

The Civil Engineering Technologist and the Civil Engineer – According to the Authorities, What's the Difference?

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Dr. Thomas Lenox is the executive vice president of Professional and Educational Strategic Initiatives for the American Society of Civil Engineers (ASCE). Dr. Lenox has over 43 years of experience as a leader, team builder, and manager in diverse professional and academic environments. During his 28-year military career, he spent fifteen years on the engineering faculty of the United States Military Academy (USMA) at West Point – including five years as the director of the Civil Engineering Division. As director of the Civil Engineering Division at USMA, Dr. Lenox supervised nineteen faculty in the ABETaccredited civil engineering program. He was the USMA nominee for the 1997 Carnegie Foundation Professor of the Year Award. He served as chair of both the Civil Engineering Division and the Middle-Atlantic Section of the American Society for Engineering Education (ASEE), and as a member of ASCE's Educational Activities Committee. Dr. Lenox also served as co-principal instructor of the NSF-supported Teaching Teachers to Teach Engineering (T4E) workshops at West Point in 1996, 1997, and 1998. Upon his retirement from the U.S. Army on October 1, 1998, Dr. Lenox joined the staff of the American Society of Civil Engineers (ASCE). In his position as educational staff leader of ASCE, he led several new educational initiatives – collectively labeled as Project ExCEEd (Excellence in Civil Engineering Education). A notable example is the ExCEEd Teaching Workshop, a nationally recognized workshop that develops inexperienced faculty into effective teachers and role models for the civil engineering profession. He continues to be very active in ASEE and other associations which foster teaching excellence - and has written numerous papers, made presentations, and run workshops dedicated to engineering educational reform. Currently, as ASCE's Executive Vice President (Professional & Educational Strategic Initiatives), Dr. Lenox is leading several educational and professional career-development projects for the civil engineering profession - with the overall objective of properly preparing individuals for their futures as civil engineers. A prime example is his long-term engagement in ASCE's initiative to "raise the bar" for entry into professional practice. Dr. Lenox received a Bachelor's of Science degree from the United States Military Academy, Master's of Science degree from Cornell University, Master's of Business Administration degree from Long Island University, and a Ph.D. degree from Lehigh University. He is also a graduate of several Army service and specialty schools to include the Army War College. Recent awards include the ASCE's ExCEEd Leadership Award, ASEE's George K. Wadlin Award, ASCE's William H. Wisely American Civil Engineer Award, and the CE News' "2010 Power List - 15 People Advancing the Civil Engineering Profession." Dr. Lenox was selected as a Distinguished Member of ASCE in 2013. He is married to Jane O'Connor Lenox. They have three adult children and three grandchildren.

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Background

While participating in a blue-ribbon panel at the 2008 ASCE Annual Civil Engineering Conference in Pittsburgh, Chuck Pennoni (a past president of both ASCE and ABET, and twice the interim president of Drexel University) stated "A problem that exists in civil engineering is that we do not have a clear definition between the capabilities and responsibilities of the Technician, the Technologist, and the Engineer."

The recent work of three ASCE task committees (the Paraprofessional Exploratory Task Committee, the Paraprofessional Task Committee, and the Technologist Credentialing Task Committee) has brought attention to the "problem" articulated by Chuck Pennoni. In particular these committees have wrestled with the differences between the educational requirements, career expectations, capabilities, roles, and responsibilities of the graduate of four year (a) ETAC/ABET-accredited civil engineering technology programs and (b) EAC/ABET civil engineering programs.

Purpose and Scope

This is first of several coordinated papers that will be written and presented to the Civil Engineering Division of ASEE. Collectively these scholarly papers will attempt to answer the question:

What <u>are</u> and what <u>should be</u> the differences between the capabilities and responsibilities of the civil engineering technologist (a graduate of a four-year ABET-accredited program in civil engineering technology [CET]) and the civil engineer (a graduate of an ABET-accredited program in civil engineering [CE])?

This particular paper will provide the background to this discussion. Specifically, the paper will analyze the <u>theoretical</u> differences between the capabilities and responsibilities of the CET and CE by examining key policy, criteria, and marketing documents of several relevant professional societies. By examining and analyzing several of the existing documents of these engineering organizations, this first paper will attempt to address a portion of the question posed above by addressing the following more narrow question:

According to several relevant and/or representative professional engineering societies, what <u>should be</u> the differences between the capabilities and responsibilities of the civil engineering technologist and the civil engineer?

For the purpose of this paper, the authors selected the following organizations (listed in the order of discussion) as being relevant and/or representative:

- 1. American Society of Civil Engineers (ASCE)
- 2. National Society of Professional Engineers (NSPE)
- 3. National Institute for Certification in Engineering Technologies (NICET)
- 4. National Council of Examiners for Engineering and Surveying (NCEES)
- 5. International Engineering Alliance (IEA)
- 6. ABET, Inc. (ABET)
- 7. U.S. Office of Personnel Management (USOPM)
- 8. American Society for Engineering Education (ASEE)

While the nominal topic of this paper is the theoretical difference between the responsibilities and capabilities of the <u>civil</u> engineering technologist (compared to the <u>civil</u> engineer), most of the authoritative documents on this subject are not discipline specific. That is, these documents relate to all <u>engineering</u> technologists regardless of their specific engineering discipline. As such, the authors believe that including key documents related to all engineering technologist is important, if not critical, to the information and analysis herein.

American Society of Civil Engineers (ASCE)

It is appropriate to begin this review of the authoritative statements regarding roles and responsibilities of the <u>civil</u> engineering technologist with the American Society of Civil Engineers (ASCE) – the lead professional society of the individual civil engineer. ASCE has the most authoritative policy statements related to the civil engineering technologist. The most pertinent to this paper include ASCE Policy Statements (PS) 433, 465, and 535. Of these three, Policy Statement 535 (PS 535) is the most relevant, and directly related, to this study.¹⁰

PS 535 clearly defines the civil engineering team as consisting of members fulfilling three distinct roles; specifically the (1) civil engineering professional, (2) civil engineering technologist, and (3) civil engineering technician – emphasizing that all are important members of the civil engineering project team. According to this PS 535, a --

- Civil Engineering Professional (CE Professional) is a person who holds a professional engineering license. A person initially obtains status as a CE Professional by professional engineering (PE) licensure obtained through the completion of requisite formal education, experience, examination, and other requirements as specified by an appropriate Board of Licensure. A person working as a CE Professional is qualified to be professionally responsible for engineering work through the exercise of direct control and personal supervision of engineering activities and can comprehend and apply an advanced knowledge of widely applied engineering principles in the solution of complex problems.
- Civil Engineering Technologist (CE Technologist) is a person who exerts a high level of judgment in the performance of engineering work, while working under the direct control and personal supervision of a CE Professional. A person initially obtains status as a CE Technologist through the completion of requisite formal education and experience and may include examination and other requirements as specified by a

credentialing body. A person working as a CE Technologist can comprehend and apply knowledge of engineering principles in the solution of broadly defined problems.

• Civil Engineering Technician (CE Technician) is a person typically performing taskoriented scientific or engineering related activities and exercising technical judgments commensurate with those specific tasks. A person working as a CE Technician works under the direct control and personal supervision of a CE Professional or direction of a CE Technologist. A person initially obtains status as a CE Technician through the completion of requisite formal education, experience, examination(s), and/or other requirements as specified by an appropriate credentialing body. A person working as a CE Technician is expected to comprehend and apply knowledge of engineering principles toward the solution of well-defined problems.

Based upon these three definitions, certain key points need to be emphasized:

- 1. ASCE's use of the terms engineering professional, engineering technologist, and engineering technician is consistent with the use of these terms by the other professional societies. Unfortunately, our experience is that authors/speakers are often imprecise when differentiating between the three roles particularly the roles of the engineering technologist and the engineering technician. As in most scholarly discussions, the use of the correct vocabulary is absolutely necessary for clear, consistent, and correct communications.
- 2. ASCE clearly defines level of authority and a "chain-of-command." Specifically:
 - a. A civil engineering professional is qualified to be professionally responsible for engineering work through the exercise of direct control and personal supervision of engineering activities.
 - b. A civil engineering technologist exerts a high level of judgment in the performance of engineering work, while working under the direct control and personal supervision of a professional civil engineer.
 - c. A civil engineering technician works under the direct control and personal supervision of a professional civil engineer or direction of a civil engineering technologist.
- 3. ASCE specifically states that the professional engineering license is held by civil engineering professionals and makes no inference that the civil engineering technologist (or technician) should be licensed as a professional engineer.
- 4. Based upon PS 535, ASCE has made fundamental statements relative to the competencies of the three classifications of members within the civil engineering team:
 - a. The professional civil engineer can comprehend and apply an advanced knowledge of widely applied engineering principles in the solution of complex problems.
 - b. The civil engineering technologist can comprehend and apply knowledge of engineering principles in the solution of broadly defined problems.

c. The civil engineering technician is expected to comprehend and apply knowledge of engineering principles toward the solution of well-defined problems.

As will be pointed out later in this paper, ASCE's statements of competency are consistent with the statements made by the International Engineering Alliance (IEA) -- the organization that coordinates worldwide agreements associated with the education of engineers, engineering technologists, and engineering technologists.

5. PS 535 makes repetitive use of the phrase "requisite formal education" in its three classifying definitions. These are not defined explicitly within PS 535; however, ASCE addresses the "requisite formal education" for professional civil engineers in ASCE Policy Statements 433 and 465. This will be explained in the next paragraphs.

ASCE Policy Statement 433 (PS 433) provides explicit statements relevant to the use of the term "engineer." According to PS 433, the only bases for using the title or designation "engineer" are -

- a. Graduation from an accredited engineering program with a degree in engineering;
- b. Licensure as a professional engineer or engineer-in-training under a state engineering registration law; or
- c. An official ruling designating an individual or a group in an engineering capacity as meeting the definition of "Professional Engineer" (P.E.) under the Taft-Hartley Act or the Fair Labor Standards Act.

PS 433 also addresses the use of the term "engineer" by others in the engineering community by stating that—

Only persons in one of these categories should be designated by the title "engineer" or "professional engineer." This policy shall not be construed to prohibit using the word "engineering" as a modifier in titles such as "engineering assistant," "engineering aide" and "engineering technologist" where the title clearly implies that the duties of the position are not those of professional engineer.

ASCE Policy Statement 465 (PS 465) also addresses the academic prerequisites for licensure and practice as a professional civil engineer.⁸ PS 465 supports the attainment of an explicit Body of Knowledge for entry into the practice of civil engineering at the professional level – and that fulfillment of this Body of Knowledge includes "a baccalaureate degree in civil engineering."

National Society of Professional Engineers (NSPE)

The National Society of Professional Engineers (NSPE) is the national organization committed to addressing the professional concerns of licensed PEs across <u>all</u> disciplines. NSPE is considered the recognized voice and advocate of licensed Professional Engineers. Its membership includes approximately 35,000 individuals – primarily professional engineers and engineer interns.

NSPE has three professional policies (PP) that, when taken collectively, provide NSPE's perspective on the differences between the capabilities and responsibilities of the engineer and the engineering technologist. These include NSPE's PP 128 (Technology/Engineering), PP 152 (Licensure and Qualifications for Practice), and PP 166 (Professional Engineers/Certified Engineering Technicians and Technologists Relations). Since this issue is important for the professional licensure community, NSPE has publicized a special "Issue Brief" on this topic.²⁴ NSPE's position states--

NSPE believes that a bachelor's degree in engineering from a program accredited by ABET's Engineering Accreditation Commission, or one assessed by EAC/ABET as substantially comparable, should be the minimum educational requirement for professional engineer licensure. NSPE endorses the NCEES Model Law, which establishes as the sole minimum educational requirement for PE licensure that the individual possess an engineering degree from an engineering program accredited by EAC/ABET. NSPE opposes efforts to establish legal competency criteria for engineering technicians and technologists. However, NSPE supports the establishment of recognized levels of competence for technicians and technologists, and has sponsored the National Institute for Certification in Engineering Technologies with this interest in mind.

The key background points made by NSPE in support of this position include the following:

- 1. Under the requirements of professional engineer licensing laws, an individual's competence to practice engineering is determined by subjecting him or her to a rigorous process. This process typically requires the individual to obtain a bachelor of engineering degree from an engineering program accredited by ABET's Engineering Accreditation Commission, successfully complete two comprehensive examinations written by the National Council of Examiners for Engineering and Surveying, and demonstrate a level of acceptable engineering experience.
- 2. Many state PE laws also provide routes to PE licensure that bypass the EAC/ABET education requirement. Some states explicitly permit individuals holding a bachelor of engineering technology degree to become licensed as PEs. This reflects a lack of understanding of the distinction between engineering and engineering technology.
- 3. Engineering and engineering technology are recognized as distinct points on the technical occupational spectrum. For example, ABET's accreditation criteria defines engineering as "the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to use economically the materials and forces of nature for the benefit of mankind." Engineering technology is defined as "that part of the technological field that requires the application of scientific and engineering activities; it lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer." In other words, the engineer is the person who implements it.

- 4. The distinction between engineering and engineering technology emanates primarily from differences in their educational programs. Engineering programs are geared toward development of conceptual skills, and consist of a sequence of engineering fundamentals and design courses, built on a foundation of complex mathematics and science courses. Engineering technology programs are oriented toward application, and provide their students introductory mathematics and science courses, and only a qualitative introduction to engineering fundamentals. Thus, engineering programs provide their graduates a breadth and depth of knowledge that allows them to function as designers. Engineering technology programs prepare their graduates to apply others' designs.
- 5. This distinction between engineering and engineering technology is acknowledged in several ways. For example, ABET establishes separate accreditation criteria for each program. The criteria prohibit an accredited engineering technology program from claiming that it gives its graduates the equivalent of an engineering education. In addition, a comparison of the pass rates on the Fundamentals of Engineering exam between engineering and engineering technology graduates indicates that technology graduates have a significantly more difficult time with the exam than do engineering graduates.
- 6. Proponents of PE licensure for engineering technologists argue that, for purposes of licensure, the engineering technology program provides a substantially equivalent education to the engineering program. They argue the prohibition on PE licensure for technologists unduly restricts otherwise qualified individuals from seeking licensure. Proponents also point out that because over half of the states permit technology graduates to become licensed; those states that prohibit such licensure are essentially depriving their citizens of economic and professional opportunities in their home states.

The authors of this paper suspect that many members of the engineering community do not agree with NSPE's perspective. However, we suspect that most will agree that NSPE has been very clear, consistent, and transparent with their perspective on the differences between the capabilities and responsibilities of the engineer and the engineering technologist.

National Institute for Certification in Engineering Technologies (NICET)

The Institute for the Certification of Engineering Technicians (ICET) was established in 1961 to create a recognized certification for engineering technicians within the United States. ICET was originally authorized to issue certifications to those qualified on three levels: engineering technician trainee, engineering technician, and senior engineering technician. These same levels exist today, plus a fourth, the associate engineering technician. In the 1970s, confusion over the relationship between technologists and engineers culminated in the 1976 founding of the Engineering Technologist Certification Institute (ETCI). ETCI shared staff with ICET but maintained its own board of trustees. Certification for technologists was slow, with less than 500 by 1980, and the two institutes merged under the NICET name in the summer of 1981. The result is a nonprofit organization that provides a nationally recognized and accepted procedure

for recognition of qualified engineering technicians and technologists. Since its founding, this wholly owned service of NSPE has issued more than 130,000 certifications.

The mission of NICET is to "Provide an independent evaluation of technical knowledge and experience, through certification, among those working in the fields of engineering and engineering technology; define and support career paths for engineering technicians, and engineering technologists and related disciplines; and ensure recognition and continued professional development of certified individuals."

NICET, in its role as a certification organization of technicians and technologists, has made explicit statements related to the capabilities and responsibilities of the members of the engineering team.²² These include—

- 1. NICET defines <u>engineering technicians</u> as the "hands-on" members of the engineering team who work under the direction of engineers, scientists, and technologists. They have knowledge of the components, operating characteristics, and limitations of engineering systems and processes particular to their area of specialization.
- 2. NICET defines <u>engineering technologists</u> as members of the engineering team who work closely with engineers, scientists, and technicians. Technologists have a thorough knowledge of the equipment, applications, and established state-of-the-art design and implementation methods in a particular engineering area.

NICET makes a clear and explicit statement regarding the relationship between the work of the technician/technologist and the work of the licensed professional engineer.

NICET certification does not entitle the certificant to practice engineering. The practice of engineering is defined and regulated by state engineering licensing boards; unlawful practice of engineering is a violation of state laws. When not exempted by state law, the performance of work by the engineering technician/technologist which constitutes the practice of engineering must be under the direct supervision and control of a licensed professional engineer.²²

NICET Policy 32 ("Certification and the Practice of Engineering") further states that "NICET is opposed to any effort by any individual or group to misrepresent the NICET certification program as a program designed or intended to demonstrate qualifications to practice engineering as defined under state law or regulations."²²

National Council of Examiners for Engineering and Surveying (NCEES)

The National Council of Examiners for Engineering and Surveying (NCEES) is a national nonprofit organization that works to advance professional licensure for engineers and surveyors. It develops, administers, and scores the examinations used for engineering and surveying licensure in the United States. The members of NCEES are the engineering and surveying

licensure boards from all 50 states, the District of Columbia, Guam, Puerto Rico, and the U.S. Virgin Islands.

The primary purpose of NCEES is to serve as an organization through which its member boards can counsel and act together to better discharge their duties as individual, autonomous regulatory agencies dedicated to the protection of the public life, health, and property. NCEES also facilitates professional mobility and promotes uniformity of the U.S. licensure processes through services (records program, study materials, credentials evaluations, exam administration, etc.) for its member licensing boards and licensees. One of the most important services that NCEES provides to facilitate professional mobility and to promote uniformity is the maintenance of an up-to-date "Model Law." As stated by NCEES in its introduction to the Model Law –

The intent of NCEES in preparing this document [the Model Law] is to present to the jurisdictions a sound and realistic guide that will provide greater uniformity of qualifications for licensure, to raise these qualifications to a higher level of accomplishment, and to simplify the interstate licensure of engineers and surveyors. . . . Standards presented in this publication have been approved by the NCEES member boards and represent optimum, realistic levels of qualifications for initial and subsequent licensure to ensure protection of the public's interest.¹⁹

Related to NCEES and/or its Model Law, the following facts are important to this study:

- 1. All state licensure jurisdictions will provide a license to a "Model Law Engineer" who possesses Model Law attributes including: a baccalaureate degree in engineering from a program accredited by the Engineering Accreditation Commission of ABET (EAC/ABET); four years or more of acceptable and progressive engineering experience; documentation of having passed both the Fundamentals of Engineering (FE) examination and the Principles and Practices of Engineering (PE) examination, and; a record which is clear of violations of ethical standards.
- 2. While many states have other additional pathways to engineering licensure for those not having an EAC/ABET degree (commonly also requiring additional years of engineering experience), the NCEES Model Law does not provide for any alternative formal educational path other than being a "graduate of an engineering of 4 years or more accredited by the Engineering Accreditation Commission of ABET (EAC/ABET) or an engineering master's program accredited by EAC/ABET." That is, the Model Law is "silent" regarding the licensure of graduates of programs accredited by the Engineering Technology Commission of ABET (ETAC/ABET). Said another way, the Model Law does not recognize a four-year ETAC/ABET technology degree as being "equivalent" to a four-year EAC/ABET engineering degree.
- 3. Effective no earlier than 2020, the Model Law educational requirements for engineering licensure have been raised by NCEES. "Model Law 2020" specifies that future professional engineers have (1) a master's degree from a program accredited by EAC/ABET, or (2) a baccalaureate degree from a program accredited by EAC/ABET plus either (2a) a master's degree in engineering from an institution which offers EAC/ABET programs, or; (2b) 30 additional semester credits of upper level

undergraduate or graduate level coursework in engineering, math, science and professional practice topic areas. "Model Law 2020" does not recognize a four-year ETAC/ABET technology degree as being "equivalent" to an EAC/ABET baccalaureate degree.

In addition to the Model Law, NCEES has three important policies related to engineering and engineering technology education. These include NCEES Position Statements (PS) 7 and 8:

PS 7 (Evaluation of Applicants with Degrees in Technology) states that graduates of four-year baccalaureate programs in engineering technology accredited by ETAC/ABET should be granted a maximum of two years of educational credit toward professional engineering licensure. In other words, NCEES equates a year of an ETAC/ABET baccalaureate program to a half-year of an EAC/ABET baccalaureate program– and maximizing the educational credit for an engineering technology degree to a maximum of two years.²⁰

PS 8 (Bachelor of Science Degree in Engineering) recommends that any applicant who applies for engineering licensure in any jurisdiction of the United States (and who is not already licensed to practice engineering by a state) be required to have at least a four-year bachelor of science degree in engineering, acquired through the successful completion of an EAC/ABET-accredited program or through a board-approved equivalent program. This position reinforces the standard of an EAC/ABET degree for licensure as compared to programs accredited by other accreditation commissions (e.g., ETAC/ABET) or organizations.²⁰

One other NCEES position statement warrants discussion, i.e., PS 13 (NCEES-Recommended Education/Experience Guidelines for P.E. Licensing). This position statement consists solely of the following table (with its single footnote):²¹

4-Year or More Degree	Years of Experience Required	Comments
EAC/ABET Accredited	4	NCEES PS 8
Canada (CEAB) Accredited	4	
Other Countries	4 or more	Education should be evaluated for EAC/ABET equivalence.

Recommendations below are only for member boards that must evaluate applicants who do not meet the minimum education of an EAC/ABET or equivalent degree as specified in PS 8.

Unaccredited Engineering Program	6	Needed by some boards
ETAC/ABET Accredited	6	Needed by some boards
Related Science*	8	Needed by some boards
No Degree	20	Needed by some boards

*A related science curriculum from a school or college approved by the board is defined as a four-year curriculum leading to a bachelor of science degree in chemistry, physics, mathematics, or similar science curriculum.

The last four rows of this table from PS 13 are often interpreted as an NCEES acknowledgement of the "equivalence" of the ETAC/ABET degree as fulfilling the NCEES Model Law. This would be an incorrect interpretation. The sole purpose of these last four rows is to standardize

the experience requirements in those states that accept applicants that do not meet the minimum educational standard of the Model Law and NCEES PS 8.

International Engineering Alliance (IEA)

The International Engineering Alliance (IEA) is a global organization that coordinates worldwide agreements associated with the education of engineers, engineering technologists, and engineering technicians. The IEA consists of those who have signed any of the following agreements: Washington Accord, Sydney Accord, Dublin Accord, International Professional Engineers Agreement (IPEA), International Engineering Technologist Agreement (IETA), International Agreement for Engineering Technicians (IETECHA), or APEC Engineer Agreement (APECEA). ABET, NCEES, and NSPE (through their membership in the United States Council for International Engineering Practice (USCIEF)) participates in both the IPEA and APECEA. This paper will focus only on the three accords.

The Washington Accord, Sydney Accord and Dublin Accord are agreements among organizations that accredit academic degree programs. These are non-governmental agreements that recognize the substantial equivalency of the organizations' accreditation processes and the graduates' preparedness to begin professional practice at the entry level. The Washington Accord was the first (signed in 1989). It recognizes substantial equivalence in the accreditation of qualifications of professional <u>engineers</u>. The Sydney Accord (2001) recognizes substantial equivalence in the accreditation of qualifications of engineering technologists. The Dublin Accord (2002) is an agreement for substantial equivalence in the accreditation of qualifications of engineering technologists. ABET is a signatory of both the Washington Accord and the Sydney Accord. ABET is not a signatory of the Dublin Accord.¹⁶

IEA has developed a document called the "Graduate Attributes and Professional Competencies." This document includes statements of the graduate attributes and professional competency profiles for engineers, engineering technologists, and engineering technicians. "Graduate Attributes and Professional Competencies" is an international authoritative document that defines the differences between the capabilities and responsibilities of the engineer, the engineering technologist, and the engineering technician.¹⁵

"Graduate Attributes and Professional Competencies" is extremely insightful and valuable in documenting the differences between the three categories of members of the engineering team. The document is very explicit and extremely thorough in defining and differentiating between complex problems, broadly-defined problems, and well-defined problems/activities – generally associating these terms with the work of the engineer, engineering technologist, and engineering technician, respectively. These definitions are used to tabulate "knowledge profiles" and "graduate attribute profiles" of the three categories of engineering roles. Finally, IEA documents the differentiating characteristics of the engineer, engineering technologist, and engineering technologist in a key table called "Professional Competency Profiles."¹⁵

IEA's "Graduate Attributes and Professional Competencies" is both scholarly and masterful in how it addresses a very complex topic. As such, the authors have attached the entire 15-page

document as an appendix to this paper. Of particular interest to the reader should be the table in Section 6 – "Professional Competency Profiles." The yellow highlights were added by this paper's authors.

ABET, Inc.

ABET was founded in 1932 as the Engineers' Council for Professional Development (ECPD), an engineering professional body dedicated to the education, accreditation, regulation, and professional development of the engineering professionals and students in the United States. In 1936, ECPD evaluated its first engineering degree programs. Ten years later, the council began evaluating engineering technology degree programs. By 1947, ECPD had accredited 582 engineering programs and 14 technology programs. In 1980, ECPD was renamed the Accreditation Board for Engineering and Technology (ABET) to more accurately describe its emphasis on accreditation of both engineering (1303 programs) and technology programs (637). In response to the boom in computer science education, ABET helped establish the Computing Sciences Accreditation Board (now called CSAB) in 1985. CSAB is now one of ABET's largest member societies with more than 300 accredited programs. In 2005, ABET formally changed its name to ABET and no longer uses the title "Accreditation Board for Engineering and Technology." ABET is an organization of professional and technical societies - not individuals. Currently, ABET has 31 member societies.

In analyzing the <u>theoretical</u> differences between the capabilities and responsibilities of the engineer and the engineering technologist, the authors will address ABET in two separate subsections. The first will address ABET policies and governing documents; the second will address ABET accreditation criteria.

ABET Policies and Governing Documents

The clearest evidence that ABET differentiates between the capabilities and responsibilities of the engineer and the engineering technologist is the fact that ABET has separate governing bodies for engineering and technology. As specified in the Section Fourteen of the ABET Bylaws: "The accreditation of educational programs leading to degrees shall be conducted by bodies called Commissions that are established by the Board of Directors. The Accreditation Commissions are responsible for conducting accreditation evaluations of educational programs and rendering decisions, on these programs, that are based on policies and Accreditation Criteria that have been approved by the Board."⁴ Section Fourteen of the ABET Bylaws also states that the commissions shall be the Applied Science Accreditation Commission (ASAC), the Computing Accreditation Commission (CAC), the Engineering Accreditation Commission (EAC), and the Technology Accreditation Commission (TAC).⁴

[Authors' Note: The ABET Board of Directors approved changing the name of the Technology Accreditation Commission (TAC) to the Engineering Technology Accreditation Commission (ETAC) on March 24, 2012. During the current transition period of modifying ABET's official documents to reflect this decision, readers are advised to treat the two names synonymously in this paper.] The Accreditation Policy and Procedure Manual of ABET (APPM) provides some additional differentiation between the roles of the four commissions. Regarding the EAC and TAC, the APPM states:¹

II.E.3.c. EAC - Programs accredited by EAC are those leading to the professional practice of engineering. EAC accredits a program at the baccalaureate or master's degree level.

II.E.3.d. TAC - Programs accredited by TAC prepare baccalaureate degree graduates for careers as engineering technologists and prepare associate degree graduates for careers as engineering technicians. TAC accredits a program at the associate or baccalaureate degree level.

For the record, paragraph II.E.3.d is scheduled to be modified in the APPM for the 2013-2014 accreditation cycle to state:⁵

II.E.3.d. ETAC - Baccalaureate programs accredited by ETAC are those leading to the professional practice of engineering technology. Associate degree programs prepare graduates for careers as engineering technicians. ETAC accredits a program at the associate or baccalaureate degree level.

ABET has supplemented its governing documents with an explanation of the difference between the engineer and the engineering technologist that is understandable and accessible to potential students and their parents. ABET's explanation at <u>http://www.abet.org/engineering-vs-</u> engineering-technology/ is depicted in the

ABET Accreditation Criteria

graphic to the right.

The EAC and the ETAC have separate criteria that define the expected "outcomes" of engineering and engineering technology programs, respectively. "Outcomes," as used by ABET, are statements that describe what students are expected to know and be

Engineering vs. Engineering Technology

How are they different?

Engineering and engineering technology are separate but closely related professional areas. Here are some of the ways they differ:



Text

Curricular Focus

Engineering programs often focus on theory and conceptual design, while engineering technology programs usually focus on application and implementation.

Also, engineering programs typically require additional, higher-level mathematics, including multiple semesters of calculus and calculus-based theoretical science courses. Engineering technology programs typically focus on algebra, trigonometry, applied calculus, and other courses that are more practical than theoretical in nature.

Career Paths

Graduates from engineering programs are called engineers. They often pursue entry-level work involving conceptual design or research and development. Many continue on to graduate-level work in engineering.

Graduates of four-year engineering technology programs are called technologists, while graduates of two-year engineering technology programs are called technicians. These professionals are most likely to enter positions in sectors such as construction, manufacturing, product design, testing, or technical services and sales. Those who pursue further study often consider engineering, or facilities management, or business administration.

Of course, there is much overlap between the fields. Engineers may pursue MBAs and open their own consulting firms, while technologists may spend their entire careers in design capacities.

Differences in ABET Accreditation

For ABET accreditation, engineering and engineering technology programs are reviewed and accredited by two separate accreditation commissions, using two separate sets of accreditation criteria: the Engineering Accreditation Commission and the Engineering Technology Accreditation Commission.

able to do by the time of their graduation. These relate to the knowledge, skills, and behaviors that students acquire as they progress through their program. While the outcomes differ for each of the four commissions, "harmonization" of the four accreditation criteria resulted in the outcomes being included in "Criterion 3. Student Outcomes" in each of the four commissions' criteria.

A side-by-side comparison of the student outcomes of the EAC criteria² and the ETAC criteria³ is included in the following table. Please note that while the EAC outcomes are listed in order, the ETAC are not. The ETAC outcomes are listed adjacent to the EAC outcome that is most similar. Please note that EAC Outcome 3(j) has no similar ETAC outcome; and ETAC Outcome 3(k) has no similar EAC outcome.

Crit.	EAC	Crit.	ETAC (TAC)
3(a)	An ability to apply knowledge of mathematics, science, and engineering	3(b)	An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;
3(b)	An ability to <mark>design and conduct</mark> experiments, as well as to analyze and interpret data	3(c)	An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;
3(c)	An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	3(d)	An ability to design systems, components, or processes for <mark>broadly-defined engineering</mark> technology problems appropriate to program educational objectives;
3(d)	An ability to function on multidisciplinary teams	3(e)	An ability to function effectively as a member or leader on a technical team;
3(e)	An ability to identify, formulate, and solve engineering problems	3(f)	An ability to identify, analyze, and solve <mark>broadly-</mark> defined engineering technology problems;
3(f)	An understanding of professional and ethical responsibility	3(i)	An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity;
3(g)	An ability to communicate effectively	3(g)	An ability to apply written, oral, and graphical communication in both technical and non- technical environments; and an ability to identify and use appropriate technical literature;
3(h)	The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	3(j)	A knowledge of the impact of engineering technology solutions in a societal and global context; and
3(i)	A recognition of the need for, and an ability to engage in life-long learning	3(h)	An understanding of the need for and an ability to engage in self-directed continuing professional development;
3(j)	A knowledge of contemporary issues		
3(k)	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	3(a)	An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;
		3(k)	A commitment to quality, timeliness, and continuous improvement.

In the opinion of the authors, the table shows that –

- Even though ETAC's criteria do not include an outcome similar to EAC Criterion 3(j) ("knowledge of contemporary issues") and EAC's criteria do not have a comparable outcome to ETAC Criterion 3(k) ("commitment to quality, timeliness, and continuous improvement"), the criteria are quite similar. Since these criteria were developed several years apart (with the EAC criteria being published first), this is not surprising. Regardless of the similarity, the authors of this paper have tried to show the key differences in each similar criterion by selective use of yellow highlighting in the list above.
- The two criteria were designed to be different. This is intuitively obvious since the authors of the ETAC criteria had the opportunity to use the exact wording of the EAC criteria but did not elect to do so!
- The ETAC criteria use the phrase "broadly-defined" several times. The authors surmise that this was done intentionally to incorporate the phraseology used in the International Engineering Alliance (IEA) document related to the Sydney Accord and the competency profile of the technologist (see the previous section of this paper related to the IEA).

The program criteria for the civil engineer and the civil engineering technologist can also be analyzed for their differences. For civil engineering programs, the criteria states² –

The program must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science, consistent with the program educational objectives; apply knowledge of four technical areas appropriate to civil engineering; conduct civil engineering experiments and analyze and interpret the resulting data; design a system, component, or process in more than one civil engineering context; explain basic concepts in management, business, public policy, and leadership; and explain the importance of professional licensure.

For the four-year civil engineering technology graduate, the program criteria include³ –

- utilize principles, hardware, and software that are appropriate to produce drawings, reports, quantity estimates, and other documents related to civil engineering;
- o conduct standardized field and laboratory tests related to civil engineering;
- o *utilize surveying methods appropriate for land measurement and/or construction layout;*
- apply fundamental computational methods and elementary analytical techniques in subdisciplines related to civil engineering.
- o plan and prepare documents appropriate for design and construction;
- perform economic analyses and cost estimates related to design, construction, operations and maintenance of systems associated with civil engineering;
- o select appropriate engineering materials and practices, and;
- perform standard analysis and design in at least three sub-disciplines related to civil engineering.

In the two listing of program criteria shown above, the authors of this paper have highlighted key differences between the criteria. A primary difference is the EAC's requirement for advanced mathematics, calculus-based physics, and additional basic science in the civil engineering program criteria. And while the ETAC criteria require the graduate to utilize surveying methods appropriate for land measurement and/or construction layout, the EAC criteria for civil engineering have no explicit requirement for surveying. It is notable that both sets of program criteria require "civil engineering technical breadth."

Federal Government and the Office of Personnel Management (OPM)

The federal government employs thousands of engineers throughout the United States and overseas. These positions generally range from GS-5 to GS-15 in more than twenty disciplines and occupational specialties. Engineering positions have a fairly strict education requirement. The applicant must have completed a four-year degree in engineering (not engineering technology) from an accredited college or university. There are alternative ways to qualify, such as (1) professional registration as a professional engineer (PE) through a state or (2) passing the engineer-in-training exam accompanied by an engineering technology degree; however, these non-standard employment paths require very thorough documentation.

The grade level at which an applicant is qualified can be summarized as --

- Basic education will qualify the applicant at the GS-5 level.
- Superior academic achievement, roughly a grade point average of 3.0 overall or 3.5 in an engineering major, can qualify the applicant as a GS-7.
- Qualification at the GS-9 level and above is based on the length and extent of experience.

The key point is that four-year engineering technology graduates are limited in the OPM classified job description to the technician designation. According to the OPM, engineering technology graduates are not qualified to hold the title of "engineer" unless they can comply with the following provisions:²⁵

Applicants who have passed the EIT examination and have completed all the requirements for either (a) a bachelor's degree in engineering technology (BET) from an accredited college of university that included 60 semester hours of courses in the physical, mathematical, and engineering sciences, or (b) a BET from a program accredited by the Accreditation Board for Engineering and Technology (ABET) may be rated eligible for certain engineering positions at GS-5. Eligibility is limited to positions that are within or closely related to the specialty field of the engineering technology program. Applicants for positions that involve highly technical research, development, or similar functions requiring an advanced level of competence in basic science must meet the basic requirements in paragraph A [Note: "the basic requirements in paragraph A" stipulate that the candidate have an accredited <u>engineering</u> degree].

Because of the diversity in kind and quality of BET programs, graduates of other BET programs are required to complete at least 1 year of additional education or highly technical work experience of such nature as to provide reasonable assurance of the possession of the

knowledge, skills, and abilities required for professional engineering competence. The adequacy of this background must be demonstrated by passing the EIT examination.

As such, the Federal Government, employing 6% of the engineering workforce in the United States, makes a clear distinction between the potential roles and responsibilities of the civil engineering graduate and the civil engineering technology graduate.

American Society for Engineering Education (ASEE)

The American Society for Engineering Education (ASEE) is a nonprofit organization of individuals and institutions committed to furthering education in engineering and engineering technology. According to its web site, it accomplishes this mission by --

- promoting excellence in instruction, research, public service, and practice;
- exercising worldwide leadership;
- fostering the technological education of society; and
- providing quality products and services to members.

ASEE develops policies and programs that enhance professional opportunities for engineering faculty members, and promotes activities that support increased student enrollments in engineering and engineering technology educational institutions. ASEE has over 12,000 members -- primarily deans, department heads, and faculty members who represent all disciplines of engineering and engineering technology. It also includes some students and government and industry representatives. ASEE also includes organizational members composed of 400 engineering and engineering technology colleges and affiliates, more than 50 corporations, and numerous government agencies and professional associations. ASEE directs many of its efforts at providing for open and ongoing dialogues among these groups.

Related to the purpose of this paper, the authors' research did not uncover <u>any</u> ASEE policy explicitly related to the distinction between the engineer and the technologist. However, the authors believe that there is <u>implicit</u> evidence that ASEE recognizes a distinct difference between the capabilities and responsibilities of these two groups. This implicit evidence includes –

- ASEE has 50 separate "divisions" related to engineering and engineering technology. Of these, there is a single Engineering Technology Division for those interested in issues related to the technology education of all specialty disciplines. Most of the other 49 divisions of ASEE (e.g. Biomedical Engineering , Chemical Engineering, Civil Engineering, Electrical & Computer Engineering , Industrial Engineering , etc.) focus on engineering education topics related to a specific engineering discipline.
- ASEE has separate "councils" for the institutional leaders of engineering programs and engineering technology programs called the Engineering Deans Council (EDC) and Engineering Technology Council (ETC), respectively.
 - The EDC has 344 members, representing over 90 percent of all engineering deans in the United States. The objectives of the EDC are to (1) provide vision on engineering education and research, (2) advocate for engineering education and research, and

serve as a resource to its constituents and the public at large, (3) articulate and influence US public policy on engineering education and research, (4) partner with stakeholders (e.g. industry, government, educators and professional organizations) to promote excellence at every level of engineering education and research, (5) facilitate the exchange of information among its members and their stakeholders, and (6) provide a forum for member colleges to foster dialog and collaboration and to share best practices.⁶

- In comparison, the mission statement of the ETC states that it "is the national organization that speaks for engineering technology education and is committed to promoting quality education and creative endeavors in engineering technology." Its goals are to (1) strengthen its position as the national organization that speaks for engineering technology education, (2) promulgate the definition of engineering technology, (3) promote quality engineering technology education, (4) develop leaders for engineering technology education, and (5) develop appropriate guidelines and promote scholarship for engineering technology educators.⁷
- ASEE is a "Member Society" of ABET and a member of <u>both</u> the EAC/ABET and the ETAC/ABET. Within EAC, it is the "Lead Society" for programs in Engineering, General Engineering, Engineering Science, and Engineering Physics. Within ETAC, it is the "Lead Society" for programs in Engineering Technology (without modifiers).

This implicit evidence could be considered very weak. Nonetheless, absent any official ASEE policies, this implicit evidence is arguably the sole indicator that ASEE draws a distinction between the capabilities and responsibilities of future engineers and engineering technologists. Having said this, ASEE has become a focal point for much of the "unofficial" written scholarship concerning this potentially controversial topic. Specifically, during 2012, the *Journal of Engineering Technology* included several excellent (and thought provoking!) articles related to the capabilities of future engineering technologists. These articles, written by technology educational leaders include (listed in the order of the date of their publication):

- 1. "Engineering Technologists Are Engineers."¹⁸
- 2. "A Modest Proposal Regarding the Future of Engineering Technology Education in America." ¹²
- 3. "The Future of Engineering Science & Engineering Technology: Collision or Convergence?"¹⁷
- 4. "Engineering Technology National Forum: An Action Arm of ETC for National Impact." ¹⁴
- 5. "On Engineering Technology Education: BS to PhD." ¹¹
- 6. "Mechanical Engineering Technology: ASME Vision 2030's Call for the Future."¹³

Conclusions and Summary

The authors have researched and reviewed the official documents and policies of eight different organizations that have been involved in articulating the differences between the capabilities and responsibilities of the engineer and the engineering technologist. Seven of these organizations (ASCE, NSPE, NICET, NCEES, IEA, ABET, and OPM) have articulated the distinctions in a relatively clear, consistent, and transparent manner. This paper has provided the reader with the specific text used by these organizations in their official communications. Comparison of the policies and documents of these seven organizations have led the authors to conclude that there is general agreement among these seven organizations that the engineer and the engineering technologist are meant to have different and distinct capabilities. The differences and distinction are not explicit in the policies and documents of an eighth organization, ASEE; however, the basic organizational structure of ASEE implies that ASEE believes that there is a definite distinction. The authors also believe that ASEE, particularly through its Engineering Technology Division and Engineering Technology Council, has become a focal point for much of the written scholarship concerning this potentially controversial topic.

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International Engineering Alliance

Washington Accord Sydney Accord Dublin Accord Engineers Mobility Forum Engineering Technologists Mobility Forum

Graduate Attributes and Professional Competencies

Version 2 - 18 June 2009

Executive Summary

Several accrediting bodies for engineering qualifications have developed outcomesbased criteria for evaluating programmes. Similarly, a number of engineering regulatory bodies have developed or are in the process of developing competencybased standards for registration. Educational and professional accords for mutual recognition of qualifications and registration have developed statements of graduate attributes and professional competency profiles. This document presents the background to these developments, their purpose and the methodology and limitations of the statements. After defining general range statements that allow the competencies of the different categories to be distinguished, the paper presents the graduate attributes and professional competency profiles for three professional tracks: engineer, engineering technologist and engineering technician.

1 Introduction

Engineering is an activity that is essential to meeting the needs of people, economic development and the provision of services to society. Engineering involves the purposeful application of mathematical and natural sciences and a body of engineering knowledge, technology and techniques. Engineering seeks to produce solutions whose effects are predicted to the greatest degree possible in often uncertain contexts. While bringing benefits, engineering activity has potential adverse consequences. Engineering therefore must be carried out responsibly and ethically, use available resources efficiently, be economic, safeguard health and safety, be environmentally sound and sustainable and generally manage risks throughout the entire lifecycle of a system.

Typical engineering activity requires several roles including those of the engineer, engineering technologist and engineering technician, recognized as professional registration categories in many jurisdictions¹. These roles are defined by their distinctive competencies and their level of responsibility to the public. There is a degree of overlap between roles. The distinctive competencies, together with their educational underpinnings, are defined in sections 4 to 6 of this document.

The development of an engineering professional in any of the categories is an ongoing process with important identified stages. The first stage is the attainment of an *accredited educational qualification*, the graduate stage. The fundamental purpose of *engineering education* is to build a knowledge base and attributes to enable the graduate to continue learning and to proceed to formative development that will develop the competencies required for independent practice. The second stage, following after a period of formative development, is *professional registration*. The fundamental

¹ The terminology used in this document uses the term *engineering* as an activity in a broad sense and *engineer* as shorthand for the various types of professional and chartered engineer. It is recognized that *engineers*, *engineering technologists* and *engineering technicians* may have specific titles or designations and differing legal empowerment or restrictions within individual jurisdictions.

purpose of formative development is to build on the educational base to develop the competencies required for independent practice in which the graduate works with engineering practitioners and progresses from an assisting role to taking more individual and team responsibility until competence can be demonstrated at the level required for registration. Once registered, the practitioner must maintain and expand competence.

For engineers and engineering technologists, a third milestone is to qualify for the *international register* held by the various jurisdictions. In addition, engineers, technologists and technicians are expected to maintain and enhance competency throughout their working lives.

Several international accords provide for recognition of graduates of accredited programmes of each signatory by the remaining signatories. The Washington Accord (WA) provides for mutual recognition of programmes accredited for the engineer track. The Sydney Accord (SA) establishes mutual recognition of accredited qualifications for engineering technologist. The Dublin Accord (DA) provides for mutual recognition of accredited qualifications for engineering technologist. These accords are based on the principle of substantial equivalence rather than exact correspondence of content and outcomes. This document records the signatories' consensus on the attributes of graduates for each accord.

Similarly, the Engineers Mobility Forum (EMF) and the Engineering Technologists Mobility Forum (ETMF) provide mechanisms to support the recognition of a professional registered in one signatory jurisdiction obtaining recognition in another. The signatories have formulated consensus competency profiles for the registration and these are recorded in this document. While no mobility forum currently exists for technicians, competency statements were also formulated for completeness and to facilitate any future development.

Section 2 give the background to the graduate attributes presented in section 5. Section 3 provides background to the professional competency profiles presented in section 6. General range statements are presented in section 4. The graduate attributes are presented in section 5 while the professional competency profiles are defined in section 6. Appendix A defines terms used in this document. Appendix B sketches the origin and development history of the graduate attributes and professional competency profiles.

2 Graduate Attributes

2.1 **Purpose of Graduate Attributes**

Graduate attributes form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practise at the appropriate level. The graduate attributes are exemplars of the attributes expected of graduate from an accredited programme. Graduate attributes are clear, succinct statements of the expected capability, qualified if necessary by a range indication appropriate to the type of programme.

The graduate attributes are intended to assist Signatories and Provisional Members to develop outcomes-based accreditation criteria for use by their respective jurisdictions. Also, the graduate attributes guide bodies developing their accreditation systems with a view to seeking signatory status.

Graduate attributes are defined for educational qualifications in the engineer, engineering technologist and engineering technician tracks. The graduate attributes serve to identify the distinctive characteristics as well as areas of commonality between the expected outcomes of the different types of programmes.

2.2 Limitation of Graduate Attributes

Each signatory defines the standards for the relevant track (engineer, engineering technologist or engineering technician) against which engineering educational programmes are accredited. Each

educational level accord is based on the principle of *substantial equivalence*, that is, programmes are not expected to have identical outcomes and content but rather produce graduates who could enter employment and be fit to undertake a programme of training and experiential learning leading to professional competence and registration. The graduate attributes provide a point of reference for bodies to describe the outcomes of substantially equivalent qualification. The graduate attributes do not, in themselves, constitute an "international standard" for accredited qualifications but provide a widely accepted common reference for bodies to describe the outcomes of substantially equivalent qualifications.

The term graduate does not imply a particular type of qualification but rather the exit level of the qualification, be it a degree or diploma.

2.3 Scope and Organisation of Graduate Attributes

The graduate attributes are organized using twelve headings shown in section 5.2. Each heading identifies the differentiating characteristic that allows the distinctive roles of engineers, technologists and technicians to be distinguished by range information.

For each attribute, statements are formulated for engineer, engineering technologist and engineering technician using a common stem, with ranging information appropriate to each educational track. For example, for the **Knowledge of Engineering Sciences** attribute:

Common Stem: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization ...

Engineer Range: ... to the solution of complex engineering problems.

Engineering Technologist Range: ... to defined and applied engineering procedures, processes, systems or methodologies.

Engineering Technician Range: ... to wide practical procedures and practices.

for Washington Accord	for Sydney Accord Graduate	for Dublin Accord Graduate	
Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to defined and applied engineering procedures, processes, systems or methodologies.	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to wide practical procedures and practices.	

The resulting statements are shown below for this example:

The range qualifier in several attribute statements uses the notions of *complex engineering problems*, *broadly-defined engineering problems* and *well-defined engineering problems*. These shorthand level descriptors are defined in section 4.

The attributes are chosen to be universally applicable and reflect acceptable minimum standards and be capable of objective measurement. While all attributes are important, individual attributes are not necessarily of equal weight. Attributes are selected that are expected to be valid for extended periods and changed infrequently only after considerable debate. Attributes may depend on information external to this document, for example generally accepted principles of ethical conduct.

The full set of graduate attribute definitions are given in section 5.

2.4 Contextual Interpretation

The graduate attributes are stated generically and are applicable to all engineering disciplines. In interpreting the statements within a disciplinary context, individual statements may be amplified and given particular emphasis but must not be altered in substance or individual elements ignored.

2.5 Best Practice in Application of Graduate Attributes

The attributes of Accord programmes are defined as a *knowledge profile*, an indicated volume of learning and the attributes against which graduates must be able to perform. The requirements are stated without reference to the design of programmes that would achieve the requirements. Providers therefore have freedom to design programmes with different detailed structure, learning pathways and modes of delivery. Evaluation of individual programmes is the concern of national accreditation systems.

3 Professional Competency Profiles

3.1 Purpose of Professional Competency Profiles

A professionally or occupationally *competent person* has the attributes necessary to perform the activities within the profession or occupation to the standards expected in independent employment or practice. The *professional competency profiles* for each professional category record the elements of competency necessary for competent performance that the professional is expected to be able to demonstrate in a holistic way at the stage of attaining registration.

Professional competence can be described using a set of attributes corresponding largely to the graduate attributes, but with different emphases. For example, at the professional level, the ability to take responsibility in a real-life situation is essential. Unlike the graduate attributes, professional competence is more than a set of attributes that can be demonstrated individually. Rather, competence must be assessed holistically.

3.2 Scope and Organisation of Professional Competency Profiles

The professional competency profiles are written for each of the three categories: engineer, engineering technologist and engineering technician at the point of registration². Each profile consists of thirteen elements. Individual elements are formulated around a differentiating characteristic using a stem and modifier, similarly to the method used for the graduate attributes described in section 2.3.

The stems are common to all three categories and the range modifiers allow distinctions and commonalities between categories to be identified. Like their counterparts in the graduate attributes, the range statements use the notions of complex engineering problems, broadly-defined engineering problems and well-defined engineering problems defined in section 4.1. At the professional level, a classification of engineering activities is used to define ranges and to distinguish between categories. Engineering activities are classified as *complex, broadly-defined* or *well-defined*. These shorthand level descriptors are defined in section 4.2.

3.3 Limitations of Professional Competency Profile

As in the case of the graduate attributes, the professional competency profiles are not prescriptive in detail but rather reflect the essential elements that would be present in competency standards.

The professional competency profiles do not specify performance indicators or how the above items should be interpreted in assessing evidence of competence from different areas of practice or for different types of work. Section 3.4 examines contextual interpretation.

² Requirements for the EMF and ETMF International Registers call for enhanced competency and responsibility.

Each jurisdiction may define *performance indicators*, that is actions on the part of the candidate that demonstrate competence. For example, a design competency may be evidenced by the following performances:

1: Identify and analyse design/ planning requirement and draw up detailed requirements specification

- 2: Synthesise a range of potential solutions to problem or approaches to project execution
- 3: Evaluate the potential approaches against requirements and impacts outside requirements
- 4: Fully develop design of selected option
- 5: Produce design documentation for implementation

3.4 Contextual Interpretation

Demonstration of competence may take place in different areas of practice and different types of work. Competence statements are therefore discipline-independent. Competence statements accommodate different types of work, for example design, research and development and engineering management by using the broad phases in the cycle of engineering activity: problem analysis, synthesis, implementation, operation and evaluation, together the management attributes needed. The competence statements include the personal attributes needed for competent performance irrespective of specific local requirements: communication, ethical practice, judgement, taking responsibility and the protection of society.

The professional competency profiles are stated generically and are applicable to all engineering disciplines. The application of a competency profile may require amplification in different regulatory, disciplinary, occupational or environmental contexts. In interpreting the statements within a particular context, individual statements may be amplified and given particular emphasis but must not be altered in substance or ignored.

3.5 Mobility between Professional Categories

The graduate attributes and professional competency for each of three categories of engineering practitioner define the benchmark route or vertical progression in each category. This document does not address the movement of individuals between categories, a process that usually required additional education, training and experience. The graduate attributes and professional competencies, through their definitions of level of demand, knowledge profile and outcomes to be achieved, allow a person planning such a change to gauge the further learning and experience that will be required. The education and registration requirements of the jurisdiction should be examined for specific requirements.

4 Common Range and Contextual Definitions

4.1 Range of Problem Solving

	Attribute	Complex Problems	Broadly-defined Problems	Well-defined Problems
1	Preamble	Engineering problems which cannot be resolved without in-depth engineering knowledge, much of which is at, or informed by, the forefront of the professional discipline, and have some or all of the following characteristics:	Engineering problems which cannot be pursued without a coherent and detailed knowledge of defined aspects of a professional discipline with a strong emphasis on the application of developed technology, and have the following characteristics	Engineering problems having some or all of the following characteristics:
2	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues	Involve a variety of factors which may impose conflicting constraints	Involve several issues, but with few of these exerting conflicting constraints
3	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models	Can be solved by application of well-proven analysis techniques	Can be solved in standardised ways
4	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach	Requires a detailed knowledge of principles and applied procedures and methodologies in defined aspects of a professional discipline with a strong emphasis on the application of developed technology and the attainment of know-how, often within a multidisciplinary engineering environment	Can be resolved using limited theoretical knowledge but normally requires extensive practical knowledge
5	Familiarity of issues	Involve infrequently encountered issues	Belong to families of familiar problems which are solved in well-accepted ways	Are frequently encountered and thus familiar to most practitioners in the practice area
6	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering	May be partially outside those encompassed by standards or codes of practice	Are encompassed by standards and/or documented codes of practice
7	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs	Involve several groups of stakeholders with differing and occasionally conflicting needs	Involve a limited range of stakeholders with differing needs
8	Consequences	Have significant consequences in a range of contexts	Have consequences which are important locally, but may extend more widely	Have consequences which are locally important and not far-reaching
9	Interdependence	Are high level problems including many component parts or sub-problems	Are parts of, or systems within complex engineering problems	Are discrete components of engineering systems

IEA Graduate Attributes and Professional Competency Profiles

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4.2 Range of Engineering Activities

	Attribute	Complex Activities	Broadly-defined Activities	Well-defined Activities
1	Preamble	Complex activities means (<i>engineering</i>) activities or projects that have some or all of the following characteristics:	Broadly defined activities means (engineering) activities or projects that have some or all of the following characteristics:	Well-defined activities means (engineering) activities or projects that have some or all of the following characteristics:
2	Range of resources	Involve the use of diverse resources (and for this purpose resources includes people, money, equipment, materials, information and technologies)	Involve a variety of resources (and for this purposes resources includes people, money, equipment, materials, information and technologies)	Involve a limited range of resources (and for this purpose resources includes people, money, equipment, materials, information and technologies)
3	Level of interactions	Require resolution of significant problems arising from interactions between wide- ranging or conflicting technical, engineering or other issues,	Require resolution of occasional interactions between technical, engineering and other issues, of which few are conflicting	Require resolution of interactions between limited technical and engineering issues with little or no impact of wider issues
4	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	Involve the use of new materials, techniques or processes in non-standard ways	Involve the use of existing materials techniques, or processes in modified or new ways
5	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation	Have reasonably predictable consequences that are most important locally, but may extend more widely	Have consequences that are locally important and not far-reaching
6	Familiarity	Can extend beyond previous experiences by applying principles-based approaches	Require a knowledge of normal operating procedures and processes	Require a knowledge of practical procedures and practices for widely-applied operations and processes

5 Accord programme profiles

The following tables provides profiles of graduates of three types of tertiary education engineering programmes. See section 4 for definitions of complex engineering problems, broadly-defined engineering problems and well-defined engineering problems.

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5.1 Knowledge profile

A Washington Accord programme provides:	A Sydney Accord programme provides:	A Dublin Accord programme provides:	
A systematic, theory-based understanding of the natural sciences applicable to the discipline (e.g. calculus-based physics)	A systematic, theory-based understanding of the natural sciences applicable to the sub-discipline	A descriptive, formula-based understanding of the natural sciences applicable in a sub-discipline	
Conceptually-based mathematics, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling applicable to the discipline	 Conceptually-based mathematics, numerical analysis, statistics and aspects of computer and information science to support analysis and use of models applicable to the sub-discipline 	 Procedural mathematics, numerical analysis, statistics applicable in a sub-discipline 	
A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline	A systematic , theory-based formulation of engineering fundamentals required in an accepted sub-discipline	A coherent procedural formulation of engineering fundamentals required in an accepted sub-discipline	
 engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline. 	 engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for an accepted sub-discipline 	 engineering specialist knowledge that provides the body of knowledge for an accepted sub-discipline 	
 knowledge that supports engineering design in a practice area 	 knowledge that supports engineering design using the technologies of a practice area 	knowledge that supports engineering design based on the techniques and procedures of a practice area	
 knowledge of engineering practice (technology) in the practice areas in the engineering discipline 	 knowledge of engineering technologies applicable in the sub-discipline 	 codified practical engineering knowledge in recognised practice area. 	
 comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: ethics and the professional responsibility of an engineer to public safety; the impacts of engineering activity: economic, social, cultural, environmental and sustainability; 	 comprehension of the role of technology in society and identified issues in applying engineering technology: ethics and impacts: economic, social, environmental and sustainability 	 knowledge of issues and approaches in engineering technician practice: ethics, financial, cultural, environmental and sustainability impacts 	
Engagement with selected knowledge in the research literature of the discipline	engagement with the technological literature of the discipline		
A programme that builds this type of knowledge and develops the attributes listed below is typically achieved in 4 to 5 years of study, depending on the level of students at entry.	A programme that builds this type of knowledge and develops the attributes listed below is typically achieved in 3 to 4 years of study, depending on the level of students at entry.	A programme that builds this type of knowledge and develops the attributes listed below is typically achieved in 2 to 3 years of study, depending on the level of students at entry.	

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5.2 Graduate Attribute profiles

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		Differentiating Characteristic	for Washington Accord Graduate	for Sydney Accord Graduate	for Dublin Accord Graduate
1.	Engineering Knowledge	Breadth and depth of education and type of knowledge, both theoretical and practical	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to defined and applied engineering procedures, processes, systems or methodologies.	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to wide practical procedures and practices.
2.	Problem Analysis	Complexity of analysis	Identify, formulate, research literature and analyse <i>complex</i> engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.	Identify, formulate, research literature and analyse <i>broadly-defined</i> engineering problems reaching substantiated conclusions using analytical tools appropriate to their discipline or area of specialisation.	Identify and analyse <i>well-defined</i> engineering problems reaching substantiated conclusions using codified methods of analysis specific to their field of activity.
3.	Design/ development of solutions	Breadth and uniqueness of engineering problems i.e. the extent to which problems are original and to which solutions have previously been identified or codified	Design solutions for <i>complex</i> engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Design solutions for <i>broadly- defined</i> engineering technology problems and <i>contribute to</i> the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.	Design solutions for well-defined technical problems and assist with the design of systems, components or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4.	Investigation	Breadth and depth of investigation and experimentation	Conduct investigations of <i>complex</i> problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.	Conduct investigations of <i>broadly-defined</i> problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions.	Conduct investigations of <i>well-defined</i> problems; locate and search relevant codes and catalogues, conduct standard tests and measurements.
5.	Modern Tool Usage	Level of understanding of the appropriateness of the tool	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to <i>complex</i> engineering activities, with an understanding of the limitations.	Select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to <i>broadly-defined</i> engineering activities, with an understanding of the limitations.	Apply appropriate techniques, resources, and modern engineering and IT tools to <i>well-defined</i> engineering activities, with an awareness of the limitations.

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6.	The Engineer and Society	Level of knowledge and responsibility	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.	Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technology practice.	Demonstrate knowledge of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering technician practice.
7.	Environment and Sustainability	Type of solutions.	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.	Understand the impact of engineering technology solutions in societal societal and environmental context and demonstrate knowledge of and need for sustainable development.	Understand the impact of engineering technician solutions in societal societal and environmental context and demonstrate knowledge of and need for sustainable development.
8.	Ethics	Understanding and level of practice	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.	Understand and commit to professional ethics and responsibilities and norms of engineering technology practice.	Understand and commit to professional ethics and responsibilities and norms of technician practice.
9.	Individual and Team work	Role in and diversity of team	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.	Function effectively as an individual, and as a member or leader in diverse technical teams.	Function effectively as an individual, and as a member in diverse technical teams.
10.	Communication	Level of communication according to type of activities performed	Communicate effectively on <i>complex</i> engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	Communicate effectively on <i>broadly-</i> <i>defined</i> engineering activities with the engineering community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	Communicate effectively on <i>well-defined</i> engineering activities with the engineering community and with society at large, by being able to comprehend the work of others, document their own work, and give and receive clear instructions
11.	Project Management and Finance	Level of management required for differing types of activity	Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a team and to manage projects in multidisciplinary environments	Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a technical team and to manage projects in multidisciplinary environments
12.	Life long learning	Preparation for and depth of continuing learning.	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	Recognize the need for, and have the ability to engage in independent and life- long learning in specialist technologies.	Recognize the need for, and have the ability to engage in independent updating in the context of specialized technical knowledge.

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6 Professional Competency Profiles

To meet the minimum standard of competence a person must demonstrate that he/she is able to practice competently in his/her practice area to the standard expected of a reasonable Professional Engineer/Engineering Technologist/Engineering Technolo

The extent to which the person is able to perform each of the following elements in his/her practice area must be taken into account in assessing whether or not he/she meets the overall standard.

		Differentiating Characteristic	Professional Engineer	Engineering Technologist	Engineering Technician
1.	Comprehend and apply universal knowledge	Breadth and depth of education and type of knowledge	Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice	Comprehend and apply the knowledge embodied in widely accepted and applied procedures, processes, systems or methodologies	Comprehend and apply knowledge embodied in standardised practices
2.	Comprehend and apply local knowledge	Type of local knowledge	Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice specific to the jurisdiction in which he/she practices.	Comprehend and apply the knowledge embodied procedures, processes, systems or methodologies that is specific to the jurisdiction in which he/she practices.	Comprehend and apply knowledge embodied in standardised practices specific to the jurisdiction in which he/she practices.
3.	Problem analysis	Complexity of analysis	Define, investigate and analyse complex problems	Identify, clarify, and analyse broadly- defined problems	Identify, state and analyse well-defined problems
4.	Design and development of solutions	Nature of the problem and uniqueness of the solution	Design or develop solutions to complex problems	Design or develop solutions to broadly- defined problems	Design or develop solutions to well- defined problems
5.	Evaluation	Type of activity	Evaluate the outcomes and impacts of complex activities	Evaluate the outcomes and impacts of broadly defined activities	Evaluate the outcomes and impacts of well-defined activities
6.	Protection of society	Types of activity and responsibility to public	Recognise the reasonably foreseeable social, cultural and environmental effects of complex activities generally, and have regard to the need for sustainability; recognise that the protection of society is the highest priority	Recognise the reasonably foreseeable social, cultural and environmental effects of broadly-defined activities generally, and have regard to the need for sustainability; take responsibility in all these activities to avoid putting the public at risk.	Recognise the reasonably foreseeable social, cultural and environmental effects of well-defined activities generally, and have regard to the need for sustainability; use engineering technical expertise to prevent dangers to the public.
7.	Legal and regulatory	No differentiation in this characteristic	Meet all legal and regulatory requirements and protect public health and safety in the course of his or her activities	Meet all legal and regulatory requirements and protect public health and safety in the course of his or her activities	Meet all legal and regulatory requirements and protect public health and safety in the course of his or her activities

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8.	Ethics	No differentiation in this characteristic	Conduct his or her activities ethically	Conduct his or her activities ethically	Conduct his or her activities ethically
9.	Manage engineering activities	Types of activity	Manage part or all of one or more complex activities	Manage part or all of one or more broadly- defined activities	Manage part or all of one or more well- defined activities
10.	Communication	No differentiation in this characteristic	Communicate clearly with others in the course of his or her activities	Communicate clearly with others in the course of his or her activities	Communicate clearly with others in the course of his or her activities
11.	Lifelong learning	Preparation for and depth of continuing learning.	Undertake CPD activities sufficient to maintain and extend his or her competence	Undertake CPD activities sufficient to maintain and extend his or her competence	Undertake CPD activities sufficient to maintain and extend his or her competence
12.	Judgement	Level of developed knowledge, and ability and judgement in relation to type of activity	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgement in the course of his or her complex activities	Choose appropriate technologies to deal with broadly defined problems. Exercise sound judgement in the course of his or her broadly-defined activities	Choose and apply appropriate technical expertise. Exercise sound judgement in the course of his or her well-defined activities
13.	Responsibility for decisions	Type of activity for which responsibility is taken	Be responsible for making decisions on part or all of complex activities	Be responsible for making decisions on part or all of one or more broadly defined activities	Be responsible for making decisions on part or all of all of one or more well- defined activities

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Appendix A: Definitions of terms

Note: These definitions apply to terms used in this document but also indicate equivalence to terms used in other engineering education standards.

Branch of engineering: a generally-recognised, major subdivision of engineering such as the traditional *disciplines* of Chemical, Civil, or Electrical Engineering, or a cross-disciplinary field of comparable breadth including combinations of engineering fields, for example Mechatronics, and the application of engineering in other fields, for example Bio-Medical Engineering.

Broadly-defined engineering problems: a class of problem with characteristics defined in section 4.1.

Broadly-defined engineering activities: a class of activities with characteristics defined in section 4.2.

Complementary (contextual) knowledge: Disciplines other than engineering, basic and mathematical sciences, that support engineering practice, enable its impacts to be understood and broaden the outlook of the engineering graduate.

Complex engineering problems: a class of problem with characteristics defined in section 4.1.

Complex engineering activities: a class of activities with characteristics defined in section 4.2.

Continuing Professional Development: the systematic, accountable maintenance, improvement and broadening of knowledge and skills, and the development of personal qualities necessary for the execution of professional and technical duties throughout an engineering practitioner's career.

Engineering sciences: include engineering fundamentals that have roots in the mathematical and physical sciences, and where applicable, in other natural sciences, but extend knowledge and develop models and methods in order to lead to applications and solve problems, providing the knowledge base for engineering specializations.

Engineering design knowledge: Knowledge that supports engineering design in a practice area, including codes, standards, processes, empirical information, and knowledge reused from past designs.

Engineering discipline: synonymous with branch of engineering.

Engineering fundamentals: a systematic formulation of engineering concepts and principles based on mathematical and basic sciences to support applications.

Engineering problem: is one that exists in any domain that can be solved by the application of engineering knowledge and skills and generic competencies.

Engineering practice: a generally accepted or legally defined area of engineering work or engineering technology.

Engineering speciality or specialization: a generally-recognised practice area or major subdivision within an engineering discipline, for example Structural and Geotechnical Engineering within Civil Engineering; the extension of engineering fundamentals to create theoretical frameworks and bodies of knowledge for engineering practice areas.

Engineering technology: is an established body of knowledge, with associated tools, techniques, materials, components, systems or processes that enable a family of practical applications and that relies for its development and effective application on engineering knowledge and competency.

Formative development: the process that follows the attainment of an accredited education programme that consists of training, experience and expansion of knowledge.

Manage: means planning, organising, leading and controlling in respect of risk, project, change, financial, compliance, quality, ongoing monitoring, control and evaluation.

Mathematical sciences: mathematics, numerical analysis, statistics and aspects of computer science cast in an appropriate mathematical formalism.

Natural sciences: Provide, as applicable in each engineering discipline or practice area, an understanding the physical world including physics, mechanics, chemistry, earth sciences and the biological sciences,

Practice area: *in the educational context:* synonymous with generally-recognised engineering speciality; *at the professional level:* a generally recognised or distinctive area of knowledge and expertise developed by an engineering practitioner by virtue of the path of education, training and experience followed.

Research-based knowledge: a systematic understanding of knowledge and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of the academic discipline, field of study or area of professional practice.

Solution: means an effective proposal for resolving a problem, taking into account all relevant technical, legal, social, cultural, economic and environmental issues and having regard to the need for sustainability.

Subdiscipline: Synonymous with *engineering speciality*.

Substantial equivalence: applied to educational programmes means that two programmes, while not meeting a single set of criteria, are both acceptable as preparing their respective graduates to enter formative development toward registration.

Well-defined engineering problems: a class of problem with characteristics defined in section 4.1.

Well-defined engineering activities: a class of activities with characteristics defined in section 4.2.

Appendix B: History of Graduate Attributes and Professional Competency Profiles

The signatories to the Washington Accord recognized the need to describe the attributes of a graduate of a Washington Accord accredited program. Work was initiated at its June 2001 meeting held at Thornybush, South Africa. At the International Engineering Meetings (IEM) held in June 2003 at Rotorua, New Zealand, the signatories to the Sydney Accord and the Dublin Accord recognized similar needs. The need was recognized to distinguish the attributes of graduates of each type of programme to ensure fitness for their respective purposes.

The Engineers Mobility Forum (EMF) and Engineering Technologist Mobility Forum (ETMF) have created international registers in each jurisdiction with current admission requirements based on registration, experience and responsibility carried. The mobility agreements recognize the future possibility of competency-based assessment for admission to an international register. At the 2003 Rotorua meetings, the mobility fora recognized that many jurisdictions are in the process of developing and adopting competency standards for professional registration. The EMF and the ETMF therefore resolved to define assessable sets of competencies for engineer and technologist. While no comparable mobility agreement exists for technicians, the development of a corresponding set of standards for engineering technicians was felt to be important to have a complete description of the competencies of the engineering team.

A single process was therefore agreed to develop the three sets of graduate attributes and three professional competency profiles. An International Engineering Workshop (IEWS) was held by the three educational accord and the two mobility fora in London in June 2004 to develop statements of Graduate Attributes and International Register Professional Competency Profiles for the Engineer, Engineering Technologist and Engineering Technician categories. The resulting statements were then opened for comment by the signatories. The comments received called for minor changes only.

The Graduate Attributes and Professional Competencies were adopted by the signatories of the five agreements in June 2005 at Hong Kong as version 1.1.

A number of areas of improvement in the Graduate Attributes and Professional Competencies themselves and their potential application were put to the meetings of signatories in Washington DC in June 2007. A working group was set up to address the issues. The IEA workshop held in June 2008 in Singapore considered the proposals of the working group and commissioned the Working Group to make necessary changes with a view to presenting Version 2 of the document for approval by the signatories at their next general meetings. Version 2 was approved at the Kyoto IEA meetings, 15-19 June 2009.

This document is available through the IEA website: <u>http://www.ieagreements.org</u>.