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The Demise of Basic Surveying Mathematics

Where Have All the Trig Skills Gone?

May I get on my soapbox and vent for just a bit? This has to do with the demise of basic surveying mathematics. Where has the knowledge of the basic math skills gone, knowledge on which our profession is founded? Where has the ability gone for those young people entering our profession to accomplish seemingly simple math problems? Where has the responsibility gone for

its labs have changed to reflect changing equipment, calculators (whatever happened to HP and RPN?), hardware and software. The Department has changed as well, recently reducing the number of credit hours to receive the B.S. in Civil Engineering degree. As a part of this reduction, the surveying course went from 4 to 3 credit hours.

But something very troubling has changed during my many semesters teaching the class, and that is the distinct

and the reverse? No problem. Areas by coordinates? No problem. Applying geometry to horizontal circular curve nomenclature, then derive equations to compute curve parts? No problem. The students' general knowledge of algebra, trigonometry and geometry was excellent. There was no need to review or explain these subjects before jumping off into surveying.

Missing the Basics

Most of that has changed for the worse. The entering students' knowledge of the basic subjects of algebra, trigonometry and geometry has sunk to such a low level in the past five to ten years, that for all practical purposes I can say they have virtually none when it comes to being prepared to attack surveying. Discussing such pre-surveying topics as triangle solutions, orthogonal vectors calculation (*i.e.*, latitudes and departures), even doing something simple as recognizing similar triangles when trying to derive horizontal curve equations just draws blank stares. What's the problem? I believe we can lay most of the blame at the feet of high school math curricula. In the "old days," algebra, trigonometry and geometry were the staples of high school mathematics. Calculus was largely left to colleges and universities. It seems these days that high schools, in their rush to impress or seek prestige or to offer students the opportunity for "AP" (Advanced Placement) and to get college credit for their students prior to even entering college, have swept aside the basics of algebra, trigonometry and geometry to teach calculus. It's not

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teaching the basic math that is needed for a career in surveying?

Each semester since the fall of 1980 (that's 52 of them), I have taught a "first" course in plane surveying. It has been a conventional, fundamentals course: differential and trigonometric leveling, direction and angles, latitudes and departures, polar to rectangular conversions (and the reverse), coordinates, areas, horizontal curves and vertical curves. The course has a lab component in which the students accomplish 13 field exercises. Over the years, the course and

decline in the math skills of the students taking the class. This has especially been the case in the past decade or so. The rate of decline in the students' math skills has increased.

In the "old days," students entered the class with a generally excellent (by today's standards) understanding of algebra, trigonometry and geometry. I would say to the class "Surveying is one big applied trigonometry class..." and start teaching surveying. Triangle solutions? No problem. Calculate coordinates? No problem. Polar to rectangular

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“cool” to grind away at those basics, therefore let’s “help” our students and offer calculus.

Look at the titles of math courses in today’s high schools. Don’t expect to find a straight up course titled “Trigonometry” or “Geometry.” I’m told these subjects are inside courses like “Math Methods” or some such class.

I believe surveying (as well as science and engineering) would be best served if high schools went back to the basics and taught straight up courses in algebra, trigonometry and geometry and leave calculus to colleges and universities. Pass a law: No calculus will hereafter be taught in high school. Forget math “AP,” it is a disservice to students and our profession. Give us students well founded in algebra, trigonometry and geometry!

College Students Aren’t the Only Ones

But the problems of poor math skills for those entering or in the early years of our profession aren’t limited to troubles with courses taken while in high school. It seems those doing survey calculations now rely almost totally on software. Gone are the days when surveying calculations were done on a calculator (aided by elementary survey programs). Azimuth and distance to stake a point from a known instrument position and backsight point? Where’s the computer? Still needed is basic knowledge of surveying mathematics and the ability to solve those problems using a calculator along with skills in trigonometry and geometry. We can’t be complete monkeys...yet. You don’t believe this is true? Is it okay to be a trained monkey and only know which buttons to push in which order? If so, then what about the licensed surveyor exams? Trained monkeys can’t pass the exams. That’s good. State licensing boards are licensing professionals, and knowledge of basic surveying math and the ability to solve problems with a scientific calculator are a part of the exam process and part of being a surveying professional.

So Who’s Failing?

As one who has worked on two states’ state specific exams for many years, I can report that it seems the examinees’ abilities to solve relatively simple coordinate geometry problems has declined. These typically are single proportion or double

proportion problems using coordinates, applied to the U.S. Public Land Survey System (USPLSS). Lower skill levels in solving this type of problem is due either to lack of knowledge in using coordinate geometry and a scientific calculator or lack of knowledge in proportioning in the USPLSS. Either is not acceptable. Someone has failed those who fail these exams: either their surveying educators (by not teaching the right materials) or by the practitioners under whom the prospective licensees have been working (by not coaching the employee), or the examinee (by not being disciplined enough to prepare for the exam), or by “whizzing by” or ignoring trigonometry and geometry while in high school.

It’s sad to say, but it appears surveying education programs need to develop an early course in surveying titled something like “Elementary Surveying Mathematics.” The course would be algebra, trigonometry and geometry applied to surveying. Proportioning, coordinate geometry, areas, curves, coordinate transformations, rotations, “setting out,” all would be covered with healthy doses of homework. The calculation device would probably be limited to a scientific calculator. And, oh yes, have the course taught by a surveying educator with surveying practice background, not a mathematician. In the “old days,” this course would not be needed, the subject matter would have been taught inside other surveying courses to those with competent algebra, trigonometry, geometry and scientific calculator skills. Unfortunately today we are in the position of having to teach those skills to our own. *A*

Editor’s Note: Dr. Elgin is that rare combination of surveying practitioner and surveying educator. He was Assistant Professor of Civil Engineering at the University of Missouri Rolla (UMR) prior to purchasing the family surveying business (in 1984) which he now owns and operates. He now is Adjunct Professor of Surveying at UMR. He is a former Missouri Registration Board member, coauthor of the Sokkia *Celestial Observation Handbook and Ephemeris*, has written many questions for the NCEES surveying exams as well as other books and software with Drs. Knowles and Senne. He owns a large collection of early American surveying equipment, rides bicycles, plays tennis, and drives a perfectly restored 1964 Morgan.