

Explore the Roles of Engineers

Unit: Historical Perspectives of the Drafting and Design Field Industry

Problem Area: Historical Roles of Drafters, Designers, Engineers, and Architects

Lesson: Explore the Roles of Engineers

- **Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

- 1 Describe the role of an engineer.
- 2 Summarize the historical influence of engineers.
- 3 Identify career opportunities related to the field of engineering.

- **List of Resources.** The following resources may be useful in teaching this lesson:

American Design Drafting Association. Accessed March 10, 2008.
<www.adda.org>.

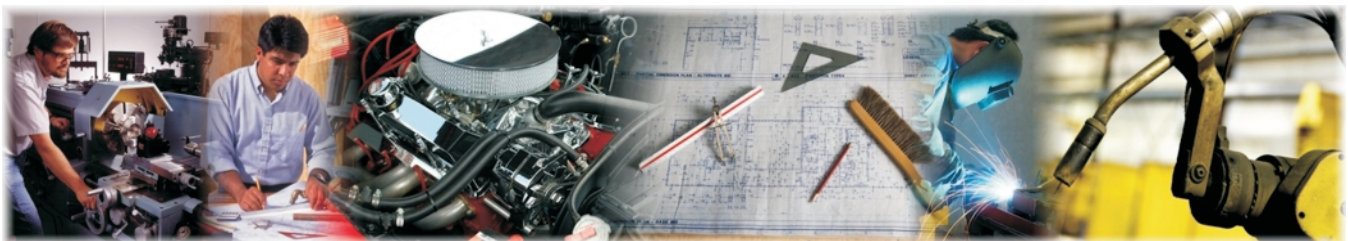
American Institute of Architects. Accessed March 10, 2008. <www.aia.org>.

Brown, Walter C., and Cloise E. Kicklighter. *Drafting for Industry.* Goodheart-Willcox, 1995.

Kicklighter, Cloise E. *Architecture-Residential Drawing and Design.* Goodheart-Willcox, 2005.

Occupational Information Network. Accessed March 10, 2008.
<<http://online.onetcenter.org/>>.

Occupational Outlook Handbook. U.S. Department of Labor. Accessed March 10, 2008. <www.bls.gov/oco/>.



Walker, John R., and Bernard D. Mathis. *Exploring Drafting*. Goodheart-Willcox, 2007.

Wohler, Terry. *Applying AutoCad 2008*. McGraw-Hill, 2008.

■ **List of Equipment, Tools, Supplies, and Facilities**

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

■ **Terms.** The following terms are presented in this lesson (shown in bold italics):

- ▶ aerospace engineers
- ▶ chemical engineers
- ▶ civil engineers
- ▶ computer engineers
- ▶ electrical engineers
- ▶ engineering technicians
- ▶ industrial engineers
- ▶ marine engineers
- ▶ material engineers
- ▶ mechanical engineers
- ▶ nuclear engineers
- ▶ petroleum engineers
- ▶ structural engineers

■ **Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Ask students to identify items in the room that have been designed or engineered before being manufactured or produced. Create a group list (e.g., desk, clock, overhead projector, windows, and room dividers). Next, ask students to identify items in the room that have not been designed before being manufactured or produced. Create a group list (e.g., people, animals, and plants). Ask if any students have parent(s) or guardian(s) working in engineering. List the engineering careers on the board. (See the terms for this lesson for a beginning list of engineering job titles.)

SUMMARY OF CONTENT AND TEACHING STRATEGIES

Objective 1: Describe the role of an engineer.

Anticipated Problem: What is the role of an engineer?

- I. Engineering knowledge, skills, abilities, tasks, and technology acumen
 - A. Engineering knowledge
 1. Design—An engineer must excel in design techniques, tools, and principles involved in the production of precision technical plans, blueprints, drawings, and models.
 2. Engineering and technology—An engineer must have an interest in the practical application of engineering science and technology.
 3. Mathematics—Arithmetic, algebra, geometry, calculus, statistics, and their applications must be strengths of an engineer.
 4. English language—The structure and content of the English language (including the meaning and spelling of words, rules of composition, and grammar) are necessary in this field as clear communication is vital to success.
 5. Production and processing—An engineer must be familiar with raw materials, production processes, quality control, costs, and other techniques to maximize the effective manufacture and distribution of goods.
 6. Customer and personal service—An engineer should possess knowledge of the principles and processes for providing customer and personal services (e.g., customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction).
 7. Physics—Predicting physical principles and laws and their interrelationships; understanding the applications of fluid, material, and atmospheric dynamics; and tinkering with mechanical, electrical, atomic, and subatomic structures and processes are essential interests for an engineer.
 - B. Engineering skills
 1. Time management—Managing one’s own time and that of others is a useful skill.
 2. Active listening—Giving full attention to what others say, taking time to understand the points being made, asking questions (as appropriate), and not interrupting are essential in this team-oriented industry.
 3. Reading comprehension—Understanding written sentences and paragraphs found in work-related documents is mandatory for these jobs.
 4. Mathematics—Using mathematics to solve problems is one of the basic ingredients of an engineering career.

5. Judgment and decision making—The ability to consider the relative costs and benefits of potential actions and to choose the most appropriate option(s) is critical in the engineering field.
 6. Writing—Communicating effectively in writing as appropriate to the needs of the audience and the purpose of the document is extremely important.
 7. Critical thinking—Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems is vital to success.
 8. Speaking—Conveying information effectively to others through speech can “make or break” an engineer’s marketability because of the interview process. In addition, speaking clearly saves time and money by avoiding confusion due to a lack of communication.
 9. Complex problem solving—The ability to identify complex problems and review related information to develop and evaluate options and implement solutions makes a job applicant more valuable.
- C. Engineering abilities
1. Oral comprehension—The ability to listen to and understand information and ideas presented through the spoken word is critical.
 2. Oral expression—The ability to clearly communicate information and ideas through the spoken word so others will understand the meaning is vital to avoiding communication breakdowns.
 3. Deductive reasoning—An engineer needs the ability to apply general rules to specific problems to produce answers that are reasonable and that make sense.
 4. Inductive reasoning—An engineer needs the ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
 5. Originality—An engineer should have the ability to create unusual or clever ideas about a given topic or situation or to develop creative methods to solve problems.
 6. Written comprehension—The ability to read and understand information and ideas presented in written form is critical.
 7. Problem sensitivity—An engineer should have the ability to perceive when something is wrong or is likely to go wrong; this does not involve solving the problem, only recognizing that a potential problem exists.
- D. Engineering tasks
1. Engineers read and interpret blueprints, technical drawings, schematics, and computer-generated reports.
 2. Engineers confer with engineers and other personnel to implement operating procedures, resolve system malfunctions, and provide technical information.
 3. Engineers research and analyze customer design proposals, specifications, manuals, and other data to evaluate the feasibility, cost, and maintenance requirements of designs or applications.

4. Engineers specify system components or direct modifications of products to ensure conformance with engineering design and performance specifications.
 5. Engineers research, design, evaluate, install, operate, and maintain mechanical products, equipment, systems, and processes to meet requirements by applying a knowledge of engineering principles.
 6. Engineers investigate equipment failures and difficulties to diagnose faulty operation and to make recommendations to maintenance crews.
 7. Engineers assist drafters in developing the structural design of products by using drafting tools, computer-assisted design (CAD), or drafting equipment and software.
 8. Engineers provide feedback to design engineers about customer problems and needs.
 9. Engineers oversee the installation, operation, maintenance, and repair of machines and equipment to ensure correct installations and to ensure that each machine or piece of equipment functions according to the specifications.
 10. Engineers conduct research to test and analyze the feasibility, design, operation, and performance of equipment, components, and systems.
- E. Engineering technology acumen
1. Analytical or scientific software—Statistical analysis software
 2. Computer-aided design (CAD) software—Autodesk AutoCAD; SolidWorks CAD
 3. Development environment software—Microsoft Visual Basic
 4. Industrial control software—Computer numerical control (CNC) software; human machine interface software
 5. Object- or component-oriented development software

Host a classroom discussion regarding the knowledge, skills, abilities, tasks, and technology acumen an engineer must possess/use to perform job tasks effectively and efficiently. Ask students to describe some of the personality traits that might be useful for those entering the field of engineering.

Objective 2: Summarize the historical influence of engineers.

Anticipated Problem: What historical influences have engineers had on society?

II. Historical influences

- A. Design and engineering tasks have a long and documented history (millions of years), beginning with primitive people who depicted their daily lives, hunting expeditions, worship ceremonies, births, and deaths with illustrations on cave walls.
- B. The greatest changes are noted during the Egyptian and Chinese Empires and as a result of the development of rice paper. This marks the beginning of modern drafting, aside from the tools used to make drawings more accurate and legible.

- C. From the Age of Empires through the Industrial Revolution, many changes affected drafting equipment and precision. For instance, the printing press made designs and plans available across the globe.
- D. Over the past 25 years, the creation of modern electronic devices and software, including Computer-Aided Drafting and Design (CADD), has revolutionized the design, engineering, and product-development industries.

Developing and presenting students with a timeline may help them visualize the history of engineering and design. The use of VM–A may help students visualize the history of engineering and design.

Objective 3: Identify career opportunities related to the field of engineering.

Anticipated Problem: Which careers are associated with the field of engineering?

III. Engineering career opportunities

- A. **Aerospace engineers** perform a variety of engineering work in designing, constructing, and testing aircraft, missiles, and spacecraft.
 - 1. A bachelor's degree is the minimum educational requirement, and some aerospace specialties require a master's degree.
 - 2. The median wage is \$42.12 hourly and \$87,610 annually.
- B. **Chemical engineers** design chemical plant equipment and devise processes for creating and manufacturing chemicals and products (e.g., gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp) by applying the principles and technology of chemistry, physics, and engineering.
 - 1. Most occupations require a bachelor's degree.
 - 2. The median wage is \$37.91 hourly and \$78,860 annually.
- C. **Civil engineers** plan, design, and oversee construction and maintenance of building structures and facilities (e.g., roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, water and sewage systems, and waste disposal units).
 - 1. Most occupations require a bachelor's degree.
 - 2. The median wage is \$32.98 hourly and \$68,600 annually.
- D. **Computer engineers** research, design, develop, and test computer or computer-related equipment for commercial, industrial, military, or scientific use. Engineers may also supervise the manufacture and installation of computer or computer-related equipment and components.
 - 1. Most occupations require a bachelor's degree.
 - 2. The median wage is \$42.54 hourly and \$88,470 annually.
- E. **Electrical engineers** research, design, develop, and test electronic components and systems for commercial, industrial, military, or scientific use by utilizing knowledge of electronic theory and material properties. Electrical engineers design

electronic circuits and components for use in fields such as telecommunications, aerospace guidance and propulsion control, acoustics, or instruments and controls.

1. Most occupations require a bachelor's degree.
 2. The median wage is \$38.97 hourly and \$81,050 annually.
- F. **Engineering technicians** apply engineering theory and principles to problems of industrial layout or manufacturing production, usually under the direction of engineering staff. Engineering technicians use CADD and CNC software programs to aid the engineer during the design process.
1. These jobs require training in vocational-technical schools, related on-the-job experience, and/or an associate degree.
 2. The median wage is \$22.51 hourly and \$46,610 annually.
- G. **Industrial engineers** design, develop, test, and evaluate integrated systems for managing industrial production processes, including human work factors, quality control, inventory control, logistics and material flow, cost analysis, and production coordination.
1. Most occupations require a bachelor's degree.
 2. The median wage is \$32.99 hourly and \$69,620 annually.
- H. **Marine engineers** design, develop, and take responsibility for the installation of ship machinery and related equipment, including propulsion machines and power supply systems.
1. Most occupations require a bachelor's degree.
 2. The median wage is \$35.09 hourly and \$72,990 annually.
- I. **Material engineers** evaluate various materials and develop machinery and processes to manufacture materials for use in products that must meet specialized design and performance specifications. Material engineers also develop new uses for known materials.
1. Most occupations require a bachelor's degree.
 2. The median wage is \$37.91 hourly and \$78,860 annually.
- J. **Mechanical engineers** plan and design tools, engines, machines, and other mechanically functioning equipment.
1. A bachelor's degree is the minimum requirement, and some mechanical engineering specialties require a master's degree.
 2. The median wage is \$33.58 hourly and \$69,850 annually.
- K. **Nuclear engineers** conduct research about nuclear engineering problems or apply principles and theories of nuclear science to problems concerned with the release, control, and utilization of nuclear energy and nuclear waste disposal.
1. A bachelor's degree is the minimum requirement, and some nuclear engineering specialties require a master's degree.
 2. The median wage is \$43.38 hourly and \$90,220 annually.

- L. **Petroleum engineers** devise methods to improve oil and gas well production; they also determine the need for new or modified tool designs. Petroleum engineers oversee drilling and offer technical advice to achieve economical and satisfactory progress.
1. A bachelor's degree is the minimum requirement, and some petroleum engineering specialties require a master's degree.
 2. The median wage is \$47.30 hourly and \$98,380 annually.
- M. **Structural engineers** possess many specialized skills, including the calculation of loads and stresses; the investigation of foundation strength; and the analysis of the behavior of beams and columns in steel, concrete, and other materials. These skill sets ensure that structures have the strength required to perform their function(s) safely, economically, and with a shape and appearance that is visually satisfying.
1. A bachelor's degree is the minimum requirement, and some structural engineering specialties require a master's degree.
 2. The median wage is \$42.12 hourly and \$87,610 annually.

Use VM–B to reinforce the points in this objective. Assign LS–A, and have the students complete it as the class discusses engineering career opportunities. You may also conduct a review of the following Web sites:
<http://online.onetcenter.org> and <http://www.bls.gov/oco/home.htm>.

- **Review/Summary.** Use the student learning objectives to summarize the lesson. Ask students to discuss the engineering careers that most appeal to them. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle.
- **Application.** Use the included visual masters and lab sheet to apply the information presented in the lesson. Students could complete the lab sheet as the careers are presented and discussed.
- **Evaluation.** Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities, completion of the lab sheet, or participation in class discussion. A sample written test is provided.

■ **Answers to Sample Test:**

Part One: True/False

1. T
2. F
3. F
4. T
5. T

6. T
7. F
8. T
9. F
10. T

Part Two: Multiple Choice

1. a
2. d
3. d
4. c
5. b

Part Three: Matching

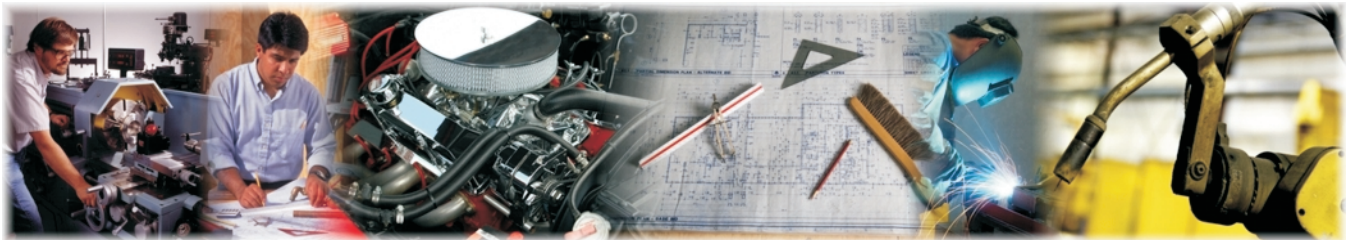
1. c
2. b
3. e
4. f
5. d
6. a

Explore the Roles of Engineers

► Part One: True/False

Instructions: Write T for true or F for false.

- ___ 1. In most cases, postsecondary education is required to become an engineer.
- ___ 2. Engineering drawings must be completed using a CADD system.
- ___ 3. Aerospace engineers are also known as civil engineers.
- ___ 4. Drawings provide a good way to describe design ideas that are hard to describe in words.
- ___ 5. Engineers must have an understanding of various manufacturing processes.
- ___ 6. Most engineers specialize in a specific area of engineering.
- ___ 7. Engineers are not required to complete tasks by specific deadlines.
- ___ 8. CADD allows engineers to modify designs without having to redraw the entire plan.
- ___ 9. Nuclear engineers design computer systems and software.
- ___ 10. Aerospace engineers would be candidates for careers with NASA.



► **Part Two: Multiple Choice**

Instructions: Circle the letter of the correct answer.

- ____ 1. The primary function of an industrial ____ is to improve industrial product designs.
- a. engineer
 - b. model maker
 - c. education teacher
 - d. illustrator
- ____ 2. To design the cutting and holding devices used in manufacturing, you must be ____.
- a. an architectural engineer
 - b. an interior engineer
 - c. a technical illustrator
 - d. a mechanical engineer
- ____ 3. Engineers are responsible for ____.
- a. providing technical and managerial leadership in industry and government
 - b. designing and developing new products
 - c. planning structures and highways
 - d. All of the above
- ____ 4. Most engineering positions require ____.
- a. a few years of work experience
 - b. an associate degree
 - c. a bachelor's degree
 - d. a master's degree
- ____ 5. The responsibilities of a material engineer include ____.
- a. preparing plats and maps of features above and below ground level
 - b. developing machinery and processes to manufacture materials
 - c. planning and subdividing property
 - d. All of the above

► Part Three: Matching

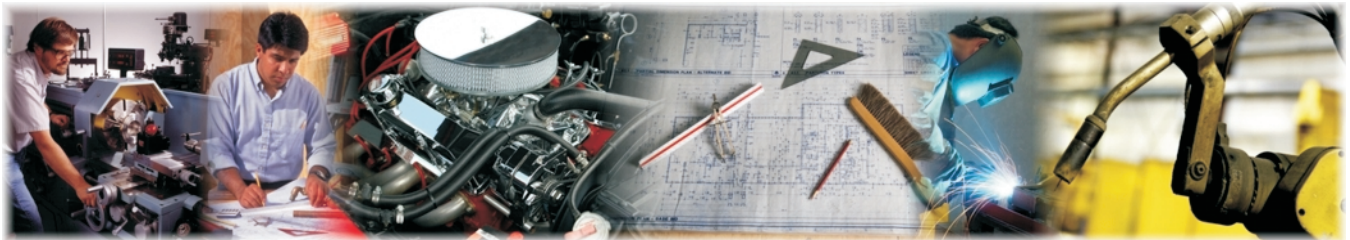
Instructions: Match the term with the correct definition.

- | | |
|-------------------------|-----------------------|
| a. mechanical engineers | d. marine engineers |
| b. aerospace engineers | e. civil engineers |
| c. industrial engineers | f. computer engineers |

- _____ 1. People who design, develop, test, and evaluate integrated systems for managing production processes
- _____ 2. People who perform a variety of engineering work in designing, constructing, and testing aircraft, missiles, and spacecraft
- _____ 3. People who plan, design, and oversee the construction and the maintenance of building structures and facilities (e.g., roads, railroads, airports, bridges, harbors, and channels)
- _____ 4. People who research, design, develop, and test technology equipment and software for commercial, industrial, military, or scientific use
- _____ 5. People who design, develop, and take responsibility for the installation of ship machinery and related equipment, including propulsion machines and power supply systems
- _____ 6. People who plan and design tools, engines, and machines

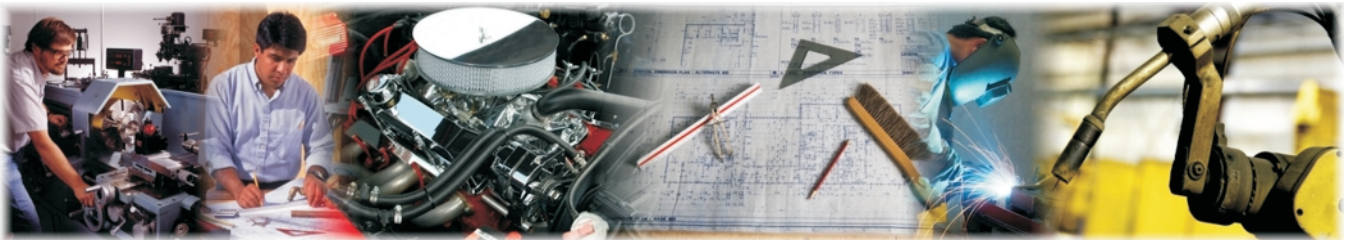
HISTORY OF DESIGN

- ◆ Primitive man
- ◆ Chinese design
- ◆ Egyptian design
- ◆ Age of Empires design
- ◆ Industrial Age design
- ◆ Technological Age design



ENGINEERING CAREERS

- ◆ aerospace engineer
- ◆ chemical engineer
- ◆ civil engineer
- ◆ computer engineer
- ◆ electrical engineer
- ◆ engineering technician
- ◆ industrial engineer
- ◆ marine engineer
- ◆ material engineer
- ◆ mechanical engineer
- ◆ nuclear engineer
- ◆ petroleum engineer
- ◆ structural engineer



Engineering Careers

Purpose

The purpose of this activity is to explore various engineering careers and their related descriptions, educational requirements, and salary.

Objectives

1. Fill in the area below with the various careers as your instructor presents each one.
2. Make notations of each engineering career description, educational requirements, and average salary.

Materials

- ◆ lab sheet
- ◆ writing utensil

Procedure

Use the area below and the back of this worksheet to further communicate the careers associated with engineering.

