Modeling with Mathematics: A Bridge to Algebra II

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Extra! Extra! Scientists Use Mathematical Modeling!

From ancient times, people have tried to make sense of the world around them. Nomadic Native Americans made observations about the behavior of the buffalo herds in the central plains of North America. These observations led them to make conjectures about the movement of the herd, which was essential to the tribe's survival. If they successfully followed the herd, then food was plentiful. If the herd left them behind, then they starved.

Some civilizations began to use numbers to describe relationships. In ancient Egypt, people began writing down numerals to keep count of things. They began to write simple equations to perform calculations.

These numeric observations prompted early scientists to want to learn more. They noticed that certain quantities are related, such as the length of day and the location of certain stars, and began to use mathematics to describe these relationships. These observations were the early stages of what we now call mathematical modeling.

In this chapter, you will explore some of the work of three notable scientists who used mathematics to describe relationships that they noticed in the natural world.

Archimedes (**Figure 1.1**) was a Greek scientist who lived in Syracuse, Sicily, during the third century BC. Archimedes wrote many books about geometry, mathematics, and physical science and was a good friend of King Hiero of Syracuse. Archimedes was instrumental in defending his home city against the Roman siege in 212 BC, before his death that same year.

Archimedes is perhaps best known for what is today called Archimedes' Principle. This idea describes the forces that interact between a fluid, such as water, and an object that is submerged in that fluid.

FIGURE 1.1.
Archimedes.

FIGURE 1.2.
Robert Hooke.

Robert Hooke (**Figure 1.2**) was an English scientist who lived in London during the 1600s. This was an exciting time to be a scientist in England. Like most of Western Europe, England was enjoying the Age of Enlightenment, a time when scientists and philosophers explored new ideas about the world around them. After a long period of silence, they rediscovered the work of the ancient Greeks and Romans. As technology had become quite advanced for the day, scientists now had many new tools at their disposal, and they began to look for new ways to use them.

Robert Hooke began his work with springs as he searched for a way to build a better clock. Ships had been sailing from Europe to North America and Asia for over 200 years in Hooke's day. Yet, they had difficulty telling time in order to determine their longitude. European clocks at this time used a pendulum that swung back and forth, keeping steady time. However, on long sea voyages, waves disrupted the pendulum. So, Hooke began to explore the use of springs to make clocks tick. Along the way, he discovered a relationship between the length that a spring stretches and the amount of force required to make it stretch to that length. This relationship today is known as Hooke's Law.

FIGURE 1.3.
Robert Boyle.

Robert Boyle (**Figure 1.3**) was also an English scientist in London during the 1600s. In fact, Robert Hooke was one of his students. Boyle studied religion, chemistry, and physics. Like many of his colleagues, he wanted to take the mystery out of science, and he relied heavily on mathematics to do so.

Boyle was keenly interested in the properties of air, which were still largely misunderstood. Boyle's predecessors in Italy had found that air has weight and exerts a force on the ground called air pressure. Boyle learned through a series of experiments that not only did air have weight but also that fire cannot burn without air.

Boyle also studied the relationship between air pressure and volume. In 1662, he wrote in *Touching the Spring of the Air and Its Effects* about his experiments with a vacuum chamber to determine the relationship between pressure and volume of a gas. His findings are today known in chemistry as Boyle's Law.

Scientists continue to use mathematical modeling to describe natural events and to make predictions. Astrophysicists use mathematical modeling to chart the paths of stars and solar systems. Aeronautical engineers use mathematical modeling to build better airplanes and space vehicles. Social scientists use mathematical modeling to make predictions about populations and natural resource management.

Throughout this book, you will study how different people use mathematical modeling to make decisions about everyday life. You will also see how mathematics appears in unlikely places and is used by people from a variety of backgrounds.

In Chapter 1 you will explore some important ideas in science using mathematical modeling.