgement. Three of these relate to the department and the learning environment (quality assurance, staffing and resources) and four relate to the individual academic programmes (aims and philosophy; legal, social, ethical and professional issues; projects and assessment, entry qualifications and graduation profiles). Each of these sections is further divided into six or so subsections. The

Society requires academic programmes to be described using the QAA Programme Specification. They specifically ask for details on how the Programme meets the QAA Computing Benchmark Statement. In this way BCS is attempting to reduce the accreditation load on universities by reducing duplication.

The BCS has also moved away from specifying a core component of curriculum, apart from requiring legal, social, ethical and professional issues to be addressed. They have recognised that specifying a core reduces flexibility in an environment that is changing rapidly both in terms of the content of programmes and the type of programmes that the BCS wish to accredit. As with most Professional Bodies the BCS places great emphasis on design and pays a lot of attention to this when visiting a university. Again as with most other professional bodies they use a checklist system, but failure to meet one of the criteria does not necessarily mean that accreditation will be withheld. One of the criteria is the SARTOR 3 entry standard.

The Institution of Electrical Engineers (IEE) also places significant emphasis on clear aims and objectives for the academic programme and these are used as the main driver for a visit. They have a system in which eight identified elements of the programme are scored on a scale of 1 to 4 similar to the former Teaching Quality Assessment approach. If any one element scores 2 or less the programme is not fully accredited. The IEE recognises that there are conflicting priorities that need to be resolved when developing engineering programmes and they attempt to assure themselves that this has been done in a reasonable and balanced way. For example the IEE are well aware of the conflict between the need to produce graduates who are able to apply the technology of today and who are immediately employable and the need to provide graduates with a good and sound grounding in the fundamental principles of mathematics and relevant science and who can invent and develop the technologies of the future.

The Institution of Incorporated Engineers (IIE) places significant emphasis on project work and activities and investigates both process and outcomes in this area. They regard this as a very reliable measure of graduate output. The assessors carry out a desk audit of the submitted documentation prior to the visit and their report is used to focus the content of the visit meetings. They have been able to engage in joint validation/accreditation procedures successfully, thus reducing the workload on universities.

The Joint Board of Moderators (JBM) attempts to assess input and output aspects of the provision. They particularly like to see involvement of practising engineers in the area of design. They like to adopt a broad non-confrontational approach to visits and they do not like to just tick boxes or 'nit pick', but rather to assess the overall flavour of the programme. However they state that they are strict on admission standards and have introduced minimum levels of 18 A-level points for MEng and 16 A-level points for BEng as well as imposing the SARTOR 3 averages.

The Institution of Mechanical Engineers (IMechE) guideline documentation refers to output standards and lists a number of 'Ability to...Statements' closely aligned to those in SARTOR 3. As with other Professional Bodies the IMechE attempts to assess these through discussions with students, graduates and employers, a review of projects, design work and examination papers and a study of external examiners' reports. However the 'Ability to...Statements' and other outputs are not benchmarked. Otherwise the IMechE engages in the accreditation process in a similar manner to the other Professional Bodies. The IMechE is currently reviewing its accreditation procedures and intends to rewrite its Educational Base Document.

Although not members of the PBWG it was brought to our attention that the Institution of Chemical Engineers (IChemE) has just (January 2002) published draft accreditation guidelines based on learning outcomes. The document identifies required learning outcomes covering the

aspects of knowledge and understanding, intellectual abilities, practical skills and general transferable skills. Without attempting to specify a detailed core curriculum, the document states the required learning outcomes for Chemical Engineers and identifies the methods of assessing the achievement of these outcomes through examination papers and projects, design and laboratory reports. In general terms the core of chemical engineering is identified and, for guidance purposes only, the minimum academic credits required to cover this core for both the BEng(Hons) degree and the MEng are stated. Interestingly, and in line with a possible approach being considered by the PBWG, the document presents three different types of design assignments in terms of learning outcomes and identifies ways in which these outcomes may be evidenced.

3.5 Reasons for withholding Accreditation

The Working Group felt that it was important to identify reasons for withdrawing or withholding accreditation. What follows is a summary of the discussions and identifies a number of deficiencies that may lead to an unfavourable accreditation outcome.

Accreditation is not given to a programme when serious deficiencies are identified in relation to the relevant accreditation guidelines produced by the various Professional Engineering Bodies. Nearly all these deficiencies are related to input and it is expected that they can be identified during the initial review of the submission documentation. The accreditation process may then cease at this stage. However if this is not the case and recoverable deficiencies are identified during the visit stage, accreditation may be awarded for a limited period on the condition that the deficiencies are formally addressed to the satisfaction of the Accreditation Committee.

The IIE members of the PBWG stated that sometimes a programme is offered for accreditation with a number of different pathways identified by a clearly defined set of modules. An accreditation outcome may be that some pathways are accredited and others are not due to content deficiencies being identified. In such cases accreditation is not being withheld from the providing department but from some of the courses within the programme in that department.

The BCS may withhold accreditation for a number of reasons including, failure to adequately meet the requirements for coverage of legal, social, ethical and professional issues, projects which are not practical problem solving projects, or honours degrees which appear not to satisfy the honours qualification descriptor in the QAA national qualifications framework. Other issues such as poor quality assurance processes, insufficient resources, as well as the above issues may lead to reduced periods of accreditation and the need for evidence at the end of the reduced accreditation period that the relevant issues have been addressed.

Other deficiencies that may lead to accreditation being withheld or only being awarded for a short time may include such things as:

- identified weaknesses in the curriculum with key aspects missing or optional;
- absence of leadership in a discipline area, or the lack of suitably qualified staff;
- inadequate equipment resources;
- inadequate numbers of technical support staff;
- student numbers that are too small for a viable MEng cohort;
- a student entry qualifications profile that is consistently failing to achieve the required SARTOR 3 admissions standard.

To summarise, therefore: accreditation may be withheld, withdrawn or given for a reduced period on deficiencies identified in input or output or both.

4 Mapping of Professional Body Current Practice on to the EPC Output Standard

In an attempt to evaluate the possible use of the EPC Output Standard framework as a means of supporting output standard assessment, the PBWG decided to ask each of the Professional Bodies represented on the Working Group to complete a pro-forma. The pro-forma is attached as Appendix 4. The Professional Bodies represented, agreed to use this pro-forma to attempt to describe methods they would use to assess the 26 'Ability to...Statements', together with their expectations of the levels of these attainments, through the identification of typical exemplar benchmarks which might be used as a basis of assessment that the threshold had been achieved. On the whole, all the Professional Bodies were readily able to identify a range of methods employed to assess 'ability to' output but most found it difficult or were unable to define threshold attainment through typical exemplar benchmarks. Clearly a significant amount of further work would be required by the Accreditation Committees of the various Professional Engineering Bodies before the EPC Output Standard and associated benchmarks could be used in any meaningful way to support the accreditation process.

After attempting to complete the pro-forma there was a long debate about the feasibility and indeed the advisability of attempting to produce exemplar benchmarks as part of this mapping exercise, although there was general agreement that the EPC 'Ability to...Statements' are an appropriate framework for an output standard. However it was felt that if a Professional Body was to produce benchmark exemplars for each of the 'Ability to...Statements', they may not properly reflect the wide variety of possible exemplars likely to be found for each ability. Furthermore, if such benchmarks were to become available in the wrong hands they could be interpreted as prescriptions and followed in a slavish, copycat manner. As such, they might stifle innovation and creativity in programme planning and module development. They could also be used by universities to argue the case for accreditation even though other aspects of the provision were identified as being unacceptable and below the threshold.

"I agree with the objection raised in the paper to the development of benchmark exemplars that they could promote slavish copycat imitations. A portfolio of exemplar attributes would be preferred than exemplar benchmarks. There are those who will say 'Tell us what to do and don't leave it to us to think'. This was the response of many to goal-setting health and safety legislation!

The experience in the H&S field of the change from prescription eg machine guards, dust masks, etc to goal setting eg risk assessment and avoidance by design, is I think highly relevant to what you are trying to do." *Professor Jim McQuaid*

However it was recognised by members of the PBWG that if progress was to be made in the use of the EPC Output Standard by the Professional Engineering Bodies, it would be difficult for accreditation committees to articulate the desired level of attainment that they were expecting for a programme to be accredited if they were unable to provide exemplar benchmarks. It was thought that an alternative approach would be to express a standard in terms of the complexity and open-ended nature of the tasks that graduates were expected to undertake, and that benchmarking a portfolio of exemplar tasks in these terms might be worth exploring. (This may be the approach being adopted by the IChemE as described in the report in Section 3.4 and is the way forward suggested by Professor McQuaid).

"I think an ability to explain one's judgements is an increasingly important competence for engineers and a structure for doing so should be a part of the curriculum. The medical and legal professions realise this since they deal with problems with no 'right'

answers and weight of evidence, balance of probability etc figure strongly in their decisions. Engineering teaching is based far too much on problems with 'right' answers and assessment based on the student getting the 'right' answer. The poor student is brought rapidly down to earth after graduation when he finds that the problems he deals with are characterised by insufficient information so that judgements have to be exercised. Development of that judgement then takes an unnecessarily long time in career terms since it is not supported by any educational foundation."

Professor Jim McQuaid

All members of the Working Group agreed to continue working on the mapping exercise particularly with respect to the identification of benchmark exemplars.

A comparison was also carried out between the EPC Output Standard 'Ability to...Statements' and the professional competencies and outcome statements in SARTOR 3 set out and referred to in Section 3.1 above. The comparison shows that close correlation exists between the requirements of SARTOR 3 and the 'Ability to...Statements' in the EPC document.

5 A review of Accreditation by non-UK Professional Engineering Bodies

The working Group felt that it was important to have some understanding of the accreditation practices of Professional Engineering Bodies outside the UK. This section of the report attempts to give a brief summary of this limited review.

5.1 European Countries

In many European countries professional accreditation of courses is a relatively recent development. There is however increasing interest being shown in it as higher education structures in many countries change and universities seek third party validation of their programmes. While practice has tended to be based on inputs, there is increasing interest being shown in output measures, although there is generally less experience of using these in relation to higher education than there is in the UK. A recent development is the establishment of a European Standing Observatory for Engineering Professional Education (ESOEPE) which exists to exchange information about accreditation practice in different countries. The current members are UK, France, Germany, Italy and Portugal. Further details of ESOEPE can be found at <http://www.feani.org>.

5.2 Other Countries

A number of other countries, principally from the English-speaking world, have signed the Washington and/or Sydney Accords which provide for mutual recognition of accredited engineering degrees. These are briefly described in Appendix 5. In many of these countries (eg Australia, New Zealand, South Africa) the approach to accreditation basically follows the UK model. Interest is being shown in using output measures and some preliminary work is being done on these. The chief alternative model of accreditation, used principally in the USA and Canada, is the ABET model and this is described in more detail below.

5.3 The United States Accreditation Board for Engineers and Technologists (ABET)

ABET [9] is recognised by the US Department of Education as the sole agency responsible for the accreditation of educational programmes leading to degrees in engineering and technology and related engineering areas. ABET appears to use an approach similar to that of the

Professional Bodies in the UK, in that it requires a submission document and an accreditation visit by a panel of experts. However it seems to have an overarching role emphasising procedure and process with less of an emphasis on programme content and level of attainment. The individual discipline-specific Institutions in the USA seem to have very little input into the accreditation process. Each has a small section in the criteria specification, which makes the otherwise generic criteria more discipline-specific.

Programmes are assessed against eight criteria presented under the headings of students, programme educational objectives, programme outcomes and assessment, professional component, faculty (academic staff), facilities, institutional support and financial resources and programme criteria.

Of particular interest to the Working Group was the reference in the ABET document to output and how this is assessed. Under the heading of Programme outcomes and assessment, ABET does address the output of graduates by specifying eleven output measures with eight of these containing an ‘Ability to...Statement’. This list is quoted in full as follows:

Engineering programmes must demonstrate that their graduates have:

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

This criterion also states that ‘each programme 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 programme. The assessment process must demonstrate that the outcomes important to the mission of the institution and the objectives of the programme, 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.

Compared to the EPC Output Standard and some of the expectation of UK Professional Body accreditation requirements, this is a very abbreviated statement although it is presented in the familiar ‘ability to’ format. It does not give levels of attainment or benchmarks for the ‘Ability to...Statements’ and there are only three statements addressing technical content requirements. However, it is very definite about the requirement for the abilities to be evidenced and to be in a form that is consistent with the mission statement of the institution and the objectives of the programme.

More details of the ABET approach can be found on the Website: <http://www.abet.org>.

5.4 Other non-UK Professional Bodies in the EU

As far as non-UK Professional Bodies are concerned, it was confirmed that activity is sparse and it seems that most are following either UK or US accreditation practice. In particular it is believed that EU activity is still in its early stages of development although more information is required to confirm this. However the Working Group was informed that developments were taking place and, where this was happening, the use of output standards was being actively pursued. This was on the basis of reports received from CEPIS (Committee of European Professional Information Systems) and from ESOPE (Observatory on European Accreditation Practice).

6 Review of Output Standards of other relevant UK Professions

To understand the accreditation practices of other UK professions, the PBWG obtained information on the processes used by a number of the major professions and in particular how they dealt with the assessment of output. The professions identified for study were nurses, medical practitioners, accountants and lawyers. Appendix 6 gives a brief summary of the information obtained, relevant to the aim of the PBWG, gained from a study of these professions using published literature, public reports and discussions with key individuals. Other information was obtained from papers of the UK Inter-Professional Group. It is clear that all the professions use accreditation practices that have strong similarities to those being used by the engineering profession. It is of interest to note that they are all examining, to different extents, how the ability and capability of the graduate output can best be assured to improve professional competency. This is particularly urgent in the health professions, largely as a consequence of the recent (January 2002) report into children's heart surgery at the Bristol Royal Infirmary. In response to the findings from this report, the GMC is totally reviewing undergraduate medical education. This is resulting in a stronger focus on learning objectives and outcomes and identifying approaches for the assessment of the competency of students and graduates.

Another example is that of the accountancy profession. In a recent review of the academic requirements for membership of the Institute of Chartered Accountants in England and Wales, professional stage syllabus learning outcomes are specifically included and are presented in the 'ability to' format.

Furthermore the Law Society is conducting a review of the training framework for solicitors, and this is based very strongly on the idea of a grid of competencies. At the present, this is still at an early stage, but will no doubt impact upon the way initial qualification requirements are stated.

From the information studied on the various professional bodies and illustrated by the examples above, it is evident that many professional bodies in the UK are attempting to assess the ability and capability of graduates through a greater focus being placed on the assessment of output.

7 The QAA approach to setting standards and a comparison with the EPC Output Standard

The Quality Assurance Agency (QAA) has produced a number of documents that set out a generic framework for setting standards in Higher Education programmes. Three documents are key to the discussion of the Working Group. Since there is no doubt that these will have a direct impact on the way in which university engineering departments prepare their programmes and

maintain their programme provision, it was felt by members of the Working Group that a section on the QAA work should be included in this report. In fact it was brought to the attention of the Working Group that the BCS now requires university departments to submit a programme specification as part of their accreditation process. The Working Group does not however intend to duplicate the work of the Joint EPC/QAA Compatibility Working Group which has been specifically requested to study the QAA and EPC approaches in depth.

The four key documents are:

- The Framework for Higher Education Qualifications in England, Wales and Northern Ireland (The QAA Qualifications Framework) [10]
- Academic Standards – Engineering (The QAA Benchmarks) [11]
- Academic Standards – Computing (The QAA Benchmark) [12]
- Guidelines for Preparing Programme Specifications (The QAA Programme Specification) [13]

The QAA Qualifications Framework contains high level descriptors of all the qualifications offered by Higher Education. The two descriptors most relevant to Engineering are the Bachelors degree with Honours and the MEng. QAA acknowledges the MEng as an undergraduate programme with output at masters level that lasts, typically, a year longer than honours degree programmes.

Of particular relevance to PBWG are the QAA's documents on Engineering and Computing subject benchmarking. The QAA brief for these documents was to produce 'generic' statements which represent general expectations about standards for the award of honours degrees in Engineering and in Computing. The documents define respectively Engineering and Computing and the skills, attributes and qualities of an engineer and computing specialist in terms of knowledge and understanding, intellectual abilities, practical skills and general transferable skills. Having defined these qualities, they go on to define, in general terms, content, delivery and attainment. The QAA is working on an appendix to the BEng (Hons) document that provides more guidance on MEng degrees.

The QAA Programme Specification is a set of guidelines that offer help to university departments which are preparing descriptions of academic programmes. A programme specification is a concise description of the intended outcomes of learning from a higher education programme, and the means by which these outcomes are achieved and demonstrated. The development of programme specifications is in response to the recommendation from the Report of the National Committee into Higher Education (The Dearing Report). In future all HE programmes will be required to be defined in terms of programme specifications and the QAA document gives an example of a Cambridge University BA (Hons)/MEng Programme defined in this way. The BCS is requiring specifications for all programmes submitted to them for accreditation as a means of reducing the workload on university departments.

The Working Group compared the EPC Output Standard with both the QAA Engineering and the QAA Computing Benchmark Statements.

It is clear that the Engineering Benchmark and the EPC Output Standard both focus on the same area and there are close similarities in the structure of the approach. Both documents are based on a list of abilities that engineering graduates are expected to acquire and these in turn are based on the procedures carried out by engineers in the delivery of engineering projects. The

EPC sets out its list of abilities in the context of the engineering process and in terms of what a graduating engineer may be expected to be able to do, whereas the QAA approach identifies graduate capabilities in terms of knowledge and understanding, intellectual abilities, practical and general transferable skills associated with the areas of Mathematics, Science, Information Technology, Business Context and Engineering Practice.

Thus the EPC standard is couched in terms which explicitly reflect abilities associated with the definition and solution of engineering problems with the necessary underpinning knowledge and skills implied, whereas the QAA approach is structured more to suit the assessment of their performance within the subject areas identified above. Another difference in approach emerges in the description of the level at which the abilities are attained. The QAA Engineering Benchmark has three general level descriptors for each ability which are threshold, good and excellent and differentiates between achievement at these three levels by statements such as ‘has basic knowledge; has basic knowledge and understanding; has comprehensive understanding’. In comparison the EPC Output Standard identifies a threshold through an ‘Ability to...Statement’ and illustrates its achievements by exemplar benchmarks.

The QAA Computing Benchmark differs from the Engineering Benchmark, in that it does not address the content of computing degree programmes, rather it identifies a broad set of curriculum areas and issues related to course design. However, the two benchmarks are very similar in identifying the abilities expected of graduates in the two discipline areas. The Computing Benchmark breaks the abilities into three broad areas – computing-related cognitive skills, computer-related practical skills and transferable skills. Although the language is not the same as that used in the EPC Output Standard, there are many similarities. As such, it is relatively easy to equate the ‘Ability to...Statements’ in the Computing Benchmark to those in the EPC Output Standard. The Computing Benchmark has only two generic level descriptors – threshold and modal. The comparison made between the EPC Output Standard and the Engineering Benchmark above thus holds true for the Computing Benchmark.

The specification of level is an essential element of the specification of a standard that, after all, is an expected or actual level of attainment. It is needed to make any sense of the Qualifications Framework in the context of engineering. BSc and BEng honours degrees are supposed to be at the same level according to the Qualifications Framework, but are also to be used in various ways to lead to the professional qualifications of IEng and CEng, which are different in nature, although not in level, according to the Engineering Council. The MEng has to be at masters level and is for the Professional Bodies the exemplar academic qualification for CEng. As stated above the QAA is currently producing guidance on the interpretation of the Engineering benchmark in the context of the MEng.

The report from the Joint EPC/QAA Compatibility Working Group establishes the compatibility of the QAA Academic Standard – Engineering and the EPC Output Standard. It concludes that they do not contradict each other but say very similar things, although in different formats. The report observes that opportunities will arise, in the not too distant future, for the principal stakeholders to determine whether the standards, including SARTOR 3, should be co-ordinated in some formal manner, or whether the retention of these different, but compatible perspectives for characterising what is expected of a graduate engineer provides opportunity and flexibility. The PBWG agrees that in any review of output standards all three documents should be considered but takes the view that in the long term harmonisation of the three approaches to output standards would in fact be very helpful to the accreditation process.

8 Possible impact on Accreditation of the QAA and EPC Standards

If all HE academic programmes of study are to be defined in terms of the QAA programme specifications document and, as QAA expects, universities are to use the Benchmarking Statements as a point of reference in designing and validating engineering programmes of study, duplication and hence workload would be reduced if the accreditation process included the use of this information in their required documentation. In fact, the BCS now requires universities to submit a programme specification for programmes submitted to them for accreditation. Taking into account the comparison of the QAA and EPC approaches to assessing graduate output given in Section 7, the Professional Bodies will need to decide which approach is more likely to provide the information required to allow them to make sound and defensible accreditation decisions.

However, no matter which approach succeeds in becoming the accepted norm, it is clear that the Professional Body Accreditation Committees will need to engage more with output standards, benchmarking and assessment. An understanding of these issues will enable the accreditation teams of the Professional Bodies to use these as an important and integral part of the accreditation process.

9 General Observations

- Four output standards are relevant to the work of Engineering Professional Bodies in their accreditation processes. These are: the two QAA Benchmarks relating to Computing and Engineering, SARTOR 3 and the EPC Output Standard. In any review of output all four documents should be considered.
- Throughout the PBWG discussions it was clear that there was significant commonality between the approaches used by the various Professional Engineering Bodies in their accreditation practices.
- All Professional Engineering Bodies assess a mixture of input and output criteria when considering the accreditation of academic programmes. However assessment of input is better established than the assessment of output.
- Some of the Professional Engineering Bodies are moving towards to the explicit assessment of output in their accreditation procedures. Recently developed accreditation documentation from the IMarEST and IChemE concentrates on the assessment of output.
- Many non-engineering Professional Bodies in the UK are moving towards the assessment of output in their approaches to improving the competency of their members and potential members.
- ABET uses ‘Ability to...Statements’ in its accreditation documentation.
- Accreditation within Europe is at an early stage of development.
- All members of the PBWG found it difficult to identify exemplar benchmarks through the mapping exercise described in Section 4 although they readily identified the methods they used to assess output.

10 Recommendations

Although members of the PBWG were strongly of the opinion that the current approaches to academic programme accreditation were robust, it was agreed that there was room for continuous improvement particularly in the assessment of graduate output. This improvement would be achieved through the acceptance of the following five recommendations:

Recommendation 1

The Engineering Council is urged to instigate a dialogue between itself, QAA, EPC and the Professional Engineering Bodies with a view to harmonising the three approaches to output standards so as to allow accreditation committees to make sound judgements using output criteria.

[ACTION: Engineering Council]

Recommendation 2

Professional Engineering Bodies are encouraged to move away from a concentration on the assessment of input to a more explicit use of agreed output criteria where appropriate and possible.

[ACTION: Professional Bodies]

Recommendation 3

Professional Engineering Bodies are urged to work on a mapping exercise to produce appropriate exemplar benchmarks and/or attributes to support the accreditation process in the assessment of graduate output.

[ACTION: Professional Bodies]

Recommendation 4

The Professional Engineering Bodies should work together through DABCE and JAB in order to harmonise the various accreditation processes used. This is of particular importance as the shift towards the assessment of graduate output occurs

[ACTION: DABCE and JAB]

Recommendation 5

The EPC should monitor the progress on the four recommendations and report progress to its annual Congress in 2003.

[ACTION: EPC]

11 References

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- 11 The Quality Assurance Agency for Higher Education, (<http://www.qaa.ac.uk>), Academic standards – Engineering
- 12 The Quality Assurance Agency for Higher Education, (<http://www.qaa.ac.uk>), Academic standards - Computing
- 13 The Quality Assurance Agency for Higher education, Guidelines for the preparing programme specifications, (<http://www.qaa.ac.uk>)

Appendix 1

Rationale and Terms of Reference for Professional Body Working Group

1 Context

Work on the EPC Engineering Output Standard continues in pursuit of the aims defined by EPC members. Phases 1 & 2 of the work to define a framework for the standard are largely complete and are a subject of an Interim Report entitled EPC Occasional Paper Number 10, December 2000.

The EPC Committee has recently approved Phase 3 of the work with the following aims:

- To build widespread acceptance of the EPC Standard as the preferred method of specifying and comparing the achievement of engineering graduates;
- To link and converge the EPC Standard with other National Standards, particularly the QAA Engineering Benchmarks;
- To foster the process of development and peer review of discipline-specific benchmarks, thereby clarifying and consolidating the level of expected graduate ability;
- To establish and articulate employer expectation of graduates in relation to and using the 'language' of the EPC Output Standard.

Phase 3 will comprise five linked sub-projects. One of these is a project on accreditation by professional bodies. The others are to do with assessment, convergence with QAA benchmarking, the relationship with employers, and IEng benchmarking.

2 EPC Engineering Output Standard Project – Phase 3 (Professional Bodies Sub-Project Working Group)

The overall aim of the sub-project is to encourage the peer-review of benchmarks in relation to the EPC Engineering Output Standard and to explore the benefits to accrediting bodies of a single standard applicable across all engineering disciplines.

It is proposed to achieve this aim by:

- identifying ways in which the EPC Engineering Output Standard can be used to aid and support the accreditation processes used by the accrediting bodies;
- supporting professional engineering body accreditation committees in the effective and efficient use of the EPC Engineering Output Standard in the accreditation processes employed;
- encouraging the use of the EPC Engineering Output Standard by the Professional Engineering Bodies.

3 Professional Bodies Working Group – Terms of Reference

A Professional Bodies Working Group is to be established with the following draft Terms of Reference. These terms of reference will be discussed at the first meeting of the Working Group and changed if necessary and appropriate:

- 1 To pursue the aim of the EPC Engineering Output Standard Professional Bodies sub-project which is to encourage the peer-review of benchmarks in relation to the EPC Engineering Output Standard and to explore the benefits to accrediting bodies of a single standard applicable across all engineering disciplines.
- 2 To receive advice from the EPC Output Standard Advisory Group and EPC Output Standard Co-ordinating Group;
- 3 To discuss the questions raised in the Appendix to these Terms of Reference and any others that might be identified as the result of these discussions;
- 4 To produce exemplar accreditation benchmark statements against the EPC Output Standard;
- 5 To report progress to the EPC Committee through the EPC Output Standard Co-ordinating Group;
- 6 To produce a final report on the outcomes from the Working Group for the EPC Output Standard Co-ordinating Group;
- 7 To disseminate outcomes from the Working Group to the accrediting bodies and the overarching accreditation co-ordinating groups, via the EPC.

Questions that might be addressed by the Working Group

In order to achieve the aims of the sup-project the following questions might be addressed by the Working Group:

What constitutes good accreditation practice in the present context?

- How does each accrediting body currently deal with the accreditation of courses?
- Are there examples of good practice nationally, internationally and in other disciplines?
- What is the current balance between the assessment of input measures, process and output standards?
- How are output standards currently assessed and evaluated?
- What examples of good practice are available for assessing output standards?
- What are the barriers to the universal application of best practice?

What changes in accreditation practice are implicit in the present QAA Programme Specification and Benchmark Standards, and QAA Qualifications Framework?

- Will accrediting bodies use the QAA Programme Specification and Benchmark Standards, or Qualifications Framework, in support of the accreditation process?
- How will the QAA Programme Specification and Benchmark Standards, or Qualifications Framework, be used by the accrediting bodies when assessing engineering courses and programmes?

What changes in accreditation practice are implicit in the use of the EPC Engineering Degree Output Standard?

- How would accrediting bodies wish to use the EPC Engineering Degree Output Standard to assess whether a course or programme is acceptable for accreditation at either CEng or IEng levels?
- What is the role of accreditation in the assessment process?
- What critical issues does the use of a threshold output standard raise in the accreditation processes used by the accrediting bodies?
- How would the accrediting bodies wish to change their accreditation processes to incorporate the assessment of threshold output standards?
- What would be the implications for the use of SARTOR as currently framed?

How can good accreditation practice, appropriate to the use of the output standard, best be identified, developed and disseminated across the accrediting bodies?

- Is there a case for some form of common approach or framework?
- What are the barriers to a common approach?
- What should be the role of the overarching accreditation co-ordinating groups in this process?
- Does the EPC Output Standard provide an opportunity for the accrediting bodies to communicate more effectively with stakeholders including Industry, HE and FE?

What are the barriers to applying the EPC Engineering Output Standard to the accreditation process of the accrediting bodies?

- How can any identified be overcome?

What are the next steps?

Accrediting bodies to produce exemplar benchmark statements against the EPC Standard for disciplines within their scope of influence.

The process will involve:

- disseminating outcomes from the Working Group;
- informing accrediting bodies by seminars;
- promoting feedback between accrediting bodies about benchmark requirements

Appendix 2

Membership of Professional Bodies Working Group

Mr David Eaton (Chair)	(IMechE) Sheffield Hallam University
Prof Gordon Bull	(BCS)
Mr Peter Cannings	(IIE)
Dr John Chudley	(IMarEST) University of Plymouth
Mr Phil Cooper	(JBM) Harris and Sutherland, Cambridge
Prof Nicos Ladommatos	(IMechE) Brunel University
Rev Stuart Poole	(IIE)
Richard Shearman	Engineering Council
Prof DG (Geoff) Smith	(IEE) University of Strathclyde
Prof Jim White	(Secretary and EPC)

Appendix 3

List of Professional Engineering Bodies licensed by the Engineering Council

Institute of Acoustics
Royal Aeronautical Society
Institution of Agricultural Engineers
Chartered Institution of Building Services Engineers
Institute of Cast Metals Engineering
Institution of Chemical Engineers
Institution of Civil Engineers
British Computer Society
Institution of Electrical Engineers
Institute of Energy
Institution Engineering Designers
Society of Environmental Engineers
Institution of Fire Engineers
Institution of Gas Engineers and Managers
Institute of Healthcare Engineering and Estate Management
Institute of Highway Incorporated Engineers
Institution of Incorporated Engineers
Institution of Lighting Engineers
Institute of Marine Engineering, Science and Technology
Institute of Materials
Institute of Measurement and Control
Institution of Mechanical Engineers
Institution of Mining and Metallurgy
Royal Institute of Naval Architects
British Institute of Non-Destructive Testing
Institution of Nuclear Engineers
Society of Operations Engineers
Institute of Physics
Institute of Physics and Engineering in Medicine
Institute of Plumbing
Institution of Railway Signal Engineers
Institution of Structural Engineers
Chartered Institution of Water and Environmental Management
Institution of Water Officers
Welding Institute

Appendix 4

Mapping of 'Ability to...Statements' with output assessment methods employed by Professional Bodies

Professional Engineering Body

	Generic 'Ability to...Statement'	Method(s) used to assess 'ability to' (indicate using numbers given on page 1 of note)	Typical exemplar benchmarks used to assess that the threshold level has been reached
1.2.1	Ability to exercise Key Skills in the completion of engineering-related tasks at an appropriate level		
(a)	Communication	(a)	
(b)	IT	(b)	
(c)	Application of Number	(c)	
(d)	Working with others	(d)	
(e)	Problem Solving	(e)	
(f)	Improving own learning and performance	(f)	

Mapping of 'Ability to...Statements with output assessment methods employed by Professional Bodies

Professional Engineering Body

	Generic 'Ability to...Statement'	Method(s) used to assess 'ability to' (indicate using numbers as on page 1 of note)	Typical exemplar benchmarks used to assess that the threshold level has been reached
1.2.2	Ability to transform existing systems into conceptual models		
(a)	Elicit and clarify client's true needs	(a)	
(b)	Identify, classify and describe engineering systems	(b)	
(c)	Define real target systems in terms of objective functions, performance specifications and other constraints (ie define the problem)	(c)	
(d)	Take account of risk assessment, and social and environmental impacts, in the setting of constraints (including legal, and health and safety issues)	(d)	
(e)	Select, review and experiment with existing engineering systems in order to obtain a database of knowledge and understanding that will contribute to the creation of specific real target systems.	(e)	
(f)	Resolve difficulties created by imperfect and incomplete information	(f)	
(g)	Derive conceptual models of real target systems, identifying the key parameters	(g)	

Mapping of 'Ability to...Statements' with output assessment methods employed by Professional Bodies

Professional Engineering Body

	Generic 'Ability to...Statement'	Method(s) used to assess 'ability to' (indicate using numbers as on page 1 of note)	Typical exemplar benchmarks used to assess that the threshold level has been reached
1.2.3	Ability to transform conceptual models into determinable models		
(a)	Construct determinable models over a range of complexity to suit a range of conceptual models	(a)	
(b)	Use mathematics and computing skills to create determinable models by deriving appropriate constitutive equations and specifying appropriate boundary conditions	(b)	
(c)	Use industry standard software tools and platforms to set up determinable models	(c)	
(d)	Recognise the value of Determinable Models of different complexity and the limitations of their application	(d)	

Mapping of 'Ability to...Statements' with output assessment methods employed by Professional Bodies

Professional Engineering Body

	Generic 'Ability to...Statement'	Method(s) used to assess 'ability to' (indicate using numbers as on page 1 of note)	Typical exemplar benchmarks used to assess that the threshold level has been reached
1.2.4	Ability to use determinable models to obtain system specifications in terms of parametric values		
(a)	Use mathematics and computing skills to manipulate and solve determinable models; and use data sheets in an appropriate way to supplement solutions	(a)	
(b)	Use industry standard software platforms and tools to solve determinable models	(b)	
(c)	Carry out a parametric sensitivity analysis	(c)	
(d)	Critically assess results and, if inadequate or invalid, improve knowledge database by further reference to existing systems, and/or improve performance of determinable models	(d)	

Mapping of 'Ability to...Statements' with output assessment methods employed by Professional Bodies

Professional Engineering Body

	Generic 'Ability to...Statement'	Method(s) used to assess 'ability to' (indicate using numbers as on page 1 of note)	Typical exemplar benchmarks used to assess that the threshold level has been reached
1.2.5	Ability to select optimum specifications and create physical models		
(a)	Use objective functions and constraints to identify optimum specifications	(a)	
(b)	Plan physical modelling studies, based on determinable modelling, in order to produce critical information	(b)	
(c)	Test and collate results, feeding these back into determinable models	(c)	

Mapping of 'Ability to...Statements' with output assessment methods employed by Professional Bodies

Professional Engineering Body

	Generic 'Ability to...Statement'	Method(s) used to assess 'ability to' (indicate using numbers as on page 1 of note)	Typical exemplar benchmarks used to assess that the threshold level has been reached
1.2.6	Ability to apply the results from physical models to create real target systems		
(a)	Write sufficiently detailed specifications of real target systems, including risk assessments and impact statements	(a)	
(b)	Select production methods and write method statements	(b)	
(c)	Implement production and deliver products fit for purpose, in a timely and efficient manner	(c)	
(d)	Operate within relevant legislative frameworks	(d)	

Mapping of 'Ability to...Statements' with output assessment methods employed by Professional Bodies

Professional Engineering Body

	Generic 'Ability to...Statement'	Method(s) used to assess 'ability to' (indicate using numbers as on page 1 of note)	Typical exemplar benchmarks used to assess that the threshold level has been reached
1.2.7	Ability to critically review real target systems and personal performance		
(a)	Test and evaluate real systems in service against specification and client needs	(a)	
(b)	Recognise and make critical judgements about related environmental, social, ethical and professional issues	(b)	
(c)	Identify professional, technical and personal development needs and undertake appropriate training and independent research	(c)	

Appendix 5

Brief details of the Washington and Sydney Accords

1 Washington Accord

This is an agreement between the UK, USA, Canada, Hong Kong, Australia, New Zealand, Ireland and South Africa and was signed in Washington in 1989.

It arose because there had been reciprocal accreditation of each countries engineering degrees – much of it undertaken by the UK following requests from the other countries – from which it became clear that the procedures for accreditation being followed by all the countries was similar. It was also helped by the fact that in all the countries, engineering degree courses are based on the British system.

Mutual accreditation had also given comfort as to the standard of such courses as well as the process, and therefore by the signing of the agreement, each country would recognise the education base of the degree courses of the signatory countries. Provision is made in the agreement for any country to visit another and verify the process and standards, although in practice this has not happened to a significant degree.

2 Sydney Accord

This is a more recent provisional agreement, based on the same countries as the Washington Accord, but concentrating on what we would describe as Incorporated Engineers. Its intent is similar to that of the Washington Accord and its name derives from the fact that the agreement to establish this was signed in Sydney.

Appendix 6

Brief details of developments in accreditation and assessment of output in other UK non-engineering professions

1 Medical Doctors

The General Medical Council is charged by Section 5 of the Medical Act 1983 with the responsibility for “determining the extent of the knowledge and skill which is required for the granting of primary UK qualifications”. The act requires it to ensure “that the instruction given in universities in the UK to persons studying for each qualification is sufficient to equip them with the knowledge and skills of that extent.” Section 5(3) goes on to say that the GMC’s determinations “shall be embodied in recommendations which may be directed to all or any of the universities or other bodies concerned with medical education”. The Education Committee of the GMC is charged by statute with responsibility for “promoting high standards of medical education and co-ordinating all stages of medical education”.

‘Tomorrow’s Doctors: Recommendations on Undergraduate Medical Education’ (1993) is the key document, although it is currently being revised. The recommendations embodied in this document relate to that part of training which is encompassed during the undergraduate years in medical school.

This had as its objective the reduction of curriculum overload, and encouraged universities and medical schools to identify a core curriculum and means of delivery, which might be supplemented by special study modules or electives, to allow medical students to express choice and explore particular interests. The report sets out key knowledge skills and attitudinal objectives, specifying student achievement on completion of the undergraduate course through the attainment of thirty-six attributes. Many of these attributes are presented in the ‘ability to’ format. For example ‘the ability to exercise sound clinical judgement, to analyse symptoms and physical signs in pathophysiological terms, to establish diagnoses, and to offer advice to the patient taking account of physical, psychological, social and cultural factors’. How these attainments are assessed in terms of level supported by exemplar benchmarks marks is not evident from the documentation studied.

The Medical Act and subsequent statutory instruments list the universities whose qualifications will be accepted for registration purposes. The GMC has the power to recommend to the Privy Council that universities be removed from the list if their provision is unsatisfactory. Universities are monitored through a regular programme of visits, and must by statute respond to the GMC’s observations and recommendations about their provision. However, unlike the accreditation process in engineering, the review appears to be institutional rather than specific to courses. The visit reports by the GMC are in the public domain, on the website. Ever since the publication of ‘Tomorrow’s Doctors’ the GMC has directed these visits towards monitoring what progress universities have made towards implementing its principal recommendations. Visit reports do therefore contain observation on how the delivery of essential skills is being addressed. However the reports are not written in any way that delivers a yes or no verdict on individual universities.

2 Nurses

The Department of Health in England is contracting with the QAA for the development and organisation of a process to review health profession academic programmes that lead to professional registration (Reference A). These programmes include time spent in clinical

practice and are analogous to a graduate apprenticeship scheme and the way in which the school teaching profession has moved to putting more of the educational base into the classroom. Nurses, for example, qualify after spending 2400 hours in clinical practice settings following an educational base equivalent to a Diploma of Higher Education.

Anticipating this development the United Kingdom Central Council (UKCC) for Nursing, Midwifery and Health Visiting established a Commission for Education under the chairmanship of Sir Leonard Peach. In its report, *Fitness for Practice*, (Reference B), the Commission recommended the construction of standards required for the registration of nurses in terms of benchmarked outcome competencies which were consistent with the QAA's thresholds for degrees and diplomas.

In August 2000, the Secretary of State approved new UKCC 2000 No. 2554 rules for Nurses training, (Reference C). These rules contain a Schedule listing of twenty outcomes to be achieved within a one-year Common Foundation Programme and a further seventeen outcomes to be achieved at the end of the two year Branch Programme and for entry to Parts 12-15 of the register.

At this stage the Working Group knows little about the way in which these outcomes are assessed although the documentation reviewed indicates that programmes will only be approved if they have:

- (a) clear learning outcomes in accordance with the QAA qualifications framework and the relevant benchmark statement;
- (b) a curriculum that is designed to enable the intended outcomes to be achieved;
- (c) assessment that is effective in measuring achievement of the outcomes;
- (d) student achievement that matches the intended outcomes and the level of the qualification.

3 The Legal Profession

Both the Law Society and the General Council of the Bar will recognise completion of a recognised law degree as satisfying the requirements of the initial or academic degree of training. For a degree to be recognised, the HEI providing it must satisfy the professional bodies that adequate learning resources are provided to support the course; that it has degree awarding powers; that the standards of achievement expected are set at or above the minimum level of performance as set out in the QAA Benchmarking statements for Law; and that there is at least one and a half year's coverage (180 credits) of some specified subjects known as the Foundations of Legal Knowledge. However, neither body actually carries out course accreditation. They instead assume that all law degrees will meet these requirements until they have reason to believe otherwise. However, the Bar Council has recently said that the possible attenuation of subject review as a result of changes to QA arrangements for higher education may mean that it will have to undertake its own accreditation in future.

It is worth noting that the Law Society is conducting a review of the training framework for solicitors, and that this is based very strongly on the idea of a grid of competencies. At present this is still at an early stage, but will no doubt impact upon the way initial qualification requirements are stated.

4 Accountancy

The structure of professional recognition in the accountancy profession is, in many ways similar to the engineering profession.

There is no legal licence requirement to practice as an accountant, however the Companies Act 1989 statutorily recognises five qualifying bodies (RQB's) in the UK for company auditors. The five recognised bodies are:

- The Institute of Chartered Accountants of England and Wales (ICAEW)
- The Institute of Chartered Accountants in Scotland (ICAS)
- The Institute of Chartered Accountants in Ireland (ICAI)
- The Association of Chartered Certified Accountants (ACCA)
- The Association of International Accountants (AIA)

Accountancy has a wide range of professional bodies representing the specialist activities within the profession, for example:

- The Institute of Financial Accountants (IFA)
- Association of Cost and Executive Accountants (ACEA)
- Chartered Institute of Public Finance and Accountancy (CIPFA)
- Association of Accounting Technicians (AAT)
- Chartered Institute of Management Accountants (CIMA)

In engineering the educational base for professional registration is achieved through the award of an 'accredited' degree from an Institution of Higher Education, in accountancy the academic courses recognised for professional registration are provided by the professional bodies and are assessed almost exclusively by output standard through national final examinations.

There are four levels to the academic base, each notionally a year of study:

Stage 1	Intermediate	–	AAT Certificate
Stage 2	Technician	–	AAT Membership
Stage 3	Professional	–	Professional Accountancy Certificate
Stage 4	Advanced	–	Chartered status

There are two pathways available: (1) Public Practice and (2) Commercial. However the examinations are the same for each pathway. Most entrants with a degree gain exemption from stages 1 and 2.

The assessment for the Professional stage consists of six examination papers which can be undertaken before entering a training contract. There are three sittings of the professional stage examinations each year.

The aim of the advanced stage is to integrate professional skills with business issues. The assessment consists of a rigorous Advanced Case Study (ACS) which consists of an examination of four hours duration, together with a Test of Advanced Technical Competence (TATC) which consists of two papers of 3.5 hours duration.

The ACS cannot be undertaken until the final year of the training contract and there are two sittings of the Advanced stage examinations each year.

The educational base of the accountancy profession is assessed almost exclusively by output standard through the medium of national examinations. The authorisation of training providers and the validation of curriculum provides a small measure of input standards. The educational base is linked to authorised training contracts which are available in approximately 2200 offices in the UK.

In the recently introduced new ICAEW qualification the professional stage syllabuses are written in full learning outcome format and have introduced a small element of objective testing into some examinations.

Whilst a numerate profession the skill appears to be viewed as artistic as well as scientific and, from a curriculum coverage point of view, the sole use of examinations as the means of assessment would be a cause for concern.

