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Welcome to the Designed World

Amy Smith

Courtesy of the MIT News Office

Many people think that the term ***technology*** refers only to computers, cell phones, and other electronics. But technology refers to anything people do to change the natural world to better suit human needs and wants, even something as simple as preparing and cooking the food we eat. With this definition in mind, think about all the different ways humans have changed the natural world to gather and prepare food. Consider all the technologies involved in growing and harvesting crops, and delivering them from the farm to the market. All tools and equipment we use to prepare our food, such as refrigerators, cutlery, pots, stoves, ovens, and so on are technologies, too! We even need technology to dispose of our food wastes in the town landfill. Just about the only thing that doesn't involve any technology is the process of eating.

Map of Haiti

I'm Amy Smith. I teach at the Massachusetts Institute of Technology (MIT), a university in Cambridge, Massachusetts. I specialize in creating technologies for people to use in the developing world.

Besides teaching soon-to-be engineers, I also have a laboratory at MIT where I work with my students to create new technologies for people living in rural villages in Haiti and other developing countries. Why does Haiti need new methods of cooking? Well, while most people in the United States use gas- or electric-powered stoves, many people in Haiti only use charcoal as a cooking fuel. Charcoal is made from wood; meeting the demand for wood has led to widespread ***deforestation***. Ninety-eight percent of the forests in Haiti have been harvested, resulting in wildlife habitat loss and soil erosion.

Still, Haitian villagers have many good reasons for using wood charcoal as a cooking fuel. It's cheaper than other fuels, and it's very easy to find. Widespread unemployment has led to poverty in many communities in rural Haiti; many people simply cannot afford any other fuel. Some people even have difficulty paying for charcoal.

In the next chapter, one of my students will tell you more about how we are developing a new cooking fuel that may help combat environmental degradation and poverty in rural Haiti. But first, I want to tell you why I became a mechanical engineer.

Engineers
improve or create new technologies.

Technology
refers to everything that people do to change the world to suit human needs and wants.

Scientists
investigate the natural world and how it functions.

I'll start by explaining what engineers do. ***Engineers*** improve existing technologies or create new ones to meet human needs or wants. The English words "engineer" and "ingenuity" originate from the same Latin root, *ingeniare,* which means to devise or invent. ***Technicians*** are people who operate, repair, and maintain equipment; as such, they participate in engineering projects, too.

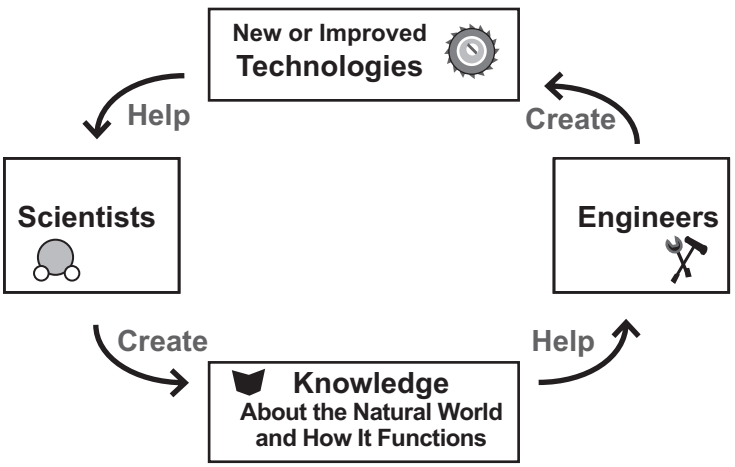
There are many kinds of engineers. You may already know that electrical engineers invent and improve cell phones, computers, and hearing aids, or that civil engineers design bridges, skyscrapers, and low-cost housing.

Do you know that, among other things, environmental engineers find ways to reduce the impact of our technologies on the environment by designing sewage systems, or that chemical engineers develop chemical ways to purify drinking water? Mechanical engineers, like me, are best known for creating new machines, but in reality, our work tends to overlap into other branches of engineering. My projects are good examples of how different engineering fields interact.

Another common misconception about engineers is that we are scientists. ***Scientists*** observe and investigate how the natural world functions, develop explanations for why things happen, then conduct experiments to see if their explanations are right. ***Engineers*** use the laws and theories that scientists develop to design new technologies. Engineers and scientists actually have a reciprocal relationship. Scientists often use new technologies to aid them in their pursuit of knowledge. A microscope is an obvious example of a technology that helps scientists study the natural world. You can imagine there is some overlap such that a chemical engineer must know a lot about chemistry to design a chemical process that purifies water. Likewise, a civil engineer must have a good understanding of physics if she wants her bridge to bear the weight of a locomotive.

Courtesy of Lemelson-MIT Program

Amy Smith was the 2000 winner of the $30,000 Lemelson-MIT Student Prize.

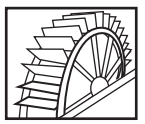


Technologies come in all shapes and sizes. Scientists who study animal behavior have claimed that humans are not the only ones who shape their surroundings to suit their needs. Most birds build nests. Beavers construct dams. Scientists have even observed chimpanzees using twigs as tools to extract termites from tunnels. But humans are, by far, the greatest users and inventors of technology. In fact, people who study the past have named major periods of human history by the prevailing type of technology, from the Stone Age to the Information Age.

The Stone Age 2 million years ago
started with the development of stone tools. In the Stone Age, people developed ways to harness fire for heating, cooking, and protection.

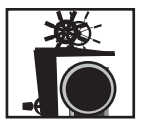
The Bronze Age 6,500 years ago
began with the discovery of copper and other metals. Agricultural technologies increased the reliability of food supplies and the growth of cities.

The Iron Age 2,500 years ago
was defined by the use of iron and steel for tools and weapons. During this period, people migrated from farms to towns and cities for work.



The Middle Ages 500 A.D.–1400 A.D.
saw the development of technologies, including book printing, the water wheel, and mechanisms for creating paper money.

The Renaissance 1400 A.D.–1750 A.D.
was a period of rapid advances in technology. The name Renaissance, which means “re-birth,” described the revival in art, science, and architecture.



The Industrial Revolution 1750 A.D.–1900 A.D.
saw the invention of machinery to run factories and power vehicles. During this period, workers flocked to cities for factory jobs.

The Information Age mid-1900–present
gave birth to computers, the Internet, and tremendous advances in science and technology.

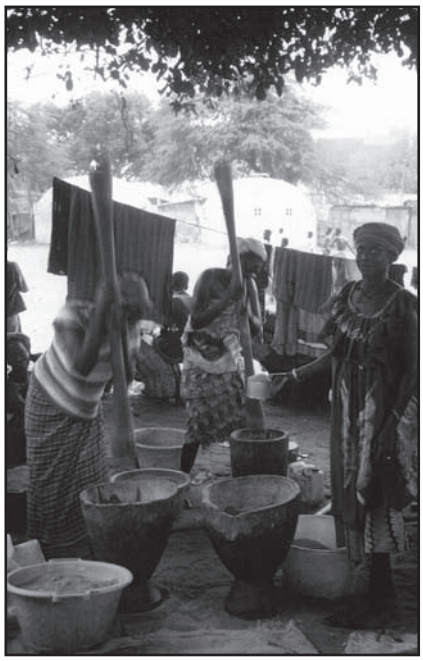
In your opinion, what will the next age be called?

Technologies That Cross Borders

My interest in engineering first expressed itself around the dinner table when I was growing up. During family meals, I'd talk with my parents about how a motor worked or how to prove a math equation. My father was an electrical engineer and my mother a math teacher, so conversations like this were pretty common in our house. Their attitude about solving problems—mathematical and otherwise—led me to study engineering at MIT. After graduation, I entered the Peace Corps, a government organization that sends Americans all over the world to help people.

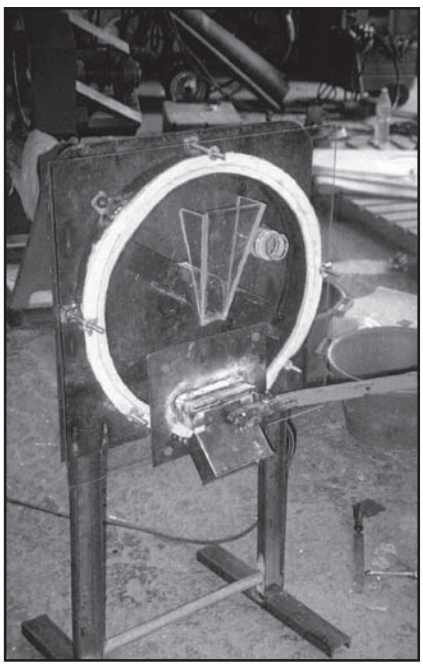
The Peace Corps sent me to the African nation of Botswana as a math and science teacher. One afternoon, as I was looking out over the Kalahari Desert from my kitchen window, I realized that, as an engineer, I might be able to develop new technologies that could help people in Botswana and countries like it. I decided to go back to school to get more training as an engineer so I could learn how to make a difference for people in ***developing nations,*** nations where the standard of living and average income are much lower than in the United States, Canada, and Japan.

As a graduate student at MIT, my first field experience gave me an opportunity to create a technology for people in rural Senegal. In many Senegalese communities, women make flour by grinding grain by hand. It's backbreaking work. I once spent about three hours grinding enough grain to make a cup-and-a-half of flour! Using a motorized technology called a hammermill, a person can grind enough grain in one minute to make twelve or thirteen cups of flour. However, a hammermill requires a metal screen that separates the flour from the hulls of grain. When the screen breaks—and they all eventually do—the hammermill is useless. Most communities that use hammermills cannot afford to replace the screens and don't have the equipment to make new ones. Hammermills with broken screens gather dust, while women return to pounding grain by hand.



Courtesy of Amy Smith

Women in rural Senegal grinding grain by hand. It is backbreaking work.



Courtesy of Amy Smith

My screenless hammermill

After studying the hammermill dilemma for a few months, I figured out a way to use the air that flows through the mill instead of a screen, to separate the particles of wheat. This technology increases the lifespan of the hammermill by many years. The screenless hammermill I developed uses less fuel than the original hammermill and costs about a quarter of the price.

The screenless hammermill is an excellent example of an ***appropriate technology***—a technology that can be manufactured, maintained, repaired, and improved with local community resources. The screenless hammermill seldom breaks, and if one does break, it's easily repaired with commonly available materials and tools.

In the courses I teach at MIT, students learn how to invent appropriate technologies that can be used for microenterprise. A ***microenterprise*** is a small business that can be run by an individual or a family. A family might use a screenless hammermill to make and sell their own flour, or they might charge others a small fee for using the mill. Some of these new businesses have been very successful at helping people rise above the poverty line. If the technology also reduces human impact on the environment, that's an added benefit.

A ***patent*** is a document issued by the government that gives an inventor the sole right to make, distribute, or sell a particular invention for a certain number of years.

Patents

After devising a new technology, many engineers apply for a patent. A ***patent*** is a document the government issues granting an inventor the sole right to make, distribute, or sell a particular invention for a specified number of years. Most engineers patent their designs. If a company wants to manufacture and sell an invention, the company must get written permission from the inventor. It's illegal to make or sell an invention without that permission. The patent system ensures that engineers get appropriate credit and compensation for their work.

Obtaining a patent for an invention can take a long time. The inventor must submit detailed documentation with evidence proving that he or she invented the device in question. The paperwork even includes signed copies of the engineer's notebook! The U.S. government keeps extensive records of patents, dating back hundreds of years. When developing new technologies, engineers often conduct patent research by studying old patents to learn how other engineers developed related technologies.

I chose not to patent the screenless hammermill I developed because I wanted people around the world to be able to make, distribute, and use the technology without having to get my permission and without having to pay a fee. That's an unusual decision; most engineers are quick to patent their work.

Technologies Are Everywhere

Technology is such an important part of being human that, like breathing, we hardly notice it. Pause for a moment and take a close look at this book. What technologies were involved in creating it? How many different technologies can you see from where you are sitting right now? I don't mean just cell phones and computers, but also pencils, papers, chairs, and many more.

Some of these technologies are used all over the world, but many technologies don't cross borders very well. Engineers like me must always consider available resources when designing products for users in other countries. Take, for example, an incubator. An incubator is a device that can keep its contents warm for a long time. Doctors in American hospitals routinely use incubators for several purposes, such as caring for babies born prematurely or culturing bacteria to diagnose disease. Incubators run on electricity. While many communities in rural areas of developing countries would benefit from having incubators, these areas often lack access to electricity. Clearly, it wouldn't make sense to ship a bunch of incubators to these communities. Incubators wouldn't be an appropriate technology in those places. It makes much more sense to redesign a technology or create a new one that suits users' particular needs. So I invented an incubator that works with inexpensive chemicals that maintain the same temperature for a long time after they are heated without using any electricity. This incubator is ideal for the developing communities I'm interested in helping.

As an engineer, I find developing appropriate technologies to be very satisfying work. It's a special kind of challenge to create a new technology for people in other parts of the world—and, of course, I get to travel a lot. But everyone who enters the field of engineering or technical trades has different motivations for doing the work that he or she does. You'll learn more about that by reading this book.

What's the Story?

1. How has engineering been important in human history? Give at least three examples.

2. What is the difference between a scientist and an engineer?

3. According to Amy's definition, the term "technology" refers to anything you do to change the world to suit human wants and needs. List at least ten different technologies you have seen or used in the past hour. List five technologies that may have been involved in the production of this textbook.

4. What does the term "appropriate technology" mean? Give an example of an appropriate technology. Give an example of a technology that is not appropriate.

5. What is a patent, and what motivates engineers to patent a new technology they develop?

What Do You Think?

6. How can teamwork lead to better solutions? Why is it valuable to have people with different backgrounds work on a team? Give an example from your own experience.

7. Imagine that you've been hired as a consultant by the International Red Cross to help determine the best ways to foster economic growth in a country where most of the people are very poor. One member of your team is interested in finding American companies to set up branch offices to provide well-paid work for locals. Another team member says it's better to help the people establish their own microenterprise. What course of action do you think is better and why? Be sure to define the term "microenterprise" in your answer.

8. Describe a personal experience you've had in solving a design problem.