

# If You Think Education is Expensive, Try Ignorance



*It is important for surveying educators to be part of the surveying profession, in the widest sense. We have to be out of the ivory tower and involved in the profession and its discussion and debates.* — **By N.W.J. Hazelton**

In any discussion about surveying education, a question may come up from time to time along these lines: “I don’t use calculus / vector algebra / photogrammetry / [your favorite topic here] in my daily work, so why should I (or other surveyors) need to study it as part of our education?”

As part of a civilized and intelligent professional discussion, this is an excellent question. I will attempt to provide an answer (actually, several answers), although, as with many really good professional questions, there is no single, definitive answer.

Perhaps the primary answer is that there is no single model of a surveyor. A surveying program graduate may find work in a small practice doing local property surveys, or join NGS, or become a survey project manager with responsibility for a very wide variety of surveys, or may work with a company providing consulting and support services in GIS and mapping to NGA, or may even end up teaching surveying or GIS to a new generation of potential professionals. Some of my own students have taken these paths.

The incoming students, who know little of the broader profession, are hardly in a position to say where their career will take them, nor which areas of surveying will ignite their passion. Similarly, it is not in the interests of the profession that it narrows its perception of itself, especially in a time of rapid technological change—that seems a recipe for extinction. So while an individual organization may narrow the focus of its activities, the education sector of the pro-

fession cannot do this and continue to serve the profession as a whole.

A second answer is that none of us knows what our graduates, or surveyors in general, will be doing over the course of the next forty years. This is the approximate working life of a graduate, and so a good yardstick for looking ahead. In 1969, would any of us have predicted LiDAR, laser scanners, robotic total stations, digital levels, RTK GPS, and massive computing power in handheld devices? While we might have predicted some of these technologies, would we have predicted all of them being mainstream for surveyors? Would we have predicted the change in mindset that comes with these technologies?

Consequently, we are not serving our students, nor the profession in the long-term, if we educate our students for today’s work environment, without considering that of the future. No one wants to become redundant as the technologies they use become outdated.

Technology has a half-life of about five to seven years. This means that over a period of five to seven years, about half the technology we are using will have become obsolete. Over a period of 35 years, we would expect only about one to three percent of the technology originally in place to remain in regular use, and this is about what we see in surveying. So to educate bachelors degree students to use technology that is current at the time they begin a four-year program means that about half of

this technology will be obsolete by the time they graduate and get a job.

By contrast, theory has a half-life of about 15 to 20 years, so over a period of 35 years, we would expect about 12 to 25 percent of theory to still be relevant. The remainder is not wrong, merely no longer needed. We have little need for long-line geodetic formulae in these GPS days, nor the theory of tacheometry.

A third answer concerns flexibility for graduates in the future. An education that ties graduates to a single avenue of work encourages them to leave the profession if they can't see their future in that avenue. Graduates with widely applicable education can move to different work, using the education they acquired to support their work. They will tend to remain part of the profession, rather than burn their boats and jump into something completely different.

Flexibility in choosing one's career is important to potential students. It helps them realize that the cost of their education is not a gamble on the long-term viability of a single line of work, but an investment in a very broad professional endeavor that will provide life-long returns and benefits. In the current economic climate, being able to change focus within the broader profession and stay profitable is a huge benefit.

A fourth answer concerns where the profession is heading. Measurement itself is becoming simpler and universally available, as can be seen by the presence of GPS and cameras in every other mobile phone. Google applications, among others, are allowing a large segment of the population to manipulate spatial information in simple and useful ways, especially for supporting decision-making. Should the profession be focusing less on measurement and more on spatial information management? Should we make the profession's central technology GIS, rather than GPS or total stations, as a means to integrate everything else we do?

If this is a direction in which the profession should travel, then we need to prepare future professionals to travel that road. This means broadening the curriculum to

encompass a viable future direction for the profession, without knowing exactly where we'll be going or what we'll need for the journey.

A fifth answer relates to the way we look at education. If we use the analogy of crossing a large cave, there are different ways of thinking about education, and how it affects the outlook of those who become educated.

We can look at education as the acquisition of a body of knowledge that only provides a basis for a career. In the cave, this is the acquisition of a flashlight that enables one to follow an existing path across the cave. One's education is therefore the minimum illumination that is sufficient for safely navigating existing career paths and work methodologies. We have to hope the batteries last for the entire journey.

We can look at education as the acquisition of a body of knowledge that illuminates our lives, providing a basis for a career as almost a secondary outcome. In the cave, this is the acquisition of a burning torch. We can use the torch's light to find our path, but we can also try different ways around the cave. The light also provides a circle of illumination around us, and some personal warmth. Perhaps most importantly, we can transfer the flame to other materials we may find in the cave and continue to have light, even after the original torch's fuel is exhausted.

We can look at education as an exploration of the depth of our own ignorance. When we learn something, it serves to show us how much there is still to know. In the cave, this is the acquisition of a burning torch that we use to create a succession of small fires to illuminate our path, as well as to explore the cave. Each new fire we establish lights its immediate area and shows how much we have explored—but also shows us how much is still dark.

Ideally, professional education would have all three aspects. The first aspect is the minimalist model, while the second is the classical education model, the one that drives the inclusion of general education courses. The third is critical to professional

education because it shows the professionals the limits of their knowledge and skills.

Professionals are often required to limit their activities to their areas of expertise, and these limits are often left to the individual to decide. Deciding where your expertise ends depends upon knowing what you don't know, as much as knowing what you do know. So professional education needs to go beyond the bounds of "regular" expertise to illuminate the edges of the darkness, if only for a few moments.

The importance of this last point may be illustrated by the following example.

Some years ago, there was a case where a construction company sued over wrongful termination of their contract in a major construction project on the U.S. East coast. As the primary issues concerned survey control for the project, I was asked to look at some aspects of the case.

When the project was first started, the objective was to refurbish an existing transportation structure in a major urban area. A survey company was engaged to provide a detailed topographic survey of the entire construction area, so that design and planning could be undertaken.

The survey company produced an excellent topographic survey of fine and precise detail, based on a control traverse that was tied to the SPCS, closed to around 1 in 100,000, and had error ellipses at the traverse points generally less than 20 mm. This was despite the traverse being along both sides of a single, narrow urban road, and having about 35 angles over almost 10 km.

As the design process advanced, the project objectives changed. Instead of refurbishment, the entire structure was to be replaced. However, in order to keep the system operational during construction, the various pieces would be constructed off-site and then installed on weekends, with occasional one-to-two week stoppages. The construction tolerances for final placement were 6 mm in 3-D, over the entire project.

The problem was the original traverse for the topographic survey, while outstanding for its original purpose, was not good

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—By Bill Coleman, RPLS

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enough for construction control at this level of precision. In fact, it was almost impossible to create any control traverse that could provide the required level of precision. The construction control network had to be done by something other than a traverse, but designing such a network was clearly not something with which anyone among those involved was familiar. The original survey company was, quite rightly, very uneasy about the entire situation, but their concerns were overruled by the project management group; and they were kept outside the decision-making processes.

Construction was begun using what was left of the original traverse points, and problems started surfacing almost immediately. Survey work from different control points wouldn't agree to the required tolerance, simply because sufficient precision wasn't there in the first place. The result was stop-work orders, delays, and rising tempers.

The project was redesigned at least once, to allow for any construction already done, and the construction process was changed so that the parts to be built off-site were only started once their anchor points were placed. All this led to significant delays and cost overruns. Ultimately, the contractor in question was terminated for poor performance and sued on the grounds that there was no way to construct the project as designed, given the control used. (The case was settled out of court).

This was clearly a case where all the parties involved had gone beyond the limits of their expertise. The original survey company can't really be blamed, because their misgivings about the situation were ignored. They, too, were later replaced. But had they been able to advance some very strong arguments about the situation and provide the basis for a solution early on, the later problems may have been avoided.

The project management group clearly didn't understand the importance of high-precision survey control to manage a project with very fine construction tol-

erances. There appears to have been no one with the expertise to undertake a comprehensive error analysis of the project requirements and work backwards to design a suitable control network that would have allowed the project to be constructed as originally designed. No one with any influence on the management of the project realized the limits of their knowledge and ability, including the limits of a traverse (any traverse).

The construction project has not yet been finished. It is currently about three years behind schedule and at least \$250 million over budget. While not all of the problems can be tied to the survey control issues encountered, much of the delay and cost overruns can. And while it is not possible to attach blame to any individual or company, there definitely was general failure to understand the nature of errors in survey measurements.

Here, then, is a realistic dollar value on ignorance—ignorance of an aspect of measurement science that is a fundamental part of many advanced surveying courses. Understanding this aspect of measurement science requires understanding calculus and statistics, as well as how to use a least squares adjustment properly—which, as some other parties (not mentioned) in this story demonstrated, was beyond their ability.

Often, it is these subject areas whose usefulness is questioned when people ask: "If I don't use it, why should it be part of the curriculum?"

The quarter-of-a-billion dollar cost overrun for this one project could have been profitably invested in other areas. It is taxpayers' money, so it could have been used for almost any other purpose.

On average, it costs about \$20,000 to obtain a four-year degree in surveying (not including living expenses). The money wasted in this project would have funded 300 students per year (the approximate number of graduates with four-year surveying degrees in the entire U.S.), for just over 40 years. As my grandmother would say, "Willful waste makes woeful want."

Each year in June, high school educators in Texas are invited by the Texas Society of Professional Surveyors (TSPS) to participate in a retreat aimed at increasing the awareness of surveying, mapping, and other geospatial science activities. This year's event was held on the campus of Lone Star College-Montgomery in Woodlands and was a great success.

The first Annual TSPS High School Educators Retreat was held in 2007, in Corpus Christi and was hosted by Texas A & M University—Corpus Christi. Organized by the TSPS University Advisory Committee (Joey Stanger, RPLS, and Dr. Stacey Lyle, RPLS) and the Education Committee (Bill Coleman, RPLS), the event aimed to promote the inclusion of surveying and geospatial science in high school curricula through an exchange of knowledge between industry professionals and educators.

Pleased with the results, TSPS decided to continue sponsoring the event in different parts of the state. In 2008, the retreat was held in Tyler, and it was sponsored by Tyler Junior College. The college offers an Associate degree in Surveying and has an articulation program with University of Texas, leading up to a Bachelors Degree for students wishing to pursue professional registration.

One of the unintended, but much appreciated, sidelines to develop from the first annual retreat was the establishment of the Texas SkillsUSA Basic Surveying Contest. Attendee Barton Burnett, Duncanville ISD Engineering Instructor and District 6 SkillsUSA director, saw an opportunity to inject surveying directly into the Engineering Academy at Duncanville High School.

With the assistance of TSPS Chapters 5 (Dallas) and 2 (North Central Texas), the first contest was conducted in February 2008. This was followed by a statewide contest at Corpus Christi in April, with teams from districts in all corners of the state advancing. Representatives from the Texas State Contest teams had the opportunity to participate in a demonstration of the contest at the SkillsUSA University at the National Contest in Kansas City, June 2008. [[www.tsp.org](http://www.tsp.org)]