The Future-Ready Engineering Ecosystem (FREE) Initiative

Phase II: Stakeholder Perspectives on the FREE Competency Model and the Future of Engineering Preparation

FREE
Future Ready Engineering Ecosystems

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ASEE seeks to be the pre-eminent authority on the education of engineering professionals by advancing innovation, excellence, and access at all levels of education.

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- We support education across institutions by identifying opportunities to share proven and promising instructional practices.
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The Future-Ready Engineering Ecosystem (FREE) Initiative — Phase II: Stakeholder Perspectives On The Free Competency Model And The Future Of Engineering Preparation

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This report is available for download at *www.asee.org*.

Suggested Citation:

American Society for Engineering Education. (2026). The Future-Ready Engineering Ecosystem (FREE) Initiative — Phase II: Stakeholder Perspectives On The Free Competency Model And The Future Of Engineering Preparation. Washington, DC.

This material is based upon work supported by the National Science Foundation under Award No. EEC- 2042343. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not represent the views of the ASEE Board of Directors, ASEE's membership, or the National Science Foundation.

Acknowledgments

ASEE would like to acknowledge the many contributors to this report and to the activities associated with Phase II of the Future-Ready Engineering Ecosystem (FREE) initiative.

First, we extend our sincere appreciation to the faculty, deans, administrators, and institutional representatives who dedicated their time to participate in the Phase II stakeholder convenings and interviews. Their thoughtful engagement, completion of discussion templates, and willingness to share insights and perspectives were essential to informing this work and shaping the findings presented.

Phase II of the project was directed by Dr. Jacqueline El-Sayed, who served as Principal Investigator (PI) through September 2025, after which Dr. Joseph Roy assumed the role. Dr. Sarah DeLeeuw served as co-PI through September 2025; the co-PI role was then assumed by Alexandra Sharpe. Dr. Russell Korte (The George Washington University) served as lead rapporteur across Phase II convening and interview activities.

The FREE Faculty Advisory Committee, comprised of Kacey Beddoes (Washington State University), Samantha Brunhaver (Arizona State University), and Homero Murzi (Marquette University), reviewed and contributed perspectives that informed the discussions and interpretation of findings presented in this report. We extend our appreciation to Dean's Advisory Committee members Jenna Carpenter (Campbell University), Wael Ibrahim (ECPI University), and Michael McGinnis (LeTourneau University).

ASEE staff made substantial contributions to the planning, execution, analysis, and documentation of this work. David Scott Mazzeo, Senior Project Manager, managed the organization and production of the stakeholder convenings, developing convening materials and analyzing and synthesizing content generated during the convenings. In his role, Scott Mazzeo also managed Advisory Committee meetings and activities and ensured timely and complete project deliverables. Rachel Koroloff, Senior Project Manager, provided coordination and implementation support across project activities. Additional staff contributed through notetaking and meeting support, including Rachel Levitin, Program Director; Darcelle Larkin, Senior Manager, Learning and Events; Ray Phillips, Program Director; Rashida Johnson, Program Director; Tonya Tucker, Senior Governance Manager; and Elisheba Wilson, Assistant Program Manager.

Dr. Russell Korte prepared the initial draft of this report, which was edited and finalized by co-PI Alexandra Sharpe.

This report is based on work supported by the National Science Foundation under Award No. EEC-2042343.

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1.0 Executive Summary

In an era of accelerated technological and industrial change, reimagining how students are educated to prepare for the future of work has become imperative. To address this need, the Defining and Building the Engineering Workforce of the Future: Future-Ready Engineering Ecosystem (FREE) project, funded by the National Science Foundation (NSF) under Award No. EEC-2042343 and administered by the American Society for Engineering Education (ASEE), was developed to define a forward-looking competency taxonomy and rubric for action that enable faculty, administrators, and institutions to implement meaningful educational change.

In Phase I of the FREE initiative, ASEE convened four workshops in 2022 to define the competencies engineers will need to meet the challenges of future work. The first two workshops focused on defining a competency taxonomy for a future-ready engineering workforce. The latter two workshops focused on identifying strategies for educators, policymakers, and industry to co-develop engineers equipped for emerging challenges. These efforts produced the FREE Competency Taxonomy and the accompanying Framework and Rubric for Action (collectively referred to as the FREE Competency Model), designed to help institutions and educators assess their readiness for change and identify practical strategies for implementation.

Phase II of the FREE initiative focused on how the FREE Competency Model might be received and applied by the broader engineering education community and commenced with a survey distributed to ASEE members soliciting feedback on the model. While respondents endorsed the model's goals and values, they emphasized the need for greater clarity, feasibility, alignment with existing systems, and institutional support. In response, the project team launched two targeted convenings and one set of interviews to refine the model and explore implementation at the individual, programmatic and institutional levels.

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2.0

Project Overview

Over the past several decades, major shifts in the landscape of higher education have created a need to re-examine how we educate. Public concerns have arisen around the value of a college education, often related to issues like increasing tuition, declining graduation rates, general economic challenges, and the perception that college students are not graduating with necessary professional skills, like critical thinking (Roksa, Arum, & Cook, 2016). Employers have reinforced these concerns, citing ongoing gaps between graduate capabilities and workforce requirements (Ehrmann, 2021).

The Defining and Building the Engineering Workforce of the Future: Future-Ready Engineering Ecosystem (FREE) project, funded by the National Science Foundation (NSF) under Award No. EEC-2042343 and administered by the American Society for Engineering Education (ASEE), was established to define a forward-looking competency taxonomy and rubric for action designed to guide meaningful change across engineering classrooms, programs, and institutions.

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3.0 FREE Phase I: Designing the FREE Competency Model

In Phase I of the FREE initiative, ASEE convened a series of four workshops in 2022 that brought together educators, industry leaders, and other stakeholders with the goal of identifying the competencies engineers will need to thrive in the future workforce amid emerging challenges including artificial intelligence (AI), machine learning, advanced manufacturing, quantum information science, data science and analytics, advanced communication networks/5G, and biotechnology. The first two workshops focused on visioning and definition, specifically disaggregating key competencies for the future-ready engineering workforce and identifying a prioritized taxonomy of the key competencies with details and context summaries to provide meaningful specificity. The third and fourth workshops focused on operationalization, specifically building upon the outcomes of the first two workshops to define what specific actions educators, policymakers, and leaders in industry need to take to co-develop a critical mass of emerging engineers with the competencies needed to succeed in the future.

The first and second workshops resulted in the development of the FREE Competency Taxonomy (refer to Appendix A: *FREE Competency Taxonomy*), designed as a general guide on what abilities engineers need to meet future challenges. The third and fourth workshops resulted in the development of a Framework and Rubric for Action (refer to Appendix B: *Framework and Rubric for Action*), developed as a general guide for change in higher education. These tools were designed to help educators and institutions assess their readiness for change and identify practical strategies for implementation. For the remainder of this report, the collective FREE Competency Taxonomy, Framework, and Rubric for Action are referred to as the FREE Competency Model.

Across the workshops, participants emphasized the importance of personal and professional competencies, such as competence in multidisciplinary fields, awareness of global and culture issues, the ability to work collaboratively, the desire to continue learning, having integrity and respect, and having a commitment to the welfare of others. Participants acknowledged that redesigning engineering education around competencies presents significant challenges, particularly considering the reality of rigid instructional structures and limited resources. Rather than proposing a one-size-fits-all model, the FREE initiative recognized the importance of context and readiness across different institutional types. The FREE Competency Model is therefore intended as a flexible guide for reflection, adaptation, and progress (El-Sayed, DeLeeuw, & Korte, 2024).

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4.0

FREE Phase II: Stakeholder Perspectives on the FREE Competency Model and the Future of Engineering Preparation

4.1 FREE Competency Model Feedback Survey

Phase II of the FREE initiative examined how the FREE Competency Model might be received and applied across the engineering education community. In fall 2024, the FREE project team distributed the FREE Competency Model to ASEE members, accompanied by a brief survey to solicit initial feedback. At the time of this report, 87 responses have been received.

Survey feedback on the FREE Competency Model was largely positive, with more than 80% of survey respondents agreeing or somewhat agreeing that the taxonomy was relevant for "…preparing engineering students for future work." About half of respondents also provided suggestions for improving both the model.

Analysis of open-ended survey responses related to the FREE Competency Model revealed common themes, which were synthesized by ChatGPT in response to a prompt requesting key patterns in respondent feedback. In general, respondents supported the goals of the tools while emphasizing the need for greater feasibility, clarity, and alignment with institutional realities.

Across the model, respondents raised concerns about scope and practicality, noting that the breadth of competencies and proposed actions may be difficult to implement within existing curricular, staffing, and resource constraints. Feedback consistently called for simplification, clearer organization, and more actionable guidance, including concrete examples and implementation pathways that translate the framework into practice.

Respondents also emphasized the importance of alignment with established systems such as ABET and existing workforce frameworks, as well as the need to situate the FREE Competency Model within current educational and professional ecosystems. Additional themes highlighted the importance of representation and responsiveness to evolving societal and technological contexts, including emerging areas such as AI, sustainability, ethics, and mental health.

Respondents stressed that meaningful adoption of the FREE Competency Model would require attention to cultural and structural conditions within higher education, including leadership support, collaboration across institutions, and engagement with a broad range of stakeholders.

At the end of the survey, the FREE project team invited respondents to indicate their interest in participating in future meetings to help refine the FREE Competency Model and explore ways to make the work more actionable. Based on that interest, the team initiated two stakeholder convenings and one set of interviews aimed at examining (a) how the FREE Competency Model could be implemented across different levels of the engineering education ecosystem and (b) perspectives on quality assurance, credentialing, and the future of engineering preparation. The convenings and interviews were organized around three distinct levels of application: 1) Individual Level: Faculty/Classroom; 2) Program Level: Deans; and 3) Institutional Level: ABET, Professional Associations, Industry.

4.2 Faculty Perspectives on Applying the Free Competency Model at the Classroom/Lab Level

The first of two stakeholder convenings focused on implementation of the FREE Competency Model at the individual level, specifically, how faculty might begin to incorporate competency-based education (CBE) into their teaching and classroom practices (for a detailed description of CBE, refer to Appendix C: *Working Description of CBE*). The objectives of the convening were to (1) identify classroom/lab activities that can promote greater competency development in engineering students, (2) discuss challenges and enablers that may affect the successful implementation of rubric-driven strategies, and (3) develop clear and actionable plans for integrating rubric-driven practices into teaching, with a focus on achieving the ideal scenario.

This convening was held virtually on February 28, 2025 and was facilitated by Dr. Julie P. Martin, EETI Director and Professor of Engineering Education at the University of Georgia. The event was attended by more than 35 participating faculty members. Faculty represented more than 10 disciplines (including Aerospace Engineering, Bioengineering, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electronics and Communications Engineering, Engineering Education, Mechanical Engineering, and Materials Engineering) and multiple institution types (including R1, R2, Master's College/University, Baccalaureate College, Associate's College, Special Focus Institution, and International).

The event incorporated both presentations and breakout sessions. The presentations, led by Dr. Russell Korte, provided brief overviews of the FREE Competency Model tools – the Competency Taxonomy and corresponding Framework and Rubric for Action. The convening included three topic-focused breakout sessions: (1) Competency-Based Education (CBE), (2) Application Plans for Implementation, and (3) Bridging the Gap. Participants were provided with templates to record their breakout session discussions. Those templates were used to identify common discussion themes.

Discussion Topic 1: Competency-Based Education (CBE)

For the first breakout session on Competency-Based Education (CBE), groups were asked to consider (a) the advantages and challenges of CBE and (b) how those challenges can lead to new opportunities to enhance student learning. The following discussion themes around the topic of CBE were identified and synthesized with assistance from ChatGPT.

Participants identified multiple advantages of CBE, particularly its capacity to support personalized and mastery-oriented learning. CBE helps enable students to progress at their own pace while ensuring competence before advancement. Participants emphasized its alignment with workforce expectations, noting that competency frameworks can integrate technical knowledge with professional skills. CBE was also seen as fostering greater accountability through clearly articulated learning outcomes and structured progress tracking. More broadly, discussions highlighted the potential of CBE to promote holistic student development and to normalize iterative learning processes.

With regard to the challenges of CBE, time and resource demands placed on faculty, particularly related to course redesign, assessment development, and individualized feedback, were emphasized. Assessment complexity emerged as a recurring concern, especially in large or team-based courses. Participants also noted cultural resistance from both students and faculty accustomed to traditional grading systems.

Discussions identified several opportunities to strengthen and advance CBE models. Participants pointed to the potential of emerging technologies to support scalable assessment, feedback, and progress tracking. Collaboration across disciplines and with industry partners could help with competency definitions and ensuring workforce relevance. Participants also highlighted opportunities to integrate co-curricular and experiential learning into competency frameworks and to foster broader cultural shifts toward development-focused educational models.

Discussion Topic 2: Application Plans for Implementation

For the second breakout session on Application Plans for Implementation, groups were asked to consider (a) what classroom activities, unrestricted by any limitations, would foster greater competency development in their students, (b) how implementation success would be measured, and (c) what specific actions and resources will be required from different stakeholder groups to effectively implement these activities. The following discussion themes around the topic of Application Plans for Implementation were identified and synthesized with assistance from ChatGPT.

Participants emphasized the importance of embedding competency development within applied, experiential learning environments. Recommended instructional strategies included service-learning, internships, and project-based learning experiences. Multidisciplinary collaborations were viewed as particularly valuable. Groups also highlighted iterative design experiences, cross-cultural and global projects, and the use of emerging technologies to personalize learning and expand competency development opportunities.

Conversations around measurement centered on moving beyond traditional grading toward more holistic and authentic assessment models. Suggested approaches included evaluating the quality and impact of student-generated products, incorporating peer and self-assessments, and establishing multi-source feedback loops involving faculty, industry partners, and external reviewers. Participants also recommended the use of student artifacts and competency portfolios, along with indicators such as engagement, reflective learning, and longitudinal career outcomes, to capture longer-term evidence of competency attainment.

Finally, participants highlighted that effective implementation would require coordinated action and resourcing across institutional levels. Faculty would need professional development, time, and assessment tools to adopt project-based and competency-focused pedagogies. Administrative leaders were seen as critical in providing incentives, supporting curricular redesign, and aligning promotion and tenure structures. At the institutional level, investments in infrastructure, technology, and collaborative learning spaces were viewed as essential, alongside cultural shifts that prioritize competency development.

Discussion Topic 3: Bridging the Gap

For the third breakout session on Bridging the Gap, groups focused on the current realities of implementing CBE and the actionable next steps that can be taken to move closer to the ideal scenario. The following discussion themes around the topic of Bridging the Gap were identified and synthesized with assistance from ChatGPT.

Participants consistently noted misalignment between CBE principles and existing institutional norms. Resource limitations like faculty time, personnel capacity, and financial support were cited as major constraints. Participants also emphasized the complexity of assessing diverse student projects, adding to already overextended faculty workloads.

Participants advocated for incremental implementation strategies, beginning with pilot initiatives or targeted integration of competency-based assessments. Expanding faculty development, creating communities of practice, and providing time and institutional incentives for experimentation would offer additional support, along with stronger collaboration with industry to embed authentic, relevant learning experiences. Participants further emphasized the importance of transparent communication with students to build understanding and buy-in, alongside gradual assessment reform toward more holistic evaluation models. Finally, institutional flexibility was viewed as critical for sustained adoption.

Common Themes and Recommendations

The following common themes emerged from the three breakout sessions focused on CBE, Action Plans for Implementation, and Bridging the Gap:

1. **Resistance to Change:** A major challenge discussed across all breakout sessions was resistance to change from both faculty and students. Faculty are often accustomed to traditional teaching and assessment models, while students may prefer structured, assignment-driven learning environments over open-ended, iterative approaches. Shifting these mindsets will require intentional communication and support. Institutional and structural barriers also emerged as critical factors.
2. **Siloes and Rigid Systems:** Departmental silos, rigid grading systems, and performance metrics that prioritize efficiency over learning outcomes make it difficult to adopt more flexible, student-centered models. Faculty time constraints and limited institutional resources further limit capacity for course redesign, new assessment practices, and ongoing professional development.
3. **Disconnect Between Classroom Practices and Real-World Needs:** Without strong industry partnerships, it can be difficult to ensure that students are developing competencies aligned with workforce expectations. A lack of shared language around competencies among educators, institutions, and employers adds further complexity.

Participants proposed several recommendations to facilitate successful incorporation of CBE into their teaching and classroom practices:

- Create manageable entry points for introducing CBE practices such as gradual implementation through pilot courses or targeted changes to existing courses. Utilize emerging technologies to support scalable assessment, feedback, and progress tracking.
- Prioritize faculty development, with more time, training, and professional learning communities to support pedagogical shifts. Institutional leaders can support these efforts through incentives and reducing structural barriers.
- Build stronger collaboration across disciplines and with industry to provide students with authentic learning experiences and external feedback.
- Build trust and strengthen engagement with students by maintaining clear communication with them about the purpose and value of CBE.
- Support cultural shifts toward development-focused, rather than grade-centered, educational models by utilizing student artifacts and competency portfolios, peer and self-assessments, and non-traditional indicators to capture longer-term evidence of competency attainment.

4.3 Administrator Perspectives on Applying the FREE Competency Model at the Program Level

The second of two stakeholder convenings focused on program-level implementation of the FREE Competency Model and targeted engineering deans. The convening objectives were organized in three categories:

1. **Buy-in:** Brainstorm ways to achieve a shared commitment to adopt and embrace personal/professional competencies,
2. **Necessary Changes:** Discuss changes that Deans would make to strengthen student learning of personal/professional competencies in their program(s), and
3. **Strategies and Resources:** Identify the strategies and resources required to make the changes to strengthen student learning of personal/professional competencies.

This convening was held virtually on April 24, 2025 and was facilitated by Dr. Jacqueline El-Sayed, former project Principal Investigator (PI). The event was attended by 19 Deans. The Deans represented variety of programs/colleges across a range of R1, R2, R3, and Master's College/Universities.

The convening included one breakout session, during which participants were asked to discuss the three overarching meeting topics related to personal/professional competencies: (1) Buy-in, (2), Necessary Changes, and (3) Strategies and Resources. The focus on personal/professional competencies was emphasized because there is relatively unanimous support for teaching technical competencies across engineering programs. The personal/professional competencies are more generally marginalized as learning objectives in engineering programs.

Participants were provided with templates to record their breakout session discussions. Those templates were used to identify common discussion themes.

Discussion Topic 1: Buy-In

When discussing buy-in, groups emphasized the need for systemic alignment, noting that competencies must be integrated into institutional strategic plans, accreditation frameworks like ABET, and faculty promotion and tenure criteria. Faculty engagement and development were also viewed as critical, with recommendations to expand professional development opportunities, training programs, and incentive structures. Leadership ownership and visible institutional commitment, including the designation of departmental and college-level champions to guide implementation, were also mentioned. Groups suggested engaging external partners to validate workforce relevance and strengthen credibility. Finally, discussions highlighted the necessity of culture-building (for example, using shared language and frameworks) to foster institutional buy-in and sustained adoption.

Discussion Topic 2: Necessary Changes

On the topic of necessary changes, groups noted the need for competencies to be embedded across the curriculum, with greater flexibility and cross-disciplinary integration to support student development. Active and experiential learning, along with co-curricular activities and internships, were consistently identified as essential for building both technical and professional skills. Groups suggested that faculty and advisors be trained to support student development beyond academics. Insights from alumni and employers were also viewed as valuable for identifying gaps. There was an emphasis on the importance of aligning recognition and incentive structures to recognize innovation in teaching.

Discussion Topic 3: Strategies and Resources

When discussing strategies and resources, groups mentioned necessary faculty-level resources like release time, training, and tools for assessment (particularly for non-cognitive skills). At the institutional/system-level, groups suggested creating systems for cross-collaboration and strategic alignment, along with providing grants, structural support, and approval pathways for course and curriculum reform. In terms of assessment and feedback infrastructure, mechanisms for evaluation and continuous improvement (such as exit employer surveys; and new rubrics for leadership, communication, and teamwork) were suggested. Finally, groups emphasized the importance of cross-sector collaboration, with institutions partnering with ABET, NSF, professional societies, and industry to support scaling and sustainability.

Common Themes and Recommendations

The following common themes emerged from the discussions focused on buy-in, necessary changes, and strategies and resources. These themes were identified and synthesized with assistance from ChatGPT.

1. **Alignment Across Systems:** In order for a program to adopt and embrace personal/ professional competencies, a systemic alignment is necessary, from curriculum to accreditation, faculty development, and institutional policies.
2. **Faculty Buy-in:** Faculty are both the gatekeepers and owners of curricular change, and their buy-in is essential for increasing instruction of personal/professional competencies for students in engineering programs. Related to faculty buy-in, because of the complexity and variety of ways that competencies can be learned, faculty want to know to what they are buying into. This emphasizes the need to co-create change efforts with faculty and other stakeholders from the beginning.
3. **Student-Centered Development:** Enhancing student experiences and supporting student-centered development includes not only increasing the various opportunities for students but also increasing individualized support for students and developing better and more relevant assessment tools. Student growth, both academic and non-academic, can be supported through mentoring, co-curriculars, and community engagement.
4. **External Partnerships:** Engaging external partners, like industry, professional societies, ABET, and alumni can have multiple benefits. These partnerships can help validate workforce relevance, strengthen credibility, and support scaling and sustainability.

Participants proposed several recommendations to facilitate the successful integration of personal/professional competency-based learning into their programs:

- Strive for alignment across systems by integrating competencies into curriculum design, assessment, and promotion/tenure criteria; ensuring ABET accreditation outcomes reflect these competencies; and embedding changes into the strategic plans of colleges or departments.
- Start small. Introduce small changes within existing courses, curricula, and programs.
- Increase faculty buy-in and engagement through incentivization and development. Tie faculty recognition and reward systems (e.g., promotion and tenure) to teaching innovations and student development. Provide faculty development programs and workshops, or invite external experts to help faculty become more cognizant of and adept at developing the personal/ professional competence of their students and assessing non-cognitive skills.
- Build strong external collaborations. Strong partnerships with industry and alumni help keep curricula relevant and competencies practical. Use industry advisory boards and recent alumni feedback to align student development with workforce needs. Include industry professionals in curriculum co-creation or as guest faculty. Cross-sector collaborations with ABET, NSF, professional societies, and industry can support scaling and sustainability.

4.4 Institutional Perspectives on Quality Assurance, Credentialing, and the Future Of Engineering Preparation

The third Phase II effort examined the perspectives of professional organizations that support and regulate the development of practicing engineers. Given the distinct institutional viewpoints involved, the project team conducted two separate interviews, one with ABET and one with the Kern Family Foundation, rather than hosting a single convening. The questions driving these interviews were:

1. What do professional engineers need to know and do?
2. How can we improve the development, education, and socialization of engineering students into the engineering profession (highlighting curricular changes to emphasize a competency-oriented education as suggested in the Rubric for Action)?
3. How can the work of the FREE initiative complement current practices of quality assurance and credentialing?

An Overview of the Professions and Professional Stature of Engineering

The professions are a relatively recent social form of work aimed at differentiating specific kinds of highly complex, specialized work from other occupations. In modern societies with complex divisions of labor, the professions garnered higher status, trust, and resources by developing high levels of expertise, applying knowledge ethically, along with client-centric practices and confidentiality. A further focus has been on the development and maintenance of professional identities, through common experiences of education, knowledge, world views, work culture, and associational memberships. This results in common and normative ways of perceiving problems and solutions, as well as common ways of perceiving and interacting with customers and clients—manifested by the practices and interactions in workplaces. A common view of the professions is that they are knowledge-based service occupations entered only through extended education and experience, which deal with the riskier aspects of society—birth, death, health, finance, education, spirituality, defense, infrastructure, technology, and so on (Evetts, 2011).

In the early 1900s the concept of professionalism was used to control rampant individualism in an effort to stabilize and civilize society. It was perceived as a means of focusing individuals on the common good and fostering a community orientation—and a way of protecting against the encroachment of industrial and governmental power. Also emphasized was the altruistic or service orientation that valued community and clients, collegiality, cooperation, and mutual support. Enhanced relations of trust between professionals and clients were valued and guaranteed by education and/or licensing (Evetts, 2011). Common tenets of the professions (e.g., engineering, medicine, teaching, nursing, law, and the clergy) are to: (a) deliver worthwhile services toward important human and social goals,

(b) develop and maintain fundamental (mostly academic) knowledge, research, and skills, (c) develop and maintain abilities to perform complex professional practices, (d) make sound judgments under uncertainty, (e) learn from experience, and (f) participate in a responsible, effective professional community (Sheppard, Colby, Macatangay, & Sullivan, 2006).

As dynamic social institutions, the professions continuously develop and react to societal changes. Recently, four influences are changing the nature of engineering work: (1) new technologies, (2) globalization, (3) new engineering problems, and (4) the changing culture and demographics of young people entering engineering studies and practice (Stevens, Johri, & O'Connor, 2014).

1. New technologies have increasingly replaced manual and hands-on work with computational technologies. Information technologies are changing the ways engineering projects are managed, as well as how engineers collaborate.
2. Globalization has fostered different work practices that allow for passing projects around the world to maintain continuous work, as well as subcontracting and off-shoring parts of the job (distributed work). This has also created the need for multi-cultural understanding, management, and coordination.
3. New engineering problems are facing society. There is some evidence of movement out from under the corporate umbrella and profit motives to solve the larger and more complex problems facing society. Yet, many engineering students still aspire to engineering as a source of providing a good living—largely provided by corporate work.
4. There have been significant changes in the populations of young people who become engineers. From an experiential, hands-on, working-class tradition, engineering professionalized itself into an academic and scientific enterprise in the 20th century. In recent decades, as with other professions, de-professionalization has eroded the distinctions between engineering versus non-engineering endeavors, human versus non-human materials, and the authority of institutions to control the professions. Additionally, a "digital" generation is bringing along different assumptions, practices, and co-habitation with technology (Stevens et al., 2014).

An Introduction to Engineering Quality Assurance and Credentialing

The professions also include regulatory efforts to ensure compliance with their norms and standards. The engineering quality assurance and credentialing processes begin with: (1) students graduating from an ABET-accredited engineering program or meeting the National Council of Examiners for Engineering and Surveying (NCEES) Engineering Education Standards; (2) an engineering graduate (or near graduate) passing the Fundamentals of Engineering (FE) exam to become an EIT (engineer in training); (3) the EIT completing at least four years of engineering work experience in the field and providing references to be eligible to take the Professional Engineering (PE) exam; (4) passing the PE exam to become a licensed Professional Engineer; and (5) regularly renewing their PE license according to the requirements of the particular state board governing their licensing and practice. Usually, some form of continuing education and professional development are required for renewal (National Society of Professional Engineers, n.d.).

As a forerunner of ABET, the Society for the Promotion of Engineering Education (SPEE) sponsored a major evaluation in the 1920s of the many varied educational programs in engineering, which led to the establishment of the Engineering Council for Professional Development (ECPD) in 1932. The initial council brought together a group of seven professional societies to set standards for engineering education programs and review programs for compliance to the standards. This work resulted in the first list of accredited engineering education programs published in 1936 (Prados, Peterson, & Lattuca, 2005). The number of accredited programs grew from that point, as well as the number of engineering fields included in the accreditation process. The ECPD eventually evolved into ABET in the 1980s and is currently made up of member experts from 34 professional societies who develop the criteria and standards guiding the accreditation process. Currently (February 2026), ABET accredits “4,773 programs at 930 colleges and universities in 42 countries” (ABET, n.d.). The growth of engineering education in the 20th century created the need for accreditation that assured students and the public that graduates from engineering programs had at least a minimum level of competence in their field to assure the safety, health, and well-being of the public. ABET formed different accreditation commissions to evaluate education programs for engineering, technology, applied science, and computer science (Prados et al., 2005). Graduating from an accredited engineering education program or meeting the NCEES Engineering Education Standard for graduates from non-accredited programs is the first step on the way to obtaining a Professional Engineer (PE) license.

Currently, ABET’s criteria and standards are organized into two broad categories: General Criteria, which pertain to all engineering programs, and Program Criteria, which pertain to specific requirements in areas of specialization. The General Criteria for Baccalaureate-level programs consist of eight criteria for (refer to Appendix D: 2025–2026 Criteria for Accrediting Engineering Programs): 1) Students, 2) Program Education Objectives, 3) Student Outcomes, 4) Continuous Improvement, 5) Curriculum, 6) Faculty, 7) Facilities, and 8) Institutional Support. These criteria cover a range of competencies and program attributes that guide educational programs in the engineering education ecosystem. The Program Criteria are specific to 31 different specialized fields of engineering.

Professional Licensure and Quality Assurance of Engineering Practice

Professional licensure is a common feature of the professions (e.g., law, medicine) designed to ensure the competence of members and the quality of their professional work to protect public safety, health, and well-being (Prados et al., 2005 and Chassie, 2001). One of the key professional issues in engineering is the licensure of engineers after they graduate from higher education. The argument for requiring licensure is based on the idea that the academic competence of engineering graduates is not enough to ensure competent practice of engineering in society (Aldrich, Rosenfield, Walton, and Hofmann, 2020).

"Engineering licensure is a legal standard that sets the minimum competency for practice" (Aldrich et al., 2020). The National Society of Professional Engineers (NSPE) advocates for engineers to become licensed via their state's licensing boards to ensure the safety, health, and well-being of the public by achieving a minimal level of competency in the practice of engineering.

Professional organizations support the advocacy of the profession and the professional development of members. For example, the American Society of Civil Engineers (ASCE) publishes *The Civil Engineering Body of Knowledge* promoting "the need for civil engineers to pursue post-graduate education along with structured mentorship and life-long self-development to acquire and maintain the necessary knowledge, skills, and attitudes to prepare them for responsible charge of civil engineering services" (Aldrich et al., 2020). Additional engineering disciplines (e.g., mechanical engineering, electrical engineering, and chemical engineering) each have professional organizations dedicated to the continuous development and advancement of interests in their respective fields.

Engineering licensure is controlled by individual states through the licensing processes recommended by the NCEES in partnership with NSPE. To varying degrees, licensing is required by most states in the U.S. for engineers to provide services to the public. However, licensure faces some scrutiny due to perceptions that the exams are not relevant to professional practice, concerns that the process creates barriers to entry, and broader societal shifts that are reshaping how traditional professional structures and credentials are viewed.

Another major challenge to licensing in the U.S. is the "industrial exemption," which allows engineers working for a corporation/industrial organization to work without a license. In this case, which applies to a large number of practicing engineers, the assurance of engineering competence, quality, and liability is assumed by the corporation (Chassie, 2001). There are also emerging trends for reducing the power of licensing by making it easier to obtain, more transferable (between states and globally), and more inclusive of other occupational groups outside of the traditional profession, such as covering technicians and the trades.

The quality assurance and credentialing of engineers was developed over the past 100 years to protect the public's safety, health, and well-being by prescribing particular bodies of knowledge, skills, experiences, and other attributes of professional engineers. Prescribing what they know, what they do, and who they are as professionals helps assure the public that the work of engineers will not negatively affect their safety, health, and well-being.

Institutional Stakeholder Interviews

ABET

An interview with Dr. Michael Milligan, CEO of ABET, provided insights into the role accreditation plays in assuring the quality and professional readiness of engineering graduates from an ABET perspective.

ABET's primary mission is to prepare students for entry into the engineering profession, with a sustained focus on strong technical foundations alongside the broader societal impact of engineering practice. Established by industry and continuously shaped by industry engagement, ABET reflects workforce expectations through its accreditation standards, which currently encompass more than 4,700 programs across 42 countries and influence the preparation of approximately 200,000 graduates annually.

Dr. Milligan highlighted the evolution of accreditation through initiatives like Engineering Criteria 2000 (EC2000), which shifted the emphasis from educational inputs to student learning outcomes, particularly professional skills. He also noted that contemporary engineers must be prepared to address complex, multidimensional challenges beyond purely technical problem-solving (e.g., sustainability, ethics, cultural context, and lifecycle considerations). A persistent challenge for ABET lies in effecting engineering curricular change. To meet this challenge, ABET has partnered with other organizations to create materials designed to help faculty drive curricular change. Effective communication around change in engineering curricula is critical to help both faculty and administrators understand and engage with developing new skills among students.

ABET is a federation of 34 professional societies representing almost 1.5 million individual members who, as Dr. Milligan noted, “help us determine what the future of education looks like.” NSPE is one of ABET’s founding-member societies focusing on the professional side of engineering practice. ABET is an active partner in global agreements such as the Washington Accord and partners with several other organizations related to engineering education including the International Engineering Alliance (IEA), the Global Engineering Deans’ Council (GEDC), and the International Federation of Engineering Education Societies (IFEES). As such, ABET operates within a broad ecosystem of professional organizations that collectively shape standards, credentialing practices, and the future direction of engineering education worldwide.

In 2024, ABET announced the launch of four new credentialing courses focused on program assessment, in alignment with “ABET’s strategic initiative to continue furthering [their] mission to provide resources that support continuous improvement and development” (ABET, 2024, para 4). The courses are flexible and stackable, providing a tailored and personalized experience for learners and “position[ing] educators as leaders in their field, able to enhance their ability to teach an increasingly diverse population of learners” (ABET, 2024, para 4).

The Kern Family Foundation Entrepreneurial Engineering Network (KEEN)

An interview with Dr. Douglas Melton, Program Director for the Kern Entrepreneurial Engineering Network (KEEN) at the Kern Family Foundation, provided an additional perspective on facilitating changes in engineering education.

Insights from this interview highlighted the growing emphasis on entrepreneurial formation as a core dimension of future-ready engineering preparation. Dr. Melton described the field as being at an inflection point, with expectations for engineering graduates expanding beyond technical proficiency to include value creation, opportunity recognition, and societal impact. Central to this work is the entrepreneurial mindset framework, operationalized through KEEN’s “3Cs” of curiosity, connections, and creating value, which seek to cultivate students’ professional narrative (story) and self-concept (identity) as engineers.

KEEN advances this vision through faculty development workshops, conferences, mentoring initiatives, and the collaborative KEEN Engineering Unleashed Network, all of which are designed to build a strong sense of community among educators and catalyze collective curricular change toward cultivating a stronger entrepreneurial mindset among future engineers.

KEEN's faculty development workshops are immersive, high-touch experiences featuring teams of faculty peers facilitating work on different topics related to new ways of educating engineering students. During the workshops, groups create living documents and resources of innovative ideas, referred to as "Cards" that reside on the Engineering Unleashed website (*https://engineeringunleashed.com/*) to help faculty integrate entrepreneurial mindset into their teaching through curriculum, discussions, and classroom activities. Similarly, the KEEN National Conference convenes hundreds of people each year who interact, build relationships, and share ideas and experiences of new ways of educating engineering students. KEEN is also beginning to embark on partnerships with professional societies focused on faculty development and graduate student development; Dr. Melton acknowledged the value of ASEE as a partner for advocating for and supporting change in engineering education.

Dr. Melton stressed that industry wants students who can think beyond just the technical. Students are ready for change, and changes in institutional programs are essential. The "vehicle" of change includes the collaboration of industry, students, and engineering faculty and administrative leaders. Collectively, KEEN's initiative positions entrepreneurial mindset development as a complementary quality dimension alongside traditional accreditation and credentialing structures in preparing engineers for evolving professional contexts.

Common Themes

There were several common themes that resulted from the interviews conducted with ABET and the Kern Family Foundation. Taken together, the interviews reinforced a shared recognition that engineering education is at a pivotal moment of transformation, requiring expanded conceptions of quality and professional preparation.

Both perspectives affirmed the continued importance of strong technical foundations while emphasizing that future-ready engineers must also demonstrate professional, societal, and human-centered competencies (e.g., ethical decision-making, sustainability issues, and cultural and social environments).

ABET is evolving to incorporate outcomes-based models and broader skill domains, through curricular change efforts, partnerships with professional societies and global organizations, and new flexible credentialing systems. The Kern Family Foundation's KEEN initiative is working to advance complementary frameworks, particularly entrepreneurial mindset development, to cultivate value creation, identity formation, and societal impact in engineering education.

Across both interviews, industry influence emerged as a central driver shaping expectations for engineering graduates, along with the need for increased collaboration among educational institutions, professional societies, and employers. Both leaders also highlighted the challenges of catalyzing curricular change, pointing to faculty development, institutional support, and cross-sector partnerships as essential mechanisms for advancing curricular reform. Collectively, these insights suggest that assuring the quality of engineering education and preparing engineers for future practice will require an interconnected approach that integrates accreditation, credentialing, faculty development, and innovation in teaching and learning.

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5.0 Conclusions

Building on the FREE Competency Model developed in Phase I, Phase II of the FREE initiative focused on gathering stakeholder perspectives from faculty, academic leaders, and institutional representatives to assess both the applicability of the FREE Competency Model and the broader conditions shaping the preparation of future engineers.

An overriding consideration across the engineering education ecosystem is the perceived need to change the education and development of engineers toward a broader and more holistic set of competencies that reach beyond the traditional technical competence of engineers. These changes include the addition of developing the level of personal and professional competencies in students, as well as more understanding and appreciation for global issues, multidisciplinary thinking, diversity, and sustainability. Lack of resources, rigid curricular and bureaucratic structures in higher education, and misalignment with faculty incentives and promotion and tenure systems were cited as obstacles to making these changes. Fortunately, there appears to be widespread recognition and support across all levels of the ecosystem that changing engineering education and development toward developing more holistic, human- and society-oriented engineers, while maintaining competence in the technical fundamentals, is both a necessary and positive change.

Despite societal pressures eroding the status and power of the professions, professional organizations from accreditation to licensure are responding to this change driven by their partnerships with industry and academia. They are in tune with the complexity and difficulties of changing strong traditions in education and professional practice. To that end, they are also committed to helping their constituents find ways to accommodate new ideas in their programs without having to abandon current programs and rebuild them anew. Professional organizations are incrementally evolving their standards and recommendations to help embed new competencies and content within current engineering education and professional development structures. Multiple professional organizations have partnered with each other to coordinate and collaborate around a common vision of the future engineer.

Across survey feedback, stakeholder convenings, and institutional interviews, the FREE Competency Model was viewed as relevant and necessary, considering that future engineers must be equipped to confront challenges spanning technological disruption, globalization, sustainability, ethics, and societal impact. Stakeholders were unanimous about the importance of complementing strong technical foundations with professional, societal, and human-centered competencies. Experiential learning, multidisciplinary collaboration, and industry engagement were repeatedly identified as promising pathways for cultivating these attributes in current engineering students.

At the same time, participants stressed that adopting and implementing Competency-Based Education (CBE) will require addressing structural, cultural, and resource constraints embedded within higher education systems. Examples of constraints and barriers to implementation included faculty workload, rigid curricular structures, assessment complexity, and misalignment with faculty incentives and promotion and tenure systems. Deans highlighted the importance of systemic alignment, while also investing in faculty development and cross-sector partnerships. Faculty and deans agreed that starting small was the best approach for advancing change while building institutional readiness, with ideas including incremental implementation, pilot initiatives, and communities of practice.

Phase II of the FREE initiative affirms the urgency and opportunity of advancing a competency-centered vision for engineering education. Transformation will not occur through a single pathway or within a single institution. As the engineering profession continues to evolve, sustained collaboration across key stakeholder groups will be essential to ensuring that educational systems, quality assurance mechanisms, and professional development pathways remain responsive to the competencies required for future practice. The FREE Competency Model represents a catalyst for a broader effort to reimagine and ultimately reshape engineering education for the future.

6.0

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7.0 Appendices

Appendix A: FREE Competency Taxonomy

Table 7.1 Competency Taxonomy (v.7, March 13, 2023)

TECHNICAL COMPETENCE: Characterizes a person as competent in a particular field of knowledge/technology (e.g., engineering)

1. TECHNICAL KNOWLEDGE
What you know and understand...

1.1. Know and understand emerging fields in engineering, including theoretical and practical knowledge of...

- 1.1.1. Data science, computer science, big data analytics
- 1.1.2. Artificial intelligence, machine learning, robotics, advanced manufacturing, automation, cyber-physical systems, cognitive agents, virtual and augmented reality
- 1.1.3. Connectivity, networks, integrated systems (iot, ios, iop), cloud computing, systems thinking, systems architecture, cyber-security, semiconductors
- 1.1.4. Bioengineering, biotechnology
- 1.1.5. Environmental engineering, climate science, sustainable materials
- 1.1.6. Quantum information science and technology

1.2. Know and understand existing fields in engineering, including theoretical and practical knowledge of...

- 1.2.1. Engineering sciences: mechanical, civil, electrical, chemical, systems, and industrial engineering
- 1.2.2. Design science
- 1.2.3. Systems science and systems thinking

1.3. Know and understand perspectives of multiple disciplines, stakeholders, and communities

- 1.3.1. Cross-disciplinary, organizational, environmental, and community issues
- 1.3.2. Leverage STEM expertise in multiple areas

1.4. Know and understand practical reasoning

- 1.4.1. Experiential knowledge, intuitions, biases, creativity
- 1.4.2. Natural decision-making, sense-making
- 1.4.3. Contextual understanding (business, economics, organizations, environment)

Table 7.1 Competency Taxonomy (v.7, March 13, 2023) (continued)

2. TECHNICAL SKILLS

What you can do...

2.1. Manage and perform the work of emerging technologies and engineering fields

- 2.1.1. Use, monitor, and control technologies
- 2.1.2. Design and enhance technologies
- 2.1.3. Model various systems and processes

2.2. Manage, model, and process data to create meaningful information and knowledge

- 2.2.1. Process data (envision, collect,analyze, evaluate, create, and synthesize)
- 2.2.2. Interpret, critique, and apply data-based knowledge for decision-making, quick responses, improved productivity, higher quality products, services, and solutions

2.3. Design, conduct, and communicate technical and scientific information

- 2.3.1. Collaborate in team science
- 2.3.2. Work with automated research workflows (ARWs)
- 2.3.3. Communicate with multiple stakeholders

2.4. Design solutions for people and planet

- 2.4.1. Develop creative, innovative, and intuitive solutions
- 2.4.2. Commercialize solutions and disseminate to professions and society

2.5. Design for sustainability

- 2.5.1. Use resources effectively and practically
- 2.5.2. Consider consequences of decisions

2.6. Design, change, and integrate multiple systems (technical, human, business/financial)

- 2.6.1. Analyze, improve systems, reduce risks
- 2.6.2. Effectively use tools and data

2.7. Manage multi-disciplinary projects

- 2.7.1. Apply PMI processes and engineering expertise
- 2.7.2. Lead teams, people, stakeholders
- 2.7.3. Manage project constraints
- 2.7.4. Meet goals and objectives

3. TECHNICAL ATTRIBUTES

Who you are...

3.1. A Scientist-Engineer

- 3.1.1. Curious, creative, innovative
- 3.1.2. Disciplined, analytical, evidence-based
- 3.1.3. Experimenter, explorer, inventor

3.2. A Problem-Solver

- 3.2.1. Realistic about constraints
- 3.2.2. Analytical, insightful, and decisive, even in uncertain situations
- 3.2.3. Adaptable and flexible
- 3.2.4. Action-oriented
- 3.2.5. Motivated to transfer knowledge/solutions to society

3.3. A Project Manager

- 3.3.1. PM process and technical expert
- 3.3.2. Leader, partner, manager, team player
- 3.3.3. Effective communicator and collaborator with multiple and diverse partners and stakeholders

Table 7.1 Competency Taxonomy (v.7, March 13, 2023) (continued)

PERSONAL/PROFESSIONAL COMPETENCE: Characterizes an individual as a competent, well-rounded person and professional (e.g., engineer, professional, group/organization member, community member, citizen)

4. PERSONAL/PROFESSIONAL KNOWLEDGE

What you know and understand...

4.1. Knowledge of general and multi-disciplinary knowledge

- 4.1.1. Humanities, psychology, sociology
- 4.1.2. Business, management, organization behavior

4.2. Knowledge of global, cultural, and societal issues

- 4.2.1. How different people/communities perceive and experience issues
- 4.2.2. Interpersonal/social interactions, group dynamics, and relationship building
- 4.2.3. Ethics in work and community
- 4.2.4. Legal issues and human rights

4.3. Know and understand oneself

- 4.3.1. Awareness and understanding of personality and personal biases, limits, strengths, weaknesses, and emotions
- 4.3.2. Understand one's positionality and privilege in social hierarchies and how power structures affect relationships, decisions, and contexts
- 4.3.3. Understand and apply complexity and dialectics over simplistic, dualistic thinking
- 4.3.4. Develop and commit to thriving in health and well-being stakeholders

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Appendix B: Framework and Rubric for Action

Table 7.2 Framework and Rubric for Action

INDIVIDUAL-LEVEL Indicators of HIGH PROGRESS	Moderate Progress	Low Progress
ADMINISTRATORS		
Substantial, high-level support for and actions taken to integrate competency-based educational components in curricula (including policy changes, additional resources, and recognition and rewards for faculty, students, and industry/community partners)		
FACULTY		
Faculty continuously **engage in professional development,** especially related to competency-based education and industry/professional experiences (specific competencies)		
Faculty actively c**ollaborate with each other, community members, and industry partners** to enhance the competency-based learning of students		
Faculty actively participate in competency-based education by **designing competency-based instruction** into their courses (e.g., service learning and project-based learning)		
Faculty provide students with **broad interdisciplinary experiences to enhance competency-based learning**		
Faculty serve as **coaches and mentors to students** emphasizing competency-based development		
Faculty have **real, measurable impact** on student competency development and community/industry engagement		
STUDENTS		
Students have a **high level of support for and participation** in developing their competence		
Students have a **high sense of accomplishment and satisfaction** for competency-based learning		
Students **regularly interact with and serve** community, industry, the profession, and associations		
Students **take greater control of planning and managing their experiences** to meet their goals (individualized pathways)		
Students own, develop, and enhance their **professional identities**		
OTHERS		
Industry and community partners **engage in competency-based programs and contribute** knowledge, projects, mentoring, and advice to students and faculty related to the development of engineering competencies		

Table 7.2 Framework and Rubric for Action (continued)

PROGRAM-LEVEL Indicators of HIGH PROGRESS	Moderate Progress	Low Progress
Program-wide acceptance and implementation of modular, competence-based instructional approaches and learning outcomes across courses, curricula, and colleges		
Increase **interdisciplinary collaborations** across colleges, industries, and communities		
Offer **customizable, individualized, non-standard degree requirements, program tracks**		
Program **implements and supports robust competency and other professional development**		
Programs **include holistic criteria to assess competency and demonstrate mastery** (including portfolios, presentations, and other alternative measures)		
Programs foster a **broad abundance of resources, mentors, and industry partners engaged** in programs		
Programs focus on **hiring faculty and other professionals having competency-based experience**		
Accreditation efforts **recognize and reward competency-based learning outcomes**		
INSTITUTIONAL-LEVEL Indicators of HIGH PROGRESS	**Moderate Progress**	**Low Progress**
HIGHER EDUCATION		
Institution shows enthusiastic **commitment and support for competency-based learning** (including from university administration, trustees, etc., as well as students, faculty, community, and industry)		
Institution demonstrates **high level of transparency regarding power** relations in educational change efforts		
Significant **emphasis on, recognition of, and rewards for faculty, staff, and other personnel for development and teaching to advance competency-based education,** including in evaluation, promotion, and tenure process		
Institution has a stronger **emphasis on skills and attributes,** along with knowledge competencies in learning		
Effective increase of **vertical integration of K-16 STEM education**		
Greater emphasis on **real-world issues in education,** including interdisciplinary service learning and project-based learning		
Support for increasing **global faculty exchanges**		
Increased **student enrollments and graduation rates, including increased graduates' success and satisfaction** with engineering education and career		
Competency-based learning outcomes included in **ABET and institution evaluation metrics** (including quality of instruction)		
Complete redesign and integration of programs to **eliminate fixed 4-year/3-credit model in favor of individualized pathways** codesigned by students and faculty		
Competency-based assessment accepted as an alternative assessment instrument, including portfolios and other means of assessing success		
INDUSTRY, COMMUNITY		
Robust **collaboration with industry partners, organizations, and multiple colleges** to integrate competency-based and interdisciplinary education into curricula		
Enhanced **community and industry relations and collaborations**		
Employers support improvements in graduates' competencies for work		

Appendix C: Working Description of CBE

Competency-Based Education (CBE) has no commonly accepted definition or design in education. Across the various understandings, descriptions include characteristics such as: CBE is considered to be more learner centered (i.e., learners have flexibility to progress at their own pace and choosing their own pathways), based on learning outcomes (i.e., demonstrated mastery of specific competencies), supported by an array of learning resources (i.e., virtual, physical, in-person faculty and staff, etc.), and assessed by demonstrated mastery of specified knowledge and skills (competencies) [1].

CBE is an approach to preparing students for practice that is oriented toward graduate competence in the abilities and proficiencies of competencies derived from academic, industrial, and societal needs. It de-emphasizes time-based education and promises greater accountability, flexibility, and learner-centered education [2].

CBE allows learners to engage and progress through education and training programs at their own pace obtaining credit and credentials based on demonstrated competence [3], [4]. As an alternative to traditional learning systems that generally measure learning of instructor-led objectives within a fixed time frame (e.g., a semester), CBE measures students' achievement of stakeholder-determined learning outcomes in the time needed by the learner to demonstrate mastery [4].

A useful definition of CBE is: "An outcomes-based approach to education that incorporates modes of instructional delivery and assessment efforts designed to evaluate mastery of learning by students through their demonstration of the knowledge, attitudes, values, skills and behaviours required for the degree sought" [5].

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Appendix D: ABET 2025–2026 Criteria for Accrediting Engineering Programs

Source: *https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2025-2026/*

ABET General Criteria for Baccalaureate Level Programs In Engineering

All programs seeking accreditation from the Engineering Accreditation Commission of ABET must demonstrate that they satisfy all of the following General Criteria for Baccalaureate Level Programs.

Criterion 1. Students

Student performance must be evaluated. Student progress must be monitored to foster success in attaining student outcomes, thereby enabling graduates to attain program educational objectives. Students must be advised regarding curriculum and career matters. The program must have and enforce policies for accepting both new and transfer students, awarding appropriate academic credit for courses taken at other institutions, and awarding appropriate academic credit for work in lieu of courses taken at the institution. The program must have and enforce procedures to ensure and document that students who graduate meet all graduation requirements.

Criterion 2. Program Educational Objectives

The program must have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria. There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they remain consistent with the institutional mission, the program's constituents' needs, and these criteria.

Criterion 3. Student Outcomes

The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.

Criteria for Accrediting Engineering Programs

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Criterion 4. Continuous Improvement

The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the program's continuous improvement actions. Other available information may also be used to assist in the continuous improvement of the program.

Criterion 5. Curriculum

The curriculum requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The program curriculum must provide adequate content for each area, consistent with the student outcomes and program educational objectives, to ensure that students are prepared to enter the practice of engineering. The curriculum must include:

A. A minimum of 30 semester credit hours (or equivalent) of a combination of college-level mathematics and basic sciences with experimental experience appropriate to the program.

B. A minimum of 45 semester credit hours (or equivalent) of engineering topics appropriate to the program, consisting of engineering and computer sciences and engineering design, and utilizing modern engineering tools.

C. A broad education component that complements the technical content of the curriculum and is consistent with the program educational objectives.

D. A culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work.

Criterion 6. Faculty

The program must demonstrate that the faculty members are of sufficient number and they have the competencies to cover all of the curricular areas of the program. There must be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students. The program faculty must have appropriate qualifications and must have and demonstrate sufficient authority to ensure the proper guidance of the program and to develop and implement processes for the evaluation, assessment, and continuing improvement of the program. The overall competence of the faculty may be judged by such factors as education, engineering experience, teaching effectiveness and experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and licensure as Professional Engineers.

Criterion 7. Facilities

Classrooms, offices, laboratories, and associated equipment must be adequate to support attainment of the student outcomes and to provide an atmosphere conducive to learning. Modern tools, equipment, computing resources, and laboratories appropriate to the program must be available and systematically maintained and upgraded to enable students to attain the student outcomes and to support program needs. Students must be provided appropriate guidance regarding the use of the tools, equipment, computing resources, and laboratories available to the program. The library services and the computing and information infrastructure must be adequate to support the scholarly and professional activities of the students and faculty.

Criterion 8. Institutional Support

Institutional support, resources, and leadership must be sufficient to: a) ensure the quality and continuity of the program; b) attract, retain, and provide for the continued professional development of a qualified faculty; c) acquire, maintain, and operate infrastructures, facilities and equipment appropriate for the program; and d) create and foster a respectful environment among the program's students, faculty, staff, and administrators such that the student outcomes can be attained. Resources include institutional services and policies, financial support, and administrative and technical staff

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