Introducing Students to the Building Envelope

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Abstract

The education of architects and other design professionals has left them notoriously ill-prepared to deal with the challenges of building envelope design. This paper will include an exhibition of work from the two most recent student design competitions sponsored by the RCI Mid-Atlantic Chapter. Work from the third and fourth years of this competition will be shown, focusing on lessons learned by the students from a jury of building envelope consultants, architects, and engineers. Through their participation in these competitions, students began to understand building performance in terms of thermal comfort, durability, and sustainability.

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ABSTRACT
The education of architects and other design professionals has left them notoriously ill prepared to deal with the challenges of the building envelope. Recognizing this, the author has teamed up with members of a local chapter of RCI to explicitly bring building science concepts into the design studio of an architectural school. This paper includes an exhibition of work from the two most recent student design competitions sponsored by the RCI Mid-Atlantic Chapter. Work from the third and fourth years of this competition is shown, focusing on lessons learned by the students from a jury of building envelope consultants, architects, and engineers. Through their participation in these competitions, students began to understand the importance of considering building performance in terms of thermal comfort, durability, and sustainability in tandem with their consideration of the building’s aesthetic and spatial qualities. The competitions also exposed students to RCI and its educational offerings, and introduced them to building envelope consulting as a viable career option. Students, interns, emerging professionals, and all those who hire them and work with them will benefit from this insight into architectural education and how it might be improved through RCI initiatives.

BUILDING PERFORMANCE IN ARCHITECTURE
Eric Cesal’s book, Down Detour Road: An Architect in Search of Practice, was published in 2010, in the aftermath of a recession that was particularly punishing to architects. While he seems to have eventually found professional satisfaction with the nonprofit Architecture for Humanity in a range of capacities, the book was written as a series of epiphanies he had about the profession during a period of protracted unemployment. A main premise of the book is that architects need to be more open about their value to their clients and about what they do well if the profession is to survive intact. He is concerned that much of architects’ expertise is deliberately shrouded in mystique, which gives them some cultural cachet, but will eventually weaken the vocation. He likens an architect to a medieval “sorcerer,” or his modern-day equivalent – the “IT guy” who fixes computers, both of whose means are inscrutable but seemingly necessary:

Because of the ways in which architects are trained, incomplete knowledge is often no barrier to a complete design. A design’s function is merely to convince. This often lulls us into self-deception—especially where reality is too complicated or aggravating. We cease to be transparent, even to ourselves. As designers, we have the ability to conduct our work in a way that deceives the client as well as ourselves. Both in the academic world and the professional world, architects have many incentives to obscure any half-knowledge. We are called upon to be experts in situations where we’re clearly not, and we are sanctioned for demonstrating understandable ignorance. We are pushed into being sorcerers.¹

While the laws and statues within the United States vary, they unfortunately do not offer much guidance in reigning architects in from overextension. They are, in practice, often required to decide for themselves the limits of their own professional knowledge. Following, for example, are two snippets of code from the two states where the author has practiced as a licensed architect. Florida’s statute states:

Notwithstanding the provisions of this part [on Architecture and Interior Design] or of any other law, no…registered architect, or employee or subordinate under the responsible supervision or control of such architect, [is] precluded from performing engineering services which are purely incidental to his or her architectural practice.²

While Virginia’s law reads:

The following shall be exempted from the provisions of this chapter [regulating architects, engineers, surveyors, landscape architects and interior designers]: 1. Practice of professional engineering and land surveying by a licensed architect when such practice is incidental to what may be properly considered an architectural undertaking.³

Neither of these are enormously helpful. This is not a purely theoretical concern. Often the architect will be the one trying to determine what is “purely incidental” or “properly considered an architectural undertaking.” Each practitioner is left asking him or herself, “Can I produce a plumbing riser diagram? Can I design a simple mechanical system for a small office building? How far do I draw outside that imaginary 5-ft. (1.5 m) boundary around the exterior of the building?” Unless the professional has a lawyer on retainer, which might not be a bad idea, it will most often be his or her job to draw the line at what he or she feels competent to design, or supervise another architect or intern in the firm to design. Reasonable architects may conclude that a consultant is necessary, but there is nothing in the law to indicate that they must use one.

BUILDING PERFORMANCE IN DESIGN EDUCATION
Cesal believes architects are shooting themselves in the foot to a certain extent because of false bravado that they can handle anything, merely by ignoring whole swaths of information. He argues that this attitude begins in architecture school. He writes:

Frequently, the student is not even required to confront the inconvenience. In designing his City for 3 Million Inhabitants, Le Corbusier famously described his process thus: “Proceeding in the manner of an
investigator in his laboratory, I have avoided all special cases, and all that may be accidental, and I have assumed an ideal site to begin with” (Le Corbusier, 1987, p. 164). It is questionable whether Le Corbusier had ever been in a laboratory. The average scientist would find such a proposition absurd. Scientific investigation does not begin by avoiding or ignoring special cases. Scientists may make efforts to exclude statistical outliers, or marginalize random events that might compromise the intent of the study. But such exclusions are done with rigor. These procedures are documented and repeatable. They are not used merely to exclude information or phenomena that the scientist finds inconvenient.3

Cesal goes on to lament academic projects that begin with quick precedent research on high-profile buildings, often limited to the information available on the Internet and periodicals that focus on generalities, and end with designs that never confront any of the inconveniences Le Corbusier so glibly rejects.

Cesal develops the argument further in his description of the deepening schism within the profession. On the one hand, he describes architects and firms that claim to possess “design skill” of a caliber necessary to produce highly regarded and recognized work, plus the “general technical knowledge” to get it built. He defines this general technical knowledge as the type of information gained during schooling, practiced during internships, and tested in licensing exams; for example, the basic understanding of site work, structures, envelopes, building systems, and code requirements.

In many cases, such as the Seattle Central Library that Cesal holds up as an example of this first approach (Figure 1), the design firm and the executing firm, or “architect of record” for the project are not the same entity. It is perhaps of no surprise that LMN Architects, with whom the Office for Metropolitan Architecture (OMA) collaborated on the project, were not only local to Seattle, but received an American Association of Architects/American Library Association (AIA/ALA) Library Buildings Award for the Seattle Public Library Temporary Central Library in the “Renovations” category of this award in 2003 for their work in temporarily relocating the Central Library to the Washington State Convention and Trade Center while the original Central Library was being demolished. OMA and LMN in collaboration won the same award in 2005, plus a 2005 National AIA Honor Award for Architecture, for the new facility. From this, it seems evident that though they may be credited with their visionary rethinking of what a library should be in the twenty-first century, OMA relied on LMN’s specific understanding of the requirements unique to libraries to pull off this project. But very few architecture students will consider the contribution of LMN when thinking about the Seattle Central Library, or will have heard of LMN’s solo AIA/ALA award.

This brings us to Cesal’s description of the other kind of architecture firms, the ones who market themselves as experts on a limited number of project types, and thus possess the aforementioned “general technical knowledge” plus the “specialized technical knowledge” to provide a building suitable for their clients. They may design competently and well, but their designs do not often receive the exposure, and thus the professional and academic accolades, of the firms purporting to excel in “design skill.”

To draw a parallel to the sciences, these “specialized” firms, and the building envelope consultants on whom they often rely, perhaps are working within “normal science,” by which Thomas Kuhn in The Structure of Scientific Revolutions means “research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice.” Conversely, the “design skill” firms are dispensing with old, and thus creating new, paradigms. Paradigm is a word that has fallen out of circulation a bit since Kuhn introduced it. He defines scientific achievements that rank as paradigms as follows, “Their achievement was sufficiently unprecendented to attract an enduring group of adherents away from competing modes of scientific activity. Simultaneously, it was sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve.”

Architects, engineers, and consultants working within established paradigms are completing the vast majority of the built work in the world, and thus their value and importance should not be diminished. After all, if paradigms are constantly broken by every new project, how can they have any...
value in the first place? We need design professionals who are willing to continue within the current paradigm, which Kuhn also describes as “works [that] served for a time implicitly to define the legitimate problems and methods of a research field for succeeding generations of practitioners.” If you replace “research” with “design” in the previous sentence, you can imagine how many firms could, for example, design beautiful, functional libraries that work within OMA’s new paradigm of a library as a place where media and people mix in dynamic, interactive ways, rather than a place where books are merely stored and retrieved (Figure 2). This in fact is occurring around the country in projects such as Snøhetta’s James B. Hunt Jr. Library on the campus of North Carolina State University in Raleigh, which of course was completed in collaboration with “executive architect” Pearce Brinkley Cease + Lee (now Clark Nexsen) (Figure 3).

Cesal, who has master’s degrees in business administration and construction management in addition to his master of architecture degree, concludes by suggesting that neither the “design skill” firms nor the “specialized” firms are sustainable within the broader market. He states that neither will last in the long run; the former run the risk of falling out of fashion when the next big thing comes along, and the latter are hamstrung by their very specificity, as they cannot branch out to new types of projects when their niche markets run dry. He holds up companies such as Google and Apple as models for our profession. These broad-based corporations are both purveyors of style and innovation, and suppliers of the necessary products to ensure that they can meet the consumer desires they themselves have created. They possess both
the design prowess necessary to lead the industry and the technical knowledge to ensure a near-monopoly on the instruments that help their customers achieve what they want. Their control over a wide, synthetic range of products and services makes them resilient. He calls for an approach to architecture that acknowledges that while no one architect or firm can be expert in all three realms of "design skills," "general knowledge," and "specialized technical knowledge," architects can use their skills in framing problems to get their arms around complex design challenges. He summarizes his main point as follows: "the only thing that is required is a resolve to design in a way that does not consciously exclude the inconvenient or the unpleasant." To do otherwise is to be irresponsible to our clients and to our profession.

Further, it is this author’s contention that all architects—not just the ones who purport to have "specialized technical knowledge," or who end up as building envelope consultants—need to be concerned with the responsibility of designing buildings not to fall down, not to leak, and not to make people uncomfortable or sick. It is the obligation of architectural educators to hammer this point home. It is not possible, within the context of a college degree program, to educate architecture students on the full range of issues they will encounter in the future. Architects need ongoing training and education over the span of a career to enable them to adapt to new advances and changing conditions. What is most needed in schools is for faculty to instill a commitment in architects to appreciate basic building performance mandates, to acknowledge what they do not know, and to seek assistance from consultants and specialists where appropriate.

THE RCI MID- ATLANTIC CHAPTER STUDENT DESIGN COMPETITIONS

The two student competitions discussed in this paper, and the two preceding competitions presented at the RCI Inc. 30th International Convention and Trade Show in San Antonio, Texas, were born out of the desire to introduce architecture students to building science concepts while they are still in school. Even in the age of specialization, architects must still know a lot, and that need is reflected in their education. Unfortunately, with all the time devoted to history and theory, cultural conditions, site considerations, structural systems, and electrical, mechanical, plumbing, and acoustical building systems, instruction about the building envelope often receives insufficient attention. While the curriculum at the author’s School of Architecture + Design, for example, includes building assemblies courses and addresses ideas such as assembly dew point, window-to-wall ratios, and insulation, there is still much for students to learn.

With the increasing focus both in schools and in the profession on rendering and graphic skills and the ability to generate spatially complex designs, many students never get to the level of detail necessary to understand how a foundation, exterior wall, or roof are constructed, much less how they interact with one another. Faculty, some of whom have either practiced architecture minimally, or many years prior, must play catch-up with the latest advances in building technology and do their best to convey these to their students while also juggling their research and service obligations. The result is graduates who must learn almost everything they know about the building envelope while working as interns, and who experience a bit of a culture shock when they enter the workforce. One past participant of the RCI Mid-Atlantic Chapter Student Design Competition observed after his first few months of working post-graduation in an architecture firm:

So far what I’ve learned from working: First is that I feel like most days, I’m stretched over a range of things to do, rarely doing one thing for an extended amount of time. Working at a very different pace than in architecture school, where I could spend days (and some people their entire thesis year) in a stream of thinking about one corner of a building. I’ve found that it is much easier to make grand gestures than to design the intricacies that can make these gestures manifest. (I have a deep sense of appreciation for the attention to detail that I picked up from being in your studio...that knowledge of green roofs and building envelopes is coming in handy so far.) Code really is super important (...lost some hair). Things do cost money. ... The culture in school tends to look down at engineers for some reason—they save our a**** all the time.

Because of testimonials like these, and observations from the author’s own time in practice, it is clear that architecture students need more instruction in concepts of building integrity and thermal comfort. These two building performance mandates, along with four others, were first defined by Hartkopf, Loftness and Mill in a chapter of The Building Systems Integration Handbook.

Thermal performance, according to Hartkopf et al., includes the ideas of air temperature, radiant temperature, humidity, air speed, and occupancy factors and controls. All of these are measurable aspects that collectively contribute to an immeasurable quality that Lisa Heschong calls “thermal delight in architecture.” Beyond thermal comfort, their careful manipulation within occupied spaces also contributes to energy management, which is a key element of sustainability. To define building integrity, Hartkopf et al. list loads of all types, moisture, temperature, air movement, radiation and light, chemical attack, biological attack, fire, natural disaster, and man-made disaster as forces that buildings must resist. These are challenges that architecture students don’t often think about, but are obligated to understand if they are to become professionals entrusted with the health, safety, and welfare of their buildings’ occupants.

In the spring of 2012, members of the RCI Mid-Atlantic Chapter proposed holding a competition at Virginia Tech to get architecture students excited about RCI and careers in building envelope consulting, and to reward them for work that considered the types of issues that consultants deal with regularly. As the idea developed, it became evident that such a competition should entail more than a static judging of completed projects, but rather should include mentoring from building consultants eager and able to share their expertise and insights with the students. The first two competitions were held in the fall of 2012 and 2013 within third-year architecture studios, and the results were presented in San Antonio in 2015. This paper discusses the work of the third and fourth competitions held in the spring of 2015 and 2016, respectively.
In the third year of this competition, held in the spring of 2015, third-year architecture students tackled a retrofit project on a historic site. There is an abandoned building in Pulaski, Virginia, called the Dalton Theatre, which is on the National Register of Historic Places. It was a Beaux-Arts building constructed in 1921, but the theater portion collapsed in 1982 due to neglect and disrepair. At the time of the competition, a developer had an option on the remaining portion of the building, and was looking for ideas for how to revive it. The students spent seven weeks documenting and then re-envisioning the building, with the help of as-built drawings from an architect who was concurrently working for the developer. They also met with representatives of the town and county government to discover what Pulaski most wanted and needed from this high-profile building sitting dormant on a prime piece of real estate. They developed schemes ranging from bed and breakfasts to breweries, from coffee bars to hydroponic indoor greenhouses. Following this, the author enlisted the help of an architect who specializes in building forensics to help the students study the building’s makeup. Through a little destructive testing, we were able to discover the composition of the exterior walls: load-bearing brick with headers at every seventh course, with a plaster coat on the inside and a separate brick veneer layer on the outside. Though all the wall and ceiling surfaces were covered in plaster, we were able to verify the location of the bearing walls and understand the building’s structure.

This gave the students a baseline to which they could respond. In the ensuing five-week-long competition, they were asked to consider the nature of the foundation, floor, wall, and roof structures and assemblies that they had begun to describe in the first seven weeks of the project. They were obligated to show how they would handle the separation between inside and outside, and to explain how the building meets the ground and the sky. Because there was already a building on the site—one that the town seemed eager to save—students had to show which components they were preserving, which they were adding, and how the two might interface. As before, they used the tools of the architect, such as plans, sections, elevations, details, models, and renderings, to accomplish this.

The students created three 24- by 36-in. (610- by 910-mm) presentation boards and a physical model of a corner condition of the building, from the ground plane through the roof plane, at 1:24 scale. Entries were judged according to the following criteria: articulation of the building section (i.e., providing an unambiguous depiction of the building’s structure and envelope, including the components of foundations, floors, walls, and roofs), coordination and consistency of the drawings—both individually and collectively, clear rendering of materials, constructability and consideration of the forces of gravity and nature, and accessibility and code compliance.

The first-place project (Figures 4 and 5) considered the aging population of the town in a proposal for an orthopedic and wellness center. The jury noted that this was the most complete, well-rounded, and realistic design that addressed the details...
while not losing sight of the big picture. The project dealt with both aesthetic and functional obligations. While the butterfly roof structure needed some further development, its expressive character and the detailing of its connection to the adjacent wall were acknowledged.

The second-place scheme (Figure 6) was ambitious; it included a luthier’s shop in the body of the existing building with an amphitheater occupying the currently vacant land where the theater itself once stood. The jury appreciated the combination of a program suited to the context of the place with the consideration of emerging building envelope systems such as the vegetated wall on the east façade. The student’s 1:24 scale model showed an investigation of multiple building systems, from foundation to roof (Figure 7).

The project selected for third place (Figure 8) was a brewery and reception hall that capitalized on the existing building’s proximity to Peak Creak, a much-neglected, but nonetheless, scenic waterway running through the middle of town. Both the imagery of the student’s board and the more detailed sections were concerned with placing this building in context and capturing views of the creek and the Town Hall building, a critical local monument. The project also dealt with the structural difficulties arising when interior components of the existing building were carved away to allow a new program to emerge.

THE FOURTH COMPETITION

The fourth competition was held in the spring semester of 2016, and this time, fourth-year architecture students participated. Their work had the greatest sophistication and complexity of any group to date, due to their higher level of experience. The project involved the design of a K-8 school for 270 students focused on the humanistic approach to pedagogy. The new school was located at the site of the existing Claremont Elementary School building in Pulaski, Virginia, which long ago ceased to serve its original purpose and currently houses the Claremont Therapeutic Day Treatment Program. Students were given the opportunity to repurpose the existing building, or demolish and...
rebuild on the site. They visited the building and grounds on January 25, 2017, and were able to access the original drawings for the existing building.

The students were required to provide presentation materials within a wall space 4 ft. wide by 6 ft. high (1200 mm by 1800 mm), and to create a 1:24 scale model of a portion of the building, from ground to sky, and from exterior wall to exterior wall. Judging criteria were similar to those in the prior year's competition, listed above. This competition extended over five weeks; and this time, the jury was able to come for an interim visit to give critiques and suggestions after the first three weeks of the competition's duration.

At the final jury, three winners were selected. The first-place winner’s school centered on the ideas of shared learning spaces, net-zero water, and building as teacher. To that end, the student worked out a system whereby middle-school students were able to view building systems in the corridors, and courtyards contained cisterns that doubled as landscape elements (Figure 9). He researched multiple wall types and progressively simplified the roof plan of his scheme over the course of the competition (Figure 10). Different wall claddings, from dressed stone veneer at the administration areas, to marble veneer panels at classroom areas, to wood rainscreen facades at interior courtyards, were explored and used to visually signify different programmatic areas of the school (Figure 11). He retained the existing school’s cafeterium at the core of his scheme, and added vegetative roofs to the surrounding building addition to reduce runoff. Because his wall sections were fully labeled, the jury
was able to have a detailed conversation about masonry, grout, and mortar, which is not usually achievable at this point in a student’s education. While he was challenged to bring heavy materials down to the ground visually, such as the dressed stone veneer at the administrative areas of the building, it was clear that he had extensively investigated the building assemblies he had employed, he had the most developed roof plan of the group, and he had provided a workable, legible school design.

The second-place entry was a school with classroom arrangements that allowed for collaborative as well as individualized teaching. This included the provision of a unique vertical folding door assembly between twinned classrooms (Figure 12).

Most architecture students are enamored with the idea of a full-glass wall, and the student submitting the second-place entry was no exception. She spent a great deal of time working out how to accomplish her aesthetic goal while still providing sill and cap flashing (Figure 13). This led to a productive discussion with the jury about how architects need to understand that normative construction details are normative because they have stood the test of time. They challenged her to be selective in her use of special conditions in the building, to get the maximum impact with the least need for expensive, high-maintenance, or failure-prone assemblies.

The third-place entry took advantage of the sloped site with a two-story building (Figure 14). Instead of the typical double-loaded corridor, the student provided grade-level classrooms only on the south side of the building. He controlled the light entering south-facing windows by using a combination of view and clerestory windows, as well as by providing deep, tapered overhangs. He also provided zones above corridors for mechanical, plumbing, and electrical equipment. The jury was impressed by the student’s presentation and drawings, which were succinct and clear. He had simplified the scheme from earlier iterations, which had included low-slope roofs with a 2:12 slope that made for cumbersome ceiling planes and unintentionally exaggerated façades. The jury also discussed the need to protect the floor structure of the uppermost level from fire.

The proof is in the pudding, and one of the best ways to know whether a teaching strategy got through to students is to read their anonymous teacher evaluations, now euphemistically called “student perceptions of teaching,” at the end of the term. After a semester of being constantly judged themselves, these surveys give the students the chance to provide an unadulterated view of what they thought of their experiences. They tend to be an honest and mostly accurate critique of the success of the course and the method of instruction. Following are excerpts from Spring 2015 and 2016, of some of the comments that attest to the benefits of the RCI Mid-Atlantic Chapter competition.

From Spring 2015:
I really think we need more one-on-one time to really discuss the project at hand and figure out how to put everything together. Also, I feel we waited too long to start learning about building envelopes and the details of construction. But I also don’t know if [the architecture school] has a specific schedule of when to introduce certain building principles, but I say the sooner the better.

From Spring 2016:
Elizabeth did an awesome job in making sure we had an understanding [of] our semester-long project. She went the extra mile to bring in professionals as well as provide supplemental literature to aid in our understanding. The field trips were also very beneficial.

One of my favorite semesters of studio. Really felt like I became involved...
in my project and enjoyed what I was doing. The competitions also help me motivate myself to push a little bit harder.

Over the years, it has become clear that students crave more individual instruction, and more explanation about how building envelope concepts apply to their specific projects. Only so much of this can be learned from books, journals, and all-too-brief site visits. Time in the design lab with professors is finite, as is their range of knowledge. The student design competitions gave the students an incentive to go a little deeper, and their instructor a spur to work a little bit harder, to help them learn how to find these answers themselves. The jurors, through their mentoring session and the final juries, helped the students know what questions they needed to be asking.

**STUDENTS LEARN ABOUT RCI AND BUILDING ENVELOPE CONSULTING**

It is difficult to track the degree to which architects recognize the importance of building envelopes and either become skilled in designing them themselves, or actively seek out consultants to assist them in doing so. In either case, student exposure to architects, engineers, and consultants actively engaged in designing building envelopes is critical. In the author’s experience of architecture schools in the United States, building envelope design is not well represented in most schools’ lecture series nor in the body of work schools choose to discuss and promote publicly. As mentioned earlier, the role of architects as heroes with stellar “design skills” often overshadows their roles as professionals with “general technical knowledge” and as experts with “specialized technical knowledge.” Architecture students should be taught that all three of these roles must be satisfied by members of the design team to ensure the success of many architectural endeavors.

Another observation is that students tend to talk to one another from year to year, and last year, seven second- and third-year students from Virginia Tech attended the RCI Convention, thanks to generous Annual Convention and Trade Show College Student Attendance Sponsorships offered by the RCI Foundation. At the convention, students are steeped in building envelope knowledge, gaining access to far more information than faculty can transmit in a few class sessions per semester. At Virginia Tech’s School of Architecture + Design, RCI is becoming a known entity, and the sponsored competitions, along with the convention sponsorships, are helping to spread the word. Consultants throughout the United States and Canada might consider similar mentored student design competition programs at universities within their regions—both to promote RCI and to help prepare their local graduates for the increasingly complex worlds of building design and construction.

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**ENDNOTES**

5. Cesal. p. 158.
7. Ibid., pp. 10-11.
8. Ibid. p. 10.