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INTRODUCTION

The Worthington City School District has developed a Graded Course of Study for Technological Studies 7-12 to communicate with staff members, students, parents and community the overall goals and learning expectations of the Technological Studies Program. This document establishes the standards, benchmarks and performance indicators that students must not only learn but also demonstrate proficiency using and applying technology. It provides teachers with clear direction on what all students should know and be able to do.

The Ohio Academic Content Standards for Technology provides the framework for the Worthington Technological Studies Graded Course of Study.

Sincere appreciation is extended to the many staff members and community representatives who shared their expertise and time in the development of this Technological Studies Graded Course of Study.

Writing Team Members:

Jon Baird        Mike Faler        Jim Postle
Roger Beck      Tom Karns         Bob Swanson
Bryan Brown     Mike Miller       Debbie Voisin
Ron Charlton    Randy Ross
Todd Deisher    Rob Pierce

Jennifer E. Wene
Director of Teaching and Learning

Board Adoption Date: September 10, 2007
PHILOSOPHY AND GOALS OF THE WORTHINGTON
BOARD OF EDUCATION

Instructional Philosophy and Goals

A. Generally

The state and the nation need a well educated and competent citizenry capable of fulfilling the American ideals of opportunity and achievement. It is the responsibility of the Board of Education to articulate the wishes of the community so that the children under its jurisdiction mature to become knowledgeable, active, and concerned citizens capable of dealing with the challenges of a changing technological world.

The Board of Education of the Worthington Schools believes that the instructional program of the district is its first priority and that every effort be made to carefully plan, organize, implement, evaluate, and communicate this program to the community.

Furthermore, the Board believes the general public should be given ample opportunity to participate in the setting of goals for the instructional program and its evaluation. The professional staff is responsible for the implementation of the goals and the Board has the responsibility of seeking from the community the resources necessary to accomplish the mutually agreed upon goals.

B. Philosophical Bases for Instructional Program

The Board believes that the instructional program is an essential ingredient of the school system and, therefore, matters relating to instruction should be carefully planned, organized, evaluated, and communicated to the community. In its role as the representative policy-making body for the school district, the Board establishes the philosophical bases upon which the school district’s programs are built.

They are as follows:

- The instructional program will emphasize the development of fundamental skills and a command of basic knowledge while preparing young persons for the rapidly changing and highly technical world in which they live.

- Students will learn how to make critical judgments and to use their inherent creativity to become effective problem solvers.

- Students will learn self-directed study skills which will serve them during and beyond their years of formal schooling.

- The instructional program will foster positive student attitudes toward change and develop in students the capacities necessary for dealing successfully with a changing world.

- Students will be given varied opportunities to develop their appreciation for the aesthetic aspects of human existence and to develop their talents for artistic self-expression.

- The instructional program will provide varied educational experiences in recognition of the diversity of student abilities, talents and interests.
• The instructional program will provide for the physical and emotional well-being of students.

• Students will be made aware of the interdependence of all peoples and will be encouraged to accept their responsibilities as members of the human family for the survival and welfare of all.

• The instructional program will foster a sense of self-worth and a sense of worth in others along with a sense of responsibility for one’s personal development.

• The instructional program will recognize the need for lifelong learning and provide educational opportunities for citizens of all ages.

C. Personnel

The Board recognizes that the successful implementation of the instructional program requires the employment of quality personnel. Furthermore, the Board believes opportunities for continuous personal and professional development are essential for ensuring the vitality of the educational program.

D. Evaluation

The curriculum shall be periodically and systematically reviewed by staff as determined by the superintendent but at a minimum as required by state law.
WORTHINGTON SCHOOLS MISSION STATEMENT AND BELIEFS

Mission

The Worthington Schools Inspires Learning for All.

Vision

We develop life-long learning through visionary leadership, effective teaching and learning practices, wise resource management, and information-based accountability in a safe, positive, and supportive environment.

Beliefs

- Provide a culture of safety and respect for each member of the school community.
- Enhance learning and self worth by meeting individual needs
- Effectively utilize human, technological, and financial resources.
- Recruit, select, and retain quality staff.
- Expect personal and professional growth of each member of the school community.
- Involve community through engagement, partnership, and collaboration.
The following narrative reflects the fundamental beliefs of the Technological Studies Education Department relative to society, our students, the subject matter and the curriculum:

A central role of education is to offer a curriculum that provides students with the basic understandings and skills needed to function effectively in society. Since our democratic society is characterized by rapidly advancing technological developments, it is absolutely necessary for all people to understand technology to insure their functioning as informed voters, productive workers, and wise consumers of technological products and services.

Technologies spring from the human abilities to reason, solve problems, create, construct and use materials imaginatively. Since these abilities are an integral part of our technological society, they must be developed in all students, regardless of their education and career goals. Experience in applying technology and in solving problems builds both the competence and confidence for effective interaction with technology. An understanding of the applications and functioning of technological systems is important for decision making in the arenas of career, home, personal affairs and government.

Technological Studies Education is a comprehensive, experience-based curriculum in which students learn about technology – its evolution, systems, techniques, utilization, and social and cultural significance. It develops technological literacy by dealing with the ways in which scientific information, materials, and other resources are applied for solving problems to meet our needs.

In today’s high-tech society, it is necessary for all students to become technologically literate. Through the application of technical skills, knowledge and processes, students need to solve problems in a systematic fashion. Coupled with sound work values, attitudes and habits, these skills enable students to become wise consumers, productive members of the community, and contributors to the forces of change that shape the world.

The Worthington School District recognizes and supports Technological Studies Education as an important part of a student’s education at all levels from kindergarten through grade twelve.
TECHNOLOGICAL STUDIES PROGRAM GOALS

- Maximize students’ technological literacy.
- Develop the knowledge and ability of students to properly use the resources, processes, and systems of technology.
- Support opportunities to explore technological design, problem solving, and creative thinking.
- Promote understanding of the nature and history of technology.
- Demonstrate the impact of technology on society and the environment.
- Develop in students the potential to become responsible citizens in a technological society.
- Provide students with opportunities for career exploration.
- Facilitate the integration of technology into the overall curriculum.
- Provide opportunities to create, invent, design, transform, produce, control, maintain and use technological systems.
- Apply practical applications of science, math, social sciences and language arts in the technological design process.
While all content for the study of technology is drawn from the Ohio Technology Academic Content Standards, full implementation of the standards is a responsibility shared by the entire school community. The scope of the Technology ACS is wide. Not only do the standards address technological literacy but also computer and information literacy. This Ohio document is the first in the nation to combine these three “literacies” into one set of standards. No single program is capable of delivering all of the content. This is a contrast to the standards in other areas. A paradigm shift is required for educators to see the “big picture” of technological literacy.

Since technology is integral and relative to other fields of study, the Technology ACS can be woven into each curricular discipline. Multiple standards can be addressed within one unit. Technology concepts may be integrated into other subject areas or taught in partnership between Technological Studies teachers and those of other academic areas. This integration strategy helps students make realistic connections between what they learn in each content area and the real world. It must be underscored, however, that there is a body of knowledge and a skill-set unique to Technological Studies that cannot be delivered through technology integration. The Technological Studies program uses an engineering-design, problem-solving pedagogy. Students apply their science and mathematics skills to solving technological problems, while learning about technology and its impact on our world. This practice is commonly known as STEM (Science, Technology, Engineering and Mathematics) education.

The Technological Studies teaching staff will collaborate with other professionals to appropriately infuse broad-based technology content and assist in the development of student performance assessments. The Technology Integration chart which follows shows where the Technology Benchmarks, 7-8 and 9-12, integrate with the Language Arts, Math, Science, Health and Social Studies Academic Content Standards.
TECHNOLOGY INTEGRATION

Standard 1: Nature of Technology
Students develop an understanding of technology, its characteristics, scope, core concepts and relationships between technologies and other fields.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Health</th>
<th>Social Studies</th>
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</thead>
<tbody>
<tr>
<td>By the end of the 7-8 program:</td>
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<tr>
<td>A. Analyze information relative to the characteristics of technology and apply in a practical setting.</td>
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<tr>
<td>B. Apply the core concepts of technology in a practical setting.</td>
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<tr>
<td>C. Analyze the relationships among technologies and explore the connections between technology and other fields of study.</td>
<td></td>
<td></td>
<td></td>
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<td>✓</td>
</tr>
<tr>
<td>By the end of the 9-12 program:</td>
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</tr>
<tr>
<td>A. Synthesize information, evaluate and make decisions about technologies.</td>
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<td></td>
</tr>
<tr>
<td>B. Apply technological knowledge in decision-making.</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>C. Examine the synergy between and among technologies and other fields of study when solving technological problems.</td>
<td></td>
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</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Health</th>
<th>Social Studies</th>
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<tbody>
<tr>
<td>By the end of the 7-8 program:</td>
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</tr>
<tr>
<td>A. Analyze technologically responsible citizenship.</td>
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</tr>
<tr>
<td>B. Describe and explain the impact of technology on the environment.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>C. Describe how design and invention have influenced technology throughout history.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>D. Articulate intellectual property issues related to technology and demonstrate appropriate, ethical and legal use of technology.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>E. Assess the impact of technological products and systems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>By the end of the 9-12 program:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Interpret and practice responsible citizenship relative to technology</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Demonstrate the relationship among people, technology and the environment.</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>C. Interpret and evaluate the influence of technology throughout history, and predict its impact on the future.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>D. Analyze ethical and legal technology issues and formulate solutions and strategies that foster responsible technology usage.</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>E. Forecast the impact of technological products and systems.</td>
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</tbody>
</table>
Standard 3: Technology for Productivity Applications

Students learn the operations of technology through the usage of technology and productivity tools.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Health</th>
<th>Social Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>By the end of the 7-8 program:</td>
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<td></td>
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</tr>
<tr>
<td>A. Demonstrate an understanding of concepts underlying hardware, software</td>
<td>✓</td>
<td>✓</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>and connectivity.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>B. Select appropriate technology resources to solve problems and support</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>learning.</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>C. Use productivity tools to produce creative works, to prepare publications</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>and to construct technology-enhanced models.</td>
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<tr>
<td>By the end of the 9-12 program:</td>
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<td></td>
</tr>
<tr>
<td>A. Integrate conceptual knowledge of technology systems in determining</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>practical applications for learning and technical problem-solving.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>B. Identify, select and apply appropriate technology tools and resources</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>to produce creative works and to construct technology-enhanced models.</td>
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</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Health</th>
<th>Social Studies</th>
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<tbody>
<tr>
<td>By the end of the 7-8 program:</td>
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<tr>
<td>A. Communicate information technologically and incorporate principles of</td>
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<tr>
<td>design into the creation of messages and communication products.</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>B. Develop, publish and present information in a format that is appropriate</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
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<tr>
<td>for content and audience.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>C. Select appropriate technology communication tools and design collaborative</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>interactive projects and activities to communicate with others.</td>
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<td>By the end of the 9-12 program:</td>
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<tr>
<td>A. Apply appropriate communication design principles in published and</td>
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<td>✓</td>
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<tr>
<td>presented projects.</td>
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<tr>
<td>B. Create, publish and present information, utilizing formats appropriate</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>to the content and audience.</td>
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<tr>
<td>C. Identify communication needs, select appropriate communication tools</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>and design collaborative interactive projects and activities to</td>
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<tr>
<td>communicate with others, incorporating emerging technologies.</td>
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</table>
**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.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Health</th>
<th>Social Studies</th>
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<tbody>
<tr>
<td><strong>By the end of the 7-8 program:</strong></td>
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</tr>
<tr>
<td>A. Evaluate the accuracy, authority, objectivity, currency, coverage and</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>relevance of information and data sources.</td>
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<tr>
<td>B. Use technology to conduct research and follow a research process model</td>
<td>✓</td>
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<tr>
<td>which includes the following: developing essential question; identifying</td>
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<tr>
<td>resources; selecting, using and analyzing information; synthesizing and</td>
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<tr>
<td>generating a product; and evaluate both process and product.</td>
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<tr>
<td>C. Develop search strategies, retrieve information in a variety of formats</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>and evaluate the quality and appropriate use of Internet resources.</td>
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<tr>
<td>D. Select, access and use appropriate electronic resources for a defined</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>information need.</td>
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<td><strong>By the end of the 9-12 program:</strong></td>
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<tr>
<td>A. Determine and apply an evaluative process to all information sources</td>
<td>✓</td>
<td></td>
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<tr>
<td>chosen for a project.</td>
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<tr>
<td>B. Apply a research process model to conduct research and meet information</td>
<td>✓</td>
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</tr>
<tr>
<td>needs.</td>
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</tr>
<tr>
<td>C. Formulate advanced search strategies, demonstrating an understanding of</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>the strengths and limitations of the Internet, and evaluate the quality</td>
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<tr>
<td>and appropriate use of Internet resources.</td>
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</tr>
<tr>
<td>D. Evaluate choices of electronic resources and determine their strengths</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>and limitations.</td>
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</tbody>
</table>

**Standard 6: Design**

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Health</th>
<th>Social Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By the end of the 7-8 program:</strong></td>
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</tr>
<tr>
<td>A. Evaluate the aesthetic and functional components of a design and identify</td>
<td></td>
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<tr>
<td>creative influences.</td>
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<td>B. Recognize the role of engineering design and of testing in the design</td>
<td>✓</td>
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<td>process.</td>
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<tr>
<td>C. Understand and apply research, innovation and invention to problem-</td>
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<tr>
<td>solving.</td>
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<tr>
<td><strong>By the end of the 9-12 program:</strong></td>
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<tr>
<td>A. Identify and produce a product or system using a design process, evaluate</td>
<td>✓</td>
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<td>the final solution and communicate the findings.</td>
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<tr>
<td>B. Recognize the role of teamwork in engineering design and of prototyping in the design process.</td>
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<tr>
<td>C. Understand and apply research, development and experimentation to problem-solving.</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Language Arts</th>
<th>Math</th>
<th>Science</th>
<th>Health</th>
<th>Social Studies</th>
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<tbody>
<tr>
<td>By the end of the 7-8 program:</td>
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<tr>
<td>A. Develop an understanding of, and be able to select and use, physical</td>
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<tr>
<td>technologies.</td>
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<tr>
<td>B. Develop an understanding of, and be able to select and use, informational</td>
<td>✓</td>
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<tr>
<td>technologies.</td>
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<tr>
<td>C. Develop an understanding of how bio-related technologies have changed</td>
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<td>✓</td>
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<td>over time.</td>
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<td>By the end of the 9-12 program:</td>
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<tr>
<td>A. Classify, demonstrate, examine, and appraise energy and power</td>
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<tr>
<td>technologies.</td>
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<tr>
<td>B. Classify, demonstrate, examine and appraise transportation technologies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>C. Classify, demonstrate, examine and appraise manufacturing technologies.</td>
<td></td>
<td></td>
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<td>✓</td>
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<tr>
<td>D. Classify, demonstrate, examine and appraise construction technologies.</td>
<td></td>
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<td>✓</td>
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<tr>
<td>E. Classify, demonstrate, examine and appraise information and</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>communication technologies.</td>
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<tr>
<td>F. Classify, demonstrate, examine and appraise medical technologies.</td>
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<tr>
<td>G. Classify, demonstrate, examine and appraise agricultural and related</td>
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<tr>
<td>biotechnologies.</td>
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</table>
KEY TERMS

The following terms are commonly used throughout the Technological Studies Graded Course of Study and are key to understanding the terminology in the context of the document.

Technological Studies

“Technological Studies” is the commonly used title for technology curricula. The Worthington School District has retained Technological Studies as the title for this school subject. As a school subject, Technological Studies develops the technological literacy and capabilities of all students, grades K-12. Its curriculum focuses on the development and applications of technology and the effects technology has on individuals, society, and the environment.

Our program of the study of technology provides all students with opportunities to develop concept and process knowledge. The study of technology enhances student learning by highlighting the relationships among technologies and between technology and other school subjects, including science, mathematics, social studies, language arts, and other content areas. Students are engaged in activities that promote technological literacy through the development of knowledge and abilities necessary to make informed decisions regarding the use and management of technology.

Technological Studies plays a crucial role in advancing students toward technological literacy. Students engage in cognitive and psychomotor activities that foster critical thinking, decision-making, and problem solving related to the use, management and evaluation of the designed world.

Technology

The word “technology” is perhaps one of the most overused and least understood terms in the English language. A lack of common understanding for this term has led to a great deal of confusion over its meaning, particularly within educational settings where many equate technology with equipment, such as computers and VCRs. Product-oriented perspectives of technology such as this overlook the enormous impact it has as a social force on civilization and the global economy.

Technology is defined as:

- STL (Standards for Technological Literacy) defines technology as the innovation, change or modification of the natural environment in order to satisfy perceived human needs and wants.
- Technology is how humans modify the world around them to meet their needs and wants or to solve practical problems. (ITEA – International Technology Education Association)
- The definition provided in the National Science Education Standards states that the goal of technology is to make modifications in the world to meet human needs.

To fully understand the nature, scope and significance of technology it must be viewed broadly and comprehensively.

The Worthington School District defines technology as: Human application of resources to solve practical problems, modify the world, and extend capabilities.
Technological Literacy

Characteristics of a Technologically Literate Person:

“Technological literacy is much more than just knowledge about computers and their applications.”

Technologically literate persons are capable problem solvers who consider technological issues from different points of view and in relationship to a variety of contexts. They acknowledge that the solution to one problem often creates other issues and problems. They also understand that solutions often involve trade-offs, which necessitate accepting less of one quality in order to gain more of another. They appreciate the interrelationships between technology and individuals, society and the environment.

Technologically literate persons understand that technology involves systems, which are groups of interrelated components designed to collectively achieve a desired goal or goals. No single component or device can be considered without understanding its relationship to all other components, devices and processes in the system. Those who are technologically literate have the ability to use concepts from science, math, English, social studies, humanities and the fine arts as tools for understanding and managing technological systems. Therefore, technologically literate people use a strong system-oriented approach to thinking about and solving technological problems.

Technologically literate persons can identify appropriate solutions and assess and forecast the results of implementing the chosen solution. As managers of technology, they consider the impacts of each alternative and determine which is the most appropriate course of action for the situation.

Technologically literate persons understand the major technological concepts behind the issues. They are skilled in the safe use of technological processes that are lifelong prerequisites for their careers, health and enjoyment.

Technologically literate persons incorporate various characteristics from engineers, artists, designers, craft persons, technicians, mechanics and sociologists that are interwoven and act synergistically. These characteristics involve system-oriented thinking, the creative process, the aspect of producing, and the consideration of impacts and consequences.

Technologically literate persons understand and appreciate the importance of fundamental technological developments. They have the ability to use decision-making tools in their lives and work. Most importantly, they understand that technology is the result of combining ingenuity and resources to meet human needs and wants.

*Reprinted from Technology for All Americans International Technology Education Association.

Vision

All students need to become technologically literate.

Rationale

We live in a technological world. Living in the twenty-first century requires much more from every individual than a basic ability to read, write, and perform simple mathematics. Technology affects virtually every aspect of our lives, from enabling citizens to perform routine tasks to requiring that they be able to make responsible, informed decisions that affect individuals, our society, and the environment.
Citizens of today must have a basic understanding of how technology affects their world and how they exist both within and around technology. The need for technological literacy is fundamentally important to students as traditional core subject knowledge and abilities. Students need and deserve the opportunity to attain technological literacy through the educational process.

**Technological Capability**

Being technologically capable does not mean possessing job-specific skills. Consequently the Technological Studies curriculum does not provide training programs for job-specific skills. Students need not become expert users of any one particular piece of equipment, but they must be able to make intelligent decisions regarding the selection of appropriate systems and be able to use them effectively.

As a field of study in general education, the technology curriculum does, however, provide a foundation of knowledge for higher education in engineering, mathematics or science, or for a technical program at a two-year college. It also develops desirable career skills such as problem solving, communication and cooperative skills, and adaptability to new technological systems in the workplace.

Technological capability is developed in students as a result of their participation in technological design problems. These problems “set the stage” for learning by providing contexts (or problem situations) within which students think and act systematically to solve problems.

**Technology and Science**

Although technology and science are interrelated and in many respects depend on one another, technology has its own unique body of knowledge and associated modes of thinking.

Science seeks answers to questions about the natural universe. Science describes the world by asking the question, “Why?”

Technology attempts to adapt the environment by solving problems. Technology seeks different kinds of answers because it asks very different questions; it asks the question “How?” in an effort to solve practical problems. Technology uses knowledge from all disciplines. Knowledge from art, design, engineering, history, language arts, mathematics, psychology, science and other disciplines contributes to technological solutions to problems.

**Technological Studies and Educational Technology**

Technological Studies education is different from instructional technology, also called educational technology. Educational technology, which involves using technological developments such as computers, audio-visual equipment, and mass media to aid in teaching all subjects, is concerned with creating the optimum teaching and learning environment through the use of technology. Technological Studies education is a school subject designed to develop technological literacy, while educational technology is used as a tool to enhance teaching and learning. The role of educational technology in Technological Studies education is the same as it is in mathematics, science, the humanities, or any other field of study.

**Design**

The Worthington School District defines design as:

A process composed of purposeful thought and associated actions directed at creating a desired outcome.
Simon (1969) defines the act of designing as “devising courses of action aimed at changing existing situations into preferred ones.” The term design can also mean the appearance of an inanimate object. In this way, an object’s design implies the amalgamation of its shape, size, color, lines, etc.

Designing is a central element of the technology curriculum. It provides cognitive schema such as reflection, envisioning, critical thinking and creativity, as well as perceptible factors such as aesthetics, ergonomics and function. Further, design becomes a context for technological learning, where students apply technology as well as interdisciplinary concepts and skills.

**Problem Solving**
Problem solving is defined as:

*The cognitive process of finding answers to questions and solutions to undesired situations.*

Design and problem solving in technology are very closely related – the purpose of design in technology is to solve practical problems. Therefore, technological design and problem solving refer to the process used to solve practical problems. The terms “technological design,” “technological problem solving,” and “technological design and problem solving” will be used interchangeably throughout this document.

Technological problem solving differs from other forms of problem solving, such as mathematical problem solving. There are no right or wrong answers in technological problem solving, only varying degrees of effectiveness; mathematical problem solving, on the other hand, results in a single, correct answer. There are many different solutions to technological problems – some are more effective than others. The best solutions generally reflect the most acceptable compromise between human needs, imposed constraints, and negative consequences.
This document is consistent with Ohio’s Technology Academic Content Standards and National Standards for Technological Literacy.

**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. 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.*

**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 and 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.

**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.

**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.

**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.

**Standard 6: Design**

Students 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 problems using different design approaches including troubleshooting, research and development, innovation, invention and experimentation.

**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 student's 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, and agricultural and related biotechnologies.
The Middle School Technological Studies program offers a unique experience for students. The underlying theme is the relationship of technology and engineering to mathematics, science, communication, and society. By exploiting this interrelatedness, teachers engage students in a multitude of integrated activities. The program provides active learning situations that help the early adolescent explore and develop a broad view of engineering (design) and technology. While students obtain significant content knowledge, the program is inherently hands-on and exploratory in nature. Experiences are organized in ways that correspond to the distinct developmental needs of learners.

The development of the Middle School Technological Studies program continues to be a dynamic and evolving process. Meeting the immediate needs of students through ongoing cross-curricular collaboration is a major consideration in instructional design. Since technology is integral and relative to all other disciplines, Technological Studies is an essential part of the curriculum. The program assists students in learning about the processes that apply to research, design, development, and use of technological products and systems.

In the middle grades, students begin to assess the impacts and consequences of technological systems on individuals, society, and the environment. Through classroom experiences, students see how technology has contextual relationships with other fields of study. Contemporary Technological Studies activities heavily employ instructional technologies to perform various real-time tasks, thus allowing students to strengthen their computer literacy skills as they become more technologically literate.

The teacher may facilitate student learning using discrete lessons, integrated classroom activities, or through collaborative (team) planning. In this scenario, science and technology teachers provide direct instruction independently of one another and also collaboratively. Working in concert, the teachers have the best possible conditions for individual student support and differentiated instruction. The classroom environment changes to meet the needs of students.

Integrated assignments most often take the form of extended problem-based projects, with students working in collaborative-cooperative groups. Teachers facilitate these projects and develop assessments together. They may work with students in a large laboratory setting, supervise students in multiple locations, or work with students on an individual basis. Student experiences are designed to focus on curricular interrelationships and build interconnected knowledge, bringing coherence to an otherwise miscellaneous collection of topics.

The Federal Elementary and Secondary Education Act (ESEA) “No Child Left Behind” provision mandates that “all children must be technologically literate by the completion of the Eighth Grade.” The Federal government allows each state to define “technologically literate.” In Ohio, the Technology Academic Content Standards define technological literacy. Technological Studies teachers, therefore, bear a large accountability for the delivery of the Technology Academic Content Standards. As such, they have a role that is different from other classroom teachers. They are involved in teacher professional development and subsequent support during integrated activities, and act not only as a classroom teacher but also as a collaborator and resource person to the teaching staff.
### OHIO TECHNOLOGY STANDARDS ASSESSMENT

<table>
<thead>
<tr>
<th>Ohio K-12 Technology Academic Content Standards and Benchmarks</th>
<th>Developing</th>
<th>Proficient</th>
<th>Advanced</th>
<th>Assessment Method</th>
</tr>
</thead>
</table>

#### Standard 1: Nature of Technology
Students develop an understanding of technology, its scope, core concepts, characteristics and relationships between technologies and other fields.

A. Analyze information relative to the characteristics of technology and apply in a practical setting.

B. Apply the core concepts of technology in a practical setting.

C. Analyze the relationships among technologies and explore the connections between technology and other fields of study.

#### 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.

A. Analyze technologically responsible citizenship.

B. Describe and explain the impact of technology on the environment.

C. Describe how design and invention have influenced technology throughout history.

D. Articulate intellectual property issues related to technology and demonstrate appropriate, ethical, and legal use of technology.

E. Assess the impact of technological products and systems.

#### Standard 3: Technology for Productivity Applications
Students learn the operations of technology through the usage of technology and productivity tools.

A. Demonstrate an understanding of concepts underlying hardware, software and connectivity.

B. Select appropriate technology resources to solve problems and support learning.

C. Use productivity tools to produce creative works, to prepare publications and to construct technology-enhanced models.

#### 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.

A. Communicate information technologically and incorporate principles of design into the creation of messages and communication products.

B. Develop, publish and present information in a format that is appropriate for content and audience.

C. Select appropriate technology communication tools and design collaborative interactive projects and activities to communicate with others.
## 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.

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<tr>
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<th>Assessment Method</th>
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<tbody>
<tr>
<td>A.</td>
<td>Evaluate the accuracy, authority, objectivity, currency, coverage and relevance of information and data sources.</td>
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<tr>
<td>B.</td>
<td>Use technology to conduct research and follow a research process model which includes the following: developing essential question; identifying resources; selecting, using and analyzing information; synthesizing and generating a product; and evaluate both process and product.</td>
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<tr>
<td>C.</td>
<td>Develop search strategies, retrieve information in a variety of formats and evaluate the quality and appropriate use of Internet resources.</td>
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<tr>
<td>D.</td>
<td>Select, access and use appropriate electronic resources for a defined information need.</td>
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## Standard 6: Design

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering, and the role of assessment.

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<th>Assessment Method</th>
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<tbody>
<tr>
<td>A.</td>
<td>Evaluate the aesthetic and functional components of a design and identify creative influences.</td>
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<tr>
<td>B.</td>
<td>Recognize the role of engineering design and of testing in the design process.</td>
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<tr>
<td>C.</td>
<td>Understand and apply research, innovation and invention to problem-solving.</td>
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## 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.

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<th>Assessment Method</th>
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<tbody>
<tr>
<td>A.</td>
<td>Develop an understanding of, and be able to select and use, physical technologies.</td>
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<tr>
<td>B.</td>
<td>Develop an understanding of, and be able to select and use, informational technologies.</td>
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<tr>
<td>C.</td>
<td>Develop an understanding of how bio-related technologies have changed over time.</td>
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</table>
STANDARD 1: NATURE OF TECHNOLOGY

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

**Benchmark A:** Analyze information relative to the characteristics of technology and apply in a practical setting.

Technology Development

1. Recognize that there are multiple factors associated with developing products and systems.

2. Describe and apply the factors involved in developing products and systems using technology (e.g., market survey, design, development, prototyping, assessing, producing, quality assurance, marketing).

3. Suggest alternative technological solutions for everyday problems that occur in the school or classroom.

4. Follow procedures for identifying and solving system and equipment problems that may occur.

5. Cite examples of how characteristics of technology are evident in daily life:
   a. Technology is based on human knowledge
   b. Technology involves tools, materials and systems
   c. Application of technology results in artifacts (things or items)
   d. Technology is developed by people to control natural and human-made environments

6. Design technological solutions to problems generated by individual or collective needs.

7. Interpret the interrelationship between technology, creativity and innovation.

8. Formulate how a demand for a product may be created through marketing and advertising (e.g., marketing personal computers, music and game devices).

**Benchmark B:** Apply the core concepts of technology in a practical setting.

Systems

1. Describe the relationship among input, process, output and feedback as components of a system.

2. Differentiate between open-loop and closed-loop systems: recognize that an open-loop system has no feedback path and requires human intervention, while a closed-loop system uses feedback.

3. Describe and demonstrate how technological systems can be connected to one another.

Requirements

1. Identify and examine parameters and constraints that may be placed on the development of a product or system (e.g., cost, time, size).
Controls

1. Cite examples of controls, and predict resultant changes in a system for that control (e.g., the heating system thermostat regulates the air temperature of the room).

2. Utilize controls to make changes in a system resulting in a desired outcome (e.g., calibrate a robot to perform a task with accuracy).

Trade-offs

1. Indicate ways a system malfunction may affect the function and quality of the system.

2. Recognize that trade-offs are the result of the decision-making process, involving careful compromises among competing factors.

Processes

1. Recognize that maintenance is the process of inspecting and servicing of a product or system on a regular basis.

Benchmark C: Analyze the relationships among technologies and explore the connections between technology and other fields of study.

Technology Interaction

1. Understand that products, systems and environments that have been developed for one setting may be applied to another setting.

2. Describe the situational interdependence of technologies (e.g., space shuttle crew depends on communication technologies in order to maneuver the craft).

3. Identify products that have been applied to alternative settings.

4. Explain how knowledge from other fields of study may impact the development of technological systems and products.

5. Demonstrate ways that technological systems interrelate.

6. Suggest products that could be used in an alternative setting.

7. Explain ways that invention and innovation within one field can transfer into other areas of technology.

8. Cite examples of how transferred knowledge has impacted the development of technological systems and products (e.g., 1805 Jacquard weaving loom punch card system influenced development of 1950s computer punch card systems).

9. Describe and cite examples illustrating how different technologies require different processes.
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.

**Benchmark A:** Analyze technologically responsible citizenship.

*Technology and Citizenship*

1. Describe how the use of technology affects humans in various ways including their safety, comfort, choices and attitudes about technology’s development and use.

2. Classify how new technologies have resulted from the demands, values and interests of individuals, businesses, industries and societies.

3. Relate ways that the uses of inventions and innovations have led to changes in society and the creation of new needs and wants.

4. Identify and describe how societal expectations drive the acceptance and use of products and systems (e.g., impact of the automobile in Ohio 1891 to the present).

5. Explain how economic, political and cultural issues are influenced by the development and use of technology.

**Benchmark B:** Describe and explain the impact of technology on the environment.

*Technology and the Environment*

1. Explain how technologies can be used to repair damage caused by natural disasters.

2. Identify an existing, or an area needing, a riparian buffer between a developed area and a natural stream or waterway.

3. Explain how the life-cycle of a product or structure may impact the environment.

4. Explain how the development and use of technologies often put environmental and economic concerns in direct competition with one another.

5. Identify items/products that would benefit the environment if they were designed to be biodegradable.

*Product Life-Cycle*

1. Describe the proper disposal and/or recycling of used products (e.g., electronic equipment, lawnmower oil, batteries).
Emerging Technology

1. Investigate emerging environmental restoration technologies (e.g., electrokinetic remediation to remove chemical contaminants from soil).

Benchmark C: Describe how design and invention have influenced technology throughout history.

Technology and History

1. Describe how some inventions have evolved by using a deliberate and methodical process of tests and refinements.

2. Describe how in the past an invention or innovation was not always developed with the knowledge of science.

3. Explain how the design and construction of structures for service or convenience have evolved from the development of techniques for measurement, controlling systems, and the understanding of spatial relationships.

4. Analyze a design or invention and explain its historical importance (e.g., 1735 invention of a timepiece that English ships used to accurately navigate longitude position around the world).

5. Describe how the specialization of function has been at the heart of many technological improvements (e.g., welding: many different processes have been developed to join materials).

6. Examine and compare eras of design in architecture, aviation, transportation, medical instruments and astronomy.

Benchmark D: Articulate intellectual property issues related to technology and demonstrate appropriate, ethical and legal use of technology.

Intellectual Property

1. Understand the concept of intellectual property (e.g., author’s ownership of work).

2. Compare key concepts of intellectual property including ownership of technology, copyright, patent, trademark, trade name, and discuss consequences of violating others intellectual property rights.

3. Distinguish original work from work that is plagiarized.

4. Analyze a situation to determine the steps necessary to respect intellectual property rights including patents, copyrights, trade names and trademarks.

5. Discuss plagiarism and its ramifications.
6. Understand that installation of software requires an appropriate software license, and that the license determines how many times the software may be installed (e.g., does the license allow the software to be installed on more than one computer?).

7. Understand that Web page content may not be copied and imported into a new owner’s Web page.

8. Understand that photos, images, graphics, sounds or videos displayed on the Internet are generally copyright protected and may not be copied, pasted, saved, imported or used in new content without permission of the copyright owner.

9. Explore appropriate use of logos, icons, graphics, etc. in relation to trademark and trade name rights (e.g., understand that trademark logos may not be incorporated into new works without consent of the owner or payment of fees and/or royalties).

10. Analyze situations that arise regarding the use of intellectual property, including ethical considerations.

11. Determine steps necessary to respect intellectual property rights (e.g., obtain permission from the owner, credit the source of the items, pay a license fee to use the item).

12. Demonstrate legal and ethical practices when completing projects/schoolwork.

13. Adhere to copyright restrictions.

14. Define fair use in regard to technology-generated educational materials.

15. Discuss software piracy, its impact on the technology industry, and possible repercussions to individuals and/or the school district.

16. Determine copyright, trademark, trade name restrictions to consider when using the Internet or other technology resources (e.g., do not violate intellectual property restrictions when using materials).

Acceptable Use

1. Follow policies presented in the district Acceptable Usage Policy (AUP) and discuss consequences of inappropriate use of technology.

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

Technology Assessment

1. Employ the use of instruments with different measuring standards to collect data (e.g., temperature, acidity—pH level, voltage, heart rate, speed).

2. Use data collected to analyze and interpret trends in order to identify the positive or negative effects of a technology.
3. Identify trends and monitor potential consequences of technological development.

4. Analyze an environmental health concern and identify the elements of that problem (e.g., sources of environmental stressors, types of environmental stressors, environmental media, distribution of environmental stressors, and human receptors).

5. Design and use appropriate instruments to gather data (e.g., design, fabricate and use a balance scale).

6. Interpret and evaluate the accuracy of the information obtained during a test or experiment and determine if it is useful.

**Environmental Health**

1. Analyze responses to an environmental health concern and identify the types of solutions to that problem (e.g., psychological/social responses; political, legal and economic processes; environmental controls; waste/material management).
STANDARD 3: TECHNOLOGY FOR PRODUCTIVITY APPLICATIONS

Students learn the operations of technology through the usage of technology and productivity tools.

**Benchmark A:** Demonstrate an understanding of concepts underlying hardware, software and connectivity.

*Understanding Concepts*

1. Use vocabulary related to computer and multimedia technology systems (e.g., network, local area network—LAN, wide area network—WAN, wireless connectivity, USB, network switch).

*Understanding Operations*

1. Describe how computers connect to the Internet (e.g., what is the information super highway/World Wide Web and how can you connect to it?).
2. Explain how computer components interact.
3. Explain the purpose and different functions of software programs.
4. Describe how computer and multimedia technology systems work (e.g., asynchronous transfer mode—ATM, Internet protocol—IP, local area networks—LAN, wide area networks—WAN, wireless).

**Benchmark B:** Select appropriate technology resources to solve problems and support learning.

*Understanding Operations*

1. Explain the purpose of software programs.

*Communication Tools*

1. Present independent research findings in a multimedia format.

*Research Tools*

1. Investigate technology tools used to organize and represent data collected in problem situations.
2. Research educational video clips available online for use in class projects (e.g., consider copyright and fair use issues when selecting video clips).

*Keyboarding*

1. Demonstrate effective keyboarding skills in a word processing environment.
Problem-solving

1. Solve problems using all available technologies for inquiry, investigation, analysis and presenting conclusions.

2. Incorporate all available technology tools and resources to research, investigate, solve and present findings in a problem situation.

Productivity Tools

1. Investigate various formats of video content and methods of presentation (e.g., mpeg, .avi).

2. Edit video clips using video editing software.

3. Create a video production related to a class activity.

Benchmark C: Use productivity tools to produce creative works, to prepare publications and to construct technology-enhanced models.

Research Tools

1. Use content-specific tools, software and simulations to support learning and research (e.g., thermometers, applets, interactive geometric programs, model robots).

2. Use content-specific tools, software and simulations to support learning and research to create educational projects (e.g., aerodynamic model design, bridge building simulation, design tools, how-it-works Websites, real-time data collection and logging).

3. Apply technology resources to support group collaboration and learning throughout the curriculum.

4. Use content-specific tools, software and simulations to support learning, and research societal and educational problems (e.g., economic simulations, city planning simulation, flight simulators, rapid prototyping).

5. Apply technology resources to support personal productivity and learning throughout the curriculum.
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.

**Benchmark A:** Communicate information technologically and incorporate principles of design into the creation of messages and communication products.

**Principles of Design**

1. Define principles of design used to create print, multimedia and Web communications or products (e.g., color, contrast, repetition, alignment, proximity).

2. Integrate advanced design features into communication products (e.g., background selection, framing, set design).

3. Identify and practice Universal Design principles that ensure accessibility for all users of communication projects or products.

**Communications**

1. Classify reasons to communicate information and explain why technology enhances communication (e.g., to explain, inform, persuade, sell, archive information in ways that reach a variety of audiences).

2. Reconstruct messages with different communication tools and determine if the tool changes the meaning of the message.

3. Examine the connections among message content, context and purpose (e.g., is the content of the message impacted by the context in which the message is given? does the context impact the purpose?).

**Multimedia Applications**

1. Generate multimedia presentations that communicate information for specific purposes.

**Benchmark B:** Develop, publish and present information in a format that is appropriate for content and audience.

**Productivity Tools**

1. Select an appropriate software tool to create and publish print information (e.g., word processor for a report, desktop publishing tool for signs / calendars / newsletters).

2. Distinguish electronic file types and determine extensions including .txt, .rtf, .doc, .pdf and others.

3. Insert original sound files into multimedia presentation (e.g., AVI, WAV, MPEG).
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4. Insert copyright-free images (photos/graphics) into multimedia presentations (e.g., GIF, JPEG).

5. Transform digital images by using editing software to:
   a. Crop
   b. Rotate, flip, invert
   c. Add text, borders, decorative elements
   d. Adjust color (apply spot coloring, image touch-up)
   e. Layer or merge images

Publication

1. Construct and publish information in printed and electronic form (e.g., printed reports, resumes, brochures, charts and electronic presentations, videos, Web sites).

2. Select appropriate file types (documents, sounds, images, and multimedia) based on communication need.

Evaluation

1. Evaluate information product based on content and audience (e.g., did the information communicate the intended message to the correct audience?).

Benchmark C: Select appropriate technology communication tools and design collaborative interactive projects and activities to communicate with others.

Use of Communications

1. Use e-mail functions including:
   a. Sending
   b. Receiving
   c. Replying
   d. Adding a hyperlinked address in message
   e. Organizing mail folders
   f. Adding attachments to message

2. Participate in discussion lists, message boards, chat and other means of appropriate electronic communication (e.g., ask-an-expert, pen pals).

3. Investigate assigned topics using online learning resources (e.g., weblogs, Web cast, videoconferencing and other distance learning opportunities).

4. Compose e-mail messages and incorporate advanced techniques (e.g., include attachments, send to multiple recipients, format stationery, manage inbox, create address book).

5. Acquire and disseminate information by participating in virtual learning activities (e.g., Web casts, videoconferencing, distance learning offerings).
**Principles of Design**

1. Design collaborative interactive activities or projects (e.g., online election for school office, survey, data collection).

**Use of Communications**

1. Disseminate results obtained through collaborative research projects to a larger audience (e.g., post results on a Web page, e-mail to group participants).

2. Select an appropriate communications tool to obtain and share information (e.g., e-mail, chat, message board, videoconferencing, online project).

**Evaluation**

1. Critique e-mail to determine communication clarity, and consider appropriate operations and etiquette (e.g., reply, reply all, include original message in reply, etc.).
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.

Benchmark A: Evaluate the accuracy, authority, objectivity, currency, coverage and relevance of information and data sources.

Evaluating Sources

1. Select relevant information by identifying main ideas and supporting facts that help answer questions.

2. Determine that information located can be used legally and choose appropriately (e.g., locate copyright information for print and graphic information, check for copyright restrictions).

3. Check copyright and publication dates to determine currency of information.

4. Investigate the authority of an online information source to determine the author’s qualification to be an expert about a topic (e.g., famous scientist versus a sixth-grader’s Web site; well-known organization versus a personal Web site).

5. Distinguish when current copyright dates of sources are important in answering an information need (e.g., science information on cloning, results of an election).

6. Assess the objectivity (ability of an author to present information without bias) of a source when using information.

7. Compare multiple sources (online encyclopedia, Web site, online magazine database, print source) to check accuracy of information (e.g., do facts match on each site?).

8. Determine the scope of coverage for a given source (does the source cover all of the needed information?).

9. Chart information gathered from multiple sources to determine facts to be used in a project.

10. Understand the structure and organization of information sources including keywords, subject directory, subject search in a library catalog or search engine.

11. Demonstrate how to determine copyright issues when creating new products:
    a. Ask permission to use articles, quotations and graphics
    b. Credit information to be included in the product

12. Examine two Web sites with opposing viewpoints and describe the objectivity and intent of the author (e.g., candidates in an election or other public issues).

13. Evaluate the validity of information by comparing information from different sources for accuracy (e.g., what makes the author an expert? is information the same in multiple sources?).
Benchmark B: Use technology to conduct research and follow a research process model which includes the following: developing essential question; identifying resources; selecting, using and analyzing information; synthesizing and generating a product; and evaluate both process and product.

Decide

1. Develop open-ended research questions about a defined information need.
2. Formulate an essential question to guide the research process.

Find

1. Select and evaluate relevant information about a specific topic in several sources.
2. Identify and evaluate relevant information and select pertinent information found in each source.
3. Select information from different types of subscription resources (fee-based, pay-per-use) to meet an information need (e.g., magazine database, picture archive, online encyclopedia).
4. Analyze information, finding connections that lead to a final information product.

Use

1. Compile information learned about a topic from a variety of sources.
2. Demonstrate how to determine copyright issues when creating new products (e.g., permission to use articles and graphics, credit information to be included).
3. Create information products to share information using different formats (e.g., print, audio recording, digital, video, slide show).
4. Use a teacher or district designated citation or style manual to credit sources used in work (e.g., MLA style manual, APA Guidelines or other selected style manuals).
5. Digitize information for archiving and future use (e.g., creating an electronic portfolio of curricular projects).

Check

1. Evaluate how information was found and assess the quality of the information product.
2. Revise and edit information product.
3. Evaluate final product for its adherence to project requirements (e.g., recognize weaknesses in process and product and find ways to improve).
Benchmark C: Develop search strategies, retrieve information in a variety of formats and evaluate the quality and appropriate use of Internet resources.

**Internet Concepts**

1. Recognize that some Web information requires special software for its use (e.g., discuss what plug-ins are and how they expand the use of the Internet).

2. Troubleshoot error messages in a Web browser (e.g., verify the address, use refresh and/or stop buttons).

**Search Strategies**

1. Search a student-selected online directory or search engine by subject, keyword, author, title, date and/or format.

2. Use Boolean operators in the search process (e.g., use Boolean logic to expand a search and to limit a search “AND” “OR” “NOT”).

3. Perform searches for information in specific formats (e.g., graphics, images, journal articles).

4. Compare information found in searches done on different types of Internet resources (e.g., directory, search engine, meta engine).

5. Incorporate Boolean operators in the search process for curricular needs (e.g., know the basic Boolean operators and use them in a search).

6. Compare information found in searches completed on different search engines (directories, spiders, meta crawlers) and discuss differences in how search engines select, rank and display information:
   a. Relevancy
   b. Popularity
   c. Paid placement

**Evaluating Sources**

1. Report elements of a Web site that make it effective (e.g., describe why the Web site is appropriate for the particular information needed).

2. Compare several Web sites on the same topic and evaluate the purpose of each site (e.g., use several sites for a specific curricular need and note whether the sites have similar or conflicting data).
**Benchmark D:** Select, access and use appropriate electronic resources for a defined information need.

*Electronic Resources*

1. Demonstrate search techniques: author, title, subject for subscription (fee-based) databases.

2. Use online library catalog to choose and locate a variety of resources on a topic.

3. Compare search results through the use of different keywords (e.g., search for conservation information using “garbage” and search again using “waste disposal”).

4. Examine information in different types of subscription (fee-based) databases to locate information for a curricular need (e.g., online encyclopedia, online subject dictionaries, magazine index, picture archive).

5. Select research databases that align with identified information need (e.g., specialized databases on government, science, history, as needed for assignments).

6. Retrieve information in different types of subscription (fee-based) databases to support information for a curricular need.

7. Locate and use advanced search features and appropriate tools such as Boolean operators (“AND” “OR” “NOT”) and a thesaurus in an online database.
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

Benchmark A: Evaluate the aesthetic and functional components of a design and identify creative influences.

Design Process

1. Describe how design is a creative planning process that leads to useful products and systems.

Requirements

1. Identify appropriate materials (e.g., wood, paper, plastic, aggregates, ceramics, metals, solvents, adhesives) based on specific properties and characteristics (e.g., weight, strength, hardness and flexibility) for the design.

2. Categorize the requirements for a design as either criteria or constraints.

Design Application

1. Apply a design process to solve a problem in the classroom specifying criteria and constraints for the design (e.g., criteria include function, size and materials; constraints include costs, time and user requirements).

Optimization and Trade-offs

1. Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.

2. Make the product or systems and document the design.

Redesign

1. Recognize that any design can be improved (e.g., old style scissors work but new ones with plastic on the finger holes are more comfortable and give more surface area for leverage).

Technical Communication

1. Diagram how design is iterative and involves a set of steps, which can be performed in different sequences and repeated as needed (e.g., identify need, research problem, develop solutions, select best solution, build prototype, test and evaluate, communicate, redesign).

2. Make two- and three-dimensional representations of the designed solution (e.g., 2-D includes sketches, drawings, and computer-aided designs—CAD and 3-D includes graphic, mathematical and physical models).
Technical Careers

1. Investigate how products are created and communicate findings (e.g., interview an architect, industrial designer, contractor about the processes they follow).

Inventors/Inventions

1. Identify inventors and designers from antiquity who contributed to the development of each of the technological systems (e.g., contributions from Chinese, Greeks, Romans, Arabs, Egyptians and Renaissance in Europe).

Universal Design

1. Evaluate examples of Universal Design use that meet common challenges individuals encounter (e.g., limitations concerning mobility, vision, strength, reach and clarity in communication).
2. Identify environments or products that are examples of the application of the principles of Universal Design (e.g., equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use).

Technical Contradictions

1. Describe how aesthetic and functional components both complement and conflict with each other (e.g., a brace to keep a bookcase from rocking may not be consistent with the beauty of the object).

Research and Development

1. Review existing designs and suggest ways that they can be improved (e.g., how have food containers changed over time and how can they be improved?).

Technical Problem-solving

1. Describe how brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.

Design Application

1. Apply a design process to solve a problem in the school or community (e.g., identify need, research problem, develop solutions, select best solution, build prototype, test and evaluate, communicate, and redesign.

Technology Assessment

1. Research and diagram the product development life-cycle of an invention.

Ergonomic Design

1. Apply ergonomic considerations to a design to maximize a design’s ease of use and to minimize product liability (e.g., ergonomic keyboards decrease wrist injury).
Optimization and Trade-offs

1. Document compromises involved in design (e.g., cost, material availability).

**Benchmark B**: Recognize the role of engineering design and of testing in the design process.

**Engineering Design**

1. Describe how engineering design is a subset of the overall design process concerned with the functional aspect of the design.

2. Summarize the role of engineering design.

3. Examine how modeling, testing, evaluating and modifying are used to transform ideas into practical solutions (e.g., making adjustments to a model race vehicle to improve performance).

4. Describe the relationship between engineering, science and mathematics.

5. Describe and test the characteristics of various materials (e.g., strength, color, conductivity).

6. Explain how design involves a set of steps that can be performed in different sequences and repeated as needed (e.g., plan – do – study – act; problem analysis – design – coding and debugging – integration – testing and validation; define problem – identify options – identify best solution – plan how to achieve best solution – evaluate results).

7. Identify how modeling, testing, evaluating and modifying are used to transform ideas into practical solutions.

**Technical Careers**

1. Describe what an engineer does (e.g., analyze information found on engineering society Web sites).

**Strength and Materials**

1. Test compression, tension and torsion strength of a material or system.

**Benchmark C**: Understand and apply research, innovation and invention to problem-solving.

**Technical Problem-solving**

1. Examine how troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system (e.g., if after installing a switch in a circuit the light does not come on, how would you determine the problem?).

2. Distinguish between problems that do and do not have a technological solution (e.g., a recycling system and processes can be designed, but voluntary participation is a public attitude issue).
Design Application

1. Determine the best use of recycled plastics in the manufacture of new products (e.g., using seven different plastic packaging resin code-marked products).

Technology Assessment

1. Recognize the patterns of the technological evolution of an invention (e.g., steam engines were invented, went through a period of rapid improvement, followed by a period of fine tuning and eventually were replaced by diesel/electric technology).

Redesign

1. Modify an existing product or system to improve it (e.g., something to improve storage in your locker).

Technical Contradictions

1. Explain that understanding the function of an object requires a higher level of thinking than focusing on the object itself.

Research and Development

1. Describe how some technological problems are best solved through experimentation.
2. Describe and complete an experiment to evaluate the solution to a problem.

Technical Communication

1. Evaluate the credibility and applicability of information obtained to address a specific problem (e.g., what measurements should be used to build a chair or a piece of clothing?; are they based on the prospective customers?).

Technology Transfer

1. Identify the patterns of technological invention (e.g., identify the patterns of invention in current products and systems).

Principles of Design

1. Explain the design axiom that form follows function.

Design Application

1. Invent a tool to solve a problem.

Optimization and Trade-offs

1. Describe how invention is a process of turning ideas and imagination into devices and systems; and innovation is the process of modifying an existing product or system to improve it.
Technology Assessment

1. Evaluate a variety of creativity-enhancing techniques.

Technology Transfer, Diffusion

1. Describe how inventions can have multiple applications, some not originally intended.

Innovation and Invention

1. Identify the five levels of innovation and describe their characteristics:
   a. Apparent or conventional solution
   b. Small invention inside paradigm
   c. Substantial invention inside technology
   d. Invention outside technology
   e. Discovery
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.

Benchmark A: Develop an understanding of, and be able to select and use, physical technologies.

Energy and Power

1. Describe and use different energy storage devices.
2. Describe how power systems are used to drive and provide propulsion to other technological products and systems.
3. Understand that energy can be used to do work using many processes.
4. Describe why it is important for personnel in energy and power technologies to constantly update their knowledge and skills.
5. Understand that power is the rate at which energy is converted from one form to another or transferred from one place to another, or the rate at which work is done.
6. Solve a problem involving energy and power systems (e.g., build a roller coaster for marbles, solar vehicles or solar cookers).
7. Explore ways that energy can be used more efficiently (e.g., improved insulation to reduce heat loss, improved aerodynamics to reduce drag, improved engines to increase efficiency).
8. Estimate and measure power consumption and compare estimates to actual measurements (e.g., compare real to the estimated energy bills at home).

Transportation

1. Describe how transporting people and goods involves an interdependence of individuals and vehicles (e.g., flying from Orlando to Cleveland involves transportation to the departure airport, transportation through the airport, the flight, and transportation from the destination airport).
2. Identify and compare examples of transportation systems and devices that operate on each of the following: land, air, water and space.
3. Describe how transportation vehicles are made up of subsystems, such as structural, propulsion, suspension, guidance, control and support that must function together for a system to work effectively.
4. Describe how licensure and certification are an integral part of transportation careers (e.g., commercial driver’s license, safety inspector’s license, pilot’s license).
5. Identify and manipulate the factors that influence vehicle performance (e.g., lift, drag, friction, thrust, pressure and gravity).

6. List the processes, such as receiving, holding, storing, loading, moving, unloading, delivering, evaluating, marketing, managing, communicating and using conventions which are necessary for the entire transportation system to operate efficiently.

7. Describe how governmental regulations influence the design and operation of transportation systems (e.g., seatbelts, airbags, noise levels).

8. Describe why it is important for personnel in transportation technology to constantly update their knowledge and skills.

Manufacturing

1. Produce a product using mechanical processes that change the form of materials through the processes of separating, forming, combining and conditioning them (e.g., build a solar cooker).

2. Classify manufactured goods at home as durable and nondurable (e.g., appliances, furniture, clothing, fabrics).

3. Design, develop, fabricate and service a product (e.g., a pop bottle rocket, manufacture toys, clean computer keyboards).

4. Analyze how marketing impacts the selection of the manufacturing process for a product.

5. Safely disassemble a (possibly broken) product and describe what systems are inside, hypothesize how it was manufactured, and explain what materials were used and, possibly, how it works.

6. Describe a manufacturing organization (e.g., corporate structure, research and development, production, marketing, quality control, distribution).

7. Discuss how chemical technologies can be used in manufacturing processes (e.g., plastics, adhesives, insulation, personal care product).

8. Describe the location and extraction of natural resources that are used in manufacturing processes (e.g., harvesting, drilling and mining).

9. Explain and utilize basic processes in manufacturing systems (e.g., cutting, shaping, assembling, joining (including stitching), finishing, quality control and safety).

10. Explain and give examples of the impacts of interchangeable parts, components of mass-produced products, and the use of automation (e.g., robotics).

11. Organize and implement an enterprise to manufacture a product.

Construction

1. Describe why it is important that structures rest on a solid foundation.
2. Describe and explain parts of a structure (e.g., foundation, flooring, decking, wall, roofing systems).

3. Identify the components of various building subsystems (e.g., on pictures of classroom or various places in the school, label the electrical, lighting, HVAC, plumbing, communication and structural subsystems).

4. Identify and construct a type of structure (e.g., a model bridge including arch, beam and suspension) and their appropriate uses (e.g., site, span, resources and load).

5. Describe how the selection of designs for structures is based on factors such as building laws and codes, including Americans with Disabilities Act concerns, style, convenience, cost, climate and function.

6. Explain how the forces of tension, compression, torsion, bending and shear affect the performance of structures.

7. Describe and model the effects of loads and structural shapes on structures.

**Benchmark B:** Develop an understanding of, and be able to select and use, information technologies.

**Information and Communication**

1. Describe how information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine.

2. Demonstrate the importance of a common language to express ideas through the use of symbols, measurements and drawings.

3. Identify the source, encoder, transmitter, receiver, decoder and destination in communication systems.

4. Solve a problem involving information and communication technological systems (e.g., prepare a video presentation, set up a communication system between two points in the school).

5. Identify and explain the appropriate tools, machines and electronic devices (e.g., drawing tools, computer-aided design, and cameras) used to produce and/or reproduce design solutions (e.g., engineering drawings, prototypes, and reports).

6. Explain the factors that influence message design (e.g., intended audience, medium, purpose, budget and nature of message).

7. Describe why it is important for personnel in information and communication technologies to constantly update their knowledge skills.
Benchmark C: Develop an understanding of how bio-related technologies have changed over time.

Medical

1. List advances and innovations in medical technologies that are used to improve health care (e.g., prevention, diagnosis, treatment, rehabilitation).

2. Describe why it is important for medical personnel to constantly update their knowledge and skills.

3. Explain that there are a variety of diagnostic methods and treatments for a medical problem.

4. Describe how advances in a variety of technological systems influence the development of medical devices.

5. Describe how the sanitation processes used in the disposal of medical products help to protect people from harmful organisms and disease and shape the ethics of medical safety.

6. Describe how previously discarded medical practices are sometimes reinstated.

7. Recognize how the medicines we use affect our ongoing health and attitudes.

8. Explain examples of adaptive or assistive devices (e.g., prosthetic devices, wheelchairs, eyeglasses, grab bars, hearing aids, lifts, braces, computer devices).

9. Relate how vaccines developed for use in immunization require specialized technologies to support/control environments in which a sufficient amount of vaccines are produced.

10. Describe how licensure is an integral part of medical careers.

11. Recognize the need for appropriate models in testing medicines and medical procedures (e.g., medicine testing that developed dosages for adult males but was used for children and females).

12. Describe how technology is used to protect people from disease and illness, but can also aid their spread.

Agriculture and Related Biotechnologies

1. Describe how technological advances in agriculture directly affect the time and number of people required to produce food for a large population.

2. Describe how biotechnology applies the principles of biology to develop commercial products or processes.

3. Describe a wide range of specialized equipment and practices that are used to improve the production of food, fiber, fuel and the care of animals.
4. Identify artificial ecosystems that are human-made complexes that replicate some aspects of the natural environment.

5. Describe how agricultural products are used to produce fuels (e.g., converting corn to ethanol and soy beans to biodiesel).

6. Explain that the development of refrigeration, freezing, dehydration, preservation and irradiation allows for long-term storage of food and reduces the health risks caused by tainted food.

7. Describe why it is important for personnel in agriculture and biotechnologies to constantly update their knowledge and skills.
HIGH SCHOOL TECHNOLOGICAL STUDIES PROGRAM

The High School Technological Studies Program is experience-based and involves the application of mathematics, science, language arts, and social studies concepts in technological systems such as construction, communications, woods, electricity, photography, multimedia, principles of technology and computer assisted drafting. Students work individually and in teams to solve problems related to technology – its evolution, systems techniques, utilization, and social and cultural significance. Students are taught how to utilize, interact and live in a rapidly changing, highly technological society.

The development of the High School program demonstrates an effective integrated approach to learning with mathematics and language arts. Interdisciplinary teams of teachers work together for cross-curriculum planning and integrated delivery of instruction. Cooperative learning, ingenuity challenges, and computer assisted instruction are some of the approaches used to provide students with hands-on learning experiences in which they can demonstrate established learning outcomes.

The Worthington Schools High School Technological Studies Program recognizes and capitalizes on the students’ inherent potential for reasoning and problem-solving, for imagining and creating, for constructing and expressing by using tools and materials from which technology and industry spring.
Course Description:
Principles of Technology is a course comprised of seven units, each of which focuses on the important concepts that form the foundation of modern technology concepts. Each unit explains how that concept applies to mechanical, fluid, electrical, and thermal systems. It blends an understanding of basic principles with practice in practical applications. It will provide a firm foundation for understanding the technology that surrounds students today and in the future. Principles of Technology integrates the basic principles of physical science and incorporates mathematical concepts in the application process.

STANDARD 1: NATURE OF TECHNOLOGY
Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion
1. List and describe factors that may influence the development of technology.
2. 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).
3. Illustrate ways that the rate of technological development and diffusion is exponential.
4. Predict the impact of the exponential development and diffusion of technology.

Goal-directed Research
1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.
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).
3. Describe, discuss and cite examples of how goal-directed research results in innovation.
4. Invent a product using goal-directed research.

Commercialization of Technology
1. Make informed choices among technology systems, resources and services.
2. Explain how technological development is influenced by many factors, including profit incentive and market economy.
3. Predict how profit incentive and the market economy influence technological development.
4. Plan/construct technological products considering profit incentive and market economy.
**Nature of Technology**

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

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

**Benchmark B:** Apply technological knowledge in decision-making.

**Optimization and Trade-offs**

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.

2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

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

**Sustainability**

1. Discuss how sustainability is a balance of economic prosperity, environmental quality and social equity.

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

**Nature of Technology**

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

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

**Technology Transfer**

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.

2. Analyze technology transfer scenarios.
3. Identify technologies suitable for transfer and defend the rationale for selection.

4. 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**

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

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.

4. Cite examples of how technological innovation has resulted when ideas, knowledge or skills have been shared within, or among, other technologies.

5. Illustrate the relationship of technological progress to the advancement of science, mathematics and other fields.

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

7. 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.

**Benchmark A:** Interpret and practice responsible citizenship relative to technology.

*Technology and Citizenship*

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Review how different factors, such as individual curiosity, advertising, the strength of the economy, the goals of a company and the current trends, contribute to shaping the design of and demand for various technologies.

4. Understand how different cultures develop their own technologies to satisfy their individual and shared needs, wants and values.

5. Understand that the development of technology may be influenced by societal opinions and demands, in addition to corporate cultures.

6. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

7. Assess technology systems, resources and services relative to responsible usage of technology.

8. Describe how changes caused by the use of technology can range from gradual to rapid, and from subtle to obvious.

9. Compare and evaluate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

10. Analyze the causes, consequences and possible technology solutions to problems in a persistent, contemporary and emerging world (e.g., health, security, resource allocation, economic development or environmental quality).

11. Examine the ethical considerations of a governmental technology policy that affects the physical characteristics of a place or region (e.g., building of the oil pipeline in Alaska, mineral rights under farmland).

12. Compare and evaluate alternate public policies for technology deployment and the use of natural resources.

13. Make informed choices among technology systems, resources and services.
14. 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.

15. Debate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

16. 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).

**Technology Transfer**

1. Provide examples of technology transfer from a government agency to private industry, and discuss the benefits (e.g., global positioning systems—GPS, Internet).

2. 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).

3. 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 workplace needs.

4. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

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

**Technology and Environment**

1. Investigate the use and development of appropriate technologies to meet the needs of persons living in developing countries (e.g., hand-crank powered radio for communication).

2. 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).

3. 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).

4. Demonstrate how technological decisions involve trade-offs between predicted positive and negative effects on the environment.

5. Forecast intended and unintended consequences of technology deployment.
Benchmark C: Interpret and evaluate the influence of technology throughout history, and predict its impact on the future.

Technology and History

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

2. Select a technology or tool and predict how it will change in the future.

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

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

5. Compare and contrast periods of technology proliferation in the world, and the related social and economic influences.

6. Understand the basic elements of the evolution of technological tools and systems throughout history.

7. Debate the position that technology has been a powerful force in reshaping the social, cultural, political and economic landscape, citing references and examples.
STANDARD 3: TECHNOLOGY FOR PRODUCTIVITY APPLICATIONS

Students learn the operations of technology through the usage of technology and productivity tools.

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

Understanding Operations

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

Productivity Tools

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).

2. Utilize advanced word processing and desktop publishing features and programs.

Communication Tools

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

Problem-solving

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

Knowledge Generation

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

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.

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

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

5. Describe quality and how it is evaluated in the product or system.

6. Select and use simulation in the design process.

7. 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).

8. 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).

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

10. 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.

11. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

Technical Contradictions

1. 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).
2. 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).

3. Identify how contradictions were overcome in existing solutions.

4. 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).

5. Apply the separation principles to overcome contradictions in systems (e.g., time, space, combining or dividing systems, physical-chemical changes).

Requirements

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

Optimization and Trade-offs

1. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).

2. Identify criteria and constraints for a design problem and determine how they 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).

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

Technical Problem-solving

1. 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).

2. Apply the concepts of system dynamics and systems thinking to the solution of problems.

Technical Communication

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

2. 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.
3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.

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

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

4. Predict/project the need for changes in copyright, patent and trademark laws, considering the rapid changes in technology and society.

**Understanding Technological Systems**

1. 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.

2. 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).

3. 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).

**Technology Transfer**

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

**History of Design**

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

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

**Universal Design**

1. 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).

2. Evaluate and rate the quality of an existing household product or system.
Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

**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).

4. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

5. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

6. 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).

7. Build a prototype to use as a working model to demonstrate a design’s effectiveness to potential customers.

**Requirements**

1. 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**

1. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

2. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

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

4. Demonstrate the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills in the design process.
**Technical Careers**

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

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

**Quality Design**

1. Evaluate a design using established design principles to collect data on the design’s effectiveness, and suggest improvements (e.g., how can bicycles be made safer?).

2. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process.

3. Explain how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

4. Explain how gender-bias, racial-bias and other forms of stereotyping and discrimination can affect communication within an engineering team.

5. Evaluate a design completed or created by another group of students using established design principles.

6. Describe the relationship between engineering disciplines.

7. Describe how a prototype is a working model used to show how subsystems interact.

8. Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

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

10. 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 Practice**

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

**Technical Communication**

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

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

**Technical Contradictions**

1. Describe how to identify conflicts or contradictions in technological systems.
Engineering Design

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

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

Research and Development

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

Market Research

1. Research consumer preferences for a new product.

Quality Design

1. 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.

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

Idea Generation

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

Technical Problem-solving

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

Redesign

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

Emerging Technology

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

Innovation and Invention

1. 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**

1. 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).

2. 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).

**Universal Design**

1. 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**

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

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

**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**

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

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

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

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

Safety

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

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

Engineering Practice

1. Measure voltage, resistance and current in electrical systems and describe the different instruments used.

2. Explain the relationship between resistance, voltage and current (Ohm’s Law).

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

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

Use and Maintain Technological Systems

1. Differentiate between hydraulic and pneumatic systems and provide examples of appropriate applications of each as they relate to manufacturing and transportation systems.

2. Identify and investigate AC and DC circuits (e.g., sources, conductors, controls, loads, applications, purposes, safety, components, symbols, principles and operations).
3. Employ energy and power technologies to resolve practical problems (e.g., efficient power production, conversion and transmission).

4. Build energy and power devices using the appropriate technological tools, machines, equipment, materials and technical processes to solve a problem in the community.

5. Identify the sources of energy, conversion process, and load in a variety of power systems (e.g., tractor, electrical grid, elevator).

6. Differentiate among conduction, convention, and radiation in a thermal system (e.g., heating and cooling a house, cooking).

7. Identify and explain the components of a circuit including a source, conductor, load and controllers (controllers are switches, relays, diodes, transistors, integrated circuits).

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

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

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

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

12. 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**

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

2. 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).

**Emerging Technology**

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

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

*Design Application*

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

2. 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).

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

*Technical Standards*

1. 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).

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

*Technical Careers*

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

*System Management*

1. 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).

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

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.

*Safety*

1. Identify and apply appropriate safety measures when working with transportation technologies.
Use and Maintain Technological Systems

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

Design Applications

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

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

Emerging Technology

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

Technical Standards

1. 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.

Technical Careers

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

System Management

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

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

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

2. 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).
Use and Maintain Technological Systems

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

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

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

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

5. 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).

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

7. 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).

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

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

Technology Assessment

1. 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

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

Design Applications

1. 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).

2. Use marketing to establish a product’s viability and identity, conduct research on its potential, advertise it, package it, distribute it and sell it.
**Technical Communication**

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

**Engineering Practice**

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

**Technical Standards**

1. 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.

**Technical Careers**

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

**System Management**

1. 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**

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

**Engineering Practice**

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

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

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

4. Calculate quantitatively the resultant forces for live loads and dead loads.
Use and Maintain Technological Systems

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

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

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.

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

8. 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).

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

Design Applications

1. 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).

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

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 Communication

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

Emerging Technology

1. 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).
Technical Standards

1. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, 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 E: Classify, demonstrate, examine and appraise information and communication technologies.

Technical Careers

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

Safety

1. 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

1. 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).

2. 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).

3. 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).

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

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

6. 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**

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

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).

**Emerging Technology**

1. Investigate emerging (state-of-the-art) and innovative applications of information and community technology.

**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.

**Technical Standards**

1. 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.

**Technical Careers**

1. Appraise the careers available in medical technological systems and the training period needed to pursue them.
2. List advances in the sciences of biochemistry and molecular biology that have made it possible to manipulate the genetic information found in living creatures.

3. Describe how medicines and treatments may have both expected and unexpected results.

**Safety**

1. Identify and apply appropriate safety measures when working with medical technologies.

2. Safely use the tools and processes of medical technological systems (e.g., virtual dissection software).

3. Monitor and apply appropriate safety measures when working with medical technologies.

**Design Application**

1. 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**

1. Examine new sensing technologies being used to diagnose medical conditions less invasively (e.g., CT-Scan, MRI, MRA).

**Emerging Technology**

1. Investigate emerging (state-of-the-art) and innovative applications of medical technologies.

2. Investigate and evaluate new medical technologies.

**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.

**Use and Maintain Technological Systems**

1. Employ medical technologies to resolve practical problems (e.g., choose an appropriate bandage for an injury, contact the appropriate service provider in an emergency).

**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

1. 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.

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

1. 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).

2. 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).

Safety

1. Identify and apply appropriate safety measures when working with agricultural and related biotechnologies.

2. Investigate emerging (state-of-the-art) and innovative applications of agricultural and related biotechnologies.

3. Prioritize and apply appropriate safety measures when working with agricultural and related biotechnologies.

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.

Use and Maintain Technological Systems

1. Employ agricultural and biotechnologies to resolve practical problems (e.g., growing food year-round, using plants to eliminate erosion).
Technology Assessment

1. 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 distribution center grown hydroponically and traditionally).

2. Evaluate the effects of genetic engineering, fertilizers, herbicides, and pesticides on the environment and the production of food.

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).

Technical Standards

1. 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).
Course Descriptions:

Computer Aided Design (CAD) 1 is an introductory course that provides students with basic knowledge of computer assisted drafting processes and techniques. Students explore some of the problems in and relative to the language of technical illustration and design. The two main themes of this course include establishing skills in computer assisted drafting and applying those skills to problem-based situations found in the architectural and engineering fields. This course also provides a means by which students can visualize and express graphically their own ideas and interpret the ideas of others.

Computer Aided Design 2 is an intermediate level course that continues the themes of CAD 1 but with strong focus on architecture. Computer aided design skills are reinforced, enhanced and challenged in this course. A significant portion of this course is dedicated to applying the learned drafting and CAD skills to challenging engineering and architectural projects.

Computer Aided Design 3 is an advanced level course designed for the student that has identified strong personal interest and/or recognized individual talent for the skills and concepts associated with design, engineering, architecture or other associated fields of study. Computer aided design skills are reinforced, enhanced and challenged at an advanced level. A majority of this course is dedicated to meeting the needs of each individual student. The teacher and each individual student work together at the beginning of the course to develop an individual education plan. This plan identifies the field of study, goals, objectives, specific activities, timelines and assessment requirements.

STANDARD 1: NATURE OF TECHNOLOGY

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion

1. List and describe factors that may influence the development of technology.

2. 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).

3. Illustrate ways that the rate of technological development and diffusion is exponential.

Goal-directed Research

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

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).

3. Describe, discuss and cite examples of how goal-directed research results in innovation.

Commercialization of Technology

1. Make informed choices among technology systems, resources and services.
Benchmark B: Apply technological knowledge in decision-making.

**Optimization and Trade-offs**

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.

2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

**Sustainability**

1. Discuss how sustainability is a balance of economic prosperity, environmental quality and social equity.

2. 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.

**Innovation and Invention**

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

2. Describe how technological innovation often results when ideas, knowledge or skills are shared within a technology.

3. Cite examples of how technological innovation has resulted when ideas, knowledge or skills have been shared within, or among, other technologies.

4. 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.

**Benchmark A:** Interpret and practice responsible citizenship relative to technology.

*Technology and Citizenship*

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Understand how different cultures develop their own technologies to satisfy their individual and shared needs, wants and values.

4. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

5. Compare and evaluate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

6. Analyze the causes, consequences and possible technology solutions to problems in a persistent, contemporary and emerging world (e.g., health, security, resource allocation, economic development or environmental quality).

7. Make informed choices among technology systems, resources and services.

*Technology Transfer*

1. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

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

*Technology and Environment*

1. 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).

2. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.
3. Forecast intended and unintended consequences of technology deployment.

4. 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.

**Technology and History**

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

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

3. Understand the basic elements of the evolution of technological tools and systems throughout history.

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

**Technology and Ethics**

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

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

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.

**Technology Assessment**

1. Collect information about products and systems and evaluate the quality of that information.
STANDARD 3: TECHNOLOGY FOR PRODUCTIVITY APPLICATIONS

Students learn the operations of technology through the usage of technology and productivity tools.

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

**Understanding Operations**

1. Explore state-of-the-art devices to store data that will be used for researching projects.
2. Create a design for a basic network and list skills needed to manage networks.
3. Examine current and past devices for storing data and predict potential devices for the future.
4. Analyze various types of connectivity and list pros and cons of each.
5. Make informed choices among technology systems, resources and services.
6. Explore state-of-the-art devices to store data.

**Problem-solving**

1. Describe strategies for identifying and solving routine hardware and software problems that occur during everyday use.
2. Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.
3. Research technology systems, resources and services to solve technical problems.
4. 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.

**Understanding Operations**

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras-a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

**Productivity Tools**

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).
2. Utilize advanced word processing and desktop publishing features and programs.
Communication Tools

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

Problem-solving

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

Knowledge Generation

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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.

Benchmark A: Apply appropriate communication design principles in published and presented projects.

Multimedia Applications

1. Format text, select color, insert graphics and include multimedia components in student-created media/communication products.

Accessibility Guidelines

1. Modify electronic publications and other communication products to meet accessibility guidelines so that access to information is not limited.
2. Verify accessibility components of the communication product and adapt as needed.

Evaluation

1. Examine how and why image, language, sound and motion convey specific messages designed to influence the audience.
2. Assess the accuracy of the communication product.
3. Compare and contrast the accuracy of the message/communication product with the audience results (e.g., was the audience influenced by inaccurate information?).
4. Select and evaluate message-appropriate designs for print, multimedia, video and Web pages for curricular and personal needs (e.g., silly graphics may not be appropriate for academic projects).
5. Analyze the complexities and discrepancies found in communication products.
6. Interpret ethical considerations and legal requirements involved in construction of communication products.

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

1. Manipulate communication design elements (image, language, sound and motion) based on intent of the message (e.g., inform or persuade).
2. Employ design techniques taking into consideration the psychological impact and cultural connotations of color when designing for print media and multimedia, video and Web pages.
3. Apply principles of design (contrast, repetition, alignment and proximity) for academic and personal needs (e.g., resume, scholarship application).

4. Adapt design concepts to emerging technologies.

5. 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).

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

**Use of Communications**

1. Use e-mail in a teacher-moderated discussion group and in threaded discussion lists.

2. Use technology to publish information in electronic form (e.g., Web, multimedia, digital video, electronic portfolio).

3. Use Web technologies to disseminate information to a broader audience.

**Evaluation**

1. Validate use of communication techniques.

2. Evaluate communication products.

3. Critique personal communication products.

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

**Publication**

1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).

**Electronic Communications**

1. Archive communication products in appropriate electronic forms (e.g., store electronic publications so that they may be accessed when needed).
Benchmark C: Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

Use of Communications

1. Demonstrate communication clarity and use elements and formats of e-mail to communicate with others (e.g., discussion lists, message board, chat, instant messaging).

2. Identify and use the appropriate communication tool to collaborate with others (e.g., presentation, Web site, digital video).

3. Investigate the uses of videoconferencing, Web casting, and other distance learning technologies (e.g., interviews, meetings, course work).

4. Develop collaborative online projects to research a problem and disseminate results.

5. Contribute to organized e-mail discussions (e.g., discussion list, list serv, threaded discussion list, courseware discussion).

6. Employ online communication capabilities to make inquiries, do research and disseminate results (e.g., develop dialogues on issues in U.S. government).

7. Implement online-structured learning experiences (e.g., tutorials, virtual classes, industry certification courses).

8. Select an appropriate e-mail discussion list to meet communication needs (e.g., purpose of list, participants, audience, topics, ease of use).

9. Integrate online communication capabilities to make inquiries, do research and disseminate results (e.g., group writing projects, college searches, career information inquiry).

10. Collaborate in online learning or videoconferencing activities based on research and/or an investigation of real-world problems (e.g., study of community or regional ecosystem).

11. Select and use appropriate online structured learning experiences to meet individual learning needs.

12. Communicate using all manifestations of e-mail, as needed, for personal and curricular purposes, demonstrating appropriate and responsible use.

13. Use all available online communication capabilities to make inquiries, do research and disseminate results.

Evaluation

1. 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.

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

**Evaluating Sources**

1. Define terms which determine information validity:
   a. Accuracy
   b. Authority
   c. Objectivity
   d. Currency
   e. Coverage (including objectivity and bias)

2. Determine the author’s authority for all resources and identify points of agreement and disagreement among sources.

3. 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).

4. 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).

5. Create a bibliography of sources in an electronic format.

6. Select appropriate information on two sides of an issue (e.g., identify the author of each information source and their expertise and/or bias).

7. Seek and evaluate information to answer both personal and curricular needs.

8. Analyze the intent and authorship of information sources used for a curricular need.

9. Determine valid information for an assignment from a variety of sources.

10. Evaluate information collected to answer both personal and curricular needs to determine its accuracy, authority, objectivity, currency and coverage.

11. Acknowledge intellectual property in using information sources.

12. 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.

**Decide**

1. Determine the essential questions and plan research strategies.

2. Select the essential question to be examined by the research.

3. 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.

4. Select essential questions for research and use a recognized or personally developed model to conduct independent research.

5. Derive a personally developed research model to conduct independent research.

6. Refine the information question to focus the research process, modifying the question as necessary to broaden or narrow the inquiry.

**Find**

1. Select and evaluate appropriateness of information from a variety of resources, including online research databases and Web sites to answer the essential questions.

2. Evaluate information and select relevant and pertinent information found in each source, and maintain accurate records of sources used.

3. Identify, evaluate information and select relevant and pertinent information found in each source.

4. Identify relevant facts, check for validity, and record appropriate information keeping track of all sources.

5. Critique information sources to determine if different points of view are included.

6. Integrate multiple information sources in the research process.

**Use**

1. Integrate copyrighted information into an information product, following appropriate use of guidelines (e.g., quote using proper citation format, request permission to use).

2. Identify relevant facts, check facts for accuracy and record appropriate information.

3. Incorporate a list of sources used in a project using a standard bibliographic style manual (e.g., MLA and APA Style Manuals).

4. Organize and analyze information, finding connections that lead to a final product.

5. Follow copyright law and use standard bibliographic format to list sources.
6. Analyze information and synthesize into a communicated product.

7. Respect copyright laws and guidelines, and use standard bibliographic format to list sources.

8. Create a product to communicate information, representing a personal point of view based on findings.

9. 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**

1. Evaluate the research process and product as they apply to the information need (e.g., does the process reflect the actual information need).

2. Assess whether the essential questions are answered, gather more information and data and modify search terms as needed. Edit the product.

3. Review and evaluate research process and the resources used (e.g., how can the research process be improved?).

4. Critique and revise the information product.

5. Review the research process for efficiency and effectiveness.

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

**Manage**

1. Archive the final product in a format that will be accessible in the future.

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**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.

**Search Strategies**

1. Identify multiple directories and search engines matching curricular need (e.g., given an assignment, use knowledge of tools to pick an appropriate tool to search for information).

2. Construct search strategies focused on the retrieval of specific search results by incorporating Boolean operators “AND” “OR” NOT” and adjacency/proximity techniques.

3. Compare and chart the search results from multiple Web sites to check for consistency of information (e.g., compare data on acid rain from more than one site).

4. Construct an effective search strategy to retrieve relevant information through multiple search engines, directories and Internet resources.
5. Narrow or broaden the search strategy by modifying the keywords entered in the original search strategy.

6. 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).

7. Demonstrate the use of parentheses for nesting search terms to alter retrieval strategies through multiple Internet resources.

8. Create a product on a specific curricular topic that includes annotated Web sites constructed according to a standard style manual (e.g., electronic pathfinder on careers).

9. Incorporate defined field searching by initiating a search string identifying the desired field of information to be retrieved (e.g., search author or title).

10. Create a stand-alone system for tracking Internet resources for personal and academic needs (e.g., postsecondary institutions of interest).

**Evaluating Sources**

1. Establish criteria for evaluating the information retrieved through Internet searching: author’s expertise, bias, coverage of topic and timeliness.

2. Examine the information retrieved through Internet searching for authenticity of information, bias, currency, relevance and appropriateness.

3. Develop a systematic approach to judge the value of the retrieved Web information.

4. Synthesize search results retrieved from a variety of Internet resources to create an information product for a targeted audience.

5. 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.

**Electronic Resources**

1. Integrate search strategies within the electronic resource that targets retrieval for specific information need (e.g., limit by date of publication, focus on specific format such as image, sound file).

2. Review strengths and weaknesses of various types of electronic resources for research need (e.g., compare subject-specific magazine database to general online index of articles).

3. Demonstrate the difference between databases, directories and database archives (e.g., free vs. fee-based, delivery mechanism, such as CD, DVD, network, Internet, and general vs. specific discipline).
4. Select a specific database for an assignment and explain why it is the appropriate one to use (e.g., in researching a particular author, use a literary database of biographical and critical information about writers).

5. Choose a topic and identify appropriate electronic resources to use, citing the name and date of the resource database archive collection.

6. Research and critique information in different types of subscription (fee-based) electronic resources to locate information for a curricular need.

7. Investigate tools within electronic resources to generate search strategies (e.g., use a thesaurus to identify subject terms for improved retrieval of information).

8. Modify a search through the use of different keywords and other techniques specific to an electronic resource (e.g., online database, Web-based index).

9. Integrate online subscription resources and other electronic media to meet needs for research and communication on a routine basis.

10. Differentiate coverage of electronic resources to select information need.

11. Support choices of free and fee-based Web information used to create a class project.

12. Research information from electronic archives (e.g., list serv archives, web logs).

13. Use a variety of technology resources for curriculum and personal information needs (e.g., streaming video, CD/DVD, subscription database).

14. Evaluate technology resources and determine strengths and weaknesses for curricular or personal needs.

15. Select an appropriate tool, online resource or Website based on the information need.
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

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.

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

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

5. Describe quality and how it is evaluated in the product or system.

6. Select and use simulation in the design process.

7. 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).

8. 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).

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

10. 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.

11. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

Technical Contradictions

1. 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).
2. 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).

3. Identify how contradictions were overcome in existing solutions.

Requirements

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

Optimization and Trade-offs

1. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).

2. Identify criteria and constraints for a design problem and determine how they 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).

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

Technical Problem-solving

1. 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).

2. Apply the concepts of system dynamics and systems thinking to the solution of problems.

Technical Communication

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

2. 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.

3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.
Intellectual Property

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.

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

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

Understanding Technological Systems

1. 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.

2. 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).

3. 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).

Technology Transfer

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

History of Design

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

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

Universal Design

1. 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).

2. Evaluate and rate the quality of an existing household product or system.
Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

**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).

4. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

5. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

6. 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).

7. Build a prototype to use as a working model to demonstrate a design’s effectiveness to potential customers.

**Requirements**

1. 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**

1. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

2. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

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

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

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

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

Quality Design

1. Evaluate a design using established design principles to collect data on the design’s effectiveness, and suggest improvements (e.g., how can bicycles be made safer?).

2. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process.

3. Explain how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

4. Explain how gender-bias, racial-bias and other forms of stereotyping and discrimination can affect communication within an engineering team.

5. Evaluate a design completed or created by another group of students using established design principles.

6. Describe the relationship between engineering disciplines.

7. Describe how a prototype is a working model used to show how subsystems interact.

8. Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

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

10. 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 Practice

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

Technical Communication

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

2. Choose the appropriate media to communicate elements of the design process in each technological system.
Engineering Design

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

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

Research and Development

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

Market Research

1. Research consumer preferences for a new product.

Quality Design

1. 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.

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

Idea Generation

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

Technical Problem-solving

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

Redesign

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

Emerging Technology

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

1. 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).

2. 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).

Reverse Engineering

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

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

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

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

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

*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.

**Benchmark C**: Classify, demonstrate, examine and appraise manufacturing technologies.

*System Management*

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

*Safety*

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

2. 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).

*Use and Maintain Technological Systems*

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

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

*Technology Assessment*

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

*Design Applications*

1. 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).
Benchmark D: Classify, demonstrate, examine and appraise construction technologies.

Technical Careers

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

System Management

1. 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

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

Engineering Practice

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

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

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

Use and Maintain Technological Systems

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

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

3. 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).

4. 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

1. 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).

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

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

**Emerging Technology**

1. 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).

**Technical Standards**

1. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, 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).
Course Description:
Computer Aided Design/Wood (CAD/Wood) is a design/build class where students design projects using CAD programs and then build them in the woodshop. This class is team taught so students move back and forth between the woodshop and the CAD Lab. CAD 1 is a prerequisite for this course.

STANDARD 1: NATURE OF TECHNOLOGY

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Goal-directed Research

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

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).

3. Describe, discuss and cite examples of how goal-directed research results in innovation.

4. Invent a product using goal-directed research.

Commercialization of Technology

1. Make informed choices among technology systems, resources and services.

2. Predict how profit incentive and the market economy influence technological development.


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

Innovation and Invention

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

2. Describe how technological innovation often results when ideas, knowledge or skills are shared within a technology.
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.

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

Technology and Environment

1. Design, model/build and evaluate a plan/method for conserving resources.

2. Investigate the use and development of appropriate technologies to meet the needs of persons living in developing countries (e.g., hand-crank powered radio for communication).

3. Describe the economic impact of invasive foreign species present in Ohio as a result of technology activity or other human intervention.

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

Technology and Ethics

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

2. Discuss access to information in a democratic society.

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

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

5. Understand the importance of diverse information and access to information in a democratic society.
STANDARD 3: TECHNOLOGY FOR PRODUCTIVITY APPLICATIONS

Students learn the operations of technology through the usage of technology and productivity tools.

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

**Understanding Operations**

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

**Productivity Tools**

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).

2. Utilize advanced word processing and desktop publishing features and programs.

**Communication Tools**

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

**Problem-solving**

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

**Knowledge Generation**

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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.

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

**Use of Communications**

1. Use technology to publish information in electronic form (e.g., Web, multimedia, digital video, electronic portfolio).

2. Use Web technologies to disseminate information to a broader audience.

**Publication**

1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).

**Electronic Communications**

1. Archive communication products in appropriate electronic forms (e.g., store electronic publications so that they may be accessed when needed).

**Benchmark C:** Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

**Use of Communications**

1. Identify and use the appropriate communication tool to collaborate with others (e.g., presentation, Web site, digital video).

2. Employ online communication capabilities to make inquiries, do research and disseminate results (e.g., develop dialogues on issues in U.S. government).
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

**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.

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

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

5. Describe quality and how it is evaluated in the product or system.

6. Select and use simulation in the design process.

7. 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).

8. 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).

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

10. 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.

11. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

**Technical Contradictions**

1. 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).
2. 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).

3. Identify how contradictions were overcome in existing solutions.

**Requirements**

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

**Optimization and Trade-offs**

1. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).

2. Identify criteria and constraints for a design problem and determine how they 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).

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

**Technical Problem-solving**

1. 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).

2. Apply the concepts of system dynamics and systems thinking to the solution of problems.

**Technical Communication**

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

2. 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.

3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.
2. Describe how trademarks, patents and copyrights are obtained.

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

4. Predict/project the need for changes in copyright, patent and trademark laws, considering the rapid changes in technology and society.

**Understanding Technological Systems**

1. 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.

2. 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).

3. 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).

**Technology Transfer**

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

**History of Design**

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

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

**Universal Design**

1. 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).

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

**Benchmark B:** Recognize the role of teamwork in engineering design and of prototyping in the design process.

**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).

4. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

5. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

6. 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).

7. Build a prototype to use as a working model to demonstrate a design’s effectiveness to potential customers.

Requirements

1. 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

1. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

2. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

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

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

Technical Careers

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

Technical Contradictions

1. Describe how to identify conflicts or contradictions in technological systems.
**Benchmark C:** Understand and apply research, development and experimentation to problem-solving.

**Research and Development**

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

**Market Research**

1. Research consumer preferences for a new product.

**Quality Design**

1. 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.

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

**Idea Generation**

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

**Technical Problem-solving**

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

**Redesign**

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

**Emerging Technology**

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

**Innovation and Invention**

1. 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

1. 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).

2. 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).

Universal Design

1. 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

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

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

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

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

**Benchmark C:** Classify, demonstrate, examine and appraise manufacturing technologies.

**Technical Careers**

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

**System Management**

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

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**

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

2. 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).

**Use and Maintain Technological Systems**

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

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

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

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

5. 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).

6. Demonstrate product and system maintenance and service technique (e.g., installing, diagnosing, troubleshooting, recalling, maintaining, repairing, altering and upgrading, and retrofitting).
7. 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).

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

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

**Technology Assessment**

1. 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**

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

**Design Applications**

1. 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).

2. Use marketing to establish a product’s viability and identity, conduct research on its potential, advertise it, package it, distribute it and sell it.
**Course Description:**

**Multimedia Communications** is a course that provides students with the opportunity to gather, arrange and manipulate computer-based digital media. Audio, video, text and graphics are integrated to create the final product. Students create and design presentations, manipulate files, scan images, and use both digital cameras and video equipment. Problem solving skills are developed as students create, design and product copy ready work for posters, brochures, videos or web sites for school or community groups. This is a production type course that requires students to apply their multimedia skills in a meaningful way.

**Advanced Multimedia Communications** builds upon the fundamental knowledge and skills developed in Multimedia Communications. This advanced course is for students who are interested in the areas of computer graphics, digital imaging, electronic publishing, animation, multimedia presentations, and web site design. Students will explore advanced projects as well as 2D and 3D animation. Students pursue a more in-depth study in an area of interest on a contract basis with the instructor. Throughout the course students are guided to develop a portfolio of their work. Skills will benefit high school, college or professional careers. Evaluation is based upon completed in-class assignments, tests and projects.

**STANDARD 1: NATURE OF TECHNOLOGY**

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

**Technology Diffusion**

1. List and describe factors that may influence the development of technology.
2. 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).
3. Illustrate ways that the rate of technological development and diffusion is exponential.
4. Predict the impact of the exponential development and diffusion of technology.

**Goal-directed Research**

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.
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).
3. Describe, discuss and cite examples of how goal-directed research results in innovation.
4. Invent a product using goal-directed research.
Commercialization of Technology

1. Make informed choices among technology systems, resources and services.
2. Explain how technological development is influenced by many factors, including profit incentive and market economy.
3. Predict how profit incentive and the market economy influence technological development.
4. Plan/construct technological products considering profit incentive and market economy.

Nature of Technology

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.
2. Demonstrate how the development of technological knowledge and processes are functions of the setting.

Benchmark B: Apply technological knowledge in decision-making.

Optimization and Trade-offs

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.
2. 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).
3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).
4. Make, support and defend decisions that involve trade-offs between competing values (e.g., use of criteria in making an equipment purchase).

Sustainability

1. Discuss how sustainability is a balance of economic prosperity, environmental quality and social equity.

Nature of Technology

1. Design/construct a model to demonstrate how all components contribute to the stability of a technological system.
**Benchmark C:** Examine the synergy between and among technologies and other fields of study when solving technological problems.

**Technology Transfer**

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.

**Innovation and Invention**

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

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.

4. Cite examples of how technological innovation has resulted when ideas, knowledge or skills have been shared within, or among, other technologies.

5. Illustrate the relationship of technological progress to the advancement of science, mathematics and other fields.

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

7. 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.

Benchmark A: Interpret and practice responsible citizenship relative to technology.

Technology and Citizenship

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Review how different factors, such as individual curiosity, advertising, the strength of the economy, the goals of a company and the current trends, contribute to shaping the design of and demand for various technologies.

3. Understand that the development of technology may be influenced by societal opinions and demands, in addition to corporate cultures.

4. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

5. Describe how changes caused by the use of technology can range from gradual to rapid, and from subtle to obvious.

6. Compare and evaluate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

7. Make informed choices among technology systems, resources and services.

8. 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.

9. Debate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

Technology Transfer

1. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.
Benchmark B: Demonstrate the relationship among people, technology and the environment.

Technology and Environment

1. 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).

2. Demonstrate how technological decisions involve trade-offs between predicted positive and negative effects on the environment.

3. Forecast intended and unintended consequences of technology deployment.

4. 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.

Technology and History

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

2. Select a technology or tool and predict how it will change in the future.

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

4. Understand the basic elements of the evolution of technological tools and systems throughout history.

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

Technology and Ethics

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

2. Discuss access to information in a democratic society.

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

4. Forecast changes in laws and legislation that might result from the exponential growth of technology.
5. Practice responsible and ethical usage of technology.

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

**Technology Assessment**

1. Collect information about products and systems and evaluate the quality of that information.
2. Describe criteria for assessing the quality of information.
3. Compare and contrast the past, present and future developments of a technological system.
4. 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).
5. Describe how a technological change has affected the local community (e.g., how a new highway has changed traffic and building patterns).
6. 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.

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

*Understanding Operations*

1. Explore state-of-the-art devices to store data that will be used for researching projects.
2. Examine current and past devices for storing data and predict potential devices for the future.
3. Analyze various types of connectivity and list pros and cons of each.
4. Make informed choices among technology systems, resources and services.
5. Explore state-of-the-art devices to store data.

*Problem-solving*

1. Describe strategies for identifying and solving routine hardware and software problems that occur during everyday use.
2. Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.
3. 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.

*Understanding Operations*

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

*Productivity Tools*

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).
2. Utilize advanced word processing and desktop publishing features and programs.
Communication Tools

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

Problem-solving

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

Knowledge Generation

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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.

Benchmark A: Apply appropriate communication design principles in published and presented projects.

Multimedia Applications

1. Format text, select color, insert graphics and include multimedia components in student-created media/communication products.

Accessibility Guidelines

1. Modify electronic publications and other communication products to meet accessibility guidelines so that access to information is not limited.

Evaluation

1. Examine how and why image, language, sound and motion convey specific messages designed to influence the audience.

2. Assess the accuracy of the communication product.

3. Compare and contrast the accuracy of the message/communication product with the audience results (e.g., was the audience influenced by inaccurate information?).

4. Select and evaluate message-appropriate designs for print, multimedia, video and Web pages for curricular and personal needs (e.g., silly graphics may not be appropriate for academic projects).

5. Analyze the complexities and discrepancies found in communication products.

6. Interpret ethical considerations and legal requirements involved in construction of communication products.

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

1. Manipulate communication design elements (image, language, sound and motion) based on intent of the message (e.g., inform or persuade).

2. Employ design techniques taking into consideration the psychological impact and cultural connotations of color when designing for print media and multimedia, video and Web pages.
3. Apply principles of design (contrast, repetition, alignment and proximity) for academic and personal needs (e.g., resume, scholarship application).

4. 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).

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

**Use of Communications**

1. Use e-mail in a teacher-moderated discussion group and in threaded discussion lists.

2. Use technology to publish information in electronic form (e.g., Web, multimedia, digital video, electronic portfolio).

3. Use Web technologies to disseminate information to a broader audience.

**Evaluation**

1. Validate use of communication techniques.

2. Evaluate communication products.

3. Critique personal communication products.

**Publication**

1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).

**Electronic Communications**

1. Archive communication products in appropriate electronic forms (e.g., store electronic publications so that they may be accessed when needed).

**Benchmark C**: Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

**Use of Communications**

1. Demonstrate communication clarity and use elements and formats of e-mail to communicate with others (e.g., discussion lists, message board, chat, instant messaging).
2. Identify and use the appropriate communication tool to collaborate with others (e.g., presentation, Web site, digital video).

3. Employ online communication capabilities to make inquiries, do research and disseminate results (e.g., develop dialogues on issues in U.S. government).

4. Implement online-structured learning experiences (e.g., tutorials, virtual classes, industry certification courses).

5. Integrate online communication capabilities to make inquiries, do research and disseminate results (e.g., group writing projects, college searches, career information inquiry).

6. Collaborate in online learning or videoconferencing activities based on research and/or an investigation of real-world problems (e.g., study of community or regional ecosystem).

7. Select and use appropriate online structured learning experiences to meet individual learning needs.

8. Use all available online communication capabilities to make inquiries, do research and disseminate results.

**Evaluation**

1. 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.

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

*Evaluating Sources*

1. Define terms which determine information validity:
   a. Accuracy
   b. Authority
   c. Objectivity
   d. Currency
   e. Coverage (including objectivity and bias)

2. Determine the author’s authority for all resources and identify points of agreement and disagreement among sources.

3. 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).

4. 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).

5. Create a bibliography of sources in an electronic format.

6. Select appropriate information on two sides of an issue (e.g., identify the author of each information source and their expertise and/or bias).

7. Seek and evaluate information to answer both personal and curricular needs.

8. Analyze the intent and authorship of information sources used for a curricular need.

9. Determine valid information for an assignment from a variety of sources.

10. Evaluate information collected to answer both personal and curricular needs to determine its accuracy, authority, objectivity, currency and coverage.

11. Acknowledge intellectual property in using information sources.

12. 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.

**Decide**

1. Determine the essential questions and plan research strategies.
2. Select the essential question to be examined by the research.
3. 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.
4. Select essential questions for research and use a recognized or personally developed model to conduct independent research.
5. Derive a personally developed research model to conduct independent research.
6. Refine the information question to focus the research process, modifying the question as necessary to broaden or narrow the inquiry.

**Find**

1. Select and evaluate appropriateness of information from a variety of resources, including online research databases and Web sites to answer the essential questions.
2. Evaluate information and select relevant and pertinent information found in each source, and maintain accurate records of sources used.
3. Identify, evaluate information and select relevant and pertinent information found in each source.
4. Identify relevant facts, check for validity, and record appropriate information keeping track of all sources.
5. Critique information sources to determine if different points of view are included.
6. Integrate multiple information sources in the research process.

**Use**

1. Integrate copyrighted information into an information product, following appropriate use of guidelines (e.g., quote using proper citation format, request permission to use).
2. Identify relevant facts, check facts for accuracy and record appropriate information.
3. Incorporate a list of sources used in a project using a standard bibliographic style manual (e.g., MLA and APA Style Manuals).
4. Organize and analyze information, finding connections that lead to a final product.
5. Follow copyright law and use standard bibliographic format to list sources.
6. Analyze information and synthesize into a communicated product.

7. Respect copyright laws and guidelines, and use standard bibliographic format to list sources.

8. Create a product to communicate information, representing a personal point of view based on findings.

9. 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**

1. Evaluate the research process and product as they apply to the information need (e.g., does the process reflect the actual information need).

2. Assess whether the essential questions are answered, gather more information and data and modify search terms as needed. Edit the product.

3. Review and evaluate research process and the resources used (e.g., how can the research process be improved?).

4. Critique and revise the information product.

5. Review the research process for efficiency and effectiveness.

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

**Manage**

1. Archive the final product in a format that will be 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.

**Search Strategies**

1. Identify multiple directories and search engines matching curricular need (e.g., given an assignment, use knowledge of tools to pick an appropriate tool to search for information).

2. Construct search strategies focused on the retrieval of specific search results by incorporating Boolean operators “AND” “OR” “NOT” and adjacency/proximity techniques.

3. Compare and chart the search results from multiple Web sites to check for consistency of information (e.g., compare data on acid rain from more than one site).

4. Construct an effective search strategy to retrieve relevant information through multiple search engines, directories and Internet resources.
5. Narrow or broaden the search strategy by modifying the keywords entered in the original search strategy.

6. 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).

7. Demonstrate the use of parentheses for nesting search terms to alter retrieval strategies through multiple Internet resources.

8. Create a product on a specific curricular topic that includes annotated Web sites constructed according to a standard style manual (e.g., electronic pathfinder on careers).

9. Incorporate defined field searching by initiating a search string identifying the desired field of information to be retrieved (e.g., search author or title).

10. Create a stand-alone system for tracking Internet resources for personal and academic needs (e.g., postsecondary institutions of interest).

**Evaluating Sources**

1. Establish criteria for evaluating the information retrieved through Internet searching: author’s expertise, bias, coverage of topic and timeliness.

2. Examine the information retrieved through Internet searching for authenticity of information, bias, currency, relevance and appropriateness.

3. Develop a systematic approach to judge the value of the retrieved Web information.

4. Synthesize search results retrieved from a variety of Internet resources to create an information product for a targeted audience.

5. 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.

**Electronic Resources**

1. Integrate search strategies within the electronic resource that targets retrieval for specific information need (e.g., limit by date of publication, focus on specific format such as image, sound file).

2. Review strengths and weaknesses of various types of electronic resources for research need (e.g., compare subject-specific magazine database to general online index of articles).

3. Demonstrate the difference between databases, directories and database archives (e.g., free vs. fee-based, delivery mechanism, such as CD, DVD, network, Internet, and general vs. specific discipline).
4. Select a specific database for an assignment and explain why it is the appropriate one to use (e.g., in researching a particular author, use a literary database of biographical and critical information about writers).

5. Choose a topic and identify appropriate electronic resources to use, citing the name and date of the resource database archive collection.

6. Research and critique information in different types of subscription (fee-based) electronic resources to locate information for a curricular need.

7. Investigate tools within electronic resources to generate search strategies (e.g., use a thesaurus to identify subject terms for improved retrieval of information).

8. Modify a search through the use of different keywords and other techniques specific to an electronic resource (e.g., online database, Web-based index).

9. Integrate online subscription resources and other electronic media to meet needs for research and communication on a routine basis.

10. Differentiate coverage of electronic resources to select information need.

11. Support choices of free and fee-based Web information used to create a class project.

12. Research information from electronic archives (e.g., list serv archives, web logs).

13. Use a variety of technology resources for curriculum and personal information needs (e.g., streaming video, CD/DVD, subscription database).

14. Evaluate technology resources and determine strengths and weaknesses for curricular or personal needs.

15. Select an appropriate tool, online resource or Website based on the information need.
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

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.

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

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

5. Describe quality and how it is evaluated in the product or system.

6. Select and use simulation in the design process.

7. 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).

8. 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).

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

10. 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.

11. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

Technical Contradictions

1. 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).
2. 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).

3. Identify how contradictions were overcome in existing solutions.

4. 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).

5. Apply the separation principles to overcome contradictions in systems (e.g., time, space, combining or dividing systems, physical-chemical changes).

Requirements

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

Optimization and Trade-offs

1. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).

2. Identify criteria and constraints for a design problem and determine how they 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).

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

Technical Problem-solving

1. 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).

2. Apply the concepts of system dynamics and systems thinking to the solution of problems.

Technical Communication

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

2. 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.
3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.

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

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

4. Predict/project the need for changes in copyright, patent and trademark laws, considering the rapid changes in technology and society.

**Understanding Technological Systems**

1. 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.

2. 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).

3. 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).

**Technology Transfer**

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

**History of Design**

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

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

**Universal Design**

1. 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).

2. Evaluate and rate the quality of an existing household product or system.
Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

**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).

4. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

5. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

6. 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).

7. Build a prototype to use as a working model to demonstrate a design’s effectiveness to potential customers.

**Requirements**

1. 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**

1. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

2. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

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

4. Demonstrate the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills in the design process.
**Technical Careers**

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

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

**Quality Design**

1. Evaluate a design using established design principles to collect data on the design’s effectiveness, and suggest improvements (e.g., how can bicycles be made safer?).

2. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process.

3. Explain how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

4. Explain how gender-bias, racial-bias and other forms of stereotyping and discrimination can affect communication within an engineering team.

5. Evaluate a design completed or created by another group of students using established design principles.

6. Describe the relationship between engineering disciplines.

7. Describe how a prototype is a working model used to show how subsystems interact.

8. Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

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

10. 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 Practice**

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

**Technical Communication**

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

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

**Technical Contradictions**

1. Describe how to identify conflicts or contradictions in technological systems.
**Engineering Design**

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

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

**Research and Development**

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

**Market Research**

1. Research consumer preferences for a new product.

**Quality Design**

1. 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.

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

**Idea Generation**

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

**Technical Problem-solving**

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

**Redesign**

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

**Emerging Technology**

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

**Innovation and Invention**

1. 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

1. 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).

2. 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).

Universal Design

1. 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

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

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

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

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

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

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

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

Safety

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

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

Engineering Practice

1. Measure voltage, resistance and current in electrical systems and describe the different instruments used.

2. Describe the application of the first and second laws of thermodynamics (e.g., the concept and function of a heat engine).

3. Explain the relationship between resistance, voltage and current (Ohm’s Law).

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

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

6. Explain Bernoulli’s Principle and its effect on practical applications (e.g., airfoil design, spoiler design, carburetor).
Use and Maintain Technological Systems

1. Differentiate between hydraulic and pneumatic systems and provide examples of appropriate applications of each as they relate to manufacturing and transportation systems.

2. Identify and investigate AC and DC circuits (e.g., sources, conductors, controls, loads, applications, purposes, safety, components, symbols, principles and operations).

3. Employ energy and power technologies to resolve practical problems (e.g., efficient power production, conversion and transmission).

4. Build energy and power devices using the appropriate technological tools, machines, equipment, materials and technical processes to solve a problem in the community.

5. Identify the sources of energy, conversion process, and load in a variety of power systems (e.g., tractor, electrical grid, elevator).

6. Differentiate among conduction, convention, and radiation in a thermal system (e.g., heating and cooling a house, cooking).

7. Identify and explain the components of a circuit including a source, conductor, load and controllers (controllers are switches, relays, diodes, transistors, integrated circuits).

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

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

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

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

12. 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

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

2. 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).

Emerging Technology

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

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

Design Application

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

2. 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).

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

Technical Standards

1. 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.

Technical Careers

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

System Management

1. 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).

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

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.
Safety

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

Use and Maintain Technological Systems

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

Design Applications

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

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

Emerging Technology

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

Technical Standards

1. 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.

Technical Careers

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

System Management

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

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

1. Identify and apply appropriate safety measures when working with manufacturing technologies.
2. 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).

**Use and Maintain Technological Systems**

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

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

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

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

5. 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).

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

7. 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).

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

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

**Technology Assessment**

1. 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**

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

**Design Applications**

1. 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).

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

Engineering Practice

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

Technical Standards

1. 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.

Technical Careers

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

System Management

1. 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

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

Engineering Practice

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

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

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

4. Calculate quantitatively the resultant forces for live loads and dead loads.
Use and Maintain Technological Systems

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

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

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.

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

8. 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).

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

Design Applications

1. 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).

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

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 Communication

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

Emerging Technology

1. 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).
Technical Standards

1. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, 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 E: Classify, demonstrate, examine and appraise information and communication technologies.

Technical Careers

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

Safety

1. 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

1. 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).

2. 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).

3. 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).

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

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

6. 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

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

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).

Emerging Technology

1. Investigate emerging (state-of-the-art) and innovative applications of information and community technology.

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.

Technical Standards

1. 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.

Technical Careers

1. Appraise the careers available in medical technological systems and the training period needed to pursue them.
2. List advances in the sciences of biochemistry and molecular biology that have made it possible to manipulate the genetic information found in living creatures.

3. Describe how medicines and treatments may have both expected and unexpected results.

Safety

1. Identify and apply appropriate safety measures when working with medical technologies.

2. Safely use the tools and processes of medical technological systems (e.g., virtual dissection software).

3. Monitor and apply appropriate safety measures when working with medical technologies.

Design Application

1. 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

1. Examine new sensing technologies being used to diagnose medical conditions less invasively (e.g., CT-Scan, MRI, MRA).

Emerging Technology

1. Investigate emerging (state-of-the-art) and innovative applications of medical technologies.

2. Investigate and evaluate new medical technologies.

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.

Use and Maintain Technological Systems

1. Employ medical technologies to resolve practical problems (e.g., choose an appropriate bandage for an injury, contact the appropriate service provider in an emergency).

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

1. 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.

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

1. 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).

2. 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).

Safety

1. Identify and apply appropriate safety measures when working with agricultural and related biotechnologies.

2. Investigate emerging (state-of-the-art) and innovative applications of agricultural and related biotechnologies.

3. Prioritize and apply appropriate safety measures when working with agricultural and related biotechnologies.

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.

Use and Maintain Technological Systems

1. Employ agricultural and biotechnologies to resolve practical problems (e.g., growing food year-round, using plants to eliminate erosion).
Technology Assessment

1. 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 distribution center grown hydroponically and traditionally).

2. Evaluate the effects of genetic engineering, fertilizers, herbicides, and pesticides on the environment and the production of food.

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).

Technical Standards

1. 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).
Course Descriptions:

**Communication Technology 1** provides opportunities for students to learn many of the components, skills, and knowledge of video production, film, and broadcast journalism as they actually broadcast daily or weekly news programs over closed circuit TV. Throughout the course students are engaged in writing, interviewing, editing, fact-finding, running equipment and being on camera. In addition, there is an emphasis on media literacy, which involves becoming active and critical thinkers about various forms of media.

**Communication Technology 2** students will use the basic video editing and production techniques learned in Communication Technology 1 to produce a 30-minute television show to be shown to the public. Each student will be responsible for various components of the production during the semester. Creativity and advanced video editing/production techniques such as animation and film-making are also emphasized in this class.

**STANDARD 1: NATURE OF TECHNOLOGY**

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

*Technology Diffusion*

1. List and describe factors that may influence the development of technology.

2. 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).

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

4. Illustrate ways that the rate of technological development and diffusion is exponential.

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

*Goal-directed Research*

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

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).

3. Describe, discuss and cite examples of how goal-directed research results in innovation.

4. Invent a product using goal directed research.
COMMUNICATION TECHNOLOGY
Grades 9-12

Commercialization of Technology

1. Make informed choices among technology systems, resources and services.

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

3. Predict how profit incentive and the market economy influence technological development.

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

Nature of Technology

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

Benchmark B: Apply technological knowledge in decision-making.

Optimization and Trade-offs

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.

2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

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

Sustainability

1. Discuss how sustainability is a balance of economic prosperity, environmental quality and social equity.

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

Nature of Technology

1. Design/construct a model to demonstrate how all components contribute to the stability of a technological system.
**Benchmark C:** Examine the synergy between and among technologies and other fields of study when solving technological problems.

**Technology Transfer**

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.

2. Analyze technology transfer scenarios.

3. Identify technologies suitable for transfer and defend the rationale for selection.

4. 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**

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

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.

4. Cite examples of how technological innovation has resulted when ideas, knowledge or skills have been shared within, or among, other technologies.

5. Illustrate the relationship of technological progress to the advancement of science, mathematics and other fields.

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

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

*Technology and History*

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.
2. Select a technology or tool and predict how it will change in the future.
3. Examine the social/economic climate for invention and innovation in different periods of history.
4. Explain how the evolution of civilization has been directly affected by, and has affected, the development and use of tools and materials.
5. Compare and contrast periods of technology proliferation in the world, and the related social and economic influences.
6. Understand the basic elements of the evolution of technological tools and systems throughout history.
7. 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.

*Technology and Ethics*

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).
2. Discuss access to information in a democratic society.
3. Describe/discuss the ethical considerations involved in the development or deployment of a technology.
4. Analyze technology law, legislation and policy in context of user rights and responsibilities.
5. Understand the importance of diverse information and access to information in a democratic society.
6. Debate the ethical considerations involved in the development or deployment of new technologies (e.g., medical technologies to create or extend life, satellite imagery, software to capture content or monitor user activity).

7. Examine and discuss how technology, its use and resultant societal changes are viewed by different ethnic, cultural and religious groups.

8. Evaluate access (expanded and limited) determined by technology, law, legislation and/or policy.

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

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

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

12. Practice responsible and ethical usage of technology.

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

Technology Assessment

1. Collect information about products and systems and evaluate the quality of that information.

2. Describe criteria for assessing the quality of information.

3. Compare and contrast the past, present and future developments of a technological system.

4. 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).

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

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

7. Use assessment techniques, such as trend analysis and experimentation to make decisions about the future development of technology.

8. Locate and evaluate past predictions about the development of technology.

9. Describe techniques for making decisions about the future development of technology.

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

11. 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.

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

**Understanding Operations**

1. Explore state-of-the-art devices to store data that will be used for researching projects.
2. Create a design for a basic network and list skills needed to manage networks.
3. Examine current and past devices for storing data and predict potential devices for the future.
4. Analyze various types of connectivity and list pros and cons of each.
5. Make informed choices among technology systems, resources and services.
6. Explore state-of-the-art devices to store data.

**Problem-solving**

1. Describe strategies for identifying and solving routine hardware and software problems that occur during everyday use.
2. Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.
3. Research technology systems, resources and services to solve technical problems.
4. 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.

**Understanding Operations**

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

**Productivity Tools**

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).
2. Utilize advanced word processing and desktop publishing features and programs.
Communication Tools

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

Problem-solving

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

Knowledge Generation

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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.

**Benchmark A:** Apply appropriate communication design principles in published and presented projects.

**Multimedia Applications**

1. Format text, select color, insert graphics and include multimedia components in student-created media/communication products.

**Accessibility Guidelines**

1. Modify electronic publications and other communication products to meet accessibility guidelines so that access to information is not limited.

2. Verify accessibility components of the communication product and adapt as needed.

**Evaluation**

1. Examine how and why image, language, sound and motion convey specific messages designed to influence the audience.

2. Assess the accuracy of the communication product.

3. Compare and contrast the accuracy of the message/communication product with the audience results (e.g., was the audience influenced by inaccurate information?).

4. Select and evaluate message-appropriate designs for print, multimedia, video and Web pages for curricular and personal needs (e.g., silly graphics may not be appropriate for academic projects).

**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**

1. Manipulate communication design elements (image, language, sound and motion) based on intent of the message (e.g., inform or persuade).

2. Employ design techniques taking into consideration the psychological impact and cultural connotations of color when designing for print media and multimedia, video and Web pages.

3. Apply principles of design (contrast, repetition, alignment and proximity) for academic and personal needs (e.g., resume, scholarship application).

4. Adapt design concepts to emerging technologies.
5. 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_

1. Analyze the complexities and discrepancies found in communication products.
2. 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.

**Use of Communications**

1. Use e-mail in a teacher-moderated discussion group and in threaded discussion lists.
2. Use technology to publish information in electronic form (e.g., Web, multimedia, digital video, electronic portfolio).

_Evaluation_

1. Validate use of communication techniques.
2. Evaluate communication products.
3. Critique personal communication products.
4. Explain evaluation criteria and processes used to communicate with technology (e.g., telecommunications, Wi-Fi, voice over IP).

**Publication**

1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).

**Electronic Communications**

1. Archive communication products in appropriate electronic forms (e.g., store electronic publications so that they may be accessed when needed).

**Use of Communications**

1. Use Web technologies to disseminate information to a broader audience.
Benchmark C: Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

Use of Communications

1. Demonstrate communication clarity and use elements and formats of e-mail to communicate with others (e.g., discussion lists, message board, chat, instant messaging).

2. Identify and use the appropriate communication tool to collaborate with others (e.g., presentation, Web site, digital video).

3. Investigate the uses of videoconferencing, Web casting, and other distance learning technologies (e.g., interviews, meetings, course work).

4. Develop collaborative online projects to research a problem and disseminate results.

5. Contribute to organized e-mail discussions (e.g., discussion list, list serv, threaded discussion list, courseware discussion).

6. Employ online communication capabilities to make inquiries, do research and disseminate results (e.g., develop dialogues on issues in U.S. government).

7. Implement online-structured learning experiences (e.g., tutorials, virtual classes, industry certification courses).

8. Select an appropriate e-mail discussion list to meet communication needs (e.g., purpose of list, participants, audience, topics, ease of use).

9. Integrate online communication capabilities to make inquiries, do research and disseminate results (e.g., group writing projects, college searches, career information inquiry).

10. Collaborate in online learning or videoconferencing activities based on research and/or an investigation of real-world problems (e.g., study of community or regional ecosystem).

11. Select and use appropriate online structured learning experiences to meet individual learning needs.

12. Communicate using all manifestations of e-mail, as needed, for personal and curricular purposes, demonstrating appropriate and responsible use.

13. Use all available online communication capabilities to make inquiries, do research and disseminate results.

Evaluation

1. 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.

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

Evaluating Sources

1. Define terms which determine information validity:
   a. Accuracy
   b. Authority
   c. Objectivity
   d. Currency
   e. Coverage (including objectivity and bias)

2. Determine the author’s authority for all resources and identify points of agreement and disagreement among sources.

3. 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).

4. 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).

5. Create a bibliography of sources in an electronic format.

6. Select appropriate information on two sides of an issue (e.g., identify the author of each information source and their expertise and/or bias).

7. Seek and evaluate information to answer both personal and curricular needs.

8. Analyze the intent and authorship of information sources used for a curricular need.

9. Determine valid information for an assignment from a variety of sources.

10. Evaluate information collected to answer both personal and curricular needs to determine its accuracy, authority, objectivity, currency and coverage.

11. Acknowledge intellectual property in using information sources.

12. 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.

**Decide**

1. Determine the essential questions and plan research strategies.
2. Select the essential question to be examined by the research.
3. 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.
4. Select essential questions for research and use a recognized or personally developed model to conduct independent research.
5. Derive a personally developed research model to conduct independent research.
6. Refine the information question to focus the research process, modifying the question as necessary to broaden or narrow the inquiry.

**Find**

1. Select and evaluate appropriateness of information from a variety of resources, including online research databases and Web sites to answer the essential questions.
2. Evaluate information and select relevant and pertinent information found in each source, and maintain accurate records of sources used.
3. Identify, evaluate information and select relevant and pertinent information found in each source.
4. Identify relevant facts, check for validity, and record appropriate information keeping track of all sources.
5. Critique information sources to determine if different points of view are included.
6. Integrate multiple information sources in the research process.

**Use**

1. Integrate copyrighted information into an information product, following appropriate use of guidelines (e.g., quote using proper citation format, request permission to use).
2. Identify relevant facts, check facts for accuracy and record appropriate information.
3. Incorporate a list of sources used in a project using a standard bibliographic style manual (e.g., MLA and APA Style Manuals).
4. Organize and analyze information, finding connections that lead to a final product.
5. Follow copyright law and use standard bibliographic format to list sources.
6. Analyze information and synthesize into a communicated product.

7. Respect copyright laws and guidelines, and use standard bibliographic format to list sources.

8. Create a product to communicate information, representing a personal point of view based on findings.

9. 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**

1. Evaluate the research process and product as they apply to the information need (e.g., does the process reflect the actual information need).

2. Assess whether the essential questions are answered, gather more information and data and modify search terms as needed. Edit the product.

3. Review and evaluate research process and the resources used (e.g., how can the research process be improved?).

4. Critique and revise the information product.

5. Review the research process for efficiency and effectiveness.

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

**Manage**

1. Archive the final product in a format that will be accessible in the future.
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.

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

Technical Careers

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

Safety

1. 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

1. 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).

2. 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).

3. 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).

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

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

6. 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

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

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).

Emerging Technology

1. Investigate emerging (state-of-the-art) and innovative applications of information and community technology.

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.

Technical Standards

Course Descriptions:

**Beginning Electricity/Electronics** introduces students to basic theory, practices, and applications of electrical energy. The course is generally designed to reinforce learning with hands-on activities. Areas of study may include A.C./D.C. circuits, magnetism, motor theory, electron flow, electricity generation, and residential wiring.

**Advanced Electricity/Electronics** is designed as a continuation of Beginning Electricity/Electronics. The study of advanced topics and concepts such as robotics and computer control systems broaden students’ understanding of the world of electronic systems and their technological impact on society.

**STANDARD 1: NATURE OF TECHNOLOGY**

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

*Technology Diffusion*

1. List and describe factors that may influence the development of technology.

2. 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).

3. Illustrate ways that the rate of technological development and diffusion is exponential.

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

*Goal-directed Research*

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

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).

3. Describe, discuss and cite examples of how goal-directed research results in innovation.

4. Invent a product using goal-directed research.

*Commercialization of Technology*

1. Make informed choices among technology systems, resources and services.

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

3. Predict how profit incentive and the market economy influence technological development.
4. Plan/construct technological products considering profit incentive and market economy.

**Nature of Technology**

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

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

**Benchmark B**: Apply technological knowledge in decision-making.

**Optimization and Trade-offs**

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.

2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

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

**Sustainability**

1. Discuss how sustainability is a balance of economic prosperity, environmental quality and social equity.

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

**Nature of Technology**

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

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

**Technology Transfer**

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.
2. Analyze technology transfer scenarios.

3. Identify technologies suitable for transfer and defend the rationale for selection.

4. 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**

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

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.

4. Cite examples of how technological innovation has resulted when ideas, knowledge or skills have been shared within, or among, other technologies.

5. Illustrate the relationship of technological progress to the advancement of science, mathematics and other fields.

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

7. 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.

**Benchmark A**: Interpret and practice responsible citizenship relative to technology.

*Technology and Citizenship*

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Review how different factors, such as individual curiosity, advertising, the strength of the economy, the goals of a company and the current trends, contribute to shaping the design of and demand for various technologies.

4. Understand how different cultures develop their own technologies to satisfy their individual and shared needs, wants and values.

5. Understand that the development of technology may be influenced by societal opinions and demands, in addition to corporate cultures.

6. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

7. Assess technology systems, resources and services relative to responsible usage of technology.

8. Describe how changes caused by the use of technology can range from gradual to rapid, and from subtle to obvious.

9. Compare and evaluate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

10. Analyze the causes, consequences and possible technology solutions to problems in a persistent, contemporary and emerging world (e.g., health, security, resource allocation, economic development or environmental quality).

11. Examine the ethical considerations of a governmental technology policy that affects the physical characteristics of a place or region (e.g., building of the oil pipeline in Alaska, mineral rights under farmland).

12. Compare and evaluate alternate public policies for technology deployment and the use of natural resources.

13. Make informed choices among technology systems, resources and services.
14. 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.

15. Debate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

16. 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).

**Technology Transfer**

1. Provide examples of technology transfer from a government agency to private industry, and discuss the benefits (e.g., global positioning systems—GPS, Internet).

2. 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).

3. 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 workplace needs.

4. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

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

**Technology and Environment**

1. Design, model/build and evaluate a plan/method for conserving resources.

2. Investigate the use and development of appropriate technologies to meet the needs of persons living in developing countries (e.g., hand-crank powered radio for communication).

3. 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).

4. Demonstrate how technological decisions involve trade-offs between predicted positive and negative effects on the environment.

5. Forecast intended and unintended consequences of technology deployment.

6. 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.

Technology and History

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

2. Select a technology or tool and predict how it will change in the future.

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

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

5. Compare and contrast periods of technology proliferation in the world, and the related social and economic influences.

6. Understand the basic elements of the evolution of technological tools and systems throughout history.

7. Debate the position that technology has been a powerful force in reshaping the social, cultural, political and economic landscape, citing references and examples.
STANDARD 3: TECHNOLOGY FOR PRODUCTIVITY APPLICATIONS

Students learn the operations of technology through the usage of technology and productivity tools.

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

Understanding Operations

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

Productivity Tools

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).

2. Utilize advanced word processing and desktop publishing features and programs.

Communication Tools

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

Problem-solving

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

Knowledge Generation

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

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.

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

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

5. Describe quality and how it is evaluated in the product or system.

6. Select and use simulation in the design process.

7. 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).

8. 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).

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

10. 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.

11. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

Technical Contradictions

1. 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).
2. 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).

3. Identify how contradictions were overcome in existing solutions.

4. 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).

5. Apply the separation principles to overcome contradictions in systems (e.g., time, space, combining or dividing systems, physical-chemical changes).

Requirements

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

Optimization and Trade-offs

1. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).

2. Identify criteria and constraints for a design problem and determine how they 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).

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

Technical Problem-solving

1. 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).

2. Apply the concepts of system dynamics and systems thinking to the solution of problems.

Technical Communication

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

2. 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.
3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.

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

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

4. Predict/project the need for changes in copyright, patent and trademark laws, considering the rapid changes in technology and society.

**Understanding Technological Systems**

1. 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.

2. 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).

3. 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).

**Technology Transfer**

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

**History of Design**

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

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

**Universal Design**

1. 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).

2. Evaluate and rate the quality of an existing household product or system.
Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

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).

4. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

5. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

6. 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).

7. Build a prototype to use as a working model to demonstrate a design’s effectiveness to potential customers.

Requirements

1. 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

1. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

2. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

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

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

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

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

Quality Design

1. Evaluate a design using established design principles to collect data on the design’s effectiveness, and suggest improvements (e.g., how can bicycles be made safer?).

2. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process.

3. Explain how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

4. Explain how gender-bias, racial-bias and other forms of stereotyping and discrimination can affect communication within an engineering team.

5. Evaluate a design completed or created by another group of students using established design principles.

6. Describe the relationship between engineering disciplines.

7. Describe how a prototype is a working model used to show how subsystems interact.

8. Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

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

10. 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 Practice

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

Technical Communication

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

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

Technical Contradictions

1. Describe how to identify conflicts or contradictions in technological systems.
Engineering Design

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

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

Research and Development

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

Market Research

1. Research consumer preferences for a new product.

Quality Design

1. 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.

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

Idea Generation

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

Technical Problem-solving

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

Redesign

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

Emerging Technology

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

Innovation and Invention

1. 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

1. 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).

2. 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).

Universal Design

1. 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

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

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

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

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

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

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

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

Safety

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

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

Engineering Practice

1. Measure voltage, resistance and current in electrical systems and describe the different instruments used.

2. Explain the relationship between resistance, voltage and current (Ohm’s Law).

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

Use and Maintain Technological Systems

1. Differentiate between hydraulic and pneumatic systems and provide examples of appropriate applications of each as they relate to manufacturing and transportation systems.

2. Identify and investigate AC and DC circuits (e.g., sources, conductors, controls, loads, applications, purposes, safety, components, symbols, principles and operations).

3. Employ energy and power technologies to resolve practical problems (e.g., efficient power production, conversion and transmission).
4. Build energy and power devices using the appropriate technological tools, machines, equipment, materials and technical processes to solve a problem in the community.

5. Identify the sources of energy, conversion process, and load in a variety of power systems (e.g., tractor, electrical grid, elevator).

6. Differentiate among conduction, convention, and radiation in a thermal system (e.g., heating and cooling a house, cooking).

7. Identify and explain the components of a circuit including a source, conductor, load and controllers (controllers are switches, relays, diodes, transistors, integrated circuits).

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

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

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

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

12. 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

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

2. 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).

Emerging Technology

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

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. Classify energy-using devices and systems into the major forms: electrical, mechanical, chemical, nuclear and acoustic.
**Design Application**

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

2. 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).

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

**Technical Standards**

1. 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.

**Technical Careers**

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

**System Management**

1. 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).

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

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.

**Safety**

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

**Use and Maintain Technological Systems**

1. Employ transportation technologies to resolve practical problems (e.g., getting students to athletic events).
ELECTRICITY/ELECTRONICS
Grades 9-12

Design Applications

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

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

Emerging Technology

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

Technical Standards

1. 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.

Technical Careers

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

System Management

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

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

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

2. 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).

Use and Maintain Technological Systems

1. Classify materials as natural, synthetic or mixed (e.g., wood, plastic, cotton/polyester blend fabric).
2. Employ manufacturing technologies to resolve practical problems (e.g., produce a product).

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

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

5. 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).

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

7. 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).

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

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

**Technology Assessment**

1. 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**

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

**Design Applications**

1. 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).

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

**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).
Engineering Practice

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

Technical Standards

1. 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.

Technical Careers

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

System Management

1. 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

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

Engineering Practice

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

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

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

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

Use and Maintain Technological Systems

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

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

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

8. 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).

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

**Design Applications**

1. 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).

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

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 Communication**

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

**Emerging Technology**

1. 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).

**Technical Standards**

1. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, 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 E: Classify, demonstrate, examine and appraise information and communication technologies.

Technical Careers

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

Safety

1. 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

1. 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).

2. 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).

3. 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).

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

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

6. 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

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

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).

**Emerging Technology**

1. Investigate emerging (state-of-the-art) and innovative applications of information and community technology.

**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.

**Technical Standards**

1. 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.

**Technical Careers**

1. Appraise the careers available in medical technological systems and the training period needed to pursue them.

2. List advances in the sciences of biochemistry and molecular biology that have made it possible to manipulate the genetic information found in living creatures.

3. Describe how medicines and treatments may have both expected and unexpected results.
Safety

1. Identify and apply appropriate safety measures when working with medical technologies.
2. Safely use the tools and processes of medical technological systems (e.g., virtual dissection software).
3. Monitor and apply appropriate safety measures when working with medical technologies.

Design Application

1. 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

1. Examine new sensing technologies being used to diagnose medical conditions less invasively (e.g., CT-Scan, MRI, MRA).

Emerging Technology

1. Investigate emerging (state-of-the-art) and innovative applications of medical technologies.
2. Investigate and evaluate new medical technologies.

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.

Use and Maintain Technological Systems

1. Employ medical technologies to resolve practical problems (e.g., choose an appropriate bandage for an injury, contact the appropriate service provider in an emergency).

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

1. 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.

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

1. 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).

2. 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).

Safety

1. Identify and apply appropriate safety measures when working with agricultural and related biotechnologies.

2. Investigate emerging (state-of-the-art) and innovative applications of agricultural and related biotechnologies.

3. Prioritize and apply appropriate safety measures when working with agricultural and related biotechnologies.

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.

Use and Maintain Technological Systems

1. Employ agricultural and biotechnologies to resolve practical problems (e.g., growing food year-round, using plants to eliminate erosion).
Technology Assessment

1. 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 distribution center grown hydroponically and traditionally).

2. Evaluate the effects of genetic engineering, fertilizers, herbicides, and pesticides on the environment and the production of food.

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).

Technical Standards

1. 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).
BEGINNING WOODWORKING
Grades 9-12

Course Description:
Beginning Woodworking is an introductory course for those students who are interested in an entry-level experience in woodworking. Basic woodworking skills are introduced in conjunction with shop safety and the proper and safe operation of many hand and power tools. Students complete at least two projects starting with rough-cut lumber and culminating with useful and valuable projects that students take home.

STANDARD 1: NATURE OF TECHNOLOGY
Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion

1. List and describe factors that may influence the development of technology.

2. 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).

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

Nature of Technology

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

Benchmark B: Apply technological knowledge in decision-making.

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.

Technology Transfer

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.
Innovation and Invention

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

2. Describe how technological innovation often results when ideas, knowledge or skills are shared within a technology.
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.

Benchmark A: Interpret and practice responsible citizenship relative to technology.

Technology and Citizenship

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

4. Analyze the causes, consequences and possible technology solutions to problems in a persistent, contemporary and emerging world (e.g., health, security, resource allocation, economic development or environmental quality).

5. Examine the ethical considerations of a governmental technology policy that affects the physical characteristics of a place or region (e.g., building of the oil pipeline in Alaska, mineral rights under farmland).

Technology Transfer

1. Provide examples of technology transfer from a government agency to private industry, and discuss the benefits (e.g., global positioning systems—GPS, Internet).

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

Technology and Environment

1. Design, model/build and evaluate a plan/method for conserving resources.

2. Describe the economic impact of invasive foreign species present in Ohio as a result of technology activity or other human intervention.

3. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.
**Benchmark C**: Interpret and evaluate the influence of technology throughout history, and predict its impact on the future.

*Technology and History*

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

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

*Technology and Ethics*

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).
STANDARD 3: TECHNOLOGY FOR PRODUCTIVITY APPLICATIONS

Students learn the operations of technology through the usage of technology and productivity tools.

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

**Communication Tools**

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

**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.

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

4. Select and use simulation in the design process.

5. 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).

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

**Requirements**

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

**Technical Communication**

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

**Understanding Technological Systems**

1. 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.
Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

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.
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.

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

Safety

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

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

Technology Assessment

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

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

Safety

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

Use and Maintain Technological Systems

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

2. 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).

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

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

Safety

1. 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).
Technical Communication

1. Communicate technological knowledge and processes using symbols, measurement, conventions, icons, graphic images and languages that incorporate a variety of visual, auditory and tactile stimuli.
Course Description:  
Intermediate Woodworking includes a review of shop safety and equipment operating procedures learned in beginning woodworking. Each student completes one project, which they select from a variety of projects available. The student evaluates, designs, calculates cost of materials and determines a schedule of completion for the project. The advanced techniques of joinery, wood turning, pen making, and wood finishing are introduced and mastered in this class.

STANDARD 1: NATURE OF TECHNOLOGY

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion

1. List and describe factors that may influence the development of technology.

2. 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

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

Nature of Technology

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

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

Benchmark B: Apply technological knowledge in decision-making.

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).

2. Make, support and defend decisions that involve trade-offs between competing values (e.g., use of criteria in making an equipment purchase).
Benchmark C: Examine the synergy between and among technologies and other fields of study when solving technological problems.

Technology Transfer

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.

Innovation and Invention

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

2. Describe how technological innovation often results when ideas, knowledge or skills are shared within a technology.
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.

**Benchmark A:** Interpret and practice responsible citizenship relative to technology.

*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*

1. Provide examples of technology transfer from a government agency to private industry, and discuss the benefits (e.g., global positioning systems—GPS, Internet).

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

*Technology and Environment*

1. Design, model/build and evaluate a plan/method for conserving resources.

2. Describe the economic impact of invasive foreign species present in Ohio as a result of technology activity or other human intervention.

3. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.

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

*Technology and History*

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

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.

Technology and Ethics

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

2. Practice responsible and ethical usage of technology.

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

Technology Assessment

1. Describe how a technological change has affected the local community (e.g., how a new highway has changed traffic and building patterns).
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

**Design Process**

1. Explain and apply the methods and tools of inventive problem-solving to develop and produce a product or system.

2. Describe quality and how it is evaluated in the product or system.

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

4. 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.

**Requirements**

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

**Technical Communication**

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

2. 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.

3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.
Understanding Technological Systems

2. 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).

Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

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.
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.

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

**Safety**

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

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

**Technology Assessment**

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

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

**Safety**

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

**Use and Maintain Technological Systems**

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

2. 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).

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

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

**Safety**

1. 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).
Technical Communication

1. Communicate technological knowledge and processes using symbols, measurement, conventions, icons, graphic images and languages that incorporate a variety of visual, auditory and tactile stimuli.
Course Description:
Advanced Woodworking is designed for the student who has a strong interest in fine woodworking. Each student will use all of the techniques and practices learned in beginning and intermediate woodworking and expand their skills through the completion of challenging projects. The students work closely with the instructor to evaluate plans, costs, flow charts, and schedules of their projects.

STANDARD 1: NATURE OF TECHNOLOGY
Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion

1. List and describe factors that may influence the development of technology.

2. 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

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

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).

3. Invent a product using goal-directed research.

Commercialization of Technology

1. Make informed choices among technology systems, resources and services.

2. Predict how profit incentive and the market economy influence technological development.

Nature of Technology

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

2. Demonstrate how the development of technological knowledge and processes are functions of the setting.
Benchmark B: Apply technological knowledge in decision-making.

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).

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

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

Technology Transfer

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.

Innovation and Invention

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

2. Describe how technological innovation often results when ideas, knowledge or skills are shared within a technology.
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.

Benchmark A: Interpret and practice responsible citizenship relative to technology.

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

1. Provide examples of technology transfer from a government agency to private industry, and discuss the benefits (e.g., global positioning systems—GPS, Internet).

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

Technology and Environment

1. Design, model/build and evaluate a plan/method for conserving resources.

2. Describe the economic impact of invasive foreign species present in Ohio as a result of technology activity or other human intervention.

3. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.

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

Technology and History

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

2. Select a technology or tool and predict how it will change in the future.

3. 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

Technology and Ethics

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

2. Practice responsible and ethical usage of technology.

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

Technology Assessment

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

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

**Evaluating Sources**

1. Define terms which determine information validity:
   a. Accuracy
   b. Authority
   c. Objectivity
   d. Currency
   e. Coverage (including objectivity and bias)

2. Determine valid information for an assignment from a variety of sources.

3. Evaluate information collected to answer both personal and curricular needs to determine its accuracy, authority, objectivity, currency and coverage.

4. Acknowledge intellectual property in using information sources.

5. 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.

**Decide**

1. Determine the essential questions and plan research strategies.

2. Select the essential question to be examined by the research.

3. 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.

4. Select essential questions for research and use a recognized or personally developed model to conduct independent research.

5. Refine the information question to focus the research process, modifying the question as necessary to broaden or narrow the inquiry.
**Find**

1. Select and evaluate appropriateness of information from a variety of resources, including online research databases and Web sites to answer the essential questions.

2. Evaluate information and select relevant and pertinent information found in each source, and maintain accurate records of sources used.

3. Identify, evaluate information and select relevant and pertinent information found in each source.

4. Identify relevant facts, check for validity, and record appropriate information keeping track of all sources.

5. Integrate multiple information sources in the research process.

**Use**

1. Integrate copyrighted information into an information product, following appropriate use of guidelines (e.g., quote using proper citation format, request permission to use).

2. Identify relevant facts, check facts for accuracy and record appropriate information.
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

Design Process

1. Explain and apply the methods and tools of inventive problem-solving to develop and produce a product or system.

2. Describe quality and how it is evaluated in the product or system.

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

4. 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.

5. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

Requirements

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

Optimization and Trade-offs

1. 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 Communication

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

2. 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.
3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.

**Understanding Technological Systems**

1. 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).

**Benchmark B**: Recognize the role of teamwork in engineering design and of prototyping in the design process.

**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. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

4. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).
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.

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

Safety

1. Identify and apply appropriate safety measures when working with energy and power technologies.
2. Safely use the tools and processes of energy and power technological systems.

Technology Assessment

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

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

Safety

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

Use and Maintain Technological Systems

1. Identify and use a variety of technological tools, equipment, machines, materials and technical processes used in construction technologies to build/construct products or systems.
2. 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).
3. Demonstrate the ability to acquire, store, allocate, and use materials or space efficiently.

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

Safety

1. 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).
Technical Communication

1. Communicate technological knowledge and processes using symbols, measurement, conventions, icons, graphic images and languages that incorporate a variety of visual, auditory and tactile stimuli.
Course Description:
Construction Technology provides a conceptual understanding needed of the construction industry. This course introduces students to a large sector of the nation’s industrial economy dealing with land use and the construction of facilities on a given site to meet an identified need. Students have the opportunity to gain experiences of an educational-occupational nature.

STANDARD 1: NATURE OF TECHNOLOGY

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion

1. List and describe factors that may influence the development of technology.

2. 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).

3. Illustrate ways that the rate of technological development and diffusion is exponential.

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

Goal-directed Research

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

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).

3. Describe, discuss and cite examples of how goal-directed research results in innovation.

4. Invent a product using goal directed research.

Commercialization of Technology

1. Make informed choices among technology systems, resources and services.

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

3. Predict how profit incentive and the market economy influence technological development.

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

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

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

**Benchmark B**: Apply technological knowledge in decision-making.

Optimization and Trade-offs

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.

2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

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

Sustainability

1. Discuss how sustainability is a balance of economic prosperity, environmental quality, and social equity.

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

Nature of Technology

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

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

Technology Transfer

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.

2. Analyze technology transfer scenarios.
3. Identify technologies suitable for transfer and defend the rationale for selection.

4. 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

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

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.

4. Cite examples of how technological innovation has resulted when ideas, knowledge or skills have been shared within, or among, other technologies.

5. Illustrate the relationship of technological progress to the advancement of science, mathematics and other fields.

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

7. 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.

**Benchmark A:** Interpret and practice responsible citizenship relative to technology.

*Technology and Citizenship*

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Review how different factors, such as individual curiosity, advertising, the strength of the economy, the goals of a company and the current trends, contribute to shaping the design of and demand for various technologies.

4. Understand how different cultures develop their own technologies to satisfy their individual and shared needs, wants and values.

5. Understand that the development of technology may be influenced by societal opinions and demands, in addition to corporate cultures.

6. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

7. Assess technology systems, resources and services relative to responsible usage of technology.

8. Describe how changes caused by the use of technology can range from gradual to rapid, and from subtle to obvious.

9. Compare and evaluate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

10. Analyze the causes, consequences and possible technology solutions to problems in a persistent, contemporary and emerging world (e.g., health, security, resource allocation, economic development or environmental quality).

11. Make informed choices among technology systems, resources and services.

12. 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.

13. Debate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.
Technology Transfer

1. Provide examples of technology transfer from a government agency to private industry, and discuss the benefits (e.g., global positioning systems—GPS, Internet).

2. 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).

3. 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 workplace needs.

4. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

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

Technology and Environment

1. Design, model/build and evaluate a plan/method for conserving resources.

2. Investigate the use and development of appropriate technologies to meet the needs of persons living in developing countries (e.g., hand-crank powered radio for communication).

3. 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).

4. 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).

5. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.

6. Demonstrate how technological decisions involve trade-offs between predicted positive and negative effects on the environment.

7. Forecast intended and unintended consequences of technology deployment.

8. 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.

**Technology and History**

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

2. Select a technology or tool and predict how it will change in the future.

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

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

5. Compare and contrast periods of technology proliferation in the world, and the related social and economic influences.

6. Understand the basic elements of the evolution of technological tools and systems throughout history.

7. 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

**Technology and Ethics**

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

2. Discuss access to information in a democratic society.

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

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

5. Debate the ethical considerations involved in the development or deployment of new technologies (e.g., medical technologies to create or extend life, satellite imagery, software to capture content or monitor user activity).

6. Predict what might happen if the principles of intellectual property were ignored in one’s own community.
7. Forecast changes in laws and legislation that might result from the exponential growth of technology.

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

9. Practice responsible and ethical usage of technology.

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

**Technology Assessment**

1. Describe criteria for assessing the quality of information.

2. Compare and contrast the past, present and future developments of a technological system.

3. 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).

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

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

6. Use assessment techniques, such as trend analysis and experimentation to make decisions about the future development of technology.

7. Locate and evaluate past predictions about the development of technology.

8. Describe techniques for making decisions about the future development of technology.

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

10. 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.

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

*Understanding Operations*

1. Make informed choices among technology systems, resources and services.

*Problem-solving*

1. Research technology systems, resources and services to solve technical problems.
2. 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.

*Understanding Operations*

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

*Communication Tools*

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

*Problem-solving*

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

*Knowledge Generation*

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).
2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.
3. 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.

Benchmark A: Apply appropriate communication design principles in published and presented projects.

Evaluation

1. Assess the accuracy of the communication product.

2. Select and evaluate message-appropriate designs for print, multimedia, video and Web pages for curricular and personal needs (e.g., silly graphics may not be appropriate for academic projects).

Principles of Design

1. Apply principles of design (contrast, repetition, alignment and proximity) for academic and personal needs (e.g., resume, scholarship application).

2. 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).
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.

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

**Evaluating Sources**

1. Define terms which determine information validity:
   - a. Accuracy
   - b. Authority
   - c. Objectivity
   - d. Currency
   - e. Coverage (including objectivity and bias)

2. 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).

3. 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).

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).

5. Seek and evaluate information to answer both personal and curricular needs.

6. Determine valid information for an assignment from a variety of sources.

7. Evaluate information collected to answer both personal and curricular needs to determine its accuracy, authority, objectivity, currency and coverage.

8. 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.

**Decide**

1. Determine the essential questions and plan research strategies.

2. Select the essential question to be examined by the research.

3. 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

1. Select and evaluate appropriateness of information from a variety of resources, including online research databases and Web sites to answer the essential questions.

2. Evaluate information and select relevant and pertinent information found in each source, and maintain accurate records of sources used.

Use

1. Integrate copyrighted information into an information product, following appropriate use of guidelines (e.g., quote using proper citation format, request permission to use).

2. Identify relevant facts, check facts for accuracy and record appropriate information.
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

**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.

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

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

5. Describe quality and how it is evaluated in the product or system.

6. Select and use simulation in the design process.

7. 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).

8. 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).

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

10. 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.

11. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

**Technical Contradictions**

1. 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).
2. 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).

3. Identify how contradictions were overcome in existing solutions.

4. 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).

5. Apply the separation principles to overcome contradictions in systems (e.g., time, space, combining or dividing systems, physical-chemical changes).

Requirements

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

Optimization and Trade-offs

1. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).

2. Identify criteria and constraints for a design problem and determine how they 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).

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

Technical Problem-solving

1. 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).

2. Apply the concepts of system dynamics and systems thinking to the solution of problems.

Technical Communication

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

2. 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.
3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.

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

3. Predict/project the need for changes in copyright, patent and trademark laws, considering the rapid changes in technology and society.

**Understanding Technological Systems**

1. 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.

2. 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).

3. 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).

**Technology Transfer**

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

**History of Design**

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

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

**Universal Design**

1. 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).

2. Evaluate and rate the quality of an existing household product or system.
Benchmark B: Recognize the role of teamwork in engineering design and of prototyping in the design process.

**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).

4. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

5. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

6. 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).

7. Build a prototype to use as a working model to demonstrate a design’s effectiveness to potential customers.

**Requirements**

1. 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**

1. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

2. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

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

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

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

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

Quality Design

1. Evaluate a design using established design principles to collect data on the design’s effectiveness, and suggest improvements (e.g., how can bicycles be made safer?).

2. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process.

3. Explain how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

4. Explain how gender-bias, racial-bias and other forms of stereotyping and discrimination can affect communication within an engineering team.

5. Evaluate a design completed or created by another group of students using established design principles.

6. Describe the relationship between engineering disciplines.

7. Describe how a prototype is a working model used to show how subsystems interact.

8. Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

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

10. 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 Practice

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

Technical Communication

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

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

Technical Contradictions

1. Describe how to identify conflicts or contradictions in technological systems.
Engineering Design

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

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

Research and Development

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

Market Research

1. Research consumer preferences for a new product.

Quality Design

1. 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.

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

Idea Generation

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

Technical Problem-solving

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

Redesign

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

Emerging Technology

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

Innovation and Invention

1. 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

1. 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).

2. 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).

Universal Design

1. 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

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

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

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

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

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

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

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

Safety

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

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

Engineering Practice

1. Measure voltage, resistance and current in electrical systems and describe the different instruments used.

2. Describe the application of the first and second laws of thermodynamics (e.g., the concept and function of a heat engine).

3. Explain the relationship between resistance, voltage and current (Ohm’s Law).

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

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

Use and Maintain Technological Systems

1. Differentiate between hydraulic and pneumatic systems and provide examples of appropriate applications of each as they relate to manufacturing and transportation systems.
2. Identify and investigate AC and DC circuits (e.g., sources, conductors, controls, loads, applications, purposes, safety, components, symbols, principles and operations).

3. Employ energy and power technologies to resolve practical problems (e.g., efficient power production, conversion and transmission).

4. Build energy and power devices using the appropriate technological tools, machines, equipment, materials and technical processes to solve a problem in the community.

5. Identify the sources of energy, conversion process, and load in a variety of power systems (e.g., tractor, electrical grid, elevator).

6. Differentiate among conduction, convention, and radiation in a thermal system (e.g., heating and cooling a house, cooking).

7. Identify and explain the components of a circuit including a source, conductor, load and controllers (controllers are switches, relays, diodes, transistors, integrated circuits).

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

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

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

12. 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**

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

2. 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).

**Emerging Technology**

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

**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).

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

**Design Application**

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

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

**Technical Standards**

1. 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.

**System Management**

1. 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).

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

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.

**Design Applications**

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

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

**Emerging Technology**

1. Investigate emerging (state-of-the-art) and innovative applications of transportation technology.
Technical Standards

1. 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.

Technical Careers

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

System Management

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

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

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

2. 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).

Use and Maintain Technological Systems

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

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

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

4. 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).

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).

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

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

**Technology Assessment**

1. 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**

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

**Design Applications**

1. 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).

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

**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).

**Engineering Practice**

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

**Technical Standards**

1. 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.

Technical Careers

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

System Management

1. 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

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

Engineering Practice

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

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

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

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

Use and Maintain Technological Systems

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

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

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

8. 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).

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

**Design Applications**

1. 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).

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

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 Communication**

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

**Emerging Technology**

1. 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).

**Technical Standards**

1. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, 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 E:** Classify, demonstrate, examine and appraise information and communication technologies.

**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. 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).

**Emerging Technology**

1. Investigate emerging (state-of-the-art) and innovative applications of information and community technology.

**Technical Standards**

1. 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 G:** Classify, demonstrate, examine and appraise agricultural and related biotechnologies.

**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**

1. 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**

1. Prioritize and apply appropriate safety measures when working with agricultural and related biotechnologies.

**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).

**Technology Assessment**

1. 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 distribution center grown hydroponically and traditionally).
2. Evaluate the effects of genetic engineering, fertilizers, herbicides, and pesticides on the environment and the production of food.

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).

Technical Standards

1. 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).
Course Descriptions

Beginning Photography/Digital Imaging: Beginning Photography/Digital Imaging is a course that introduces students to the world of photography. Basic principles of photography, basic techniques employed in the use of various formats of cameras, film developing and printing, and the latest digital photography/imaging equipment and techniques are taught. No prior knowledge of photography is necessary. Students should have their own 35mm SLR or digital SLR camera to use in class, though other camera formats may be acceptable. Students will study the history of photography, cameras, film developing and darkroom techniques, then move into the digital darkroom learning about digital photography and image editing using Adobe Photoshop CS2. All lab activities use black and white film, color film, and digital technology. Evaluation will be based on the effort in class, improvement of quality images, tests, written work, and the completion of portfolios and other photographic/digital imaging assignments.

Advanced Photography/Digital Imaging: Advanced Photography/Digital Imaging will give students a chance to further pursue and explore their knowledge and skills in photography/digital imaging. Students will be responsible for deciding the areas of photography/digital imaging they wish to pursue more in depth and research the information needed to achieve their goals. Students will have more opportunity to create a personal portfolio of their work, which will be beneficial to their application and acceptance to various colleges and programs. Students need to have access to a 35mm film SLR or digital SLR camera or some other format of camera. Students will be given photojournalistic assignments to capture images of various school activities such as sporting events, dances, and club events that may be used for the school newspaper, the yearbook, or the school literary magazine. Students are expected to purchase some materials such as film, print paper, ink jet photography paper and matte board. Evaluation will be based upon successful completion of contracts, independent research project, and portfolios of their work.

STANDARD 1: NATURE OF TECHNOLOGY

Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion

1. List and describe factors that may influence the development of technology.

2. 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

1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.

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

1. Make informed choices among technology systems, resources and services.

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

Benchmark B: Apply technological knowledge in decision-making.

Optimization and Trade-offs

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.

2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

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

Sustainability

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

**Benchmark A:** Interpret and practice responsible citizenship relative to technology.

*Technology and Citizenship*

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Review how different factors, such as individual curiosity, advertising, the strength of the economy, the goals of a company and the current trends, contribute to shaping the design of and demand for various technologies.

4. Understand that the development of technology may be influenced by societal opinions and demands, in addition to corporate cultures.

5. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

6. Assess technology systems, resources and services relative to responsible usage of technology.

7. Describe how changes caused by the use of technology can range from gradual to rapid, and from subtle to obvious.

8. Compare and evaluate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

9. Make informed choices among technology systems, resources and services.

10. 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.

11. Debate the advantages of widespread use and reliance on technology in the workplace and in society as a whole.

12. 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.

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).

3. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.

4. Demonstrate how technological decisions involve trade-offs between predicted positive and negative effects on the environment.

5. Forecast intended and unintended consequences of technology deployment.

6. 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.

Technology and History

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

2. Select a technology or tool and predict how it will change in the future.

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

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

5. Compare and contrast periods of technology proliferation in the world, and the related social and economic influences.

6. Understand the basic elements of the evolution of technological tools and systems throughout history.
PHOTOGRAPHY/DIGITAL IMAGING
Grades 10-12

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

Technology and Ethics

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

2. Discuss access to information in a democratic society.

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

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

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

6. Debate the ethical considerations involved in the development or deployment of new technologies (e.g., medical technologies to create or extend life, satellite imagery, software to capture content or monitor user activity).

7. Examine and discuss how technology, its use and resultant societal changes are viewed by different ethnic, cultural and religious groups.

8. Evaluate access (expanded and limited) determined by technology, law, legislation and/or policy.

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

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

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

12. Practice responsible and ethical usage of technology.

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

Technology Assessment

1. Collect information about products and systems and evaluate the quality of that information.

2. Describe criteria for assessing the quality of information.

3. Compare and contrast the past, present and future developments of a technological system.
4. 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).

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

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

7. Use assessment techniques, such as trend analysis and experimentation to make decisions about the future development of technology.

8. Locate and evaluate past predictions about the development of technology.

9. Describe techniques for making decisions about the future development of technology.

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

11. 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.

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

*Understanding Operations*

1. Explore state-of-the-art devices to store data that will be used for researching projects.
2. Create a design for a basic network and list skills needed to manage networks.
3. Examine current and past devices for storing data and predict potential devices for the future.
4. Analyze various types of connectivity and list pros and cons of each.
5. Make informed choices among technology systems, resources and services.
6. Explore state-of-the-art devices to store data.

*Problem-solving*

1. Describe strategies for identifying and solving routine hardware and software problems that occur during everyday use.
2. Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.
3. Research technology systems, resources and services to solve technical problems.
4. 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.

*Understanding Operations*

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

*Productivity Tools*

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).
2. Utilize advanced word processing and desktop publishing features and programs.

*Communication Tools*

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

*Problem-solving*

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

*Knowledge Generation*

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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).
PHOTOGRAPHY/DIGITAL IMAGING
Grades 10-12

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.

Benchmark A: Apply appropriate communication design principles in published and presented projects.

Multimedia Applications

1. Format text, select color, insert graphics and include multimedia components in student-created media/communication products.

Accessibility Guidelines

1. Modify electronic publications and other communication products to meet accessibility guidelines so that access to information is not limited.
2. Verify accessibility components of the communication product and adapt as needed.

Evaluation

1. Examine how and why image, language, sound and motion convey specific messages designed to influence the audience.
2. Assess the accuracy of the communication product.
3. Compare and contrast the accuracy of the message/communication product with the audience results (e.g., was the audience influenced by inaccurate information?).
4. Select and evaluate message-appropriate designs for print, multimedia, video and Web pages for curricular and personal needs (e.g., silly graphics may not be appropriate for academic projects).
5. Analyze the complexities and discrepancies found in communication products.
6. Interpret ethical considerations and legal requirements involved in construction of communication products.

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

1. Manipulate communication design elements (image, language, sound and motion) based on intent of the message (e.g., inform or persuade).
2. Employ design techniques taking into consideration the psychological impact and cultural connotations of color when designing for print media and multimedia, video and Web pages.

3. Apply principles of design (contrast, repetition, alignment and proximity) for academic and personal needs (e.g., resume, scholarship application).

4. Adapt design concepts to emerging technologies.

5. 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).

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

Use of Communications

1. Use e-mail in a teacher-moderated discussion group and in threaded discussion lists.

2. Use technology to publish information in electronic form (e.g., Web, multimedia, digital video, electronic portfolio).

3. Archive communication products in appropriate electronic forms (e.g., store electronic publications so that they may be accessed when needed).

4. Use Web technologies to disseminate information to a broader audience.

Evaluation

1. Validate use of communication techniques.

2. Evaluate communication products.

3. Critique personal communication products.

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

Publication

1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).
Benchmark C: Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

**Use of Communications**

1. Demonstrate communication clarity and use elements and formats of e-mail to communicate with others (e.g., discussion lists, message board, chat, instant messaging).

2. Identify and use the appropriate communication tool to collaborate with others (e.g., presentation, Web site, digital video).

3. Investigate the uses of videoconferencing, Web casting, and other distance learning technologies (e.g., interviews, meetings, course work).

4. Develop collaborative online projects to research a problem and disseminate results.

5. Contribute to organized e-mail discussions (e.g., discussion list, list serv, threaded discussion list, courseware discussion).

6. Employ online communication capabilities to make inquiries, do research and disseminate results (e.g., develop dialogues on issues in U.S. government).

7. Implement online-structured learning experiences (e.g., tutorials, virtual classes, industry certification courses).

8. Select an appropriate e-mail discussion list to meet communication needs (e.g., purpose of list, participants, audience, topics, ease of use).

9. Integrate online communication capabilities to make inquiries, do research and disseminate results (e.g., group writing projects, college searches, career information inquiry).

10. Collaborate in online learning or videoconferencing activities based on research and/or an investigation of real-world problems (e.g., study of community or regional ecosystem).

11. Select and use appropriate online structured learning experiences to meet individual learning needs.

12. Communicate using all manifestations of e-mail, as needed, for personal and curricular purposes, demonstrating appropriate and responsible use.

13. Use all available online communication capabilities to make inquiries, do research and disseminate results.

**Evaluation**

1. 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.

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

Evaluating Sources

1. Define terms which determine information validity:
   a. Accuracy
   b. Authority
   c. Objectivity
   d. Currency
   e. Coverage (including objectivity and bias)

2. Determine the author’s authority for all resources and identify points of agreement and disagreement among sources.

3. 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).

4. 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).

5. Create a bibliography of sources in an electronic format.

6. Select appropriate information on two sides of an issue (e.g., identify the author of each information source and their expertise and/or bias).

7. Seek and evaluate information to answer both personal and curricular needs.

8. Analyze the intent and authorship of information sources used for a curricular need.

9. Determine valid information for an assignment from a variety of sources.

10. Evaluate information collected to answer both personal and curricular needs to determine its accuracy, authority, objectivity, currency and coverage.

11. Acknowledge intellectual property in using information sources.

12. 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.

**Decide**

1. Determine the essential questions and plan research strategies.

2. Select the essential question to be examined by the research.

3. 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.

4. Select essential questions for research and use a recognized or personally developed model to conduct independent research.

5. Derive a personally developed research model to conduct independent research.

6. Refine the information question to focus the research process, modifying the question as necessary to broaden or narrow the inquiry.

**Find**

1. Select and evaluate appropriateness of information from a variety of resources, including online research databases and Web sites to answer the essential questions.

2. Evaluate information and select relevant and pertinent information found in each source, and maintain accurate records of sources used.

3. Identify, evaluate information and select relevant and pertinent information found in each source.

4. Identify relevant facts, check for validity, and record appropriate information keeping track of all sources.

5. Critique information sources to determine if different points of view are included.

6. Integrate multiple information sources in the research process.

**Use**

1. Integrate copyrighted information into an information product, following appropriate use of guidelines (e.g., quote using proper citation format, request permission to use).

2. Identify relevant facts, check facts for accuracy and record appropriate information.

3. Incorporate a list of sources used in a project using a standard bibliographic style manual (e.g., MLA and APA Style Manuals).

4. Organize and analyze information, finding connections that lead to a final product.
PHOTOGRAPHY/DIGITAL IMAGING
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5. Follow copyright law and use standard bibliographic format to list sources.

6. Analyze information and synthesize into a communicated product.

7. Respect copyright laws and guidelines, and use standard bibliographic format to list sources.

8. Create a product to communicate information, representing a personal point of view based on findings.

9. 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**

1. Evaluate the research process and product as they apply to the information need (e.g., does the process reflect the actual information need).

2. Assess whether the essential questions are answered, gather more information and data and modify search terms as needed. Edit the product.

3. Review and evaluate research process and the resources used (e.g., how can the research process be improved?).

4. Critique and revise the information product.

5. Review the research process for efficiency and effectiveness.

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

**Manage**

1. Archive the final product in a format that will be 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.

**Search Strategies**

1. Identify multiple directories and search engines matching curricular need (e.g., given an assignment, use knowledge of tools to pick an appropriate tool to search for information).

2. Construct search strategies focused on the retrieval of specific search results by incorporating Boolean operators “AND” “OR” “NOT” and adjacency/proximity techniques.

3. Compare and chart the search results from multiple Web sites to check for consistency of information (e.g., compare data on acid rain from more than one site).
4. Construct an effective search strategy to retrieve relevant information through multiple search engines, directories and Internet resources.

5. Narrow or broaden the search strategy by modifying the keywords entered in the original search strategy.

6. 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).

7. Demonstrate the use of parentheses for nesting search terms to alter retrieval strategies through multiple Internet resources.

8. Create a product on a specific curricular topic that includes annotated Web sites constructed according to a standard style manual (e.g., electronic pathfinder on careers).

9. Incorporate defined field searching by initiating a search string identifying the desired field of information to be retrieved (e.g., search author or title).

10. Create a stand-alone system for tracking Internet resources for personal and academic needs (e.g., postsecondary institutions of interest).

**Evaluating Sources**

1. Establish criteria for evaluating the information retrieved through Internet searching: author’s expertise, bias, coverage of topic and timeliness.

2. Examine the information retrieved through Internet searching for authenticity of information, bias, currency, relevance and appropriateness.

3. Develop a systematic approach to judge the value of the retrieved Web information.

4. Synthesize search results retrieved from a variety of Internet resources to create an information product for a targeted audience.

5. 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.

**Electronic Resources**

1. Integrate search strategies within the electronic resource that targets retrieval for specific information need (e.g., limit by date of publication, focus on specific format such as image, sound file).

2. Review strengths and weaknesses of various types of electronic resources for research need (e.g., compare subject-specific magazine database to general online index of articles).
3. Demonstrate the difference between databases, directories and database archives (e.g., free vs. fee-based, delivery mechanism, such as CD, DVD, network, Internet, and general vs. specific discipline).

4. Select a specific database for an assignment and explain why it is the appropriate one to use (e.g., in researching a particular author, use a literary database of biographical and critical information about writers).

5. Choose a topic and identify appropriate electronic resources to use, citing the name and date of the resource database archive collection.

6. Research and critique information in different types of subscription (fee-based) electronic resources to locate information for a curricular need.

7. Investigate tools within electronic resources to generate search strategies (e.g., use a thesaurus to identify subject terms for improved retrieval of information).

8. Modify a search through the use of different keywords and other techniques specific to an electronic resource (e.g., online database, Web-based index).

9. Integrate online subscription resources and other electronic media to meet needs for research and communication on a routine basis.

10. Differentiate coverage of electronic resources to select information need.

11. Support choices of free and fee-based Web information used to create a class project.

12. Research information from electronic archives (e.g., list serv archives, weblogs).

13. Use a variety of technology resources for curriculum and personal information needs (e.g., streaming video, CD/DVD, subscription database).

14. Evaluate technology resources and determine strengths and weaknesses for curricular or personal needs.

15. Select an appropriate tool, online resource or Website based on the information need.
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

Research and Development

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

Market Research

1. Research consumer preferences for a new product.

Quality Design

1. 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

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

Technical Problem-solving

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

Redesign

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

Emerging Technology

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

Innovation and Invention

1. 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

1. 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).

2. 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).

Quality Design

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

Universal Design

1. 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

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

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

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

Reverse Engineering

1. 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.

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

Technical Careers

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

Safety

1. 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

1. 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).

2. 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

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

Emerging Technology

1. Investigate emerging (state-of-the-art) and innovative applications of information and community technology.

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.

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

3. 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**

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

2. Analyze a dysfunctional communication system and suggest improvements (e.g., the school public address system).

3. Identify and explain the applications of laser and fiber optic technologies (e.g., telephone systems, cable TV, medical technology, and photography).

**Technical Standards**

1. 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).
Course Description:
Home B.A.S.E. (Building Academic Skills and Experiences) Construction is the Technology Education part of the Home B.A.S.E. group of classes (English, Government, and Home B.A.S.E. Construction) that provides 12th grade students with the opportunity to integrate their Government/Economics and Advanced Composition courses with community service by building a home for a working American family in need. In the past, some of the homes have been built in partnership with Habitat for Humanity. These integrated courses (English, Government, and Technology Education) have their focus on social issues such as poverty, homelessness, the working poor, education, construction of a house, associated reflections, and affordable housing. Other issues are energy, the environment, and creating a sustainable human environment. Home B.A.S.E. Construction provides the scaffolding from which the two other integrated courses derive their instruction. Home B.A.S.E. Construction encourages students to work with a team to solve the problem of poverty housing for American families. Authentic assignments for students are incorporated into and are essential to Home B.A.S.E. Construction.

STANDARD 1: NATURE OF TECHNOLOGY
Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion

1. List and describe factors that may influence the development of technology.

2. 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).

3. Illustrate ways that the rate of technological development and diffusion is exponential.

Commercialization of Technology

1. Make informed choices among technology systems, resources and services.

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

3. Predict how profit incentive and the market economy influence technological development.

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

Benchmark B: Apply technological knowledge in decision-making.

Optimization and Trade-offs

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.
2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

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

**Sustainability**

1. Discuss how sustainability is a balance of economic prosperity, environmental quality and social equity.

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

**Innovation and Invention**

1. 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.

**Benchmark A:** Interpret and practice responsible citizenship relative to technology.

*Technology and Citizenship*

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Assess technology systems, resources and services relative to responsible usage of technology.

4. Analyze the causes, consequences and possible technology solutions to problems in a persistent, contemporary and emerging world (e.g., health, security, resource allocation, economic development or environmental quality).

5. Make informed choices among technology systems, resources and services.

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

*Technology and Environment*

1. Design, model/build and evaluate a plan/method for conserving resources.

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).

3. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.

4. Demonstrate how technological decisions involve trade-offs between predicted positive and negative effects on the environment.

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

*Technology and Ethics*

1. Practice responsible and ethical usage of technology.
Benchmark E: Forecast the impact of technological products and systems.

Technology Assessment

1. Collect information about products and systems and evaluate the quality of that information.
2. Describe criteria for assessing the quality of information.
3. Compare and contrast the past, present and future developments of a technological system.
4. Describe how a technological change has affected the local community (e.g., how a new highway has changed traffic and building patterns).
STANDARD 3: TECHNOLOGY FOR PRODUCTIVITY APPLICATIONS

Students learn the operations of technology through the usage of technology and productivity tools.

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

**Communication Tools**

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

**Knowledge Generation**

1. 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.

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

**Use of Communications**

1. Use technology to publish information in electronic form (e.g., Web, multimedia, digital video, electronic portfolio).

2. Use Web technologies to disseminate information to a broader audience.

**Publication**

1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).

**Benchmark C:** Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

**Use of Communications**

1. Identify and use the appropriate communication tool to collaborate with others (e.g., presentation, Web site, digital video).
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.

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

*Evaluating Sources*

1. Acknowledge intellectual property in using information sources.
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

Understanding Technological Systems

1. 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.
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.

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

**System Management**

1. Understand that all energy delivery systems need an infrastructure (e.g., identify features of natural gas and gasoline pipeline distribution systems across Ohio).

**Benchmark C:** Classify, demonstrate, examine and appraise manufacturing technologies.

**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).

**Engineering Practice**

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

**Technical Standards**

1. 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.

**Technical Careers**

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

**System Management**

1. 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

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

Engineering Practice

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

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

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

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

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.

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

8. 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).

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

Design Applications

1. 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).

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

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

**Emerging Technology**

1. 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).

**Technical Standards**

1. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, 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).
Course Description:
The Adaptive Technology Program provides both academic and pre-vocational experiences for special education students. Students are exposed to a variety of technological processes such as tools and machines, electricity, photography and computers. They learn in a laboratory setting with hands-on activities. Learning experiences are created to help meet the needs of each student as identified in the Individualized Education Program (IEP). Although specific instructional objectives are tailored to the needs of each student, some fundamental goals are designed for all special education students who take this course.

STANDARD 1: NATURE OF TECHNOLOGY
Students develop an understanding of technology, its characteristics, scope, core concepts, and relationships between technologies and other fields.

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

Technology Diffusion
1. List and describe factors that may influence the development of technology.
2. 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).
3. Illustrate ways that the rate of technological development and diffusion is exponential.
4. Predict the impact of the exponential development and diffusion of technology.

Goal-directed Research
1. Describe goal-directed research, define invention and innovation, and explain the relationship among them.
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).
3. Describe, discuss and cite examples of how goal-directed research results in innovation.
4. Invent a product using goal-directed research.

Commercialization of Technology
1. Make informed choices among technology systems, resources and services.
2. Explain how technological development is influenced by many factors, including profit incentive and market economy.
3. Predict how profit incentive and the market economy influence technological development.
4. Plan/construct technological products considering profit incentive and market economy.

**Nature of Technology**

1. Articulate and cite examples of how the development of technological knowledge and processes are functions of the setting.

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

**Benchmark B**: Apply technological knowledge in decision-making.

**Optimization and Trade-offs**

1. Demonstrate how the stability of a technological system is influenced by all system components, especially those in the feedback loop.

2. 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).

3. Cite examples showing how the failure of system components contributes to the instability of a technological system (e.g., if the fuel pump in an automobile malfunctions, the entire system will not work properly; or if a computer hard drive fails, the computer system will not work properly).

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

**Sustainability**

1. Discuss how sustainability is a balance of economic prosperity, environmental quality and social equity.

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

**Nature of Technology**

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

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

**Technology Transfer**

1. Describe how technology transfer occurs when an innovation in one setting is applied in a different setting.
2. Analyze technology transfer scenarios.

3. Identify technologies suitable for transfer and defend the rationale for selection.

4. 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

1. Describe how technologies are, or can be, combined (e.g., a computer-controlled surgical laser scalpel represents the combination of physical, information and bio-related technology).

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.

4. Cite examples of how technological innovation has resulted when ideas, knowledge or skills have been shared within, or among, other technologies.

5. Illustrate the relationship of technological progress to the advancement of science, mathematics and other fields.

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

7. 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.

Benchmark A: Interpret and practice responsible citizenship relative to technology.

Technology and Citizenship

1. Explain how making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

2. Understand that ethical considerations are important in the development, selection and use of technologies.

3. Review how different factors, such as individual curiosity, advertising, the strength of the economy, the goals of a company and the current trends, contribute to shaping the design of and demand for various technologies.

4. Understand how different cultures develop their own technologies to satisfy their individual and shared needs, wants and values.

5. Understand that the development of technology may be influenced by societal opinions and demands, in addition to corporate cultures.

6. Contrast ethical considerations and how they are important in the development, selection and use of technologies.

7. Assess technology systems, resources and services relative to responsible usage of technology.

8. Describe how changes caused by the use of technology can range from gradual to rapid, and from subtle to obvious.

9. Compare and evaluate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

10. Analyze the causes, consequences and possible technology solutions to problems in a persistent, contemporary and emerging world (e.g., health, security, resource allocation, economic development or environmental quality).

11. Examine the ethical considerations of a governmental technology policy that affects the physical characteristics of a place or region (e.g., building of the oil pipeline in Alaska, mineral rights under farmland).

12. Compare and evaluate alternate public policies for technology deployment and the use of natural resources.

13. Make informed choices among technology systems, resources and services.
14. 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.

15. Debate the advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

16. 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).

Technology Transfer

1. Provide examples of technology transfer from a government agency to private industry, and discuss the benefits (e.g., global positioning systems—GPS, Internet).

2. 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).

3. 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 workplace needs.

4. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and in society as a whole.

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

Technology and Environment

1. Design, model/build and evaluate a plan/method for conserving resources.

2. Investigate the use and development of appropriate technologies to meet the needs of persons living in developing countries (e.g., hand-crank powered radio for communication).

3. Describe the economic impact of invasive foreign species present in Ohio as a result of technology activity or other human intervention.

4. 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).

5. 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).

6. Understand that humans can devise technologies to conserve water, soil and energy through such techniques as reusing, reducing and recycling.
7. Demonstrate how technological decisions involve trade-offs between predicted positive and negative effects on the environment.

8. Forecast intended and unintended consequences of technology deployment.

9. 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.

**Technology and History**

1. Describe how some technological development has been evolutionary, the result of a series of refinements to basic inventions or innovations over time.

2. Select a technology or tool and predict how it will change in the future.

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

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

5. Compare and contrast periods of technology proliferation in the world, and the related social and economic influences.

6. Understand the basic elements of the evolution of technological tools and systems throughout history.

7. 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

**Technology and Ethics**

1. Practice responsible usage of technologies (e.g., download legally, install licensed software, adhere to copyright restrictions).

2. Discuss access to information in a democratic society.

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

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

5. Understand the importance of diverse information and access to information in a democratic society.
6. Debate the ethical considerations involved in the development or deployment of new technologies (e.g., medical technologies to create or extend life, satellite imagery, software to capture content or monitor user activity).

7. Examine and discuss how technology, its use and resultant societal changes are viewed by different ethnic, cultural and religious groups.

8. Evaluate access (expanded and limited) determined by technology, law, legislation and/or policy.

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

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

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

12. Practice responsible and ethical usage of technology.

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

**Technology Assessment**

1. Collect information about products and systems and evaluate the quality of that information.

2. Describe criteria for assessing the quality of information.

3. Compare and contrast the past, present and future developments of a technological system.

4. 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).

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

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

7. Use assessment techniques, such as trend analysis and experimentation to make decisions about the future development of technology.

8. Locate and evaluate past predictions about the development of technology.

9. Describe techniques for making decisions about the future development of technology.

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

11. 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.

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

*Understanding Operations*

1. Explore state-of-the-art devices to store data that will be used for researching projects.
2. Create a design for a basic network and list skills needed to manage networks.
3. Examine current and past devices for storing data and predict potential devices for the future.
4. Analyze various types of connectivity and list pros and cons of each.
5. Make informed choices among technology systems, resources and services.
6. Explore state-of-the-art devices to store data.

*Problem-solving*

1. Describe strategies for identifying and solving routine hardware and software problems that occur during everyday use.
2. Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.
3. Research technology systems, resources and services to solve technical problems.
4. 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.

*Understanding Operations*

1. Identify and use input and output devices to operate and interact with computers and multimedia technology resources (e.g., digital video camera, mobile cameras—a camera on a robot base, like a Mars rover, how to connect analog equipment to digital equipment).

*Productivity Tools*

1. Demonstrate proficiency in all productivity tools (e.g., word processing, spreadsheet, database, desktop publishing).
2. Utilize advanced word processing and desktop publishing features and programs.
Communication Tools

1. Use equipment related to computer and multimedia technology imaging (e.g., digitalization, optical character recognition, scanning, computerized microscopes).

Problem-solving

1. Identify/recognize state-of-the-art technology tools for solving problems and managing personal/professional information.

Knowledge Generation

1. Apply emerging technology tools and resources for managing and communicating personal/professional information (e.g., distance learning, voice-recognition tools, personal digital devices, automatic identification systems, bar codes, radio frequency tags).

2. Assimilate productivity and technological tools into all aspects of solving problems and managing personal information and communications.

3. 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.

**Benchmark A:** Apply appropriate communication design principles in published and presented projects.

**Multimedia Applications**

1. Format text, select color, insert graphics and include multimedia components in student-created media/communication products.

**Accessibility Guidelines**

1. Modify electronic publications and other communication products to meet accessibility guidelines so that access to information is not limited.

2. Verify accessibility components of the communication product and adapt as needed.

**Evaluation**

1. Examine how and why image, language, sound and motion convey specific messages designed to influence the audience.

2. Assess the accuracy of the communication product.

3. Compare and contrast the accuracy of the message/communication product with the audience results (e.g., was the audience influenced by inaccurate information?).

4. Select and evaluate message-appropriate designs for print, multimedia, video and Web pages for curricular and personal needs (e.g., silly graphics may not be appropriate for academic projects).

5. Analyze the complexities and discrepancies found in communication products.

6. Interpret ethical considerations and legal requirements involved in construction of communication products.

**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**

1. Manipulate communication design elements (image, language, sound and motion) based on intent of the message (e.g., inform or persuade).

2. Employ design techniques taking into consideration the psychological impact and cultural connotations of color when designing for print media and multimedia, video and Web pages.
3. Apply principles of design (contrast, repetition, alignment and proximity) for academic and personal needs (e.g., resume, scholarship application).

4. Adapt design concepts to emerging technologies.

5. 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).

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

**Use of Communications**

1. Use e-mail in a teacher-moderated discussion group and in threaded discussion lists.

2. Use technology to publish information in electronic form (e.g., Web, multimedia, digital video, electronic portfolio).

3. Use Web technologies to disseminate information to a broader audience.

**Evaluation**

1. Validate use of communication techniques.

2. Evaluate communication products.

3. Critique personal communication products.

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

**Publication**

1. Publish information in printed and electronic version, and select appropriate publication format (e.g., paper, Web, video).

**Electronic Communications**

1. Archive communication products in appropriate electronic forms (e.g., store electronic publications so that they may be accessed when needed).

**Benchmark C:** Identify communication needs, select appropriate communication tools and design collaborative interactive projects and activities to communicate with others, incorporating emerging technologies.

**Use of Communications**
1. Demonstrate communication clarity and use elements and formats of e-mail to communicate with others (e.g., discussion lists, message board, chat, instant messaging).

2. Identify and use the appropriate communication tool to collaborate with others (e.g., presentation, Web site, digital video).

3. Investigate the uses of videoconferencing, Web casting, and other distance learning technologies (e.g., interviews, meetings, course work).

4. Develop collaborative online projects to research a problem and disseminate results.

5. Contribute to organized e-mail discussions (e.g., discussion list, list serv, threaded discussion list, courseware discussion).

6. Employ online communication capabilities to make inquiries, do research and disseminate results (e.g., develop dialogues on issues in U.S. government).

7. Implement online-structured learning experiences (e.g., tutorials, virtual classes, industry certification courses).

8. Select an appropriate e-mail discussion list to meet communication needs (e.g., purpose of list, participants, audience, topics, ease of use).

9. Integrate online communication capabilities to make inquiries, do research and disseminate results (e.g., group writing projects, college searches, career information inquiry).

10. Collaborate in online learning or videoconferencing activities based on research and/or an investigation of real-world problems (e.g., study of community or regional ecosystem).

11. Select and use appropriate online structured learning experiences to meet individual learning needs.

12. Communicate using all manifestations of e-mail, as needed, for personal and curricular purposes, demonstrating appropriate and responsible use.

13. Use all available online communication capabilities to make inquiries, do research and disseminate results.

**Evaluation**

1. Research emerging communication technologies (e.g., wireless systems, open source software and systems, virtual reality).
STANDARD 6: DESIGN

Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.

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

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.

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

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

5. Describe quality and how it is evaluated in the product or system.

6. Select and use simulation in the design process.

7. 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).

8. 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).

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

10. 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.

11. 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 note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).

Technical Contradictions

1. 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).
2. 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).

3. Identify how contradictions were overcome in existing solutions.

4. 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).

5. Apply the separation principles to overcome contradictions in systems (e.g., time, space, combining or dividing systems, physical-chemical changes).

Requirements

1. Identify the elements of quality in a product/system (e.g., tolerances, fit, finish, function, form (aesthetics), repeatability, durability, material).

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

Optimization and Trade-offs

1. Explain that design problems are seldom presented in a clearly defined form (e.g., problems often involve competing constituencies, undiscovered constraints and unidentified regulations).

2. Identify criteria and constraints for a design problem and determine how they 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).

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

Technical Problem-solving

1. 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).

2. Apply the concepts of system dynamics and systems thinking to the solution of problems.

Technical Communication

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

2. 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.
3. Summarize to another person the enjoyment and gratification of designing/creating/producing a completed illustration, drawing, project, product or system.

**Intellectual Property**

1. Recognize that patent, trademark and copyright laws protect technological ideas and intellectual property.

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

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

4. Predict/project the need for changes in copyright, patent and trademark laws, considering the rapid changes in technology and society.

**Understanding Technological Systems**

1. 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.

2. 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).

3. 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).

**Technology Transfer**

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

**History of Design**

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

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

**Universal Design**

1. 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).

2. Evaluate and rate the quality of an existing household product or system.
**Benchmark B**: Recognize the role of teamwork in engineering design and of prototyping in the design process.

**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).

4. Build a prototype to test a design concept and make actual observations and necessary design adjustments.

5. Design a prototype using quality control measures (e.g., measuring, checking, testing, feedback).

6. 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).

7. Build a prototype to use as a working model to demonstrate a design’s effectiveness to potential customers.

**Requirements**

1. 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**

1. Describe how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

2. Describe the importance of teamwork, leadership, integrity, honesty, work habits and organizational skills of members during the design process.

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

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

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

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

Quality Design

1. Evaluate a design using established design principles to collect data on the design’s effectiveness, and suggest improvements (e.g., how can bicycles be made safer?).

2. Explain how established design principles are used to evaluate existing designs, collect data and guide the design process.

3. Explain how engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

4. Explain how gender-bias, racial-bias and other forms of stereotyping and discrimination can affect communication within an engineering team.

5. Evaluate a design completed or created by another group of students using established design principles.

6. Describe the relationship between engineering disciplines.

7. Describe how a prototype is a working model used to show how subsystems interact.

8. Understand that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

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

10. 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 Practice

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

Technical Communication

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

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

Technical Contradictions

1. Describe how to identify conflicts or contradictions in technological systems.
**Engineering Design**

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

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

**Research and Development**

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

**Market Research**

1. Research consumer preferences for a new product.

**Quality Design**

1. 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.

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

**Idea Generation**

1. Identify factors that inhibit creativity (e.g., perceptual, emotional, cultural, functional, environmental).

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

**Technical Problem-solving**

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

**Redesign**

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

**Emerging Technology**

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

**Innovation and Invention**

1. 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

1. 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).

2. 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).

Universal Design

1. 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

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

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

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

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

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

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

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

Safety

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

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

Engineering Practice

1. Measure voltage, resistance and current in electrical systems and describe the different instruments used.

2. Describe the application of the first and second laws of thermodynamics (e.g., the concept and function of a heat engine).

3. Explain the relationship between resistance, voltage and current (Ohm’s Law).

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

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

6. Explain Bernoulli’s Principle and its effect on practical applications (e.g., airfoil design, spoiler design, carburetor).
Use and Maintain Technological Systems

1. Differentiate between hydraulic and pneumatic systems and provide examples of appropriate applications of each as they relate to manufacturing and transportation systems.

2. Identify and investigate AC and DC circuits (e.g., sources, conductors, controls, loads, applications, purposes, safety, components, symbols, principles and operations).

3. Employ energy and power technologies to resolve practical problems (e.g., efficient power production, conversion and transmission).

4. Build energy and power devices using the appropriate technological tools, machines, equipment, materials and technical processes to solve a problem in the community.

5. Identify the sources of energy, conversion process, and load in a variety of power systems (e.g., tractor, electrical grid, elevator).

6. Differentiate among conduction, convention, and radiation in a thermal system (e.g., heating and cooling a house, cooking).

7. Identify and explain the components of a circuit including a source, conductor, load and controllers (controllers are switches, relays, diodes, transistors, integrated circuits).

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

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

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

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

12. 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

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

2. 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).

Emerging Technology

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

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

Design Application

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

2. 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).

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

Technical Standards

1. 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.

Technical Careers

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

System Management

1. 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).

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

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.
Safety

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

Use and Maintain Technological Systems

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

Design Applications

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

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

Emerging Technology

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

Technical Standards

1. 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.

Technical Careers

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

System Management

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

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

1. Identify and apply appropriate safety measures when working with manufacturing technologies.
2. 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).

**Use and Maintain Technological Systems**

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

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

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

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

5. 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).

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

7. 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).

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

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

**Technology Assessment**

1. 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**

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

**Design Applications**

1. 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).

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

Engineering Practice

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

Technical Standards

1. 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.

Technical Careers

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

System Management

1. 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

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

Engineering Practice

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

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

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

4. Calculate quantitatively the resultant forces for live loads and dead loads.
Use and Maintain Technological Systems

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

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

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.

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

8. 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).

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

Design Applications

1. 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).

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

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 Communication

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

Emerging Technology

1. 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).
Technical Standards

1. Identify and apply appropriate codes, laws, standards or regulations related to construction technologies (e.g., local building codes, 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 E: Classify, demonstrate, examine and appraise information and communication technologies.

Technical Careers

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

Safety

1. 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

1. 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).

2. 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).

3. 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).

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

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

6. 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

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

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).

Emerging Technology

1. Investigate emerging (state-of-the-art) and innovative applications of information and community technology.

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.

Technical Standards

1. 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.

Technical Careers

1. Appraise the careers available in medical technological systems and the training period needed to pursue them.
2. List advances in the sciences of biochemistry and molecular biology that have made it possible to manipulate the genetic information found in living creatures.

3. Describe how medicines and treatments may have both expected and unexpected results.

**Safety**

1. Identify and apply appropriate safety measures when working with medical technologies.

2. Safely use the tools and processes of medical technological systems (e.g., virtual dissection software).

3. Monitor and apply appropriate safety measures when working with medical technologies.

**Design Application**

1. 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**

1. Examine new sensing technologies being used to diagnose medical conditions less invasively (e.g., CT-Scan, MRI, MRA).

**Emerging Technology**

1. Investigate emerging (state-of-the-art) and innovative applications of medical technologies.

2. Investigate and evaluate new medical technologies.

**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.

**Use and Maintain Technological Systems**

1. Employ medical technologies to resolve practical problems (e.g., choose an appropriate bandage for an injury, contact the appropriate service provider in an emergency).

**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

1. 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.

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

1. 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).

2. 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).

Safety

1. Identify and apply appropriate safety measures when working with agricultural and related biotechnologies.

2. Investigate emerging (state-of-the-art) and innovative applications of agricultural and related biotechnologies.

3. Prioritize and apply appropriate safety measures when working with agricultural and related biotechnologies.

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.

Use and Maintain Technological Systems

1. Employ agricultural and biotechnologies to resolve practical problems (e.g., growing food year-round, using plants to eliminate erosion).
Technology Assessment

1. 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 distribution center grown hydroponically and traditionally).

2. Evaluate the effects of genetic engineering, fertilizers, herbicides, and pesticides on the environment and the production of food.

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).

Technical Standards

1. 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).
STUDENT ASSESSMENT

Definition of Student Assessment

For the purposes of this document, student assessment is defined as the systematic, multi-step process of collecting evidence on student learning, understanding, and abilities and using that information to inform instruction and provide feedback to the learner, thereby enhancing student learning.

Worthington Schools provides all students with the opportunity to be successful learners. Teachers use evaluation to measure student progress and determine interventions. Assessment should align with curriculum and direct classroom instruction. Assessment represents a student’s demonstration of understanding; it provides evidence of what students should know and are able to do. A comprehensive and thoughtful assessment system also provides needed information for instructional planning and decision-making.

Assessment for each student in Technological Studies focuses on the student’s progress toward demonstrating the performance indicators. Frequent oral and written feedback is provided to each student to ensure continued progress and growth.

Examples of various assessments include:

1. Student responses both oral and written to various types of questions.
2. Demonstrations of acquired skills, knowledge and attitudes in such forms as:
   - Creative expressions of learning designed by the student in conjunction with the teacher
   - Portfolio of work personalized by the ability and interest of the student
   - Projects, technology programs, and activities
3. Student self-evaluation
4. Observations and anecdotal notes of the student’s progress
5. Individual assessment designed to meet the needs of each student
6. Individualized conferences with the student, the teacher, and the parent
7. Achievement and diagnostic tests

Strategic instruction relies on assessment and intervention which are performance and data driven.

Examples of intervention activities utilized in the Worthington School District include the following:

- Individual Tutoring – Academic Assistant
- Individual Tutoring – Teacher
- Individual Tutoring – Peer/Student
- Individual Tutoring – Parent/Volunteer
- Large Group Instruction
- Small Group Instruction
- Differentiated Instruction
- Referral for Diagnostic Assessment
- Special Education Services
- Flexible Grouping
- Educational Options
- Independent Study
- Correspondence Courses
- Parent Conferences
- Individual Tutoring – Technology
- Assistance through Advisory
- Summer School
- Modified Assignments
- ESL Services
- Guided Studies Course
- Parent Communication

Examples of Assessment (ITEA):

- Computerized Assessment
- Demonstrations/Presentations/Multimedia
• Individual and Group Activities
• Informal Observations/Discussions
• Open-Ended Questioning
• Paper and Pencil Tests
• Peer Assessment
• Performances
• Portfolios
• Projects/Products/Media
• Reports/Research
• Rubrics/Checklists
• Student Interviews – Written and Oral
• Student Self Reflection/Assessment
• Videos/Slide Shows/Posters
• Work Samples