Teaching Sustainable Development/Transportation in Institutions of Higher Education

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Systems Thinking – breaking apart problems results in paying an enormous hidden price

“From a very early age, we are taught to break apart problems, to fragment the world. This apparently makes complex tasks and subjects more manageable, but we pay a hidden, enormous price. We can no longer see the consequences of our actions: we lose our intrinsic sense of connection to a larger whole.”

Peter Senge, p. 3

ASCE Policy Statement 418

- The civil engineering profession recognizes the reality of limited natural resources, the desire for sustainable practices …, and the need for social equity in the consumption of resources.

To achieve these objectives, ASCE supports the following implementation strategies:

- Promote broad understanding of economic, environmental, political, social, and technical issues and processes as related to sustainable development;
- Advance the skills, knowledge and information necessary for a sustainable future; including habitats, natural systems, system flows, and the effects of all phases of the life cycle of projects on the ecosystem;
- Advocate economic approaches that recognize natural resources and our environment as capital assets;

ASCE Policy Statement 418

- Promote multidisciplinary, whole system, integrated and multi-objective goals in all phases of project planning, design, construction, operations, and decommissioning;
- Promote reduction of vulnerability to natural, accidental, and willful hazards to be part of sustainable development; and
- Promote performance based standards and guidelines as bases for voluntary actions and for regulations in sustainable development for new and existing infrastructure.

Finding the ‘Root Cause’ of a Problem

Economics and markets
• Inadequate and/or perverse incentives, prices, markets, institutional/organizational structure and behavior, free-rider problems, and unrecognized/unmet needs and demands

Legislation and political process
• Inadequacy of existing legislation/regulations, lack of knowledge/enforcement thereof, and inadequate stakeholder involvement

Public/private-sector management
• lack of adequate incentives or perverse incentives for, or commitment to, management of the problem

Technical system capabilities
• Technical solutions do not yet exist

Responding to the Root Cause

**Economics and markets**
- Changes in prices, markets, and industry structure
- Changes in demand

**Legislation and the political process**
- Changes in law and political process (legislation, regulation, negotiation, and stakeholder participation)

**Public/private-sector management**
- System changes related to organizational/institutional structure
- Changes in public- and private-sector activity

**The technical system**
- Technological/scientific changes (options for R&D, innovation, and diffusion)

“Triple Bottom Line (TBL) is an integrated rather than a stand-alone concept: TBL is not exclusive to any one policy area or system. Given the integrated nature of transportation with the rest of human activity, it is difficult to view the transportation system in isolation. Sustainable transportation requires considering a broad definition of sustainability that considers how transportation affects overall social sustainability and how other policy areas need to be coordinated to achieve sustainability.”
Questions Facing Institutions of Higher Education?

- What knowledge and skills do students need to learn?
- How should we promote ‘Sustainability in Higher Education’ (SHE) – e.g., top down vs. bottom up?
- How do we change the hearts and minds of faculty?
- What should be the role of non-academic entities – e.g., government agencies, private businesses, and NGOs?

What knowledge and skills do students need to learn?

- Qualitative and quantitative modeling
- Institutional, decision, governance, social systems analysis
- Systems multi-methodologies (e.g., “thick” description methodology)
- Participatory systems approaches, including participatory modeling
- Participatory methods, including negotiation, mediation, deliberation, constructive conflict methodology
- Teamwork methods
- Methods to design governance arrangements, policies, institutions
- Planning methodologies
- Decision support methodologies
- Transition management methodology
- Methods to support learning and reflexivity
- Organizational (change) management
- Methods to support behavioral change
- Multi-criteria assessment methods
- Risk analysis
- Sustainability efficiency analysis
- Envisioning methods (e.g., backcasting)
- Participatory normative methods, including negotiation methods and consensus conference

What knowledge and skills do students need to learn?

**Boundary Crossing Skills**

Students need to:

- Be aware of different perspectives (*knowledge*)
- Appreciate the ‘value’ of different disciplinary perspectives (*attitude*)
- Apply different perspectives/disciplines and leverage the connections between them (*skills*)

**Deep Learning**

Students need to:

- Be internally/intrinsically motivated via a strong personal interest in sustainability
- Benefit from varied teaching styles (*that promote both ‘mastery’ and ‘discovery’ learning*)
- Be guided towards principles/concepts (*rather than facts*) in a ‘spiral curriculum’


How should we promote Sustainability in Higher Education (SHE)?

<table>
<thead>
<tr>
<th>SHE focus</th>
<th>SHE delivery</th>
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<tbody>
<tr>
<td>Narrow (discipline-specific)</td>
<td>Existing structures</td>
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<tr>
<td>I. Integrate into existing course(s) minor(s), major(s), or programs(s)</td>
<td>II. Create new, discipline-specific sustainability course(s), minor(s), major(s) or programs(s)</td>
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<tr>
<td>Broad (cross-disciplinary)</td>
<td>III. Integrate into common core requirements</td>
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How do we change the hearts and minds of faculty?

Should I really mess up a scientifically derived curricula? This subject is multidisciplinary, it can be studied in dedicated courses and programs.

Future employers will ask for sustainability related knowledge when they need it. Until then there is no reason to include it.

I don’t see how it would fit into the course. I don’t know the subject that well.

I have read the environmental report. It says that successful greening of curricula is already achieved

Will the promotion and tenure (P&T) committee penalize me for being too broad?

Where are the resources to support the effort it will take to transform the way I teach?

It doesn’t seem to be prioritised by university management, since I never hear or read about it.

I will not be rewarded for my effort. I’d rather do something that I know will pay off.

It’s scary to realise that current world development is not sustainable and that we need to do something about it. If that was really the case, why haven’t someone reacted?

I am not an expert on sustainable development, I might say or do something wrong and get criticized, both by my peers and by the students.

Source: Adapted from Lidgren et al. (2006) A Systemic Approach to Incorporate Sustainability into University Courses and Curricula. Journal of Cleaner Production, 14, pp. 797-809.
What should be the role of non-academic entities?

- Government agencies, private businesses, and NGOs can support active and project-based learning (PBL)
- Active and PBL – is an effective way to learn interdisciplinary skills and systems thinking
- ‘Real’ problems motivate students

**Challenges:**
- Requires resources/effort (on both sides) to manage
- Establishing and certifying learning objectives is more complex
- How to ensure students see the broader implications of a case
- Management of commercial or political interests

Concluding Thoughts

- Provide students with the ability/confidence to ask better questions – e.g., to think systemically/holistically

- Equip students with cross-disciplinary skills to promote technological, institutional, organizational, and social change

- Each institution of higher education will need to tailor its approach to fit within existing systems/structures

- Need to explore ‘collaborative models’ that promote active and problem-based learning – requires greater cooperation with public and private actors

- Will there be sufficient employment opportunities for students?
Questions?