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Linkages between Construction Engineering Education and Research

Two Types of Research

Construction Engineering
- Developing practical applications of basic science and mathematics to enable the construction activities and processes of a project.
  - May require experimental lab or field work
  - Often relatively expensive to execute

Construction Management
- Development of the direction and control techniques that are necessary to administer construction projects.
  - Usually does not require experimental or field work
  - Often relatively inexpensive to execute

Genesis of Construction Engineering Academic Programs
- 1952 First engineering degree devoted to construction (NC State)
- 1958 First ABET accredited construction engineering degree (NC State)
- Undergraduate emphasis
- Limited funding for research
- Pent up demand for management capabilities
- Low cost of management research
Current Concerns

• Disproportionate emphasis on Construction Management Research Topics (JCEM Survey).
• 2005-2009: 608 JCEM papers, 16% engineering, 63% management, 21% mixed,
• Continued need for Construction Engineering expertise as documented in several sources
• Concerns about continuing to provide Construction Engineering expertise in the future in academic settings.

Current Academic Business Model

• Reductions in public funding
• Continued high undergraduate enrollment
• Pressures to limit tuition
• Emphasis on scholarship for promotions
• Opportunity for support with extramurally funded research grants and contracts
• Preferences to hire faculty in areas where research opportunities exist.

Result: Need for alignment between research and teaching areas for faculty members.
What should we teach?

• NCEES sponsored a very systematic and rigorous survey of construction engineering requirements for professional activities and knowledge
• Results: balanced needs amongst technical and management topics.
• Tatum (2010) came to similar conclusions.

What does industry need?

• The answer to this question should be similar to the one given to NCEES.
  – Survey was based on the needs of the profession.
  – Research that is useful to the industry will roughly follow the results of the NCEES sponsored survey.
  – Give more reason to strive for alignment between research and teaching

PE Exam Knowledge Areas

• Earthwork Construction and Layout
• Estimating Quantities and Costs
• Construction Operations and Methods
• Scheduling
• Material Quality control and Production
• Temporary Structures
• Worker Health, Safety and Environment
• Other
  Engineering and Management
Cost of a Construction Project

Materials 50%
Installation 50%

CERF 1995 Research Distribution

Distribution of 7.1% of Construction R&D
Opportunities for Expanded Construction Engineering Research

- Should exist when 50% of construction cost is installation
- Could expand Research on Construction Engineering Topics
- Construction faculty as sole PI
- Construction faculty as team member
- Maintain or grow construction management research

Standards Development

- Faculty member serves on volunteer committee that is in charge of the standard
- Learns about the details and the needs with regard to the standard during committee work
- No direct connections with research funders, but can exert influence
- Becomes qualified to compete to be an investigator for recommended research

Example Construction Standard Committees

- ACI 347 Concrete Formwork
- ACI 115 Concrete Construction Tolerances
- ASCE 37 Construction Loads
- ASME B30.20 Below the Hook Lifting Devices
- Council for Masonry Wall Bracing
Specifications Development

- Many opportunities in transportation construction and local, state and federal level
- Less expectation that academics will participate in committee business
- Possibly closer connection between research funding authority and spec committee
- Possibly less formal requirement to obtain research funding

Recent examples of research connected with specification improvement

- Trenchless Technology
- Automatic Machine Guidance
- Links between roadway performance and roadway construction process

We need to increase Construction Engineering Research. It is:
1) Challenging
2) Necessary

So, where do we go from here?
A Path Forward for Early Career Faculty

- Participate in construction standards committee activities
  - Get travel funding from start up accounts and later from research projects
- Investigate needs associated with changes in specifications
  - Start with state and local transportation agencies

A Path Forward for Established Faculty

- Serve on standards committees
- Participate in research project prioritizations efforts
- Convert construction engineering knowledge to a shareable format
  - Textbooks
  - Sharable media and/or class notes
- Encourage alignment of research and teaching efforts

A Path Forward for Industry

- Participate in national, state and local research needs prioritization sessions
- Advocate for projects that meet industry needs
- Participate in research project technical advisory committees
- Be aware of and use the results of research efforts.
Summary

• A balance is required between construction engineering and construction management research and education. Necessary to address
  – Education needs
  – Industry needs
• Compared to economic activity, construction research is underfunded, especially construction engineering research.
  – Grow construction engineering research (not at the expense of construction management research)

Summary Continued

• Faculty
  – Participate on committees
  – Guide graduate students to also build an engineering background in coursework
  – Share educational information on construction engineering topics
  – Maintain alignment of research and educational duties.
• Industry
  – Support governmental funding of appropriate topics
  – Assist with research topic prioritization and research execution

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Thank You!