Whetherability: How Do Architectural Design Students Consider the Building Envelope?

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Abstract

This presentation will describe a scholarship program initiated by the RCI Mid Atlantic Chapter in conjunction with Virginia Tech’s School of Architecture and Design comprising a student competition to develop a project focusing on the building envelope and its constructability, sustainability, and code requirements. This beginner-level presentation will appeal to employers of architectural and engineering graduates and all professionals interested in promoting the knowledge and understanding of building envelopes to the next generation of design professionals.

Speaker

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WHETHERABILITY: HOW DO ARCHITECTURAL DESIGN
STUDENTS CONSIDER THE BUILDING ENVELOPE?

ABSTRACT
In the work of design students, the consideration of building envelopes can sometimes be marginalized in favor of more formal and theoretical concerns. Often, students enter the workforce with little to no knowledge of building envelope design and components. In light of this, the RCI Mid Atlantic Chapter has recently sponsored design competitions at the School of Architecture and Design at Virginia Tech. The competitions encouraged students in the formative third year of their undergraduate studies to consider the importance of the building envelope and how it relates to constructability and building code requirements. Programs were written with a deliberate emphasis on the building envelope. In essence, the assignments were intended to celebrate the building envelope as interpreted in various ways. The authors of this paper, who were jurors representing faculty and the private sector, will present “teachable moments” where they had an opportunity to discuss assumptions about suitability, constructability, weatherability, and code compliance in relation to the design intentions of the students’ work. The authors will present work from the two competitions, giving readers a chance to see how creative design ideas can be supported by good building science, especially when these concepts are introduced as part of the educational experience.

The Building Envelope in Architectural Education
Recent college graduates seeking employment rarely, if ever, have a significant understanding of the building envelope. While broad concepts and theories related to the building envelope are introduced in architectural education, there is often insufficient space in the curriculum to instruct students in other critical factors, such as constructability, compliance with code requirements, and durability. Consequently, building characteristics such as air and water management, which have become paramount in the consulting industry, are foreign concepts to these students.

In the authors’ experience, the typical incoming third-year architecture student’s conception of an exterior wall section is often a 12-in.-thick cast-in-place concrete wall without insulation, or perhaps a 4-in. layer of batt insulation embedded between two 4-in.-thick wythes of concrete. Rain screens are also a popular wall treatment, but they are often merely additive and are drawn with no knowledge of their potential for pressure-equalization or the necessity for drainage. Roofs are often the last building surface considered, and when they are drawn, they are most often dead-level, with a single line representing an anonymous layer of weatherproofing, again over batt insulation. In some cases, projects are completed with no consideration of the roof construction at all.

In architecture schools, there are classes addressing building assemblies that attempt to ameliorate this problem, but they often carry less weight than other courses, and they are often survey courses that cannot get into the level of detail necessary to address each student’s design. Faculty expect students to work out the components of their own building envelopes, which depend greatly on the architectural intent of the student. To do this, students turn to a range of sources. These vary widely in quality from proprietary details found on the web, to precedents in architectural journals (which often gloss over the details of envelope composition), to excellent resources such as Building Construction Illustrated by Ching. In some cases, students struggle with this process due to the lack of a strong foundation in basic building science concepts. Building envelopes are often drawn by pulling elements from the work of others without a fundamental understanding of how they will perform in the student’s own design.

In the effort to give architects a well-rounded education, it can be argued that insufficient time and resources are dedicated to the topics of energy conservation, water management, and vapor diffusion in the curriculum. These concepts are learned in the workplace—often too late, and occasionally after a failure has occurred. This results in disappointed owners and monetary loss due to legal fees and property damage.

When Architects Enter the Workforce
Employer expectations for incoming intern architects are woefully low; in the words of the old chestnut, the young architect is expected to know very little about a great deal. But in practice, design professionals—particularly architects—are expected to have an awareness of all aspects of a building (e.g., spatial conditions; code requirements, including egress and accessibility; structural systems; and mechanical, electrical, and plumbing systems). Often, new design professionals merely know that certain requirements exist and expect to retain the services of specialist consultants to actually design buildings that can comply with these requirements.

Most recent college graduates will have a very limited knowledge of building requirements, especially relative to the building envelope. Interns may only have a basic understanding that roofs need to slope to drain, require some amount of insulation, and should keep the building dry. They have no parameters to help them select from among the plethora of materials available. Similarly, young design professionals understand that a wall needs to resist some water and somehow should connect with the roof. They lack a fundamental understanding of the demands imparted on the assembly as they relate to loads and air and water management. Without an understanding of how these systems function, there is no appreciation of the need for continuity of protective layers or knowledge of how to handle transitions between building components. These critical details are often overlooked because the architect does not know how to address them, nor does he or she appreciate their importance.

While specific statistics are difficult to obtain, an article in Architectural Record reported that between 15 and 21% of insured architecture firms filed a professional liability claim in each year between
1995 and 2004, based on data supplied by Victor O. Schinnerer & Company. The exact nature of these claims was not specified, but the majority, or 66.5%, were initiated by the project owner. Negligence on behalf of the design professional accounts for many construction defect claims. Time and again, design defects could be averted through proper education, knowledge, and credentials, many of which are offered through the RCI educational programs.

Engaging Students’ Interest in the Building Envelope

In 2012, the Mid Atlantic Chapter of RCI initiated a program that awarded $2,500 in scholarships to third-year students within the School of Architecture and Design at Virginia Tech. The scholarships were awarded based on the results of a competition that was coincident with a project assigned in the students’ design laboratory. While winners received larger cash awards, all students received a small stipend for their participation in the competition. The program was developed with three key concepts in mind:

1. To offer financial assistance to students who were pursuing careers in design and/or consulting of the building envelope
2. To provide awareness of the purpose and agenda of RCI while encouraging student membership
3. To promote education about the building envelope while providing the students with an advantage over their competition in the pursuit of employment.

The First Competition

The competition brief in the fall of 2012 asked beginning third-year students to design a 10,000-sq.-ft. “Building Envelope Museum” on one of three sites in downtown Roanoke, Virginia. The design of the museum required analysis of and response to the existing urban context. Designs were to celebrate the design of the building envelope, from traditional practices to new technological developments in the building sciences. Judging criteria were as follows: 1) articulation of the building section, 2) coordination and consistency of the drawings individually and collectively, 3) clear rendering of materials, 4) constructability and consideration of the forces of gravity and nature, and 5) accessibility and code compliance. The objective was for students to think of the museum as both a space to occupy and an object with constructed qualities; as both a destination for museum-goers and a demonstration of how buildings go together.

Nine weeks were allotted for completion of the designs. With these limitations, students were not expected to create fully developed schemes. The intent was rather to have them explore the building envelope, perhaps for the first time, and to engage in dialog relative to the opportunities and concerns that their designs presented. On the day of the jury session, November 5, 2012, students presented their competition boards and architectural models, giving a five-minute summary of their work and answering jurors’ questions for another five minutes. The winning designs were selected by the authors, along with Professor Mario Cortes of Virginia Tech’s School of Architecture and Design. One of the main criteria for selection was the successful integration of pragmatic considerations of envelope construction with the aesthetic and spatial experience of the space of the museum. The best schemes accomplished both of these goals.

The winning entry shown in Figure 1 was a children’s building envelope museum providing an interesting spatial sequence...
Learning
Integrate. Educate.

The building envelope is the fabric through which energy is transferred between the building’s internal and external environments.

The building envelope must reconcile and balance several demands: Ventilation, solar heat gain, glare, daylighting, thermal insulation, water management, materials, assembly, sound and pollution.

The comfort range of the human body is limited, and it is a good starting point when considering the design of the building envelope.

Figure 2 – Section from the first-place entry from the 2012 competition.

Discovery
Interact. Control.

As a means to assist discovery, exhibits will be a way for visitors to experience the building envelope first hand, through interactive exhibits that elaborate and demonstrate the concepts listed above.

with a monumental stair connecting the floors. An articulated roof plane included a vegetated roof and amphitheater with edge protection to allow patrons to enjoy the city from four stories up. The student’s competition boards contained drawings that corresponded well with one another and successfully portrayed the building and its connection to its site. The project received first place largely because the detailing of the envelope contributed to the enjoyment of the space; the scheme demonstrated a building envelope that was constructible and added to the experience of the museum from both the interior and the exterior.

The exterior wall section in Figure 2 shows a concrete wall clad with Trespa panels, with inserts of translucent argon-filled acrylic blocks animating the façade. These blocks also served as benches throughout the building interior and occupied roof deck. While the student did not provide adequate insulation, and there would likely be thermal comfort issues in the large glazed box on the south façade of the museum, she did consider some details of the construction. For example, her section included coping and a drip edge at the top of the exterior wall, and gaps in the Trespa cladding to accommodate movement.

The second-place entry, seen in Figure 3, caught the jury’s attention with its intricate roof and ceiling assembly, creating a dynamic lighting pattern around the two central circulation cores, which also serve as thermal chimneys. The scheme featured façades that cut back from the street plane to encourage patrons to enter the museum. The building section shows insulation between the load-bearing concrete wall and the concrete cladding layer, but the jury would have also liked to see the roof section shown in detail. The building exterior would have benefited from a heightened expression of the dynamism that is manifested in the building’s interior.

Figure 3 – The second-place entry from the 2012 competition.

The third-place entry from the 2012 competition.
The third-place entry, shown in Figure 4, also included a grand staircase and a rooftop amphitheater. The student expressed different building materials on different floors: The first floor was built with exposed brick masonry on interior and exterior vertical and horizontal surfaces, while the second floor transitioned to concrete walls and floors. While many details needed more development (for example, the insufficiently insulated walls), the student was applauded for his clear tectonic expression and his depiction of steel reinforcement, tapered roof insulation, and a roof deck system on pedestals. In addition, the excellent correlation of the drawings and the overall quality of the graphic presentation were recognized.

The Second Competition

In the fall of 2013, the RCI Mid Atlantic Chapter once again supported a student design competition. That year, the brief challenged students to design an “Enclosure Education Center” to serve as a forum for discussion of best practices and new developments in building enclosures. The 12,000-sq.-ft. facility, located in Pulaski, Virginia, would host classes and demonstrations for a range of groups, including students, educators, owners, builders, architects, and consultants. The judging criteria were the same as the previous year’s competition, with the authors serving as jurors. The prompt required students to provide 6,000 gross square feet of laboratory space, 3,000 gross square feet of classroom space, and 1,500 gross square feet each for visitors and staff. The project duration was of necessity compressed to six weeks, with work presented by the students and reviewed by the jury on October 7, 2013.

As before, the jury looked for projects that were compelling from both an architectural and a pragmatic perspective. The winning scheme shown in Figure 6 attempted to tie the building to the earth with the use of cross-laminated timber, wood cladding, glu-lam beams, bamboo floors, gravel pavements, and a vegetated roof. The presentation board was successful in depicting the building in all the ways requested by the competition brief, with plans (including the oft-neglected roof plan), building section, elevation, a detailed wall section, and a ren-
dering to give the jury a sense of the spatial qualities of the envisioned building.

A detailed section (see Figure 7) depicted the roof-to-wall connection and manifested the student’s investigation of cross-laminated timber construction, inverted roof membrane assemblies, vegetated roof systems, and wood veneer systems. It also showed slope at windowsills and copings; insulation in exterior walls; and callouts for roof, wall, and floor components. While the student was criticized for using a relatively high-maintenance material for his façade, he stayed true to his desire to use natural, renewable materials wherever possible.

The second-place winner, whose board is shown in Figure 8, focused on the expression of metal through the use of steel structure and aluminum cladding, as well as the use of natural light to render these materials. The building’s mass included classrooms that jutted over the creek behind the site. A large south-facing light monitor created a spine running through the interior, and angled windows projected over the sidewalk on the Main Street elevation to express the program elements contained within. Questions were raised about the interaction of different metals with one another and how materials come together throughout the building. Specifically, the student was cautioned about the propensity for condensation on metal surfaces, and the use of vapor retarders and insulation were discussed. He was also questioned about his strategy for fireproofing the exposed
Figure 9 – The third-place entry from the 2013 competition.

metal structure. The jury commended his use of watercolor as a medium to depict the interior space.

The project awarded third place (see Figure 9) had an unfortunate lack of detail, but placed in the competition due to its straightforward and legible design. The main element, a butterfly roof, gathers and organizes the different programmatic elements and drains dramatically toward the creek behind the site. The jury appreciated the way the concrete roof structure thickened toward the central gutter element in consideration of anticipated ponding and drift loads, and the visual separation between the walls and the roof through the use of glass, creating the appearance of a “floating roof.”

The work of the second competition was again presented in downtown Pulaski on April 30, 2014, as shown in Figure 10. This invited exhibition was hosted by West Main Street Development, LLC, a company interested in the economic development of the town. Attendees to the exhibition were excited by the students’ propositions for a key site at the heart of Pulaski.

What the Students Learned

While many of the architecture students presented schemes that may appear fantastical to practitioners, they were challenged to defend their ideas and think about how they might be realized in built form. Through their participation in the RCI Mid Atlantic Chapter student design competitions, students began to consider the consequences of their design decisions. The jurors discussed a range of issues, from formal and structural expression, to constructability and compliance with various code requirements, to ways to keep the building watertight and thermally comfortable. The students gained an appreciation for the demands placed on the design professional, and this competition brought issues of the building envelope into high relief. Thanks to this introduction, many of the students went on in future projects to investigate more fully the building materials and systems they had explored during the competition. They also came away with an understanding that the architect has an obligation to create buildings that satisfy all of the Vitruvian dictates: durability, convenience, and beauty, as described below.

All these [types of buildings] must be built with due reference to durability, convenience, and beauty. Durability will be assured when foundations are carried down to the solid ground and materials wisely and liberally selected; convenience, when the arrangement of the apartments is faultless and presents no hindrance to use; and when each class of building is assigned to its suitable and appropriate exposure; and beauty, when the appearance of the work is pleasing and in good taste, and when its members are in due proportion according to correct principles of symmetry. 3

CONCLUSION

Through their research and preparation, and through their presentations and subsequent critique and commentary from the jurors, the students began to comprehend the complexity involved in designing buildings. While the students did not fully master the skills needed to design sound building envelopes, this was neither the intention nor the expectation of the competitions. Rather, the competitions allowed the students to become more aware of the wide range of materials and assemblies that are available to comprise a building’s walls and roof, and the parameters that must be
considered when incorporating these into a design. Additionally, the students became familiarized with the numerous resources available to the design professional during the development of a project.

While the primary focus of the competitions was educational, the competition process also familiarized students with the agenda of RCI and the value of RCI membership. Without the facilitation of the competitions and the financial assistance offered by the RCI Mid Atlantic Chapter, it is quite possible these students would not have known about this organization and the educational resources it offers.

The competitions held in 2012 and 2013 provided architectural students with the opportunity to connect with juries composed of members with extensive design experience, and to hear the perspective of a design professional active in the industry. Thanks to the introduction to RCI afforded by the competitions, some students went on to participate in additional RCI activities, including chapter and regional educational meetings and the annual international convention, and maintained contact with the jury members via academic and social media avenues. Not only did the competition give the students a sense of what to expect when entering the workforce; it also gave them a competitive edge when seeking employment.

The RCI MAC student design competitions conducted in cooperation with Virginia Tech’s School of Architecture and Design achieved the aforementioned objectives to provide financial assistance to design students, to introduce students to RCI and the benefits of membership, and to promote education about the building envelope. This program manifested RCI’s stated mission “to advance the profession of building envelope (roofing, waterproofing and exterior wall) consultants” through its facilitation of interactions with architecture faculty and the next generation of design professionals.

FOOTNOTES