Maryland Technology Education Standards

Grades 6 - 12

Division of Career and College Readiness

Image developed by the STEM Center for Teaching and Learning, International Technology and Engineering Educators Association

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Rationale for Technology Education Standards

Technology education is critical part of a comprehensive educational program. Students must be prepared to responsibility create, modify, use, assess, and interact with technology. Technology is the innovation, change, or modification of the natural environment in order to satisfy perceived human wants and needs (Standards for Technological Literacy, 2000). Technology comprises the entire system of people and organizations, knowledge, processes, and devises that go into creating and operating technological artifacts, as well as the artifacts themselves. Technology encompasses engineering know-how and design, manufacturing expertise, and various technical skills (Technically Speaking, 2002).

Technology education fosters the development of technological literacy and exposes students to the work performed by science, technology, engineering, and mathematics (STEM) professionals. It builds problem solving, technical, and critical thinking skills and prepares students to make well-informed decisions on matters that affect or are affected by technology (Technically Speaking, 2002). Aspects of technology education permeate multiple disciplines. For example, the Common Core State Standards, CSTA K-12 Computer Science Standards, and Next Generation Science Standards all incorporate components of technology education. However, technology education must be included as core area of study in order for students to reach the level of proficiency required of technologically literate students. Technology education courses were among the first to demonstrate an integrated approach to STEM instruction and continues to remain an integrated, experienced-based instructional program that fosters technological literacy. Technological literacy is the ability to use, manage, assess, and understand technology (Standards for Technological Literacy, 2000). The goal of technological literacy is to provide people with the tools to participate intelligently and thoughtfully in the world around them (Technically Speaking, 2002).

Developing Technology Education Standards

Nationally, the task of developing content standards for technology education began in 1995 with the Technology for All Americans Project (TfFAAP). The National Science Foundation and the National Aeronautics and Space Administration funded this effort to develop a nationally viable rationale and structure for technology education. The International Technology and Engineering Educators Association (ITEEA) led this effort and in 1996 TfAAP published *Technology for All Americans: A Rationale and Structure for the Study of Technology*. This document provided the foundation for technology education state curriculum and established the guidelines for what each person should know and be able to do in order to be technologically literate.

In 2000, ITEEA published Standards for Technological Literacy: Content for the Study of Technology. The Maryland State Department of Education used ITEEA's standards as the foundation for Maryland Technology Education Standards. In 2005, the Maryland State Department of Education published the Maryland Technology Education State Curriculum which defined what students must know and do to be technologically literate. In 2015, a team of stakeholders representing business, higher education, governmental agencies, non-profits, and local school systems collaborated to revise Maryland Technology Education Standards. The redesign team focused on essential skills and knowledge that are necessary to compete in the global workforce and will provide a strong foundation for technological literacy. Their culminating efforts of the design team are presented in this document.

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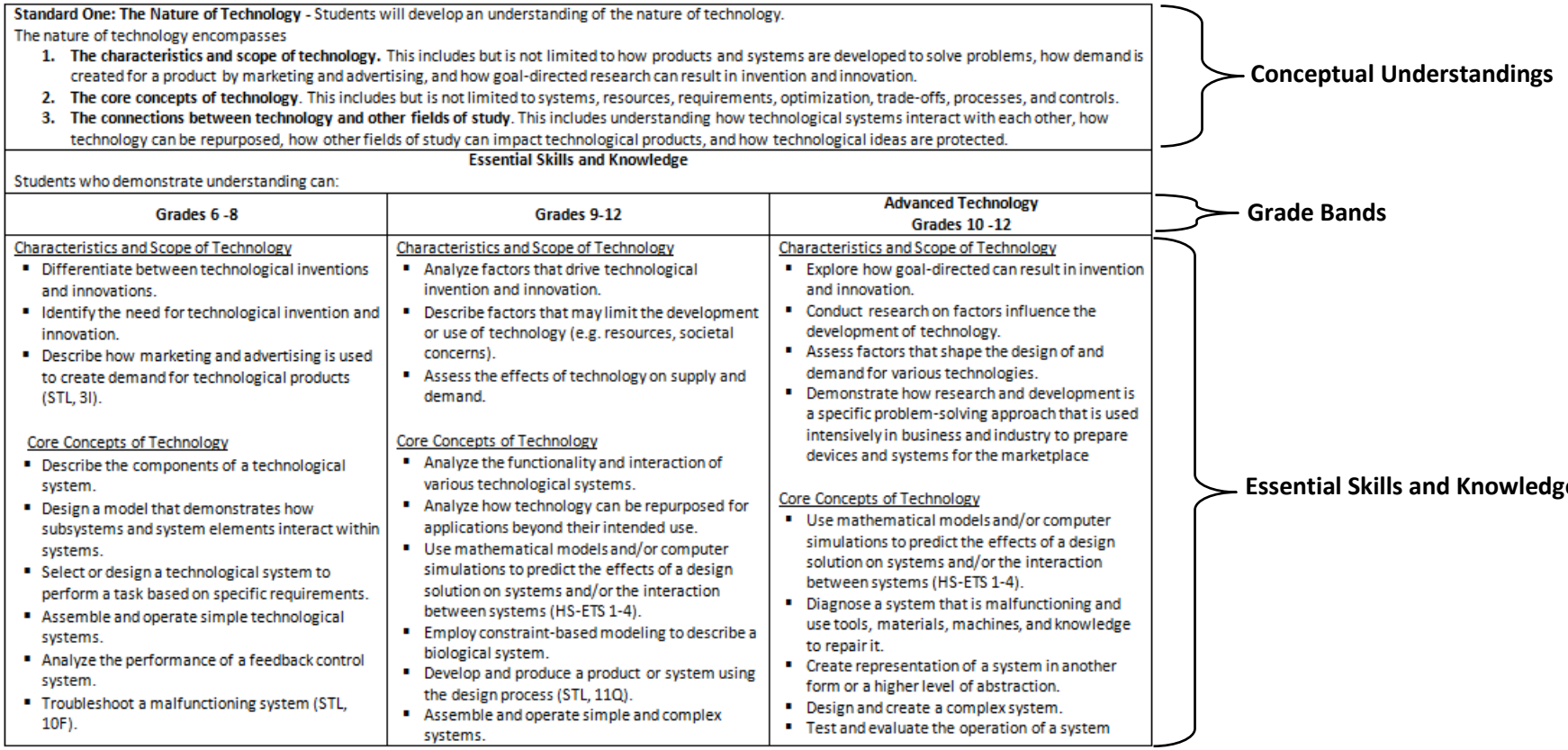
Reading the Technology Education Standards Document

Maryland Technology Education Standards are organized into five interdependent conceptual understanding categories.

1. The Nature of Technology
2. Impacts of Technology
3. Engineering Design and Development
4. Core Technologies and the Designed World
5. Computational Thinking and Computer Science Applications

Each category represents an overarching concept that fosters technological literacy. Concepts are deconstructed into essential skills and knowledge that details what students must know and do to demonstrate in-depth understanding of each category. Essential skills and knowledge are organized by grade bands representing middle school (grades 6-8), high school (grades 9-12), and advanced technology (grades 10-12) expectations.



Standard One: The Nature of Technology - Students will develop an understanding of the nature of technology.
The nature of technology encompasses

1. **The characteristics and scope of technology.** This includes but is not limited to how products and systems are developed to solve problems, how demand is created for a product by marketing and advertising, and how goal-directed research can result in invention and innovation.
2. **The core concepts of technology**. This includes but is not limited to systems, resources, requirements, optimization, trade-offs, processes, and controls.
3. **The connections between technology and other fields of study**. This includes understanding how technological systems interact with each other, how technology can be repurposed, how other fields of study can impact technological products, and how technological ideas are protected.

Conceptual Understandings

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grade Bands

Grades 6 -8	Grades 9-12	Advanced Technology Grades 10 -12
Characteristics and Scope of Technology ▪ Differentiate between technological inventions and innovations. ▪ Identify the need for technological invention and innovation. ▪ Describe how marketing and advertising is used to create demand for technological products (STL, 3I). Core Concepts of Technology ▪ Describe the components of a technological system. ▪ Design a model that demonstrates how subsystems and system elements interact within systems. ▪ Select or design a technological system to perform a task based on specific requirements. ▪ Assemble and operate simple technological systems. ▪ Analyze the performance of a feedback control system. ▪ Troubleshoot a malfunctioning system (STL, 10F).	Characteristics and Scope of Technology ▪ Analyze factors that drive technological invention and innovation. ▪ Describe factors that may limit the development or use of technology (e.g. resources, societal concerns). ▪ Assess the effects of technology on supply and demand. Core Concepts of Technology ▪ Analyze the functionality and interaction of various technological systems. ▪ Analyze how technology can be repurposed for applications beyond their intended use. ▪ Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interaction between systems (HS-ETS 1-4). ▪ Employ constraint-based modeling to describe a biological system. ▪ Develop and produce a product or system using the design process (STL, 11Q). ▪ Assemble and operate simple and complex systems.	Characteristics and Scope of Technology ▪ Explore how goal-directed can result in invention and innovation. ▪ Conduct research on factors influence the development of technology. ▪ Assess factors that shape the design of and demand for various technologies. ▪ Demonstrate how research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace Core Concepts of Technology ▪ Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interaction between systems (HS-ETS 1-4). ▪ Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. ▪ Create representation of a system in another form or a higher level of abstraction. ▪ Design and create a complex system. ▪ Test and evaluate the operation of a system

Implementing Maryland Technology Education Standards

Described below are approaches school system leaders can take to implement technology education standards. It should be noted that technology education standards are designed to be used in conjunction with Maryland Common Core State Curriculum Frameworks for Reading and Writing in Science and Technical Subjects.

School system leaders have the option of using Maryland State Department of Education (MSDE) preapproved course options or identifying their own technology education courses that meet requirements detailed in the technology education standard document. Ultimately, students should be able to participate in rigorous technology education courses that will allow them to acquire the skills and knowledge expected of technological literate individuals.

Grades 6 – 8

Local school systems can offer students course options that will allow them to meet expectations detailed in the Maryland Technology Education Standards document. Local school system leaders can develop or adopt their own course offerings or use MSDE preapproved courses. Preapproved courses consist of offerings that are a part of the Project Lead the Way Gateway program or International Technology and Engineering Educators Association's (ITEEA) STEM Center for Teaching and Learning Engineering by Design program.

Grades 9-12

Technology education is a graduation requirement for all Maryland public school students (COMAR 13A.04.01.01). Each local school system is required to offer a technology education program in grades 9-12 that will allow students to meet graduation requirements and select advanced technology education electives. There are two approaches school systems can use to identify courses that will allow students to fulfill their technology education graduation requirement.

1. School system leaders can offer students any of the MSDE preapproved engineering design or computer science-based courses listed in the table below.

MSDE Preapproved Courses for Technology Education Graduation Credit	
Engineering Design-Based Courses	**Computer Science-Based Courses**
• ITEEA's Foundations of Technology • Project Lead the Way Introduction to Engineering Design* • Project Lead the Way Principles of Engineering*	• Exploring Computer Science • Foundations of Computer Science* • Advanced Placement Computer Science Principles

*Identifies courses in a Career and Technology Education Program of Study. School systems must adhere to Career and Technology Education completer program requirements.

2. School system leaders can identify additional courses that meet requirements by completing the MSDE curriculum alignment review process for technology education. This process includes submission of the appropriate completed curriculum alignment rubric and associated documents from the school system to MSDE for review. If the course meets or exceeds all components of the rubric, students may take the course to fulfill their technology education graduation requirement. For assistance with the curriculum alignment review process, please contact Tiara Booker-Dwyer, Education Program Specialist, via email at tiara.booker-dwyer@maryland.gov.

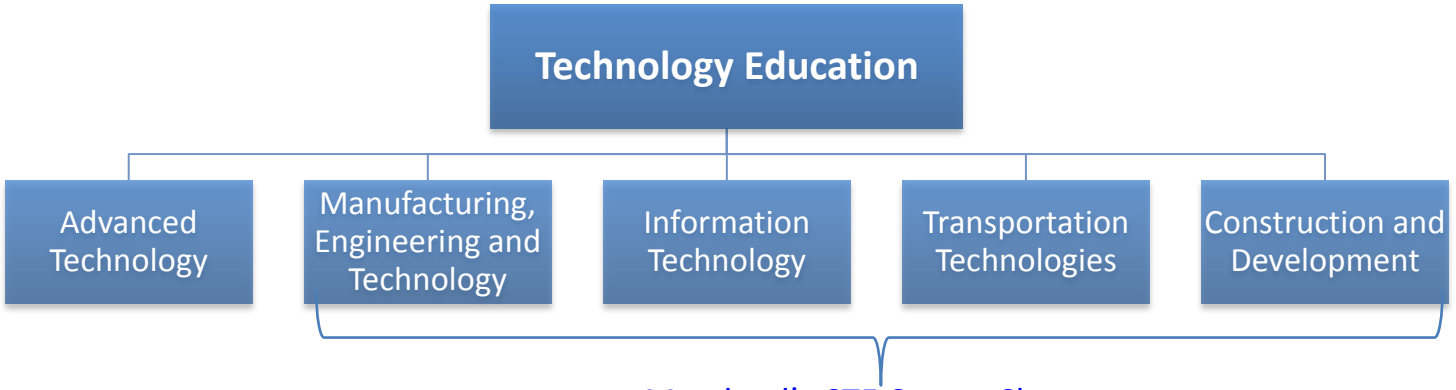
Advanced Technology Grades 10 - 12

Advanced technology education is an instructional program in which students develop advanced skills and understandings related to the use, assessment, design, functionality, and production of technological systems. It is a series of course offerings that meet Maryland's high school enrollment and credit requirements for advanced technology education (COMAR 13A.03.02.03). Students participating in advanced technology education courses take a deep dive into the impacts of technology, technological issues, and engineering design. There are two approaches school systems can use to identify courses that will allow students to fulfill their technology education graduation requirement.

1. School system leaders can offer students any of the MSDE preapproved courses developed by the ITEEA's STEM Center for Teaching and Learning Engineering by Design program (courses are listed below).
    - Advanced Design Applications
    - Advanced Technological Applications
    - Engineering Design

2. Local school system leaders can identify courses that meet requirements by completing the MSDE curriculum alignment review process for advanced technology education. This process includes submission of the advanced technology education curriculum alignment rubric and associated documents from the school system to MSDE for review. If courses meet all components of the rubric, students may take the course to fulfill their advanced technology education graduation requirement. For assistance with the curriculum alignment review process, please contact Tiara Booker-Dwyer, Education Program Specialist, via email at tiara.booker-dwyer@maryland.gov.

The approaches described above allow school system leaders the flexibility to identify courses that best meet the needs of their diverse student population. Students also have the option of building on the skills and knowledge developed in their technology education courses by participating in a Maryland Career and Technology Education (CTE) Program of Study. Maryland has career clusters focusing on Manufacturing, Engineering and Technology, Information Technology, Transportation Technologies, and Construction and Development. Each cluster builds off of foundational knowledge established in technology education courses.



Limitations of Standards

1. Maryland Technology Education Standards establish expectations of what technologically literate students should know and be able to do upon graduation from high school. This document is not a curriculum. Local school system leaders can develop or adopt curriculum that will provide the opportunity for students to demonstrate mastery of standards.
2. Maryland Technology Education Standards are intrinsically interconnected. Standards are not designed to be taught independently. Teachers can facilitate instruction and assessment of multiple standards at once. This approach provides greater flexibility in determining and implementing the tools, accommodations, interventions, or enrichments necessary to meet the needs of diverse learners.
3. Maryland Technology Education Standards are holistic in nature and have equal importance toward fostering technological literate students. The standard document is not intended to convey a hierarchical or sequential order for standards or essential skills and knowledge.
4. Essential skills and knowledge focus on key performance expectations. Maryland Technology Education Standards does not delineate the comprehensive set of skills and knowledge that technological literate students may demonstrate. Students should continue to grow in their technological literacy as they progress academically.

Standard One: The Nature of Technology - Students will develop an understanding of the nature of technology.
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1. **The characteristics and scope of technology.** This includes but is not limited to how products and systems are developed to solve problems, how demand is created for a product by marketing and advertising, and how goal-directed research can result in invention and innovation.
2. **The core concepts of technology**. This includes but is not limited to systems, resources, requirements, optimization, trade-offs, processes, and controls.
3. **The connections between technology and other fields of study**. This includes understanding how technological systems interact with each other, how technology can be repurposed, how other fields of study can impact technological products, and how technological ideas are protected.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 -8	Grades 9-12	Advanced Technology Grades 10 -12
Characteristics and Scope of Technology ▪ Differentiate between technological inventions and innovations. ▪ Identify the need for technological invention and innovation. ▪ Describe how marketing and advertising is used to create demand for technological products (STL, 3I). Core Concepts of Technology ▪ Describe the components of a technological system. ▪ Design a model that demonstrates how subsystems and system elements interact within systems. ▪ Select or design a technological system to perform a task based on specific requirements. ▪ Assemble and operate simple technological systems. ▪ Analyze the performance of a feedback control system. ▪ Troubleshoot a malfunctioning system (STL, 10F).	Characteristics and Scope of Technology ▪ Analyze factors that drive technological invention and innovation. ▪ Describe factors that may limit the development or use of technology (e.g. resources, societal concerns). ▪ Assess the effects of technology on supply and demand. Core Concepts of Technology ▪ Analyze the functionality and interaction of various technological systems. ▪ Analyze how technology can be repurposed for applications beyond their intended use. ▪ Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interaction between systems (HS-ETS 1-4). ▪ Employ constraint-based modeling to describe a biological system. ▪ Assemble and operate simple and complex systems. ▪ Diagnose a system that is malfunctioning and use tools, materials, and knowledge to repair it (STL, 12M).	Characteristics and Scope of Technology ▪ Assess factors that shape the design of and demand for various technologies. ▪ Demonstrate how research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. Core Concepts of Technology ▪ Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interaction between systems (HS-ETS 1-4). ▪ Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. ▪ Create representation of a system in another form or a higher level of abstraction. ▪ Design and create a complex system. ▪ Test and evaluate the operation of a system based on its specified purpose. ▪ Design instructions for system maintenance. ▪ Repurpose a technological device for an application beyond its intended use.

Standard One: The Nature of Technology - Students will develop an understanding of the nature of technology.
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1. **The characteristics and scope of technology.** This includes but is not limited to how products and systems are developed to solve problems, how demand is created for a product by marketing and advertising, and how goal-directed research can result in invention and innovation.
2. **The core concepts of technology**. This includes but is not limited to systems, resources, requirements, optimization, trade-offs, processes, and controls.
3. **The connections between technology and other fields of study**. This includes understanding how technological systems interact with each other, how technology can be repurposed, how other fields of study can impact technological products, and how technological ideas are protected.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 -8	Grades 9-12	Advanced Technology Grades 10 -12
▪ Use tools, materials, and machines safely to diagnose, adjust and repair systems (STL, 12I). ▪ Provide examples of optimization and trade-offs for products, processes, and systems. <u>Connections Between Technology and Other Fields of Study</u> ▪ Analyze how knowledge gained from other fields of study has impacted the development of technological products and systems (STL, 3F). ▪ Describe how patents protect intellectual property (STL, 3I). ▪ Assess the limitations of open source technology.	▪ Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision. ▪ Create a model of a feedback control system. ▪ Demonstrate how trade-offs can impact a design product. <u>Connections Between Technology and Other Fields of Study</u> ▪ Correlate technological advances to progress in other fields of study such as science and mathematics (STL, 3J). ▪ Analyze the purpose and functionality of subject matter (SMEs) on a team. ▪ Assess ways to protect intellectual property (e.g. patent, trademark, copyright). ▪ Differentiate between open source and proprietary technology.	▪ Differentiate between quality control and quality assurance. ▪ Apply the quality control process to a designed product. <u>Connections Between Technology and Other Fields of Study</u> ▪ Collaborate with subject matter experts to develop solutions to problems. ▪ Analyze and apply the process for protecting intellectual property.

Standard Two: Impacts of Technology - Students will evaluate the impact of technology.
The impact of technology incorporates

1. **The cultural, social, economic, political, and environmental effects of technology.** This includes but is not limited to ethical considerations, trade-offs between the positive and negative effects of technology, impact of transferring technology from one society to another, and the impact of technological advances on the environment.
2. **The role of society in the development and use of technology**. This includes but is not limited to factors that contribute to the design and demand for various technologies.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 – 8	Grades 9-12	Advanced Technology Grades 10 -12
Effects of Technology ▪ Discriminate between responsible and irresponsible use of technology. ▪ Analyze the cultural, social, economic, political and environmental effects of technology. ▪ Describe legal and ethical concerns resulting from the development and use of technology (STL, F). ▪ Explain that decisions about the use of technology involve trade-offs between positive and negative effects (STL, 4I). ▪ Assess the impact of technology transfer from one society to another (STL, 4K). ▪ Evaluate the advantages and disadvantages of technology.	Effects of Technology ▪ Evaluate the desirable and undesirable consequences of technological advancements. ▪ Apply assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology (STL, 13L). ▪ Analyze legal and ethical considerations in the development and application of technology. ▪ Analyze the relationship between technological and natural systems. ▪ Design a forecasting technique to evaluate the results of altering natural systems (STL, 13M). ▪ Create and design a product to mitigate the undesirable consequences of an existing technology.	Effects of Technology ▪ Conduct research on technological issues that currently affect a society. ▪ Assess the unintended consequences of technology on a society. ▪ Assess the impact of technological advances on the environment. ▪ Predict future consequences of technological solutions on a society. ▪ Weigh available information about the benefits, risks, costs, and trade-offs of technology in a systematic way.

Standard Two: Impacts of Technology - Students will evaluate the impact of technology.

The impact of technology incorporates

1. **The cultural, social, economic, political, and environmental effects of technology.** This includes but is not limited to ethical considerations, trade-offs between the positive and negative effects of technology, impact of transferring technology from one society to another, and the impact of technological advances on the environment.
2. **The role of society in the development and use of technology**. This includes but is not limited to factors that contribute to the design and demand for various technologies.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 – 8	Grades 9-12	Advanced Technology Grades 10 -12
<u>Role of Society in the Development and Use of Technology</u> ▪ Describe how new technologies have evolved as a result of combing existing technologies. ▪ Assess the impact that technological invention and innovation has on the needs and wants of a society (STL, 4E). ▪ Explain how technological advances have impacted the nature of work.	<u>Role of Society in the Development and Use of Technology</u> ▪ Distinguish factors that affect the scaling of technology. ▪ Analyze how different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values. ▪ Compare and contrast the development, availability, and application of technology in developed and underdeveloped countries. ▪ Draw connections between technological advances and evolution of civilization through different archaeological periods (e.g. stone age, bronze age, iron age) (STL, 4H).	<u>Role of Society in the Development and Use of Technology</u> ▪ Explain the ethical considerations that inform the development, selection, and use of technologies. ▪ Analyze the impact that technology transfer between societies has on the economy, culture, and government of each society. ▪ Assess the impact that technological invention and innovation has on economic competitiveness and shifts in employment opportunities (job creation and destruction). ▪ Assess how technology stimulates changes in society, influence cultural patterns, political movements, and local and global economies.

Standard Three: Engineering Design and Development - Students will demonstrate knowledge of and apply the engineering design process to develop solutions to problems.

Engineering design and development includes but is not limited to **research and development**, **invention and innovation**, **problem solving**, and **using and maintaining technological products and systems**.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 - 8	Grades 9-12	Advanced Technology Grades 10 -12
▪ Explain how the design process is an iterative, systematic approach to problem solving that includes collaboratively: ○ Defining a problem – students will be able to employ technical reading and writing skills to develop concise problem statement. ○ Brainstorming – students will be able to apply team brainstorming rules and techniques. ○ Researching and Generating Ideas – students will be able to conduct research to assess prior solutions to the problem. ○ Identifying Criteria and Specifying Constraints – students will be able to assess the criteria (guidelines) and prioritize constraints (limitations) of the problem. This includes people, time, materials, capital, energy, etc. ○ Exploring Possibilities – students will conduct research and explore possibilities for potential solutions. ○ Selecting an Approach – students will be able to employ a decision matrix to select the best approach to solve the problem. ○ Developing a Design Proposal – students will be able to create a plan of action that details the specifics of the project. ○ Making a Model or a Prototype – students will be able to develop conceptual, mathematical, or physical models and/or a prototype that performs the final solution and can be used for testing/evaluating. This includes the creation of two and three dimensional scale drawings.	▪ Apply the design process to develop solutions to real-world problems. ▪ Document the design process and solutions in a journal, notebook, or portfolio. ▪ Assess the reliability and validity of researched information. ▪ Apply design principles (e.g. flexibility, balance, function, proportion) to evaluate existing designs, to collect data, and to guide the design process (STL, 9I). ▪ Evaluate design solutions using software and other tools to develop conceptual, physical, and mathematical models at various intervals of the design process in order to ensure compliance with design requirements (STL, 11P). ▪ Assess how design requirements such as criteria, constraints, and efficiency can compete with each other (STL, 8K). ▪ Identify the capital and other resources needed to develop solutions to problems. ▪ Apply assessment techniques (e.g. trend analysis) to determine if a solution should be pursued to design and development. ▪ Engage in failure analysis and optimization. ▪ Assess the validity of a research results.	▪ Conduct market research to make informed decisions about product development. ▪ Develop or refine products based on the results of market research. ▪ Apply the engineering design process to develop solutions to real-world problems. ▪ Engage in the reverse engineering process to deduce design features in a novel product. ▪ Document the design process and solutions in a journal, notebook, or portfolio. ▪ Evaluate the reliability and validity of researched information. ▪ Employ risk analysis to minimize the likelihood of unwanted side effects. ▪ Engage in cost-benefit analysis. ▪ Use assessment techniques to ascertain if a solution should be pursed to design and development. ▪ Compare trade-offs between competing values. ▪ Implement current industry standard systems for quality control. ▪ Analyze how the engineering code of ethics impact product design. ▪ Engage in ethical engineering practices.

Standard Three: Engineering Design and Development - Students will demonstrate knowledge of and apply the engineering design process to develop solutions to problems.

Engineering design and development includes but is not limited to **research and development**, **invention and innovation**, **problem solving**, and **using and maintaining technological products and systems**.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 - 8	Grades 9-12	Advanced Technology Grades 10 -12
○ Testing and Evaluating Design Using Specifications – students will be able to use establish specifications to assess their design product. ○ Refining a Design – student will employ data-driven decision making to improve their product. ○ Creating or Making the Product – students will be able to produce the design product ○ Communicate Processes and Results – students will be able to communicate throughout the design process demonstrating application of the essential skills and knowledge presented in Maryland's College and Career Ready Disciplinary Literacy Standards. ▪ Apply the design process to develop solutions to real-world problems. ▪ Document the design process and solutions in a journal, notebook, or portfolio. ▪ Assess the reliability and validity of researched information. ▪ Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of a problem (MS-ETS1-2). ▪ Discriminate between ethical and unethical engineering practices.	▪ Apply the research and development problem-solving approach to prepare devices and systems for the marketplace. ▪ Engage in ethical engineering practices.	

Standard Four: Core Technologies and The Designed World - Students will demonstrate knowledge of the core technologies that underpin the designed world and major enterprises that produce the goods and services of the designed world. Core technologies include but are not limited to biotechnology, electrical, electronics, fluid, material, mechanical, optical, structural, and thermal technologies. Major enterprises include medical, agriculture, biotechnology, energy and power, information and communication, transportation, and manufacturing and construction technologies.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 - 8	Grades 9-12	Advanced Technology Grades 10 -12
▪ Analyze the function of select core technologies in the designed world. *Medical Technologies* ▪ Explore the function and application of several medical technologies. ▪ Correlate advances in medical technologies to improvements in the length and quality of life for multicellular organisms. ▪ Describe ethical considerations involved in the development and application of medical technologies. *Agricultural Technologies* ▪ Explore the function and application of a variety of technological processes, equipment, and systems used in agriculture (e.g. agroforestry, irrigation, global positioning systems). ▪ Design, develop, use, manage, maintain, and assess a closed system that supports living organisms (e.g. terrarium, hydroponics station). ▪ Evaluate the positive and negative effects of technological solutions to agricultural problems.	▪ Apply knowledge of core technologies in the development of solutions to problems. *Medical Technologies* ▪ Employ trends, research, and forecasting techniques to analyze emerging health and medical technologies. ▪ Investigate the benefits and consequences of advances in medicine made through the use of technology. ▪ Analyze ethical issues and global concerns surrounding the development, access, application, and effects of health and medical technologies. ▪ Assess how advances in medical technology have improved the health of multicellular organisms (e.g. reducing the instances of serious diseases in humans). *Agricultural Technologies* ▪ Analyze how advancement in technology has improved the yield and quality of food. ▪ Assess the products and systems used to produce, process, and distribute food, fiber, fuel, chemical, and other products (STL, 16K). ▪ Assess the need for regulations governing technologies used in agriculture.	▪ Apply knowledge of core technologies in the development of solutions to problems. *Medical Technologies* ▪ Assess the social, cultural, political, and environmental forces impacting the design, development, application, and access to a variety of medical technologies. ▪ Analyze factors that need to be established to make emerging medical technologies viable in the marketplace. ▪ Describe the application of bioinformatics in health and wellness. ▪ Apply bioinformatics to analyze and interpret biological data. ▪ Analyze and evaluate health data collection tools (e.g. patient monitoring equipment, medical wearable devices). ▪ Analyze technological advances that allow for identification of disease pathogens. ▪ Design and build a medical device that meets a specific medical need. *Agricultural Technologies* ▪ Assess the impact that technologies such as automation, sensors, mobile computing, and telematics have on agriculture.

Standard Four: Core Technologies and The Designed World - Students will demonstrate knowledge of the core technologies that underpin the designed world and major enterprises that produce the goods and services of the designed world. Core technologies include but are not limited to biotechnology, electrical, electronics, fluid, material, mechanical, optical, structural, and thermal technologies. Major enterprises include medical, agriculture, biotechnology, energy and power, information and communication, transportation, and manufacturing and construction technologies.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 - 8	Grades 9-12	Advanced Technology Grades 10 -12
▪ Describe techniques used to provide long-term storage of food and reduce the health risk caused by tainted food (STL, 15J). *Biotechnology* ▪ Explore applications of biotechnology. ▪ Examine positive and negative impacts of biotechnology. ▪ Analyze ethical, societal, and legal issues that arise from biotechnology applications. *Energy and Power Technologies* ▪ Analyze how power systems are used to drive and provide propulsion to other technological products and systems (STL, 16H). ▪ Design, construct, and test a device that either minimizes or maximizes energy transfer (MS-PS3-3). ▪ Explore ways to conserve energy. ▪ Assess advantages and disadvantages of different forms of renewable and nonrenewable energy.	▪ Examine the social side effects and trade-offs of using various technologies in the production of food. *Biotechnology* ▪ Analyze the application of biotechnology processes and products in medicine, agriculture, food processing, and the environment. ▪ Assess the ethical, social, and legal issues regarding the use of biotechnology (e.g. genetic engineering). ▪ Assess the application and impacts of biotechnology on other fields of study such as bioinformatics, bioprocess engineering, and biorobotics. *Energy and Power Technologies* ▪ Analyze the production, conversion, transmission, and application of different forms of energy (e.g. mechanical, radiant, chemical, thermal, electrical, nuclear). ▪ Analyze energy inputs, processes and outputs. ▪ Assess energy efficiency at generation, distribution, and point of use.	▪ Assess governmental regulations on agricultural practices. ▪ Explore sustainable farming practices. ▪ Analyze the advantages and disadvantages of innovation farming techniques (e.g. vertical farms, hydroponics, rooftop farming). ▪ Design and build a model of agricultural technology that meets a specific need. *Biotechnology* ▪ Conduct research on emerging trends in biotechnology. ▪ Apply biotechnology techniques to assess how genetic engineering can alter the function of cellular processes for a specific purpose. ▪ Assess the connection between biotechnology and other fields of study. *Energy and Power Technologies* ▪ Examine renewable and conventional energy production technologies. ▪ Analyze the global production, distribution, and consumption of energy. ▪ Compare and contrast means to transfer and store energy. ▪ Create models and design experiments to improve energy efficiency.

Standard Four: Core Technologies and The Designed World - Students will demonstrate knowledge of the core technologies that underpin the designed world and major enterprises that produce the goods and services of the designed world. Core technologies include but are not limited to biotechnology, electrical, electronics, fluid, material, mechanical, optical, structural, and thermal technologies. Major enterprises include medical, agriculture, biotechnology, energy and power, information and communication, transportation, and manufacturing and construction technologies.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 - 8	Grades 9-12	Advanced Technology Grades 10 -12
Information and Communication Technologies ▪ Assess the application and functionality of the parts of a communication system (source, encoder, transmitter, receiver, decoder, and destination) (STL, 17H). ▪ Explore different steps in the communication process (encode message, encoded message is transmitted or switched through a channel, message is received and decoded by the receiver). ▪ Design and send messages using various types of communication systems. ▪ Design and develop a simple communications system. *Transportation Technologies* ▪ Investigate the functionality of various methods of transportation for land, water, air, and space. ▪ Assess processes necessary for an entire transportation system to operate efficiently (e.g. receiving, holding, storing, loading) (STL, 18I). ▪ Analyze the interdependence of transportation systems. ▪ Design and develop models of subsystems in a transportation system (structural, propulsion, suspension, guidance, control, and support).	▪ Create computational models to calculate the change in the energy of one component in a system when the change in the energy of the other component(s) an energy flows in and out of the system are known (HS-PS3-1). ▪ Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy (HS-PS3-3). *Information and Communication Technologies* ▪ Analyze the inputs, processes, and outputs associated with sending and receiving information (STL, 17I). ▪ Investigate components of a communication system (STL, 17O). ▪ Assess approaches to reduce noise and promote clear communication. ▪ Analyze the function and application of different forms of communication technologies (e.g. internet, wireless networks). ▪ Demonstrate the transfer of information through different communication systems. ▪ Analyze factors that influence messages (e.g. timing, sequencings, processing). ▪ Design, use, and assess various types of information and communication systems (e.g. graphic, optical, radio, tactical).	▪ Create models that demonstrate energy and power flow in electromechnical systems and optoelectronic devices. *Information and Communication Technologies* ▪ Analyze the interconnectivity of telecommunication, computer, and audiovisual systems required to access, store, transmit, and manipulate information. ▪ Assess a variety of communication methods, techniques, and devices. ▪ Analyze factors that impact the design, development, use, and access to information and communication technologies. ▪ Design and assemble a communication system to fulfill a specific need. ▪ Assess the local, national, and global economic impact of information and communication technologies.

Standard Four: Core Technologies and The Designed World - Students will demonstrate knowledge of the core technologies that underpin the designed world and major enterprises that produce the goods and services of the designed world. Core technologies include but are not limited to biotechnology, electrical, electronics, fluid, material, mechanical, optical, structural, and thermal technologies. Major enterprises include medical, agriculture, biotechnology, energy and power, information and communication, transportation, and manufacturing and construction technologies.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 - 8	Grades 9-12	Advanced Technology Grades 10 -12
▪ Design and develop a model of a new energy efficient vehicle to be use on land, in the sea, in the air, or in space. ▪ Describe how governmental regulations influence the design and operation of transportation system. *Manufacturing Technologies* ▪ Identify the components of a manufacturing system. ▪ Identify resources required for manufacturing systems to operate properly (e.g. raw materials, finances, people, tools, machines, time). ▪ Examine the mechanical and chemical processes of manufacturing. ▪ Analyze the development, production, application, marketing, acquisition, and disposal of manufactured products. ▪ Assess the impact that technology (e.g. computer-aided design, automation, robots, assembly lines) has on the manufacturing process. ▪ Assess the impact that the manufacturing process has on people and the environment. ▪ Classify manufactured goods according to their longevity. ▪ Assess a variety of manufacturing methodologies.	*Transportation Technologies* ▪ Assess the role of transportation in manufacturing, construction, communication, health, safety, recreation, entertainment, and agriculture. ▪ Analyze intermodal travel of people and goods. ▪ Investigate and propose solutions to issues associated with transportation such as cost, safety, environmental impact, energy, and government regulations. *Manufacturing Technologies* ▪ Analyze manufacturing processes (designing, development, producing, and servicing). ▪ Describe mechanical processes that change the form of materials (separating, forming, combining, and conditioning). ▪ Classify manufacturing systems as being customized production, batch production, or continuous production. ▪ Design and develop an interchangeable part. ▪ Create machine code to manufacture a product. ▪ Classify materials as natural, synthetic, or mixed (STL, 19M). ▪ Analyze the life cycle of a manufactured product. ▪ Explore the life cycle costing of products in a manufacturing process.	*Transportation Technologies* ▪ Analyze how systems (e.g. structural, suspension) in vehicles, aircrafts and other means of transportation impact passenger and cargo safety. ▪ Utilize a variety of systems for controlling distance and direction of a vehicle, hovercraft, or other means of transportation. ▪ Develop a model of an intelligent transportation system. ▪ Design systems to modify the speed, torque, or direction of power. *Manufacturing Technologies* ▪ Assess of the role of manufacturing technologies in society. ▪ Assess the advantages and disadvantages of a variety of manufacturing systems. ▪ Analyze manufacturing systems in terms of material flow and storage, information flow, capacities, and times and durations of events. ▪ Analyze strategies to control quantity and quality in manufacturing systems. ▪ Evaluate advances in design and manufacturing technologies. ▪ Design a product using a computer controlled manufacturing process.

Standard Four: Core Technologies and The Designed World - Students will demonstrate knowledge of the core technologies that underpin the designed world and major enterprises that produce the goods and services of the designed world. Core technologies include but are not limited to biotechnology, electrical, electronics, fluid, material, mechanical, optical, structural, and thermal technologies. Major enterprises include medical, agriculture, biotechnology, energy and power, information and communication, transportation, and manufacturing and construction technologies.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 - 8	Grades 9-12	Advanced Technology Grades 10 -12
Construction Technologies ▪ Analyze the type of and purpose for a variety of structures. ▪ Analyze factors used in the selection of designs for structures (e.g. laws, codes, style, cost, climate, function) (STL, 20F). ▪ Examine different subsystems within buildings. ▪ Analyze the maintenance of structures and subsystems. ▪ Assess the role that community planning, laws, and regulation have in the development and maintenance of structures. ▪ Design, use, and assess building material. ▪ Design and create models of structures.	▪ Examine the need for and application of terotechnology in manufacturing. ▪ Apply marketing techniques to build awareness of a manufactured product. *Construction Technologies* ▪ Design and create models of a variety of structures. ▪ Analyze the physical infrastructures that allow a society or government to function (e.g. infrastructures of roads, airports, dams, canals, rail lines, sewers). ▪ Analyze the various materials and systems that comprise buildings. ▪ Analyze factors used to guide the process of designing and making structures. ▪ Examine the need for maintenance, alteration, or renovation to improve structures or to alter their intended use (STL, 20M). ▪ Analyze the steps in the construction process (preparing the site; setting foundations; building the framework; enclosing the structure; installing utilities; finishing the interior and exterior; completing the site).	*Construction Technologies* ▪ Analyze how architectural designs can promote human health, well-being and social interaction. ▪ Design and construct an architectural model that serves a specified purpose. ▪ Design or model buildings that utilize optimum value engineering. ▪ Analyze and apply the process and requirements for LEED certification.

Standard Five: Computational Thinking and Computer Science Applications - Students will be able to apply computational thinking skills and computer science applications as tools to develop solutions to engineering problems.

Essential Skills and Knowledge

Students who demonstrate understanding can:

Grades 6 -8	Grades 9-12	Advanced Technology Grades 10 -12
▪ Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems. ▪ Use the basic steps in algorithmic problem solving to design solutions to problems. ▪ Use modeling and simulation to represent and understand natural phenomena. ▪ Implement problem solutions using a programming language. ▪ Use productivity technology tools for individual and collaborative writing, communication, presentation, and/or publishing activities. ▪ Apply responsible legal and ethical behaviors in the use of technology systems and software. ▪ Analyze how computational thinking and computer programing can be used as tools for problem solving.	▪ Decompose a complex problem or system into parts. ▪ Use a programming language to develop solutions to problems and/or accomplish tasks. ▪ Design, use, and evaluate computational abstractions that model the state and behavior of real-world problems and physical systems. ▪ Automate solutions through algorithmic thinking. ▪ Apply strategies for identifying and solving routine hardware and software problems. ▪ Use a variety of productivity technology tools to collaborate with others, manage projects, collect and analyze data, share information, and/or publish findings. ▪ Apply responsible legal and ethical behaviors in the use of technology systems and software.	▪ Demonstrate proficiency in using a variety of programming languages to develop solutions to problems or accomplish tasks. ▪ Analyze data and identify patterns through modeling and simulation. ▪ Analyze and/or design algorithms necessary for developing solutions to problems. ▪ Select and apply the appropriate software to facilitate collaboration and project management. ▪ Select and apply productivity technology tools to collect and analyze data, and to record, share, publish, and present information. ▪ Use advanced technology tools to create digital artifacts (e.g. web design, animation, video, multimedia). ▪ Apply responsible legal and ethical behaviors in the use of technology systems and software.

Glossary

1. **Abstraction** – the process of representing essential features without including the background details or explanations. In computer science and software engineering, abstraction is used to reduce complexity and allow efficient design and implementation of complex software systems.
2. **Algorithm** – A self-contained step-by-step set of operations to be performed.
3. **Automation:** A machine or system that operates with minimal human control: using automated machines as control for production.
4. **Bioengineering** - Engineering applied to biological and medical systems, such as biomechanics, biomaterials, and biosensors. Bioengineering also includes biomedical engineering as in the development of aids or replacements for defective or missing body organs.
5. **Bioinformatics –** an interdisciplinary field that develops methods and software tools for understanding biological data.
6. **Biotechnology** – The technology of using, adapting, and altering organisms and biological processes for a desired outcome.
7. **CAD** (computer-aided design or computer-aided drafting) - 1. (Design) The use of a computer to assist in the process of designing a part, circuit, building, etc. 2. (Drafting) The use of a computer to assist in the process of creating, storing, retrieving, modifying, plotting, and communicating a technical drawing.
8. **Capital** - One of the basic resources used in a technological system. Capital (money) is the accumulated finances and goods devoted to the production of other goods.
9. **Closed-loop system** - A system that uses feedback from the output to control the input.
10. **Code** – programing instructions.
11. **Communication system** - A system that forms a link between a sender and a receiver making possible the exchange of information.
12. **Computational Thinking** – a process that generalizes a solutions to open ended problems.
13. **Constraint** - A limit to the design process. Constraints may be such things as appearance, funding, space, materials, and human capabilities.
14. **Construction** - The systematic act or process of building, erecting, or constructing buildings, roads, or other structures.
15. **Control system** - An assemblage of control apparatus coordinated to execute a planned set of actions.
16. **Core technologies –** The building blocks of technology systems including mechanical, structural, electrical, electron, fluid, thermal, optical, material, and bio technologies.
17. **Custom production** - A type of production in which products are designed and built to meet the specific needs and wants of an individual.
18. **Data processing system** - A system of computer hard- ware and software to carry out a specified computational task.
19. **Design** - An iterative decision-making process that produces plans by which resources are converted into products or systems that meet human needs and wants or solve problems.
20. **Design brief** - A written plan that identifies a problem to be solved, its criteria, and its constraints. The design brief is used to encourage thinking of all aspects of a problem before attempting a solution.
21. **Design principle** - Design rules regarding rhythm, balance, proportion, variety, emphasis, and harmony, used to evaluate existing designs and guide the design process.
22. **Design process –** A systematic problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve a problem or satisfy human needs and wants and to winnow (narrow) down the possible solutions to one final choice.
23. **Design proposal** - A written plan of action for a solution to a proposed problem.
24. **Electrical technology –** The technology of producing, storing, controlling, transmitting and getting work from electrical energy - one of the nine core technologies.

25. **Electronic technology** – The technology of using small amounts of electricity for controlling: detecting; and information collecting, storage, retrieving, processing, and communicating - one of the nine core technologies.
26. **Engineering** - The profession of or work performed by an engineer. Engineering involves the knowledge of the mathematical and natural sciences (biological and physical) gained by study, experience, and practice that are applied with judgment and creativity to develop ways to utilize the materials and forces of nature for the benefit of mankind.
27. **Engineering design** - The systematic and creative application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems.
28. **Failure Analysis** – process of collecting and analyzing data to determine the cause of failure.
29. **Fluid technology** – The technology of using fluid, either gaseous (pneumatics) or liquid (hydraulics) to apply force or to transport materials - one of the nine core technologies.
30. **Forecast** - A statement about future trends, usually as a probability, made by examining and analyzing available information. A forecast is also a prediction about how something will develop usually as a result of study and analysis of available pertinent data.
31. **Information system** - A system of elements that receive and transfer information. This system may use different types of carriers, such as satellites, fiber optics, cables, and telephone lines, in which switching and storage devices are often important parts.
32. **Innovation** - An improvement of an existing technological product, system, or method of doing something.
33. **Invention** - A new product, system, or process that has never existed before, created by study and experimentation.
34. **Manufacturing system** - A system or group of systems used in the manufacturing process to make products for an end user.
35. **Marketing** - The act or process of offering goods or services for sale.
36. **Materials technology** – The technology of producing, altering, and combining materials - one of the nine core technologies.
37. **Mechanical technology** – The technology of putting together mechanical parts to produce, control and transmit motion - one of the nine core technologies.
38. **Medical technology** - Of or relating to the study of medicine through the use of and advances of technology, such as medical instruments and apparatus, imaging systems in medicine, and mammography. Related terms: bio- medical engineering and medical innovations.
39. **Model -** A visual, mathematical, or three-dimensional representation in detail of an object or design, often smaller than the original. A model is often used to test ideas, make changes to a design, and to learn more about what would happen to a similar, real object.
40. **Open-loop system** - A control system that has no means for comparing the output with input for control purposes. Control of open-loop systems often requires human intervention.
41. **Optical technology** - The technology of producing light, controlling light, using light for information collection, processing, storage, retrieval and communication and using light to do work.
42. **Optimization** - An act, process, or methodology used to make a design or system as effective or functional as possible within the given criteria and constraints.
43. **Portfolio** – A systematic and organized collection of a student's work that includes results of research, successful and less successful ideas, notes on procedures, and data collected.
44. **Problem solving** - The process of understanding a problem, devising a plan, carrying out the plan, and evaluating the plan in order to solve a problem or meet a need or want.
45. **Production system** -A technological system that involves producing products and systems by manufacturing (on the assembly line) and construction (on the job).
46. **Programming language –** A constructed language designed to communicate instructions to a machine. Programming languages can be used to create programs to control the behavior of a machine or to express algorithms.
47. **Prototype** - A full-scale working model used to test a design concept by making actual observations and necessary adjustments.

48. **Quality assurance-** The use of quality control techniques associated with a process.
49. **Quality control** - A system by which a desired standard of quality in a product or process is maintained. Quality control usually requires feeding back information about measured defects to further improvements of the process.
50. **Quantitative:** Relating to, or expressible in terms of quantity, typically displayed in a line graph.
51. **Research and development (R&D)** - The practical application of scientific and engineering knowledge for discovering new knowledge about products, processes, and services, and then applying that knowledge to create new and improved products, processes, and services that fill market needs.
52. **Reverse Engineering** - taking apart an object to see how it works in order to duplicate or enhance the object.
53. **Risk** - The chance or probability of loss, harm, failure, or danger.
54. **Scale** - A proportion between two sets of dimensions used in developing accurate, larger or smaller prototypes or models of design ideas.
55. **Structural system** - A system comprised of the framework or basic structure of a vehicle.
56. **Structural technology –** The technology of putting parts and materials together to create supports, containers, shelters, connectors, and functional shapes - one of the nine core technologies.
57. **Subject Matter Expert** - A professional who has acquired knowledge and skills through study and practice over the years, in a particular field or subject, to the extent that his or her opinion may be helpful in fact finding, problem solving, or understanding of a situation.
58. **Subsystem** - A division of a system that, in itself, has the characteristics of a system.
59. **System** - A group of interacting, interrelated, or interdependent elements or parts that function together as a whole to accomplish a goal.
60. **Systems-oriented thinking** - A technique for looking at a problem in its entirety, looking at the whole, as distinct from each of its parts or components. Systems-oriented thinking takes into account all of the variables and relates social and technological characteristics.
61. **Technology** - 1. Human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. 2. The innovation, change, or modification of the natural environment to satisfy perceived human needs and wants.
62. **Technology education** - A study of technology, which provides an opportunity for students to learn about the processes and knowledge related to technology that are needed to solve problems and extend human capabilities.
63. **Technological transfer** - The process by which products, systems, knowledge, or skills, developed under federal research and development funding, is translated into commercial products to fulfill public and private needs.
64. **Telemedicine** - The investigation, monitoring, and management of patients and the education of patients and staff using systems which allow ready access to expert advice and patient information, no matter where the patient or the relevant information is located. The three main dimensions of telemedicine are health service, telecommunications, and medical computer technology.
65. **Terotechnology –** the maintenance of assets in optimal manner. It is the combination of management, financial, engineering, and other practices applied to physical assets such as plant, machinery, equipment, buildings and structures in pursuit of economic life cycle costs.
66. **Thermal technology** - The technology of producing, sorting, controlling, transmitting and getting work from heat energy.
67. **Thermodynamics-** The study of thermal energy as it moves from one substance to another.
68. **Trade-off** - An exchange of one thing in return for another; especially relinquishment of one benefit or advantage for another regarded as more desirable.
69. **Transportation system** - The process by which passengers or goods are moved or delivered from one place to another.
70. **Trend analysis** - A comparative study of the component parts of a product or system and the tendency of a product or system to develop in a general direction over time.

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