

**Technology Alignment of Benchmarks and Indicators
GRADE 12**

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 Twelve

Nature of Technology

1. Demonstrate how the development of technological knowledge and processes are functions of the setting.

Technology Diffusion

2. Predict the impact of the exponential development and diffusion of technology.

Goal-directed Research

3. Invent a product using goal-directed research.

Commercialization of Technology

4. Plan/construct technological products considering profit incentive and market economy.

Benchmark B: Apply technological knowledge in decision-making.

Grade Twelve

Nature of Technology

1. Design/construct a model to demonstrate how all components contribute to the stability of a technological system.

Optimization and Trade-offs

2. Make, support and defend decisions that involve trade-offs between competing values (e.g., use of criteria in making an equipment purchase).

Sustainability

3. Evaluate the sustainability of a system based on social, economic, political, technological, cultural, historical, moral, aesthetic, biological and physical dimensions.

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

Technology Transfer

1. Debate the positive and negative outcomes of technology transfer (e.g., given a selected region or country, what types of appropriate technology best meet the needs of the people?).

Innovation and Invention

2. Demonstrate how technological innovation can result when ideas, knowledge or skills are shared within or among technologies or across other fields.

3. Predict changes in society as a result of continued technological progress and defend the rationale.

Standard 2 Technology and Society Interaction

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 Twelve

Technology and Citizenship

1. Make informed choices among technology systems, resources and services.
2. Articulate how different factors, such as individual curiosity, advertising, strength of the economy, the goals of a company and current trends, contribute to shaping the design of, and demand for, various technologies.
3. Debate the advantages and disadvantages of widespread use and reliance on technology in the work place and in society as a whole.
4. Evaluate national and international policies that have been proposed as ways of dealing with social changes resulting from new technologies (e.g., censorship of the media, intellectual property rights or organ donations).

Benchmark B: Demonstrate the relationship among people, technology and the environment.

Grade Twelve

Technology and Environment

1. Forecast intended and unintended consequences of technology deployment.

2. Describe the proper disposal and recycling of computer components and other electronic devices.

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

Grade Twelve

Technology and History

1. Debate the position that technology has been a powerful force in reshaping the social, cultural, political and economic landscape, citing references and examples.

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

Grade Twelve

Technology and Ethics

1. Predict what might happen if the principles of intellectual property were ignored in one's own community.

2. Forecast changes in laws and legislation that might result from the exponential growth of technology.

3. Respect the principles of intellectual freedom and intellectual property rights.

4. Practice responsible and ethical usage of technology.

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

Grade Twelve

Technology Assessment

1. Design forecasting techniques to evaluate the results of altering natural systems.

2. Select a technology that has had national impact and describe its impact.

Standard 3 Technology for Productivity Applications

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 Twelve

Problem-solving

1. Research and create technology systems, resources and services to solve technical problems.

Benchmark B: Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-

enhanced models.

Grade Twelve

Knowledge Generation

- 1. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.**
- 2. Use technology tools to model complex systems of information to improve the communication of and access to the information (e.g., modeling physics principles, graphic/geographic information system, weather modeling).**

Standard 4 Technology and Communication Applications

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 Twelve

Principles of Design

- 1. Facilitate message intent by incorporating design elements that contribute to the effectiveness of a specific communication medium into student-generated products (e.g., black and white footage to imply documented truth; set design that suggests cultural context).**

Evaluation

- 2. Analyze the complexities and discrepancies found in communication products.**
- 3. Interpret ethical considerations and legal requirements involved in construction of communication products.**

Benchmark B: Create, publish and present information, utilizing formats appropriate to the content and audience.

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Use of Communications

- 1. Use Web technologies to disseminate information to a broader audience.**

Evaluation

- 2. Explain evaluation criteria and processes used to communicate with technology (e.g., telecommunications, Wi-Fi, voice over IP).**

Benchmark C: Identify communication needs, select appropriate communication tools and design collaborative interactive projects and

activities to communicate with others, incorporating emerging technologies.

Grade Twelve

Use of Communications

1. Communicate using all manifestations of e-mail as needed for personal and curricular purposes, demonstrating appropriate and responsible use.
2. Use all available online communication capabilities to make inquiries, do research and disseminate results.

Evaluation

3. Research emerging communication technologies (e.g., wireless systems, open source software and systems, virtual reality).

Standard 5 Technology and Information Literacy

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.

Benchmark A: Determine and apply an evaluative process to all information sources chosen for a project.

Grade Twelve

Evaluating Sources

1. Evaluate information collected to answer both personal and curricular needs to determine its accuracy, authority, objectivity, currency and coverage.
2. Acknowledge intellectual property in using information sources.
3. Determine and apply an evaluative process to all information sources chosen for a project.

Benchmark B: Apply a research process model to conduct research and meet information needs.

Grade Twelve

Decide

1. Derive a personally developed research model to conduct independent research.
2. Refine the information question to focus the research process, modifying the question as necessary to broaden or narrow the inquiry.

Find

3. Critique information sources to determine if different points of view are included.
4. Integrate multiple information sources in the research process.

Use

5. Create a product to communicate information, representing a personal point of view based on findings.
6. Adhere to copyright and intellectual property laws and guidelines when creating new products (e.g., standard bibliographic format, permissions to use information created by others).

Check

7. Monitor progress and evaluate actions during the process, revising and incorporating new information as indicated by personal evaluation.

Manage

8. Archive final product in a format accessible in the future.

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.

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Search Strategies

1. Incorporate defined field searching by initiating a search string identifying the desired field of information to be retrieved (e.g., search author or title).
2. Create a stand-alone system for tracking Internet resources for personal and academic needs (e.g., postsecondary institutions of interest).

Evaluating Sources

3. Synthesize search results retrieved from a variety of Internet resources to create an information product for a targeted audience.
4. Critique research retrieved through the Internet for authority, accuracy, objectivity, currency, coverage and relevancy.

Benchmark D: Evaluate choices of electronic resources and determine their strengths and limitations.

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Electronic Resources

1. Research information from electronic archives (e.g., list serv archives, weblogs).
2. Use a variety of technology resources for curriculum needs and personal information needs (e.g., streaming video, CD/DVD, subscription database).
3. Evaluate technology resources and determine strengths and weaknesses for curricular or personal needs.
4. Select an appropriate tool, online resource or Web-site based on the information need.

Standard 6 Design

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.

Benchmark A: Identify and produce a product or system using a design process, evaluate the final solution and communicate the findings.

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.

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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 Communication

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 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.

Standard 7 Designed World

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.

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

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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 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.

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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 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 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 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 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).