

# 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.

# Vision of Tomorrow

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

*... Henry Kissinger*

# 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

# Reality of Today

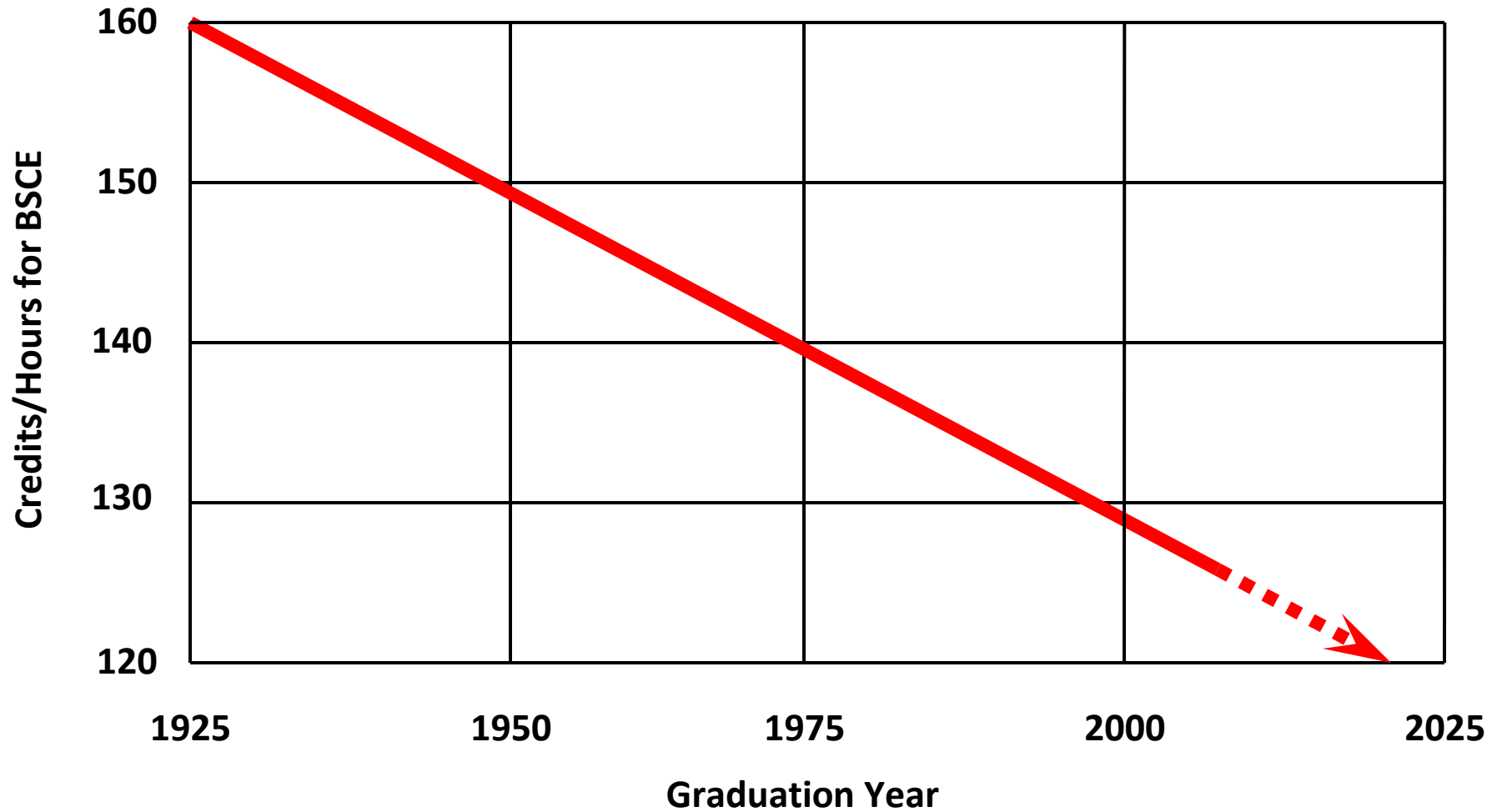
Does that SEI Vision describe our reality today?

*“Reality is merely an illusion,  
albeit a very persistent one.”  
... Albert Einstein*

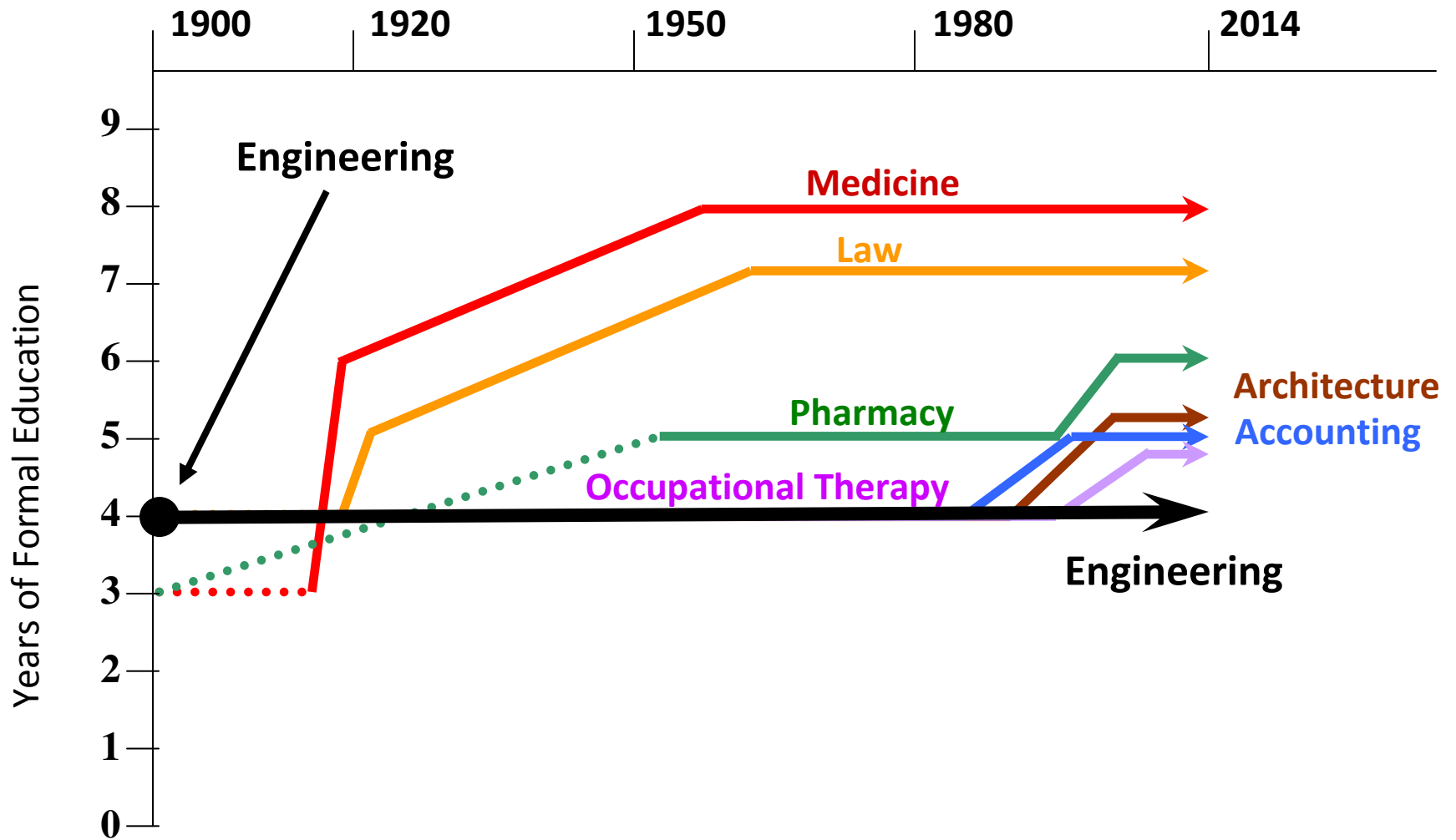
# Structural Engineering Today

- University education is inadequate.
- Formal training and mentoring programs are rare.
- Workplace training is focused on production skills.
- SE licensure and CPD are inconsistent and ineffective.
- Design codes preclude judgment and creativity.
- Construction materials have not changed much.
- 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.
- Not an adequate basis to enter the SE profession.
- MSCE provides depth, but not breadth.
- Not a springboard for leadership development.
- 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

# Intern Training & Mentoring

**Note: Intern = EIT**

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

# Licensure & CPD

- Most states, like Texas, offer only generic PE licenses.
- Engineers can practice in any field they feel competent in.
- Ten states offer SE licenses, mostly as post-PE credentials.
- Even in those states, reciprocity is very difficult for SEs.
- The 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 it is effective in none.
- State PE boards focus on attendance, not on content value.
- Currently, SECB has 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 our codes and standards.
- ❑ However: “No risk means no reward!”
- ❑ Where are the opportunities 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, but rapidly advancing technology will fundamentally change the practice of structural engineering in the future:**

- Automation is detrimental to traditional cost-plus billing models and often leads to unreasonable client expectations.**
- SE students are no longer taught the classical methods and do not develop the intuition that helped their predecessors.**
- 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.**



# 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 projects**

# Technology

- ❑ Many mid-career SEs are perfectly content sizing beams and columns, thinking that optimizing their designs is the ultimate calling of an SE.
- ❑ By 2033, these SEs will likely be just as obsolete as phone operators, bank tellers, and travel agents.
- ❑ They will become the next victims of the relentless advance of technology ... the next victims of the Easy Button!



# Globalization

Automation and telecommunications have allowed the world to shrink dramatically. This will profoundly impact the structural engineering profession:

- ❑ 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.
- ❑ More SEs are being trained abroad than here. Many foreign SEs are highly-competent, know English as well as we do, and accept lower compensation.
- ❑ SEs in Texas can no longer take comfort in local services like design coordination meetings and site visits, as well as the TBPE rules on “direct supervision”.

# Globalization

For many years, through 2005, the TBPE Rules defined direct supervision as:

*“Critical watching, evaluating, and directing of engineering activities with the authority to review, enforce, and control compliance with all engineering design criteria, specifications, and procedures as the work progresses. Direct supervision will consist of an acceptable combination of: exertion of significant control over the engineering work, regular personal presence, reasonable geographic proximity to the location of the performance of the work, and an acceptable employment relationship with the supervised persons. Engineers providing direct supervision of engineering work under the Act shall be personally present during such work.”*

Active enforcement of the last six words of this definition effectively prevented both plan-stamping and outsourcing of engineering work on projects based in Texas.

# Globalization

The TBPE Rules were 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 thwarted the enforcement of 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 others.

# Globalization

In response to globalization, American SEs must:

- Differentiate themselves from those in other countries through the knowledge and skills they can offer.
- Master international engineering and business approaches, local capabilities, languages, and cultures.
- Develop international codes and standards for engineering, thereby improving U.S. competitiveness.
- Develop global standards of practice, including the responsibilities of the “engineer-of-record”.

# Contractor-Led Procurement

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

- ❑ Design/Build, Comprehensive Development Agreement, and Construction Manager at Risk: they all mean that the SE works for the Contactor.**
- ❑ 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.**

# Contractor-Led Procurement

Alternative methods of project delivery pose many challenges to the structural engineering profession:

- SEs will struggle to ensure project quality when their clients are constructing the project.
- QBS for procurement of structural engineering services will mostly be ignored.
- SEs risk doing excessive pro-bono work “up-front” for a losing team.
- Many Contractors are likely to buy or build in-house structural engineering practices.

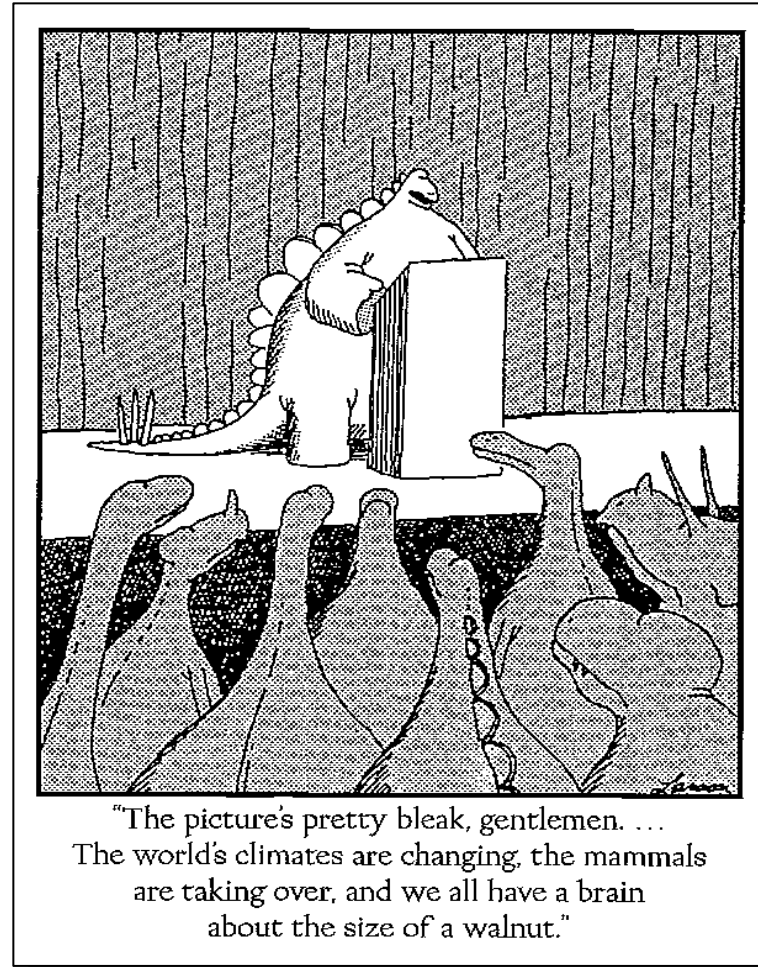


# Failure To Act

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

- The profession will shrink. There will be far fewer 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 other than traditional structural engineering design firms.**
- SE stature and compensation will generally decline.**

# Where Do We Go From Here?



# Keys To Success

INNOVATION

LEADERSHIP

***“Before anything else,  
preparation is the key to success.”  
... Alexander Graham Bell***

# Recommendation #1

**Adopt the Law School Model for university 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 intern training and mentoring:**

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

## Recommendation #3

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

- Match reasonably similar SE firms here and abroad.**
- Send young engineers both ways for perhaps a year, preferably while they are interns.**
- Allow these engineers to become immersed in the cultures 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, or equivalent, in every jurisdiction.**
- 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 engineering judgment.**
- Codes and standards should all be revised on a uniform and coordinated 5 or 6 year cycle.**
- Support efforts 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. Celebrate the accomplishments of SEs in areas such as:

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

# Recommendation #9

Expand the definition of structural engineering to include:

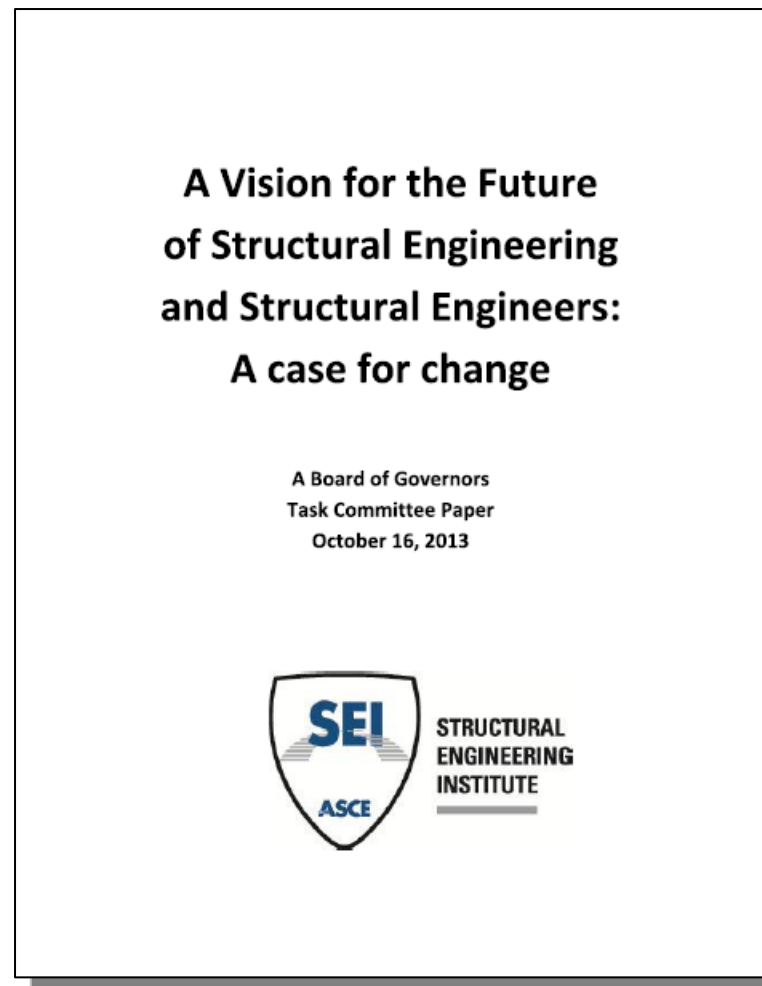
- Expertise in materials science, testing, and sustainability.
- Expertise in risk management, constructability, and life-cycle costing.
- Design of structures that are beyond the realm of traditional construction (i.e., bio-medical).
- Services that are beyond traditional structural analysis and design (i.e., project financing).

# Recommendation #10

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

- SEs can serve as the prime professionals on all projects in Texas and in most other states.
- SEs are well-qualified to run multi-discipline design firms as well as other types of businesses.
- Unlike most government and societal leaders, SEs are trained to think clearly and solve problems.
- SEs must “swim upstream” and create value to replace their existing work which is going away.

# SEI Vision Report



# SEI Initiatives

- Establishing a board-level committee on the reform of SE education.
- Evaluating best ways to advocate for effective mentoring.
- Establishing the International Activities Division of SEI.
- Actively supporting and funding the SELC ([www.selicensure.org](http://www.selicensure.org)).
- Establishing a multi-organization committee on continuing education.
- Establishing a board-level committee on performance-based design.
- Planning to lead a series of multi-discipline summits.
- Evaluating best ways to promote SEs as leaders and innovators.

# SEI Futures Fund

The graphic features a dark blue background with a large green banner at the top containing the word "INVEST" in white capital letters. Below the banner, the text "in the FUTURE of STRUCTURAL ENGINEERING" is written in white. On the left, a green circle contains the text "GIVE to the SEI FUTURES FUND". In the center, there are two small images: one of a group of five people and another of a construction worker on a site, with the text "COURTESY OF STANTEC" below it. On the right, the SEI logo (a shield with "SEI" and "ASCE" below it) is displayed, followed by the text "STRUCTURAL ENGINEERING INSTITUTE Futures Fund" and the tagline "Investing in the Future of Our Profession".

[www.asce.org/SEIFuturesFund](http://www.asce.org/SEIFuturesFund)



# Questions?

*“There are no such things as stupid questions, only stupid answers.”*

*... Colin Powell*