
Where are the Real Engineers?

by G. Harry Stine

Recently, I have been involved as a consultant on an engineering project. I'd prefer not to mention names because this column is likely to get a little rough on some of the people I worked with. In any event, the purpose of this column isn't to point fingers but to reveal a disturbing trend. Maybe something can be done about it.

The goal of the project was to build something and test it. The device did not exist, although a lot of studies and many technical papers have been written about it in the last 40 years. The first goal was to design, build and operate a proof-of-principle prototype. This would be a cheap and dirty off-performance piece of ironmongery using off-the-shelf technology and hardware. It would be used to check out some of the questionable approaches to the solution, find out if the approach was really workable, discover the items that are always overlooked even in the best designs, and then allow the company to proceed with the pre-production device with a higher degree of confidence and a lowered level of risk.

Furthermore, it had to be done on a total budget that was embarrassingly small and on a time schedule that was impossibly short.

Briefly, this approach is standard, old-hat, everyday engineering that you use when you are trying to do something new and different. No big deal, right? Wrong!

In this particular industry, no one had been allowed to make a mistake in the last 30 years. Everything had to work perfectly the first time. Everything had to be a success when the switch was flipped or the button pushed.

It has been a fascinating experience to watch the way both experienced old-time engineers (who

are now managers) and fresh-caught engineers tackled the project.

The old-time engineers had to battle two decades of on-the-job experience. Tattooed on their brains was the dictum: "Thou shalt not fail, it must work the first time, and thou hast no room for error."

Well, that attitude can be handled because these older engineers remember the time when it wasn't that way. It's not too difficult for them to shift mental gears and get back to the old method that amounts to: "Well, hell, let's just whomp up a boilerplate test model of this puppy and see if it passes the smoke test when we plug it in!" That's what engineering used to be all about, and it's one of the factors that made it fun.

Engineering used to operate on the principle, "Experience gained is directly proportional to the amount of equipment ruined."

Then you could forge ahead to design and build stuff that would not bust. Prototypes were not worth a damn unless you busted them. Otherwise, you would underestimate yourself and did not need the prototypes at all.

Once that ancient principle was reestablished in the minds of the engineering management, the project became fun. But it did not make it any less stressful. The lack of big money and the short deadlines kept the pressure on. I could see the gradual metamorphosis of the older engineers (of which "I are one," too).

The real problems came with the young engineers who had recently (within the last ten years) received their engineering degrees. The young engineers were brilliant when it came to design work. They knew how to run computer analyses

until the floor was covered with printouts. They were whizzes with CAD.

But they had never “bent tin.” They had never been responsible for designing something that could be built and was supposed to do something.

This puzzled me at first. Then I figured out what had happened.

Fifteen years ago, my son decided he wanted to be an engineer so he could become a product designer. So we went to several colleges and universities to see what their engineering curricula, facilities, and teaching staff amounted to.

Turns out that something had changed in Engine School.

Two career paths existed (and still exist) for engineers.

An engineering degree now consists of an extremely strong emphasis on scientific theory, mathematics, and computer technology. And practically no hands-on laboratory work! The venerated engineering degree has been converted into a degree in applied science!

On the other hand was the path leading to a bachelor’s degree in “engineering technology.” Upon close investigation, I discovered that this poor stepchild of modern undergraduate study was indeed the sort of hands-on, practical engineering curriculum that I was familiar with back at mid-century. But it no longer turned out “engineers.” It graduated lowly “engineering technologists.”

Aha! No wonder that some of the modern products of engineering seemed to be less than elegant in their design, construction, and operation! They have, essentially been designed by scientists, not engineers! The real grubby-handed engineers, now called “engineering technologists,” have come along after the “engineers” are finished.

The engineering technologists are the ones who have had to make the damned product work after the design has been approved!

(I have nothing against scientists. In fact, my degree is in physics, not engineering. Scientists are needed to explain why something works after inventors conceive it and engineers make it work. Yes, some modern products have sprung from the science lab. But far more of them have come from inventors.)

Robert A. Heinlein, an engineer himself as well as an eminently practical scientist, put it very well in *The Rolling Stones* in 1962: “Fiddle with finicky figures for months on end—and what have you got? A repair dock. Or a stamping mill. And who cares?” Hazel Stone missed one of the existential joys of engineering: Pride in making it work the way it is supposed to.

Dr. Wernher von Braun was one of the best real engineers I have ever known. I saw him do engineering right out on the test stands with the technicians. When I read his biography, I understood why.

Von Braun studied at Charlottenburg Institute of Technology, Germany’s equivalent of MIT and Cal Tech. As part of his education, he was apprenticed to the Borsig Werk. There, an old foreman handed him a chunk of iron about as large as a child’s head. He also gave von Braun a file and pointed to a bench vise. He was told, “Here are your tools. Make this into a perfect cube. Make every angle a right angle, every face perfectly flat and smooth, and every side equal.”

Five weeks later, von Braun had filed the chunk of iron into the required perfect cube that had become the size of a walnut. *But size had not been specified!* Borsig then put him to work on a lathe, on a shaper, in the foundry, in the forge, and finally in the locomotive assembly sheds. Von Braun later recalled that he had gotten more

insight into practical engineering during that apprenticeship period than he had in any semester in the university.

Today, von Braun would have received a degree in engineering technology, not engineering.

And the engineers involved today in the project I used as a nameless example are learning the hard way what engineers used to learn in undergraduate work and their first few years in the field. They are having to bend tin against a schedule. They are having to make do with what they can get off the shelf. They do not have one thin dime for R&D. They are learning to read *Thomas' Register*. They are learning how to scrounge through junk yards to find something cheap that will do the job. They are facing a world where good enough is the enemy of the best, where an adequate solution today is far more important than a perfect solution tomorrow.

I am convinced both the old hands and the young pups will do just fine on the project. I expect them to destroy the prototypes but also to learn from that. And they are going to come out of the project as one of the best damned engineering teams in the industry. The company they work for has a long and proud history of building gadgets that work, making money for the company and the customer, and staying in service for decades. I will not have to tell you who they are; you will know.

Now, what are we going to do about this dichotomy of engineers and engineering technologists?

If I wanted again the challenge of putting together an engineering team to do things, I think I would be partial to hiring engineering technologists. One of our problems in the United States is our penchant to study things to death before risking our careers on the real possibility of a failure, regardless of whether it is an engineering job or a business deal. Yes, we have got to use our resources

wisely and do our best to succeed rather than fail. Be we have been studying things too much. Time to build and bust some prototypes.

We have got to stop studying things to death. We have got to be willing to bust prototypes. We have to get out there in the world, make things that work, *and produce them!*

I had a friendly controversy going on with Arthur C. Clarke, whom I had known for more than 40 years. I kept telling him, "Arthur, we are not all going to sit around in front of our computer terminals being creative and communicating with one another in the global village. Someone is still going to have to milk the cows!" (Or attach, remove, clean, and repair the milking machines.)

Another friend of mine, L. Sprague de Camp, begins his excellent book, *The Ancient Engineers*, thusly: "Civilization, as we know it today, owes its existence to the engineers. These are the men who, down the long centuries, have learned to exploit the properties of matter and the sources of power for the benefit of mankind."

We do not need to educate more scientists in America. We need more engineers. I think it is time we ended the experiment of calling educated applied scientists "engineers" and transitioned back to what we know works: Educating more grubby-handed "engineers with hairy ears and long and woolly britches," as the old and unprintable ditty goes.

Maybe we also need to adopt the European custom of permitting a real engineer to place before his/her name the honorific, "Ing." Then turn them loose to continue changing the world as they have for centuries.

Originally published in the December 1992 issue of Analog Science Fiction & Fact magazine and reprinted here with permission of the author.