Standard 5—Technology
Elementary

Engineering Design

1. Engineering design is an iterative process involving *modeling* and *optimization* used to develop technological solutions to problems within given constraints.

Students:

- **describe objects, imaginary or real, that might be modeled or made differently and suggest ways in which the objects can be changed, fixed, or improved.**
- **investigate prior solutions and ideas from books, magazines, family, friends, neighbors, and community members.**
- **generate ideas for possible solutions, individually and through group activity; apply age-appropriate mathematics and science skills; evaluate the ideas and determine the best solution; and explain reasons for the choices.**
- **plan and build, under supervision, a model of the solution using familiar materials, processes, and hand tools.**
- **discuss how best to test the solution; perform the test under teacher supervision; record and portray results through numerical and graphic means; discuss orally why things worked or didn't work; and summarize results in writing, suggesting ways to make the solution better.**

This is evident, for example, when students:

- s read a story called *Humpty's Big Day* wherein the readers visit the place where Humpty Dumpty had his accident, and are asked to design and model a way to get to the top of the wall and down again safely.
- s generate and draw ideas for a space station that includes a pleasant living and working environment.
- s design and model footwear that they could use to walk on a cold, sandy surface.

Tools, Resources, and Technological Processes

2. Technological tools, materials, and other resources should be selected on the basis of safety, cost, availability, appropriateness, and environmental impact; technological processes change energy, information, and material resources into more useful forms.

Students:

- **explore, use, and process a variety of materials and energy sources to design and construct things.**
- **understand the importance of safety, cost, ease of use, and availability in selecting tools and resources for a specific purpose.**
- **develop basic skill in the use of hand tools.**
- **use simple manufacturing processes (e.g., assembly, multiple stages of production, quality control) to produce a product.**
- **use appropriate graphic and electronic tools and techniques to process information.**

This is evident, for example, when students:

- s explore and use materials, joining them with the use of adhesives and mechanical fasteners to make a cardboard marionette with moving parts.
- s explore materials and use forming processes to heat and bend plastic into a shape that can hold napkins.
- s explore energy sources by making a simple motor that uses electrical energy to produce continuous mechanical motion.
- s develop skill with a variety of hand tools and use them to make or fix things.
- s process information electronically such as using a video system to advertise a product or service.
- s process information graphically such as taking photos and developing and printing the pictures.

Key ideas are identified by numbers (1).
Performance indicators are identified by bullets (•).
Sample tasks are identified by triangles (s).

Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

Computer Technology

3. Computers, as tools for design, modeling, information processing, communication, and system control, have greatly increased human productivity and knowledge.

Students:

- **identify and describe the function of the major components of a computer system.**
- **use the computer as a tool for generating and drawing ideas.**
- **control computerized devices and systems through programming.**
- **model and simulate the design of a complex environment by giving direct commands.**

This is evident, for example, when students:

- s control the operation of a toy or household appliance by programming it to perform a task.
- s execute a computer program, such as SimCity, Theme Park, or The Factory to model and simulate an environment.
- s model and simulate a system using construction modeling software, such as The Incredible Machine.

Technological Systems

4. Technological systems are designed to achieve specific results and produce outputs, such as products, structures, services, energy, or other systems.

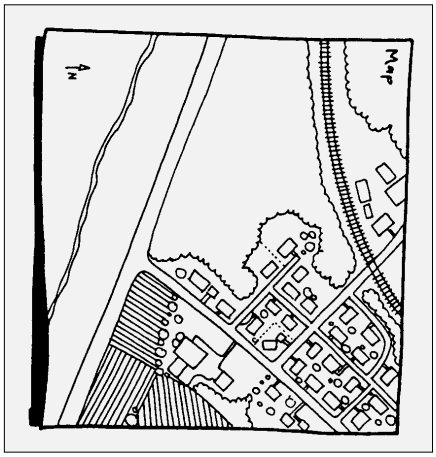
Students:

- **identify familiar examples of technological systems that are used to satisfy human needs and wants, and select them on the basis of safety, cost, and function.**
- **assemble and operate simple technological systems, including those with interconnecting mechanisms to achieve different kinds of movement.**
- **understand that larger systems are made up of smaller component subsystems.**

This is evident, for example, when students:

- s assemble and operate a system made up from a battery, switch, and doorbell connected in a series circuit.
- s assemble a system with interconnecting mechanisms, such as a jack-in-the-box that pops up from a box with a hinged lid.
- s model a community-based transportation system which includes subsystems such as roadways, rails, vehicles, and traffic controls.

Sample Problem/Activity



Computer design for model community

Standard 5—Technology

Elementary

History and Evolution of Technology Impacts of Technology

5. Technology has been the driving force in the evolution of society from an agricultural to an industrial to an information base.

Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

Management of Technology

7. Project management is essential to ensuring that technological endeavors are profitable and that products and systems are of high quality and built safely, on schedule, and within budget.

Students:

- **participate in small group projects and in structured group tasks requiring planning, financing, production, quality control, and follow-up.**
- **speculate on and model possible technological solutions that can improve the safety and quality of the school or community environment.**

This is evident, for example, when students:

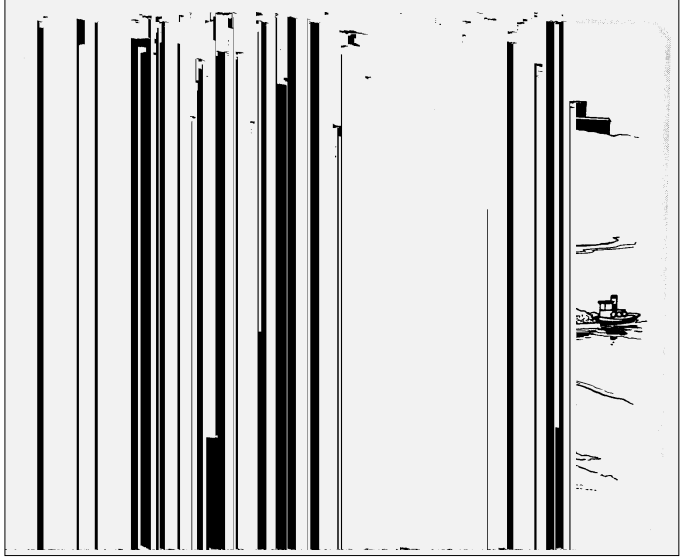
- help a group to plan and implement a school project or activity, such as a school picnic or a fund-raising event.
- plan as a group, division of tasks and construction steps needed to build a simple model of a structure or vehicle.
- redesign the work area in their classroom with an eye toward improving safety.

Sample Problem/Activity

HOW CAN WE REDUCE SOLID WASTE IN OUR SCHOOL?

Evaluation

Students will be able to develop and implement useful solid waste reduction strategies within their school based upon their investigations of the current solid waste stream.



Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

Computer Technology

3. Computers, as tools for design, modeling, information processing, communication, and system control, have greatly increased human productivity and knowledge.

Students:

- **assemble a computer system including keyboard, central processing unit and disc drives, mouse, modem, printer, and monitor.**
- **use a computer system to connect to and access needed information from various Internet sites.**
- **use computer hardware and software to draw and dimension prototypical designs.**
- **use a computer as a modeling tool.**
- **use a computer system to monitor and control external events and/or systems.**

This is evident, for example, when students:

- use computer hardware and a basic computer-aided design package to draw and dimension plans for a simple project.
- use a computer program, such as Car Builder, to model a vehicle to desired specifications.
- use temperature sensors to monitor and control the temperature of a model greenhouse.
- model a computer-controlled system, such as traffic lights, a merry-go-round, or a vehicle using Lego or other modeling hardware interfaced to a computer.

Technological Systems

4. Technological systems are designed to achieve specific results and produce outputs, such as products, structures, services, energy, or other systems.

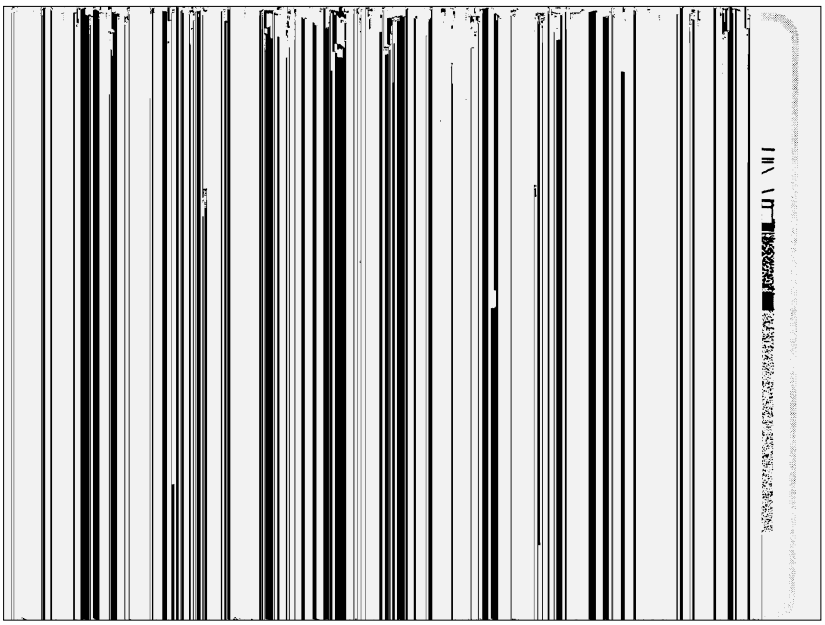
Students:

- **select appropriate technological systems on the basis of safety, function, cost, ease of operation, and quality of post-purchase support.**
- **assemble, operate, and explain the operation of simple open- and closed-loop electrical, electronic, mechanical, and pneumatic systems.**
- **describe how subsystems and system elements (inputs, processes, outputs) interact within systems.**
- **describe how system control requires sensing information, processing it, and making changes.**

This is evident, for example, when students:

- assemble an electronic kit that includes sensors and signaling devices and functions as an alarm system.
- use several open loop systems (without feedback control) such as a spray can, bubble gum machine, or wind-up toys, and compare them to closed-loop systems (with feedback control) such as an electric oven with a thermostat, or a line tracker robot.
- use a systems diagram to model a technological system, such as a model rocket, with the command inputs, resource inputs, processes, monitoring and control mechanisms, and system outputs labeled.
- provide examples of modern machines where microprocessors receive information from sensors and serve as controllers.

Sample Problem/Activity



Systems diagram for a filter system

Standard 5—Technology
Intermediate

History and Evolution of Technology

5. Technology has been the driving force in the evolution of society from an agricultural to an industrial to an information base.

Students:

- **describe how the evolution of technology led to the shift in society from an agricultural base to an industrial base to an information base.**
- **understand the contributions of people of different genders, races, and ethnic groups to technological development.**
- **describe how new technologies have evolved as a result of combining existing technologies (e.g., photography combined optics and chemistry; the airplane combined kite and glider technology with a lightweight gasoline engine).**

This is evident, for example, when students:

- s construct models of technological devices (e.g., the plow, the printing press, the digital computer) that have significantly affected human progress and that illustrate how the evolution of technology has shifted the economic base of the country.
- s develop a display of pictures or models of technological devices invented by people from various cultural backgrounds, along with photographs and short biographies of the inventors.
- s make a poster with drawings and photographs showing how an existing technology is the result of combining various technologies.

Sample Problem/Activity

Impacts of Technology

6.

Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

Management of Technology

7. Project management is essential to ensuring that technological endeavors are profitable and that products and systems are of high quality and built safely, on schedule, and within budget.

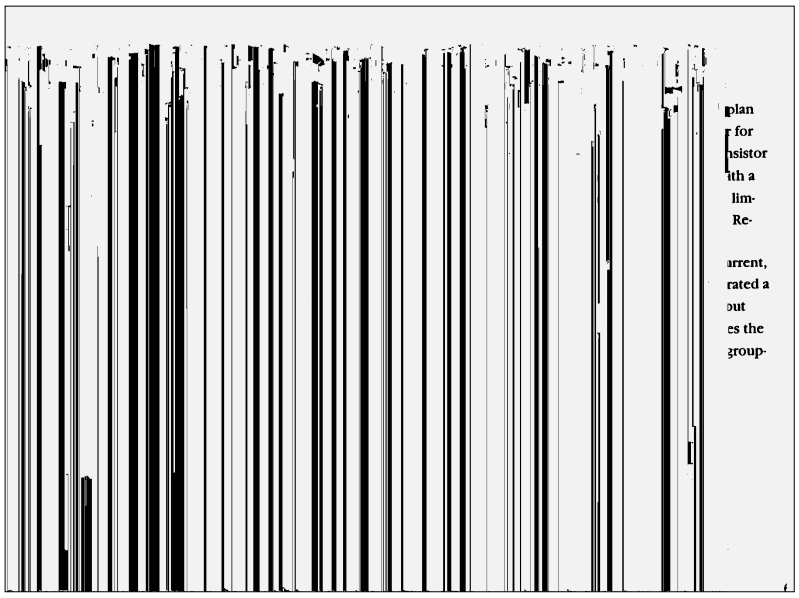
Students:

- **manage time and financial resources in a technological project.**
- **provide examples of products that are well (and poorly) designed and made, describe their positive and negative attributes, and suggest measures that can be implemented to monitor quality during production.**
- **assume leadership responsibilities within a structured group activity.**

This is evident, for example, when students:

- make up and follow a project work plan, time schedule, budget, and a bill of materials.
- analyze a child's toy and describe how it might have been better made at a lower cost.
- assume leadership on a team to play an audio or video communication system, and use it for an intended purpose (e.g., to inform, educate, persuade, entertain).

Sample Problem/Activity



Standard 5—Technology

Commencement

Engineering Design

1. Engineering design is an iterative process involving *modeling* and *optimization* used to develop technological solutions to problems within given constraints.

Students engage in the following steps in a design process:

- **initiate and carry out a thorough investigation of an unfamiliar situation and identify needs and opportunities for technological invention or innovation.**
- **identify, locate, and use a wide range of information resources including subject experts, library references, magazines, videotapes, films, electronic data bases and on-line services, and discuss and document through notes and sketches how findings relate to the problem.**
- **generate creative solution ideas, break ideas into the significant functional elements, and explore possible refinements; predict possible outcomes using mathematical and functional modeling techniques; choose the optimal solution to the problem, clearly documenting ideas against design criteria and constraints; and explain how human values, economics, ergonomics, and environmental considerations have influenced the solution.**
- **develop work schedules and plans which include optimal use and cost of materials, processes, time, and expertise; construct a model of the solution, incorporating developmental modifications while working to a high degree of quality (craftsmanship).**
- **in a group setting, devise a test of the solution relative to the design criteria and perform the test; record, portray, and logically evaluate performance test results through quantitative, graphic, and verbal means; and use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impacts and new problems, and suggest and pursue modifications.**

This is evident, for example, when students:

- s search the Internet for world wide web sites dealing with renewable energy and sustainable living and research the development and design of an energy efficient home.
- s develop plans, diagrams, and working drawings for the construction of a computer-controlled marble sorting system that simulates how parts on an assembly line are sorted by color.
- s design and model a portable emergency shelter for a homeless person that could be carried by one person and be heated by the body heat of that person to a life-sustaining temperature when the outside temperature is 20^{o} F.

Tools, Resources, and Technological Processes

2. Technological tools, materials, and other resources should be selected on the basis of safety, cost, availability, appropriateness, and environmental impact; technological processes change energy, information, and material resources into more useful forms.

Students:

- **test, use, and describe the attributes of a range of material (including synthetic and composite materials), information, and energy resources.**
- **select appropriate tools, instruments, and equipment and use them correctly to process materials, energy, and information.**
- **explain tradeoffs made in selecting alternative resources in terms of safety, cost, properties, availability, ease of processing, and disposability.**
- **describe and model methods (including computer-based methods) to control system processes and monitor system outputs.**

This is evident, for example, when students:

- s use a range of high- tech composite or synthetic materials to make a model of a product, (e.g., ski, an airplane, earthquake-resistant building) and explain their choice of material.
- s design a procedure to test the properties of synthetic and composite materials.
- s select appropriate tools, materials, and processes to manufacture a product (chosen on the basis of market research) that appeals to high school students.
- s select the appropriate instrument and use it to test voltage and continuity when repairing a household appliance.
- s construct two forms of packaging (one from biodegradable

Standard 5—Technology

Commencement

History and Evolution of Technology Impacts of Technology

5. Technology has been the driving force in the evolution of society from an agricultural to an industrial to an information base.

Students:

- **explain how technological inventions and innovations have caused global growth and interdependence, stimulated economic competitiveness, created new jobs, and made other jobs obsolete.**

This is evident, for example, when students:

- compare qualitatively and quantitatively the performance of a contemporary manufactured product, such as a household appliance, to the comparable device or system 50-100 years ago, and present results graphically, orally, and in writing.
- describe the process that an inventor must follow to obtain a patent for an invention.
- explain through examples how some inventions are not translated into products and services with market place

Students will apply technological knowledge and skills to design, construct, use, and evaluate products and systems to satisfy human and environmental needs.

Management of Technology

7. Project management is essential to ensuring that technological endeavors are profitable and that products and systems are of high quality and built safely, on schedule, and within budget.

Students:

- **develop and use computer-based scheduling and project tracking tools, such as flow charts and graphs.**
- **explain how statistical process control helps to assure high quality output.**
- **discuss the role technology has played in the operation of successful U.S. businesses and under what circumstances they are competitive with other countries.**
- **explain how technological inventions and innovations stimulate economic competitiveness and how, in order for an innovation to lead to commercial success, it must be translated into products and services with marketplace demand.**
- **describe new management techniques (e.g., computer-aided engineering, computer-integrated manufacturing, total quality management, just-in-time manufacturing), incorporate some of these in a technological endeavor, and explain how they have reduced the length of design-to-manufacture cycles, resulted in more flexible factories, and improved quality and customer satisfaction.**
- **help to manage a group engaged in planning, designing, implementation, and evaluation of a project to gain understanding of the management dynamics.**

This is evident, for example, when students:

- design and carry out a plan to create a computer-based information system that could be used to help manage a manufacturing system (e.g., monitoring inventory, measurement of production rate, development of a safety signal).
- identify several successful companies and explain the reasons for their commercial success.
- organize and implement an innovative project, based on market research, that involves design, production, testing, marketing, and sales of a product or a service.