

# The Future of the Structural Engineering Profession

*“We must welcome the future, remembering that it will soon be the past; and we must respect the past, remembering that it was once all that was humanly possible.”*

*... George Santayana*

# Why Should We Care ?

*“He who does not look ahead, remains behind”*

*... Spanish Proverb*

There are only two futures for the  
Structural Engineering Profession:

- The one the profession creates for itself.
- The one others create in the void.

# SEI Vision for the Future

In 2033, the Structural Engineering Profession will be:

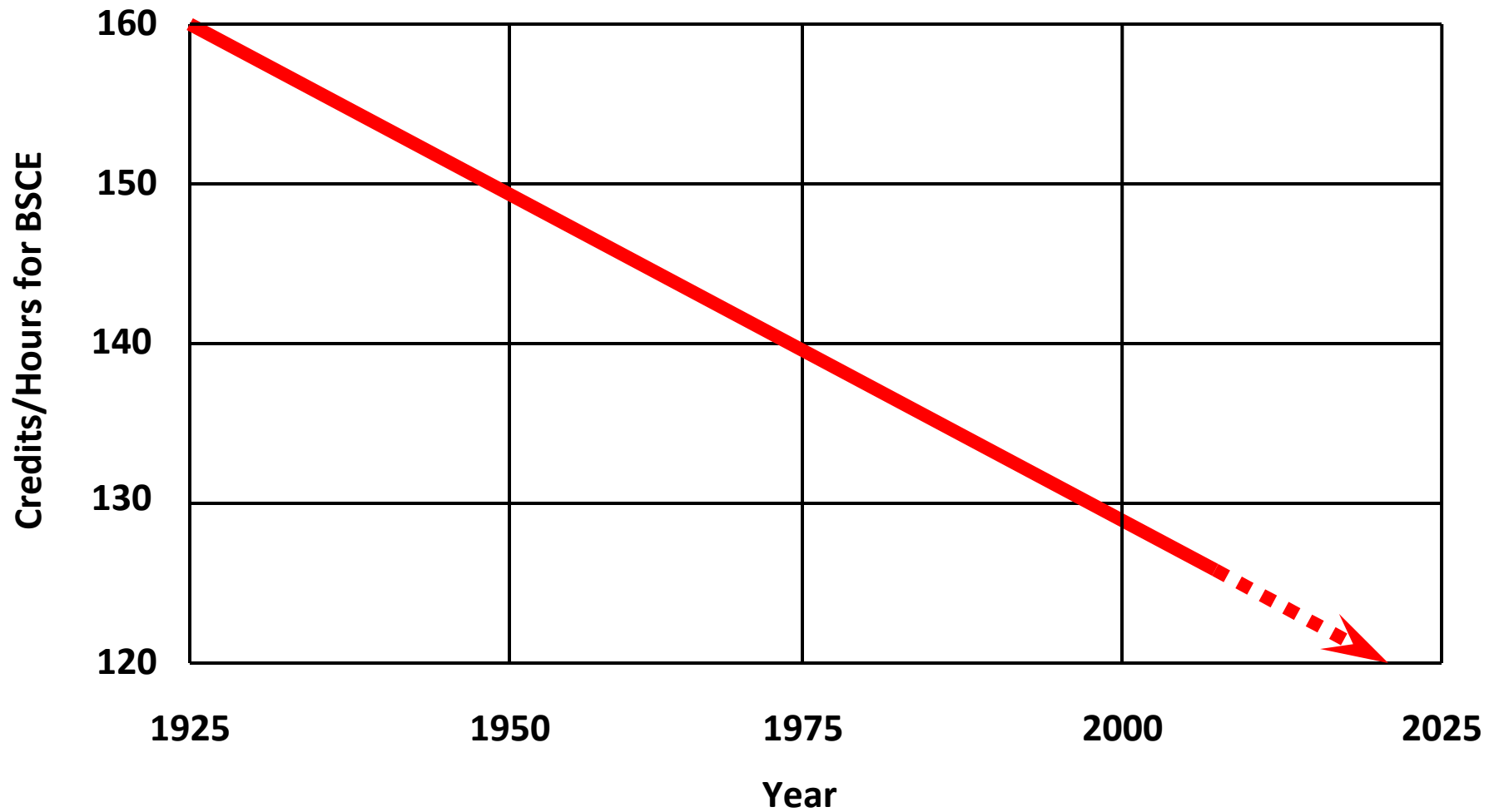
- A unique, fully engaged profession with a strong identity
- Recognized for the contribution the profession makes to:
  - public safety and risk management
  - economic and sustainable use of resources
  - the use of innovative technologies
  - the creation of inspiring structures
- Stewards of the built environment
- Attractive to the best and brightest

Adopted by the SEI Board of Governors: August 2008

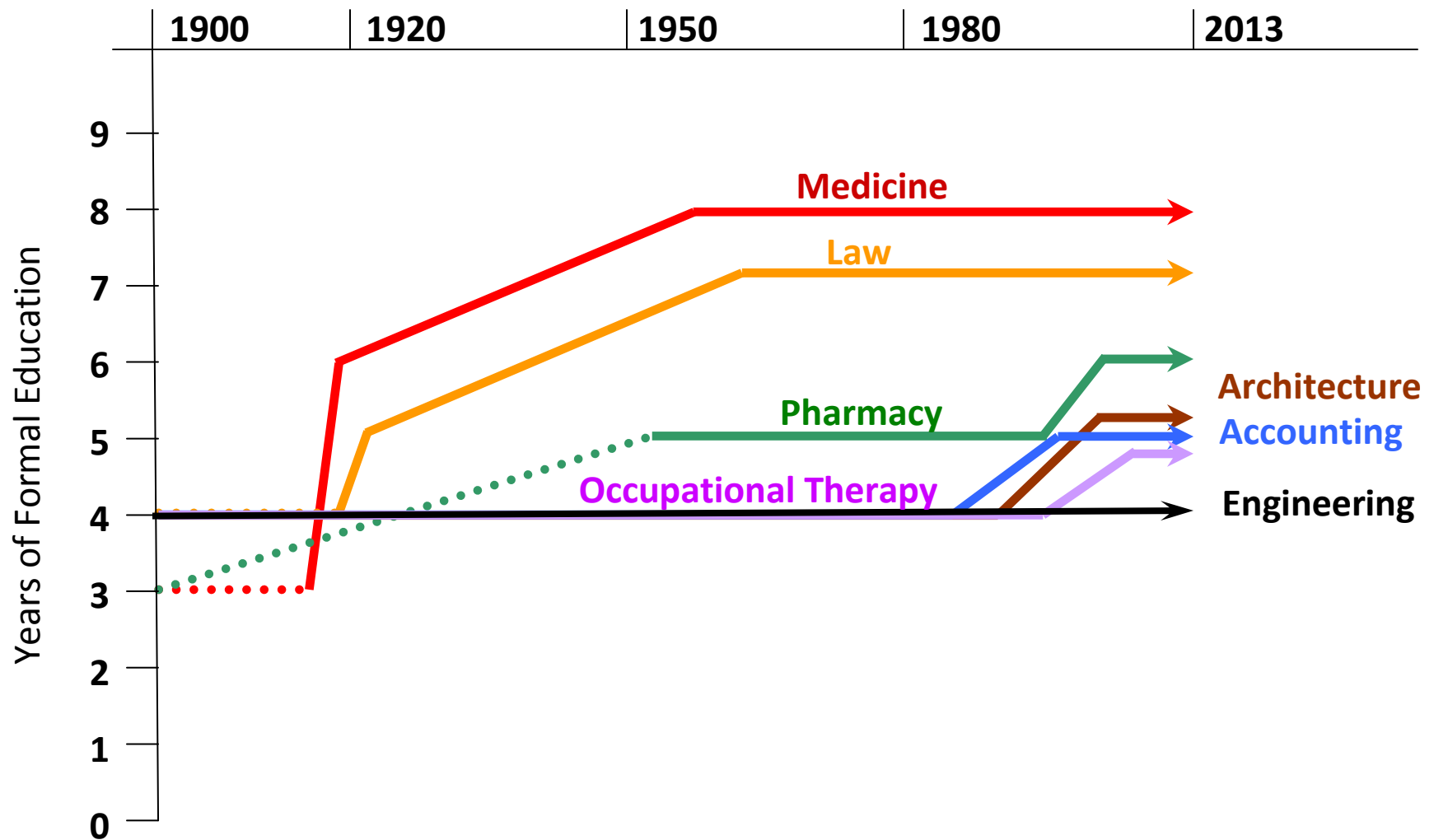
# Structural Engineering Today

- Undergraduate and graduate SE education are inadequate.
- SE internships and mentoring programs are rare.
- On-the-job training of SEs is focused on production skills.
- SE licensure and CPD are inconsistent and ineffective.
- Design codes allow little room for judgment and creativity.
- Construction materials have not changed much in 100 years.
- SEs are almost uniquely averse to taking risk.
- SEs typically are followers, rather than leaders.
- SEs are not strongly engaged in the world around them.
- SEs are not fully valued and not adequately recognized.

# Undergraduate Education



# Graduate Education



# Education: Summary

- BSCE provides neither depth nor breadth.
- BSCE is an inadequate basis to enter the SE profession.
- MSCE provides depth, but not breadth.
- MSCE is an inadequate basis to lead the SE profession.
- Most SEs are not trained in and do not develop strong:
  - Communications skills
  - Business and marketing skills
  - Teamwork and leadership skills
  - Foreign language and culture skills
  - Social and political science skills

# Internships, Mentoring & Training

- Most SE firms do not have internship programs.
- Those that do have programs that are focused on recruiting.
- Very few SE firms have formal mentoring programs.
- Young SEs want better mentoring, but their leaders are not interested.
- Most SE firms support training on technical, production skills.
- Few SE firms support training on nontechnical, “soft” skills.
- Generally, there is little interest in improving internships and training.



# Licensure & CPD

- Most states, like Texas, offer only generic PE licenses.
- Engineers can practice in any field they feel competent in.
- 10 states offer SE licenses, mostly as post-PE credentials.
- Even there, reciprocity is very difficult for SEs.
- NCEES 16-hour SE exam and MLSE are big steps forward.
- SELC now promotes SE licensure in all jurisdictions.
- Certification by SECB is an interim step toward SE licensure.
- CPD is required in 35-40 states, but effective in none.
- State PE boards focus on attendance, not on content value.
- Currently, SECB operates the only meaningful CPD program.

# Codes & Materials

- Building and bridge codes have become excessively prescriptive.
- The codes attempt to govern up to 95% of all structures.
- There is little opportunity for engineering judgment and creativity.
- It is no surprise that SEs are often viewed as math technicians.
- Concrete, steel, and timber have changed little in the past 100 years.
- SEs have been slow to embrace carbon fiber, nanotechnology, etc.
- SE evolution is poor when compared with ME, EE, ChE, and even CE.

# Risk Aversion

- ❑ SEs are taught in college that failure is not an option.
- ❑ This message is reinforced by employers, insurers, and lawyers.
- ❑ Conservatism is implicit in all of the codes and standards.
- ❑ However: “No risk, no reward!”
- ❑ Where is the opportunity for SEs to think and innovate?

*“Hell, there are no rules here, we're trying to accomplish something.”  
... Thomas Edison*

# Not Valued, Engaged, Leaders

- Leadership is the most important issue of all.
- A century ago, SEs worked as “master builders.”
- Over time, architects & CEs emerged as the managers of design.
- Contractors emerged as the managers of everything else.
- Today, architects and CEs expect to sit at the “head table.”
- SEs generally expect to be dutiful followers, rather than leaders.
- Most SEs prefer math and science to humanities and literature.
- Many SEs are more comfortable with technology than with people.
- Few SEs have the skills, abilities, and desire to lead others.

# Current Trends

*I don't set trends. I just find out  
what they are and exploit them.  
... Dick Clark*

- TECHNOLOGY
- GLOBALIZATION
- CONTRACTOR-LED PROCUREMENT

# Technology

SEs have generally benefitted from technology. It has freed us from the drudgery of manual calculations and has allowed us to study multiple alternatives and make quick changes with little extra effort. However, rapidly advancing technology will fundamentally change the practice of structural engineering in the future:

- ❑ SE students are no longer taught the classical methods of evaluating structural behavior by hand. Lacking this, they do not have the intuition that helped their predecessors.
- ❑ Automation is detrimental to traditional cost-plus billing models and often leads to unreasonable client expectations.
- ❑ Much of what used to be mainstream SE work is increasingly being done by paraprofessionals and technicians.
- ❑ Next-generation computer modeling will result in projects without construction drawings, where everything is bid and built directly from the model.

# Technology

The impact of computers on the practice of structural engineering:

- 1970s - Computerized analysis
- 1980s - Computerized design
- 1990s - Computerized drafting and detailing
- 2000s - Building information modeling (BIM)
- Next? - Automated production of paperless design

# Technology

- ❑ Many mid-career SEs are perfectly content sizing beams and columns. They believe that optimizing such design details is the ultimate calling of a SE.
- ❑ By 2033, these SEs might be just as obsolete as phone operators, bank tellers, and travel agents.
- ❑ They might become the next victims of the relentless and ruthless advance of technology ... more victims of the Easy Button!





# Globalization

The globalization of engineering and the increasing number of engineers being educated in developing nations is affecting the practice of engineering with respect to:

- ❑ How U.S. engineers differentiate themselves from those in other countries through the knowledge and skills they can offer.
- ❑ The implications of “off-shoring” and the need for global standards of practice, including the responsibilities of the “engineer-of-record.”
- ❑ The need to have knowledge of international engineering and business approaches, local capabilities, and cultural/linguistic contexts.
- ❑ The ability of the U.S. to effectively develop and influence international codes and standards related to engineering, thereby impacting U.S. competitiveness worldwide.

# Globalization

Automation and telecommunications have allowed the world to shrink dramatically. For better or for worse, this will profoundly impact the structural engineering profession in the future:

- ❑ In the next 100 years, most large projects will be in parts of the world that are undeveloped or underdeveloped, not here.
- ❑ Like British SEs 100 years ago, American SEs must quickly learn how to compete worldwide.
- ❑ There are currently more SEs being trained abroad than here. Many foreign SEs are highly-competent, know English as well as we do, and are satisfied with low compensation.
- ❑ Not long ago, globalization did not seem like much of a threat to SEs in Texas. We took comfort in local services like design coordination meetings and site visits, as well as the strict TBPE rules on “direct supervision.”

# Globalization

The TBPE Rules were inexplicably revised in 2006. Since then, TBPE has defined direct supervision as:

*“The control over and detailed professional knowledge of the work prepared under the engineer's supervision. The degree of control should be such that the engineer personally makes engineering decisions or personally reviews and approves proposed decisions prior to their implementation. The engineer must have control over the decisions either through physical presence or the use of communications devices.”*

The last six words of this definition provide a loophole that has effectively neutered the requirements for direct supervision on projects in Texas. As long as an engineer can claim that their remote supervision is adequate, they are free to affix their PE seal to work prepared by engineers in other states, by individuals who are not engineers, and by people working overseas at much lower cost.

# Contractor-Led Procurement

**Evolving methods of project delivery are changing the way structural engineers work and who they work for, thereby challenging traditional business strategies and relationships:**

- Design/Build, Comprehensive Development Agreement, and Construction Manager at Risk: They all mean that the SE works for the contractor.**
- Contractors can be excellent clients. They are business-oriented and focused on cost, schedule, and constructability.**
- In Texas, contractor-led procurement is quickly dominating public sector transportation and building projects. Government agencies are obviously enamored with one-stop-shopping.**

# Contractor-Led Procurement

This rapidly-growing method of project delivery poses many challenges to the structural engineering profession:

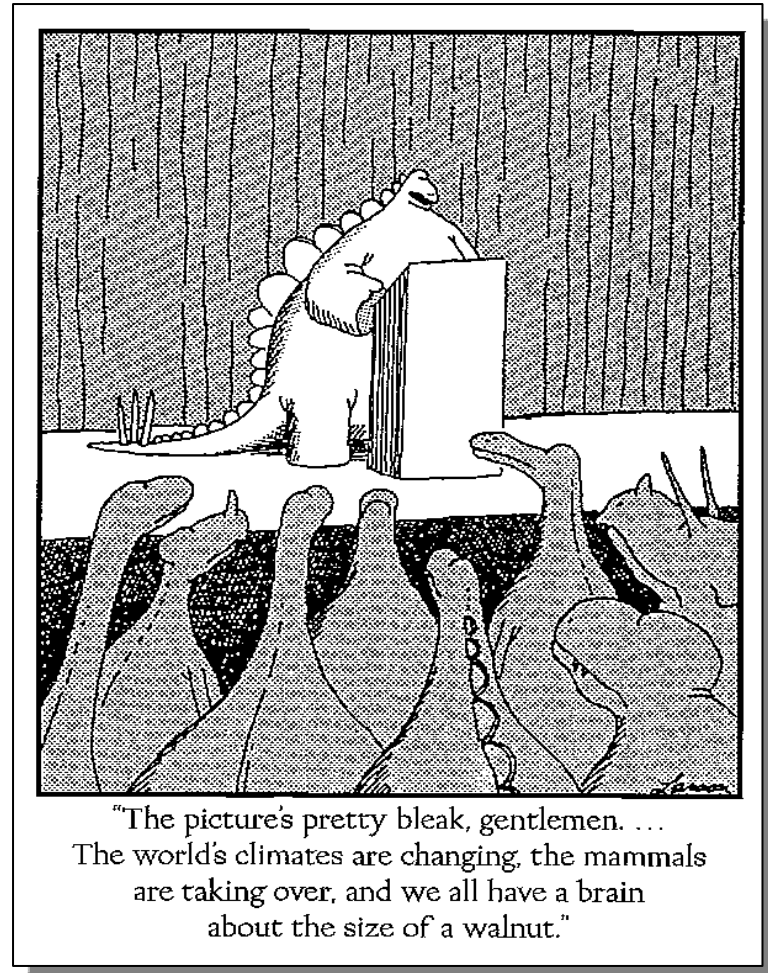
- ❑ Many contractors are likely to buy or build in-house structural engineering practices.
- ❑ QBS (Qualification-Based Selection) for procurement of structural engineering services will be ignored.
- ❑ SEs risk doing excessive pro-bono (free or nearly free) work “up-front” for a losing team.
- ❑ SEs will struggle to ensure project quality when their client is constructing the project.

# Failure To Act

**If the structural engineering profession does not adapt to the evolving business environment, certain outcomes are likely:**

- The profession will shrink. There will be less SEs working in the U.S. in the future.**
- The profession will bifurcate, with professional SEs and paraprofessional PEs.**
- Many SEs will choose to work for employers that are not traditional structural engineering design firms.**
- SE stature and compensation will generally decline.**

# Let's Not Follow The Dinosaurs!



# Keys To Success

INNOVATION

LEADERSHIP

*“If you do not know where you are going,  
every road will lead you nowhere.”*

*... Henry Kissinger*



# Recommendation #1

**Adopt the Law School Model for formal education:**

- BS or BA in any discipline, with prerequisites only in math and science. Preference is for study-abroad, business, communications, and the social sciences.**
- In senior year, those choosing structural engineering take an entrance exam to their SE School of choice.**
- SE School is an intensive 3-year structural engineering program from statics through the latest technology.**
- Graduates earn a Professional Degree in SE.**

## Recommendation #2

**Adopt the Teaching Hospital Model for internships and mentoring:**

- Covers the period between receiving a SE degree and passing the SE exam, typically 3 years.**
- Standardized program to train, mentor, and monitor the progress of graduate engineers in the workplace.**
- Internship employers may or may not become the permanent employers of the interns.**
- An intern might have more than one internship employer prior to taking the SE exam.**

## Recommendation #3

**Create foreign exchange programs for America's best and brightest young SEs:**

- Match reasonably similar SE firms here and abroad.**
- Send young engineers both ways for perhaps a year, preferably during their internship programs.**
- Allow the engineers to become immersed in the culture of the foreign firms and countries.**
- Create a clearinghouse to facilitate the exchanges.**

## Recommendation #4

**Actively support and promote SE licensure as a post-PE credential in every American jurisdiction through SELC:**

- Adopt the NCEES Model Law Structural Engineer, which is now an ANSI standard.**
- Establish the NCEES 16-hour SE Exam as the only entrance exam for structural engineering practice.**
- Create a fair transitioning program for current PEs so that they are not disenfranchised.**
- As an interim measure, support and promote SECB certification.**

## Recommendation #5

**Actively support and promote meaningful SE continuing professional development (CPD) programs in every American jurisdiction:**

- All credited professional development hours (PDHs) must be relevant to structural engineering.**
- PDH providers must be subject matter experts.**
- Enforcement should emphasize content and value received, not just proof of attendance.**
- As an interim measure, support and promote the CPD program administered by SECB.**

# Recommendation #6

**Demand substantial reform in SE codes and standards:**

- Prescriptive codes and standards should not govern more than 75% of all structures.**
- Remaining structures should be designed by performance-based methods and, when appropriate, by engineering judgment.**
- Codes and standards should all be revised on a common and coordinated 5 or 6 year cycle.**
- Support a movement to make American codes, standards, and engineering practice become the acknowledged models worldwide.**

# Recommendation #7

**Become leaders in the development of new construction materials and techniques:**

- Consider life-cycle cost models and sustainability benefits, not just initial construction cost.**
- Consider constructability issues. Labor costs are at least as important as materials costs.**
- Work to make next-generation materials and techniques economically viable.**
- Work to make pre-fabrication and robotics more widespread.**

## Recommendation #8

Encourage and pursue professional development opportunities beyond the workplace. Develop and support awards programs that recognize and publicize the accomplishments of SEs in these and similar areas:

- Philanthropic work.
- Community leadership.
- Political advocacy.
- Professional societies.
- Media interaction.



# Recommendation #9

Expand the definition of the structural engineering profession to include:

- Expertise in materials science, testing, and sustainability.
- Expertise in risk management, constructability, and life-cycle costing.
- Design of structures that are beyond the realm of traditional construction.
- Provision of services that are beyond traditional structural analysis and design.

# Recommendation #10

**Accept and embrace the concept of SEs as project, company, and societal leaders:**

- SEs are legally entitled to serve as the prime professionals on all projects in Texas and in most other jurisdictions, right now.**
- SEs are, or will be, perfectly qualified to run SE firms as well as other types of businesses.**
- SEs are trained to think clearly and solve problems. This distinguishes them from most government and societal leaders.**
- SEs must “swim upstream” and create value to replace their existing work which is going away.**

# It's Your Future!

*"Destiny is not a matter of chance,  
it is a matter of choice."  
... William Jennings Bryan*

## Questions?