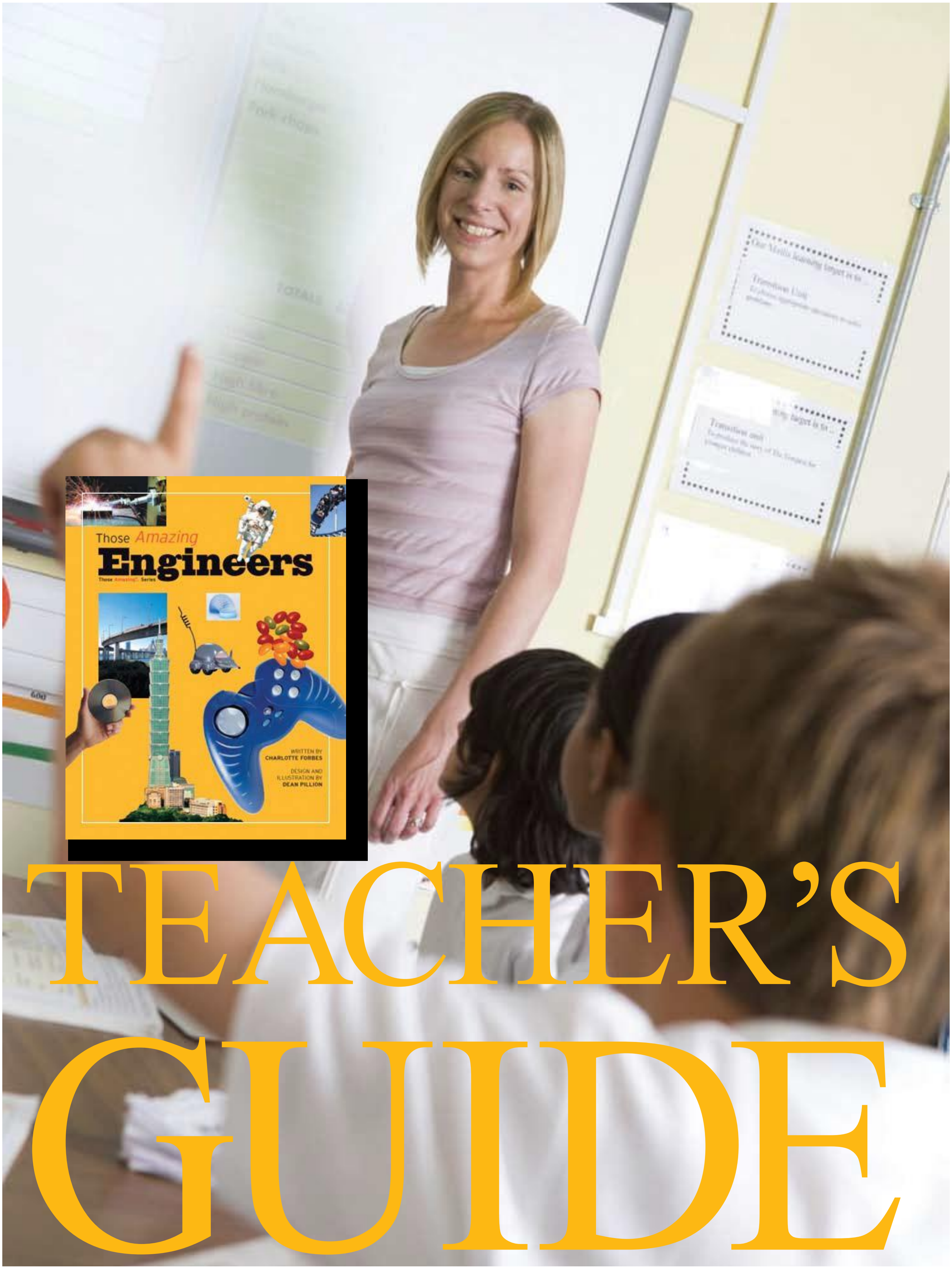
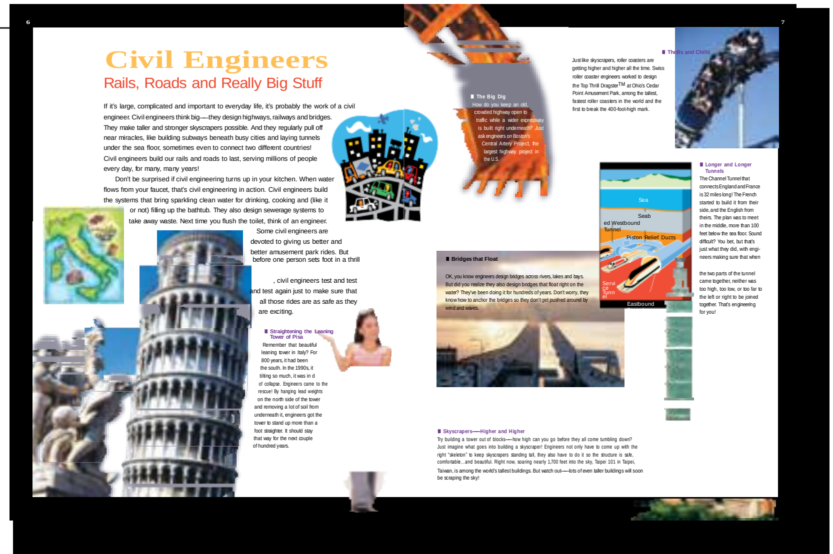


TEACHER'S GUIDE

The Book



Those Amazing Engineers is an engaging, lively, fun-to-read book aimed at upper elementary school students. The book covers the major engineering disciplines in easy-to-read language and helps students understand just what engineers do. Examples that young people can relate to, from robots to rockets, from sports stadiums to shampoo, help illustrate that engineers make a big difference in our lives.

Focus and Objectives

The focus of the lessons is to use *Those Amazing Engineers* to introduce students to engineering and engineers.

Learning objectives:

- Students learn about engineers and engineering
- Students begin to look at their environment in a new and interested way
- Students are encouraged to exercise creative problem-solving and critical thinking
- Students become curious about and interested in engineering as a possible career

This guide presents a number of activities for teachers to select from, depending on the time available. The guide also includes a vocabulary list of terms that may be unfamiliar to students, as well as a detailed list of types of engineers for teacher reference.

Classroom Activities

Pre-reading

Before beginning to read the book, ask students to quickly scan the book and silently read portions (about 5-8 minutes). Then ask students to brainstorm and generate ideas to answer the question: What do you think an engineer does? Write the ideas on the blackboard or whiteboard, generating a minimum of 20-30 ideas, and encourage participation by all—no answer is wrong. This gets the class to start thinking about engineering and also indicates how much they need to learn.

Read-aloud session (teacher and students) of the entire book

This first read-aloud session helps students at all reading levels participate and allows students to develop general ideas of what engineers do; these ideas can be refined and reinforced in further sessions that discuss each type of engineer.

Follow-up review sessions

Each session could cover one type of engineer, using a read-aloud of the appropriate page in the book to guide the discussion. Teach students new vocabulary words that appear on that specific page. A vocabulary list is provided at the end of this guide. Ask questions. For example, on what kinds of projects does a civil engineer work? Use a web diagram to group answers, stimulate classroom discussion, reinforce the reading and aid in recall.

Small-group activity

Divide the class into small groups, give each group the name of a different object in the classroom, and ask each group to discuss all the types engineers involved in producing that item and getting it to the classroom. Each group can then present their results to the class. Suggested items: blackboard, whiteboard, pencil, desk, backpack, book, plastic water bottle. Encourage students to think not only of the object itself, but the raw materials involved, packaging, shipping, tracking, etc. (For teacher reference, a list of types of engineers is provided at the end of this guide.)

Art activity

Ask students to use a construction toy or drawing materials to depict a city, road, building, or object of the future, and then to present their project to the class.

Writing Assignment

Ask students to choose one of the following to write about:

- Look around your home, and select an object; describe it in detail and tell about all the types of engineers involved in producing the object.

- I want to be a_____________engineer. Fill in the blank and then tell why that type of engineer would be a good career for you. What characteristics do you have that would make you a good engineer? What types of projects would you enjoy working on?

- Go to one of the web sites listed on pages 27 to 29; describe the information presented at the site and tell what you learned from the site.

Classroom Visit by an Engineer

Ask an engineer to visit the classroom to talk about his or her education, work and projects. Some suggested resources:

- Ask students if they have a parent or relative who is an engineer and would be willing to talk to the class

- Ask the school board or local government if they have had any recent project(s) that involved engineering and get a referral to the engineering firm

- Approach a local engineering firm

- Ask an engineering society to recommend an engineering firm in your area

Vocabulary—Terms and Definitions

Aerodynamics: The study of how the air flow around an object affects it. The rules of aerodynamics explain how an airplane is able to fly. Any object that moves through air reacts to aerodynamics—a kite, baseball, a rocket.

Aerospace: The earth's atmosphere and the outer space beyond.

Animatronics: A mechanized puppet that is either preprogrammed or remotely controlled. Animatronics are mainly used in the entertainment industry. ET and Spinosaurus of "Jurassic Park III" are animatronic devices.

Hydrofoil: A wing-like structure attached to the bottom of a boat. Hydrofoils let a boat go faster by getting its hull or bottom out of the water. When the boat reaches a certain speed, the bottom is lifted out of the water and the boat seems to "fly." Boats using such structures are also called hydrofoils.

Infrastructure: The basic physical and organizational structures or the services needed for the operation of a society or enterprise. Typically infrastructure refers to the structures that support a society, such as roads, water supply, sewers, power grids, bridges, telecommunications, etc.

Magnetic Levitation: A method by which an object is suspended solely by magnetic fields. Poles of the same charge repel and those of different charges attract. A body under magnetic levitation floats due to that special repelling quality of the magnets when the force generated by the electromagnetic repulsion is strong enough. One application is in MagLev trains, now under development, where the magnetic field created by the electrified coils in the guideway walls and the track combine to propel the train.

Microchip: A unit of packaged computer circuitry, known as an integrated circuit, manufactured from a material such as silicon at a very small scale. It is used to relay information through specific electrical characteristics and depending on what it was designed to do, can be used in many computer applications as well as in a wristwatch, a talking greeting card, a cell phone, the space shuttle, and many other things.

Microwave: A form of electromagnetic energy, like light waves or radio waves. Microwaves are used to relay long-distance telephone signals, television programs and computer information across the earth or to a satellite in space. The microwave is most familiar as the energy source for cooking food. Every microwave oven contains a magnetron, which generates microwaves at just the right frequency to interact with the molecules in food and heat it directly.

Nanoengineering: Nano engineers manipulate atoms and molecules, and study, design and fabricate materials and devices on a scale less than a micrometer to develop multifunctional materials that are strong, lightweight and versatile. Research in nanoscale science and engineering is expected to lead to a new technology and manufacturing that will have major impact on areas as diverse as computing and information technology, health care and biotechnology, environment, energy, transportation, and space exploration.

Nanofiber: Fibers similar in shape to a human hair except approximately 600 times thinner and very porous. The main advantage of these fibers is an incredibly small fiber diameter, which gives them characteristics such as high surface areas, unique textures when mixed with other materials, and new optical properties.

Satellite: Any object that orbits another object. The earth's moon is a satellite. The earth is a satellite of the sun. Scientists and engineers have placed man-made satellites in orbit around the moon, the sun, the earth, and other planets.

Submersible: A small submarine-like vehicle that is designed to operate under water, usually deep in the ocean. Used by oceanographers and marine scientists to explore the ocean and its floor, submersibles may remain connected by a tether to a support vessel that replenishes power and air. Small unmanned submersibles with cameras are used in water too deep or too dangerous for divers. Submersibles may also be used to repair offshore petroleum platforms and attach cables to hoist sunken ships.

Supersonic: The term used to define a speed that is over the speed of sound. Military jets routinely travel supersonically and can fly at well over a thousand miles per hour. When a jet travels faster than the speed of sound, it breaks the sound barrier, which creates a shock wave or sonic boom that sounds like thunder.

Telemedicine: In telemedicine, medical information is transferred by phone or the Internet for the purpose of consulting, and sometimes for remote medical examinations. Telemedicine can simply be two doctors discussing a case by phone, or as complex as using satellite technology and videoconferencing equipment to conduct a real-time consultation between medical specialists in two different countries.

Retractable Roof: Used in many sports stadiums, a retractable roof can be opened or closed to cover the playing field and spectator areas. Typically, retractable roofs are used in locations where extreme heat or extreme cold occur during the sports season.

Revolutionary: Refers to something that has a major, sudden impact on society or on some aspect of human endeavor. Analyzing the human genome is revolutionizing the field of medicine.

Engineers and Engineering

Adapted from information on the U. S. Department of Labor web site www.bls.gov/oco/ocos027.htm#nature

Engineers apply the principles of science and mathematics to develop practical and economical solutions to technical problems. Their work is the link between scientific discoveries and the commercial applications that meet societal and consumer needs.

Many engineers design and develop new products. During this process, they consider several factors. For example, in developing an industrial robot, engineers precisely specify the functional requirements; design and test the robot's components; integrate the components to produce the final design; and evaluate the design's overall effectiveness, cost, reliability, and safety. This process applies to the development of many different products, such as chemicals, computers, power plants, helicopters, and toys.

Some engineers work in testing, production, or maintenance. They supervise production in factories, determine the causes of component failure, and test manufactured products to maintain quality. They also estimate the time and cost to complete projects. Supervisory engineers are responsible for major components or entire projects.

Most engineers specialize. Following are the 17 engineering specialties covered in the Federal Government's Standard Occupational Classification (SOC) system. Many other specialties are recognized by professional societies, and each of the major branches of engineering has numerous subdivisions. Civil engineering, for example, includes structural and transportation engineering, and materials engineering includes ceramic, metallurgical, and polymer engineering. Engineers also may specialize in one industry, such as motor vehicles, or in one type of technology, such as turbines or semiconductor materials.

Aerospace engineers design, develop, and test aircraft, spacecraft, and missiles and supervise the manufacture of these products. Those who work with aircraft are called aeronautical engineers, and those working specifically with spacecraft are astronautical engineers.

Biomedical engineers develop devices and procedures that solve medical and health-related problems such as artificial organs, prostheses (artificial devices that replace missing body parts), instrumentation, medical information systems, and health management and care delivery systems.

Chemical engineers apply the principles of chemistry to solve problems. They design equipment and processes for large-scale chemical manufacturing, plan and test products and supervise production. They can also work in the energy, electronics, food, clothing, and paper industries as well as health care and biotechnology.

Civil engineers design and supervise the construction of roads, buildings, airports, tunnels, dams, bridges, and water supply and sewerage systems. They consider construction costs, expected lifetimes of projects, government regulations and potential environmental hazards such as earthquakes and hurricanes.

Computer hardware engineers research, design, develop, test, and oversee the manufacture and installation of computer hardware. Hardware includes computer chips, circuit boards, computer systems, and related equipment such as keyboards, modems, and printers.

Electrical engineers design, develop, test, and supervise the manufacture of electrical equipment. This equipment includes electric motors; machinery controls, lighting, and wiring in buildings; automobiles; aircraft; radar and navigation systems; and power generation.

Electronics engineers design a wide range of technologies, from portable music players to the global positioning system (GPS). Electronics engineers design, develop, test, and supervise the manufacture of electronic equipment such as broadcast and communications systems.

Environmental engineers develop solutions to environmental problems using the principles of biology and chemistry. They are involved in water and air pollution control, recycling, waste disposal, and public health issues.

Health and safety engineers prevent harm to people and property by applying knowledge of systems engineering and mechanical, chemical, and human performance principles. They identify and measure potential hazards, such as the risk of fires or the dangers of handling of toxic chemicals.

Industrial engineers determine the most effective ways to use the basic factors of production—people, machines, materials, information, and energy—to make a product or provide a service. They are primarily concerned with increasing productivity, and carefully study product requirements and design manufacturing and information systems to meet this goal.

Marine engineers and naval architects are involved in the design, construction, and maintenance of ships, boats, and related equipment. They design and supervise the construction of everything from aircraft carriers to submarines, and from sailboats to tankers.

Materials engineers develop, process, and test materials used to create a range of products, from computer chips and aircraft wings to golf clubs and snow skis. They also work with metals, ceramics, plastics, semiconductors, and composites to create new materials.

Mechanical engineers research, design, develop, manufacture, and test tools, engines, machines, and other mechanical devices. Mechanical engineers may work on power-producing machines such as electric generators or engines, and on power-using machines from refrigerators to elevators and escalators, and robots used in manufacturing.

Mining and geological engineers find, extract, and prepare coal, metals, and minerals for use by manufacturing industries and utilities. They design open-pit and underground mines, and devise methods for transporting minerals to processing plants.

Nuclear engineers design, develop, monitor, and operate nuclear plants to generate power. They may also work on the nuclear fuel cycle—the production, handling, and use of nuclear fuel and the safe disposal of waste produced by the generation of nuclear energy.

Petroleum engineers search the world for reservoirs containing oil or natural gas, and then work with geologists to understand the properties of the rock containing the reservoir, determine the drilling methods to be used, and monitor drilling and production operations.

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