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Technology and Engineering bring STEM to Life!
International Technology and Engineering Educators Association
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108th Mississippi Valley Technology Teacher Education Conference

MVTTEC

November 15-16, 2019

STEM
SCIENCE | TECHNOLOGY | ENGINEERING | MATHEMATICS

STEM Center for Teaching and Learning

ITEEA and the STEM CTL

STEM^4: The Power of Collaboration for Change!

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How do you define and deliver Technology and engineering education and STEM to your students?

- STL Revision Update
- NGSS
- Common Core State Standards
- National Academy of Engineering initiatives on building capacity for K-12 Engineering Education
- NAE Grand Challenges
- Maker Spaces/Maker Education
- Technology Student Association

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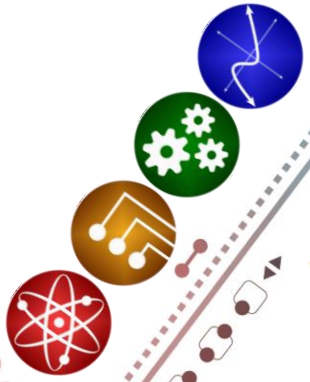

ENGINEERING byDesign™

Integrative STEM Education through the Content and Practices of Technology and Engineering Education

Students Who Study Technology and Engineering

"Bring STEM to Life!"

STEM
SCIENCE | TECHNOLOGY | ENGINEERING | MATHEMATICS

STEM^4: The power of collaboration for change

A joint document authored by Advance CTE,
Association of State Supervisors of Mathematics,
Council of State Science Supervisors, and
International Technology and Engineering Educators Association

STEM Education Policy Collaborative

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ADVANCE CTE

ASSOCIATION OF STATE SUPERVISORS OF MATHEMATICS
ASSM

CCSSO
Council of Chief State School Officers

Council of State Science Supervisors

ITEEA
Technology and Engineering bring STEM to Life!

NEXT GEN EDUCATION, LLC

Texas Instruments

The Major Issues

- Lack of STEM preparedness
- Many STEM careers have not yet been envisioned
- Lack of Equity

Three Main Principles

Principle 1.

STEM education should advance the learning of each individual STEM discipline.

Three Main Principles

Principle 2.

STEM education should provide logical and authentic connections between and across the individual STEM disciplines.

Three Main Principles

Principle 3.

STEM education should serve as a bridge to STEM careers.

Why does this matter?

- Student engagement
- Relevance
- Funding opportunities

Recommended Actions

- Ensure high-quality STEM learning
- Increase access and equity for students
- Provide professional learning opportunities for teachers.

STEM^4: Final Thoughts

This paper is the product of an organized and coordinated effort among the leadership of our respective organizations to address the challenges faced when implementing STEM education and providing access to the knowledge, skills, and career pathways necessary for all students, particularly those in underserved populations.

It is our fervent hope that this paper, the product of our integrated efforts, will help to catalyze the necessary changes required to fuel better outcomes for our students, our society, and ultimately, ourselves.

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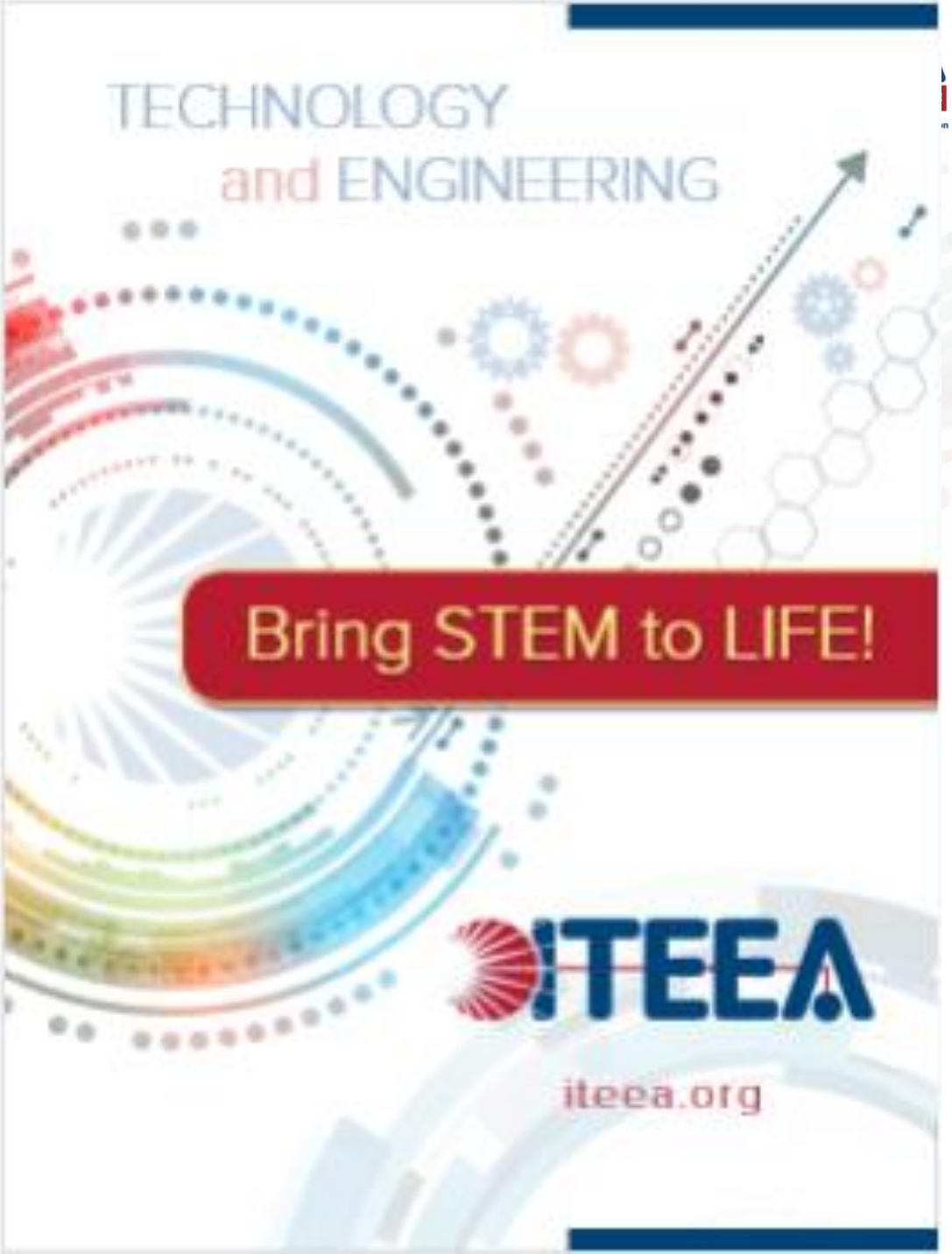

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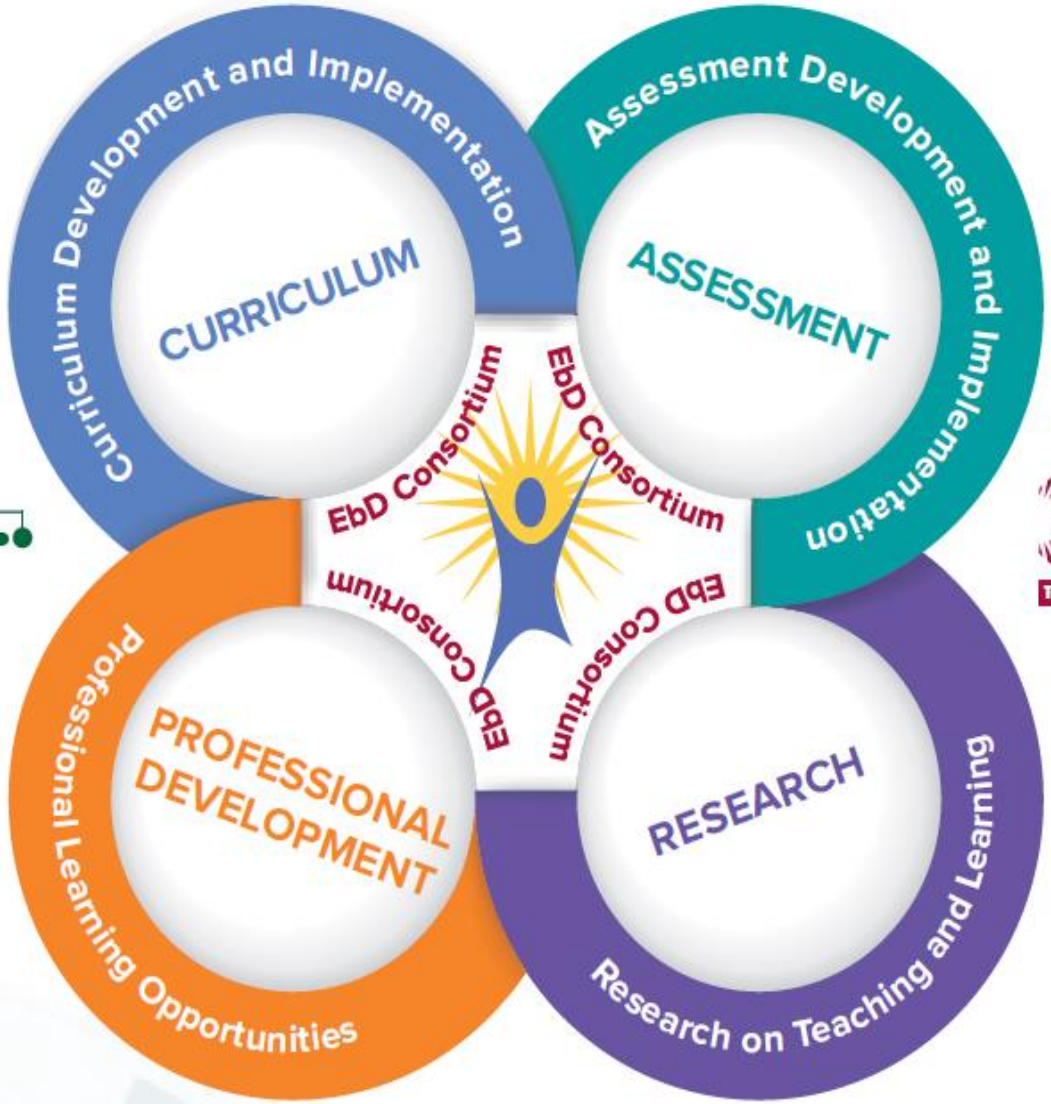
CORE PROGRAM	K–2		EbD-TEEMS NXTGEN™	1-6 weeks
	3–6		EbD-TEEMS NXTGEN™ *(6th Grade Capstone)*, I³	1-6 weeks
	6		*Exploring Technology*	18 weeks
	7		*Invention and Innovation*	18 weeks
	8		*Technological Systems*	18 weeks
	9		*Foundations of Technology*	36 weeks
	10–12	HS Choices	*Technology and Society*	36 weeks
	10–12		*Technological Design*	36 weeks
	11–12		*Advanced Design Applications* *	36 weeks
	11–12		*Advanced Technological Applications* *	36 weeks
	11–12		*Engineering Design (Capstone)*	36 weeks



STEM CTL.

ITEEA
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6E Learning byDesign

ENGAGE

The purpose of the ENGAGE phase is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.

EXPLORE

The purpose of the EXPLORE phase is to provide students with the opportunity to construct their own understanding of the topic.

EXPLAIN

The purpose of the EXPLAIN phase is to provide students with an opportunity to explain and refine what they have learned so far and determine what it means.

eNGINEER Extend/Elaborate

The purpose of the eNGINEER phase is to provide students with an opportunity to develop greater depth of understanding about the problem topic by applying concepts, practices and attitudes.

ENRICH

The purpose of the ENRICH phase is to provide students with an opportunity to explore in more depth what they have learned and to transfer concepts to more complex problems.

EVALUATE

The purpose of the EVALUATION phase is for both students and teachers to determine how much learning and understanding has taken place.

Exploring and Colonizing Mars
The 6E Learning Cycle in Practice

Humans have always had an innate desire to explore past the boundaries of earth to the moon and beyond. What do humans need to know and be able to do in order to colonize Mars and live there for an extended period of time?

How to design a rover/robot to navigate and traverse the Mars surface to assist astronauts in the exploration and colonization of Mars?

Before we can solve a problem, we must understand it as thoroughly as possible. What exactly are we being asked to do? What resources are available? What are the specifications and constraints for solving the problem?
How will we know if we have succeeded?

Apply Engineering Design Process:
-Problem identification
-brainstorming
-specifications and constraints
-multiple iterations
-predictive analysis
-modeling
-testing and evaluation
-product refinement

How can the lessons we're learning here apply to other kinds of problems we might encounter in colonizing Mars? How else might the Mars Coleman assist with other problem scenarios? What about other environments, like deep sea research?

Self evaluation

Peer evaluation

Teacher evaluation

Identify STEM practices needed to solve this problem

What about other workforce knowledge and skills?

Revision of the Standards for Technological Literacy

- A Joint Project by ITEEA and CTETE
- Funded by the National Science Foundation ATE Conference Grant

Revision of the ITEEA Standards for Technological Literacy
NSF ATE Grant

Context

- The *Standards for Technological Literacy* (STL) were developed in the late 1990s and published in 2000 and slightly changed in 2002 and 2007.
- Since then, new technological innovations, addition of "engineering" to organization, and development of STEM framework have occurred.
- The STLs need to be revised.
- Unsuccessful funding applications in 2011 and 2012

Action

- Council on Technology & Engineering Teacher Education (CTETE) and the International Technology & Engineering Educator Association (ITEEA) jointly proposed revising the STLs in summer 2018.
- November 2018 Survey to ITEEA members and stakeholders.
- NSF ATE Grant successful in early 2019.
- Convene eight member Leader Team to develop processes.
- Bring together 30 writers (14 four-year professors, 3 two-year professors, 2 supervisors, 5 classroom teachers, three reps from affiliated organizations (ASEE, NSTA, NCTM) and 3 industry reps to revise sections of the STLs. Held at Chinsegut Hill Retreat, Florida August 4th – 8th.

Results

- New title: *Standards for Technological and Engineering Literacy: Defining the Role of Technology and Engineering in STEM Education* (STEL)
- Changed from 20 standards to eight disciplinary core content standards, eight technology and engineering contexts, and eight technology and engineering practices.
- Number of benchmarks reduced from 288 to 155
- Number of chapters reduced from eight down to five
- Developing new matrix crosswalk of STEL benchmarks to benchmarks from STEM content areas of NGSS, CCSS ELA and CCSS mathematics.

Upcoming Goals

- Finish several more rounds of reviews
- Complete graduate research study on matching the matrix benchmarks.
- Publish the STELs in 2020.
- Develop interactive website for teachers to find benchmarks and STEM matching benchmarks
- Develop addendum books to accompany STEL
- Present at conferences about the new STEL standards.
- Build acceptance of the standards through ITEEA stakeholders and affiliated organizations.

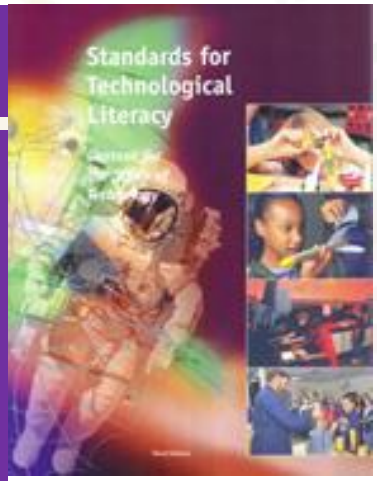
See 1-Page Briefing Handout

Q1: Are the Standards still current?

- Push for STEM and Integrated STEM in the 2000's
- Shift to inclusion of engineering in 2010
- ITEA Name Change to ITEEA 2010
- Engineering benchmarks added to NGSS in 2013.
- Current proposals to add computational literacy and coding to field.
- Robotics content very popular in Technology and Engineering classrooms.
- Field asked to help prepare students for college and career readiness through academic content.
- Field asked to teach critical thinking and 21st Century Skills.
- With all this, how are the 2000 STLs holding up?

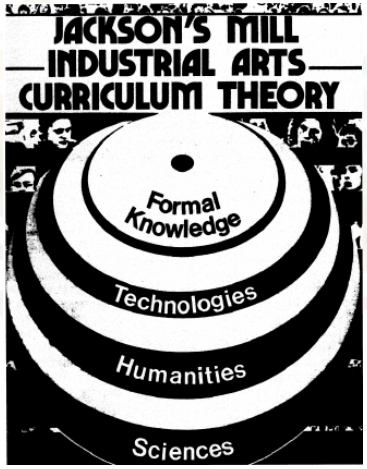
Context

- Standards for Technological Literacy released by ITEA in 2000.
- **Modest** corrections in 2002 and 2007.
- Relatively unchanged the last 19 years.
- State departments of education moving away from these "out of date" standards. Is Praxis II teacher certification exam next?
- New content and ideas in field: engineering, computational thinking, STEM since 2000.
- Change process envisioned as a second Jackson's Mill.



1980 Jackson's Mill Curriculum Project

- Jackson's Mill Industrial Arts Curriculum Theory Project - Theory Project at Jackson's Mill, W.V.
- Directed by James Hales, West Virginia Dept of Education and James Snyder, Director of Technology at Fairmont State College.
- Funded by American Technical Society
- Convened 21 Industrial Arts leaders to change focus of field from career education to technology.
- Significant event in history of field, most cited research resource in 1980's and can be directly linked to 1985 change from AIAA to ITEA.
- Importance to current effort is in the rich discussion expected, not describing the content areas.



Calls for Updating

- 2011 and 2012 ITEEA initiated revision grants but was turned down by NSF.
- Technology & Engineering Teacher special issues:
  - *Who Are We?* December/January 2017
  - *Computational Literacy* December/January 2018
  - *Standards for Technological Literacy* April 2018
- Council on Technology & Engineering Teacher Education (CTETE) Executive Board - Summer 2018 Priority

Approach: Broad Overview

1. Develop valid process of revision.
2. Solicit feedback
3. Develop information and resources
4. Apply for funding
5. Taskforce work
6. Goal is to publish *Standards for Technological and Engineering Literacy* in 2020

1. Develop Valid Process

- CTETE Executive Board worked on idea of the revision process of survey, leaders, reviewers and task work.
- ITEEA leaders became involved in later drafts of survey, process, and leader team nominees.
- Timeline approved by this development team.
- Eight revision leaders selected to represent two from CTETE board, ITEEA President and Senior Fellow, STEM CTL Director, Elementary STEM Council, and several professors with technological literacy and engineering backgrounds.

Project Team and Process

- 9 Project Leaders with 30 Reviewers:
  - Classroom teachers (1 ELED, 2 MS, 2 HS)
  - District or state supervisors
  - Three representatives from ASEE, NSTA, NCTM
  - 14 university professors (technology, engineering, STEM)
  - Three two-year college faculty (same at pre-service level)
  - Three industry (Information Technology, Renewable Energy, and Manufacturing/Robotics)
- Demographics: Find balance of gender, geography, ethnicity, and experience
- Personal Attributes: Good thinker, good writer and task completer.

Solicit feedback

- Develop ITEEA survey for November 2018 to capture views of university professors, classroom teachers and district or state supervisors on the need for revision.
- Presentation to 21st Century Leaders
- Solicit ideas from attendees at 2019 ITEEA.
- Presentations at ITEEA.
- ITEEA Website and news releases
- Engage in discussions with leaders in the field

Develop Information and Resources

- Other standards collected to be shared (NGSS, CCSS, ISTE, NAEP TEL, CSTA).
- Comments in ITEEA survey and at ITEEA collated into specific STL binders for review team
- Data collection from Fall 2018 ITEEA survey to members and stakeholders.
- Initial results from survey published in *Technology and Engineering Teacher* in May June 2019 issue.

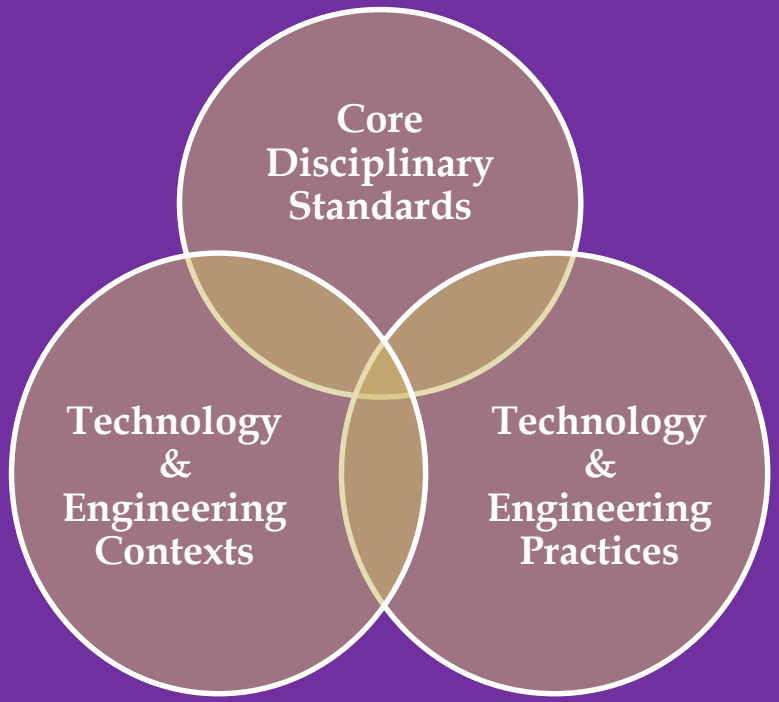
Taskforce work

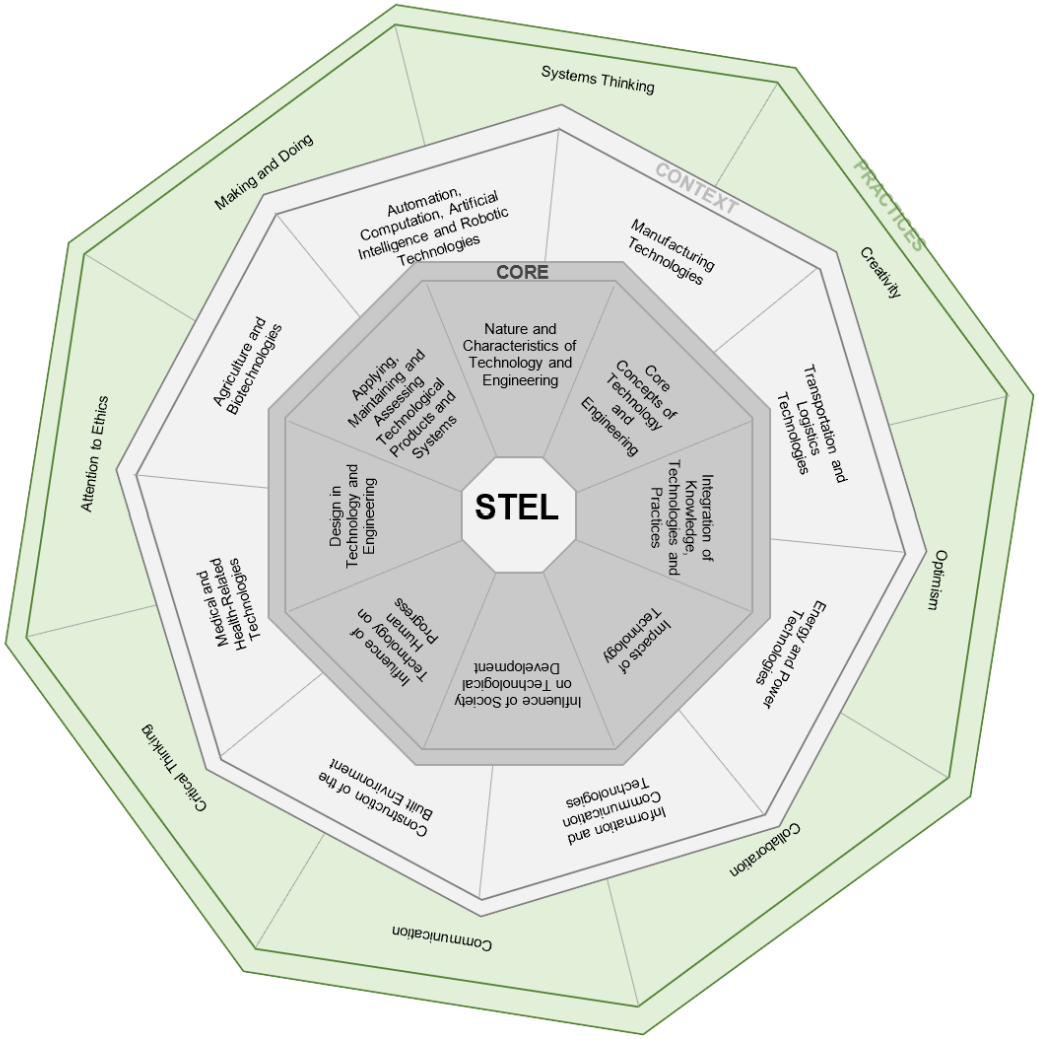
- August 4th Leaders convened. Reviewers 5th – 8th
- Small and whole group discussions throughout
- Presentations about rationale, contexts and future technologies.
- Writing teams worked on updating specific standards or writing new standards.
- Leaders mentored the review teams.
- Individuals then reviewed work of other teams.
- Presentations on last morning.

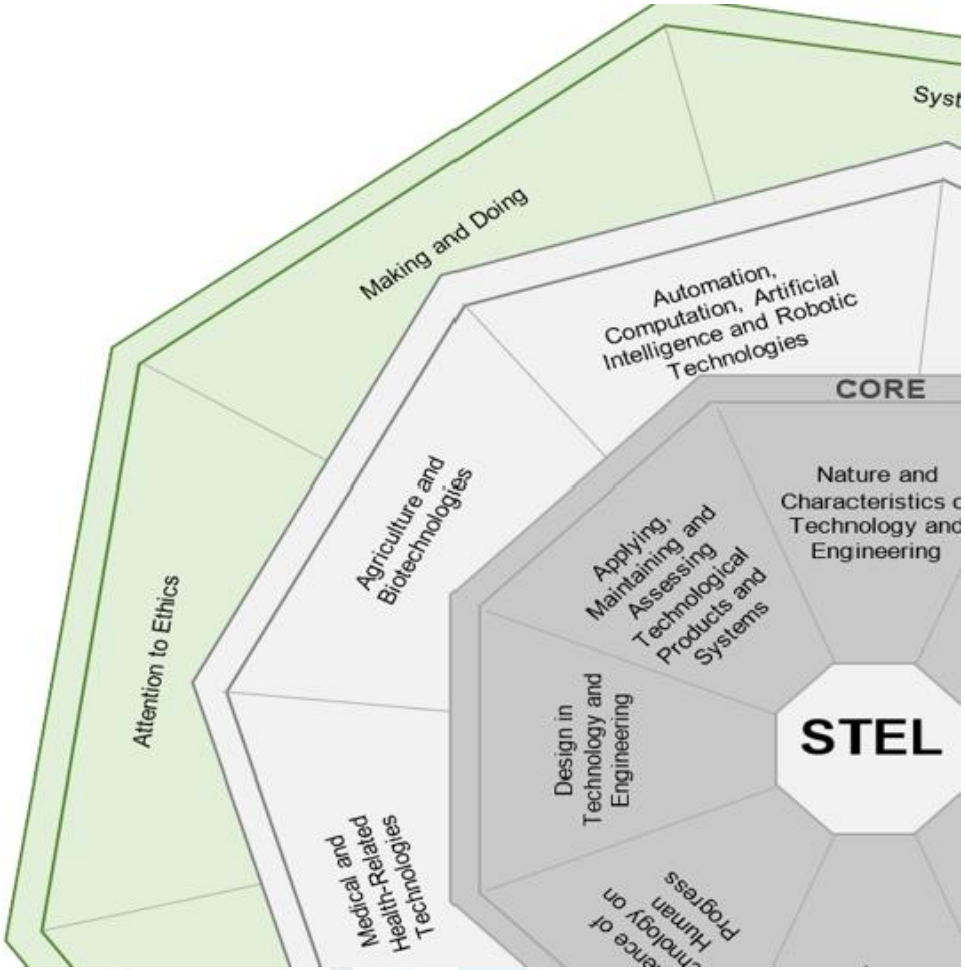
The Intended Project Outcome

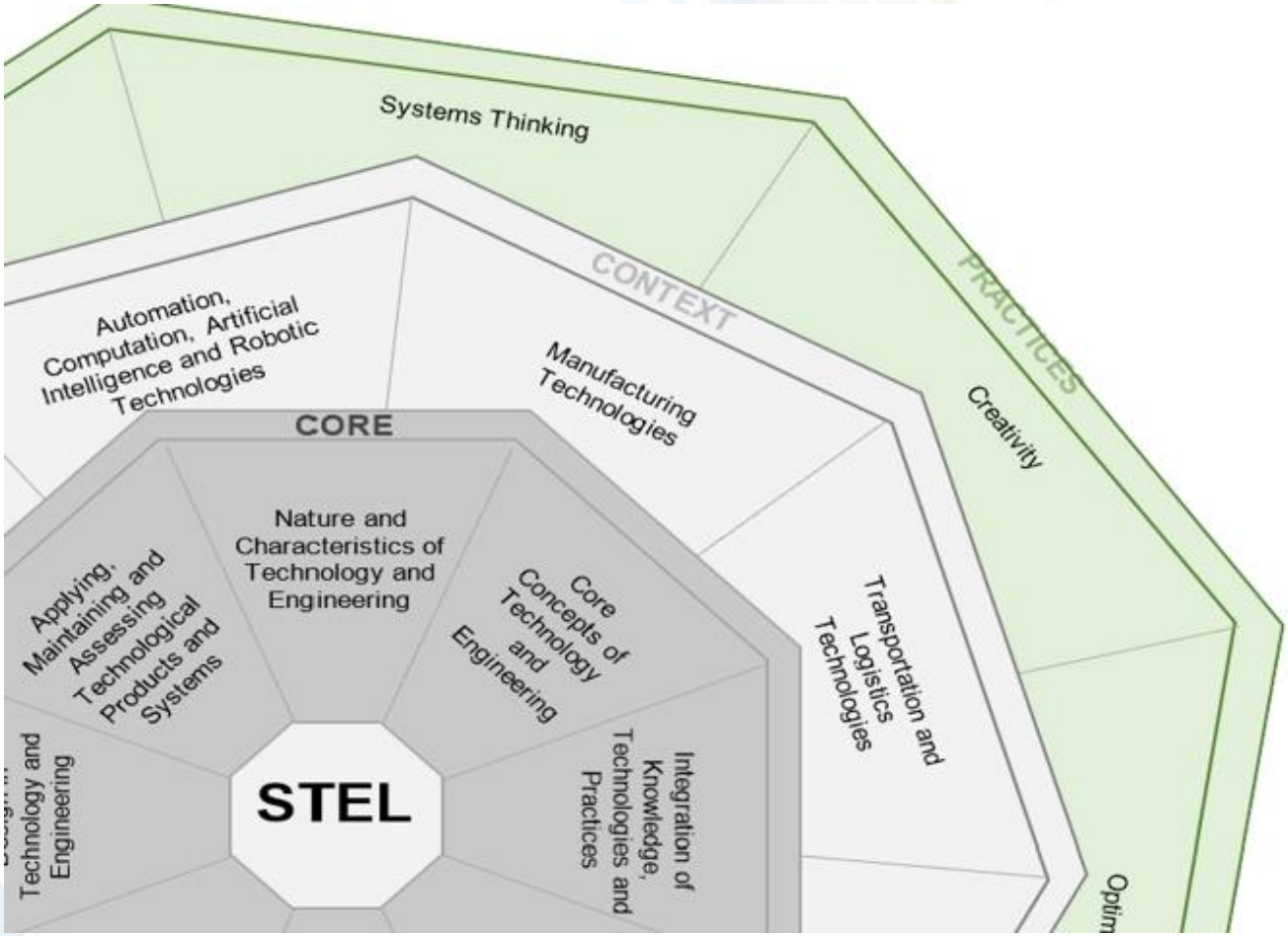
- Updated standards for Technology and Engineering Literacy that will be accepted and used by teachers, curriculum developers, certification exam developers, university professors and classroom teachers for the foreseeable future.
- The name changed to *Standards for Technological and Engineering Literacy: Defining the Role of Technology and Engineering in STEM Education*.
- The number of standards was consolidated from 20 to 8.
- The number of benchmarks condensed from 288 to 155.
- The technologies in our field always change and so there will be a continual need to revise these standards – Core Disciplinary Standards, and Technology and Engineering Contexts and Practices.

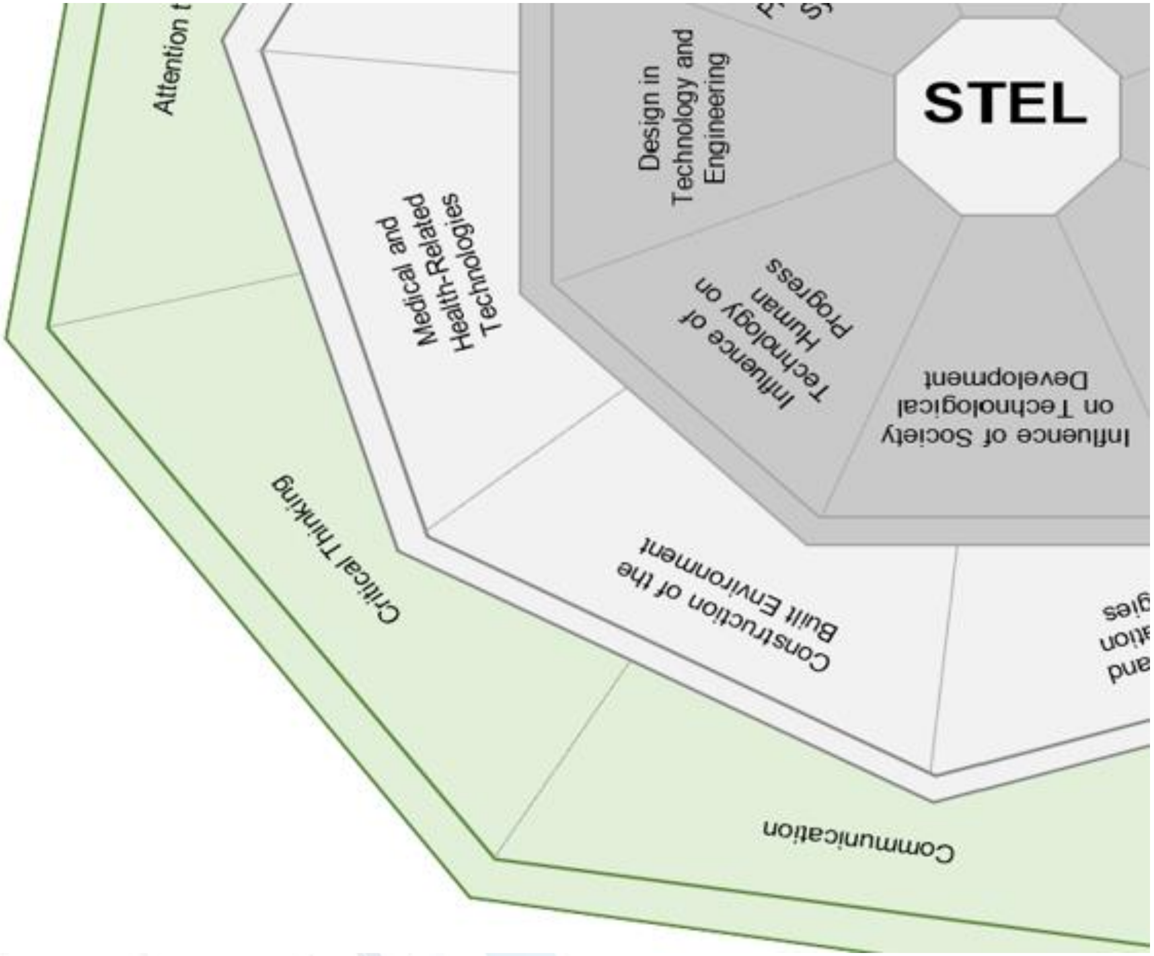
New Vision of STEL

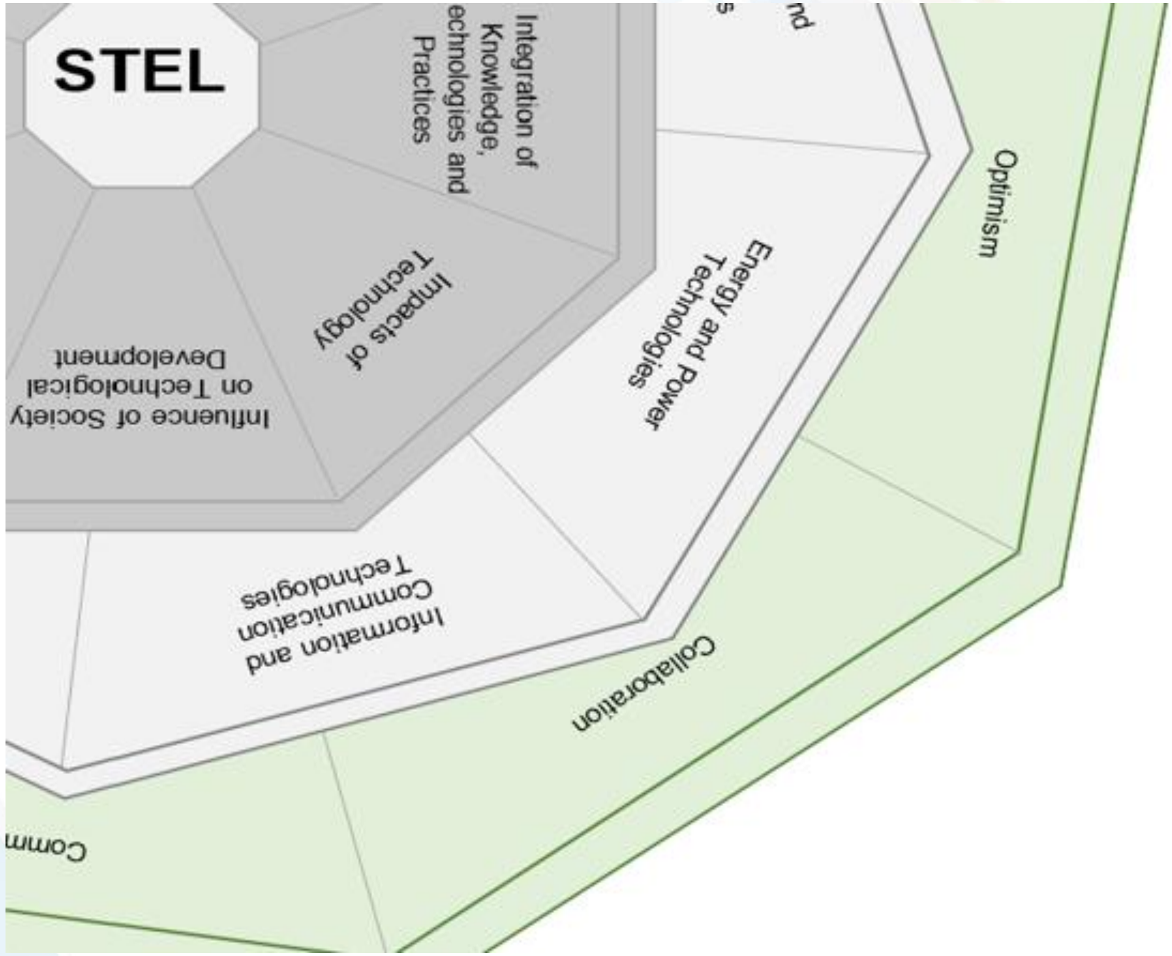









STEL
Design in Technology and Engineering
Influence of Technology on Human Progress
Influence of Society on Technological Development
Medical and Health-Related Technologies
Construction of the Built Environment
Critical Thinking
Communication



STEL Key Points

- Eight disciplinary core standards and 155 benchmarks should be taught in education but are best learned in technology and engineering classrooms.
- Eight technology and engineering contexts are WHERE the core disciplinary standards should be taught.
- Eight Technology and Engineering Practices are the key attributes and personal qualities the T & E graduates should exhibit.

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 on 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

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

Technology and Engineering

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

Next Steps

- Drafts of revised standards shared with ITEEA members, other professional associations, councils in ITEEA during Fall 2019.
- Final version written in January-February 2020.
- Revised standards released in 2020.
- Future funded work could include development of interactive website, providing example lesson plans for teachers and/or revising the four addendum books.

Summary

- The STLs needed to be revised but by how much?
- 2002 & 2007 little change
- This Funding Level for the NSF grant not equivalent to original STL grant so no four year process envisioned.
- Looking for common ground to update standards and account for changes in the field and new technologies.
- *Standards for Technological and Engineering Literacy* 2020 to provide accreditation, curriculum developers and stakeholders a definition that moves the field forward.

How Do You Define and Operationalize Technology and Engineering Literacy?

Technology is the modification of the natural environment, through human designed objects, systems, and processes, to satisfy needs and wants.

Engineering is the use of scientific principles and mathematical reasoning to optimize technologies in order to meet needs that have been defined by criteria under given constraints.

Technological and engineering literacy is the ability to understand, use, create, and assess the human designed environment in increasingly and sophisticated ways over time. -- Current Draft Version of STEL, 2020

What "STEM" Looks Like

- Ted Talk Video of Jane Chen's Project!
  - "A Warm Embrace That Saves Lives!"



https://www.iteea.org/Activities/2142/Reach.aspx?source=generalSearch


IDEO and Shark Tank

Leadership In Professional Organizations

- Be an active participant
- Leadership in Professional Organizations Like ITEEA begins with YOU! It is all about YOU!
- You. . . Serving The Profession by Supporting Others in Our Field!

ITEEA + YOU + = Δ > Professional Future!

Join us!

ITEEA

BALTIMORE

MARCH 11-14, 2020

Thank You!

FUTURE CONFERENCE DATES

Denver – March 24-27, 2021 • Orlando – March 9-12, 2022
Minneapolis – April 12-15, 2023

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TSA
TECHNOLOGY STUDENT ASSOCIATION
June 28-July 2, 2019
June 29-July 1, 2020

MAY 2019

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Questions?

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We look forward to seeing you and ALL your colleagues at ITEEA's 82nd Annual Conference!