feature article

The Leadership Team and Reviewers/Writers at Chinsegut, August 2019.

Jackson's Mill to Chinsegut: the journey to *STEL*

Standards for Technological and Engineering Literacy *is designed to provide a refined focus for the future of T&E education.*

by Thomas Loveland, DTE, Tyler S. Love, Trena Wilkerson, and Patricia Simmons

Introduction

In 1981, twenty-one industrial arts educators convened at Jackson's Mill, WV to develop an agreed-upon rationale and direction for the future of industrial arts. However, the route to achieve this goal was not as clear, as they had to "live the challenge of inquiry, assimilation, compromise, and consensus" (Snyder & Hales, 1981, p. ii). What resulted was a 66-page report known as *Jackson's Mill Industrial Arts Curriculum Project*, which served as the impetus for the American Industrial Arts Association's (AIAA) name change to the International Technology Education Association (ITEA) in 1985.

With the beginnings of the Excellence Reform Movement, launched by *A Nation at Risk: The Imperative for Educational Reform* and published by the National Commission on Excellence in Education (1983), content became the primary curricular focus in U.S. public education to better prepare students for an increasingly competitive global economy. This content focus drove the development of standards to guide American education. The passage of the Federal Goals 2000 Educate America Act led to the development of many national standards, including mathematics (NCTM, 1989) and science education (AAAS, 1989; National Research Council, 1996). To address this national focus on content and guiding standards, ITEA leaders began a six-year effort to develop a rationale and structure, and later content standards for technology

education. Initiated as the Technology for All Americans Project in 1994, the culminating result was ITEA's release of *Standards for Technological Literacy: Content for the Study of Technology* (*STL*) in 2000.

With the exception of minor updates in 2002 and 2007, the standards written two decades ago saw very little alteration despite changes in the field and technological developments since 2000. For example, in 2010 ITEA adopted engineering into the name of the organization, becoming the International Technology and Engineering Educators Association (ITEEA). This name change helped to communicate the technological and engineering design focus of the profession.

The Development of the New Standards

While proposals to revise the standards had been attempted in 2011 and 2012, ITEEA's Council on Technology and Engineering Teacher Education (CTETE), a council primarily comprised of professors and teacher educators, made the decision in June 2018 to take the lead in the standards revision. This initial push steered a planning team of leaders from ITEEA and CTETE to apply for and receive an Advanced Technological Education (ATE) grant from the National Science Foundation (NSF). ITEEA solicited feedback via a survey in November 2018 from its current members to gain a better understanding of what stakeholders wanted from the direction of the new standards. In the late Fall of 2018, eight educators were chosen to lead the project. They included Dr. Jennifer Buelin (formerly of ITEEA's STEM Center for Teaching and Learning), Dr. Michael Daugherty (University of Arkansas), Dr. Marie Hoepfl (Appalachian State University), Dr. Charlotte Holter (ITEEA's Elementary STEM Council), Dr. Todd Kelley (Purdue University), Dr. Thomas Loveland (University of Maryland Eastern Shore), Dr. Johnny Moye (ITEEA Senior Fellow), Anna Sumner, (former ITEEA President), with Steve Barbato (ITEEA Executive Director) overseeing the project.

A judicious plan was put in place to select a group of 30 individuals comprised of professors, classroom teachers, supervisors, representatives from industry, and colleagues from affiliated professional organizations, to convene in the summer of 2019 to discuss and revise the standards. Chosen through a modified Delphi process, the goal was to have a broad representation regarding reviewer/writers' gender, geographic location, age, ethnicity, role in STEM education or industry, grades taught, and technology and engineering/T&E-related content expertise. Preferred qualities included individuals who were creative thinkers, strong writers, collaborators, and project completers. One of the reviewers/writers from Australia was specifically selected to provide international insight due to his active role in numerous international T&E education organizations. The reviewers and their affiliations are listed in Table 1. It should be noted that many of the reviewers/writers had expertise in multiple areas that may

Table 1. *STEL* Revision Reviewers/Writers and Affiliation

Name / Affiliation	Category
Dr. Scott Bartholomew: Purdue University (IN)	4 YR Prof
Dr. Sharon Brusic: Millersville University (PA)	4 YR Prof
Dr. Vinson Carter: University of Arkansas (AR)	4 YR Prof
Dr. Cameron Denson: North Carolina State University (NC)	4 YR Prof
Dr. Andrew Hughes: California State University-San Bernardino (CA)	4 YR Prof
Dr. Tyler Love: Penn State University, Harrisburg (PA)	4 YR Prof
Dr. Chris Merrill: Illinois State University (IL)	4 YR Prof
Dr. Derrick Nero: University of Nebraska Omaha (NE)	4 YR Prof
Dr. Philip Reed: Old Dominion University (VA)	4 YR Prof
Dr. Thomas Roberts: Bowling Green State University (OH)	4 YR Prof
Dr. Steve Shumway: Brigham Young University (UT)	4 YR Prof
Dr. Thomas Siller: Colorado State University (CO)	4 YR Prof
Dr. Scott Warner: Millersville University (PA)	4 YR Prof
Dr. John Williams: Curtin University (Australia)	4 YR Prof
Michael Cermak: Rockford Public Schools (IL)	2 YR Prof
Dr. Taylor Kidd: Community College of Baltimore County	2 YR Prof
Dr. Geoff Knowles: Ivy Tech Community College (IN)	2 YR Prof
Kenyatta Lewis-White: Prince George's County Public Schools (MD)	Supervisor
Steve Parrott: Illinois State Dept of Education (IL)	Supervisor
Julie Sicks-Panus: Plymouth Elementary (NH)	PK-5 Teacher
Scott Jewell: Ipswich Middle School (MA)	MS Teacher
Rachel Kane: West Hartford Schools (CT)	MS Teacher
Nancye Hart: ITEEA STEM CTL (VA)	HS Teacher
Jocelyn Long: Downingtown STEM Academy (PA)	HS Teacher
Dr. Bradley Bowen: ASEE, Virginia Tech (VA)	ASEE Rep
Dr. Patricia Simmons: NSTA Director of Special Initiatives/Past-President NSTA (VA)	NSTA Rep
Dr. Trena Wilkerson: NCTM President-Elect, Baylor University (TX)	NCTM Rep
Dr. Susan Bastion: Cisco Systems (KS)	IT Industry Rep
Brandon Hamby: Stihl, Inc (VA)	Manufacturing Rep
Robi Robichaud: World Resources Institute (CO)	Renewable Energy Rep

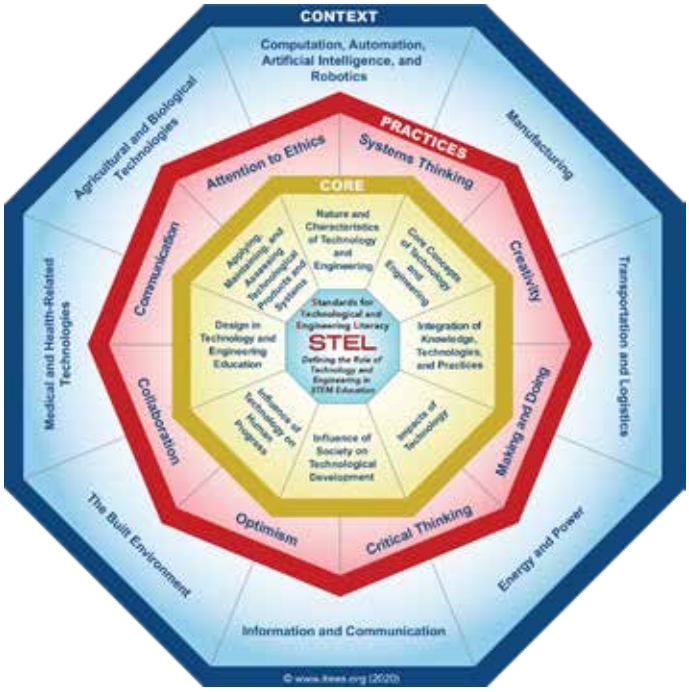

Figure 1. The *STEL* Standards, T&E Practices, and T&E Contexts.

not appear in Table 1 (e.g., professors who taught elementary education Integrative STEM Education courses were simply listed as professors in the table).

During the winter of 2019, the leadership team made a decision to make a formatting change to the original standards by reducing the number of proposed standards from 20 to 8. This was done after consensus was reached that the original Designed World standards and benchmarks would be better classified as context areas where core disciplinary standards should be applied (similar to the core ideas and practice structure of *Next Generation Science Standards* [*NGSS*]). ITEEA *Standards for Technological Literacy Revision Project: Background, Rationale and Structure* (CTETE/ITEEA, 2019) was released in May 2019 to provide the framework for *STL* to be revised in August 2019.

Figure 1 represents the symbiotic relationship among the eight core disciplinary standards, eight T&E T&E practices, and eight contexts that the leadership team believed represent the ideals of the field. This structure for the new standards was selected based on extensive scholarly research and a thorough review of past and present standards from other content areas and countries.

Chinsegut Hill Retreat

Unfortunately, it was not possible to meet at Jackson's Mill; therefore, Chinsegut Hill Retreat, near Tampa, Florida was selected for the *STL* revision retreat. Prior to their arrival, the reviewers/writers self-selected the standard and context on which they wanted to work, based on their expertise. This resulted in teams of three to seven reviewers/writers led by members of the leadership team. Reviewers/writers were assigned to teams based on self-identified content-area expertise and grade-band experience to ensure that grade-appropriate benchmarks could be developed for each standard. During the four-day writing retreat, the teams reviewed the original *STL* language to adapt or completely re-write the standards and benchmarks, forming the new *Standards for Technological and Engineering Literacy* (*STEL*). There were small writing-group meetings as well as entire group discussions, which resulted in a rough draft of the revised standards and contexts. Over the following month the rough draft was compiled and edited by the leadership team into a more polished draft for the writing teams' comments. After addressing these comments, the leadership team disseminated the document to 67 educators who had not served on the original revision/writing teams,

Table 2: Titles of the *STEL* Standards, T & E Contexts, and T & E Practices

Core Disciplinary Standards

1. Nature and Characteristics of Technology and Engineering
2. Core Concepts of Technology and Engineering
3. Integration of Knowledge, Technologies, and Practices
4. Impacts of Technology
5. Influence of Society of Technological Development
6. Influence of Technology on Human Progress
7. Design in Technology and Engineering
8. Applying, Maintaining, and Assessing Technological Products and Systems

Technology and Engineering Practices

1. Systems Thinking
2. Creativity
3. Making and Doing
4. Critical Thinking
5. Optimism
6. Collaboration
7. Communication
8. Attention to Ethics

Technology and Engineering Contexts

1. Automation, Computation, Artificial Intelligence, and Robotics
2. Manufacturing
3. Transportation and Logistics
4. Energy and Power
5. Information and Communication
6. Construction of the Built Environment
7. Medical and Health-Related Technologies
8. Agricultural and Biological Technologies

resulting in additional feedback in the fall of 2019. After considering the reviewer comments, the third draft of *STEL* will be placed on the ITEEA website for broader comment and feedback, after which the final *STEL* document will be developed by the leadership team.

Reflections from the Reviewers and Writers

In the fall of 2019, participants from the Chinsegut revision/writing groups were asked to reflect on their experience in Florida. Their responses revealed both praise and concerns, which are summarized in following paragraphs.

Discussions occurred in multiple settings at Chinsegut. The *STEL* 7 Design group is seen here at work.

NSTA Representative

As a participant in the *STEL* discussions and working groups, it was very clear that this initiative was meant to be truly transformative for the field. What made this work particularly relevant and compelling was its interdisciplinary nature and focus. In the 2000s, the stage was set for a new vision of science education that more accurately reflected the content and practices of science—*Next Generation Science Standards* (NGSS Lead States, 2013). What made *NGSS* unique was the inclusion of engineering practices and opening our community to an innovative integration of science, technology, and engineering for K-12 learners at the national level. The *NGSS* standards are structured around three primary dimensions—science and engineering practices, crosscutting concepts, and disciplinary core ideas.

Similar to many conversations that took place during the development of *NGSS*, the *STEL* retreat also engaged participants and groups about translating the "big ideas" (found in publications such as *The Grand Challenges for Engineering* [National Academy of Sciences, 2017] and *How People Learn* [National Research Council, 2000; National Academy of Science Board on Science Education, 2018]) into standards that can be used by educators to advance learning and understanding in contemporary contexts. The intersections between the Core Disciplinary Standards, Technology and Engineering Contexts, and Technology and Engineering Practices will provide a blueprint to guide educators and other stakeholders as they address the needs of students in 21st Century classrooms. Of critical importance to this development and implementation of the new standards is the inclusion of potential STEM careers. This process of review, debate, and convergence yields outcomes that present a more contemporary perspective of T&E education, champion STEM literacy, advocate for science and engineering education, and promote diversity and inclusion across our disciplines. The retreat emphasized how we can integrate among disciplines and how we can best bring T&E into a major role within the context of STEM education.

NCTM Representative

Being involved as both a reviewer and writer for the development of *STEL* provided an opportunity to have rich conversations across disciplines with a common goal of attending to the development of essential standards that will guide the field for the next ten years. Further, it was a learning experience for me personally and a time of growth and opportunity for networking, supporting opportunities to engage in significant discussions around multiple content areas related to T&E in concert with fields such as mathematics, the sciences, humanities, and language literacy. My leadership role in the National Council of Teachers of Mathematics (NCTM) gave voice to the role of mathematics in T&E literacy.

Just as the work on common standards has made significant progress in the last 35 years (particularly in K-8 mathematics to build a coherent progression), the organization of this writing retreat for *STEL* reflected similar progress. One goal is that every student be exposed to rigorous and engaging mathematics instruction that is meaningful, connected, and develops a student's positive identity as a doer of mathematics. These conversations include a focus at the state, district, and school levels on policies, practices, and procedures coupled with effective teaching practices in each and every classroom. This role of mathematics directly connected to the process implemented at the writing re-

New friendships across STEM content areas emerged. Pictured are ITEEA President-Elect, Phil Reed, Old Dominion University, with Trena Wilkerson from Baylor University and NCTM, and Patricia Simmons, NSTA Special Initiatives.

treat that supported critical conversations and the standards that were developed in Fall 2019 during the writing process. If every student is supported to learn the content standards and mathematical practices this way, we will have a generation of students ready and able to participate in our nation and world, ready to contribute to the economy and further advance the future of technology and engineering.

Representing the mathematics community provided an opportunity to examine the impact and alignment of *STEL* with mathematics content, processes, and practices to ensure learning in STEM would prepare students for the future. At the retreat I was afforded the opportunity to give a presentation that shared the historical perspective of standards development in mathematics over the past 30 years and looked at the future of mathematics standards. This provided time for not only sharing important background information in mathematics education, but also a time for beginning critical conversations to focus our upcoming work on *STEL* in considering the role of various disciplines including mathematics.

It was important for us at the writing retreat to be aware of not only the essential mathematics content connections, but also consider key mathematical teaching practices to ensure support for every student. This relates directly to issues of access and equity so that appropriate learning spaces are provided for all learners. NCTM (2018, p. 7) provides key recommendations that were also shared in consideration for our work at the writing retreat. These, along with understanding of content areas such as number, algebra, functions, geometry, measurement, and statistics, were important to consider as we reviewed the *STL* standards to ensure appropriate attention was given to mathematics in the new standards. Further, areas such as quantitative literacy, data visualization, statistical literacy, and mathematical modeling were at the forefront, with significant connections to STEM fields. We also discussed and attended to technology as a support for student engagement for doing mathematics and developing conceptual understanding, again with attention to access and equity. When various stakeholders such as educators, teachers, and business personnel gather as we did at the writing retreat, much is learned and all grow in their individual and collective understanding.

Chinsegut Reviewers/ Writers

The commitment of the Chinsegut reviewers/writers toward a common goal, to produce a rigorous document that would remain relevant for a number of years, was noted by one non-T&E education participant, "It was very obvious to an outsider that many of the participants had devoted years of their lives in the practice of teaching and also in the practice of educating teachers, with the focus on making a difference in the education of students." Despite this common goal, there were still concerns about the structure and content of the standards in relation to past standards documents. This resulted in a thought-provoking debate during one of the whole-group meetings in Chinsegut. These concerns were well summarized by one participant, "Educators will benefit from these revised standards because they do a better job of clarifying what we value in T&E education. However, if we fail to take ownership of the 'context areas' by not raising them to the level of standards and benchmarks, I think we are doing a huge disservice to our teachers and teacher educators, especially at the secondary level."

Similar to the standards revision processes that NSTA and NCTM went through years earlier, the *STEL* authors and leadership were faced with the difficult task of determining the core components of T&E education, how to differentiate T&E education from other content areas while showing opportunities for integration, and how to structure the new standards to best communicate these ideals. All of the reviewers/writers who responded to the post-retreat survey acknowledged that, in comparison to the *STL* standards, the new *STEL* is more streamlined, user-friendly, relevant to current technologies, and highlights many of the core concepts essential to our field.

Conclusion

Standards for Technological and Engineering Literacy is designed to provide a refined focus for the future of T&E education. With work being initiated to create a user-friendly online format of the standards, benchmarks, context areas, and practices on the ITEEA website, classroom teachers and curriculum directors should find the document to be coherent and easier to implement when developing curricular materials. With fewer benchmarks overall (288 original to 143 new) and a sharper focus on core disciplinary standards and benchmarks, curriculum developers, teacher certification test developers, supervisors at the state and district levels, teacher educators, international partners, and other stakeholders should find it easier to articulate what T&E education is and what is expected of students from pre-kindergarten to high school.

Industrial arts and technology education teacher candidates in the 1980s and 1990s wrote many papers on the importance of Jackson's Mill to our field. The work conducted at Chinsegut may prove to have a similar impact. After numerous recent special issues in *Technology and Engineering Teacher* about who we are, computational literacy, and *Standards for Technological Literacy*, the changes to our standards were long overdue. While there was an opportunity to simply make minor changes and update the copyright date, the leadership team chose a more challenging but necessary route, thinking more deeply about what the standards should represent in 2020 and beyond. As a result, the *STEL* reviewers and writers experienced "the challenge of inquiry, assimilation, compromise, and consensus" (Snyder & Hales, 1981, p. ii) similar to that at Jackson's Mill 38 years earlier. The process to develop such extensive and important documents is neither quick nor easy. It is the sincere hope of the leadership team, writers, and reviewers that when the new *STEL* standards are released, they will be supported by T&E educators and school systems to prepare our students with the knowledge and skills needed for the future.

References

American Association for the Advancement of Science (AAAS). (1989). *Science for all Americans: Project 2061.* New York: Oxford University Press.

Council on Technology and Engineering Teacher Education/International Technology and Engineering Educators Association (CTETE/ITEEA). (2019). *Standards for technological literacy revision project: Background, rationale and structure*. Reston, VA: Author.

International Technology Education Association (ITEA/ITEEA). (2000/2002/2007). *Standards for technological literacy: Content for the study of technology.* Reston, VA: Author.

National Academy of Sciences. (2017). *Grand challenges for engineering*. Washington, DC: Author.

National Academy of Sciences Board on Science Education. (2018). *How people learn II: Learners, contexts, and cultures.* Washington, DC: The National Academies Press.

National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics (NCTM). (2018). *Catalyzing change in high school mathematics: Initiating critical conversations.* Reston, VA: Author

National Commission on Excellence in Education, (1983). *A nation at risk: The imperative for educational reform.* Washington, DC: Author.

National Research Council. (1996). *National science education standards: Observe, interact, change, learn.* Washington, DC: National Academies Press.

National Research Council. (2000). *How people learn: Brain, mind, experience and school.* Washington, DC: National Academies Press.

NGSS Lead States. (2013). *Next generation science standards: For states, by states.* Washington, DC: National Academies Press.

Snyder & Hales, (1981). *Jackson's Mill industrial arts curriculum project.* Charleston, WV: West Virginia Department of Education.

Thomas Loveland, Ph.D., DTE, *is a professor at University of Maryland Eastern Shore and Director of the Career and Technology Education Graduate Studies program. He can be reached at tloveland@umes.edu.*

Tyler S. Love, Ph.D., *is an assistant professor of Elementary/Middle Grades STEM Education at Penn State University's Capital Campus. He can be reached at tsl48@psu.edu.*

Trena Wilkerson, Ph.D., *is a professor of Mathematics Education at Baylor University in Waco, TX and is President-Elect of the National Council of Teachers of Mathematics. She can be reached at Trena_Wilkerson@baylor.edu\ or twilkerson@nctm.org.*

Patricia Simmons, Ph.D., *is currently Director of STEM Special Initiatives for the National Science Teachers Association, a past-president of NSTA, and former professor. She can be reached at psimmons@nsta.org.*