EDITORIAL

A Commentary on the State of Engineering Education

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Author's Note: The following editorial is made up of three parts:

1. *The original draft that I wrote after seeing the Albert Kingsbury article in the October 2003 issue of S&V.*
2. *A discussion of responses that I received after sending the draft to several colleagues.*
3. *A request to all readers for follow-up.*

The Original Draft. The article on Albert Kingsbury in the October 2003 issue of S&V produced a flood of memories and a host of thoughts about the past, present and future of engineering education.

Other than the clothes (we certainly did not wear ties) Figure 1, taken in 1885, could have been of my freshman mechanical engineering classmates in 1957. As it turned out, we were the last class to use the venerable Sibley College building at Cornell. As sophomores the next year we moved across campus to sparkling new quarters (Thurston Hall named for the professor in Figure 2) that had everything except what was shown in the other pictures. The new building had drafting tables – that could not be escaped, CAD was still a long way in the future – but Thurston (and Kingsbury) probably rolled over in their graves because of what was missed.

What was lost were the dirty-hands laboratories like the foundry lab in Figure 3. The 1957 freshman class made sand molds, poured molten iron with a ladle, and made cast bookends that we could send home to our parents as evidence of how well their money was being spent. It seemed a bit trite at the time, but in retrospect, I think a mechanical engineer should know how castings are made. That critical wisdom was denied to Cornell students starting after 1957.

Cornell had other ideas about what engineers should be taught. If they were going to understand sand casting and accounting as well as solid mechanics and differential equations (not to mention ROTC), four years were not enough. So they (and MIT and a few other engineering schools) instituted a new 5-year bachelor's of engineering degree program, which was designed to construct the "complete engineer" or, at least, the beginnings of one.

Of course, reality won out. Despite the excellent preparation, the new degree did not produce any more dollars and so it was dropped. It was replaced at many schools with a 5-year track leading directly to a master's degree. This makes a lot more sense except that the world is much more complex now and maybe 6 (real) years to some sort of 'minimum' degree is more appropriate for engineers.

Figure 1. Drafting class, Sibley College, Cornell University (ca. 1885).

Figure 2. Cornell University Professor Robert H. Thurston.

Figure 3. Foundry lab, Sibley College, Cornell University (ca. 1885).

When I left Cornell, I was fortunate enough to blunder into an excellent experimental structural mechanics program directed by Wilfred Horton in the Aero Department at Stanford. Wilf was a British ex-patriot who had worked on the Spitfire (he made sure you knew that, and that it was the only worthwhile aircraft ever built), who had a real flair for exciting grad students in structural-experimental projects and a real talent for scaring up grants to support them – a perfect combination. Our main emphasis was on the buckling of thin shells, a hot topic in the 1960s and the studies required unique instrumentation and recording systems and that became my avocation. My career was defined and established before I left grad school. I was very fortunate, but the program left Stanford in the late 1960s.

Do today's students have the same opportunities? I might be wrong but I think that programs in experimental mechanics have essentially disappeared from many of the major colleges and universities. I hope that our readers can correct me – if so, I can point the graduates to excellent jobs. The old guys need to be replaced.

For me, and others that work in the engineering short-course business, this is a personal bonanza. We are kept busy giving multi-day seminars trying to pass some of our hard-earned knowledge on to the new doers. It is fun and rewarding for us and, I hope, the attendees.

But, it is not enough. We need real schools to provide real courses if industry is going to have laboratories that can perform good tests that provide reliable results. I think that a good foundation in sand casting is a good start toward understanding the difference between a good and a bad Shock Response Spectrum.

Reactions from Colleagues. The rough draft of this editorial produced an immediate response from Pat Walter at TCU. We exchanged several notes, and one of mine included the following paragraphs/ questions:

So, if they are Mechanical Engineers (or some other equally dirty-hands regimen):

1. *Have they ever done any welding?*
2. *Have they ever operated a lathe and/ or milling machine?*
3. *Have they ever stuck down a strain gage?*
4. *Have they welded a thermocouple (And done an error analysis on the result)?*
5. *Can they free-hand sketch a connecting rod? (That means: can they sketch and do they know what a connecting rod is?)*
6. *I assume that, under your auspices, they have stuck down an accelerometer and it was proven to provide proper results. Right? I doubt that other schools do.*

I guess the bottom line for me is that, *if we are developing experimental engineers, they probably are not going to be allowed to do the tasks above when they go to work (either on a school program or "for real"). If they haven't gotten their hands dirty with the real stuff, how will they:*

1. *Know what to ask for.*
2. *Know whether it is any good when it is done.*

Part of Pat's response was:

Per your questions, the MEs in the past have welded thermocouples (been taught homogenity and thermal time constants), torn down an engine (routine), pasted down lots of strain gages, understand bridge circuits, etc. This year's program has them (EEs/MEs jointly) using accelerometers, microphones, and other instrumentation to assess the state of health of 15 KV circuit breakers for Oncor (TX's power distribution company). The EE/ME team also uses LabView, DAQS, understands aliasing, is doing waterfall plots, and lots more high level signal processing, and I think they understand it all. Many will stay and work on their own initiative over part of their Xmas vacation. They have 24 hour access to the building since they have done a hazard analysis associated with their work and have generated safe operating procedures they signed after review/approval (the breakers were sent in on semi trailers).

Very impressive! The TCU curriculum is missing a few items that I think are important (How many engineers can still do a free-hand sketch?), but the program itself is far more than I had dared to hope. This exchange was followed up with a paper describing TCU's program. It describes a program that is solidly based on industry/school cooperation/interaction and the students produce a useful engineering product before graduation. It looks great.

A critical feature of the TCU program is that it is relatively new. The program founders/designers have had the advantage of starting with a clean slate. Maybe other schools should consider a fresh start.

On the other side of the fence, Larry Loh of Lockheed Martin weighed in:

We echo your concerns on the lack of "dirty-hands" training in our modern colleges and universities.

In fact, we have more concerns. Here is a summary of what they are for mechanical/structural types:

1. *Hand calculation is a dying art, there are very few of those under 35-40 years old who can do that now.*
2. *Lack of understanding of the limit of data acquisition systems and lack of training in interpreting test data and most importantly, the lack of skills to correlate models with test data.*
3. *Spend too much time on using CAD tools to put together models rather than thinking about the numbers that are being generated.*
4. *We have to train just about everyone on Drafting and Geometric Dimensioning, and Tolerancing.*

"Dirty-hands" training will address most of the above concerns. After interviewing tens of potential employees from various colleges and universities, I found that those who graduated from more prestigious schools are usually the ones that lack "dirty-hands" training.

So, there is obviously a difference of opinion. Maybe Larry needs to contact Pat and hire some of his students.

Finally . . . a Request. Is this editorial just the rambling of an old "dirty-hands" engineer condemning the younger generation, or is there really a problem?

What schools offer solid, dirty-hands, industry-useful programs? How well do they satisfy the needs of industry? How many students with "dirty-hands" experience graduate each year? How many university professors have substantial industrial experience?

Please send me your thoughts. I will follow up with another editorial and anticipate that others will contribute editorials with further information supporting either side of the fence. I hope you will join me in this discussion. SV

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