

ENGINEERS AND COMPUTERS

By Paul H. Racette, PE



A “subject of interest” currently being discussed throughout the Structural Engineering profession, and engineering community in general, is the use of computers. More specifically, the question arises, “is there an over-reliance by engineers on the use of computers, and is this reliance fostering the inability among these engineers to sense when a computer answer is likely incorrect?”

“Older generation engineers” were trained in the use of slide rules and estimations.

This knowledge inherently prepared these students to have an excellent intuitive feel for what made sense, relative to the correctness of an answer. Making rough approximations and rounding of numbers were the norm, and the thought process that accompanied such calculations led to a general understanding of what we should expect in answer to a calculation. Combining this training with the speed of the computer provides greater efficiency. Personnel, trained in this manner, carried into the computer age a strong understanding of the principles surrounding the calculations, and thus a well-earned knack for “getting it right”. With that said, in today’s environment, engineers could not remain competitive (time management-wise) if they continued to design structures using hand calculations.

As recently as just 10 or 15 years ago, Structural Engineers used “back-of-the-envelope” methods to determine starting sizes for use in project analyses. A series of calculations were subsequently initiated which would either confirm or disprove initial assumptions. If the initial estimated “size” was not adequate, it would be altered based on previous experience and then recalculated. Since the time penalty for poor initial assumptions and the ensuing re-calculations could be considerable, engineers developed good intuition for what the answer should be, prior to making their initial assumptions and beginning their calculations.

As products of the era of total computerization, it is a concern that perhaps recent engineering graduates have missed out on the development of a finely-tuned sense of intuition which was naturally gleaned by engineers of the “long-hand calculations” era. Without this sense of intuition, a data input error, or a bug in the software, might easily lead to miscalculations which could go completely unrecognized. With no pre-calculation thought process to provide a range in which the answer is likely to fall, one might easily accept an answer that was truly the result of the old adage “garbage in - garbage out” and the result could be a design that just won’t work, even though the calculator told us it would.

Currently, the norm is for educational facilities to provide computer laboratories in engineering schools. Students are routinely required to use sophisticated computer programs to work on a project/assignment, often without the benefit of knowing how these programs were developed, or what the limitations of the software might be. The result is a system that develops students who could have absolute blind faith in computer-generated results.

I concur with my colleagues who have recommended that the industry develop and conduct seminars that address methods by which computer-generated results could be generally confirmed. These methods would naturally include the presentation of classical analysis methods as well as more up-to-date techniques. We believe it would likely be beneficial for the industry to re-visit the benefits of the old “back-of-the-envelope” approaches and make them relevant for today’s practice. Engineers need to generally understand whether (and why) a calculation is correct and dependable.

Consider the Apollo 13 astronauts and the predicament they, and the NASA engineers, faced in achieving their safe return to earth following their spacecraft’s major, life-threatening malfunctions. They were thrust into a set of circumstances toward which there were no existing software programs to turn. However, their understanding of the principles that were driving the problems they faced allowed them to

analyze the situation, craft intuitive solutions, hand-calculate the probability of success of those solutions and, ultimately, facilitate the safe return of the spacecraft. Total dependence on a computer and non-existing software at that juncture would most likely have produced dire results. Reason, intuition, and slide rules saved the day!

Certainly the world and all disciplines of engineering have progressed and advanced in wondrous and exponential ways as the result of the amazing power of computers. Let's be sure we keep human intuition and reasoning as an important part of the problem-solving formula in order to catch those instances of "garbage in – garbage out" before they take on a flawed, built form.

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