

# Standard 5—Technology

Intermediate

## 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:

- identify needs and opportunities for technical solutions from an investigation of situations of general or social interest.
- locate and utilize a range of printed, electronic, and human information resources to obtain ideas.
- consider constraints and generate several ideas for alternative solutions, using group and individual ideation techniques (group discussion, brainstorming, forced connections, role play); defer judgment until a number of ideas have been generated; evaluate (critique) ideas; and explain why the chosen solution is optimal.
- develop plans, including drawings with measurements and details of construction, and construct a model of the solution, exhibiting a degree of craftsmanship.
- in a group setting, test their solution against design specifications, present and evaluate results, describe how the solution might have been modified for different or better results, and discuss tradeoffs that might have to be made.

*This is evident, for example, when students:*

- ▲ reflect on the need for alternative growing systems in desert environments and design and model a hydroponic greenhouse for growing vegetables without soil.
- ▲ brainstorm and evaluate alternative ideas for an adaptive device that will make life easier for a person with a disability, such as a device to pick up objects from the floor.
- ▲ design a model vehicle (with a safety belt restraint system and crush zones to absorb impact) to carry a raw egg as a passenger down a ramp and into a barrier without damage to the egg.
- ▲ assess the performance of a solution against various design criteria, enter the scores on a spreadsheet, and see how varying the solution might have affected total score.

## 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:

- choose and use resources for a particular purpose based upon an analysis and understanding of their properties, costs, availability, and environmental impact.
- use a variety of hand tools and machines to change materials into new forms through forming, separating, and combining processes, and processes which cause internal change to occur.
- combine manufacturing processes with other technological processes to produce, market, and distribute a product.
- process energy into other forms and information into more meaningful information.

*This is evident, for example, when students:*

- ▲ choose and use resources to make a model of a building and explain their choice of materials based upon physical properties such as tensile and compressive strength, hardness, and brittleness.
- ▲ choose materials based upon their acoustic properties to make a set of wind chimes.
- ▲ use a torch to heat a steel rod to a cherry red color and cool it slowly to demonstrate how the process of annealing changes the internal structure of the steel and removes its brittleness.
- ▲ change materials into new forms using separate processes such as drilling and sawing.
- ▲ process energy into other forms such as assembling a solar cooker using a parabolic reflector to convert light energy to heat energy.
- ▲ process information into more meaningful information such as adding a music track or sound effects to an audio tape.

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

**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.**

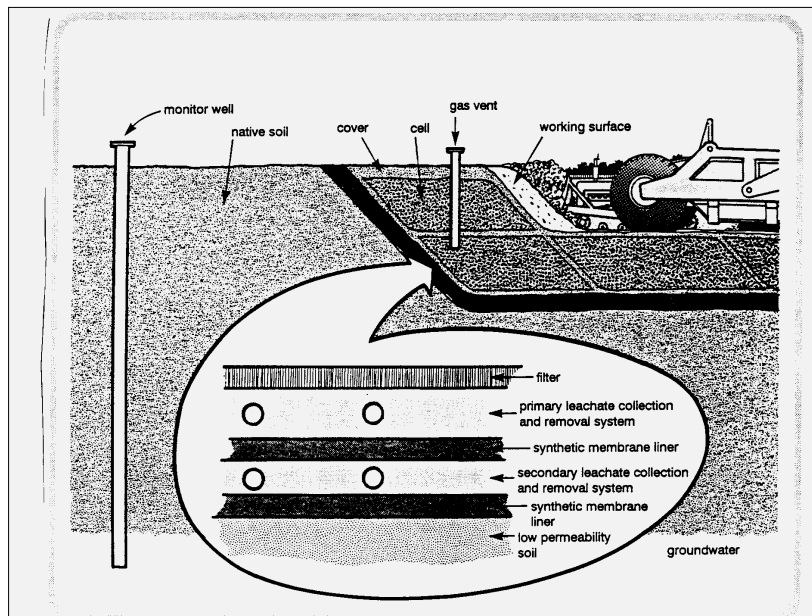
**Students:**

- 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    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:**

- 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:*

- ▲ 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.
- ▲ 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.
- ▲ make a poster with drawings and photographs showing how an existing technology is the result of combining various technologies.

**6. Technology can have positive and negative impacts on individuals, society, and the environment and humans have the capability and responsibility to constrain or promote technological development.**

**Students:**


- describe how outputs of a technological system can be desired, undesired, expected, or unexpected.
- describe through examples how modern technology reduces manufacturing and construction costs and produces more uniform products.

*This is evident, for example, when students:*

- ▲ use the automobile, for example, to explain desired (easier travel), undesired (pollution), expected (new jobs created), unexpected (crowded highways and the growth of suburbs) impacts.
- ▲ provide an example of an assembly line that produces products with interchangeable parts.
- ▲ compare the costs involved in producing a prototype of a product to the per product cost of a batch of 100.

### Sample Problem/Activity

**In how many ways can you send the same message?**



The illustration depicts several methods of communication. On the left, there is a book titled 'MORSE CODE' with a pencil and a pen resting on it. In the center, a desktop computer system including a monitor, keyboard, and mouse is shown. To the right, a mobile phone is depicted. At the bottom, two drums and a mallet are shown, representing a primitive communication method.

**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:**

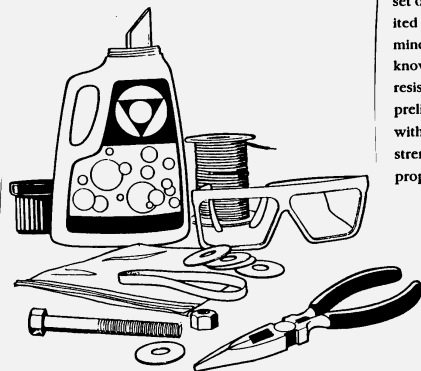
- **manage time and financial resources in a technological project.**
- **provide examples of products that are well (and poorly) designed and made, describe their positive and negative attributes, and suggest measures that can be implemented to monitor quality during production.**
- **assume leadership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

## **Can we build a working speaker?**



#### **Classroom Activity**

**1.** Divide the class into groups consisting of four students each. Challenge each group to design a plan for the construction of a homemade radio speaker for the eight-ohm speaker jack on an inexpensive transistor radio or cassette recorder. Provide each group with a set of materials, and inform students that they are limited to the use of these materials in their designs. Remind students to draw upon the information and knowledge they possess about electromagnets, current, resistors, and circuits. After each group has generated a preliminary plan, hold a class discussion. Work out with students a class consensus plan that combines the strengths and minimizes the weaknesses of their group-proposed plans (see Procedural Notes section).