*Why do we call it a...*Newton?

by Lyle D. Feisel, Ph.D., P.E. (Ret.), *Iowa Alpha '61*

This is the fifth in a series of articles that explore the history of science and engineering. One way in which this history has been preserved is in the names of the scientific units that we commonly use. Those units will serve as starting points for these articles as we explore "Why do we call it a…?"

It is hard to overstate the importance of a standard system of units of measure. If we say something weighs 73, this means nothing unless we specify what it is that it weighs 73 *of*. Pounds? Tons? Tonnes? Stone? Kilos? This makes a difference. Obviously, civilization needs a good system of standard "weights and measures" for commerce, communication, science, and most other areas of human activity. In 1790, The French Academy of Sciences appointed a commission to establish such a standard system. They based the fundamental units on the Earth itself.

The meter was defined as 1/10,000,000 the distance from the Equator to the North Pole. With the meter defined, they then could define a kilogram to be the mass of 1/1,000 of a cubic meter of water. They needed a unit of time, so they defined a second as 1/86,400 of an average solar day. At that point, they had three base units—meter, kilogram, and second—and could start deriving other useful standards based on those three.

Newton splits the color spectrum.

For instance, they defined a unit of force as that necessary to accelerate a mass of one kilogram at the rate of one meter per second per second. They named that unit the newton. Why did they call it that? I'm glad you asked.

The newton of force is the namesake of Sir Isaac Newton (1642-1727), an English physicist who made enormous contributions to science and mathematics, exploring mechanics, optics, gravity, and various other fields, and inventing the mathematical technique eventually called calculus.

Newton was born on Christmas Day, 1642, in the county of Lincolnshire, some 100 miles north of London. His father had died three months before, so Newton was raised by his mother and maternal grandmother. They were apparently not poor, because Newton was able to attend The King's School in Grantham during his teenage years. As nearly as I can determine, the school was tuition-free, but you still had to be reasonably well off to attend. Poor children were put to work to help support their family, so were rarely educated.

The Grantham school—which, by the way, still exists—was what was known as a grammar school. It taught grammar, all right, but primarily the grammar of Greek and Latin. It seems there was also a smattering of science and mathematics, because Newton emerged with an elementary understanding of those subjects as well as a burning curiosity and a creative mind.

At the age of nineteen, Newton left The King's School and enrolled in Trinity College, which was, and still is, a part of Cambridge University. There, tuition was required and Newton paid his by enrolling in the medieval version of a work-study program. His work consisted of, as one reference described it, performing the duties of a valet. This meant being a personal servant, presumably for faculty and richer students, and not parking cars.

In 1665, just as Newton was completing his bachelor's degree, the Great Plague hit London and its environs. This was bad news. The plague killed some 100,000 people—about one-fourth of the population of London—and prompted the university to shut down for almost two years. Now, we lesser mortals might have seen that as a protracted snow day and taken a long break from our studies. Not Isaac Newton. He spent his time at home

doing original research on what became calculus, on optics, and on gravitation. Newton returned to Cambridge in 1667 and completed his master's, which was the highest degree awarded at that time. He then became a member of the faculty of Trinity College and started making public contributions to the nascent field of science or, as it was then known, natural philosophy.

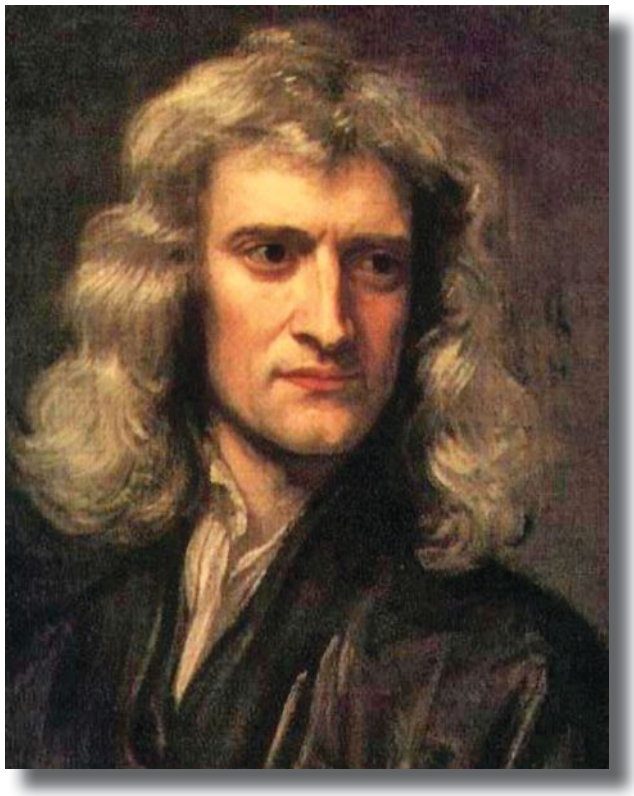
In 1687, he published his most important work, *Mathematical Principles in Natural Philosophy*, better known as simply, *"The Principia"* (pronounced with a soft *c*). This reported several of Newton's greatest contributions: the laws of motion, principles of universal gravitation, the inverse square law, planetary motion, and the beginnings of an understanding of the principles of calculus. Any one of those would be worthy of a Nobel Prize today. Yet, the most important idea established by *The Principia* was that nature could be described, understood, and studied by using mathematics.

Digressing for a bit, it is interesting to note the similarity between this revolutionary idea and a contribution made by one of Newton's countrymen at the beginning of that century. In 1600, some eighty years before publication of *The Principia,* Dr. William Gilbert (1544-1603) authored another book, entitled *The Magnet*. This was a report of Gilbert's extensive experiments exploring electricity and magnetism. It showed that carefully controlled experiments could help to explain physical phenomena and dispel widely held myths and misunderstandings. Because of our education and experience, if we have a question about the behavior of some material or system, our first response is, "Well, let's go to the laboratory and get the answer." This has not always been the case. Before Gilbert, "philosophers" were likely to just talk about physical systems and propose theories without any thought of actually trying anything in a systematic fashion. So, Newton taught us to use mathematics and Gilbert taught us to do experiments. Both concepts are totally accepted today but were radical at the time.

Huge Controversy

As engineering students, we all studied algebra, trigonometry, and calculus, and sometimes wondered why. We found out in our more advanced courses. To understand what we were studying and to be able to make predictions of physical behavior, we had to use mathematics. Calculus and differential equations were the *lingua franca* of our endeavors. For that, we can thank Sir Isaac Newton. And, not incidentally, Gottfried Leibniz, a German philosopher who was also involved in the conception and development of calculus. There was a huge controversy over whether it was Newton or Leibniz who originated the concepts of calculus. This made for some rather bad blood between these geniuses.

While Newton is best known for his work in mechanics and mathematics, he also contributed greatly to the development of optics and understanding of the properties of light. Using prisms and lenses, he broke white light into its constituent colors and then reintegrated those colored beams to produce white light. He developed an understanding of the limitations of lenses and built a reflecting telescope to overcome the problem of chromatic aberration. His work on light was recorded in his book *Opticks*, published in 1704. A popular painting, shown at left, portrays Newton and his spectrum-splitting experiment.



Newton painted in 1689 by the portraitist Sir Godfrey Kneller.

For anyone under the age of thirty, it is difficult to imagine a world without computers. For all of us, it is difficult to comprehend living in a world where no one knew that (1) f=ma, (2) white light consisted of the combination of colored light, (3) celestial bodies orbited other bodies because their gravitational attraction was just balanced by a centrifugal force due to its motion, and (4) gravitational attraction varied as the inverse of the square of the distance separating two massive bodies. But, that was the state of science before the phenomenal career of Sir Isaac Newton. It is remarkable that those four quanta of knowledge were discovered or clarified by one man, over a short period of time. He made so many contributions that it is difficult to say which is the most important, but probably his best-known contribution is his understanding of the relation of force to motion. And, that's why we call a newton a newton.

Lyle D. Feisel, Ph.D., P.E. (Ret.) is dean emeritus of the school of engineering and applied science and professor emeritus of electrical engineering at Binghamton University. Following service in the U.S. Navy, he received B.S., M.S., and Ph.D. degrees in electrical engineering from Iowa State University. From 1964 to 1983, he was a member of the faculty of the South Dakota School of Mines and Technology, serving as head of EE from 1975-83. Feisel was a national visiting professor at Cheng Kung University in Tainan, Taiwan, during 1969-70, and served as the founding dean of engineering at SUNY Binghamton from 1983 to 2001. He was named Tau Beta Pi Distinguished Alumnus in 2002. Feisel is a life fellow of the IEEE and a fellow of ASEE and NSPE.