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An Emerging Vocabulary: Architecture of Performance

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The article entitled *Studio Exchanges | An Emerging Vocabulary: Architecture of Performance* by Jeremy Stock examines a collaborative studio environment—a mix of undergraduate students in the Colleges of Design (Architecture) and Engineering (Mechanical, Electrical, and Civil)—that have worked together over the last two years to develop design solutions for the University of Kentucky Chapter of the Triangle Fraternity. It is within this context that “design” provided an avenue for translating scientific results as a means to expand knowledge that could influence the way we construct and change the world around us.

As Jeremy Stock’s essay articulates, the studio used a project-based research methodology to tackle a range of overlapping and convergent frameworks. These inquiries served to question the traditional role of both architect and engineer, and helped reinforce the students’ collective ability to envision and thus, define their impact on the built environment. The article outlines a range of viable theoretical scenarios and iterative explorations rooted in a design thinking vocabulary where students assessed user needs and then generated, tested, and evaluated building performance criteria at scales ranging from a 925 square-foot, three-bedroom, single-family affordable house for the Mayfield-Graves Habitat for Humanity to a 20,000 square-foot, forty-bed, net-zero energy house for the Triangle Fraternity.

The paper conveys a trajectory for undergraduate design research that quickly moves beyond merely solving the programmatic needs for both the Habitat for Humanity and the Triangle Fraternity houses to demonstrate a deepened level of investigation on the subject of environmental design. Using the often conflicting and divergent viewpoints of affordability and performance as scalable departure points to explore carbon neutrality, the students successfully initiated an integrated framework that allowed them to better understand a systems-thinking approach for sustainability. In turn, this approach gave the students an operative toolkit that enabled them to resolve issues related to user needs and behavior, and ultimately, to simulate building performance. This exchange impacted both the individual and team iterations, each of which sought to reduce the building’s energy footprint through design, integration, and on-site renewable energy production.

As this essay contends, by situating this investigation in an academic setting, the students saw firsthand, through thought and representation, how to develop a solid theoretical framework in which to ground their work. In doing so, they successfully articulated a performative voice in the architectural and educational community that was simultaneously up-to-date and timeless. The initial results of the two-year long study have been presented at international conferences and submitted to international affordable housing design competitions. However, the most significant and enduring example of sustained impact is on the horizon. The cottage design for Habitat for Humanity is scheduled to begin construction this fall utilizing the Mayfield, KY Area Technology Center (ATC) students, thus informing future generations of the building community.

Though cooperation (working together), collaboration (sharing and maintaining information to create a common pool of knowledge), and coordination (an ordering process that organized goals and activities), the students developed a range of feedback loops in which their work evolved. As Jeremy states, this project could ultimately serve both as placed-based educational tool for students in the design and engineering disciplines, and as an invaluable instrument that directs future generations on how to conserve the natural environment.
The research inquiry presented in this paper focuses on the collaborative design + energy studio experience of eighty-two (82) undergraduate students in the Colleges of Design and Engineering. Using a project-based learning methodology, the students articulated a comprehensive and performative architectural vocabulary resulting in a Net-zero energy Chapter House for the Triangle Fraternity.

Abstract

Re-chartered at the University of Kentucky in 2005, the Triangle Fraternity – a brotherhood of students studying Architecture, Engineering, and Sciences – now seeks to establish a visible presence by building a new fraternity house on-campus. To enable this investigation, professors Gregory Luhan, Peyman Jahed, and Bruce Walcott developed a design + energy studio experience that provided a framework for an integrated design team to use a systems-thinking approach to generate a range of scalable, net-zero energy prototypes. These prototypes can be applied in a variety of contexts and have the potential to address larger issues, such as energy efficiency and environmental stewardship. This initiative created a path towards progressively educating the future leaders of the various professions in both the short-term and long-term, and aligned well with the cutting-edge research ongoing across the University. The vocabulary produced by the studio has become an operative tool kit that, if implemented, will transform a key campus site - as outlined on the 2050 campus master plan - into a powerful gateway to the University’s “Greek Walk.” In its greatest sense, this project has formed multiple pathways that not only demonstrate design excellence, but also give a performative voice to architecture as a means to inform the University’s overhaul of on-campus housing.
Achieving these goals has been facilitated largely through four cross-disciplinary collaborative studios led by professors Gregory Luhan (Architecture), Peyman Jahed (Architecture/Engineering), and Bruce Walcott (Engineering); both internally - by connecting the resources at the College of Design to those in the College of Engineering, but also externally, by connecting the University of Kentucky to broader professional resources here in Lexington and beyond. The goal was not to have architecture as a discipline dictate the new dialogue on building performance, but rather to create a dialogue in areas where one previously did not exist. By outlining the roles of individual design studios, and tracking the narrative of the studio on the whole, this investigation aimed to establish a replicable architectural presence in performative building design.

Areas of building design such as building form, program, and materiality are traditionally labeled as explicitly architectural concerns, and as such, the architect has the strongest voice in their development. Conversely, the subjects of energy efficiencies, building systems, and environmental stewardship have long been restricted to engineering fields, and the dialogue therein carries a limited architectural presence. Current trends in building design, however, have increasingly shifted towards a more holistic model – one that links progressive thought processes to performative outcomes. This interdependent trend has allowed the various trades within the field – which was traditionally pigeonholed to individual components of building making – to actively rethink their modes of operation.

For the past two years, Professor Gregory Luhan’s third year undergraduate architecture studios have questioned these fundamental relationships through various design thinking modalities for the Triangle Fraternity House. Ultimately, the studio’s goal was two-fold: first, to develop an on campus identity for Triangle that could serve as gateway to the University’s Greek Walk as part of the 2050 Campus Masterplan. Secondly, to form what Professor Luhan refers to as an “architectural vocabulary of performance.” This performative dialogue is rooted in identifying multiple pathways towards efficiency and ecological effectiveness that are context-appropriate and place-based. Ideally, the aggregate form of this process will produce a sustained, demonstrated, and resonating impact throughout campus and the surrounding Lexington area.
Studio Pretext: Habitat for Humanity

In the Fall of 2010, in response to the University of Kentucky’s involvement with the US Department of Energy’s Solar Decathlon Competition, Habitat For Humanity approached the College of Design, posing a simple question with profound implications: could the relationship between design and performance - explored in the Solar Decathlon - be reimagined through the lens of affordability, for a client like Habitat? The investigation that followed was critical in laying the groundwork for defining an Architecture of Performance, because it exposed the problems in conventional thinking. Traditionally, affordable housing places an explicit priority on fiscal limitation – typically meaning compromises are made with respect to design and energy. This concession operates on the premise that all three conditions cannot coexist; performance and aesthetic are not commonly associated with affordability. The ensuing studio exploration aimed to challenge that assumption, and successfully produced a house for the Mayfield-Graves Habitat for Humanity. Their design will begin construction in Summer 2012, and has been submitted to an international affordable housing competition.

Studio Pedagogy: Giving an Architectural Voice to Building Performance

Since the fall 2010 semester, fifty (50) third-year undergraduate architecture students and thirty-two (32) College of Engineering students have conducted intensive research on the effects of environmental performance on the building design process. This creative exchange has not only produced a series of iterations of the building, but more importantly, has also offered students in these two colleges a synergistic forum in which to cross-pollinate ideas across fields of study. Ultimately, this fostered a collaborative dialogue that can further serve as a benchmark role model for other types of projects across the University.

In an effort to ground building performance in a series of quantifiable metrics, the studio researched a range of verifiable assessment protocols and rating systems to set our own performance standards. These include LEED, Green Globes, the Living Building Challenge, the Architecture 2030 Challenge, and Passivehaus. By using both a rigorous measurable building energy performance standard and forward-looking construction approach, the studio designed its projects to exceed the Passive House Energy Performance Standard. Buildings that meet these performance standards use roughly only 20 percent of the energy that a conventional equivalent building constructed to current codes would use. When applied to our studio investigations, we were able to reduce the energy demand for the Triangle Fraternity House to one-fifth that of a typical dormitory.

Programmatic Transparency  Figure 6 Structural Continuity  Figure 7 Blended Spatial Clarity  Figure 8

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While the bulk of design work focused in the first semester focused on Habitat for Humanity, by the end of the term students had developed a specific skill set which would prove directly relevant to the Triangle Fraternity project as the studio moved forward. This investigation was spearheaded by an interdisciplinary charrette and brainstorming session in December 2010. Students already involved with the studio were partnered with community professionals from Alt 32 Architects, BFMJ Consulting Structural Engineers, CMTA Consulting Engineers, and Messer Construction. The intent of the charrette was to develop a building program, identify and evaluate a number of available building sites across campus, and create an exchange of ideas across fields, in which the aggregate of information has the potential to challenge the limits of individual disciplines.

**Big Roof -** Beyond satisfying the basic need for enclosure, this single gesture informs the building's larger pursuits of environmental resilience, including rainwater collection, energy production, temperature control, and branding. With full exposure to the sun, the roof would provide an ideal zone for building integrated photovoltaic electrical production. While operative on the top surface, the roof would also form a passive “cloud” that would effectively mitigate extreme rooftop temperature fluctuations throughout the year.

**Core and Cantilever -** This approach first registers how the programmatic needs of the fraternity fluctuate over time and how they are spatially defined. Secondly, it structures plays of natural light relative to the form of the building over the course of the year. Lastly, it allows the ground plane to be liberated from the campus and surrounding city grid to form new datums that are programmatically driven. By allowing these concepts to overlap, a range of formal design iterations emerge that allow for a freedom of architectural expression. Programs can slide between the structural elements, and can even be pushed to the periphery of the building to form internal courtyards.

**Aggregated Modules -** By examining the programmatic needs of a client, and the area requirements of the individual spaces therein, the building can be separated into a series of off-site constructed modular components. These units can be stacked, assembled, and rearranged to establish a range of spatial logics that focus on a synthesis – or aggregate – of program (Rather than be limited by spatial compartmentalization). Moreover, its basis on an off-site module allows for additional components to plug into existing structure as programmatic needs of the client evolve over time.
The students carried this knowledge into the Spring of 2011, where investigations focused on integrating a sustainable vocabulary with architectural form. Students aimed to resolve how a body of performative building research could move outside itself, and become translated to actual built space. To answer this question, students needed to broaden the scope of traditional architectural inquiry. Taking on subjects ranging from daylight controls to living roofs, students allowed their body of research to not merely inform their design trajectory, but instead redirected the trajectory entirely. That is to say, the pursuit of a performative architecture can be analogous to the game of Chess: as information on building performance reveals itself to the designer, the appropriate architectural response is a counter-move – directly informed by an existing context.

Integrated Approaches - The integrated design team used a systems thinking for sustainability approach to further refine its Architecture of Performance. This holistic approach was informed by rigorous investigations into the unique conditions of a specific site, and as such, the application of performative components into the architecture bears little resemblance to their precursory designs. All three rubrics – big roof, core and cantilever, and aggregated modules - formed the basis of the subsequent studio investigations. But rather than focusing on a singular methodology, the intent was to experiment with techniques that vary in degree and kind, so that global best practice models could inform local place-based making. These techniques resulted in hundreds of iterations. Each option was simulated using software such as in Energy +, System Advisor Model (SAM), PV Watts, BEopt, Green Building Studio, Vasari, and Ecotect, so that building wall assemblies and systems could be designed, tested, and verified. From these simulations, the student teams developed the project literally from the inside out, so that programmatic adjacencies, building structures, egress, and code compliance could find a voice in one cohesive and singular model. As demonstrated in the final solution, this approach proved to be a useful method for form finding and ultimately for developing a performative architectural vocabulary. As evidence to the intrinsic need for a performance-based building model, one needs to look no further than existing energy demands at the University of Kentucky. A typical campus building consumes 100 kBTUs of electricity per square foot annually. In producing those 100 kBTUs of electricity, an excess of 955,000 pounds of greenhouse gasses are released into the Earth’s atmosphere. In that context, it becomes apparent that the conventional mode of building making lacks a mindfulness of the consequences of design decisions. With that as pretext, the studio investigations have taken on a systems thinking approach to design. By a process of integration – not only of disciplines, but also of built components – the magnitude of individual decisions can be revealed in a variety of contexts. The resultant successes of that awareness are evidenced in Triangle Fraternity which, as previously stated, has been designed to operate on one-fifth of a conventional energy demand.
In that vein, undergraduate architecture students, coupled with masters-level civil engineering students, initiated their performative investigations through a series of best practices – at a variety of contexts, climates, and scales of implementation. But, upon distilling that research through the lenses of a specific site (Lexington, Kentucky), a specific context (Student Housing), and a specific client (Triangle Fraternity), the entire design trajectory shifted. As such, the formal resolution that students arrived at, and presented at that semester’s Final Review, bears little resemblance to the examples they initially analyzed. Ultimately, that evolution demonstrates why an architectural voice in building performance is so critical – an *Architecture of Performance* is not an *Architecture of Homogeneity*, but articulating this in built form first requires an exchange between the subjects of design and performance.

The following semester, an entirely new group of students inherited the Triangle Project, along with the previous academic year’s body of research. With two semesters of background in which to build upon and ground their design decisions, students in this semester were able – almost immediately – to move beyond the level of investigation of a typical undergraduate studio. While previous semesters had identified programmatic user needs, this semester’s students began to articulate issues like density of program, spatial relationships and proximities, and hierarchies of space. In turn, the existing dialogue between design and building performance could be more seriously resolved, because of the now coherent relationship between site, building, and occupant.

The relationship between undergraduate architecture students and graduate civil engineering students that had been developed a year prior continued and in the fall of 2011 a group of senior undergraduate senior students from Electrical Engineering and Mechanical Engineering students joined the conversation. These students were charged with working collaboratively across disciplines to develop the building as a system of integrated components. As a precursor to their capstone projects, engineering students explored the design of structural systems, mechanical loads, and lighting design – such that, upon presenting the design at the Studio’s Final Review, the architectural development of the building was purely a component of an otherwise comprehensively detailed project. This holistic approach helped illustrate that - once architecture finds a voice in the dialogue on building performance - collaboration across fields can serve to blur the boundaries, which typically segregate disciplines from one another.
The ultimate aim of this ongoing investigation was not simply to state an *Architecture of Performance*, but ultimately to see it realized in built form. As such, the most recent architecture studio in the spring 2012 semester unified the project with conceptual gestural clarity while investigating practical life-safety and code-compliance considerations, programmatic distribution, and methods of visualization which previous semesters had not been able to fully explore or validate. From fire-rated assemblies, to egress and accessibility, this semester’s students helped bring the ongoing research of the studio to a degree of closure where the performative components of the building are grounded in performance metrics that are both qualitative and quantitative. Through a synthesis of active and passive design strategies, the Triangle Fraternity House is designed to be capable of returning as much electricity to the utility grid as it draws from it, and as such uses a standard that achieves the project’s net-zero energy goals.
By developing the project to the point where the next logical step will be authoring construction documents and specifications – before ultimately moving forward into construction - the project team has achieved its two primary studio objectives. First, it has developed a synergistic living and learning laboratory and on-campus presence for the Triangle Fraternity. Secondly, it has formed a replicable vocabulary that has the potential to serve as a precedent for several facets of the design community. Locally, the cross-disciplinary success of the studio can serve as a pedagogical model for the University of Kentucky, as the academic and professional fields become increasingly interwoven. Moreover, the performative nature of the building can serve as a new typology of campus construction here in Lexington, as students have successfully articulated site-specific solutions to our unique local conditions. Zooming out in scale, there are broader implications to the project that reveal exciting possibilities beyond the studio investigations. The dialogue that the past four semesters of research and design has facilitated can serve as a new integrated model for the practice on the whole, as it also seeks to articulate the same voice in *Performative Architecture*.

### Further Reading

To see the entire Triangle Fraternity project investigation, please refer to the book manuscript *absolute value* by Gregory Luhan.

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### Studio Bibliography

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