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Excerpt from

Engineering Technology Orientation, Part 1

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Preview

The following is a sample excerpt from a study unit converted into the Adobe Acrobat format. A sample online exam is available for this excerpt.

Problem solving and organizational skills are important fundamentals of engineering. Here you'll be introduced to these skills and many other concepts. You'll learn about the accomplishments of engineers and technicians, the development of technology throughout history, and the impact of engineering on our world.

After reading through the following material, feel free to take the sample exam based on this excerpt.

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EXAMINATION

Engineering Technology Orientation, Part 1

ENGINEERING TECHNOLOGY

Introduction

Engineering technicians play a vital role in our society. Typically, a technician works closely with engineers and occasionally with scientists. To better understand the technician's role in our world, we'll compare it to the roles of the scientist and engineer. A scientist is focused on the search for knowledge. A scientist strives to understand the how and why of something. An engineer is focused on designing or developing something. An engineer strives to turn ideas into reality. An engineering technician is focused on carrying out, analyzing, modifying, and improving the products or processes proposed by engineers. In many workplaces, engineers and engineering technicians work closely together to develop and implement ideas related to a product or process.

To help you better understand the fields of engineering and engineering technology, we'll look at some of the engineering feats of the past. In this study unit, we'll discuss how major technological developments have shaped our world. We'll also discuss how those developments continue to affect our world today. Figure 1 shows just one example. You'll also see the origins of different engineering disciplines, such as mechanical engineering, electrical engineering, and aerospace engineering. First, let's define the two words you'll see most often in this study unit.

1. *Engineering*—The application of science and mathematic principles to practical purposes such as the design, construction, and operation of efficient and economical structures, equipment, or systems

2. *Technician*—An expert in a technical field or process

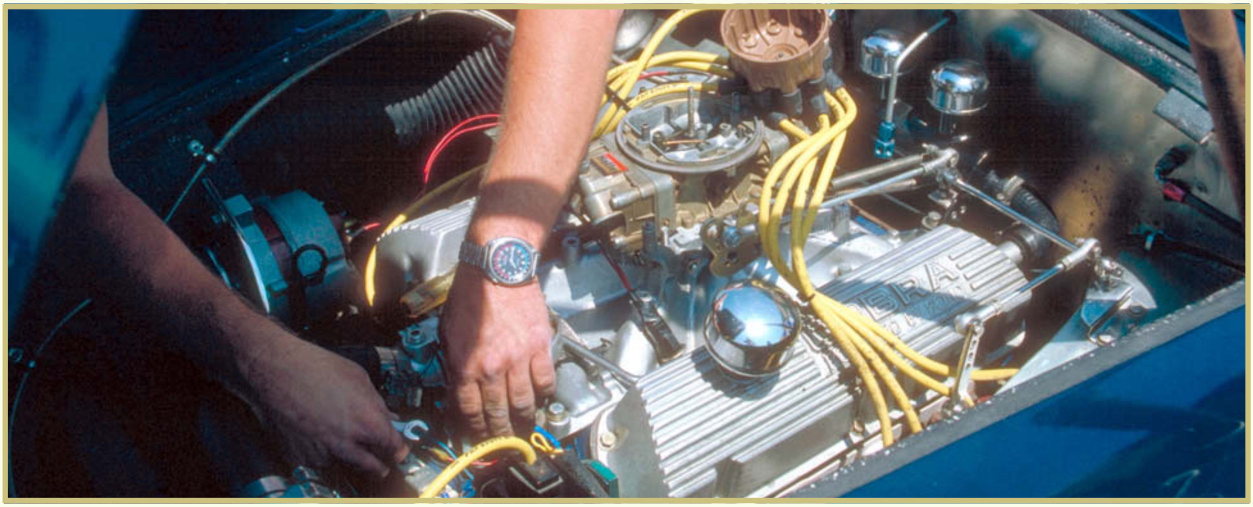


FIGURE 1—The modern automobile is just one of countless life-changing technologies that engineering technicians have helped to develop.

Engineering's Effect on History: From Fire Starters to Jet Engines

Throughout history, technological advances have created a need for further advances. As each technological advance was born, scientists and engineers took advantage of it and created new and better technologies (Figure 1).

Since long ago, people have relied on new inventions and discoveries to make life more manageable. When an enterprising cave dweller discovered how to create fire, it became easier for the clan to travel because they were no longer tied to a lightning-created fire, which they used for cooking, warmth, and protection from wild beasts. Cave dwellers reasoned that the bow and stick, which they knew made wood hot when used for drilling holes, would ignite dry material and create fire. Figure 2 shows the cave dwellers' mastery of the ability to create fire. The ability to perceive a new way to reach a desired goal is the heart of all engineering.

Since the ability to make fire developed, early inventors and their modern-day engineering descendants have imagined and created a world full of amazing inventions. Next we'll look at the growth of technology and how new inventions created the need for new and improved technologies.

FIGURE 2—Out of necessity, cave dwellers mastered the skills needed to control fire.

Ancient Engineers

As civilizations progressed, their needs became more complex. In ancient Egypt and Iraq, for example, agricultural and other needs required the movement of water over long distances. In these civilizations, engineers built irrigation canals that carried water up to 200 miles. The engineers who built these great canals had to understand many physical principles. They also had to be flexible enough to find solutions to operational problems as they occurred. One such problem was *erosion.* When erosion occurred, the dirt and mud banks of the irrigation canals broke apart and fell into the water. These ancient *civil engineers* solved the problem when they discovered that if they lined the canal walls with mats woven from common plants called *cane reeds,* they could prevent the soil from eroding. Today, modern civil engineers apply themselves to similar problems. Today's civil engineers are concerned with planning, designing, and building structures for industry, transportation, and the use and control of water.

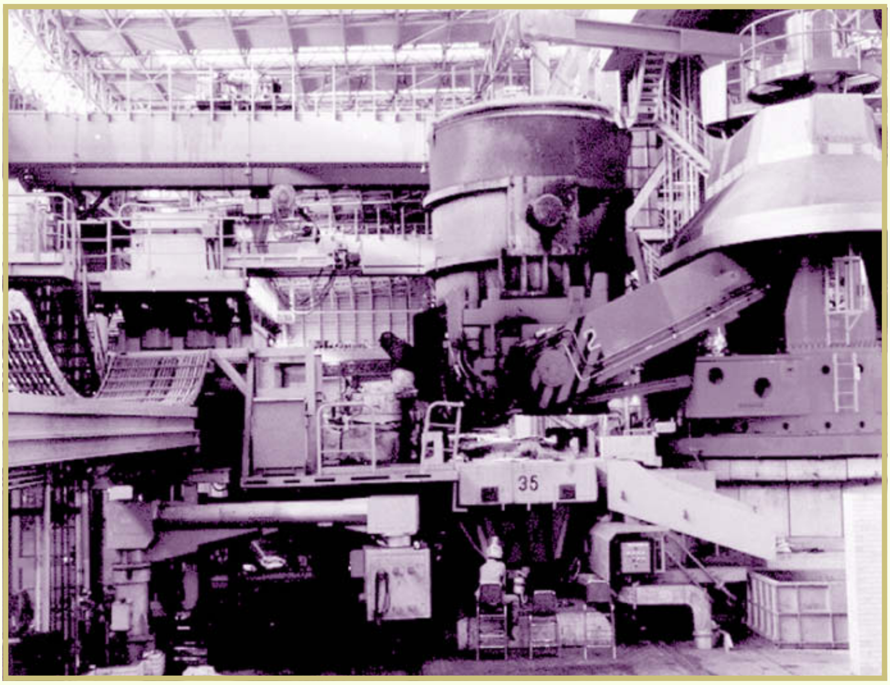
Iron Age and the Development of Steel

Iron wasn't the first metal people used, but its use has played a large part in the engineering innovations of the modern world. The first major production and use of iron occurred about 1500 B.C. in what is now Turkey. To make iron, iron ore was heated in large furnaces called *smelting furnaces,* then carbon was added. The carbon came from *charcoal*, which is made from charred wood. The amount of carbon added to the iron ore determined the strength and quality of the iron. This iron-making process was mostly unchanged for over 3,000 years. In a relatively short time however—no more than 100 years—major refinements were eventually made in this process.

After the production of iron came steel. Steel is a combination of iron and very small, exact amounts of carbon. Over time, the demand for steel products increased and so did the use of charcoal. In fact, so much wood was used for charcoal that the hardwood forests of Western Europe began to disappear. The loss of trees in England eventually reached such high levels that the British didn't have enough hardwood to build ships for their navy. But necessity proved to be the mother of invention, and in the early 1800s, a British inventor named Abraham Darby developed a process for making steel that no longer required the use of charcoal. This process was called *coal coking*. In coal coking, specific types of coal are burned to form *coke* and carbon. The coal was mined near iron ore deposits, which created a new efficiency that allowed the blast furnaces of England to produce an abundance of steel.

A short time later, people found that steel produced in a blast furnace wasn't a suitable metal for the precision machine parts that needed to be manufactured. As a result, a new technology, *iron metallurgy,* was born. Iron metallurgy came about because engineers observed the structure of fractured samples of iron, and saw that too much carbon was present to make a good steel. These early *chemical engineers* further refined the steel production process by blowing oxygen onto molten iron, causing the carbon to burn more completely. Over the years, the steel production process has been further refined into today's modern method, shown in Figure 3. Today, modern chemical engineers are concerned with similar problems. These engineers develop materials that can be used in a variety of products and deal with the design and operation of the equipment that performs such work. As you read on, you'll notice that engineering advancements are most often practical and imaginative responses to people's needs.

FIGURE 3—Steel Production Furnace



Steam Power and the Launch of the Transportation Age

Before continuing with our look at some of the history of engineering, let's stop to examine a couple of terms you'll need to know.

1. *Innovation*—A new idea, method, or device
2. *Invention*—A device or process that originates after study and experimentation

Coal mining and other activities of the 1700s led to new innovations. One innovation was a *steam engine*. The inventor of this steam engine was a British engineer named Thomas Newcomen. He advanced existing steam power technology by developing a machine that removed water from deep within a mine shaft.

Figure 4 shows Newcomen's engine. This engine created steam by heating water stored in a boiler. The water was heated using a coal-fired furnace. A *steam valve* controlled the flow of steam into a *cylinder* where the steam forced a *piston* upward. The piston was connected to the pump's operating shaft via a lever known as a *walking beam*. The walking beam operated like a seesaw. Valve F allowed cold water to flow from the water tank into the cylinder. Valve J let water leave the cylinder. In order to function, valves F and J were initially closed while the steam valve was open. The closed valves prevented fluid and steam from passing through. When the piston was pulled up in the cylinder by the seesawing action of the walking beam, the cylinder itself filled with steam. The steam valve then closed, and the F valve opened to let the cold water from the tank cool the steam held in the cylinder. Since cooling gas shrinks, the piston was sucked downward by the cooling steam. The pump rod then seesawed upward, operating the pump, and drawing water from the mine shaft.

In the late 1700s, other *mechanical engineers* perfected the steam engine's operation by adjusting the amount of steam that entered the piston. They also timed the introduction of steam, or *injection*, to the most effective moment. The newer engines ran more smoothly and used less steam and fuel than Newcomen's engine. Soon after the development of these new engines, steam-powered locomotives were developed. They were capable of pulling large loads for long distances. The steam-powered locomotive also provided a fast mode of transportation. The steam-powered locomotive made it possible for cities to develop far away from existing sea ports and river ports. Today, mechanical engineers, who deal with how to make and use tools, machines, and their resulting products, perform similar tasks.

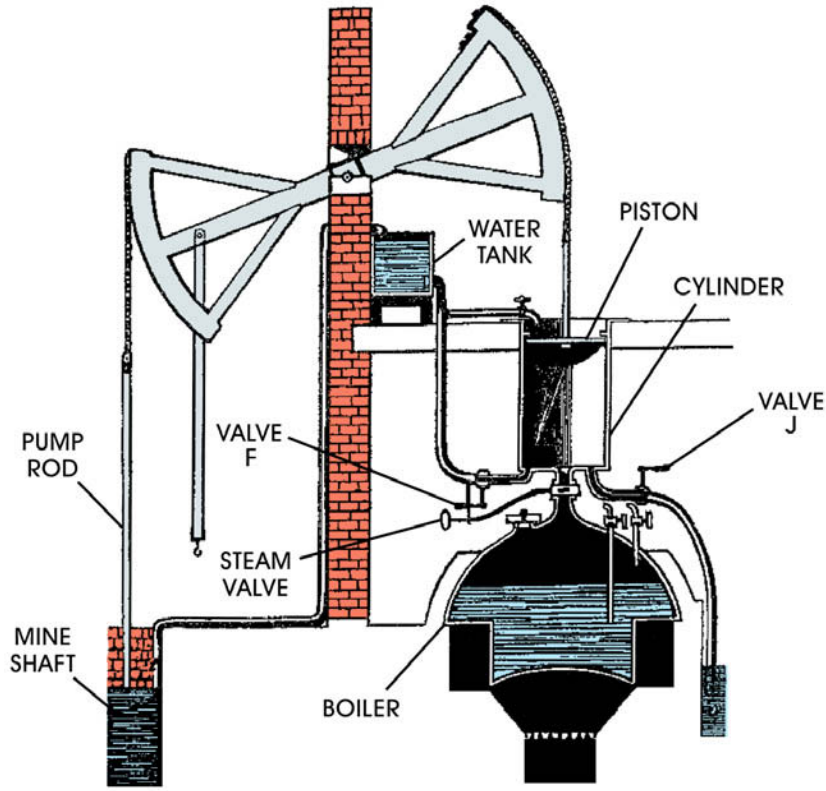


FIGURE 4—Newcomen's steam engine allowed water to be removed from mines, which made mining safer and more efficient.

In both ancient and modern times, engineering advances have changed the way people lived. These advances have also created a demand for new inventions and technologies. Technology has driven itself to new heights over time (Figure 5). As new uses for steel were found, the demand for steel increased. This caused improvements to be made in the production of steel. Since the production of steel required coal, the demand for coal also increased. This demand resulted in the development of a steam engine to increase yields from coal mines. These steam engines demanded not only better steel, but better manufacturing methods and machinery. For example, a steam engine's pistons must fit closely in the cylinders that house them. This demands carefully constructed, precision parts. Most metalwork in the time of the steam engine was done by hand, and was therefore inaccurate. So, to address the needs of steam engine manufacturers, early versions of modern machine-making tools such as *lathes* and *milling machines* were developed and refined.

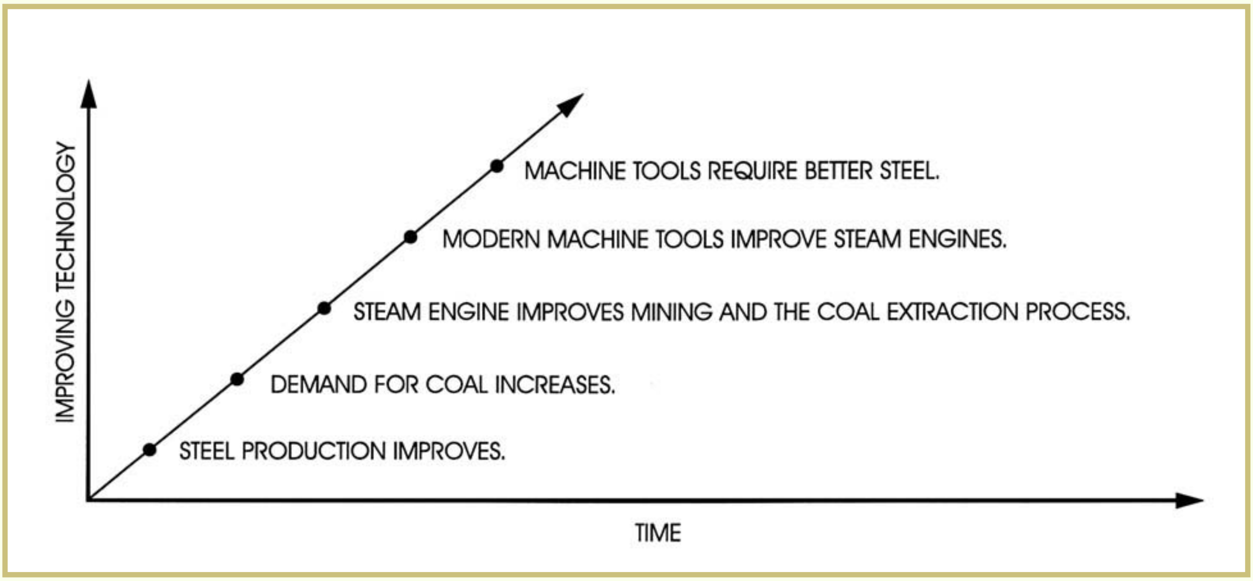


FIGURE 5—This graph shows how the level of technology increased in response to previous technological advances.

Electricity

No matter what branch of engineering technology you decide to follow, the principles of electricity will be part of your education. The ancient Greeks recognized electricity on a basic level. They recognized the existence of *static electricity*. Static electricity, the transfer of a static charge from one object to another, is the type of electricity you experience after you drag your feet across a carpet and touch an object. Much of what early engineers thought about electricity was incomplete and sometimes incorrect. It wasn't until the late 1700s that engineers began expanding on key observations made by earlier engineers.

For example, building on Ben Franklin's electrical experiments, an Italian physicist named Alessandro Volta developed a battery capable of supplying a continuous flow of electricity. Figure 6 shows the device that Volta developed. It's known as the *voltaic pile*. It used plates of silver and zinc separated by sponges soaked in salt water to generate electricity. This invention was eventually used in a wide range of manufacturing and research processes. The voltaic pile led to the development of our modern-day battery, which is shown in Figure 7.

It took thousands of years for Franklin, Volta, and others to come along and successfully expand on the early understanding the Greeks had of electricity. In contrast, it took only about 80 years for engineers and scientists to develop electric generators, motors, light bulbs, and heaters. They were also able to establish a demand for electric power in most of the world. By the 1890s, homes were supplied with electricity, and the industry of consumer electricity and electric appliances was born.

FIGURE 6—The voltaic pile was originally invented to generate electricity.

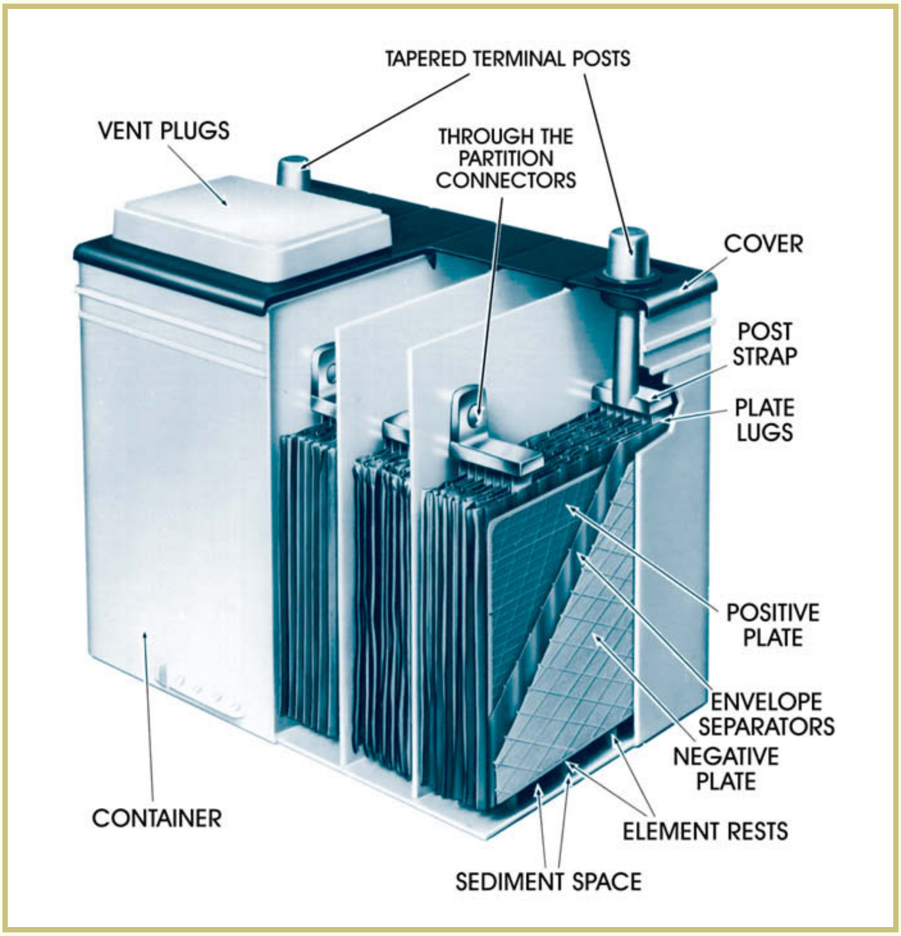


FIGURE 7—A modern-day battery eventually replaced the voltaic pile. (Courtesy of Battery Council International)

Early *electrical engineers* struggled to find more efficient methods of electrical distribution. Modern electrical engineers, who concern themselves with how to make, transmit, and use electrical energy, struggle to improve the systems that provide our world with electricity.

Flight and Space

In 1903, Wilbur and Orville Wright flew their first successful engine-powered flight. In becoming the inventors of the airplane, they paved the way for flight and the field of *aerospace engineering*. Like the Wright brothers, aerospace engineers today are concerned with the design and construction of aircraft. Aerospace engineers are also concerned with designing and building space vehicles and the special problems of flight in both the earth's atmosphere and in space.

Since 1903, the development of aircraft has quickly progressed. This has resulted in inventions and innovations that demanded extraordinary levels of creativity from engineers and technicians. The need to move military aircraft faster and higher brought about the development of the jet engine.

The jet engine led to the development of the large commercial airliner. While developing jet engines, engineers invented an assortment of strong, temperature-resistant metals that were much lighter than steel. The need for these space-age materials has fueled the development of new plastics and ceramics. Space exploration's need for control and accuracy accelerated the development of supercomputers and simulators. Supercomputer technology led to the development of the *personal computer* (*PC*). The space shuttle (Figure 8) is a great example of what results when many technological developments are combined.

FIGURE 8—The demands of space exploration are responsible for many of our most recent technical developments.

Technology's Impact on the World

Every part of our life today has been influenced by an engineer's or scientist's advancement of technology. As our look at some of the history of engineering showed, new technological innovations and inventions led to more technological advances. Our world today is full of items that couldn't have been developed without the technological advances made by our early civil, chemical, mechanical, electrical, and aerospace engineers.

As time has progressed, the speed at which engineering advancements have been made has increased considerably. For example, it took nearly 90 years after the invention of the simple voltaic pile until electricity became available to many urban American homes. However, it took only an additional 30 years before electronic devices were commercially available. The last 100 years has seen an explosion of technological improvements that have brought many changes to our society. Space shuttles, incredible civil engineering feats such as the

Golden Gate bridge, transportation improvements from automobiles to bullet trains (Figure 9), and medical miracles like artificial hearts were made possible through the imaginative and devoted work of engineers.

FIGURE 9—High-speed bullet trains and other transportation-related advancements have made travel much faster, safer, and affordable.

The need for more technological advances has created a need for more scientists, engineers, and technicians. This need makes the engineering and scientific fields of study a good career choice.

The Technician Today

As we discussed in the introduction, an engineering technician carries out, analyzes, modifies, and improves the products or processes proposed by engineers. To help you better understand the role of the engineering technician, we'll first define a few terms you should know.

1. *Product*—Something that's made or manufactured
2. *Process*—A continuous operation or series of actions leading to an end
3. *System*—An organized or established procedure

Engineering technicians are the key to product development and manufacturing processes. They create computer models of a conceptual design, and build one-of-a-kind models (known as *prototypes*) to a designer's specifications. In search of improvements, they monitor the effectiveness and accurateness of operations and manufacturing systems. They also modify existing products or processes. Engineering technicians test ideas, prototypes, and finished products for compliance with the intent of the design, and for usefulness.

In all of these tasks, the abilities to reason carefully, organize and record information, advance and expand upon the ideas of others, and communicate are irreplaceable. The rapid growth of technology requires technicians to be able to adapt to change. Technicians are in demand because they're viewed as being able to analyze today's problems, develop tomorrow's solutions, and fix yesterday's errors. These abilities help make a career in engineering technology rewarding.