SOUTHERN LEHIGH SCHOOL DISTRICT
5775 Main Street
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Scope and Sequence for **Honors Engineering Design and Development**

The Nature of Technology

National Standards for Technological Literacy	PA Standards for Science and Technology and Engineering Education
1. The characteristics and scope of technology. **9-12.J** The nature and development of technological knowledge and processes are functions of the setting. **9-12.K** The rate of technological development and diffusion is increasing rapidly. **9-12.L** Inventions and innovations are the results of specific, goal-directed research. **9-12.M** Most development of technologies these days is driven by the profit motive and the market.	**1. Characteristics of Technology** **3.4.12.A1** Compare and contrast the rate of technological development over time.
2. The core concepts of technology. **9-12.W** Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems. **9-12.X** Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. **9-12.Y** The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop. **9-12.Z** Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste. **9-12.AA** Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. **9-12.BB** Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints. **9-12.CC** New technologies create new processes. **9-12.DD** Quality control is a planned process to ensure that a product, service, or system meets established criteria. **9-12.EE** Management is the process of planning, organizing, and controlling work. **9-12.FF** Complex systems have many layers of controls and feedback loops to provide information.	**2. Core Concepts of Technology** **3.4.10.A2** Interpret how systems thinking applies logic and creativity with appropriate comprises in complex real-life problems. **3.4.12.A2** Describe how management is the process of planning, organizing, and controlling.
3. The relationships among technologies and the connections between technology and other fields. **9-12.G** Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. ***This section continues on the next page…***	**3. Technology Connections** **3.4.10.A3** Examine how technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. ***This section continues on the next page…***

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Continued… **9-12.H** Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields. **9-12.I** Technological ideas are sometimes protected through the process of patenting. **9-12.J** Technological progress promotes the advancement of science and mathematics.	***Continued…*** **3.4.12.A3** Demonstrate how technological progress promotes the advancement of science, technology, engineering and mathematics (STEM).

Technology and Society

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4. The cultural, social, economic, and political effects of technology. **9-12.H** Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious. **9-12.I** Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects. **9-12.J** Ethical considerations are important in the development, selection, and use of technologies. **9-12.K** The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.	**1. Effects of Technology** **3.4.12.B1** Analyze ethical, social, economic, and cultural considerations as related to the development, selection, and use of technologies.
5. The effects of technology on the environment. **9-12.G** Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling. **9-12.H** When new technologies are developed to reduce the use of resources, considerations of trade-offs are important. **9-12.I** With the aid of technology, various aspects of the environment can be monitored to provide information for decision-making. **9-12.J** The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment. **9-12.K** Humans devise technologies to reduce the negative consequences of other technologies. **9-12.L** Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.	**2. Technology and Environment** **3.4.12.B2** Illustrate how, with the aid of technology, various aspects of the environment can be monitored to provide information for decision making.
6. The role of society in the development and use of technology. **9-12.H** Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values. **9-12.I** The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures. **9-12.J** A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies.	**3. Society and Development of Technology** **3.4.10.B3** Compare and contrast how a number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads, contribute to shaping the design of and demand for various technologies

Technology and Society

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7. The influence of technology on history. **9-12.G** Most technological development has been evolutionary, the result of a series of refinements to a basic invention. **9-12.H** The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials. **9-12.I** Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape. **9-12.J** Early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how.	**4. Technology and History** **3.4.10.B4** Recognize that technology development has been evolutionary, the result of a series of refinements to a basic invention.

Design

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8. The attributes of design. **9-12.H** The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results. **9-12.I** Design problems are seldom presented in a clearly defined form. **9-12.J** The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved. **9-12.K** Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.	**1. Design Attributes** **3.4.10.C1** Apply the components of the technological design process.
9. Engineering design. **9-12.I** Established design principles are used to evaluate existing designs, to collect data, and to guide the design process. **9-12.J** Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. **9-12.K** A prototype is a working model used to test a design concept by making actual observations and necessary adjustments. **9-12.L** The process of engineering design takes into account a number of factors.	**2. Engineering Design** **3.4.12.C2** Apply the concept that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
10. The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. **9-12.I** 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. **9-12.J** Technological problems must be researched before they can be solved. **9-12.K** Not all problems are technological, and not every problem can be solved using technology. **9-12.L** Many technological problems require a multidisciplinary approach.	**3. Research & Development, Invention & Innovation, Experimentation/Problem Solving and Troubleshooting** **3.4.12.C3** Apply the concept that many technological problems require a multi-disciplinary approach.

Abilities for a Technological World

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11. Apply the design process. **9-12.M** Identify the design problem to solve and decide whether or not to address it. **9-12.N** Identify criteria and constraints and determine how these will affect the design process. **9-12.O** Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. **9-12.P** Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. **9-12.Q** Develop and produce a product or system using a design process. **9-12.R** Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.	**1. Applying the Design Process** **3.4.10.D1** Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of a final product.
12. Use and maintain technological products and systems. **9-12.L** Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. **9-12.M** Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it. **9-12.N** Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision. **9-12.O** Operate systems so that they function in the way they were designed. **9-12.P**. Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.	**2. Using and Maintaining Technological Systems** **3.4.10.D2** Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it. **3.4.12.D2** Verify that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
13. Assess the impact of products and systems. **9-12.J** Collect information and evaluate its quality **9-12.K** Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment. **9-12.L** Use assessment techniques, such as trend analysis and experimentation, to make decisions about the future development of technology. **9-12.M** Design forecasting techniques to evaluate the results of altering natural systems.	**3. Assessing Impact of Products and Systems** **3.4.10.D3** Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual society, and the environment.

The Designed World

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16. Energy and power technologies. **9-12.J** Energy cannot be created nor destroyed; however, it can be converted from one form to another. **9-12.K** Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others. **9-12.L** It is impossible to build an engine to perform work that does not exhaust thermal energy to the surroundings. **9-12.M** Energy resources can be renewable or nonrenewable. **9-12.N** Power systems must have a source of energy, a process, and loads.	**3. Energy and Power Technologies** **3.4.10.E3** Compare and contrast the major forms of energy: thermal, radiant, electrical, mechanical, chemical, nuclear, and others. **3.4.12.E3** Compare and contrast energy and power systems as they relate to pollution renewable and non-renewable resources and conservation.
17. Information and communication technologies. **9-12.M** Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine. **9-12.N** Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate. **9-12.P** There are many ways to communicate information, such as graphic and electronic means. **9-12.Q** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.	**4. Information and Communication Technologies** **3.4.10.E4** Evaluate the purpose and effectiveness of information and communication systems. **3.4.12.E4** Synthesize the effects of information and communication systems and subsystems as an integral part of the development of the Information Age.
19. Manufacturing technologies. **6-8.F** Manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning them. **6-8.G** Manufactured goods may be classified as durable and non-durable. **9-12.L** Servicing keeps products in good operating condition. **9-12.P** The interchangeability of parts increases the effectiveness of manufacturing processes. **9-12.Q** Chemical technologies provide a means for humans to alter or modify materials and to produce chemical products. **9-12.R** Marketing involves establishing a product's identity, conducting research on its potential, advertising it, distributing it, and selling it.	**6. Manufacturing Technologies** **3.4.10.E6** Illustrate how manufacturing systems may be classified into types such as customized production, batch production, and continuous production. **3.4.12.E6** Compare and contrast the importance of science, technology, engineering and math (STEM) as it pertains to the manufactured world.
20. Construction technologies. **9-12.J** Infrastructure is the underlying base or basic framework of a system. **9-12.K** Structures are constructed using a variety of processes and procedures. **9-12.L** The design of structures includes a number of requirements. **9-12.M** Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use. **9-12.N** Structures can include prefabricated materials.	**7. Construction Technologies** **3.4.10.E7** Evaluate structure design as related to function considering such factors as style, convenience, safety, and efficiency. **3.4.12.E7** Analyze the technologies of prefabrication and new structural materials and processes as they pertain to constructing the modern world.

Pennsylvania Core Standards for Reading in Science and Technical Subjects

Key Ideas and Details

CC.3.5.11-12.A. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CC.3.5.11-12.B. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

CC.3.5.11-12.C. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

CC.3.5.11-12.D. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

CC.3.5.11-12.E. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

CC.3.5.11-12.F. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

CC.3.5.11-12.G. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CC.3.5.11-12.H. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

CC.3.5.11-12.I. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range and Level of Complex Texts

CC.3.5.11-12.J. By the end of grade 12, read and comprehend science/technical texts in the grades 11–12 text complexity band independently and proficiently.

Pennsylvania Core Standards for Writing in Science and Technical Subjects

Text Types and Purposes

CC.3.6.11-12.A. Write arguments focused on *discipline-specific content.*

- Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.
- Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- Provide a concluding statement or section that follows from or supports the argument presented.

CC.3.6.11-12.B. * Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

- Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
- Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
- Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
- Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

Production and Distribution of Writing

CC.3.6.11-12.C. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CC.3.6.11-12.D. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

CC.3.6.11-12.E. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

CC.3.6.11-12.F. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CC.3.6.11-12.G. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

CC.3.6.11-12.H. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

CC.3.6.11-12.I. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.