Of Course Structural Engineering Education is Sustainable

By Charles W. Dolan, P.E., S.E., Ph.D.

Lawrence Bank's article, *Is Structural Engineering Education Sustainable?* (STRUCTURE, February 2015), raises interesting issues and exposes the separation between education and practice. For one thing, structural engineering education is constantly evolving. The notion that today's design is based on books from the 1950s and 1960s ignores the reality that the better texts are philosophically well-thought-out, present fundamental structural behavior, and follow with how codes and standards interpret this behavior to protect life safety. Similarly, an emphasis on mechanics, which arguably goes back centuries, provides the novice engineer with the tools and ability to assess today's sophisticated computer programs. Any practicing engineer observing a senior design project that uses 3D building information modeling (BIM) tools will observe exceptional presentation creativity, often accompanied by a naive structural framing system. Focusing on current hot topics or tools does little for fundamental understanding.

For decades, the educational community has struggled to assess the content of the engineering curriculum. Current civil engineering programs require between 128 and 132 semester hours for a bachelor's degree. This compares to the requirement of 140 to 150 semester hours only a half century ago. Arguably, today's students do not need six hours of drafting and descriptive geometry, or awareness of how many butts make a hogshead. By the same token, the increase in sophistication in all engineering disciplines hardly argues for a reduction in credit hours. Critical tradeoffs are required to expose the student to emerging technologies and determine which topics can appropriately be dropped. The educational and practical implications of this pressure on the curriculum are reflected in the ASCE initiatives to require additional credit hours beyond a bachelor's degree to be eligible for professional registration.

Structural engineering education then asks: Where does sustainability fit in the curriculum? A quick scan of ACI, AISC, or ASEE journals will find dozens of papers on methods to improve engineering education. Authors range from dedicated professors to past luminaries such as Fazlur Khan. ACI alone has over 100 articles on all aspects of sustainability, ranging from materials to structures to construction. Thus sustainability is working its way through the literature to the student.

A vision of aligning teaching, research and practice to focus on sustainability may be naïve and possibly misguided. For example, structural design could focus on optimization of structural framing systems to reduce material. Optimization algorithms were developed in the late 1960s and fell by the wayside because overall construction costs favored high repeatability, rather than close tracking of individual components. An alternative approach is suggested in the draft *National Performance Based Design Guide* (**http://npbdg.wbdg.org/**). One recommendation would require all building live loads to be at least 100 psf. This would allow for easy reconfiguration of the structure for new uses, thus capturing all of the embodied energy. Such an approach is diametrically opposite of an optimization strategy. The profession has yet to determine the preferred sustainability solution. In either event, the decision will not be made in the classroom.

Life-cycle cost analysis and triple bottom line are often useful measures of sustainable design. The General Services Administration and large corporations have a vested interest in sustainable construction because they own the facility for the long haul; hence these measures are useful to them. A speculative developer, on the other hand, looks primarily at the short-term payback and tax depreciation, and thus may have little interest in sustainability. Structural engineers serve both kinds of clients.

On a larger scale, few if any engineering programs offer courses in structural rehabilitation or use of composite materials. The former would capitalize on the extended lifespan and embodied energy of existing structures; the latter directly addresses the multitude of unreinforced masonry structures in seismically active regions. The open question is whether addition of these courses is the best use of the limited curriculum openings.

The issue of providing adequate housing for the three billion people living on less than five US dollars a day is more compelling. The effort requires clean water, transportation, and communications in addition to housing. If there is any doubt that this problem is not being addressed, you need only attend a student meeting of Engineers without Borders. Solutions abound. Research at some universities examines rapid deployment shelters for disaster areas using the Haitian earthquake as a template for what may be needed. Most importantly, students and faculty are engaged and together generating solutions to these problems.

The last and perhaps most important item in keeping structural engineering education sustainable is the interaction between education, research, the practitioner, and the codes. The interplay of these four activities keeps the profession relevant. There is no leader in this effort, but it is rather a symbiotic relationship between the players. Students require several years of professional practice prior to licensure. Part of this on-the-job training addresses the above-mentioned gaps in their educational preparation. Structural failures, while few, lead to building code changes and new research initiatives. Similarly, university research into structural systems, behavior, performance, and modeling lead to innovations in design and updating codes. Initiatives at the National Science Foundation to expand hybrid and multi-scale modeling will advance the ability of the structural engineer to incorporate sustainability into a design.

Sustainability will ultimately fall out where it best fits the societal interest. Thus, sustainability is evolving into the curriculum in materials, modeling, design and construction courses. In a profession where life safety and protection of the public are paramount, this interaction is constantly evolving, students and faculty are engaged and motivated, and the future is indeed very bright.▪

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