# Is Structural Engineering Education Sustainable?

*By Lawrence C. Bank, Ph.D., P.E.*

Within the broad field of civil engineering, structural engineers have perhaps been among the slowest to embrace and adopt the concepts of sustainability in the built environment. Many sit by with mounting frustration as architects, other types of engineers, and urban planners have defined "green" agendas for their disciplines, and successfully embraced and marketed them.

The reasons for this, which are perhaps understandable, can be traced to the way in which structural engineers are educated, as well as to the fact that it has been difficult to identify an appropriate vision for incorporating sustainability principles into our practice. In order to define the appropriate vision for the future of our profession, we need to understand how sustainability emerged from the environmental movement, where it currently is in terms of global development, and how structural engineers can restructure and develop opportunities in this new sustainable world.

According to the Department of Labor, there are approximately 258,000 civil engineers in the United States today. The total memberships of NCSEA, CASE, and SEI suggest that about 40,000 are structural engineers, and most of those have a license to practice civil engineering as a Professional Engineer (PE). A few states require an additional license to practice as a Structural Engineer (SE). SEI's report on *A Vision for the Future of Structural Engineering and Structural Engineers: A Case for Change* suggests that there is considerable angst in the SE community regarding the future.

The structural engineering curriculum typically consists of courses in engineering mechanics and linear structural analysis. These are often taught using textbooks first published in the 1960s (or earlier) and are based on the theory of structures from the late 18th century to the early 20th century. There is usually only one course in materials. Design of steel and concrete structures is taught from textbooks from the 1950s and is based on the AISC and ACI codes, respectively. The emphasis is on framed multi-story buildings and short-span bridges. Other commonly used materials may or may not be covered. There is some exposure to computer codes, but very little use of the design features of these codes.

The master's degree typically covers more of the same, except in somewhat greater detail (e.g., nonlinearity, seismic design, more classical mechanics) and perhaps an independent study or thesis. The doctorate is research-based and typically deals with advanced topics of the same type (steel and concrete frames) in great depth and of little immediate value to the practicing engineer.

In 1987, sustainable development was defined by committee in the United Nations (UN) Brundtland Report, *Our Common Future*, as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Less known is the latter part of the definition that "contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

Since then, sustainable development and sustainability science have proceeded along two distinct paths – one focused on the first key concept, sometimes referred to as the "brown agenda," including population, pollution, public health, poverty, and property rights; and the other focused on the second key concept, sometimes referred to as the "green agenda," including the Triple-Bottom-Line, P3, and LEED. Today these two streams are expressed in the UN's Millennium Development Goals (MDG) and Intergovernmental Panel on Climate Change (IPCC) reports.

In the US, sustainability in structural engineering has focused primarily on the second key concept and has worked toward the green agenda. On the materials side, this has typically been manifested in life-cycle assessment (LCA) and embodied energy; decreasing greenhouse gas emissions, primarily from cement production; and using recycled materials, primarily steel. On the structural side, the main effort has been the optimization of framing systems to use less material.

Neither of these approaches is likely to contribute significantly to sustainable development. The embodied energy in materials is a small fraction of the energy consumed over a building's lifetime, which in turn is only a small fraction of the commercial value of the property, not to mention the income and health costs of the building occupants. The cost of the structural system in a building is perhaps 15% of the initial construction cost, so optimization is unlikely to yield great sustainability benefits. In addition, there has been significant consolidation in consulting firms over the last two decades, leading to less need for specialized designers for what are now "routine" multi-story building frames.

One vision for a sustainable future for structural engineering is to align our teaching, research, and practice with the first key concept of sustainable development; i.e., reorient our curricula to focus on the knowledge and skills needed to address the needs for safe and resilient infrastructure and housing for the three billion people earning less than five US dollars per day, many living in informal and even illegal settlements. It is disgraceful that we as structural engineers do not yet know how to provide meaningful input to solve these human catastrophes that are a direct function of the built environment.

Such a focus will, of course, require a significant reprioritization and rethinking of every part of the curriculum. It will require courses in social sciences, environmental sciences, geography, world cultures, and economics. However, it will bring back to the profession – and especially to students – a sense of mission and purpose, akin to those now studying environmental engineering and sustainability sciences of various types. It will make us relevant again.▪

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