TECHNICAL DESIGN

A Standards-Based High School Model Course Guide

ENGINEERING BY DESIGN

Advancing Technological Literacy

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# TECHNICAL DESIGN

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<tr>
<th>Name of Course</th>
<th>Technological Design (HS-7)™</th>
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<td><strong>Standards Addressed</strong></td>
<td>See Responsibility Matrix for Technology, Mathematics, and Science in Appendix A</td>
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<td><strong>Intended Audience</strong></td>
<td>Grades 10–12 (Foundations of Technology, Algebra I highly recommended)</td>
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<td><strong>Course Overview</strong></td>
<td>In <em>Technological Design</em>, engineering scope, content, and professional practices are presented through practical applications. Students in engineering teams apply technology, science, and mathematics concepts and skills to solve engineering design problems and innovate designs. Students research, develop, test, and analyze engineering designs using criteria such as design effectiveness, public safety, human factors, and ethics. This course is an essential experience for students who are interested in technology, innovation, design, and engineering.</td>
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<td><strong>Course Length</strong></td>
<td>36 Weeks</td>
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<td><strong>Connections</strong></td>
<td><em>Technological Design</em> contributes to the development of each high school student’s capacity to make responsible judgments about technology’s development, control, and use. Critiquing appropriate technology and sustainable development is important. The structure of the course brings discussions of technological values so that students can reflect and develop their own ethical standards. Students are actively involved in the organized and integrated application of technological resources, engineering concepts, and scientific procedures. Through high school technology education experiences, students address the complexities of technology and issues that stem from designing, developing, using, and assessing technological systems. In developing a functional understanding of technology, students comprehend how human conditions, current affairs, and personal preferences drive technological design and problem solving. Actively engaged in making and developing as well as using and managing technological systems, students better understand the role of systems in meeting specific purposes. Students are able to analyze and understand the behavior and operation of basic technological systems in different contexts. Students are able to extend their knowledge of systems to new and emerging applications by the time they graduate from high school. <em>Technological Design</em> prepares students for the capstone <em>Engineering Design</em> course that is used as a bridge course for post-secondary study.</td>
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*It is strongly recommended that administration and guidance follow the scope and sequence course recommendations as listed.*
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Standard 1.0
Demonstrate leadership, citizenship, and teamwork skills required for success in the school, community and workplace.

Standard 2.0
Safely use tools, materials, equipment and other technology resources.

Standard 3.0
Students will understand how introduction to technological design in the designed world is the product of a design process that provides ways to turn resources and materials, tools and machines, people, information, energy, capital, and time into products and systems.

Standard 4.0
Students will apply technological design skills to the solution of practical problems. They will develop sketching and modeling skills, and communicate observations, processes and results of the technological design process using verbal, graphic, quantitative, virtual, and written means as well as three-dimensional models.

Standard 5.0
Student will apply, assess, manage, and will use design and creativity concepts to improve the daily lives of other through the study of technological design fundamentals.

Standard 6.0
Students will understand engineering resources sometimes referred to as the core technologies, are the, “basic building blocks” from which all technology systems are created.

Standard 7.0
Students to analyze technology systems that are associated with selected areas of the designed world and to apply technological design skills in problem solving.
STANDARD 1.0

Demonstrate leadership, citizenship, and teamwork skills required for success in the school, community and workplace through Technology Student Association

LEARNING EXPECTATIONS

The student will be able to:
1.1 The creed, purposes, motto, and emblem of Technology Student Association are directly related to personal and professional development.
1.2 Makes decisions and assumes responsibilities.
1.3 Respect the opinions, customs, and individual differences of others.
1.4 Build personal career development by identifying career interests, strengths, and opportunities.
1.5 Demonstrate the ability to work cooperatively with others in a professional setting.
1.6 Cooperates with peers to select and organize a community service project.
1.7 Interacts respectfully with individuals of different cultures, gender and backgrounds.
1.8 Resolves conflicts and differences to maintain a smooth workflow and classroom

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student should know and be able to:
- Create a leadership inventory and use it to conduct a personal assessment.
- Recite the TSA Motto and Creed.
- Design and produce a cover letter and a chronological or skills resume based on research of a selected technology-related career
- Participates and conducts meetings and other business according to accepted rules of parliamentary procedure.
- Demonstrate character and leadership using creative and critical thinking skills.
- Participate in a mock interview.
- Participates in a community service project
- Implement an annual program of work.
- Evaluate an activity within the school, community, and/or workplace and project effects of the project.
STANDARD 2.0
Safely use tools, materials, equipment and other technology resources.

LEARNING EXPECTATIONS

The student will be able to:

2.1 Understand general laboratory safety rules and regulations when using tools, equipment and performing processes.
2.2 Successfully pass a test on general laboratory safety and regulations with 100% accuracy.
2.4 Successfully pass a safety test on power tools used in the classroom with 100% accuracy.
2.5 Successfully pass a written or oral test on the chemical, electrical and fire safety hazards that exist in a Technology Engineering classroom and their school.
2.6 Understand safety, nomenclature and usage of all hand tools used in this course.
2.7 Demonstrate a positive attitude regarding safety practices and issues.
2.8 Demonstrate continuous awareness of potential hazards to self and others and respond appropriately.

PERFORMANCE INDICATORS: EVIDENCE STANDARDS IS MET

The student should know and be able to:

- Is attentive during safety discussions.
- Actively seeks information about safe procedures.
- Responds positively to instruction, advice, and correction regarding safety issues.
- Does not deliberately create or increase hazards, such as by horseplay, practical jokes, or creating distractions.
- Is observant of personnel and activities in the vicinity of the work area.
- Warns nearby personnel, prior to starting potentially hazardous actions.
- Provides and activates adequate ventilation equipment as required by the task.
- Reports all injuries to self to instructor.
- Reports observed unguarded hazards to their immediate supervisor.
- Complies with personal assignments regarding emergency assignments.
- List all safety rules required when performing TSA competitive events.
STANDARD 3.0
Students will understand how introduction to technological design in the designed world is the product of a design process that provides ways to turn resources and materials, tools and machines, people, information, energy, capital, and time into products and systems.

LEARNING EXPECTATIONS
The student will learn to:
3.1 Understand and identify the relationship between the technological design process and selected attributes of the designed world.
3.2 Understand, use, and apply the technological design process, sketching and drawing techniques, and prototyping.
3.3 Define and describe principles of design and analyze technological systems based on these principles.
3.4 To document the technological design processes and communicate them to audiences using appropriate oral and written techniques.

PERFORMANCE STANDARDS:
The student should know and be able to:
3.1.1 Research and report on a major area of the designed world and explain how technological design contributed to its development.
3.1.2 Describe the relationship between the technological design process and selected attributes of the designed world.
3.1.3 Define technological design as the process of converting resources and materials, tools and machines, people, information, energy, capital, and time into products and systems.
3.1.4 Develop a one-page information sheet on one of the areas of the designed world.
3.1.5 Judge the reasonableness of numerical calculations and their results.
3.1.6 Use the language of mathematics to express mathematical ideas precisely.
3.1.7 Actively participate in group discussions, ideation exercises, and debates.
3.1.8 Design an informational document that uses the language of mathematics to express mathematical ideas precisely.
3.2.1 Introduce students to the technological design process, sketching and drawing techniques, and prototyping.
3.2.2 Design a product or process following the steps of the technological design process.
3.2.3 Sketch representations of three-dimensional objects.
3.2.4 Create models and/or prototypes using a variety of techniques.
3.2.5 Contribute to a group endeavor by offering ideas, supporting the efforts of others, and focusing on the task.
3.2.6 Explain why thought should be given to how a design will be manufactured, operated, maintained, replaced, and disposed of and who will sell, operate, and take care of it.
3.2.7 Draw and construct representations of two- and three-dimensional geometric objects using a variety of tools.
3.2.8 Visualize three-dimensional objects and spaces from different perspectives and analyze their cross sections.
3.3.1 Research and report on a high-profile engineering project.
3.3.2 Identify and describe selected principles of design applied in technological design.
3.3.3 Use established design principles to analyze technologies that have been useful over long periods of time.
3.3.4 Create a scoring or rating system for product assessment.
3.3.5 Generate an appropriate table or chart to display data.
3.3.6 Cite an example of a new technology creating a new process.
3.3.7 Describe how feedback influences the stability of a technological system.
3.3.8 Explain the role of research and investigation in the technological design process.
3.3.9 Describe how product/process testing and evaluating enhances the technological design process.
3.4.1 Select an approach to a solution.
3.4.2 Develop design proposal.
3.4.3 Construct models or prototypes.
3.4.4 Communicate processes and results.
3.4.5 Develop a design portfolio.
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STANDARD 4.0
Students will apply technological design skills to the solution of practical problems. They will develop sketching and modeling skills, and communicate observations, processes and results of the technological design process using verbal, graphic, quantitative, virtual, and written means as well as three-dimensional models.

LEARNING EXPECTATIONS

The student will learn to:
4.1 Prepare students to apply the technological design process.
4.2 To enable students to convey design ideas through sketches.
4.3 To enable students to fabricate physical models or prototypes that will be used to test systems or components.
4.4 To enable students to document the technological designs processes and communicate them to audiences using appropriate oral and written techniques.

PERFORMANCE STANDARDS:

The student should know and be able to:
4.1.1 List and describe the major steps in the technological design process.
4.1.2 Identify a problem to solve and decide whether or not to address it.
4.1.3 Identify criteria and constraints and determine how they will affect the design process.
4.1.4 Refine a design using prototypes/models to ensure quality, efficiency, and productivity of the final product.
4.1.5 Evaluate a design solution using conceptual, physical, and mathematical models.
4.1.6 Develop and produce a product or system using the technological design process.
4.2.1 Create freehand sketches and technical illustrations using elements and principles of design.
4.2.2 Create technical illustrations and drawings that incorporate appropriate conventions.
4.2.3 Create traditional or computer-based industry-standard drawings (e.g., working drawings, pictorial, orthographic projections) for a design activity.
4.3.1 Research and generate ideas.
4.3.2 Identify criteria and specify constraints.
4.4.1 Select an approach (solution), develop sketches of the solution and construct models or prototypes.
4.4.2 Develop a design proposal, communicate the results and submit.
4.4.3 Develop a design portfolio.
STANDARD 5.0
Technological design is a distinctive process with a number of defining characteristics: It is purposeful; it is based on certain requirements; it is iterative; it is creative; and it is systematic.

LEARNING EXPECTATION

The student will learn to:
5.1 Understand the relationship between systems and resources and the technological design process.
5.2 Understand that optimization is a process used to make a design as effective or functional as possible within the given criteria and constraints.
5.3 Understand that controls are mechanisms or activities that use information to cause a system to change.
5.4 To apply the principles of human factors engineering to product design and use.
5.5 To familiarize students with the relationship between the protections of intellectual property through the patent process and technology transfer.
5.6 To familiarize students with fundamental concepts of project management.
5.7 To familiarize students with the career pathways related to technological design.

PERFORMANCE STANDARDS:

The student should know and be able to:
5.1.1 Identify and describe the resources for technological design.
5.1.2 Analyze technological systems.
5.1.3 Solve a problem using the technological design process.
5.1.4 Develop a design proposal.
5.1.5 Develop a design portfolio
5.1.6 Understand measurable attributes of objects and the units, systems, and processes of measurement.
5.1.7 Make decisions about units and scales that are appropriate for problem situations involving measurement.
5.1.8 Apply appropriate techniques, tools, and formulas to determine measurements.
5.1.9 Analyze precision, accuracy, and approximate error in measurement situations.
5.1.10 Apply and adapt a variety of appropriate strategies to solve problems.
5.2.1 Define the terms “optimization” and “requirements.”
5.2.2 Describe the forces that act on bridges.
5.2.3 Define the terms “optimization” and “requirements.”
5.2.4 Identify criteria and constraints in requirements for a bridge project.
5.2.5 Describe limitations of the use of physical models in the optimization process.
5.2.6 Use a computer simulation program to optimize the design of a truss bridge.
5.3.1 Identify and describe selected principles of design applied in technological design.
5.3.2 Analyze an automated technological system using a graphic organizer.
5.3.3 Construct a simple control mechanism.
5.3.4 Describe controls as mechanisms or activities that use information to cause a system to change.
5.3.5 Explain how an understanding of the forces that act on bridges might help designers create safe and cost-effective structures.
5.3.6 Explain how an understanding of the forces that act on bridges might help designers create safe and cost-effective structures.
5.3.7 Explain how an understanding of the forces that act on bridges might help designers create safe and cost-effective structures.
5.4.1 Define “human factors engineering” (HFE) as the study of human beings and their interactions with products, environments, and equipment in the performance of tasks and activities.
5.4.2 Analyze and report on the design of a technology system based on human factors criteria.
5.4.3 Identify ergonomic factors that must be addressed to facilitate human use.
5.4.4 Research and report on how “human factors engineering” might be used to improve the lives of older people.
5.4.5 Design, fabricate, and test a product using “human factors engineering” principles.
5.5.1 Interpret information about patents and technology transfer using graphs.
5.5.2 Define intellectual property (IP) as an umbrella term for various legal entitlements that attach to certain names, written and recorded media, and inventions.
5.5.3 Explain that technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function.
5.5.4 Explain that a patent is an exclusive right granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new technical solution to a problem.
5.5.5 Describe the relationship between the protection of intellectual property and economic growth.
5.5.6 Research and report on the patent process.
5.6.1 Define management as the process of planning, organizing, and controlling work.
5.6.2 Analyze a flow chart.
5.6.3 Use standard symbols to develop a flow chart.
5.6.4 Analyze information provided in a graph.
5.6.5 Use appropriate technical conventions and terminology in written and graphic forms including media (e.g., technical vocabulary, symbols).
5.6.6 Research and report on a project management task.
5.7.1 Describe career opportunities in technological design.
5.7.2 List educational requirements for specific career pathways in technological design.
5.7.3 Describe a variety of career pathways in technological design.
5.7.4 Describe the workplace skills required to be successful in the design industry.
5.7.5 Describe the work habits required to be successful in the design industry.
STANDARD 6.0

Engineering resources, sometimes referred to as the core technologies, are the “basic building blocks” from which all technology systems are created.

LEARNING EXPECTATIONS

The student will learn to:

6.1 Understand the fundamentals of mechanical technology, the technology of putting mechanical parts together to produce, control, and transmit motion which is critical to the technological design process.
6.2 Understand the fundamentals of fluid technology, including common components, basic system design, controls, system performance evaluation, science concepts applied, mathematics applications, and safety practices for interacting with technology systems.
6.3 Understand the fundamentals of thermal technology including common components, basic system design, controls, system performance evaluation, science concepts applied, mathematics applications, and safety practices.
6.4 Understand the fundamentals of electrical technology including common components, basic system design, controls, system performance evaluation, science concepts applied, mathematics applications, and safety practices.

PERFORMANCE STANDARDS:

The student should know and be able to:

6.1.1 Explain that systems thinking apply logic and creativity, with appropriate compromises, in complex real-life situations.
6.1.2 Explain that the stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop.
6.1.3 Analyze several simple machines.
6.1.4 Calculate the mechanical advantage of levers, gears, and pulleys.
6.1.5 Conduct research and develop a multimedia presentation analyzing a mechanical system.
6.2.1 Analyze the functioning and applications of fluid technology systems.
6.2.2 Identify fluid technology components that produce, control, or transmit motion.
6.2.3 Research and report on the functioning and application of a steam engine.
6.2.4 Apply the technological design process to solve problems.
6.2.5 Contribute to a group endeavor by offering useful ideas, supporting the efforts of others, and focusing on the task.
6.2.6 Work safely and accurately with a variety of tools, machines, and materials.
6.3.1 Identify thermal technology components that produce, store, control, transmit, and get work from heat energy.
6.3.2 Research and report on the functioning and application of a heat engine.
6.3.3 Apply the technological design process to solve problems.
6.3.4 Develop a design proposal.
6.3.5 Develop a design portfolio.
6.3.6 Contribute to a group endeavor by offering useful ideas, supporting the efforts of others, and focusing on the task.
6.4.1 Identify electrical technology components that produce, control, or transmit motion.
6.4.2 Assemble a simple electric motor.
6.4.3 Analyze electromechanical devices.
6.4.4 Research and report on an electromechanical device.
6.4.5 Reverse engineer an electromechanical device.
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STANDARD 7.0

Students to analyze technology systems that are associated with selected areas of the designed world and to apply technological design skills in problem solving.

LEARNING EXPECTATIONS

The student will be able to:

7.1 Apply, use, manage, analyze and research the functioning and applications of power and energy technology systems.
7.2 Apply, use, manage, analyze and research the functioning and applications of Information and communication technology systems.
7.3 Apply, use, manage, analyze and research the functioning and applications of transportation technologies.
7.4 Apply, use, manage, analyze and research the functioning and applications of manufacturing technologies.
7.5 Apply, use, manage, analyze and research the functioning and applications of construction technologies.

PERFORMANCE STANDARDS:

The student should know and be able to:

7.1.1 Identify technology systems that support the production and distribution of energy from a renewable energy source.
7.1.2 Research and report on the design of the products and processes that support modern power and energy enterprises.
7.1.3 Describe how humans devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling.
7.1.4 Cite examples of trade-offs that have to be made when new technologies are developed.
7.2.1 Explain that information and communication systems include the inputs, processes, and outputs associated with sending and receiving information.
7.2.2 Identify and describe information and communication systems that allow information to be transferred from human to human, human to machine, and machine to human.
7.2.3 Design, construct, and test a communication device.
7.2.4 Give examples and describe trade-offs that have to be considered when new technologies are developed to enhance our ability to communicate with one another.
7.2.5 Research and report on the design of a communication system.
7.3.1 Explain that humans devise technologies to reduce the negative consequences of other technologies.
7.3.2 Describe how transportation impacts the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.
7.3.3 Define “intermodalism” as the use of different modes of transportation, such as highways, railways, and waterways, as part of an interconnected system that can move people and goods easily from one mode to another.
7.3.4 Explain that, when new technologies are developed to reduce the use of resources, considerations of trade-offs are important.
7.3.5 Describe how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques.
7.3.6 Research and report on the design of a transportation system.
7.4.1 Identify and describe attributes of modern manufacturing enterprises.
7.4.2 Explain that manufacturing processes have been changed by improved tools and techniques based on more thorough scientific understanding.
7.4.3 Identify and describe materials classified as natural, synthetic, or mixed.
7.4.4 Develop and produce a product or system using a design process.
7.4.5 Collect information and evaluate its quality.
7.4.6 Research and report on the design of a manufacturing system.
7.5.1 Identify and describe constraints or requirements for the design and construction of commercial structures.
7.5.2 Explain why structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use.
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7.5.3 Identify and describe factors that influence the design of commercial structures.
7.5.4 Identify and describe the people who might be involved in the design process.
7.5.5 Collect information and evaluate its quality.
7.5.6 Research and report on the design of construction technologies.
7.5.7 Apply the technological design process to solve a construction problem.