A Proposal for a Cross-Disciplinary Design Pedagogy: Generative Full-Scale Investigations

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Within architectural education, ideas are developed through representative media such as scaled models or drawings; unmediated full-scale investigations are rare. When full-scale investigations occur, their potential for informing cross-disciplinary pedagogy is not obvious. Here, we identify and discuss in detail four distinct approaches to full-scale investigations in architectural education, focusing on work which we believe best promises to inform cross-disciplinary pedagogy, work which we classify as generative full-scale investigations. We propose that generative full-scale investigations retain promise for cross-disciplinary pedagogy precisely because they are non-deterministic, non-specific to a particular discipline, open-ended, and speculative.

Keywords: *architecture, cross-disciplinary, experiment, full-scale, pedagogy*

1 Introduction

Architecture is unique among the design disciplines: its products are very large and are not subject to mass-production. Ideas in architectural design are regularly developed through representative media such as scaled models or drawings; unmediated full-scale investigations are rare. Although full-scale investigations are more typical in other design disciplines such as fashion design, product design, graphic design or textile design, they tend strongly to be discipline-specific (e. g. fashion designers work with fabric at full-scale, product designers work with full-scale prototypes); common cross-disciplinary full-scale design pedagogy is not obvious.

Here, we identify and discuss in detail four distinct approaches to full-scale investigations in architectural education: experimental, inhabitable, prototypical, and generative. In particular, we discuss generative full-scale investigations through exercises, curriculum and student work from the architectural design studios which we teach at the University of Minnesota.

Ultimately, we argue not only that generative full-scale investigations are the most promising within architectural education, but more importantly, that they have the potential to cross disciplines as a pedagogy.

2 Background

Our interest in architectural education is a consequence of our work at the University of Minnesota's Department of Architecture (Minneapolis, Minnesota, USA), where we instruct undergraduate architectural design studio courses. The undergraduate curriculum at Minnesota is discipline-centered rather than practice-centered, as a consequence of which our department places greater focus on the development of broad-based liberal-arts thinking and making than on practical or professional concerns of building construction, ideas which we believe are best addressed through professional (i. e. graduate) study, offered at Minnesota through the graduate-level Master of Architecture professional degree program.

The broad focus of Minnesota's undergraduate program enables us as educators to engage the discipline of architecture through a rich variety of media and experiences. This paper draws on several of our personal interests and experiences gained through our participation as educators at Minnesota. Specifically, we discuss not only our own work at Minnesota and abroad, but also that of educators (such as the late Samuel Mockbee) whose work, we believe, is relevant to cross-disciplinary pedagogy.

3 Experimental Full-Scale Investigations

In the discipline of architecture, as is generally true of the plastic arts, a comprehensive understanding of material is essential to success: architectural work is bounded by, and possibilities for innovation are guided by, material properties.

As architectural educators, we are convinced that our students must engage material at full scale to build the understanding and conviction necessary for successful operation within the discipline. We believe that the study of architecture cannot be limited to representational study (i. e. "paper architecture"); at some level, successful study must engage direct, full-scale investigations of the physical components of the work.

In general, full-scale investigations into the nature of material begin with experiment. Hypotheses are explicitly or implicitly made, experiments are designed, results are observed and original hypotheses modified and reconsidered as needed.

We define experimental full-scale investigations into the nature of material to consist of clearly stated and testable hypotheses concerning material, assembly, or system performance (e. g. under simulated or actual weather conditions). Assemblies and systems are critically important within the discipline of architecture because of the multi-component nature of architectural work: buildings must simultaneously respond to a multitude of forces and agendas. In large part, it is this disciplinary focus on assemblies and systems that differentiates architecture from plastic arts such as sculpture.

We accept that the testing essential to experiment may occur within more or less rigorously defined and controlled conditions; the clean conditions of the scientific laboratory need not be replicated in the field in order for an experiment to have some educational value. Even an informal, empirical test of a material or an assembly can suggest a profitable direction for additional investigation.[1] Clearly, however, if experimental full-scale investigations are structured and executed with sufficient care and attention to method, they can provide reliable data which may be used to inform and drive higher-level decisions. We might ask, for instance, does this material, or this process, employed in this climate, at this cost, balance against a certain amount of energy savings? Does the outcome justify the input?

A typical example of this kind of investigation occurs as a component of the Eco-House project at Carleton College in rural Northfield, Minnesota. The Eco-House is a project actively developed since 2002 by Carleton faculty Richard Strong and Gary Wagenbach, whose goal is to design and construct an energy-efficient, cost-effective, small-environmental-footprint structure for student housing. The Eco-House project consists of seminars, field trips, demonstrations, and (of critical interest to this paper) experimental laboratory work.

In 2002 and 2003, under the direction of Strong and Wagenbach, students worked in a semi-controlled environment (a campus warehouse) to construct representative and comparative sample assemblies of exterior building wall enclosures using conventional construction, straw bales, rammed earth, and cordwood. The students observed and measured the assemblies over a period of time, e.g. by recording humidity and temperature differentials inside and outside of the enclosures, in order to draw conclusions about relative system performance. Additionally, and critical to the larger goals of the Eco-House project, the students measured the embodied energy of the assemblies in an attempt to incorporate the cost effects of processing, labor, and transport into an overall project cost.

In general, the laboratory component of the Eco-House project questions whether input in the form of effort and processing (i. e. embodied energy) justifies output as measured by system performance. Determining explicit answers to these questions is critical to the overall success of the project, which will necessarily result in a built, inhabitable structure: the student housing.

Any experiment, if we wish it to be forceful, convincing, and of lasting value – as we believe the work at Carleton College to be – must be approached skeptically: as educators, we must ask hard questions at every moment and seek alternate explanations at every shift in conditions. Particularly if we are testing systems or assemblies (not simply the performance of a specific, isolated material), we must diligently inquire into the role of discrete components and combinations of components; we must be prepared to isolate contributory effects from one another and to trace them to their respective sources. Additionally, for a program of experiments to be reliable, we must empower and enable our students to execute experiments with care, rigor, and patience. As educators, we must refuse to be satisfied by easy or quick results; if not replicable under similar conditions, the results of any experiment are of limited value.

Most importantly for long-term success, we must as educators be prepared for our experimental work to evolve continuously over time, to guard against the questions inherent in our investigations from becoming stale and uninteresting. We believe that successful experiments, carried out over time, must occasionally produce contradictory or conflicting results to provide educational value.

Even more critically, and with particular relevance to cross-disciplinary potential, we believe that the conditions of educational experiments must be deliberately and regularly shifted so as to increase the likelihood of contradictory or conflicting results. Occasional accident, surprise, and unpredictability are essential to the long-term vigor of an experimental program, and are, we believe, at the core of the cross-disciplinary potential of this kind of investigation. And while we believe that an experimental methodology is clearly valuable and important as a pedagogy within many disciplines, we are not fully convinced that its inherent rigor and scientific approach is particularly promising within disciplines and forms of art (e. g. performance art, aleatory music composition[2]) which depend on open-endedness rather than sequential rigor.

4 Prototypical Full-Scale Investigations

Experiments repeated too often and too predictably become stale and eventually cease to be experimental at all. Demonstrations which were once carried forward with healthy, inquiring skepticism instead become guided by dogma. Experiment gradually becomes something more like demonstration or prototype.

Having observed and participated in demonstration workshops which exemplify this quality, we have come to define prototypical full-scale investigations as those which – subject to well-defined initial conditions, processes, and outcomes – are dedicated to the instruction of particular construction techniques.

Precisely because of their limited-scope definition, prototypical full-scale investigations are of limited promise in architectural education: they serve a didactic, demonstrative purpose, often enabled by strong, almost choreographed conditions; having engaged in the demonstration, students move on, possibly possessed of a greater inclination to employ the newly learned technique in their own projects, but significantly without the heightened sense of skepticism and inquiry they might have had in an investigation more deliberately experimental and open-minded.

An example of a prototypical full-scale investigation is the rammed-earth construction study workshop at the Building Center Earth Unit in Auroville, India, in which we and our students from the University of Minnesota participated in January 2004. Our participation in this program was one component of a three-week academic study tour of India which we structured to investigate implications of globalization within the built environment.

The Earth Unit is a unit of the Auroville Building Center which conducts research and development on the use of stabilized (compressed or rammed) earth as a building material. The workshop in which we and our students participated is typical of the workshops offered at Auroville to international participants.

At the Auroville workshop, paid laborers guided us through an explicitly defined sequential process of construction to create a sample segment of a rammed-earth wall. The process began with hand-mixing powdered cement, sand, and water in a fixed proportion; the minimally moist mixture was poured into a rectangular form and compressed by repeated hand-applied blows with a stout tool. After the wall was completed to a fixed height, the form was removed and the wall cured in the sun.

Following completion of the workshop, we and our students departed the construction site and the laborers readied the ground, and possibly demolished the wall, so they could repeat the demonstration with the next group of students or visiting international professionals.

Although the workshop was of clear and important instructional value, it was in no sense experimental, though we are convinced that experiment continues to guide and invigorate the program of which the workshop is a component.

To the degree that our group's participation in the workshop generated healthy skepticism, the questions that emerged were almost exclusively about the conditions rather than the content of the workshop. For example, the students were intensely interested in whether the wall they had constructed would remain in place as a free-standing construction, become incorporated into a larger structure, or be demolished. The students were also curious about the role of the paid laborers: are the laborers best understood as employees, educators, craftsmen? How does the motivation of the laborers to participate in the workshop differ from the motivation of the workshop organizers? And while the students posed reasonably good questions about the technical nature of the work (for example, concerning the proper cement-to-sand ratio and correct moisture content, or methods for achieving the proper degree of compression, etc.), these questions did not serve to develop the exercise or increase a sense of wonder: they were asked, and straightforwardly answered.

In this sense, the work at Auroville was marginally more valuable to the students than an expertly produced demonstration film or interactive website would have been. The added value in the exercise exists solely in participation, and this value is questionable given that the participation is heavily choreographed. But even given this criticism, we believe that the demonstrative value of the workshop is important and valuable particularly as it relates to sustainable design trends in the discipline of architecture.

Our concern here is limited to the cross-disciplinary potential of instructional methods, and we believe that the methods inherent in the Auroville workshop, while valuable for architects, are generally unpromising for other disciplines.

5 Inhabitable Full-Scale Investigations

As experimental or prototypical full-scale investigations grow in size and extent, they need not limit themselves to the demonstration of a particular technology. If they are created at a sufficiently large size, the results of such investigations may become potentially or actually inhabitable.

A large enough group of students under the guidance of talented directors, given the right set of circumstances and sufficient time in which to work, can successfully engage in full-scale investigations of the practice of architecture in a community, resulting in the design and construction of buildings and homes for the people who live and work there.

The Rural Studio at Auburn University, led by the late Samuel Mockbee from 1993 until his death in 2001 (and now co-led by Auburn faculty Bruce Lindsey and Andrew Freear), is typical of this kind of investigation. In the Rural Studio as conceived by Mockbee and his fellow professor D. K. Ruth, second-year Auburn students travel to Hale County, Alabama, to reside for a fixed time – an academic semester – during which they work with local residents as clients to design and construct private homes. A separate program, open to fifth-year thesis students, focuses on the design and construction of community buildings.

Projects within Mockbee's studio would develop from initial meetings between Mockbee, potential clients, and students to determine functional and budgetary constraints. The initial students and following groups would work to design and construct houses using local, often experimental, materials and techniques. This practice is still carried on under the direction of Lindsey and Freear, and to date, the studio has constructed eight private homes and several community buildings, including multi-unit housing, chapels, pavilions, and a farmer's market.

The obvious and important educational value of inhabitable full-scale investigations such as the Rural Studio emerges because students achieve direct exposure to multiple aspects of practice. Additionally, as convincingly demonstrated in Mockbee's studio, the results of the work are a distinctly positive influence within the community, as formerly ill-housed people find housing, and the large community strengthens its sense of identity through shared experience.

Nevertheless, due to logistical constraints – something large-scale and inhabitable must be built within a fixed timeframe – such work remains guided by credulity rather than skepticism, and although the dogma may be eminently defensible and socially responsible (i. e. ecologically sensitive design, re-use of materials, direct responsiveness to existing unjust housing conditions, etc.), it remains dogma: students, clients, and faculty implicitly subscribe to it as a precondition to participation. The work is propelled both by a strong belief – almost a faith – that it results in good for the community, and since Mockbee's death, by the participants' reverence and respect for a talented and visionary leader.

To Mockbee's lasting credit, the Rural Studio is invigorated by the belief that mistakes are of profound educational value. Of his students, Mockbee once said, "I've learned to trust their resourcefulness, to let them push directions I probably wouldn't follow." Without the willingness to learn from mistakes, the value of inhabitable full-scale investigations such as the Rural Studio would completely evaporate into construction training workshops, which would scarcely do justice to Mockbee's vision of participation and active citizenship.

We believe that the instructional methods and pedagogies inherent in inhabitable full-scale investigations have reasonably good potential to translate across disciplinary boundaries. The Rural Studio illustrates the point: a component of the studio is dedicated to outreach, explicitly marketed towards disciplines other than architecture. The outreach component of the Rural Studio seeks to apply the hands-on, context-based pedagogy of the architectural design studio, with its strong and intimate connection between project conception and execution, toward a broader and explicitly multidisciplinary education engaging rural Alabama.[3] Fundamentally, the Studio as a whole, including its multidisciplinary outreach component, remains committed to good citizenship as enabled and expressed through context-informed built solutions.

We are convinced that the work of the Rural Studio is critically important to the discipline of architecture, and we applaud its organizers' efforts to broaden its pedagogical base and effectively engage "other" disciplines. But the work remains centered on built architecture, and consequently these "other" disciplines remain secondary.

6 Generative Full-Scale Investigations

Some full-scale investigations are neither inhabitable, nor prototypical, nor experimental in the sense of testing a particular hypothesis, although they have incredible value as a source of ideas and inspiration. We define such investigations, for this reason, as generative full-scale investigations.[4]

The fundamentally simplest generative full-scale investigations engage simple materials such as sand, paper, or dry-stacked masonry units. When we define a typical generative full-scale investigation for our students, we provide a description of the subject materials, and a set of simple questions, concepts, or issues, and explicitly stated conditions, such as limitations on space, material quantity, or time.

The first semester of the undergraduate architectural design studio program at the University of Minnesota begins with a generative full-scale investigation into the material properties of sand: the Sand Box exercise.

In this exercise, each student constructs a box and fills it with sand. In three distinct phases, each consisting of a minimum of ten distinctly documented "iterations" or attempts, we ask the students to manipulate and explore the sand in the box, to test its material properties, and specifically to recognize and define regions, separations, overlaps, and conceptual strengths and weaknesses within a specific iteration or configuration of sand. The questions surrounding this investigation are deliberately open-ended and not specifically testable or verifiable.

The stated conditions of the exercise consist of the size of the box (no variation is permitted), constraints upon time (regular deadlines corresponding to the three phases of investigation), and limitations upon action (e. g. no chemical changes to the material are permitted). Strict documentation is essential because of the temporal instability of the material: once an iteration is destroyed, its value to an overall process vanishes, unless it is accurately recorded (i. e. to a sufficient degree that it could be accurately reconstructed later).

In direct contradiction to the premise of experimental full-scale investigations, generative full-scale investigations such as the Sand Box exercise propose no explicit hypotheses whatsoever; there exists no stated goal, predetermined procedure, or desired outcome. Emphatically, there exists in the Sand Box exercise no direct means of testing whether a given investigation is "successful" because no criteria for judging success are ever stated at the outset of the work. As with experimental work, the conditions of generative work are tightly defined primarily as a means of focusing attention; but in contrast to experimental work, the conditions in generative work are not defined as a means of prequalifying the meaning of success.

How, then, is success judged at all? If not by a student's successful demonstration of a principle or technique; if not by the demonstrated validation of a hypothesis; if not by the achievement of some social or communal good, then by what? What constitutes our criteria for evaluation?

Simply, we attempt to recognize those students who are consistently able to discern value in their own work and to productively act upon that value. This recognition requires us to speculate about each student's observation and decision-making processes as evidenced by the hard-copy documentation of their multiple iterative processes. The documentation is revealed to be a critical component of evaluation: only through our examination of the documentation can we hope to understand the subtle shifts in configuration which compose a student's iterative process.

We believe that the best and most promising students are those whose generative processes (in the sand Box exercise in particular) consist of a cycle of seeing, thinking, acting, and judging. First, can students describe to themselves what they see in a particular iteration or set of iterations? Second, can they define for themselves whether they are seeing structures the way they are thinking? Third, can students act upon an existing configuration to strengthen a promising and defined perception? Most critically to success, can students judge whether a particular action has resulted in a positive change regarding the structuring of thought and perception?

Generative full-scale investigations, as considered within the discipline of architecture, are unique in that their connection to the products of architecture as it is professionally practised is profoundly tenuous and shaky. Playing in sand does not substitute for explicit instruction into component systems, nor for rigorous experiment. However, the connection of generative full-scale investigations to promising processes of architectural design is deep and abiding. The cycle of seeing-thinking-acting-judging recurs at every level of architectural design from the most base and fundamental to the most sublime and complex. This observation is as true of the products of our work as it is of our design processes.

7 Conclusion

From observing the successes of generative full-scale investigations in the undergraduate architectural design studio at the University of Minnesota, we believe that these investigations have promise that potentially reaches beyond our already quite broadly based discipline, for three specific reasons.

First, among the four types of full-scale investigations we observe, generative investigations are easy to translate across disciplinary boundaries because they are not specific to a given discipline. We have observed here that the connection between generative full-scale investigations and the professional practice of architecture is tenuous and shaky. More generally, we realize that generative investigations are of value within our discipline because they form a core or foundation for additional study. The investigations deal with patterns and structures of thought, not necessarily of building or architecture; as such, their value clearly has wider cross-disciplinary implications.

Second, because generative investigations are by definition nondeterministic and open-ended, they cannot easily be forced to conform to a particular agenda (e. g. architectural education to the exclusion of wider ideas). In generative investigations, there exists no defined set of criteria for judgment of success or clearly stated, testable hypotheses. There is no stated goal that forces the investigation in pursuit of a narrowly defined topic or theme.

Third, and most significantly for cross-disciplinary potential, generative investigations are speculative by nature: that is to say, they are fertile ground for defining questions about design processes. Generative full-scale investigations introduce a fundamental cycle of seeing-thinking-acting-judging, which is essential to the success of designers (and arguably, to artists and engineers).

In summary, we believe that by engaging students in a haptic experience not directly related to a specific construction technology, generative full-scale investigations foster thinking, ideation, and creation which transcend practicality and which consequently have far greater implications than demonstrative or laboratory work. Direct, unmediated experience with material – experience that is not obviously connected to the discipline of study – gives rise to open-ended learning where importance derives from the asking of questions rather than finding the answers.

We conclude that generative full-scale investigations have great cross-disciplinary potential as a means of introducing design processes precisely because they are nondeterministic, non-specific to a particular discipline, open-ended, and speculative.

Notes

1 Robert Mark, in his book Experiments in Gothic Structure, writes of Gothic architects that it is "conceivable, if unlikely, that scaled models, assembled stone by stone, were used to test for the overall stability of new [i.e. historical] architectural forms. Yet even this type of model could not have adequately predicted the structural behavior of a full-scale building under the action of all natural forces." – Mark, p. ix.

2 Douglas Hofstadter writes of aleatory compositions: "John Cage's 'Imaginary Landscape no. 4' ... is a classic of aleatoric, or chance, music – music whose structure is chosen by various random processes, rather than by an attempt to convey a personal emotion. In this case, twenty-four performers attach themselves to the twenty-four knobs on twelve radios. For the duration of the piece they twiddle their knobs in aleatoric ways so that each radio randomly gets louder and softer, switching stations all the while."

3 See Dean, 2002; also see www.ruralstudio.com.

4 In our paper subtitled The Potential Of The Unquantifiable, we discuss two specific examples of generative full-scale investigations in detail.

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