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How We Become a Nation of Engineers and Scientists

By David R. Butcher

Are engineers and scientists born? Most children are naturally inquisitive, yet only some seem driven to discover scientific facts and turn that passion into a career in engineering or science. Perhaps turning around the shortage of U.S. engineers isn't as simple as increasing funding for classes and teachers; it may mean rethinking the way schools teach science.

Just throw money at the problem. That'll make it go away. It's the American way.

So say numerous assessments by research councils, associations, organizations and commissions regarding the concern of a shortage of engineers and scientists in the United States, as well as a national falling-behind in technological literacy.

A sobering reality lies in the fact that steadily diminishing numbers of college students are choosing careers in science and engineering. The past 15 years have seen the number of engineering and computer science B.S. degrees granted in the U.S. drop from about 110,000 to a low of 88,000, although it has recently rebounded to about 109,000, according to the National Science Board (NSB). Despite the rebound, the U.S. still is granting engineering degrees at a lower rate than in the mid-1980s and, nationally, less than 55 percent of students who undertake engineering studies complete them. The Bureau of Labor Statistics (BLS) forecasts 2 million new science and engineering (S&E) jobs by 2012 (National Science Foundation, *Science & Engineering Indicators* 2006). However, the American educational system is failing to produce a sufficient number of scientists and engineers with university degrees to meet the growing demand for non-academic professionals. (The concern is not limited to the U.S., as the U.K. has also found that students are shunning engineering degrees in favor of subjects allied to medicine and mass communication.)

The most commonly suggested prescription for the problem is to significantly increase funding for classes and teachers who are developing future engineers and scientists (or who are NOT developing these particular students, as it is often argued that teachers are discouraging students to enter these professions).

Perhaps the solution lies in rethinking *how* schools teach classes that inspire future engineers and scientists. And, as many IMT readers have noted in the past, perhaps we shouldn't undervalue the importance of teaching such courses much earlier.

The conventional approach — increasing funds for teaching junior and senior high school math, biology, chemistry and physics — maintains the current standard science curricula but advocates smaller classes and more and better-trained teachers. Yet conventional wisdom also secretly assumes that if more kids are exposed to better quality courses, a greater number of them will come to choose science or engineering as a career, a BusinessWeek editorial recently noted.

"It's a peculiar version of demand-side economics (that 'guns can be converted to butter,' if the price is right) and one that's palpably false," wrote Greg Blonder, a technologist and partner at Morgenthaler Ventures. "Actually, we live in a supply-constrained world, where the pool of real scientists and engineers is relatively small and most people, no matter how bright, aren't destined for careers in science and engineering."

Why not? Are people born with an inherent aptitude to engineering- and science-related fundamentals?

Of course, all children are naturally inquisitive, eager to learn and ask questions. Only some, it seems, are driven to discover scientific facts and to turn that passion into a relevant career in engineering or science, though. They are genuinely intrigued by bridges, tall buildings, planes and LEGO bricks and toys. (Perhaps the difference between the two groups is that the potential engineer is the one who not only takes things apart but also puts them back together afterward…)

The solution to the problematic shortage of engineers, according to Blonder, lies in changing the way we teach science:

Change starts with the recognition that, while all of us need to be scientifically literate both for our own welfare and the nation's technological progress, we can't all

be scientists. That requires teaching scientific literacy generally, while reserving the tools of the trade for those pursuing scientific careers — the exact opposite of the approach academics now take.

Advanced topics, Blonder suggests, should be left for people who are going to use them later in their careers. For instance, asking general students to solve redox equations represents the same pedagogical fallacy as teaching set theory did for "the new math." Stop teaching chemistry, physics or biology classes as separate subjects where memorizing nomenclature is the first order of business. Rather, invest a year of classes in experimenting with the world — some classic science fair projects: making batteries from potatoes, building erupting volcanoes from baking soda, growing algae…teach them that science and engineering is fun! — then spend another year learning how to build scientific intuition through estimation. Then devote another year to "case studies," Blonder recommends, "comparing, say, risks to costs of building a bridge with ever-decreasing safety margins."

Simply put, do not confuse the teaching of a subject with the teaching of a skill. Such an approach has the great potential to not only engage most students but also create a technologically literate population: "the foundation for a society that's more empathetic to — and more willing to fund — scientific research."

"The education we provide engineers must prepare them to move beyond merely fulfilling a technological function and become leaders who make wise decisions about technology and set policies that foster innovation," G. Wayne Clough, Georgia Institute of Technology president and National Academy of Engineering (NAE) member, said in his alumnus magazine.

Those students destined to become engineers or scientists could either stay on the general track until college or segue to courses with more rigor and specialization in high school. With science beginning in first grade, and, in this hypothetical case, becoming *mainstream*, fewer "born scientists" would drop out due to peer pressure driving them toward other more socially acceptable pursuits.

If for no other reason, younger generations should be taught basic scientific principles so they can make informed decisions on the future of the country — and indeed, the world. They are the generations who must face the consequences of ill-informed decisions. Both training of the forthcoming workforce and education of the youth are imperative.

Of course, if and when the U.S. is able to create a sufficient number of engineers and scientists, keeping them is another issue altogether.