EDITORIAL

Educating *Relevant* Engineers

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In 1928 my father began an industrial career that spanned more than 40 years. His original employer, Carnegie Steel, subsequently became part of United States Steel (now USX Corporation). For approximately 60 years the steel mills dominated the economy of my hometown of Pittsburgh, PA. Massive shifts of men disappeared into them every eight hours, seven days a week. "Dirty-hands" engineers versed in metallurgy, welding, casting, and heavy machinery developed the steel mills into giant behemoths collectively employing hundreds of thousands of people. Each summer these mills benevolently employed me in their open hearths or rolling processes, greatly helping to fund my undergraduate engineering education. Some of this same dirty-hands training was required as part of my own degree completion in the mid 1960s.

These mills are now either nonexistent or just small shadows of their former selves. Pittsburgh, *the Steel Capital of the United States*, is currently without an operating steel mill. U. S. Steel is tremendously reduced in size, and former large companies such as Bethlehem Steel and Republic Steel have totally ceased to exist. Beginning in the 1970s, a large segment of the heavy industry in this country migrated overseas in search of lower labor costs. As all Americans know, much of our current manufacturing base continues to follow this same path. Today's high tech will always become tomorrow's low tech, and the migration will continue.

Recently my senior engineering students completed a two-semester project sponsored by Scott Walton for the U.S. Army at Aberdeen Proving Grounds (APG). Scott had provided an excellent interface to the students, including three visits to Texas Christian University, where I teach, and weekly telephone conferences with them over the duration of this project.

The project that Scott and I agreed upon required the students to design and build a test system to simulate (in terms of a specified shock spectrum) the effect of projectile impact on the operational electronics contained in an armored vehicle (an Abrams tank). In addition, they were also required to design and build a three-channel data recorder to operate in the tank and acquire data during actual impact. The recorder was to be capable of being cascaded to and working synergistically with other similar recorders to enable better measurements of the structural response of the tank during ballistic shock. The recorder also had to satisfy the economic requirement of being capable of being produced in quantities of 100 at less than $500 each. The larger, overall goal of the project was to help the Army keep its tanks fighting in combat situations.

This project was successfully delivered to the customer this past May in a design presentation in Fort Worth, TX (where I teach) before an audience of 200 people. The audience was comprised primarily of local industry, parents, and customer representatives.

Let's look at the dirty-hands engineering these now recently graduated students had to perform to complete this project. They applied traditional knowledge in: structures, gas dynamics, materials, analog circuit design, and more. However, some of the newer technologies their project depended upon were finite-element analysis of structures, 3D computer-aided design (working directly with university machinists), digital circuit analysis and design, and time and frequency analysis of signals.

Hopefully they also gained a practicum in the three credit-hours of design taken during their junior year where they studied project management, specification writing, engineering economics, risk and reliability assessment, team building, etc. In addition to the newer technologies just mentioned, these students had been exposed during their undergraduate education to other modern engineering topics such as fiber optics, MEMS (miniature electro-mechanical systems, which is one manufacturing area that is rapidly growing!), digital image processing, semiconductor fabrication, composite materials, experimental modal analysis . . ., and, oh yes, an increased focus on communications and the humanities. These areas encompass some of the new dirty-hands technologies young engineers must master independent of the university where they receive their education.

In my opinion, our future success as a nation will become increasingly dependent on producing engineers who can work in teams and communicate as part of a continuous 24-hour engineering process that spans international borders. For those of you lamenting the passing of the old time dirty-hands engineers, do you remember how much time you spent during your educational process pushing a slide rule, punching and submitting stacks of computer cards, inverting matrices on a hand calculator, drafting and building models for visualization, and even getting access to information? Yes, these tasks all taught us something, but today's students have so many more efficient tools to work with than we did. They are so much better prepared in the soft skills of teaming and communications than we were that their careers will surely be more productive than ours.

Personally, I am comfortable betting my and my grandchildren's future on the current crop of graduating engineering students and their dirty-hands skills, even though these skills are much more likely to be practiced in a clean room than in a heavy industrial environment. In an earlier discussion in this journal, my good friend Strether Smith lamented the passing of the old time dirty-hands engineers. I think a more appropriate conclusion should be that we do need and are still producing dirty-hands engineers in this country, but they are being trained in the *relevant* technologies of today. SV

Please comment on this editorial. Send them to: p.walter@tcu.edu.