Editorial

Are We Relying Too Much on Computers?

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I believe that our profession may be nearing a crisis and that most of us don't realize it or, if we do, we don't know what to do about it. I believe the crisis will be brought about by an over-reliance on computers, coupled with an inability to sense when an answer isn't correct. In fact, I will go so far as to say that I believe this crisis will manifest itself in the collapse of structures.

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Although I may sound like it, I am not a technophobe. I admit to using a sliderule in college; but I was also a computer programmer for three departments on campus, in the late sixties and early seventies. In my first professional position, I quickly transitioned from a sliderule to an electronic calculator and then to programmable calculators. In that first professional position the office had limited access to computers. Because of cost and limited access, we typically designed our structures using hand calculations, saving the computer for more complex structures.

Ten years after college, I joined the firm that became Smith & Huston, Inc. Not long after, we bought our first portable computer and some software. We bought a state of the art, 2D frame program that was so slow, you could start it running, make a pot of coffee, and pour yourself a cup before you got results. The slowness of early software was another reason that most of the structural designs in the 1980's were still performed using hand calculations.

Today, I use a computer on a daily basis. I am quite sure that I have more computing power on my laptop than was available to me on the five million dollar CDC 6400 that the University purchased in 1970, when I was still programming on campus; and I realize that we could not remain in a competitive marketplace if we designed today's structures by hand.

So then, why am I so convinced that we are approaching a crisis? It is because the engineers of my generation are starting to retire. Don't get me wrong. I don't think that the engineers of my generation are any smarter than today's graduates. They just had a few more tools to use in the design of indeterminate structures. They also had to design their indeterminate structures by hand, which took a long time. Structural engineers back then used "back of the envelope" methods to determine what starting member sizes to use. They then began a series of calculations that could take hours, days or even weeks. The results of those calculations would confirm or refute the initial member size assumptions. If the initial sizes were not adequate, the engineer would change the sizes and start over. Because the penalty for bad initial assumptions was so high, structural engineers developed good intuition about what the answer should be, before they started the calculations. The use of those "back of the envelope" methods was also refined over time.

Today, there is no penalty for a bad starting assumption. If a member is undersized, an engineer changes it and resolves the structural model. The results are almost instantaneous. So today's structural engineers haven't had to develop the same sense of intuition that those of my generation had to have. Without this sense of intuition, however, an input error or a bug in the software can lead to "garbage in, garbage out", structural designs that don't work, and errors that go undetected.

I know that today's structural engineers don't have good intuition about what the answer should be, because I see it year after year when I grade structural examinations. I've seen engineers with four (or more) years of college and four (or more) years of practical experience who had no idea what size a 30 foot long glulams girder should be. Answers to that question ranged from "Why are you using a glulam? A 4x8 would work." to "The largest glulam in the properties table isn't big enough." Then, when determining the deflection of this beam, there were answers ranging from 72 inches (for an otherwise properly sized glulam, not the 4x8) to 6×10^{-21} inches. In the first case, the beam had gone into catenary action; in the second, the deflection was being measured on the subatomic particle level. The candidates never questioned either answer, or the many other unbelievable answers that fell in between these two extremes.

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On another structural examination question, computer output for a two-story, one bay frame was presented. Of the more than four hundred attempted solutions, less than 5% of the candidates correctly determined that there actually was, or wasn't, a problem with the output. On this problem, the solution prepared for the grading session had seven independent, alternate methods of making this determination. They ranged from classic methods, such as moment distribution or energy methods, to analysis of the drift of the frame and comparison to a calculated approximate drift, to a relative stiffness analysis of the members connecting to a joint and a comparison of the moments at that joint given in the computer output.

It is even more disturbing to have the majority of candidates who are designing a single-story shear wall building state that, "I could determine the deflection of the shear wall, and thus whether that deflection met the building code allowable deflection limit, if I were in the office and had access to my computer." There are straightforward equations readily available to determine this deflection without the aid of a computer. If we are going to rely on computers to solve simple problems, are we registering engineers or computer technicians? ▪

For more on this topic, including Ed Huston's recommendations, please see NCSEA News, page **69**.