

# Pennsylvania Technology and Engineering Standards<sup>7</sup>

## Grades 6–8

### ***Nature and Characteristics of Technology and Engineering***

1. Consider historical factors that have contributed to the development of technologies and human progress.
2. Engage in a research and development process to simulate how inventions and innovations have evolved through systematic tests and refinements.
3. Differentiate between inputs, processes, outputs, and feedback in technological systems.
4. Demonstrate how systems thinking involves considering relationships between every part, as well as how the systems interact with the environment in which it is used.
5. Create an open-loop system that has no feedback path and requires human intervention.
6. Create a closed-loop system that has a feedback path and requires no human intervention.
7. Predict outcomes of a future product or system at the beginning of the design process.
8. Apply informed problem-solving strategies to the improvement of existing devices or processes or the development of new approaches.
9. Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations.
10. Compare how different technologies involve different sets of processes.

### ***Integration of Knowledge, Technologies, and Practices***

1. Compare, contrast, and identify overlap between the contributions of science, technology, engineering, and mathematics in the development of technological systems.
2. Analyze how different technological systems often interact with economic, environmental, and social systems.
3. Adapt and apply an existing product, system, or process to solve a problem in a different setting.
4. Demonstrate how knowledge gained from other content areas affects the development of technological products and systems.

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<sup>7</sup> The language of the standards is adapted, informed or from the: *International Technology and Engineering Educators Association (ITEEA). (2020). Standards for technological and engineering literacy: The role of technology and engineering in STEM education. Pennsylvania State Board of Education. (2002). Academic standards for science and technology; Pennsylvania Department of Education. (2002). Safety guidelines for elementary and technology education teachers; Pennsylvania Department of Education. (n.d.). Pennsylvania career ready skills continuum.*

## ***Applying, Maintaining, Assessing and Evaluating Technological Products and Systems***

1. Examine the ways that technology can have both positive and negative effects at the same time.
2. Analyze how the creation and use of technologies consumes renewable, non-renewable, and inexhaustible resources; creates waste; and may contribute to environmental challenges.
3. Consider the impacts of a proposed or existing technology and devise strategies for reducing, reusing, and recycling waste caused by its creation.
4. Analyze examples of technologies that have changed the way people think, interact, live, and communicate.
5. Hypothesize what alternative outcomes (individual, cultural, and/or environmental) might have resulted had a different technological solution been selected.
6. Analyze how an invention or innovation was influenced by the context and circumstances in which it is developed.
7. Evaluate trade-offs based on various perspectives as part of a decision process that recognizes the need for careful compromises among competing factors.
8. Research information from various sources to use and maintain technological products or systems.
9. Use tools, materials, and machines to safely diagnose, adjust, and repair systems.
10. Use devices to control technological systems.
11. Design methods to gather data about technological systems.
12. Interpret the accuracy of information collected.
13. Use instruments to gather data on the performance of everyday products.

## ***Design Thinking in Technology and Engineering Education***

1. Apply a technology and engineering design thinking process.
2. Develop innovative products and systems that solve problems and extend capabilities based on individual or collective needs and wants.
3. Illustrate the benefits and opportunities associated with different approaches to design.
4. Create solutions to problems by identifying and applying human factors in design.
5. Evaluate and assess the strengths and weaknesses of various design solutions given established principles and elements of design.
6. Refine design solutions to address criteria and constraints.
7. Defend decisions related to a design problem.

## **Grades 9–12**

### ***Nature and Characteristics of Technology & Engineering***

1. Evaluate how technology and engineering have been powerful forces in reshaping the social, cultural, political, and economic landscapes throughout history.
2. Relate how technological and engineering developments have been evolutionary, often the result of a series of refinements to basic inventions or technological knowledge.
3. Identify and explain how the evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools, materials, and processes.
4. Analyze how the Industrial Revolution resulted in the development of mass production, sophisticated transportation and communication systems, advanced construction practices, and improved education and leisure time.
5. Investigate the widespread changes that have resulted from the Information Age, which has placed emphasis on the processing and exchange of information.
6. Analyze the rate of technological and engineering development and predict future diffusion and adoption of new innovations and technologies.
7. Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
8. Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop.
9. Troubleshoot and improve a flawed system embedded within a larger technological, social, or environmental system.
10. Use project management tools, strategies, and processes in planning, organizing, and controlling work.
11. Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.

### ***Integration of Knowledge, Technologies, and Practices***

1. Assess how similarities and differences among scientific, technological, engineering, and mathematical knowledge and skills contributed to the design of a product or system.
2. Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.
3. Analyze how technology transfer occurs when a user applies an existing innovation developed for one function for a different purpose.
4. Evaluate how technology enhances opportunities for new products and services through globalization.

5. Connect technological and engineering progress to the advancement of other areas of knowledge and vice versa.

### ***Applying, Maintaining, Assessing, and Evaluating Technological Products and Systems***

1. Develop a solution to a technological problem that has the least negative environmental and social impact.
2. Develop a device or system for the marketplace.
3. Evaluate ways that technology and engineering can impact individuals, society, and the environment.
4. Critique whether existing or proposed technologies use resources sustainably.
5. Critically assess and evaluate a technology that minimizes resource use and resulting waste to achieve a goal.
6. Evaluate a technological innovation that arose from a specific society's unique need or want.
7. Evaluate how technology and engineering advancements alter human health and capabilities.
8. Evaluate a technological innovation that was met with societal resistance impacting its development.
9. Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.
10. Synthesize data and analyze trends to make decisions about technological products, systems, or processes.
11. Interpret laws, regulations, policies, and other factors that impact the development and use of technology.

### ***Design Thinking in Technology and Engineering Education***

1. Apply a broad range of design skills to a design thinking process.
2. Implement and critique principles, elements, and factors of design.
3. Evaluate and define the purpose of a design.
4. Conduct research to inform intentional inventions and innovations that address specific needs and wants.
5. Analyze and use relevant and appropriate design thinking processes to solve technological and engineering problems.
6. Implement the best possible solution to a design using an explicit process.
7. Apply principles of human-centered design.
8. Optimize a design by addressing desired qualities within criteria and constraints while considering trade-offs.

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9. Use a design thinking process to design an appropriate technology for use in a different culture.
10. Apply appropriate design thinking processes to diagnose, adjust, and repair systems to ensure precise, safe, and proper functionality.
11. Recognize and explain how their community and the world around them informs technological development and engineering design.
12. Safely apply an appropriate range of making skills to a design thinking process.