AC 2011-706: THE COLUMBIA CITY TRAILHEAD: A COLLABORATIVE CONSTRUCTION ENGINEERING TECHNOLOGY CAPSTONE EXPERIENCE

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Regina Leffers, Ph.D. is the Director of the Center for the Built Environment and professor of Construction Engineering Technology at IPFW. She is a founding member and past President of the Northeast Indiana Green Build Coalition, and was Co-Chair of Mayor Graham Richard’s Green Ribbon Commission for the City of Fort Wayne. Her book, Sustainable Construction and Design, was published by Prentice Hall in May, 2009. One current manuscript, being written with Architect, Matt Kubik, and colleague, Pat Ashton, is called: The Green Age: Transforming Your Life Choices for the 21st Century is nearly ready to submit for publication. A second manuscript, Technology and Sustainability from a World Perspective, has chapters written by colleagues and graduate students from different departments at IPFW, and will be ready for publication by spring of 2011.

Some of her current efforts are going toward redesigning an existing building on campus into a Sustainable Construction and Renewable Energy Lab. Briefly, the goals of the building are that it be: 1. a Positive energy building, using renewable sources to create more than enough energy to fund itself and neighboring buildings; 2. Net-zero for storm water output; and 3. a Living example of sustainable construction. The building itself will educate. All energy systems, mechanical, electrical, and renewable, will be transparent.
The Columbia City Trailhead: A Collaborative Construction Engineering Technology Capstone Experience

Abstract

In 2010, a collaborative effort between a nonprofit trail advocacy organization, a small rural Indiana city, trade unions, grantmaking organizations, materials suppliers, contractors, and the Construction Engineering Technology program at Indiana University – Purdue University Fort Wayne (IPFW) led to the successful construction of a trailhead building in a city park. Multidisciplinary collaboration began with a design charrette in January, bringing together architects, brickmasons, carpenters, electricians, engineers, greenbuilding experts, landscapers, professors, and students. Starting with a site plan by a local architect and a construction blueprint from another trailhead elsewhere in the state, charrette participants improved the design and site location. Students completed the design, obtained approval from the customer (the nonprofit trail group), and obtained approval from local and state governments. Because this was a capstone course, students were required to demonstrate knowledge and skills they acquired during their four-year degree program. As such, they created the blueprints of the new design, estimated costs and materials, scheduled the construction, and fulfilled the role of project manager. Construction professionals mentored the students as they built the trailhead restroom. The magic words “student project” led to substantial donations of money, labor, excavating, and materials from many sources. As a result, the project was completed at one-quarter the price bid by a private contractor. Assessment of student learning was conducted by the instructor, departmental colleagues, and working construction professionals.

Introduction

In part, this is the story of collaboration between two professors. Regina teaches Construction Engineering Technology, and Barry teaches Mechanical Engineering Technology. We both teach Senior Design Capstone classes. While Barry’s seniors design and build machines for local sponsoring companies, Regina’s seniors plan and build residential or commercial structures.

In the summer of 2009, Barry joined the Board of Directors of the Friends of the Eel River Trail, a nonprofit organization dedicated to building a recreational trail along an abandoned railroad corridor, connecting the cities of South Whitley and Columbia City, Indiana. The Board planned to build a trailhead, consisting of a parking area, restrooms, benches, and bicycle rack, on land owned by the Columbia City Parks Department. The City agreed to accept ownership and maintenance responsibility for the completed building.

The Board obtained architectural plans from a restroom built on a recreational trail in Indianapolis, and paid a local architect for a preliminary site plan, but funding for the $120,000 construction project fell through. Barry asked Regina whether her Construction Engineering Technology Senior Capstone class would be interested in taking on this project at a lower cost. In the past, Regina selected the projects for her Capstone classes, meeting with some resistance from students, but this year she gave the students a choice, and they enthusiastically adopted the trailhead as their project.
Construction Process

Regina started the construction process with a Design Charrette, using the United States Green Building Council’s LEED criteria for new construction as a rubric to assist participants in thinking about design topics such as energy efficiency and water use. The Design Charrette met in January 2010, and included students, Friends of the Eel River Trail board members, architects, engineers, union leaders, landscape designers, and estimators. Regina invited the Carpenter’s, Bricklayer’s, Electrician’s, and Laborer’s Unions into this project as mentors and volunteer labor. The Unions used this project as an opportunity for training apprentices.

After the design charrette, students discussed the pros and cons of the design possibilities and incorporated the best ideas into one design. They also researched building materials, and HVAC, plumbing, and electrical fixtures to find the most energy efficient products. They also researched solar panels, and chose a couple of design options that would cover the electrical needs of the building. Then students presented their design and material ideas to the Friends of the Eel River Trail Board for approval. One significant design improvement over the Indianapolis trailhead was the addition of a porch on the north side of the building, providing shelter, seating, and drinking water to trail users.

After the Friends of the Eel River Trail Board approved the design, students got to work on the project estimate and schedule. Their initial estimate was reviewed by two estimators from a local general contractor, Hagerman, Inc., one of whom was a graduate of our program. The professional estimators used our drawings and materials list to generated an estimate using commercial software. When our students removed the labor and other donated components from the Hagerman generated estimate, they found the two estimates to be fairly close.

We invited representatives from the local Carpenter’s, Bricklayer’s, and Electrician’s Unions to come to class and talk with students about how the project should proceed, and about how they saw themselves interfacing with and mentoring students during the process of building the project. Students had a rudimentary project schedule for these mentors to review, and their input was invaluable.

With the input from mentors, students created a working schedule, and took on a variety of tasks to get the work going. Students divided tasks and roles for the project. They discussed building details and revised sections for accuracy. They talked with the Columbia City building inspector.
to get specific questions answered about foundation and footings. They incorporated tools needed, projected material delivery dates, Union mentor volunteers, and their own areas of expertise into the working schedule. They began working on coordinating site excavation, and cleared up electrical, water and sewer hook-up details with respective utilities. Students surveyed the site and shot the elevations. They investigated whether an engineer’s stamp would be needed on the Construction Design Release that had to be submitted to the State. Students calculated rough quantities of materials needed for the different trades, then submitted their estimates to their Union mentors for evaluation.

The working schedule included these project phases:

1. January, Design Charrette, hone design, research materials.
2. February, present design to Friends of the Eel River Trail Board members.
3. February, estimate review with Hagerman, Inc. estimators, discuss schedule with representatives from the Carpenter’s, Bricklayer’s, and Electrician’s Unions.
4. February, project schedule review with Brad Smith, Project Manager / Estimator, Hagerman, Inc.
5. March, 1st week, site clearing. Prints submitted to State for approval.
7. 3rd week in March: Excavation, footings, form slabs.
8. 4th week in March: Slabs.
9. 1st week in April: CMU walls.
10. 2nd week in April: CMU walls and partitions, roof framing, doors.
11. 3rd week in April: Porch slab and sidewalks, trim carpentry, graffiti control.
12. 4th week in April: Metal roof install, exhaust fans and stack.
13. 5th week in April: Gutters, finishes.
14. May 7th Ribbon Cutting Ceremony.
The groundbreaking ceremony included Regina (far left), Union mentors, students, the Mayor, the local member of the Indiana State House of Representatives, Friends of the Eel River Trail board members, the Chancellor of IPFW, and volunteers from local contractors.

**Construction Photos**

Local contractor Wigent Excavating Inc. cleared the site as a donation, then students placed pins for the building. Students trenched for water and sewer hookup to the lines that feed the adjacent Firefighters’ Museum (the steel building behind the backhoe, below left).
Students uncovered large slabs of concrete when trenching for footings and conduit. Students prepared the footings under the guidance of Carpenter’s Union mentors, then the concrete was poured and leveled.

After a safety inspection, the first course of CMU was laid, followed by plumbing rough-in by volunteers from Flow-Tech Plumbing & Heating Inc. Students and mentors from the Electrician’s union installed electrical conduit to the utility pole by the road, then filled the trench and tamped the soil. They also completed the electrical rough-in.
Concrete was poured for the slab and porch post footings.

The steel doorways were installed, then students tended the masons by cutting CMU, erecting scaffolding, supplying CMU, and delivering mortar. Students learned that masonry is a skilled craft.
Students made mortar, and filled CMU with grout. The exterior walls were soon finished.

Interior CMU walls were built, then the concrete porch floor was poured and finished.
Students marked and cut expansion joints in the porch floor, and re-erected scaffolding.

Next, students and Carpenter’s Union mentors framed and sheathed the restroom roof.

Students built and raised the porch posts.
Next, they framed the porch roof, then built forms for the concrete sidewalk.

It rained the day the sidewalk was poured, so students and Union mentors scrambled to erect a rain shield over the concrete.

The bicycle rack pad was poured, finished, and broomed.
Once the shell was completed, students focused on painting and installing doors, trimming windows, installing insulation and ceilings, and spraying a graffiti-resistant silicone coating on the CMU.

Students installed doors, door hardware, ductwork, roofing, and gutters.
Students installed standing-seam roof panels.

Finally, the Grand-Opening day arrived in early May. Representatives of grant-making agencies joined students, Union mentors, political leaders, the University Chancellor, Friends of the Eel River Trail board members, the Parks Department, local contractors, and community members to celebrate the new trailhead.
Funding and Donations Process

Although the students were not directly involved in raising funds for the project, their work was critical to the success of the fundraising effort. Barry used AutoCAD drawings and elevations prepared by students in his presentations to the Columbia City Rotary Club and the Parkview Whitley Hospital Foundation to obtain substantial grants. Paragon Medical donated $2500, the Rotary Club donated $5,000, and Parkview donated $20,000 towards construction. Regina, her students, and members of the Friends of the Eel River Trail Board solicited donations and price discounts for equipment rentals and building materials. We found that the words “student project” opened many doors.

Assessment and Lessons Learned

Offering the students a choice of projects was better than presenting them with a required project, because the students developed a strong sense of ownership.

Although we invited representatives of city government to participate in the Design Charrette, none were able to attend. Later, this lack of early involvement in the planning stages caused problems with the site plan. In future projects of this kind, we will have to work harder to bring city officials into the planning process at the beginning.

Rod Mitchell, a retiree and treasurer of the Friends of the Eel River Trail, was on-site every day to buy materials, supply food, and help the students build the trailhead building. Having a member of the sponsoring organization on-site was critical in keeping communication flowing between the various parties.

Union involvement was crucial to the success of this project. Senior members of the Carpenter’s, Bricklayer’s, and Electrician’s Unions mentored our students and Union apprentices throughout the planning and construction processes.

Students learned first-hand about differences between theory and practice throughout the construction process. For example:

- The site plan prepared by a licensed architect contained numerous errors; apparently the architect never measured the locations of existing buildings or the parking lot. Students took measurements and redrew the site plan correctly.

- Soft clayey soil and sand predominates in this part of the state, so students obtained a small excavator to dig the foundation. They were not expecting to find large slabs of concrete in the soil. The students had to obtain a larger payloader to dig out the slabs.

- The original plans called for three porch posts, but the electricians laid the main conduit directly under the center post position. Students redesigned the porch on-site with four posts, so the conduit runs between the center posts.
Regina felt that it was important to feed the volunteers to build a sense of camaraderie and boost morale – and it worked beautifully! She solicited donations from local restaurants and grocery stores, and brought a propane grill on-site to cook hamburgers, hot dogs, chicken, and steaks. The volunteers were extremely appreciative; the most senior Union volunteers had never been on a construction site where food was provided.

Trailhead construction took place during a deep national economic recession which hit the construction industry particularly hard. Students, Union mentors, and other volunteers had the time to work on this project because most of them were either underemployed, unemployed, or retired. It is doubtful that this Trailhead building could have been completed on-time during a healthy economy.

One measure of the Trailhead’s success is public use and interest. Water usage records indicate 1,250 visitors per month use the restrooms, in a city of only 8,400. Another measure of the project’s success is interest by municipal government. Six months after the building was completed, the Columbia City Parks Department requested a set of detailed drawings so they can duplicate this building in another city park.

Employment figures from the U.S. Bureau of Labor Statistics show that construction employment suffered a greater loss in the recent recession than at any time in the previous half century. Construction employment in 2010 was 27% lower than the previous peak of 2006.
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