ABET and *Standards for Technological Literacy*

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Abstract
Pre-college students must be educated to make informed decisions in our technological world. *Standards for Technological Literacy: Content for the Study of Technology* and the Accreditation Board for Engineering and Technology's *Engineering Criteria 2000*'s Criterion 3 Program Outcomes and Assessment focus on producing secondary school and engineering graduates with an enhanced level of technological literacy and competency. These documents provide a perspective on pre-college through undergraduate education, with the intention being to promote improvement in the quality and quantity of engineering students and to enhance the level of technological literacy of pre-college teachers and their students.

Background
The Accreditation Board for Engineering and Technology (ABET) is widely recognized as the sole agency in the United States responsible for accrediting educational programs leading to degrees in engineering, engineering technology, computing, and applied science (formerly, related engineering) areas. The ABET list of accredited programs is widely accepted by employers, academic institutions, professional engineering societies, and the professional engineer licensure boards. Furthermore, ABET criteria and processes for accreditation are highly regarded internationally by academic institutions and agencies for accreditation.

ABET recently completed the transition phase to new engineering criteria for accreditation of engineering educational programs, initially and still popularly called *Engineering Criteria 2000* [1]. These program objectives and outcomes were nurtured from the early 1990's and adopted in 1995. The criteria are embedded in a framework that invokes continues improvement. Criterion 3 Program Outcomes and Assessment is evidence of the new focus on what college students are expected to know and be able to do upon graduation from engineering educational programs (see Horizontal listing in Table 1).

In April 2000, *Standards for Technological Literacy: Content for the Study of Technology* [2] (*STL*) was published by the International Technology Education Association (ITEA). The overall focus of *STL* is to promote the study of technology and to encourage the development of technological literacy by all pre-college students. The document provides a rationale for the need for students to develop technological literacy. It details twenty standards for technological literacy (see Vertical listing in Table 1); concludes with recommendations of what might be done to advance the cause of

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technological literacy; and encourages the adoption of the standards for technological literacy in states, regional jurisdictions, and localities.

Several groups contributed to the development of *STL* including an Advisory Group and a National Academy of Engineering Focus Review Group. In addition, *STL* underwent a rigorous review by the technology education community and the National Research Council. The support of these groups in the development of *STL* reinforced the belief that a set of standards could lead to change in fundamental components of the educational system.

Comparing Engineering Criteria 2000 and *Standards for Technological Literacy*
Tables 1 and 2 compare and contrast the concepts and principles that are recommended for technology education courses for grades K-12 in *STL* with outcomes specified in Criterion 3 Program Outcomes and Assessment of *EC2000*.

Potential Impact of *STL* on Engineering Education
As pre-college schools and districts adopt and implement *STL,* increased numbers of students will take technologically oriented coursework, and will be exposed to many aspects of engineering. These experiences will likely result in more students understanding engineering principles and selecting engineering as a career option. By interacting with the standards, they will be better able to develop life-long learning skills that will help to equip them to be successful in pursuing engineering degrees. If students understand more about the concepts and principles of technology (first column entries in Table 2) then their overall level of technological literacy will be enhanced. An increase in technological literacy will very likely result in a workforce that is capable of assuming the responsibilities of highly skilled technical positions.

The National Academy of Engineering report *Technically speaking: Why all Americans need to know more about technology* [3] stated that groups, such as schools of engineering, "are well positioned to influence the development of technological literacy" [p. 12]. Specifically, engineering educators working with pre-college teacher-educators can impact the level of technological literacy of future, as well as current, teachers who, in turn, share their technological knowledge with their students for the (remaining) duration of their teaching careers. The returned benefit is that *STL* has the potential to increase enrollments in engineering programs. The benefit is, however, considerably greater. By implementing the standards at the pre-college level, not only will the supply of future engineers almost assuredly increase, but also the level of technological literacy of society generally will certainly be enhanced.

The engineering profession can serve society and itself by encouraging and supporting the implementation of the standards for technological literacy. The National Research Council publication *Engineering Education: Designing an Adaptive System* (1995) [4] comments on the status of the engineering profession:

> "The nation's engineering education system includes not just higher education but also K-12, community colleges, and continuous (lifelong) engineering education. These elements are embedded in the larger society, whose political and economic influences typically affect engineering schools through the academic institution of which they are a part. Those socioeconomic and political factors also drive demand for engineers, as well as the supply, recruitment, and retention of engineering students" (p. 40).

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Summary

The movement to improve technological literacy in pre-college education and the new ABET engineering criteria have the potential to work synergistically to improve engineering, resulting in a stronger technological society and economy. *Technically Speaking* described the potential impact of engineering on technological literacy when it stated, "An engineering-led effort to increase technological literacy could have significant, long-term pay-offs, not only for decision makers in government but also for the public at large" [3, p.112].

STL provides a focused guide for improving technological literacy at the pre-college level. And, because there are clear connections between the standards for technological literacy and the ABET 2000 Criteria, the movement to improve technological literacy in K-12 education has the potential to improve engineering —serendipitously resulting in a more technology enriched society and thereby a stronger economy. Consequently, for self-interest alone, engineers, engineering educators, and their professional societies, are encouraged to support the implementation of *STL* at the pre-college level. William A. Wulf goes further—beyond self-interest—in describing the potential impact of the standards for technological literacy when he wrote, "The standards will provide a much-needed reference point for developers of curriculum and instructional materials. Most important, the standards lay the foundation for building a technologically literate citizenry" (Wulf, 2000, p. 10) [5].

Bibliography

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[3] National Academy of Engineering (NAE). 2002. *Technically speaking: Why all Americans need to know more about technology*. Washington, DC: National Academy Press. p. 4-5, 12, 40-2, and 112.

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[5] Wulf, W. A. 2000. The standards for technological literacy: A national academies perspective. *The Technology Teacher,* 59, p.10 – 12.

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Table 1

Key: ● denotes a correlation in ideas and concepts in both standard and outcome √ denotes the ideas and concepts may not be directly addressed, but the ideas are supported in both standard and outcome • denotes an implied idea or concept that may be used in both standard and outcome	**ABET Outcome a:** An ability to apply knowledge of mathematics, science, and engineering	**ABET Outcome b:** An ability to design and conduct experiments, as well as to analyze and interpret data	**ABET Outcome c:** An ability to design a system, component, or process to meet desired needs	**ABET Outcome d:** An ability to function on multi-disciplinary teams	**ABET Outcome e:** An ability to identify, formulate, and solve engineering problems	**ABET Outcome f:** An understanding of professional and ethical responsibility	**ABET Outcome g:** An ability to communicate effectively	**ABET Outcome h:** The broad education necessary to understand the impact of engineering solutions in a global and societal context	**ABET Outcome i:** A recognition of the need for, and an ability to engage in life-long learning	**ABET Outcome j:** A knowledge of contemporary issues	**ABET Outcome k:** An ability to use techniques, skills, and modern engineering tools necessary for engineering practice
STL Standard 1: Students will develop an understanding of the characteristics and scope of technology.	*	*	*	*	●	*	√	●	*	√	●
STL Standard 2: Students will develop an understanding of the core concepts of technology.	*	*	●	●	●	*	√	●	*	√	●
STL Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	●	●	*	*	√	●	●	●	*	√	√
STL Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.	●	*	*	*	√	●	√	●	*	●	√
STL Standard 5: Students will develop an understanding of the effects of technology on the environment.	*	*	*	*	√	●	√	●	*	●	√
STL Standard 6: Students will develop an understanding of the role of society in the development and use of technology.	*	*	*	*	●	●	√	●	*	●	√
STL Standard 7: Students will develop an understanding of the influence of technology on history.	●	*	*	*	√	●	√	●	*	●	√
STL Standard 8: Students will develop an understanding of the attributes of design.	√	●	●	*	●	*	●	●	*	√	●
STL Standard 9: Students will develop an understanding of engineering design.	√	●	●	*	●	*	●	●	*	√	●
STL Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.	√	●	●	*	●	●	●	●	*	√	●
STL Standard 11: Students will develop the abilities to apply the design process.	√	●	●	●	●	*	●	●	*	√	●
STL Standard 12: Students will develop the abilities to use and maintain technological products and systems.	√	√	●	●	√	*	●	●	*	√	●

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Table 1 (continued)

Key: ● denotes a correlation in ideas and concepts in both standard and outcome √ denotes the ideas and concepts may not be directly addressed, but the ideas are supported in both standard and outcome • denotes an implied idea or concept that may be used in both standard and outcome	**ABET Outcome a:** An ability to apply knowledge of mathematics, science, and engineering	**ABET Outcome b:** An ability to design and conduct experiments, as well as to analyze and interpret data	**ABET Outcome c:** An ability to design a system, component, or process to meet desired needs	**ABET Outcome d:** An ability to function on multi-disciplinary teams	**ABET Outcome e:** An ability to identify, formulate, and solve engineering problems	**ABET Outcome f:** An understanding of professional and ethical responsibility	**ABET Outcome g:** An ability to communicate effectively	**ABET Outcome h:** The broad education necessary to understand the impact of engineering solutions in a global and societal context	**ABET Outcome i:** A recognition of the need for, and an ability to engage in life-long learning	**ABET Outcome j:** A knowledge of contemporary issues	**ABET Outcome k:** An ability to use techniques, skills, and modern engineering tools necessary for engineering practice
STL Standard 13: Students will develop the abilities to assess the impact of products and systems.	√	●	●	●	√	●	●	●	*	√	●
STL Standard 14: Students will develop an understanding of and be able to select and use medical technologies.	√	●	●	√	●	*	●	●	*	√	●
STL Standard 15: Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.	√	●	●	√	●	*	●	●	*	√	●
STL Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.	√	●	●	√	●	*	●	●	*	√	●
STL Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.	√	●	●	√	●	●	●	●	*	√	●
STL Standard 18: Students will develop an understanding of and be able to select and use transportation technologies.	√	●	●	√	●	*	●	●	*	√	●
STL Standard 19: Students will develop an understanding of and be able to select and use manufacturing technologies.	√	●	●	√	●	*	●	●	*	√	●
STL Standard 20: Students will develop an understanding of and be able to select and use construction technologies.	√	●	●	√	●	*	●	●	*	√	●

Table 1. Comparison of Standards for Technological Literacy (STL) and Engineering Criteria 2000 (EC2000)

Source: Accreditation Board for Engineering and Technology (ABET) *Engineering Criteria 2000* and International Technology Education Association's (ITEA) *Standards for Technological Literacy: Content for the Study of Technology*.

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Table 2

CONCEPTS AND PRINCIPLES	***Engineering Criteria 2000* (Post-Secondary)**	***Standards for Technological Literacy* (K-12)**
Understand and use mathematics, science, and technology	ABETA	STLS3, STLS4, & STLS7
Understand technological knowledge	√	STLS1 & STLS2
Understand the history of technology	√	STLS7
Understand the historical significance of previous advances in technology and engineering	√	STLS3 & STLS7
Understand about engineering and technology in society	ABETF, ABETH, & ABETJ	STLS 4, STLS5, STLS6, & STLS7
Understand systemic principles	ABETC & ABETH	STLS11, STLS12, & STLS13
Understand ecological principles	ABETJ	STLS5
Use and recognize inquiry skills, apply knowledge in retrieving information, and recognize and analyze major limitations in the usefulness of information	ABETB, ABETF, ABETG	STLS3, STLS10, STLS13 & STLS 17
Understand and use abilities of engineering design • Define a problem • Brainstorm, research, and generate ideas • Identify criteria and specify constraints • Develop and propose designs and chose between alternative solutions • Implement a proposed solution • Make a model or prototype • Evaluate a solution and its consequences • Refine the design • Create or make the design • Communicate the processes and results	ABETB, ABETC, ABETE, ABETG, & ABETK	STLS8, STLS9, STLS10, &STLS11
Identify, formulate, and solve engineering problems	ABETE	STLS8, STLS9, STLS10, & STLS11
Employ tools and equipment and use appropriate tools and techniques	ABETK	STLS1, STLS11, & STLS12
Understand properties of objects and materials	√	STLS2, STLS15, STLS18, STLS19, & STLS20
Understand about risks and benefits of design solutions	√	STLS2, STLS5, & STLS13
Understand resources: ➢ Understand properties of earth materials, such as building materials & sources of fuel ➢ Understand resources and human use	√	STLS2, STLS14, STLS15 STLS16, STLS17, STLS18 STLS19, & STLS20
Work as a team or individually to solve problems	ABETD	STLS2, STLS11, STLS12, & STLS13
Assess impact and consequences of products and systems and assess impact and consequences of actions.	√	STLS13
Communicate solutions in portfolios, design sketches and drawings, journals, logs, multi-media presentations, and audio-visual presentations	ABETG	STLS12 & STLS17
Recognize the need for, and ability to engage in life-long learning	ABETI	√

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Table 2: A table depicting some of the major concepts and principles covered in technology education courses and recommended engineering accreditation criteria.

Key: A code sequence of ABETA through ABETK correlates to the ABET's outcomes a through k (in Criterion 3 of *Engineering Criteria 2000*), while STLS1 through STLS20 correlates to the ITEA's *Standards for Technological Literacy*. A check mark, √, refers to the topic being mentioned or covered in some manner, but it may not be directly stated.

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