

Engaging Interdisciplinary Teamwork: Harnessing Architectural Education as a Transformation Agent on Campus

Collaboration is a heavily weighted word in the design fields, particularly as the profession is being pulled into a new paradigm of interdisciplinary design. This paper reviews one possible structure to address this blossoming need in the form of an interdisciplinary course partnering with university facilities.

INTRODUCTION

Collaboration is a heavily weighted word in the design fields, particularly in architecture. The singular creative designer that has been highlighted throughout much of the profession's history is being pulled into a new paradigm of interdisciplinary design. The prevalence of interdisciplinary teams and processes is growing in practice, encouraging current and future architects to expand their existing dialogues and vocabularies to better collaborate with other disciplines (Keeler, 2009; Moe, 2008; Yudelson, 2009; Deutsch, 2011; Reed, 2009), both aligned and non-traditional partners. This paper reviews one possible structure to address this blossoming need in the form of an interdisciplinary course, rooted in North Carolina State University's School of Architecture. This tested course focuses on the operations and maintenance of facilities on campus, using the campus as a living laboratory, and creating a vocabulary not just between architecture and other academic majors on campus, but also between students and the University Facilities Division staff, which rarely engages students directly. This paper reviews strategies for: (1) building rapport between diverse student participants through intentional exercises; (2) meaningfully engaging multiple disciplines and departments in the University Facilities Division in an academic setting; and (3) establishing a common educational process between architectural education and aligned, but vastly differing, disciplines.

This paper profiles the LEED Lab course at North Carolina State University (NCSU), which has been held for two semesters in the same format. LEED Laboratory, a larger initiative of the U.S. Green Building Council's (USGBC) Center for Green Schools, is a transdisciplinary immersion course that utilizes the built environment to educate and prepare students to become green building leaders and sustainability-focused citizens. The NCSU LEED Lab course is one of a growing number of similar courses being offered around the world, and one of the largest with approximately twenty-five students from across three different colleges on campus. Strategically organized so that the coursework is completed in interdisciplinary teams, students are given the opportunity not only to work constructively with other fields, but also to view environmental challenges and opportunities from different perspectives. This is the only

TRACI ROSE RIDER

North Carolina State University

course at NCSU that simultaneously establishes interdisciplinary relationships, uses hands-on service learning exercises, and actively affects the broader environmental impact of the university.

A CONCEPTUAL FOUNDATION FOR THE COURSE

One of the primary goals—and challenges—for this particular interdisciplinary approach is to help the separate disciplines in the course understand the value of each other, which is becoming ever more imperative in the design professions. The different offerings, perspectives, worldviews, processes and work strategies of each discipline are distinct, yet exceptionally valuable for each other to understand. While Architecture students may not use the environmental assessment processes taught to the Environmental Science students, or see through the same lenses as the Civil Engineering students, understanding and appreciating those differences will provide a stronger foundation to support collaborations, discussions and built projects in the future. Though design and architectural education is historically without interdisciplinary partners, a number of issues can be addressed by including aligned fields in both design courses and specific course projects. In the course reviewed here, interdisciplinary collaboration was layered to address the course methods and learning outcomes at different levels: first engaging students of different backgrounds in the class, and second with facilities staff, which helped to facilitate a meaningful real-world project.

One of the primary goals for this course focuses on the interdisciplinary collaboration in the classroom to facilitate specific learning outcomes related to problem solving and the design assessment process. There is significant literature addressing the benefits of interdisciplinary collaboration in higher education, ranging from increasing student productivity and fostering professional skills (Blackburn & Chapin, 1994; Chapman, 2006; Hackett & Rhoten, 2009; Sawyer, 2007; Robinson, Sherwood & Depaolo, 2010), addressing authentic teamwork issues such as communication barriers and knowledge expertise (Fleischmann, 2010; Kim, Ju & Lee, 2015; Spelt, Van Boekel & Mulder, 2014; Shattuck, 2001), how interdisciplinary understanding can grow from disciplinary understanding (Johnston, 2014), and the need for interdisciplinary work to support the growing emphasis on sustainability and complexity (O’Rafferty, Curtis & O’Connor, 2014). This course sought to address many of these issues primarily through class exercises and group reflections on process.

Another primary goal for the course was to provide opportunities for students to participate in a real-world, environmentally-focused project to enrich their experience and better prepare them for employment in a sustainability-focused field. Numerous articles review the benefits of including real-world and service learning projects in university courses (Afacan, 2013) and the importance of experience with interdisciplinary workings in industry (Blair, 2012; Bryson, Crosby & Stone, 2006). Considering this course as a version of service learning, focusing on critical, reflective thinking as well as helping to develop personal and civic responsibility (American Association of Community Colleges, 2015), the integration of a real-world project is seen as a key element to the success of the NCSU LEED Lab course. Billig et al. (2005) noted that using service-learning projects to teach content was one of the strongest predictors of all academic outcomes, while Astin & Sax (1998) find that engaging in service learning projects substantially enhances the student’s development in academics, life skills, and sense of civic responsibility. By partnering with the NCSU University Facilities departments, the NCSU LEED Lab course students were able to meaningfully participate in the assessment and problem solving related to existing buildings on campus, with the goal to enhance both the learning objectives of the course as well as the students’ notions of environmental responsibility.

PROJECT OVERVIEW AND COURSE STRUCTURE

The NCSU LEED Lab project is a partnership between multiple parties on campus led by the College of Design and the University Sustainability Office, including University Facilities Division. In NCSU's inaugural LEED Lab course held in Fall of 2014, students assessed the performance of Nelson Hall in the University's North Campus Precinct to explore opportunities for achieving a LEED (Leadership in Energy and Environmental Design) for Building Operations and Maintenance (LEED O+M) certification. Four NCSU colleges were actively engaged in data gathering, campus outreach, and interdisciplinary group work: Design, Engineering, Natural Resources, and the NCSU Poole College of Management. The building used in the first year of LEED Lab was an academic building, very similar to a traditional office building in both activities and hours. The second year course held in Fall 2015 focused on a residence hall, which is drastically different from the previous building type, both in terms of activities and hours. Though not addressed in this paper, these different building selections allowed for different engagement and outreach opportunities on campus. The course was designed to focus on existing building stock rather than the design of a new building, with a goal of better understanding what happens to a building after the traditional role of the architect is complete, and the structure is handed over to the owner. The instructors believe that this is a significant gap in design education.

The instructors chose to keep the content of the course within the boundaries of only one semester, while other LEED Lab hosts choose to hold their class over the entire academic year. The framework for the NCSU LEED Lab course is organized to encourage students to focus on particular credits, or operations and maintenance considerations, over the sixteen weeks in a semester. Taking into account both the breadth and depth of the LEED for Building Operations and Maintenance considerations, the NCSU course is divided into two phases within the semester, which are designated Module 1 and Module 2. This segmented structure affords each student two chances to go in-depth with different credits and considerations. Ideally, in one module, students can tackle considerations applicable to their particular major and individual interests, while addressing other credits that are outside their expertise area in the other module. Each module sees the students arranged into five interdisciplinary groups; each group is dedicated to exploring different credits in the rating system, as shown in Table 1.

GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5
Sustainable Sites/ Location & Transportation	Water Efficiency	Materials and Resources	Energy and Atmosphere	Indoor Environmental Quality
PR: Site Management Policy	PR: Indoor Water Use Reduction	PR: Ongoing Purchasing and Waste Policy	PR: Energy Efficiency Best Management Practices	PR: Minimum Indoor Air Quality Performance
Site Development - Protect or Restore Habitat	PR: Building-Level Water Metering	PR: Facility Maintenance and Renovations	PR: Minimum Energy Performance	PR: Environmental Tobacco Smoke Control
Rainwater Management	Outdoor Water Use Reduction	Purchasing - Ongoing	PR: Building Level Energy Metering	Indoor Air Quality Management Program
Heat Island Reduction	Indoor Water Use Reduction	Purchasing - Lamps	Optimize Energy Performance	Enhanced Indoor Air Quality Management Program
Site Management	Cooling Tower Water Use Reduction	Purchasing - Facility Management & Renovation	Advanced Energy Metering	
Site Improvement Plan	Water Metering	Solid Waste Management - Ongoing	Demand Response	
		Solid Waste Management - Facility Management and Renovation		
GROUP 6	GROUP 7	GROUP 8	GROUP 9	GROUP 10
Indoor Environmental Quality	Indoor Environmental Quality	Energy and Atmosphere	Energy and Atmosphere	Innovations & Regional Priority
PR: Green Cleaning Policy	Thermal Comfort	PR: Fundamental Refrigeration Management	Existing Building Commissioning - Analysis	Innovation
Green Cleaning - Custodial Effectiveness Assessment	Interior Lighting	Renewable Energy and Carbon Offsets	Existing Building Commissioning - Implementation	Regional Priority Credits
Green Cleaning - Products and Materials	Daylight and Quality Views	Enhanced Refrigeration Management	Ongoing Commissioning	
Green Cleaning - Equipment	Occupant Comfort Survey	Light Pollution Reduction (Sustainable Sites)		
Integrated Pest Management				

Table 1: Module group assignments

The intent behind the development of the chart shown in Table 1 is to establish groups of similar credits as much as possible, with the hope to use credit synergies to make the students' compressed work time more efficient, while at the same time allowing for more detail. The groups of credits were also structured in an attempt to balance the overall effort needed in each group. In other words, student groups with more complicated energy consumption and analysis credits should not have remarkably more work to do than groups addressing credits with differing levels of qualitative and quantitative work, or where the university may have already developed a policy, as is the case with housekeeping considerations. This is the basic structure shared by both semesters of the NCSU LEED Lab.

ADDRESSING MYTHS AND STEREOTYPES BETWEEN ACADEMIC DISCIPLINES

Because architectural design is traditionally insular, rigorous, and unique, there are precious few opportunities to engage meaningfully with other disciplines and majors. Often "interdisciplinary" projects in architecture involve other design disciplines such as landscape architecture or interior design that have, at the very least, a similar design culture. In these instances, the structure and culture of studio is understood, along with a significant number of processes, terms, and concepts. The studio structure, while a cornerstone of design education, is at the same time a significant deterrent to integrated projects with other majors. Often the curriculum in other disciplines has a difficult time adopting to and understanding a six-credit hour course that meets for four hours per day. If students from other disciplines are asked to join in studio, they struggle adapting to and appreciating the activities that happen in the studio space. Though the studio culture and format is a challenge that can be overcome with careful thought and planning, it is a formidable challenge to interdisciplinary work nonetheless.

The NCSU LEED Lab course is held in a three-hour block of time once a week, instead of multiple times a week for shorter periods. This strategic structure provides more quality time for in-class exercises and relationship building between students during each class period. It also allows for more in-depth class exercises and site visits during the class time, without encroaching on other class commitments.

The goal of the first two classes in each semester is to make the students comfortable with the framework and rigor of the course, the dual instructors, and with the other students themselves. An important objective of the instructors throughout the semester is to enable students to be comfortable with their peers in other fields, and be aware of their expertise and value. To begin to build this comfort level, or more accurately to check any negative preconceptions at the door, the first class includes a Myths and Stereotypes exercise. Students are divided into groups of their home colleges, establishing three clusters: Design, Engineering and Natural Resources. There is no cross-pollination between disciplines in this exercise. Each of the three groups are requested to list three myths and/or stereotypes about each of the groups, including their own.

The characteristics of the different groups identified through the Myths and Stereotypes exercise in both semesters were honest, sometimes harsh, sometimes ridiculous, but largely entertaining and humorous. Responses about design students included, "They have a lot of free time, but are always stressed," and "Often forget to shower." Design students also "wear all black," have "their heads in the clouds," and "never sleep." Engineering students were perceived as, "Detail oriented and snobby," and also "So stressed—ALL the time." The engineering students also "love the World of Warcraft," are "socially impaired" and "are robots." Characteristics identified with Natural Resources students included, "They hate to wear shoes," and "They all work on grass and things...?" and "We don't really know WHAT they do..." Natural Resource students were also "treehuggers" and "alarmists." Verbally reporting these myths and stereotypes to the larger group in an informal setting afforded a

judgment-free venue to look critically at the preconceived notions that each individual was bringing to the course. By saying these statements out loud, the students realized how unfair and unreasonable the statements actually are. When one student's perceptions are listed beside obviously unfair perceptions that others have brought to the class about them, it is easier to identify unfair thinking and to breakdown superficial misconceptions.

Another exercise to build class familiarity is held in Week 2, and focuses on the individual. Taken from a workshop that one of the instructors had recently attended, the students pair up with another student that they did not already know from a different college. The pairs are given two minutes to gather interesting information about the other, then two minutes to switch roles. The goal of this exercise is to introduce their partner to the class and present them as the most interesting person in the room. Each student has 30 seconds to make the introductions in a round of speed presentations. This exercise allows each student, individually, to be the focus of the class. Not as a group from a college, and not as defined or perceived by the virtue of their major. We learned that we had a number of chefs in the classes, any number of different home countries and backgrounds, and amazingly unique and interesting hobbies. While this is not earth shattering or particularly surprising, it allows the students to see each other as individuals and not as stereotypes. Though this may not seem directly related to the goals of the course, these initial exercises are vital to establishing a good flow of communication within our interdisciplinary groups that need to be productive throughout the semester.

Multidisciplinary student teams assess sustainability and green building strategies on campus through in-class exercises led by the facilities staff, taking part in energy audits, waste audits, and occupant satisfaction and comfort surveys. "We were tasked with researching the [LEED] credits, coming up with action plans, and coordinating with professionals to solve problems we faced," said one student. "The ability to work with students from varying disciplines, apply critical thinking skills and engage in a professional project that improves our university was very rewarding. [This] has been my favorite course at NCSU." These initial team-building exercises provide a foundation for this collaborative and rewarding environment.

ENGAGING THE "OTHER SIDE" OF THE UNIVERSITY

The NCSU LEED Lab course is structured as a true partnership between the School of Architecture and the University Facilities Division. It is essential to have a symbiotic relationship and for each side to contribute meaningfully and strategically to the class activities and content. With one of the co-instructors having a dual role in both the University Sustainability Office and the University Facilities Division, this course is able to reach out to and meaningfully involve a number of applicable departments dealing with operations and maintenance on campus—the back of house of the academic institution. The departments that were engaged in the course over both semesters include Building Maintenance and Operations, Repair and Renovation, University Housekeeping, Energy Management, Waste Reduction and Recycling, Environmental Health and Safety, Energy Solutions, Purchasing, Grounds Management, and the Building Maintenance and Operations' Commissioning Team.

Representatives from each of these departments in the University Facilities Division is asked to come to a specific class period and address the class individually to share their story with the students. While these staff members do not regularly present to or even engage with students, the purpose of their presentation is to impart one fraction of their knowledge about their team's responsibilities regarding the operation of campus. They come to share the issues, challenges, successes, processes, and goals of their departments with the students. This smaller-scale interaction provides a basic level of knowledge for all of the students enrolled in the class about each topic and department. These sessions also launch a new and valuable partnership between the students and the University staff. This interaction,



1



2

Figure 1: Director, NCSU Building Maintenance and Operations, visits and speaks with the class. Photo © Traci Rider

Figure 2: Occupational Health Manager, NCSU Environmental Health and Safety, speaks with the class and walks through an Indoor Air Quality audit. Photo © Traci Rider



Figure 3: Students wrapped up the semester with a workshop/charrette with participants from the NCSU Facilities Division, including the Assistant Vice Chancellor for Facilities Operations. *Photo © Traci Rider.*

Figure 4: Two days of trash were audited with the help of NCSU Waste Reduction and Recycling. This in-class exercise helped to see how much of the building's waste could be diverted from the landfill, and what type of occupant education may be needed. *Image courtesy of NCSU Sustainability Office.*

although less than one hour, allows the students to engage in a dialogue with the facilities staff member, asking questions about the facilities world, including concerns and perceptions of the departments. In this brief time, the two to-be partners become united as they work toward the same goal—a better, more sustainable and more efficient campus environment.

All Facilities Division representatives that engage in the course participate in a number of different ways, and numerous times over the course of the semester. Instructors are purposefully efficient and considerate with the Facilities Division staff's time, recognizing their other—and principal—responsibilities on campus, while still striving to bring the most value and necessary material to the students

ESTABLISHING A COMMON VOCABULARY

The NCSU LEED Lab course leans heavily on USGBC's LEED Rating System for Operations and Maintenance. While certification of the facilities has not been a goal of the LEED Lab courses at NCSU, the framework provided and tested by USGBC is valuable as a scaffolding structure to help the students organize and distill copious amounts of considerations and information. The principal objective of this course is to use the existing, proven, organization of the LEED rating system to provide a structure for the students to consider complex issues regarding building operation and maintenance after occupancy. As noted in endless articles, sustainability and green building itself is a tremendous problem that is too complicated to be addressed by one discipline, let alone one small group of students (Stibbe, 2009; Meadows and Wright, 2008). But comprehending the levels of complication, and the major considerations for each topic, is precisely what design students and future architects are asked to do.

To make such an enormous topic addressing green building operations begin to make sense, and not be completely overwhelming, the LEED rating system is used in the class as a structure for organizing relevant issues. Though no students in the first two semesters had experience with the LEED rating system specific to Operations & Maintenance, some did have knowledge of other versions of the LEED rating system, such as Building Design and Construction or Commercial Interiors. At the very least, most of the students in the class had heard the term "LEED" in exchanges within the profession, in media, and in discussions with peers. This course capitalized on this awareness of LEED systems to help students organize the variety of issues and tasks being asked of them throughout the semester.

The use of a popular and previously known structure like LEED helped to establish a vocabulary that could be used comfortably between the different disciplines represented in the course. While there is rhetoric and common terminology within each of the different majors, terms were discovered, discussed, debated, and ultimately used constructively in the data analysis and final presentations. A shift in the conversations throughout the two semesters was noted, going from tentative at the beginning, to robust and rigorous toward the end. While increased familiarity between the students themselves would certainly play a role in that change, so did the establishment of new facet of emergent knowledge co-created by the students through this process.

IN-CLASS ACTIVITIES

One of the primary purposes of the course, and one of the most fundamental goals, is to facilitate non-traditional partnerships for design students. While this intent is tackled most obviously with the Myths and Stereotypes and Most Interesting Person in the Room ice-breaker activities previously described, as well as the semester-long group projects, in-class exercises also work to establish increased comfort with other fields. These diverse activities are purposefully arranged to establish a common understanding of a specific topic, in both processes and terminology. These experiences help to form a common vocabulary, focused on existing building and operations that diverges from the design-centered vocabulary of architectural education. For architecture students, this "new" language aids in translating the



4

“harder” science jargon of environmental sciences students, and brings the exactness from the engineering students into a common area of building function

The three primary in-class exercises included in the class are (1) a large-scale waste or recycling audit; (2) an indoor air quality test; and (3) a “lite” energy audit. These three exercises are chosen to span the different fields represented in the class, ideally pulling different bits of knowledge from each of the disciplines into a comprehensive frame of reference. While a blossoming expertise of indoor environmental quality may lie with the Environmental Sciences students, both architects and engineers can identify with different contributions and impacts from their fields. The same basic premise applies also to the other two exercises. Hands-on, in-class activities led by Facilities Division staff are a fundamental and integral to achieving the learning objectives of the course.

BENEFITS

The structured interdisciplinary collaboration of the students in the NCSU LEED Lab class was a specific determinant of the course’s process, method and outcomes, as was the collaboration with the NCSU Facilities Division. By forcing the students from different backgrounds and expertise to work closely together on real-world issues, and potentially impacting their home campus, the course aimed to capitalize on the benefits outlined in the literature for both service learning and interdisciplinary opportunities in higher education. Specifically, students valued the real-world aspect of the course, stating in the course evaluations that “The biggest strength of the course is giving students access to knowledge not typically available to students, making them more valuable in their future job hunting endeavors.” Another student stated that “The interdisciplinary work between the three schools was beneficial and helped us all to grow as students and helped prepare us for working after school. Doing a real project is rewarding and exciting. It provided a great look at LEED in practice as well as theory.” This feedback shows the opportunity for the class to help to transform the way design students view interdisciplinary collaborations, as well as peer fields in general.

REFERENCES

- Afacan, Y. (2013). Introducing sustainability to interior design students through industry collaboration. *International Journal of Sustainability in Higher Education*, 15(1), 84–97.
- Astin, A.W., & Sax, L. (1998). How undergraduates are affected by service-participation. *Journal of College Student Development*, 39(3), 251–263.
- Billig, S., Root, S., & Jesse, D. (2005). *The impact of participation in service-learning on high school students’ civic engagement*. (Circle Working Paper 33). College Park, MD: Center for Information and Research on Civic Engagement and Learning.
- Blackburn, R. S., & Chapin, D. (1994). Design and Management EDUCATION: Collaboration between Practice and Academia. *Design Management Journal (Former Series)*, 5(4), 47–54.
- Blair, B. (2012). Elastic minds? Is the interdisciplinary/multidisciplinary curriculum equipping our students for the future: A case study. *Art, Design & Communication in Higher Education*, 10(1), 33–50.
- Chapman, K. J. (2006). Can’t We Pick our Own Groups? The Influence of Group Selection Method on Group Dynamics and Outcomes. *Journal of Management Education*, 30(4), 557–569.
- Deutsch, R. (2011). *BIM and integrated design strategies for architectural practice*. Hoboken, N.J.: Wiley.

- Fleischmann, K., & Daniel, R. J. (2010). Increasing authenticity through multidisciplinary collaboration in real-life scenarios in digital media design education. *CoDesign*, 6(2), 61–74.
- Hackett, E. J., & Rhoten, D. R. (2009). The Snowbird Charrette: Integrative Interdisciplinary Collaboration in Environmental Research Design. *Minerva*, 47(4), 407–440.
- Johnston, A. S. (2014). CitySection: A Pedagogy for Interdisciplinary Research and Collaboration in Planning and Environmental Design. *Journal of Planning Education and Research*, 35(1), 86–92.
- Keeler, M. (2009). *Fundamentals of integrated design for sustainable building*. Hoboken, N.J.: John Wiley & Sons.
- Kim, M. J., Ju, S. R., & Lee, L. (2015). A Cross-Cultural and Interdisciplinary Collaboration in a Joint Design Studio. *International Journal of Art & Design Education*, 34(1), 102–120.
- Meadows, D., & Wright, D. (2008). *Thinking in systems: A primer*. White River Junction, Vt.: Chelsea Green Pub.
- Moe, K. (2008). *Integrated design in contemporary architecture*. New York, N.Y.: Princeton Architectural Press.
- O’Rafferty, S., Curtis, H., & O’Connor, F. (2014). Mainstreaming sustainability in design education—a capacity building framework. *International Journal of Sustainability in Higher Education*, 15(2), 169–187.
- Reed, B. (2009). *The integrative design guide to green building: Redefining the practice of sustainability*. Hoboken, N.J.: Wiley.
- Robinson, D. F., Shersood A.L. & Depaolo, C. A. (2010). Service-Learning by Doing. *Journal of Management Education*, 34(1), 88–112.
- Sawyer, K (2007). *Group Genius: The Creative Power of Collaboration*, Cambridge, MA: Basic Books.
- American Association of Community Colleges. (2015). *Service Learning*. Retrieved from <http://www.aacc.nche.edu/Resources/aaccprograms/horizons/Pages/default.aspx>
- Shattuck, L. G. (2001). Validating Undergraduate Human Factors Education Using Interdisciplinary Design Projects. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 45(9), 773–777.
- Stibbe, A. (2009). *The handbook of sustainability literacy: Skills for a changing world*. Totnes, UK: Green Books.
- Yudelson, J. (2009). *Green building through integrated design*. New York: McGraw-Hill.

CONCLUSION

The first two semesters of the course resulted in a number of favorable outcomes including preparing the participating students to sit for the LEED Green Associate and LEED AP O+M professional credential exams. Also, the NCSU’s Facilities Division was given data-driven feedback to reassess their policies and procedures, and to work toward a more sustainable campus, city and region. Both the University staff and student population were actively engaged in data gathering, and are being continually provided with findings and information as the projects move forward through the Facilities Division on LEED Lab student recommendations. Used as a template for student engagement, environmental stewardship, and policy management, discussions are underway as to how NCSU’s LEED Lab can be further implemented across all NCSU’s campus precincts and to similar institutions in the region.

The principal academic goal of the NCSU LEED Lab course is for all students to develop a holistic understanding of what types of considerations truly contribute to the operations of a building after occupancy. By better understanding how buildings actually work and function after occupancy, as well as the processes and considerations needed to maintain the building throughout its life, design students can understand how to deliver better building designs. It was imperative that the course address both the breadth and depth of considerations in moving toward a greener built environment post occupancy.