AC 2012-4914: INTEGRATED SUSTAINABILITY CURRICULUM

Dr. James G. Sullivan, University of Florida, Gainesville

James Sullivan is currently the Charles R. Perry Assistant Professor at the M.E. Rinker, Sr., School of Building Construction, University of Florida, Gainesville. His course work includes construction techniques, high performance, and surveying.

Integrated Sustainability Curriculum

Abstract

Sustainable construction, specifically United States Green Building Council Leadership in Energy and Environmental Design, places an emphasis on design integration, professional and industry education, and market transformation – both in products and design techniques. The question at hand is how to prepare construction and engineering students for what is quickly becoming the norm for construction in the United States. Previous research has discussed integration of curriculum and has found there are no existing standards in place. This study finds that when sustainability is viewed more in the light of integrated high performance design and delivery than course development it is more a function of integration than revision. No comparative outcome of success was measured. As sustainable construction continues to increase its market share in the commercial construction realm there is continued discussion regarding providing adequate exposure to sustainable practices in undergraduate curriculum. This paper reviews the progress made since 1998 to present in undergraduate integrated and supplemented education courses in a prominent four year construction program. The question of accreditation requirements and initial career offerings are also discussed.

Introduction

This paper summarizes the continued adaptation and creation of programs, coursework, and degrees at the University of Florida's M.E. Rinker School of Building Construction from 1988 to present. This paper's focus is to summarize efforts within a state, university, college, and traditional construction management (CM) school. The school established the first United States Green Building Chapter (USGBC) student chapter in 1998 and has continued to review curriculum content and respond to industry support over the past 14 years [i]. Other construction programs continue to struggle to compare their efforts to other institutions and in defining sustainable goals [ii,v]. This paper provides a roadmap of a single institution with regards to pre-requisites, course integration, course creation, and faculty involvement.

State Setting

In 2007, Governor Charlie Crist signed an executive order that all state funded buildings must be in accordance with United States Green Building Council (USGBC) Leadership in Energy and

Environmental Design (LEED) for New Construction and Major Renovation (LEED-NC) or LEED for Existing Building (LEED-EB). In 2008 the Florida Energy Act mandated that all state funded buildings pursue a nationally recognized high-performance green building rating system as approved by the Department of Management Services. LEED and Green Building Initiatives Green Globes are specifically mentioned. In 2010 there were over 600 registered LEED projects in the state of Florida. Preparing our students for these jobsite requirements is essential.

University Facilities Setting

In 2003, the University of Florida Facilities, Planning, and Construction (FPC) Office constructed the first USGBC Leadership in Energy and Environmental Design (LEED) Gold building in the State of Florida; the M.E. Rinker Sr., School of Building Construction was the first such LEED project on campus. In 2001, the university adopted LEED certified criteria for design and construction for all major new construction and renovation projects to deliver high performance and sustainable buildings. In 2006, Silver certification became the design and construction goal. This bar was raised in 2009 with Gold now being the certification attempted on each project. By the end of 2009, the USGBC ranked the University Florida as the number 1 campus for LEED project registrations. Table 1 summarizes the projects by certification or registration level [iv].

Table 1: LEED Certifications since 2001

Certification Level	Number of Projects Completed as of December 2011
Platinum	1
Gold	7
Silver	3
Certified	10
Submitted for Certification	5
Total Completed Projects	26
Registered or Planned Projects	30

The great support from FCP has allowed for all design and construction students availability to tour and interact with LEED projects being built around them over the past ten years. Review of standards and fee curves indicate the University does not pay a premium for these projects relative to the option of building a non-LEED project on campus. Construction management students interact with the project managers, superintendents, and subcontractors working on the projects to discuss LEED parameters and action plans for success.

The College of Design, Construction, and Planning established an Office of Sustainability in 2000 to facilitate, support, and analyze sustainability initiatives on campus. In 2006 the Student Senate urged the formation of an Office of Sustainability on a University level. The same year the University President established the Office of Sustainability and hired a Director of the Office of Sustainability to facilitate and manage campus wide goals and directives [iii].

University Based Integrated Degrees

The College of Liberal Arts and Sciences has established a Bachelor of Arts in Sustainability Studies. This across discipline degree places an emphasis on environmental well being, economic welfare and social justice. A focus is also placed on local, national, and global sustainable initiatives. The courses for this major are set in clusters for which students must pick a select number of courses to complete the requirements for graduation. A review of the courses indicates that very few courses were added by departments across campus to accommodate the 'sustainable degree.' Courses such as Environmental Ethics (Cluster A), Conservation of Resources (Cluster B), and Soil, Water, and Land Use (Cluster C) were established courses that were linked under the same program.

College Setting

The Bachelor of Science in Sustainability and the Built Environment degree is housed in the College of Design, Construction, and Planning. The courses focus on solutions to building challenges with an emphasis on impacts such as energy, water, and land. There is also an available Minor in Sustainability and the Built Environment. This degree places more emphasis on the impacts of the built environment and, thus, there is more course work centered in the College of Design, Construction, and Planning. In addition, practicum or studio credits and a capstone project related to sustainability are required.

Construction Management School Setting

The undergraduate program in construction management has been strategically improved over the last twelve years but the effective change to accommodate sustainable topics has resulted a change in prerequisites, adoption of limited elective courses, integration, and drive of the faculty for the students to have access to material outside of required course work.

Prerequisites

International Sustainable Development was established as prerequisite to the upper division. The course satisfies the social/behavioral science requirement. The instructor is a building construction faculty member with a research interest in high performance and low-impact construction. The course focus is on providing resources for the understanding human impacts, limits of design, natural capacity, and social sustainability.

Introduction to Materials has undergone a slight, albeit, simple transition as the current authors of the text book used have modified material chapters to include sustainable considerations and comparative information within each material chapter.

Elective Courses

Elective courses consist of related high performance and technology delivery courses. High Performance Green Building was an established elective that covered such topics as life-cycle assessment, life-cycle costing, energy modeling, value engineering, and sustainable rating criteria (e.g., LEED). Building Information Modeling (BIM) is an elective that goes beyond the

students' an exposure to Revit modeling to include Heating Ventilation and Air Conditioning (HVAC) systems and layout concerns. Design Build is related elective in that most of the project based learning incorporates elements of LEED requirements. Likewise Sustainable Housing is a course that covers housing economics and green home standards. Note that no specific sustainable course has been added to the requirements to graduate.

Integration with Core Undergraduate Classes

High performance owner directed buildings (i.e., green building) have been integrated throughout the existing design, finance, and construction technique courses. The introduction construction materials course, a program prerequisite, covers environmental impacts of building materials as well as ethics of development in the built environment. Table 2 comprises the semester breakdown of courses that integrate sustainable facets into the established course material (not all required courses are listed). One of the main way courses have been integrated is by the inclusion of the LEED specific reference standards. Table 3 notes the applicable design standards and associated credits. Integration depth in these courses relates specifically to what extent these standards being currently covered.

Table 2: Selected Integrated Core Courses

Junior One Semester Courses	Integrated High Performance Concepts
Introduction to Construction Management	Roles of integrated team in a high performance delivery setting
Graphic Communications	Potential impacts on building performance measures through the use of Building Information Modeling
Construction Techniques	Field trips to LEED based projects, guest lecturers from companies that emphasize LEED based management strategies, and LEED scorecard reviews
Construction Structures	Recycled content and material impacts.
Junior Two Semester Courses	Integrated High Performance Concepts
Construction Estimating I	Impacts on site development.
Soils and Concrete	Recycled content (fly ash), use of diverted materials, and material impacts
Construction Safety, Health, and the Environment	Low-VOC content and indoor environmental quality related to safety and health
Electrical System	System right sizing and building automated systems and controls
Senior One Semester Courses	Integrated High Performance Concepts
Mechanical Systems	Principles and practices of building a system – right sizing, equipment selection, and performance trade-offs are discussed.
Senior Two Semester Courses	Integrated High Performance Concepts
Construction Capstone	LEED appropriate scorecard is submitted with key credit responsibility/submittal identified (Owner/Architect/General Contractor)

Table 3: Select LEED Design, Engineering, and Construction Reference Standards

LEED Category	Design Reference Standard
Sustainable Sites – Site Work	Construction Activity Pollution 2003 Environmental Protection Act – Construction General Permit
Sustainable Sites – Site Assessment	• ASTM E1527-05 Phase I – Environmental Site Assessment • ASTM E1903-97 Phase II – Environmental Site Assessment
Sustainable Sites – Heat Island	• ASTM E408-71 – Solar Emittance • ASTM D903-96 – Solar Absorption, Reflectance, and Transmittance • ASTM E1918-97 – Solar Reflectance • ASTM C1371 – 04 – Solar Emittance • ASTM C1549-04 – Solar Reflectance
Water Efficiency	Energy Policy Act 1992/2005
Energy Efficiency	• ASHRAE 90.1: Energy Standard for Buildings Except Low Rise Residential • ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004 • New Building Institute Advanced Buildings Core Performance Guide
Indoor Air Quality	ASHRAE Standard 62.1-2007: Ventilation for Acceptable Indoor Air Quality
Thermal Comfort	ASHRAE Standard 55-2004: Thermal Comfort Conditions for Human Occupancy

Faculty Involvement Outside of Class

Faculty support sustainable endeavors outside the classroom as well. Traditional involvement with regard to this topic is with student competition teams. The LEED team has obviously focused on LEED rating system design and construction requirements and alternative execution costs. Recently however, the Construction Management and Design Build teams' pre-qualifications and problems have been on LEED certification required projects. LEED is being continually integrated into established competition teams just as it has in the industry.

In addition the faculty provides 'after hours' LEED accreditation training to the graduating undergraduate class and other interested students each semester. Table 4 lists the number of students that have attended the training sessions. Passing rate for each section has been above 90% for those who follow through with the testing process while still a student in the program.

Table 4: Number of Program Undergraduate Students taking Optional LEED Training

Semester and Year	Number of Attendees
Fall 2008	53
Spring 2009	180
Fall 2009	28
Spring 2010	35
Fall 2010	45
Spring 2011	50
Fall 2011	52

In addition faculty have supported and given LEED accreditation training to over 5,000 professional attendees (contractors, architects, and decision makers) since 2004. This continued connection within the state regarding high performance construction has strengthened the perception of the program as addressing and meeting the needs of the industry. It is expected that the graduates from this program have exposure to the LEED rating system. Accreditation during the job interview process has been a determining factor company selecting candidates. Several students have gone on to be the 'green champion' within their organization.

Conclusion

While initial concerns of LEED premiums has subsided with increased education of all involved. An understanding that first cost premiums are relative to the project, owner requirements, local building standards, certification level being pursued and project team experience has been developed. So too has the understanding to integrate sustainable constraints in existing construction management courses. Sustainable design is not unique. All credits initially established for the LEED system were selected 'off the self' from existing best practices. While there is a need to understand the system, submittal, and approval process the core traditional concepts that are involved in designing and building a project remain. This study reflects, if anything, the need for faculty and programs to integrate best practices, or sustainable practices, within the framework of their existing programs while augmenting classes with synergistic technology and sustainability elective classes that allow for better understanding of building impacts and performances.

References

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