The Learning Bridge
for Advancing Civil Engineering and its Education

A Coordinated, Multi-Institutional, Multi-Disciplinary, Academe-Industry-Government Collaborative Research Project

Growing to an International Center of Best Practices for Civil Engineering Education

Kick-off Meeting
13 Nov. 2009
Palmyra Cove
The Learning Bridge

Team Members

**Supported By:**

- National Science Foundation
- Burlington County Bridge Commission
- Others....

**Liaisons:**

- National Academy of Engineering
- American Society of Civil Engineers
- European Union Civil Eng Education Consortium

**Grantee Institutions:**

- Drexel
- Northeastern
- Purdue
- Texas A&M

**Participants:**

- Advitam
- Burlington County college
- Georgia Tech
- Pennoni
- Rowan
- Rutgers
Background

History of Civil Engineering

1775: King Louis XV authorized a School of Bridges and Highways
1794: Napoleon developed Ecole Polytechnique
1835: First class of U.S. civil engineers graduate (RPI)
1850: US census – 2000 civil engineers
1852: American Society of Civil Engineers
1870: 5% of US engineers w/college degree
1950: NSF, Compton, Applied Science
2004: 220 accredited US CE programs, ASCE Membership exceeds 140,000
Masterpieces by Master-Builders

Pont du Gard (50 AD)
The Pantheon (126 AD)
Del Duomo (1420-1434)
The Eiffel Tower (1889)
The Brooklyn Bridge (1883)
The Hoover Dam (1931-1936)
Challenges – Profession

Across Sub-Disciplines

Civil Engineering

Building Infrastructure

Architectural

Structural

Geo Engineering

Water Infrastructure

Transportation Infrastructure

Transportation and Development

Construction

Environmental and Water Resources

Coasts, Oceans, Ports and Rivers

(ASCE Institutes, 2006)

Leads to different languages, cultures and unforeseen interactions...

Flooding Cripples Subway System
BY SEWELL CHAN
Updated, 4:10 p.m.

The New York Times
Challenges – Profession

Fragmentation and Proliferation

• Civil engineering and affiliated disciplines
• Stages along life-cycle

• Degree Programs
• Consultants
• General contractors
• Specialty contractors
• Suppliers
More Recent Accomplishments

- Saving the Pisa Tower
- Everglades Restoration (1996 -)
Background

Then and now...

The Ancient Library of Alexandria

Before the World Wide Web, there was the Library of Alexandria, which collected all that had been written. <www.Di3.Drexel.edu>

Lake Mead could be dry in just 13 years
A New Civil Engineering...

Grand Visions for a Faded Bronx Blvd

Nadau Lavergne Architects re-imagines the Grand Concourse as a linear urban forest in one proposal in this show at the Bronx Museum of the Arts.

By NICOLAI OUROUSOFF Published: November 1, 2009, NY Times
Civil Engineering Curriculum

Fundamental Questions

• **21\textsuperscript{st} Century Student**: How can we motivate and reinforce/leverage the positive attributes of the new generations and mitigate the generational divide in the education and practice of civil engineering?

• **21\textsuperscript{st} Century Technology**: How can we properly leverage new technologies for improving the performance of civil eng services and products?

• **21\textsuperscript{st} Century Societal Problems**: How can we better recognize, conceptualize and formulate effective solutions for the societal challenges which demand civil engineers’ leadership and coordination?
Civil Engineering Curriculum

Core Concepts

**BASIC SCIENCES**
- Math, Physics, Chem-Bio
- Statistics, Probability Risk, Uncertainty
- Mechanics of Solids and Fluids
- Discrete Math IT for Engineers
- Material Science Energy Science

**ENGINEERING ARTS**
- Multidisciplinary Team Skills and Problem Solving
- Structural Systems
- Physical/Numerical Experiments
- Natural Systems Soil, Water, Air
- Construction Materials/Processes
- Management For Lifecycle
- Multidisciplinary Engineering Design For Sustainability
- Applied Systems Analysis

**SOCIAL SCIENCES**
- Humanities
- Ethics
- Communication
- Psychology
- Economics
- Decision

**MANAGEMENT ARTS**
- Attitudes/Leadership
- Public Policy and Law
- Organization Theory
- Management
- Globalization
"Many students graduate having accumulated whatever number of courses is required, but still lacking a coherent body of knowledge or any inkling as to how one sort of information might relate to others."

-1998 Boyer Commission Report
Approach

Key Question...

Structural Mechanics

Statics

Mechanics of Materials

Design

VS.

Design

Mechanics of Materials

Structural Mechanics

Statics
Vision

Infrastructures as Educational Centerpiece

Society and Nature:
- History and Regional Development
- Technical Management Financing
- Political Issues
- Role in Transportation Network and Commerce
- Impact on the Delaware Valley Ecosystem
- Carbon Footprint
- Preservation of Operating Landmarks

Engineered System:
- Structural, Geotechnical Transportation Engineering
- Structural Identification
- Advanced Model-based Simulation
- Physical Models
- 3D Visualization
- Information Technology
- Sensing Technology
Description

The **Learning Bridge**...

Will include interactive, multi-media documentaries composed of:

- interactive web-based portals (live images, data feeds)
- analytical/computational models
- site visits, public meetings, press coverage
- interviews, multi-disciplinary lectures

May be expanded to include new or old:

- buildings, bridges,
- highways, ports,
- water systems, dams, rivers,
- communities, cities

Will Require multi-disciplinary teams to ‘write’ and ‘direct’ the screenplay
The Learning Bridge will...

- Motivate, attract and challenge high quality students
- Provide an integrated, inquiry-based curriculum
- Illustrate multi-scale (both time and length) phenomenon in an integrated manner
- Illustrate the multiple perspectives relevant to infrastructures, including:
  - users, industry, government;
  - historical, economic, symbolic;
  - safety, operational, functional, etc.
Example

Multi-scale (length)

All stresses in ksi

\[ \sigma_1, \sigma_2, 2\theta_p, \tau_{\text{max}} \]
Example

Multi-scale (time)

Idealized performance over various time scales

Measured performance over various time scales
Example

Multiple Perspectives

“provide Burlington County's residents, commuters, and visitors with safe, accessible, and affordable bridges, roads, and facilities”

Historic

“assisting our neighbors in their economic development and community revitalization projects”

Engineering

Structural
Geotechnical
Transportation
Materials

Economic

“helping Burlington County prosper by saving taxpayers money through unique financing programs”
Relevance

Recent Recommendations

• I. Make *Research-Based* Learning the Standard
• II. Construct an *Inquiry-based* Freshman Year
• VI. Use *Information Technology* Creatively
• VII. Culminate With a *Capstone* Experience

• “...Students should be introduced to the “essence” of engineering early in their undergraduate careers.”

• “...Should introduce *interdisciplinary learning* in the undergraduate curriculum and explore the use of case studies of engineering successes and failures as a learning tool.”

• “Institutions should encourage domestic students to obtain the MS and/or PhD degrees.”
Relevance

Recent Recommendations

ASCE 24 Outcomes

**Foundational**
1. Mathematics
2. Natural sciences
3. Humanities
4. Social sciences

**Professional**
16. Communication
17. Public policy
18. Business and public administration
19. Globalization
20. Leadership
21. Teamwork
22. Attitudes
23. Lifelong learning
24. Professional and ethical responsibility

**Technical**
5. Materials science
6. Mechanics
7. Experiments
8. Problem recognition and solving
9. Design
10. Sustainability
11. Contemp. issues & hist. perspectives
12. Risk and uncertainty
13. Project management
14. Breadth in civil engineering areas
15. Technical specialization
For too long we have separated the scholarships of discovery, integration, application and teaching/mentoring.

The key to reforming civil engineering and its education is effectively bridging and re-integrating domains, disciplines and scholarships.

Academics and practicing engineers have to join forces to make civil engineering an art again instead of a commodity.
The Great Pyramid of Khufu
The Sphinx (2589-2504 BC)
Del Duomo, Florence (1420-1434)
Brooklyn Bridge, NY City (1883)
The Pantheon, Rome, 126 AD
Background

Then and now...

Original Approach
Apprentice-based
*Look then Think*

Contemporary Approach
Applied science-based
*Think then Look*

“The trouble with modernity is how efficiently it obliterates the troves of age-old knowledge otherwise known as wisdom.” NYT Editorial 4.21