Engineers and Scientists are different breeds

"A scientist studies what is; an engineer creates what never was."

–Theodore von Kármán

BY EDWIN D. REILLY, JR.
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Theodore von Kármán was not a "rocket scientist," he was an aeronautical engineer who perfected rockets. And the quote may not have originated with him; it is essentially Robert F. Kennedy's version of a quote from a play of George Bernard Shaw rendered with more specificity: "Some see things as they are and ask why; I dream of things that never were and ask 'why not?' "

Too many people think that it is quibbling to question von Kármán's profession. They see no significant difference between a scientist and an engineer, and have locked into the phrase "rocket scientist" as descriptive of a very, very smart person. Or more often, they denigrate the complexity of a task by an inverse assessment that has become a cliché: "It's not rocket science."

Most of the "science" of rocketry was done long before there were rockets, when, over three hundred years ago, Newton proclaimed his third law of motion: "For every action, there is an equal and opposite reaction." Just expel something out the back of an object floating in air or water and it will move perceptively forward. The rest of rocketry is engineering.

I do not know of many who write about engineering as a profession, but one who does, and brilliantly, is Henry Petroski, who is both a professor of civil engineering and a professor of history at Duke University. I first became aware of his work some years ago through his bimonthly column on engineering that appears in *American Scientist*, the publication of Sigma Xi, the preeminent scientific and engineering honorary society. He seems to publish a very readable book about engineering every other year, and I seldom resist buying and reading them. His subjects range from the history of grand edifices such as bridges to everyday devices that we take for granted such as bookcases and pencils. And one needn't be a rocket engineer to enjoy them.

In his latest book, "The Essential Engineer—why science alone will not solve our global problems*,"* Professor Petroski disposes of the global problems pretty quickly, but spends at least as much time reinforcing the favorite Rodney Dangerfield-like lament of many an engineer, that scientists get all the glory (and the Nobel Prizes), and "I get no respect."

Actually, engineers can and have won Nobel Prizes, provided that there is some scientific component to their work. One example cited by Petroski is that of Jack S. Kilby, an engineer who won the Nobel Prize in physics in 2000 for his invention of the integrated circuit. Another example that the author could have mentioned but didn't is that of Niskayuna's own Ivar Giaever, a mechanical engineer by education, who shared that same prize with two others

in 1973 for his work on electron tunneling in superconductors.

Because the Nobel committee would not belatedly add engineering to the list of appropriate subjects for prizes (as it had done for economics), the National Academy of Engineering has been awarding, annually since 1989, the Charles Stark Draper Prize, given for the advancement of engineering and engineering education. It is often called "the Nobel Prize of Engineering." The winner of each Draper Prize receives $500,000, one-twentieth of that awarded to the fortunate person who becomes the sole recipient of a Nobel Prize.

Robert Noyce, a co-founder of Fairchild Semiconductor—along with Jack Kilby of course—received the first Draper award in 1989, the year before he died. There have been 20 awarded thus far, and I was surprised to find that nine of them were awarded for work that could be called computer science or computer engineering. Eight were for "hardware," technological inventions that had application to computing. One, to John Backus for "FORTRAN, the first widely used, general purpose, high-level computer language," was for "software."

People that design and write software, like Backus, are now more likely to be called "software engineers" and there are now many textbooks entitled "software engineering." That's because the design of a program that meets rigid specifications; is carefully structured to allow for ease of later modification; and performs reliably while coping with a wide range of input data, is very much like engineering, "design" being the characteristic element.

Most fields of study that end in "science" are only remotely scientific. For that reason, in 1955,
rather early in the evolution of what is now called computer science, I argued that our field would command more respect if it adopted a single-word name akin to physics, chemistry, biology, geology, and mathematics. I preferred "cybernetics" so that I could be a cybernaut, but cybernetics as defined by Norbert Wiener quickly became so imbued with analog rather than digital technology that broadening its focus became a lost cause.

A significant amount of floor space in every large bookstore is devoted to something called "science fiction," but none to anything called "engineering fiction." Most of "SciFi" features more technology, the product of engineering, than science, and the science described is often considered impossible, such as Star Trek's "warp speed" and teleportation, whether of a human or a vulcan. But Arthur C. Clarke, as quoted by Petroski, once wrote "When a distinguished scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong."

The example Petroski gives is one of the many feats of the great mid-19th-century British engineer, Isambard Kingdom Brunel. When, years ago, I first encountered that preposterous name in a short story by Donald Barthelme, one titled simply "Report," I was certain that the name was pure fiction. But Brunel was a real person, one who proved, contrary to prevailing belief, that a steamship could carry enough coal to allow it to travel from Southhampton to New York and still have room for paying passengers. The ship he designed, the "Great Western," did exactly that in 1838

"The Essential Engineer" has a good index, and "Schenectady" appears

twice. One page refers to GE's very recent emphasis on wind power engineering going on downtown (production is elsewhere). Another refers to Charles Steinmetz, a scientist when he enunciated the law of magnetic hysteresis but an electrical engineer for most of his career. The page shows and explains the famous picture of Steinmetz and Albert Einstein, doctored to show them elbow to elbow when they were actually some distance apart. The culprit apparently wanted to illustrate the affinity between Einstein, the epitome of a pure scientist, and the quintessential engineer, Steinmetz.

But was Einstein so pure a scientist? No, with his friend and fellow physicist Leo Szilard, the first to conceive of the possibility of a nuclear chain reaction, the pair invented and patented an innovative refrigerator. And it is common that experimental scientists have to design and "engineer" the intricate equipment needed to perform their experiments.

Some years ago, with regard to the alleged difference in value of the work of the scientist and the engineer, a colleague made a profound point that has stuck with me for many years. He said "Ed, scientists are seldom a threat to humanity. But engineers, when they err, can kill people. Bridges collapse, buildings fall, brakes fail, and space vehicles (and oil rigs?) explode. So it is engineers, more so than scientists, who bear the greater responsibility to safeguard our lives while trying to improve them."

Score one for the engineers.

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