Technology Alignment of Benchmarks and Indicators
Grade 10

Standard 1 Nature of Technology

Students develop an understanding of technology, its characteristics, scope, core concepts* and relationships between technologies and other fields. Students learn that technology extends human potential by allowing people to do things more efficiently than they would otherwise be able to do. Students learn that useful technological development is a product of human knowledge, creativity, invention, innovation, motivation and demand for new products and systems. They learn that the natural and human-made designed worlds are different, and that tools and materials are used to alter the environment. Students learn that the development of emerging technology is exponential, driven by history, design, commercialization, and shaped by creative/inventive thinking, economic factors and cultural influences.*The core concepts of technology include systems, resources, requirements, optimization and trade-offs, processes and controls.

Benchmark A: Synthesize information, evaluate and make decisions about technologies.

Grade Ten

Technology Diffusion

1. Describe how the rate of technological development and diffusion is increasing rapidly (e.g., a computer system chip has been adapted for use in toys and greeting cards).

Goal-directed Research

***2.* Articulate how inventions and innovations are results of specific goal-directed research (e.g., companies have research and development offices to guide new product development).**

Commercialization of Technology

3. Explain how technological development is influenced by many factors, including profit incentive and market economy.

Benchmark B: Apply technological knowledge in decision-making.

Grade Ten

Optimization and Trade-offs

1. Describe situations in which the selection of resources involves trade-offs between competing values, such as availability, desirability, cost and waste (e.g., use of plastic in manufacturing has many advantages, but may put the environment at risk and deplete natural resources).

Benchmark C: Examine the synergy between and among technologies and other fields of study when solving technological problems.

Grade Ten

Technology Transfer

1. Analyze technology transfer scenarios.

Innovation and Invention

2. Describe how technological innovation often results when ideas,

knowledge or skills are shared within a technology.
3. Define examples of how technological progress is integral to the advancement of science, mathematics and other fields of study.

<u>Standard 2 Technology and Society Interaction</u>
Students recognize interactions among society, the environment and technology, and understand technology's relationship with history. Consideration of these concepts forms a foundation for engaging in responsible and ethical use of technology.Students learn that the interaction between society and technology has an impact on their lives, that technology may have unintended consequences which may be helpful or harmful. They learn that interaction of technology will affect the economy, ethical standards, environment and culture. Students evaluate the impact of products or systems by gathering and synthesizing information, analyzing trends and drawing conclusions. Students analyze technological issues and the implications of using technology. They acquire technological understanding, and develop attitudes and practices that support ethical decision-making and lifelong learning.
Benchmark A: Interpret and practice responsible citizenship relative to technology.
Grade Ten
Technology and Citizenship
1. Understand that the development of technology may be influenced by societal opinions and demands, in addition to corporate cultures.
2. Contrast ethical considerations and how they are important in the development, selection and use of technologies.
Technology Transfer
3. Provide examples of how transfer of a technology from one society to another can cause cultural, social, economic and political changes affecting both societies to varying degrees (e.g., World War II industrial mobilization drew women into the work force).
4. Identify capabilities and limitations of contemporary and emerging technology resources and assess the potential of these systems and services to address personal, lifelong learning and work place needs.
5. Analyze advantages and disadvantages of widespread use and reliance on technology in the work place and in society as a whole.
Benchmark B: Demonstrate the relationship among people, technology and the environment.
Grade Ten
Technology and Environment
1. Explain how, with the aid of technology, various aspects of the environment can be monitored to provide information for decision-making (e.g., satellites can be used to monitor wetlands in order to control disease spread by mosquitoes).
2. Understand that the appropriate design of technological devices and

systems maximizes performance and reduces negative impacts on the environment (e.g., design vehicle components for ease of recycling after use).

Benchmark C: Interpret and evaluate the influence of technology throughout history, and predict its impact on the future.

Grade Ten

Technology and History

1. Examine the social/economic climate for invention and innovation in different periods of history.

2. Explain how the evolution of civilization has been directly affected by, and has affected, the development and use of tools and materials.

Benchmark D: Analyze ethical and legal technology issues and formulate solutions and strategies that foster responsible technology usage.

Grade Ten

Technology and Ethics

1. Describe/discuss the ethical considerations involved in the development or deployment of a technology.

2. Analyze technology law, legislation and policy in context of user rights and responsibilities.

3. Understand the importance of diverse information and access to information in a democratic society.

Benchmark E: Forecast the impact of technological products and systems.

Grade Ten

Technology Assessment

1. Synthesize data, analyze trends and draw conclusions regarding the effect of technology on the individual, society and environment (e.g., current and historical time periods).

2. Produce graphs and/or charts to describe trends and visualize data.

3. Describe how a technological change has affected the local community (e.g., how a new highway has changed traffic and building patterns).

<u>Standard 3 Technology for Productivity Applications</u>

Students learn the operations of technology through the usage of technology and productivity tools. Students use computer and multimedia resources to support their learning. Students understand terminology, communicate technically and select the appropriate technology tool based on their needs. They use technology tools to collaborate, plan and produce a sample product to enhance their learning, and solve problems by investigating, troubleshooting and experimenting using technical resources.

Benchmark A: Integrate conceptual knowledge of technology systems in determining practical applications for learning and technical problem-solving.

Grade Ten

Understanding Operations

1. Examine current and past devices for storing data and predict potential devices for the future.
2. Analyze various types of connectivity, and list pros and cons of each.
Problem-solving
3. Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.
Benchmark B: Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.
Grade Ten
Productivity Tools
1. Utilize advanced word processing and desktop publishing features and programs.
Communication Tools
2. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).
Problem-solving
3. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

<u>Standard 4 Technology and Communication Applications</u>
Students use an array of technologies and apply design concepts to communicate with multiple audiences, acquire and disseminate information and enhance learning. Students acquire and publish information in a variety of media formats. They incorporate communication design principles in their work. They use technology to disseminate information to multiple audiences. Students use telecommunication tools to interact with others. They collaborate in real time with individuals and groups who are located in different schools, communities, states and countries. Students participate in distance education opportunities which expand academic offerings and enhance learning.
Benchmark A: Apply appropriate communication design principles in published and presented projects.
Grade Ten
Electronic Communications
1. Identify and incorporate common organizational techniques used in electronic communication (e.g., cause and effect, compare and contrast, problem and solution strategies).
Principles of Design
2. Manipulate communication design elements (image, language, sound and motion) based on intent of the message (e.g., inform or persuade).
Accessibility Guidelines
3. Verify accessibility components of the communication product and adapt as needed.

Evaluation
4. Compare and contrast the accuracy of the message/communication product with the audience results (e.g., was the audience influenced by inaccurate information?).
Benchmark B: Create, publish and present information, utilizing formats appropriate to the content and audience.
Grade Ten
Publication
1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).
***Evaluation* 2. Evaluate communication products.**
Benchmark C: Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.
Grade Ten
Use of Communications
1. Contribute to organized e-mail discussions (e.g., discussion list, list serv, threaded discussion list, courseware discussion).
2. Employ online communication capabilities to make inquiries, do research and disseminate results (e.g., develop dialogues on issues in U.S. government).
3. Implement online-structured learning experiences (e.g., tutorials, virtual classes, industry certification courses).

<u>Standard 5 Technology and Information Literacy</u>
Students engage in information literacy strategies, use the Internet, technology tools and resources, and apply information-management skills to answer questions and expand knowledge. Students become information-literate learners by utilizing a research process model. They recognize the need for information and define the problem, need or task. Students understand the structure of information systems and apply these concepts in acquiring and managing information. Using technology tools, a variety of resources are identified, accessed and evaluated. Relevant information is selected, analyzed and synthesized to generate a finished product. Students evaluate their information process and product.
Grades 9-12
Benchmark A: Determine and apply an evaluative process to all information sources chosen for a project.
Grade Ten
Evaluating Sources
1. Examine information for its accuracy and relevance to an information need (e.g., for a report on pollution, find information from sources that have correct and current information related to the topic).
2. Identify relevant facts, check facts for accuracy and record appropriate

information (e.g., follow a standard procedure to check information sources used in a paper).
3. Create a bibliography of sources in an electronic format.
4. Select appropriate information on two sides of an issue (e.g., identify the author of each information source and their expertise and/or bias).
Benchmark B: Apply a research process model to conduct research and meet information needs.
Grade Ten
Decide
1. Select the essential question to be examined by the research.
2. Identify sources most likely to have the needed information and determine subjects and keywords to be used in searching magazine databases and other electronic reference resources.
Find
3. Evaluate information and select relevant and pertinent information found in each source, and maintain accurate records of sources used.
Use
4. Organize and analyze information, finding connections that lead to a final product.
5. Follow copyright law and guidelines, using standard bibliographic format to list sources.
Check
6. Assess whether the essential questions are answered, gather more information and data and modify search terms as needed. Edit the product.
7. Review and evaluate research process and the resources used (e.g., how can the research process be improved?).
Benchmark C: Formulate advanced search strategies, demonstrating an understanding of the strengths and limitations of the Internet, and evaluate the quality and appropriate use of Internet resources.
Grade Ten
Search Strategies
1. Construct an effective search strategy to retrieve relevant information through multiple search engines, directories and Internet resources.
2. Narrow or broaden the search strategy by modifying the keywords entered in the original search strategy.
3. Employ a systematic approach to judge the validity of a Web information match against the defined information need (e.g., researching an author through the Web requires finding biographical information plus criticisms of the author's works).
Evaluating Sources
4. Examine the information retrieved through Internet searching for authenticity of information, bias, currency, relevance and appropriateness.
Benchmark D: Evaluate choices of electronic resources and determine their strengths and limitations.
Grade Ten

Electronic Resources
1. Choose a topic and identify appropriate electronic resources to use, citing the name and date of the resource database archive collection.
2. Research and critique information in different types of subscription (fee-based) electronic resources to locate information for a curricular need.
3. Investigate tools within electronic resources to generate search strategies (e.g., use a thesaurus to identify subject terms for improved retrieval of information).

<u>Standard 6 Design</u>
Students will apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment. Students recognize the attributes of design; that it is purposeful, based on requirements, systematic, iterative, creative, and provides solution and alternatives. Students explain critical design factors and/or processes in the development, application and utilization of technology as a key process in problem-solving. Students describe inventors and their inventions, multiple inventions that solve the same problem, and how design has affected their community. They apply and explain the contribution of thinking and procedural steps to create an appropriate design and the process skills required to build a product or system. They critically evaluate a design to address a problem of personal, societal and environmental interests. Students systematically solve a variety of types of problems using different design approaches including troubleshooting, research and development, innovation, invention and experimentation.
Grades 9-12
Benchmark A: Identify and produce a product or system using a design process, evaluate the final solution and communicate the findings.
Grade Nine
***Design Process* 1. Explain and apply the methods and tools of inventive problem-solving to develop and produce a product or system.**
2. Define simulation in the design process.
Technical Contradictions
3. Identify the conceptual and technical principles that underpin design processes (e.g., analyze characteristics of technical systems that affect performance and identify principles that resolve design contradictions).
Requirements
4. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).
Optimization and Trade-offs
5. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).
Technical Problem-solving

6. Brainstorm solutions to problems using common brainstorming techniques (e.g., select a leader, select a recorder, generate ideas, discuss and add-on to ideas of others and recognize all ideas are welcome).

Technical Communication

7. Demonstrate knowledge of pictorial and multi-view CAD drawings (e.g., orthographic projection, isometric, oblique, perspective using proper techniques).

Intellectual Property

8. Recognize that patent, trademark and copyright law protect technological ideas and intellectual property.

Understanding Technological Systems

9. Describe how the technological systems of manufacturing, construction, information and communication, energy and power, transportation, medical, and agricultural, and related biotechnologies can be used to solve practical problems.

Grade Ten

Design Process

1. Solve an inventive problem that contains a technical contradiction (e.g., analyze the technical system, state the technical contradiction and resolve the technical contradiction).

2. Apply common statistical tools to solve problems (e.g., statistical process control).

3. Describe quality and how it is evaluated in a product or system.

4. Select and use simulation in the design process.

Technical Contradictions

5. Apply the conceptual and technical principles that underpin design processes (e.g., analyze characteristics of technical systems that affect performance and identify principles that resolve design contradictions).

Requirements

6. Discuss how requirements of a design, such as criteria, constraints and efficiency, sometimes compete with each other.

Optimization and Trade-offs

7. Identify criteria and constraints for a design problem and determine how these will affect the design process (e.g., factors such as concept generation, development, production, marketing, fiscal matters, use, and disposability of a product or system).

Technology Transfer

8. Understand the role of outsourcing in the engineering process and how effective communication is essential.

History of Design

9. Describe several systems archetypes and how they explain the behavior of systems.

Intellectual Property

10. Describe how trademarks, patents and copyrights are obtained.

Grade Eleven

Design Process

1. Explain how a design needs to be continually checked and critiqued, and must be redefined and improved (e.g., the heating system design for one home may not be the best for another, given a different location, shape or size).

2. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product (e.g., proposed or existing designs in the real world).

3. Interpret plans, diagrams and working drawings in the construction of a prototype.

Technical Contradictions

4. Identify how contradictions were overcome in existing solutions.

5. Identify products that illustrate application of the 40 principles of technical innovation (e.g., thermal expansion—bimetal thermometer needle changing color; visual contrast for emergency vehicles, pneumatic or hydraulic construction, automotive—automobile air bag).

Universal Design

6. Employ Universal Design considerations in the design of a product or system (e.g., design a shower or computer workstation for use by people with and without physical handicaps).

7. Evaluate and rate the quality of an existing household product or system.

Optimization and Trade-offs

8. Explain and demonstrate how constraints influence the solution of problems (e.g., funding, space, materials, human capabilities, time, and the environment).

History of Design

9. Identify a system archetype in an existing system (e.g., styles of design, architecture, design periods, methods).

Intellectual Property

10. Predict the outcome if no copyright or patent laws were in place.

Understanding Technological Systems

11. Explain and use appropriate design processes and techniques to develop or improve products or services in one of the technological systems (energy and power, transportation, manufacturing, construction, information and communication, medical, and agricultural and related biotechnologies).

Grade Twelve

Design Process

1. Implement the design process: 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; communicating processes and results; and implement and electronically

document the design process.
2. Evaluate a design solution using conceptual, physical, 3-D computer 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 (e.g., check the design solutions against criteria and constraints).
Technical Contradictions
3. Apply the separation principles to overcome contradictions in systems (e.g., time, space, combining or dividing systems, physical-chemical changes).
Technical Problem-solving
4. Apply the concepts of system dynamics and systems thinking to the solution of problems.
Technical Communication
5. Evaluate final solutions and communicate observations, processes and results of the entire design process using verbal, graphic, quantitative, virtual and written means, in addition to three-dimensional models.
6. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.
Intellectual Property
7. Predict/project the need for changes in copyright, patent and trademark laws, considering the rapid changes in technology and society.
Understanding Technological Systems
8. Apply and evaluate appropriate design processes and techniques to develop or improve products or services in one of the technological systems (manufacturing, construction, information and communication, energy and power, transportation, medical, and agricultural and related biotechnologies).
Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.
Grade Nine
Design Process
1. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process (e.g., design principles include flexibility, unity, emphasis, balance, function and proportion).
2. Explain how a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.
3. Create a model of a design solution to an engineering problem (e.g., virtual, physical, graphic or mathematical model).
Requirements
4. Identify the factors that must be taken into account in the process of engineering design (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors in engineering, such as ergonomics).
Design Team Collaboration

5. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
6. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

Technical Careers

7. Explain the different engineering disciplines and how they relate to the major technological systems (e.g., mechanical—manufacturing, audio—communication, civil—construction).

Grade Ten

Design Process

1. Build a prototype to test a design concept and make actual observations and necessary design adjustments.
2. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

Quality Design

3. Evaluate a design using established design principles to collect data on the designs effectiveness, and suggest improvements (e.g., how can bicycles be made safer?).
4. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process.
5. Explain how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.
6. Explain how gender-bias, racial-bias and other forms of stereotyping and discrimination can affect communication within an engineering team.

Engineering Practice

7. Identify where statistical tools might be used to identify problems in a system.

Technical Communication

8. Use multimedia to communicate a design solution between technological systems.

Grade Eleven

Quality Design

1. Evaluate a design completed or created by another group of students using established design principles.
2. Describe the relationship between engineering disciplines.
3. Describe how a prototype is a working model used to show how subsystems interact.
4. Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

Collaboration

5. Collaborate with peers and experts to develop a solution to a specific problem.

6. Demonstrate the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills in the design process.

Technical Contradictions

7. Describe how to identify conflicts or contradictions in technological systems.

Technical Careers

8. Understand the professional and legal responsibilities associated with being an engineer.

Grade Twelve

Design Process

1. Solve a problem as a group with students each taking a specific engineering role (e.g., design a light rail hub with students taking the roles of architect, civil engineer, mechanical engineer).

2. Build a prototype to use as a working model to demonstrate a design's effectiveness to potential customers.

Quality Design

3. Develop and use a process to evaluate and rate several design solutions to the same problem.

4. Apply statistical tools to identify a problem in a system (e.g., measures of central tendency, linear regression, symbolic logic, non-decimal number systems).

Engineering Design

5. Explain how the process of engineering design takes into account a number of factors including the interrelationship between systems.

Technical Communcation

6. Choose the appropriate media to communicate elements of the design process in each technological system.

Benchmark C: Understand and apply research, development and experimentation to problem-solving.

Grade Nine

Research and Development

1. Describe how business and industry use research and development to prepare devices and systems for the marketplace.

Market Research

2. Research consumer preferences for a new product.

Quality Design

3. Explain that function is the purpose for which a product/system was designed and that focus on the function will expand the space in which solutions are available.

Idea Generation

4. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environment).

5. Identify and apply a variety of conceptual block-busting techniques (e.g., goal charting, bug lists, brainstorming, forced connections and attribute listing).

Grade Ten

Technical Problem-solving

1. Explain why technological problems must be researched before they can be solved.

Redesign

2. Research previous solutions to a technological problem and redesign an alternative solution.

Emerging Technology

3. Select and apply emerging technology in consultation with experts, for research, information analysis, problem-solving and decision-making in content learning.

Innovation and Invention

4. Categorize inventions in each of the technological systems as one of the five levels of innovation (e.g., apparent or conventional solution, small invention inside paradigm, substantial invention inside technology, invention outside technology, discovery).

Technical Communication

5. Use computers, calculators, instruments and devices to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate to group members (e.g., CAD—computer aided design, software, library resources, the Internet, word processing, CBLs—calculator based labs, laser measuring tools and spreadsheet software).

Grade Eleven

Quality Design

1. Recognize identify, and apply the concept of function to the solution of technological problems.

Universal Design

2. Apply anthropometric data to judge functional use of a product or design for persons of varying dimensions (e.g., standardized human factors data charts organized by percentiles).

Reverse Engineering

3. Describe and demonstrate the reverse engineering process in problem-solving.

Technical Communication

4. Use and maintain technical drawing/design tools in order to create a variety of drawings and illustrations (e.g., instruments, equipment, materials, computer aided design software, hardware and systems).

Grade Twelve

Design Team Collaboration

1. Explain why technological problems benefit from a multidisciplinary approach (e.g., the research and development of a new video game could benefit from knowledge of physiology—reaction times and hand-eye coordination, as well as psychology—attention span, color theory and memory).

Links to Other Fields

2. List the disciplines that could contribute to a solution of a specific problem.

Reverse Engineering

3. Apply and evaluate the reverse engineering process in problem-solving.

<u>Standard 7 Designed World</u>

Students understand how the physical, informational and bio-related technological systems* of the designed world are brought about by the design process. Critical to this will be students' understanding of their role in the designed world: its processes, products, standards, services, history, future, impact, issues and career connections. Students learn that the designed world consists of technological systems* reflecting the modifications that humans have made to the natural world to satisfy their own needs and wants. Students understand how through the design process the resources: materials, tools and machines, information, energy, capital, time and people are used in the development of useful products and systems. Students develop a foundation of knowledge and skills through participation in technically oriented activities for the application of technological systems. Students demonstrate understanding, skills and proficient use of technological tools, machines, instruments, materials and processes across technological systems in unique and/or new contexts. Students identify and assess the historical, cultural, environmental, governmental and economic impacts of technological systems in the designed world. *The technological systems areas include energy and power technologies, transportation technologies, manufacturing technologies, construction technologies, information and communication technologies, medical technologies, agricultural and related biotechnologies.

Grades 9-12

Benchmark A: Classify, demonstrate, examine, and appraise energy and power technologies.

Grade Nine

Understanding Technological Systems

1. Describe and demonstrate ways that energy can be converted from one form to another (e.g., heat to electrical, electrical to mechanical, electrical to heat).

2. Identify the differences between open and closed thermal systems (e.g., humidity control systems, heating systems, cooling systems).

Technical Careers

3. Describe the careers available in energy and power technological systems and the training needed to pursue them.

Safety

4. Identify and apply appropriate safety measures when working with energy and power technologies.

Engineering Practice

5. Measure voltage, resistance and current in electrical systems and describe the different instruments used.
6. Describe the application of the first and second laws of thermodynamics (e.g., the concept and function of a heat engine).

Use and Maintain Technological Systems

7. Differentiate between hydraulic and pneumatic systems and provide examples of appropriate applications of each as they relate to manufacturing and transportation systems.
8. Identify and investigate AC and DC circuits (e.g., sources, conductors, controls, loads, applications, purposes, safety, components, symbols, principles and operations).
9. Employ energy and power technologies to resolve practical problems (e.g., efficient power production, conversion and transmission).

Technology Assessment

10. Use and evaluate renewable and nonrenewable resources to operate a mechanism (e.g., petroleum, coal, biomass and solar).

Emerging Technology

11. Investigate emerging (state-of-the-art) and innovative applications of energy and power technology (e.g., fuel cells, distributed generation).

Grade Ten

System Management

1. Differentiate between open (e.g., irrigation, forced hot air system) and closed (e.g., forced hot water system, hydroponics) fluid systems and their components such as valves, controlling devices and metering devices.
2. Understand that all energy delivery systems need an infrastructure (e.g., identify features of natural gas and gasoline pipeline distribution systems across Ohio).

Safety

3. Safely use the tools and processes of energy and power technological systems.

Engineering Practice

4. Explain the relationship between resistance, voltage and current (Ohm's Law).

Use and Maintain
Technological Systems

5. Build energy and power devices using the appropriate technological tools, machines, equipment, materials and technical processes to solve a problem in the community.
6. Identify the source of energy, conversion process, and load in a variety of power systems (e.g., tractor, electrical grid, elevator).
7. Differentiate among conduction, convection, and radiation in a thermal system (e.g., heating and cooling a house, cooking).
8. Identify and explain the components of a circuit including a source, conductor, load and controllers (controllers are switches, relays, diodes, transistors, integrated circuits).

Grade Eleven

System Management

1. Classify energy-using devices and systems into the major forms: thermal, radiant, electrical, mechanical, chemical, nuclear and acoustic.

Engineering Practice

2. Identify and explain sources of resistance (e.g., 45o elbow, 90o elbow, type of pipes, changes in diameter; for water moving through a pipe).

3. Use series circuit and a parallel circuit to modify the voltage and current available from a group of batteries.

Use and Maintain Technological Systems

4. Build and operate a transportation device (e.g., a magnetic levitation vehicle, a CO2 car, wind vehicle).

5. Identify and explain the tools, controls, and properties of materials used in a thermal system (e.g., thermostats, R Values, thermal conductivity, temperature sensors).

6. Describe the differing power quality needs of end users (e.g., uninterruptability, backup generators, frequency and voltage stability).

7. Explain and demonstrate series and parallel circuit usage in residential wiring.

8. Diagnose a system that is malfunctioning and use tools, materials, machines and knowledge to repair it (e.g., digital meters or computer utility diagnostic tools).

Technology Assessment

9. Evaluate different types of energy sources for personal transportation (e.g., cleaner fuels like biodiesel, electricity, hybrid electric, ethanol, natural gas—CNG, LNG, propane—LPG, hydrogen).

Grade Twelve

Engineering Practice

1. Explain Bernoulli's Principle and its effect on practical applications (e.g., airfoil design, spoiler design, carburetor).

Design Application

2. Explain why no system is 100 percent energy efficient.

3. Determine the energy efficiency of a transportation system (e.g., compare the energy used to transport a person from Dayton to Cleveland by automobile, bus and airplane).

4. Explain how environmental conditions influence heating and cooling of buildings and automobiles.

Technical Standards

5. Identify and apply appropriate codes, laws, standards, or regulations related to energy and power technologies (e.g., American Society of Heating, Refrigeration, Air-Conditioning Engineers—ASHRAE, Occupational Safety and Health Administration—OSHA, National Electric Code—NEC, International Standards Organization—ISO, Ohio Environmental Protection Agency—Ohio EPA, American National Standards Institute—ANSI).

Benchmark B: Classify, demonstrate, examine and appraise transportation technologies.

Grade Nine

Technical Careers

1. Describe the careers available in transportation technological systems and the education needed to pursue them.

System Management

2. Describe the vital role transportation plays in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture (e.g., subsystems of aviation, rail transportation, water transportation, pedestrian walkways, roadways).

Safety

3. Identify and apply appropriate safety measures when working with transportation technologies.

Use and Maintain Technological Systems

4. Employ transportation technologies to resolve practical problems (e.g., getting students to athletic events).

Grade Ten

System Management

1. Describe how transportation services and methods have led to a population that is regularly on the move.

Design Applications

2. Describe the factors that influence the cost of producing technological products and systems in transportation technologies.

Grade Eleven

System Management

1. 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.

Emerging Technology

2. Investigate emerging (state-of-the-art) and innovative applications of transportation technology.

Grade Twelve

Design Application

1. Design transportation systems using innovative techniques (e.g., a system to more efficiently transport people in the Cincinnati, Columbus, Cleveland corridor).

Technical Standards

2. Identify and apply appropriate codes, laws, standards or regulations related to transportation technologies (e.g., National Highway Safety Board—NHSB, Occupational Safety and Health Administration—OSHA, National Electric Code—NEC, International Standards Organization—ISO, Ohio Environmental Protection Agency—Ohio EPA, American National Standards Institute—ANSI).

Benchmark C: Classify demonstrate examine and appraise manufacturing

technologies.

Grade Nine

Technical Careers

1. Describe the careers available in manufacturing technological systems and the education needed to pursue them.

System Management

2. Produce a product using the manufacturing system appropriate to the context (e.g., customized production, batch production and continuous production).

Safety

3. Identify and apply appropriate safety measures when working with manufacturing technologies.

Use and Maintain Technological Systems

4. Classify materials as natural, synthetic or mixed (e.g., wood, plastic, cotton/polyester blend fabric).

5. Employ manufacturing technologies to resolve practical problems (e.g., produce a product).

Technology Assessment

6. Identify and investigate a variety of technological tools, equipment, machines, materials and technical processes used in manufacturing technologies to manufacture/fabricate products or systems.

Emerging Technology

7. Investigate emerging (state-of-the-art) and innovative applications of manufacturing technology.

Grade Ten

Use and Maintain Technological Systems

1. Explain the manufacturing processes of casting and molding, forming, separating, conditioning, assembling and finishing.

2. Demonstrate the ability to acquire, store, allocate, and use materials or space efficiently.

3. Identify and investigate modern production technology practices and equipment in manufacturing technologies (e.g., just-in-time, lean production, six-sigma, new automation processes, systems, materials, tools).

Design Applications

4. Demonstrate how the interchangeability of parts increases the effectiveness of manufacturing processes (e.g., manufacture a product using interchangeable parts, repair a product using replacement parts).

5. Use marketing to establish a product's viability and identity, conduct research on its potential, advertise it, package it, distribute it and sell it.

Grade Eleven

Technical Communication

1. Document processes and procedures using appropriate oral and written techniques (e.g., flow charts, drawings, graphics, symbols, spreadsheets, graphs, Gantt charts and World Wide Web pages).

System Management

2. Describe the factors that influence the cost of producing technological products and systems in manufacturing technologies (e.g., materials, labor, energy, time, location).

Safety

3. Differentiate the selection of tools and procedures used in the safe production of products in the manufacturing process (e.g., hand tools, power tools, computer-aided manufacturing, three-dimensional modeling).

Engineering Practice

4. Calculate the mean, median, mode and standard deviation for a set of data and apply that information to an understanding of quality assurance.

Use and Maintain Technological Systems

5. Demonstrate product and system maintenance and service technique (e.g., installing, diagnosing, troubleshooting, recalling, maintaining, repairing, altering and upgrading, and retrofitting).

6. Describe how durable goods are designed to operate for a long period of time, while nondurable goods are designed to operate for a short period of time (e.g., durable goods: steel, furniture, washing machines; nondurable goods: food, batteries, paper).

Grade Twelve

Use and Maintain Technological Systems

1. Describe how chemical technologies provide a means for humans to alter or modify materials and to produce chemical products (e.g., adhesives, plastics, ethanol production, coatings).

2. Explain the process and the programming of robotic action utilizing three axes.

Technical Standards

3. Identify and apply appropriate codes, laws, standards or regulations related to manufacturing technologies (e.g., Occupational Safety and Health Administration—OSHA, National Electric Code—NEC, International Standards Organization—ISO, Ohio Environmental Protection Agency—Ohio EPA, American National Standards Institute—ANSI).

Benchmark D: Classify, demonstrate, examine and appraise construction technologies.

Grade Nine

Technical Careers

1. Describe the careers available in construction technological systems and the education needed to pursue them.

System Management

2. Describe the importance of infrastructure in a construction system (e.g., how utilities and roads are extended into a parcel of land when it is developed).

Safety

3. Identify and apply appropriate safety measures when working with construction technologies.

Engineering Practice

4. Distinguish among the different forces acting upon structural components (e.g., tension, compression, shear and torsion).

Use and Maintain Technological Systems

5. Identify and use a variety of technological tools, equipment, machines, materials and technical processes used in construction technologies to build/construct products or systems.

6. Employ construction technologies to resolve practical problems (e.g., a shelter for a pet, emergency shelter for disaster victims).

Design Applications

7. Differentiate the factors that affect the design and building of structures (e.g., material availability, zoning laws, the need for riparian buffer, building codes and professional standards).

Grade Ten

Engineering Practice

1. Identify and explain the engineering properties of materials used in structures (e.g., elasticity, plasticity, thermal conductivity, density).

2. Identify and investigate modern production technology practices and equipment in construction technologies (e.g., new building techniques, materials, tools).

Use and Maintain Technological Systems

3. Construct a structure using a variety of processes and procedures (e.g., material use, how it is assembled, and skill level of worker).

4. Describe how structures can include prefabricated materials (e.g., residences, bridges, commercial buildings).

5. Identify and explain the purposes of common tools and measurement devices used in construction (e.g., spirit level, laser transit, framing square, plumb bob, spring scale, tape measure, strain gauge, venturi meter, pitot tube).

6. Demonstrate the ability to acquire, store, allocate, and use materials or space efficiently.

Grade Eleven

Technical Communication

1. Apply appropriate technical and graphic communications in the technological systems (e.g., linedrawing, phantom view, rendering, animation, simulation, virtual walk-through).

Use and Maintain Technological Systems

2. Determine the need for maintenance, alteration or renovation in a structure (e.g., determine when is a new roof needed, calculate the cost benefit of purchasing more energy efficient windows).

3. Describe how structures are constructed using a variety of processes and procedures (e.g., welds, bolts and rivets are used to assemble metal framing materials).

Design Applications

4. Describe the factors that influence the selection of technological products and systems in construction technologies (e.g., function, cost, aesthetics).

Emerging Technology

5. Investigate emerging (state-of-the-art) and innovative applications of construction technology (e.g., carbon-fiberglass strips used to reinforce old beams and in making trusses that are stronger than steel).

Grade Twelve

Engineering Practice

1. Calculate quantitatively the resultant forces for live loads and dead loads.

Use and Maintain Technological Systems

2. Create a product (or prototype) or system in construction technologies using the appropriate technological tools, machines, equipment and technical processes.

Design Applications

3. Describe how the design of structures requires the interaction of style, convenience, efficiency and safety (e.g., visit local buildings designed for the same purpose and describe how the style, convenience, efficiency and safety vary).

Technical Standards

4. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, Occupational Safety and Health Administration—OSH, National Electric Code—NEC, International Standards Organization—ISO, Ohio Environmental Protection Agency—Ohio EPA, American National Standards Institute—ANSI).

Benchmark E: Classify, demonstrate, examine and appraise information and communication technologies.

Grade Nine

Technical Careers

1. Describe the careers available in information and communication technological systems and the training needed to pursue them.

Safety

2. Identify and apply appropriate safety measures when working with information and communication technologies (e.g., making sure that power is disconnected before working on the internal parts of a computer and taking proper static safeguards, protection from the effects of electromagnetic radiation).

Use and Maintain Technological Systems

3. Use a variety of information and communication technologies to demonstrate the inputs, processes, and outputs associated with sending and receiving information (e.g., computer and related devices, graphic (technical and communication) media, electronic transmitters and receiving devices, entertainment products, and various other systems).

4. Employ information and communication technologies to resolve practical problems (e.g., providing radio communication at a school function, communicating a school event to the community).

Design Applications

5. Describe the factors that influence the cost of producing technological products and systems in information and communication technologies.

EmergingTechnology

6. Investigate emerging (state-of-the-art) and innovative applications of information and communication technology.

Grade Ten

Technical Communication

1. Use multiple ways to communicate information, such as graphic and electronic means (e.g., graphic—printing and photochemical processes; electronic—computers, DVD players, digital audiotapes, MP3 players, cell and satellite phones; multimedia—audio, video, data).

2. Communicate technological knowledge and processes using symbols, measurement, conventions, icons, graphic images and languages that incorporate a variety of visual, auditory and tactile stimuli.

3. Identify and explain the applications of light in communications (e.g., reflection, refractions, additive and subtractive color theory).

4. Compare the difference between digital and analog communication devices.

Grade Eleven

Use and Maintain Technological Systems

1. Use information and communication systems to cause the transfer of information from human to human, human to machine, machine to human, and machine to machine (e.g., two people talking to each other on the phone; a person inputting data in a computer using a keyboard; an electric fax machine providing a copy of a message to a person; and an automated system transferring financial records from one bank computer to another bank computer).

2. Analyze communication systems and identify the source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination (e.g., telephone, TV, newspaper).

3. Explain how information travels through different media (e.g., electrical wire, optical fiber, air, space).

Grade Twelve

Use and Maintain Technological Systems

1. Use information and communications systems to inform, persuade, entertain, control, manage and educate (e.g., Internet, telephones, cell and satellite phones, smart phones, TVs, radios, computers, fax machines, PDAs, mobile communicators).

Design Applications

2. Address a communication problem involving the community (e.g., presenting information to the school board or town council).

3. Analyze a dysfunctional communication system and suggest improvements (e.g., the school public address system).
4. Identify and explain the applications of laser and fiber optic technologies (e.g., telephone systems, cable TV, medical technology, and photography).
Technical Standards
5. Identify and apply appropriate codes, laws, standards, or regulations related to information and communication technologies (e.g., International Electrical and Electronic Engineers—IEEE, Federal Communication Commission—FCC, Occupational Safety and Health Administration—OSHA, National Electric Code—NEC, International Standards Organization—ISO, Ohio Environmental Protection Agency—Ohio EPA, American National Standards Institute—ANSI).
Benchmark F: Classify, demonstrate, examine and appraise medical technologies.
Grade Nine
Technical Careers
1. Appraise the careers available in medical technological systems and the training needed to pursue them.
Safety
2. Identify and apply appropriate safety measures when working with medical technologies.
Design Application
3. Describe how the design process can be used to produce technological products to replace or repair human physical structures (e.g., prostheses, DNA therapy, pacemakers, lasers).
Technology Assessment
4. Examine new sensing technologies being used to diagnose medical conditions less invasively (e.g., CT-Scan, MRI, MRA).
Emerging Technology
5. Investigate emerging (state-of-the-art) and innovative applications of medical technologies.
Grade Ten
Understanding Technological Systems
1. Describe how technology has impacted medicine in the areas of prevention, diagnostic, therapeutic treatment and forensics (e.g., medical tools, instruments, materials, monitoring equipment).
2. Describe how medicines and treatments have both positive and negative effects.
Safety
3. Safely use the tools and processes of medical technological systems (e.g., virtual dissection software).
Grade Eleven
Technical Careers
1. List advances in the sciences of biochemistry and molecular biology that have made it possible to manipulate the genetic information found in living

creatures.
2. Describe how medicines and treatments may have both expected and unexpected results.
Safety
3. Monitor and apply appropriate safety measures when working with medical technologies.
Use and Maintain Technological Systems
4. Employ medical technologies to resolve practical problems (e.g., choose an appropriate bandage for an injury, contact the appropriate service provider in an emergency).
Emerging Technology
5. Investigate and evaluate new medical technologies.
Grade Twelve
Technical Communication
1. Describe how telemedicine reflects the convergence of technological advances in a number of fields, including medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science and perceptual psychology.
2. Classify the ways medical technologies are regulated.
Technical Standards
3. Identify and apply appropriate codes, laws, standards or regulations related to medical technologies (e.g., Occupational Safety and Health Administration—OSHA, National Electric Code—NEC, International Standards Organization—ISO, Ohio Environmental Protection Agency—Ohio EPA, American National Standards Institute—ANSI).
Benchmark G: Classify, demonstrate, examine and appraise agricultural and related biotechnologies.
Grade Nine
Technical Careers
1. Evaluate the training required for various careers in agricultural and biotechnology systems (e.g., chemical applicators, farmer, plant biologist, groundskeeper).
System Management
2. Describe how agriculture includes a combination of organizations that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemical and other useful products (e.g., individuals, corporations, financial institutions, and local, state and federal governments).
Safety
3. Identify and apply appropriate safety measures when working with agricultural and related biotechnologies.
Emerging Technology
4. Investigate emerging (state-of-the-art) and innovative applications of agricultural and related biotechnologies.
Grade Ten

Understanding
Technological Systems
1. Explain the conservation practices of controlling soil erosion, reducing sediment (contamination) in waterways, conserving water, and improving water quality (e.g., terraces as used in gardens and farmland).
2. Grow a plant using both hydroponics and traditional methods and compare the results.
Safety
3. Prioritize and apply appropriate safety measures when working with agricultural and related biotechnologies.
Grade Eleven
System Management
1. List biotechnology applications in such areas as agriculture, pharmaceuticals, food and beverages, medicine, energy, the environment and genetic engineering (e.g., fermentation, bio-products, microbial applications, separation and purification techniques, genetically modified seeds, modified organisms, algal fertilizers).
Use and Maintain Technological Systems
2. Employ agricultural and biotechnologies to resolve practical problems (e.g., growing food year-round, using plants to eliminate erosion).
Technology Assessment
3. Consult with experts and determine the effect of emerging biotechnologies on the job market (e.g., compare and contrast the amount of produce at a local produce distribution center grown hydroponically and traditionally).
Grade Twelve
Design Applications
1. Describe how engineering design and management of agricultural systems require knowledge of artificial ecosystems and the effects of technological development on flora and fauna (e.g., green houses, fish farms, hydroponics, aquaculture).
Technology Assessment
2. Evaluate the effects of genetic engineering, fertilizers, herbicides, and pesticides on the environment and the production of food.
Technical Standards
3. Identify and apply appropriate codes, laws, standards, or regulations related to agricultural and biotechnologies (e.g., Occupational Safety and Health Administration—OSHA, National Electric Code—NEC, International Standards Organization—ISO, Ohio Environmental Protection Agency—Ohio EPA, American National Standards Institute—ANSI, Ohio Department of Agriculture).