THE MOTHER OF INVENTION

A soldier inventories the pharmaceuticals in the hospital at a training camp. *(The National WWII Museum, 2011.065.1960)*

Several elements are involved in the creation of a successful invention. Human qualities, for an individual as well as a team, must be in sync with natural, technical, and historical events. Though happy accidents occur, an analysis of the complete problem and all it entails is usually the best way to start. From the start also, it helps if the inventor has a strong sense of how his or her creation will fill an important need. Yet another key element—preparation for the unexpected—cannot be ignored. As Alexander Fleming once said, "The unprepared mind cannot see the outstretched hand of opportunity."

Here are two examples that illustrate how inventions are conceived, how they work, and how they come to be important.

PENICILLIN

In 1928, Alexander Fleming, a Scottish scientist working in London, discovered that mold had accidentally contaminated a sample of bacteria he was growing. The fungus had stopped the growth of the bacteria. Curious about the identity of the mysterious mold, Fleming grew more of it to learn how it worked to kill the bacteria.

Fleming eventually found that the mold, Penicillium notatum, made a chemical that killed bacteria. Fleming called this chemical "penicillin." He tried but was unable to isolate penicillin from the fungus for use as a medicine to treat infections. It could be said that Alexander Fleming proved to be a better biologist than chemist.

Fleming was also not a great communicator—neither in writing nor in speech. While he found through experimentation that the fungus was not toxic to animals or humans, Fleming was unable to convince anyone to help him develop penicillin into a useful treatment.

Alexander Fleming was working during a time in which many people suffered and died from infections. The infection rate was reduced in the late 1800s when doctors began to understand that hand-washing and disinfection with soap and bleach could reduce infections. While World War I improved techniques for washing wounds, infection continued to be a major cause of death.

During the period after World War I, medical researchers looked for ways to treat infections but found little success. Not until 1940 did a team of scientists at Oxford University make an important discovery.

Led by Australian Howard Florey, the Oxford team discovered that penicillin injected in mice cured some bacterial infections. They followed these experiments with tests in humans, most of which showed that penicillin cured infections. Because they were having trouble making sizeable amounts of penicillin, they set to work to find a way to grow large quantities of the fungus and extract the chemical that killed bacteria.

By this time, World War II had started in Europe, and England was under frequent German bombardment. Hoping to find a better place to develop penicillin into a drug, Florey went to the United States. Some progress in production was made by 1942, but only enough to treat 10 patients.

By 1943, the US War Production Board,

realizing that penicillin could be critical to treating infections in soldiers, developed a plan to produce even larger quantities. With the help of a government agricultural lab and chemical engineer Margaret Hutchinson Rousseau, the international team found a very powerful strain of the fungus and developed a method to sustain substantial growth. The team then developed effective ways to extract and concentrate the penicillin from the fungus. By the time the United States and England were planning the D-Day invasion, the Allies had all the penicillin needed to treat the wounded.

Florey never patented penicillin because he believed it would be unethical to restrict its use and profit from something needed so badly for the war effort. Florey and his colleague Ernst Chain, along with Fleming—now Sir Alexander Fleming—shared a Nobel Prize in 1945 for their work in developing penicillin.

What disease or disorder would you like to cure?

Medical technicians in a laboratory at Cape Gloucester, New Britain, August 1944.
(The National WWII Museum, 2008.354.216)

PLASTICS

Not many people know that the word "plastic" really means "easy to shape." Whenever the word is used today—and it is used often—the speaker is usually referring to a synthetic polymer. A polymer is a chemical that is made of a repeating chain of smaller units.

Humans have been using polymers for millennia. Wood and cotton are both examples of naturally occurring polymers. Rubber and other polymers from plant sap have been used for many purposes for centuries. Natural rubber became even more important when scientists working in the 1840s learned to strengthen it by treating it with sulfur.

The first synthetic or man-made polymers were created in 1860 when John Wesley Hyatt treated cotton fiber with camphor to create celluloid. Celluloid was meant to replace expensive and rare substances like horn, tortoiseshell, and ivory. Although celluloid was important in some manufacturing, in most areas natural polymers were still cheap and plentiful enough that they were used instead of polymers made in the laboratory.

In the early 1900s, chemical engineers began working with a new substance called coal tar, a by-product of coal production. Engineers used coal tar as an ingredient to make a variety of products including dyes and sulfa drugs, which were used to fight infections before penicillin.

Leo Baekeland made the first completely synthetic plastic in 1907. He named the substance, produced from coal tar, Bakelite. Throughout the decades before World War II, more and more plastics were made from coal tar and oil. Radios, telephones, fancy furniture, jewelry, and even sculptures were made from synthetic polymers. However, most manufactured products still used natural materials.

THE MOTHER OF INVENTION
(CONTINUED)

A B-29, the only WWII aircraft with a pressurized cabin, flying over Guam. *(The National WWII Museum, 2010.216.358)*

Everything changed with the beginning of World War II. The synthetic fiber nylon was invented a few years earlier, but it was more expensive than the silk and linen it was meant to replace. During wartime, those natural materials were in short supply, and nylon polymer was used to make parachutes, ropes, and parts of clothing. Also, with the coming of the war, electronics systems were suddenly needed for tens of thousands of aircraft, boats, ships, radios, and radar systems. These systems needed insulation. Plant polymers, still commonly produced in the tropics, were harder to get because of Japanese occupation of the Pacific. As a result of all of these and other urgent factors, during World War II synthetic polymer production in the United States increased 300%.

What limited natural material might you replace with a substance made in the lab?

B-29s flying past Mount Fuji. *(The National WWII Museum, 2010.216.368)*