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Title: Strategic Entry Points for Sustainability in University Construction and Engineering Curricula
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Abstract: Interest is growing regarding incorporating sustainability throughout university curricula, but the already full palette of educational requirements means that common tactics of adding new elective courses tend to isolate the concept and pit them against other courses in the curriculum. This paper presents six strategic entry points for sustainability in a typical construction- or engineering-oriented curriculum: infiltrating the core; adding electives; coordinating complementary courses; sprinkling sustainability throughout; providing opportunities outside the classroom; and integrating campus operations. It compares the pedagogical costs and benefits of each approach and shares lessons learned from experiences at two leading U.S. universities: Georgia Tech and Virginia Tech. The paper discusses opportunities in terms of three perspectives on the pedagogy of sustainability: stealthy, flagrant, and a combination of the two. The paper concludes with a discussion of considerations that should be taken into account when evaluating the potential for sustainability in new educational contexts.

Sustainability and Engineering Education: Creating Sustainability Competency

Interest is growing around the world in the principles and practices of sustainable construction (Ahn & Pearce 2007, 2009; Myers 2005; Nobe & Dunbar 2004; Siddiqi et al. 2008). This interest is being driven by increased recognition of the responsibility of the construction industry for significant social, economic, and environmental impacts, even as it strives to meet the needs of a diverse and growing population. In parallel, the drivers for incorporating sustainability as part of construction and engineering education are Policy initiatives at the federal, state, and local sectors are also contributing to this growth (Pearce et al. 2007; Keysar & Pearce 2007; DuBose et al. 2007), and research addressing common barriers to sustainability and sustainable construction is flourishing (Pearce 2008; Pearce & Fischer 2002; Sibbel 2009).

Considerable attention has been directed toward pedagogical reform and evolution to support sustainability in engineering education in general (e.g., Fouger 2008; Lemkowitz et al. 1996; Lourdel et al. 2005; Orr 2002; Thom 1996; Vest 2008; Vanasupa et al. 2009; Woodruff 2000; Zhang et al. 2008), and construction-related education specifically (Ahn 2009a, b; Chau 2007; Cotgrave & Alkhaddar 2006; Fouger 2008; Graham 2000; Graham et al. 2003; Haselbach & Fiori 2006; Hayles & Holdsworth 2007; Lewis et al. 2005; Mead 2001; Murray & Cotgrave 2007; Nobe & Dunbar 2005; Pearce & Ahn 2009; Pearce & Carpenter 2005; Pearce & McCoy 2007; Riley et al. 2007; Siddiqi et al. 2008; Tinker & Burt 2004; Vanegas et al. 2002a, 2002b, 2004; Vanegas & Pearce 2004; Wang 2009). As colleges and universities seek to evolve their curricula and programs to respond to this opportunity, the challenge is to find ways to increase the sustainability-related knowledge and skills of students in the context of an already full palette of educational requirements. The most common tactic, development of new elec-

tive courses, not only increases teaching loads and competes with existing courses in the curriculum, but it also isolates the concept of sustainability pedagogically and increases the perception that it is an optional specialty rather than an essential concept for all graduates. How can students most effectively learn the sustainability skills and information they need to know to be successful in today's industry? Where are the most strategic entry points in construction and engineering curricula to introduce these concepts?

Teaching Sustainability – Goals and Opportunities

While there is general support for the idea of incorporating sustainability as part of higher education curricula, agreement is lacking as to the best way to do so (e.g., Jones et al. 2009; Wals & Jickling 2002), and a variety of pedagogical challenges exist that are unique to the concept (Lourdel et al. 2005; Sibbel 2009). To be effective, the literature suggests that pedagogical approaches for teaching sustainability-related concepts should incorporate inquiry, experience, and reflection as an integral part of instruction (Cortese 2003; Moore 2005; Brunton 2006; Hayles & Holdsworth 2007; Chappell 2007; Riley et al. 2007; Shriberg 2002), and can benefit from being situated within the context in which the concepts will be used (Anderson et al. 2000; Graham et al. 2003; Jucker 2002) rather than as isolated curricular elements (Haigh 2005; Hayles & Holdsworth 2007). Jucker (2002) and Sterling (1996) also advocate for self-determination in learning about sustainability, where students are empowered to take responsibility for their own learning experiences. Brunton (2006) identifies four attributes of effective integration of sustainability concepts as part of teaching and learning: (1) Full integration of sustainability concepts into the curriculum; (2) Student-centered activities and assessments to reward critical thinking and reflective learning; (3) Transdisciplinary teaching and learning; and (4) Teaching that emphasizes sustainability as an ongoing process without hard and fast answers. Local embedded understandings, experiences, and knowledge become a part of student experience and provide considerable insight to explain what is observed. This transition from an "investigative" to an "interpretive" approach to sustainability better reflects the context-dependent nature of sustainability (Wals & Jickling 2002; Dubose 1994).

A key barrier to incorporation of sustainability in engineering education, however, is the already full curriculum in traditional engineering and construction programs (Chau 2007; Dawe et al. 2005; Siddiqi et al. 2008; Velazquez et al. 2005) and concern that embedding sustainability within existing degree programs may displace core subject matter (Jones et al. 2009). Integration of sustainability within existing curricular elements is thought to be more effective than adding stand-alone treatments (Cotgrave & Alkhaddar 2006; Haselbach & Fiori 2006), although some educators perceive there to be a conflict between core programs and sustainability content (Jones et al. 2009). Moreover, some studies suggest that sustainability remains marginal in existing curricula (Lewis et al. 2005; McKeown & Hopkins 2003), and where included, is more due to the "enthusiasm of individual academic staff, rather than a structured approach" (Ellis & Weekes 2008, p. 484). Lack of value or priority given to sustainability, often evidenced by lack of resources allocated for change, is also a significant barrier (Hayles & Holdsworth 2007). Rigid disciplinary boundaries in traditional educational programs impede sustainability education, which requires the ability to integrate inputs from multiple disciplines (Haigh 2005; Lidgren et al. 2006; Lozano 2006). Sustainability, at least in some disciplines, is sometimes viewed by educators in terms of curriculum content rather than pedagogy employed, with perceptions of sustainability as being distinct and disparate from the rest of curricular content (Jones et al. 2009; Reid & Petocz 2006).

Desirable Sustainability Skills and Competencies for Engineering and Construction

Increased attention to sustainability by professional organizations and accrediting boards has raised awareness about the concept in higher education. Sustainability receives prominent treatment in the American Society of Civil Engineers' *Body of Knowledge for the 21st Century* (ASCE 2008), with recognition as a specific technical outcome and as an overarching concept for other foundational, technical, and professional outcome categories such as social sciences, contemporary issues, and public policy. The BOK 2 report also highlights sustainability as being related to ABET program criteria outcomes. This recognition of the importance of sustainability to civil engineering practice builds on ASCE's commitment to sustainability as an ethical obligation (ASCE 1996) and its affirmation of the leadership roles and responsibilities of engineers in achieving sustainable development (ASCE 2004). Within the construction domain, the American Council for Construction Education also includes environmental or sustainability-related coursework as part of its construction science and project planning accreditation requirements (Tinker & Burt 2004). In addition to basic sustainability literacy (Ellis & Weekes 2008; Graham 2000; Murray & Cotgrave 2007), among the competencies identified by professional bodies and in the literature as being important for sustainability education for engineers are ability to communicate and solve problems effectively and professionally with people from other disciplines and cultures; ability to decide and competence to act in ways that favor sustainable development; understanding the influence of culture and context and valuing diversity; ability to tolerate uncertainty and ambiguity and resolve conflicts; knowledge and tolerance of disciplinary perspectives that are not one's own; ability to think holistically and search for integrated solutions; ability to challenge dominant ideologies; awareness of the role of humans within a larger systems context; ability to expand the scale of thinking in spatial, temporal, biological, and intellectual terms; ability to evaluate impacts and manage tradeoffs between technological, ecological, human, and economic elements (Allen et al. 2009; ASCE 2008; Ellis & Weekes 2008; Graham 2000; Haigh 2005; Haselbach & Fiori 2006; Hayles & Holdsworth 2008; Jucker 2002; Lemkowitz et al. 1996; Lewis et al. 2005; Lourdel et al. 2005; Lozano 2006; McKeown & Hopkins 2003; Mead 2001; Moore 2005; Murray & Cotgrave 2007; Orr 1992; Pearce & Maxey 2006; Riley et al. 2007; Sibbel 2009; Sterling 1996; Vanasupa et al. 2009; Vest 2008; Wals & Jickling 2002).

The ASCE BOK 2 also identifies other desirable competencies for civil engineers that may be integrated into pedagogy designed for sustainability, including communication, business and public administration, design, management of uncertainty, teamwork, and experiments (ASCE 2008). The importance of lateral thinking outside traditional disciplinary boundaries is also emphasized. Desirable skills and competencies related to sustainability that are acknowledged in the literature as being critical for technical education include knowledge of people and how to motivate action; ability to work in teams and manage stakeholders; ability to cope with novel situations, analyze requirements, identify resources, develop solutions, monitor progress, and learn from the process; ability to filter, interpret, and integrate information and evidence, and situate one's own perspective within it; perform under constraints and use ethical judgment; and embody leadership, change management, project/process management, and life long learning (Ellis & Weekes 2008; Graham 2000; Graham et al. 2003; Haselbach & Fiori 2006; Hayles & Holdsworth 2007; Pearce & Maxey 2006; Riley et al. 2007; Vanasupa et al. 2009; Zhang et al. 2008). Along with sustainability-related skills, these other skills and competencies fit well with the likely requirements for future engineering and construction professionals (Fouger 2008; Haselbach & Fiori 2006]. This leads to the question of how best to promote learning of these skills, given the attributes and constraints of current pedagogy.

Pedagogical Approaches: Case Studies and Perspectives

The approaches to teaching and learning about sustainability are as varied as the institutions and programs that employ them. For the purposes of this paper, sustainability-related curriculum initiatives at two leading U.S. institutions help to illustrate the spectrum of pedagogical approaches to this topic.

The Georgia Tech Experience

The Georgia Institute of Technology (Georgia Tech) was one of the early innovators in sustainability education in the U.S. and began its work toward curricular transformation in the early 1990's. This work was fueled by grants from the General Electric Foundation and the National Science Foundation aimed at exploring new ways to incorporate sustainability into the engineering curriculum (Georgia Institute of Technology 1999). While Georgia Tech's approach has evolved over the twenty plus years in which it has been involved in sustainability education, formal and systematic integration of sustainability into engineering education began in 1993 with an integrated three-course sequence in sustainable development and technology that was cross-listed across all engineering departments. These original courses provided an overview of the core concepts of sustainability and tradeoffs among its various dimensions – sociocultural, economic, and ecological – from a technology perspective.

The initial overview course was followed by a case study course and a sustainable systems course, and was eventually supplemented by a fourth Sustainable Problem Solving Laboratory course that provided students with a hands-on experience in the application of sustainable principles to the solution of an engineering problem. These initial courses were ultimately phased out over time as sustainability became more thoroughly integrated throughout the engineering and other curricula. Today, Georgia Tech's vision for sustainability education includes a broad spectrum of programs ranging from new degree programs and certificates to internships and international experiences, plus K-12 education and executive education. Over 100 courses have an emphasis in sustainability across all colleges at Georgia Tech, and degree concentrations and focused projects are available in multiple areas of study.

The Virginia Tech Experience

Like Georgia Tech, Virginia Polytechnic Institute and State University (Virginia Tech) was also an early innovator in the field with a focus on green engineering. In 1992, five faculty members and administrators in Virginia Tech's College of Engineering embarked on a quest to start a program to ensure that "every Virginia Tech engineering graduate had an understanding of the environmental and societal ramifications of engineering activities" (Gregg 2005). One of the first outcomes of the program was a concentration (now a minor) in green engineering including two core courses in green engineering, two in-major green courses, and two green courses from other disciplines. Today, the list of courses pre-approved for students pursuing the Green Engineering Minor is over seventy-five and growing, with a number of courses that also meet students' core curriculum requirements for liberal arts and humanities. A number of other courses at the graduate and undergraduate levels also have precedent for approval as part of the Green Engineering Minor. The curriculum impact of sustainability has also expanded past the College of Engineering to include all undergraduates. Students with an interest in sustainability can participate in a focused Earth Sustainability clustering of their core curriculum courses. Now in its second two-year cycle, the Earth Sustainability program has grown exponentially and continues to expand. Sustainability initiatives encompass the entire campus, ranging from urban planning students calculating campus carbon footprints in their environmental studio to building construction students participating in sustainable project management courses that involve service learning projects for schools in Belize. Twenty-

nine student organizations participate in the university-wide Environmental Consortium and have played a major role in achieving change in university operations and strategic planning. The role of sustainability at Virginia Tech continues to grow with the upcoming release of the Virginia Tech Climate Action Commitment and Sustainability Plan, which will lead the university toward becoming climate neutral by 2050 and transform the way it achieves its mission in the future.

Stealthy vs. Flagrant Sustainability

Given the variety of initiatives for incorporating sustainability as part of the university mission, operations, and curriculum, how to incorporate sustainability as part of pedagogy can be a complex question. A spectrum of strategies can be defined regarding how to approach the task of sustainability integration, with the extremes of the spectrum defined as "stealthy" and "flagrant". In this context, the stealthy sustainability extreme represents completely transparent integration of the concept as part of the curriculum, where students learn sustainability concepts without even realizing they are doing so. At the other end of the spectrum, flagrant sustainability initiatives are completely visible and labeled specifically as such, and at their most extreme may include complete sustainability-based degree programs (e.g., James Madison University's Sustainable Engineering degree) or even schools (e.g., Arizona State's School of Sustainability). Which of these approaches best meets the aim of facilitating student learning of critical sustainability skills? Which best supports the desired outcome of producing students who can create a more sustainable world? Both schools of thought have their advocates, and in fact the sustainability initiatives at the two case study institutions fall somewhere in between the two extremes. However, the underlying philosophy driving Georgia Tech's sustainability education efforts ultimately tends toward the stealthy extreme, with its initial three course sustainable engineering sequence deliberately phased out in favor of less obvious sustainability education. The Virginia Tech approach, on the other hand, represents a more flagrant approach with its Green Engineering minor and recognized Earth Sustainability curriculum. Individual efforts at each university fall at various points along the spectrum. How to decide what approach may be most appropriate in other institutional contexts?

Strategic Entry Points for Sustainability in Existing Curricula

Based on experiences at the case study institutions, six strategic entry points exist to introduce sustainability into the existing curriculum, described in the following subsections.

Tactic 1: Infiltrate the Core

The first tactic, infiltrating the core, focuses on systematically introducing sustainability concepts into most or all core classes within the core curriculum for a degree. This tactic involves, at a minimum, including a guest lecture or module within each core course to introduce sustainability concepts in the context of that course, with complexity of sustainability concepts building over time in parallel to the knowledge and skills being built in the core curriculum. More extensive infiltration may involve adding sustainability components to major projects or assignments, again, with complexity increasing over time. This tactic has been undertaken at Virginia Tech as part of the B.S. in Building Construction curriculum, with sustainability-related guest lectures and projects in the major core courses culminating in a strong sustainability component in the senior capstone design-build studio project. In terms of stakeholder commitment, successfully employing this tactic requires that all faculty teaching core courses in the curriculum must be in alignment with the goals of the program. Additionally, at least one specialist is required to work with core faculty to identify areas where sustainability can be included, and to develop and deliver the sustainability-specific lectures

or modules in each course. Coordination across the courses to ensure that student exposure and skill development increases over time is also useful. Faculty alignment can be facilitated by providing resources for training and curriculum development in the form of curriculum development grants to purchase materials and supplies, attend conferences or training events, or buy salary time to review and enhance existing course materials.

Tactic 2: Add Electives

The second tactic for integrating sustainability into existing curricula involves developing new technical or general electives on sustainability-related topics. Elective courses on sustainability can be either survey courses with a broad perspective on sustainability as it relates to the discipline, or focus on discipline-specific aspects of sustainability. This tactic can be undertaken independently of the rest of the curriculum and requires only an interested faculty member who can convince the department chair and curriculum committee that sustainability is a topic worthy of further study. However, it also suffers from potential vulnerability if the faculty champion loses interest or becomes unavailability, and it competes with other elective courses for limited slots in the existing curriculum. Such courses may be perceived by other faculty as a drain on the pool of students who take electives, and they necessarily add to the teaching load of the faculty who teach them and/or displace other courses faculty may be teaching. Initiatives such as the Center for Sustainable Engineering (http://www.csengin.org) faculty workshops, sponsored by the National Science Foundation in the United States, can provide guidance, resources, and incentives to faculty who are interested in developing new elective courses for sustainable engineering curricula. Both at Virginia Tech and Georgia Tech, this tactic has been applied as part of the construction curriculum at the graduate level. Virginia Tech has two graduate-level elective courses in Sustainable Facility Systems and Sustainable Civil Infrastructure Systems that are also open to upper level undergraduates. Georgia Tech was the first graduate construction program in the U.S. to require all construction engineering and management students to take a core course in Environmentally Conscious Design and Construction, and additional elective courses are also available (Vanegas & Pearce 2004; Vanegas et al. 2002).

Tactic 3: Coordinate Complementary Courses

The third tactic for integrating sustainability into existing curricula involves stringing together complementary courses into larger programs that recognize student focus on the topic of sustainability. Courses included in this type of program may be either new sustainability-focused courses or existing courses with topical relevance. The Green Engineering Minor and the Earth Sustainability Core at Virginia Tech are both examples of this type of program. As additional sustainability-related courses come online in various disciplines, they can then be added to the set of courses that qualify a student for a minor, certificate, or other similar recognition of the focus area. This tactic requires coordination among faculty and college or university-level approval in order to be successful. Even if they do not actively contribute to larger program-level coordination, individual faculty teaching courses included in the larger program must be prepared to take on additional students from different disciplines if their course becomes listed as a qualifying course within the larger program. While this may be an asset from a learning standpoint for students in the class, it may also represent a liability for the offering department if course loads increase and either displace existing students or require additional teaching assets due to course demands. This tactic, while it takes maximum advantage of existing course assets at the university, also requires crossing disciplinary and departmental boundaries to achieve coordination and approval.

Tactic 4: Sprinkle Sustainability Throughout

The fourth tactic is a variation on previous tactics and involves introducing sustainability into existing courses through new data sets for existing parts of the course. This tactic can be undertaken by any willing faculty and requires only the need to rework existing problem sets with new data. Courses that lend themselves to this approach include basic mathematics and science, statistics, economics, and liberal arts/humanities. For instance, students taking a writing or speech course may be asked to compose a writing assignment or presentation on a sustainability-related topic. Students studying mathematics or statistics may use a data set about levels of greenhouse gas concentrations to study analytical techniques in their problem sets. Even basic engineering courses such as surveying, soil mechanics, or statics can incorporate sustainability-related examples or problem frames as part of student problem sets or in-class examples. At Virginia Tech, this tactic has been successfully applied to the construction internship-for-credit course option in Building Construction. In this two-semester internship course, students receive course credit for their work in industry in exchange for collecting and analyzing data about sustainability innovations being undertaken by their employers (Pearce & Fiori 2009; Fiori & Pearce 2009). This tactic requires a relatively low investment of resources, although it requires the interest and cooperation of each individual faculty member in adjusting course materials. Similar to Tactic 1, it may be facilitated through the use of curriculum development grants to purchase supplies, attend conferences or training events, or buy summer salary time to review and enhance existing course materials. External grants may also be available to support such efforts through programs like the National Science Foundation's Innovations in Engineering Education, Curriculum, and Infrastructure (IEECI) Program.

Tactic 5: Provide Opportunities Outside the Classroom

The fifth tactic focuses on providing opportunities outside the classroom for students to engage in projects that benefit the community or world at large. This tactic is similar to others in that it can involve modification of existing courses to include service learning components, but it can also be undertaken outside of the existing curriculum as well. This tactic can be undertaken by any enthusiastic faculty member or student group. Depending on the scope and nature of the opportunity, external resources may also be required. An example of this type of tactic is the Solar Decathlon (http://www.solardecathlon.org), a national competition sponsored by the US Department of Energy where interdisciplinary student teams compete against other universities to design, construct, and operate the most "attractive, effective, and energy-efficient solar-powered house". Similar competitions exist in other disciplines, including solar vehicle competitions in which both Virginia Tech and Georgia Tech participate. This tactic can also be undertaken on a more local or individualized scale as well. Examples of such programs include the Sustainable Orphanage Project at Georgia Tech (Pearce et al. 1997) and various service learning projects at Virginia Tech involving permeable concrete (Marinchak & Pearce 2006) and other green building technologies (Collier 2006).

Tactic 6: Integrate Campus Operations

The sixth tactic represents an integration of prior tactics in the context of an institution's campus as a living laboratory. The aim is for students to learn while doing useful things that benefit the campus and community of which they are a part. This tactic can be done on a micro scale (e.g., using a building's energy consumption data as part of a class exercise), a macro scale (e.g., performing a full-scale carbon footprint analysis of the campus and community and developing a plan to become carbon neutral), or any level in between. Both of the aforementioned extremes have been implemented at Virginia Tech as part of sustainability learning, and the latter has involved not only students and faculty but also independent student

groups, facilities staff, the local town council, and the university administration. To be truly successful, this tactic requires interested faculty, committed facilities staff, and supportive leadership. Several potentially significant barriers, including existing policy and budgets if dealing with a public university, can impede this type of effort. Building synergistic relationships with facility staff requires careful cultivation and management on the part of faculty to avoid overwhelming already busy university employees with enthusiastic student requests. The involvement of a centralized sustainability office can provide considerable assistance in coordinating requests and archiving information for use in classes. Other potential barriers include lack of interoperable or easily available data and concerns regarding proprietary or competition-sensitive data such as contractor bids and detailed design documents. If carefully designed, student involvement can benefit facility staff by enabling different types of data analysis and design/implementation review than would ordinarily be done within the traditional facility delivery process. Current efforts at Virginia Tech, for instance, include involving students in value enhancement reviews of project documents. Other institutions such as Penn State University and the University of Alabama also have programs in which facilities departments provide formal funding for graduate fellowships to manage and implement these programs (Johnson et al. 2007).

Recommendations: Sustainability in New Educational Contexts

Each of the six tactics identified here has been demonstrated with varying degrees of success at the two case study institutions, and each has its pros and cons. Success of sustainability programs is affected by a variety of factors including fit with organizational culture, alignment of programs with institutional goals and core programs, presence of indicators and standards to measure performance, endorsement/commitment by key individuals and a culture of value or priority given to sustainability, engaging the community and developing transdisciplinary collaborative networks or communities within and across institutions to exchange ideas and experiences, leveraging organizational and resource support, and credibility and persistence of sustainability champions along with academic legitimacy of the program (Hayles & Holdsworth 2007; Lidgren et al. 2006; Lozano 2006; Moore 2005; Pearce & Ahn 2009; Shriberg 2002; Velazquez et al. 2005, 2006; Woodruff 2000). Accordingly, the first step in developing a plan for sustainability integration should be to evaluate the existing organizational context. Core questions should focus on understanding the status quo, the desired end state to be achieved, and the resources and impediments that define the path between the two, including: (1) Where can sustainability be inserted in the existing curriculum? What opportunities exist? (2) Why are we undertaking the initiative? What is driving the change, and what is the desired outcome? (3) Who can be counted on as a change agent? Who will potentially get in the way? Who is already working in this area or complementary areas? (4) What other initiatives can be harnessed or leveraged? What resources can be tapped? What is already being done? and (5) When should the transformation be finished? What is the timeline?

Perhaps the most important of these lessons is to recognize and celebrate existing initiatives wherever possible. Often, the context for sustainability integration in a university setting involves scarce resources, overloaded faculty, and competing demands. Building on the successes of sustainability entrepreneurs who are already working toward the same goals is preferable to alienating these valuable assets by failing to acknowledge their work. However, it is essential to have a comprehensive inventory of what has already been accomplished. This task is often made more difficult by varying definitions of what sustainability means and what falls within its scope. Comprehensive inventories of existing courses and related research were undertaken multiple times at Georgia Tech using methodologies ranging from university-wide faculty retreats and charrettes to individual interviews of faculty by a research team using a

snowball sampling method (Pearce et al. 2005; Georgia Tech 1999). These inventories can serve as examples for other institutions to evaluate their own starting point.

Which of the two approaches – stealthy or flagrant – is better? Experiences at Virginia Tech and Georgia Tech suggest that elements of both can be helpful in various stages of sustainability implementation. With the emergence of third-party accreditations for individuals such as the LEED Accredited Professional designation, the emergence of university-level benchmarks such as the Sustainability Report Card, and national college or department-level benchmarks such as the CSE Benchmark Study of engineering programs (Allen et al. 2009), industry now has a variety of means by which to assess sustainability knowledge of students. The effect these metrics may have on externally recognizable sustainability programs at universities remains to be seen. For instance, in the construction industry, increased interest in sustainability capabilities of graduates may lead to the growth of more flagrant sustainability programs in construction curricula (Ahn & Pearce 2007, 2009; Ahn et al. 2009a, b). Ultimately, a curriculum where sustainability is so integral as to be completely transparent may be necessary to produce engineers who can design and build a truly sustainable world. The alternatives for curricular modification presented here will serve as a means to that end.

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