

# Engineering Design

## Essential Curriculum

### Topic I: Introduction to Sketching and Technical Communication (10 days)

#### Objectives: The student will be able to:

1. Identify, sketch, and explain the function of points, construction lines, object lines, and hidden lines.
2. Plot points on grid paper to aid in the creation of sketches and drawings.
3. Explain the concepts of technical sketching and drawing.
4. Sketch an isometric view of simple geometric solids.
5. Explain how an oblique view of simple geometric solids differs from an isometric view.
6. Describe the concept of proportion as it relates to freehand sketching.
7. Sketch multi-view drawings of simple geometric solids.
8. Determine the front view for a given object.

### Topic 2: Connections to Technology (5 days)

#### Objectives: The student will be able to:

1. Describe the strong relationship between technology and the study of science.
2. Defend the statement that technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across other fields.
3. Compare and contrast the interest of technology and science in natural scientific laws, systems, design, and modeling.
4. Identify and describe the attributes of selected scientific instruments.
5. Express that mathematical concepts such as the use of measurement, symbols, estimation, accuracy, and the idea of scaling and proportion are key to the development of technology.
6. Explain that technology transfer occurs when a new user applies an existing innovation developed for one purpose to a different function.
7. Explain that ideas are sometimes protected through the process of patenting.
8. Explain that technological progress promotes the advancement of science and mathematics.
9. Explain that there are different traditions in science about what is investigated and how, but they all have in common certain basic beliefs about the value of evidence, logic, and good arguments.
10. Explain that the early Egyptian, Greek, Chinese, Hindu, and Arabic cultures are responsible for many scientific and mathematical ideas and technological inventions.
11. Explain that developments in science or technology often stimulate innovations in mathematics by presenting new kinds of problems to be solved.
12. Explain that developments in mathematics often stimulate innovations in science and technology.
13. Explain that technology usually affects society more directly than science because it solves practical problems and serves human needs (and may create new problems and needs).
14. Recognize and apply mathematics in contexts outside of mathematics.

15. Conduct effective and focused research.
16. Use computers and calculators to access, retrieve, organize, and evaluate data and information in order to communicate.
17. Organize and present data effectively.
18. Present research findings effectively, using instructional technology.
19. Contribute to a group endeavor by offering useful ideas, supporting the efforts of others, and focusing on the task.
20. Address open-ended questions in verbal and written form.

### **Topic 3: History of Technology (5 days)**

#### **Objectives: The student will be able to:**

1. Explain why, early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how.
2. Explain that most technological development has been evolutionary, the result of a series of refinements to a basic invention.
3. Describe how the evolution of civilization has been directly affected by, and has in turn affected the development of tools and materials.
4. Identify the periods of human history associated with the evolution of technology.
5. Categorize inventions and innovations based on technological time periods.
6. Compare and contrast inventions or innovations based on how they evolved.
7. Describe anticipated positive and negative impacts as well as the unanticipated positive and negative impacts of technological innovations.
8. Compare and contrast life in periods of technological development.
9. Explain how the way people live and work has changed throughout history because of technology.
10. Identify and describe social, cultural, political, and economic significance of historical technological advancements.
11. Conduct effective and focused research.
12. Use computers and calculators to access, retrieve, organize, and evaluate data and information in order to communicate.
13. Organize and present data effectively.
14. Use mathematical modeling techniques for making predictions about the future applications of technology.
15. Present research findings effectively using instructional technology.
16. Conduct self-assessment of work performance.
17. Assess peers' work performance.
18. Explain mathematical functions (linear, quadratic, or exponential) and how they may represent an aspect of technological change.
19. Address open-ended questions in verbal and written form.
20. Contribute to a group endeavor by offering useful ideas, supporting the efforts of others, and focusing on the task.

### **Topic 4: Concepts of Technology (Optional)(5 days)**

#### **Objectives: The student will be able to:**

1. Identify and describe selected principles of design applied in technological design.

2. Use established design principles to analyze technologies that have been useful over long periods of time.
3. Create a scoring or rating system for product assessment.
4. Generate an appropriate table or chart to display data.
5. Cite an example of a new technology creating a new process.
6. Explain the role of research and investigation in the technological design process.
7. Describe how product/process testing and evaluating enhances the technological design process.
8. Actively participate in group discussions, ideation exercises, and debates.
9. Explain why project management and communications skills are critical elements in the technological design process.
10. Research and report on the need, vision, and delivery elements of an engineering project.

### **Topic 5: Technology and Society (Optional)(5 days)**

#### **Objectives: The student will be able to:**

1. Select, read, analyze and evaluate a variety of print and electronic texts about products and systems.
2. Select, read, analyze and evaluate a printed book from an approved list.
3. Collect information related to a product of their choosing and evaluate its quality.
4. Defend and rationalize the development and use of a proposed technology.
5. Explain changes in society caused by the use of various technologies.
6. Describe instances where decisions about the use of a technology involved trade-offs between positive and negative effects.
7. Provide and discuss instances where ethical considerations have impacted the development, selection, and use of technologies.
8. Provide and discuss a situation where the development of a new technology has magnified the inequities among peoples and societies.
9. Justify the contention that individual citizens have to make informed decisions about the development and use of technology.

### **Topic 6: The Design Process (5 days)**

#### **Objectives: The student will be able to:**

1. Students will identify and explain the function of the essential components of a mechanical system on a display they create.
2. Students will create a display of a mechanical system from a household item they disassemble.
3. Students will mathematically explain the mechanical advantage gained and explain the function of the six different types of simple machines in a presentation on the STEM device.
4. Students will apply simple machines to create mechanical systems in the solution of a design problem.
5. Students will safely use tools and machines in the creation of a STEM device.

### **Topic 7: Structural Technology (20 days)**

#### **Objectives: The student will be able to:**

1. Mathematically analyze a simple truss to determine types and magnitude of forces supported in the truss.
2. Define, describe and analyze the stresses and forces acting on an object.
3. Design, construct and test a model bridge to support the greatest amount of weight per gram of bridge mass.
4. Prepare and present a mathematical analysis of a truss design as part of an oral presentation about their bridge design.

### **Topic 8: Fluid Technology (30 days)**

#### **Objectives: The student will be able to:**

1. Explain how fluid systems enhance human capabilities.
2. Describe factors that affect a fluid system's efficiency.
3. Analyze the functioning of the fluid systems in the designed world in terms of common components, basic system design, safety, simple controls, and system performance evaluation.
4. Apply the engineering-design process to solve a problem.
5. Work safely and accurately with a variety of tools, machines, and materials.
6. Demonstrate curiosity, exhibit motivation for learning, and use class time effectively.
7. Exhibit and refine inherent personal qualities such as creativity and resourcefulness.

### **Topic 9: Electronics and Electrical Technology (45 days)**

#### **Objectives: The student will be able to:**

1. Explain how electrical systems enhance human capabilities.
2. Describe factors that affect an electrical system's efficiency.
3. Analyze the functioning of electrical systems in the designed world in terms of common components, basic system design, safety, simple controls, and system performance evaluation.
4. Apply the engineering-design process to solve a problem.
5. Work safely and accurately with a variety of tools, machines, and materials.

### **Topic 10: Transportation (10 days)**

#### **Objectives: The student will be able to:**

1. Explain that humans devise technologies to reduce the negative consequences of other technologies.
2. Describe how transportation impacts the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.
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.
4. Explain that when new technologies are developed to reduce the use of resources, considerations of trade-offs are important.
5. Describes how the design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques.
6. Develop and produce a product or system using a design process.
7. Collect information and evaluate its quality.
8. Research and report on the design of a transportation system.

**Topic 11: Reverse Engineering (10 days)**

**Objectives: The student will be able to:**

1. Identify the 9 core technologies that make technology systems.
2. Analyze a product and identify the functioning of the core technologies that make that product
3. Reverse engineer a product and identify the core technologies of that product.

**Topic 12: Control Systems (20 days)**

**Objectives: The student will be able to:**

1. Design, diagram and implement a program to control a device they construct to perform a sorting operation.
2. Select and apply concepts of mechanical, electrical, and control systems in solving design problems
3. Formulate a plan for evaluating the functioning of their sorting device and to make appropriate changes in design, circuitry or programming.
4. Demonstrate and defend their solution to the design problem in an oral presentation to the class.

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