Ends and Means: Inquiries into the Role of the Solar Decathlon in Architectural Education

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If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.[1]

- Antoine de Saint-Exupery

Introduction

Architectural education often perpetuates a feud between the mind and the hand. To one side we find thinkers, enamored with the idea of design as an intellectual act, whereby the obstinate realities of materials and construction are displaced by the heft of words and concepts. In opposition stand the builders, who cherish the bruised knuckles, scrapes and scratches that bear witness to a kind of undeniable, but unteachable knowledge. Between these two poles lay a vast landscape of design studios, forming the center of architectural pedagogy where the struggle to find balance between theoretical motivations and constructional realities is a recurring and persistent debate. To reflect on this issue, we propose to take advantage a unique moment between two Solar Decathlon houses, one nearly complete in its final rebuild, the second just underway.

To preface this discussion, it is important to note that our insights are largely born out of the experiences gained in the 2010 Solar Decathlon Europe competition, where we served as faculty advisors on the University of Florida's Team Re:Focus house (fig. 1).[2] Though we could leverage this position to shed light on many facets of the decathlon project, we are restricting our observations to the pedagogical concerns of this immense and trying experience. Anything more would unleash a torrent of recollections worthy of a Verdian opera. Instead, let it suffice that we, and many of our fellow decathlon alumni, knowingly share the honest and lovingly irreverent title of *recovering decathlete*.[3]

Fig. 1. Project Re:Focus (photographs by David To)

Design/Build?

That being said, it is also important to position our decathlon experience within the larger discourse within architecture pedagogy. The solar decathlon is commonly situated as being one of numerous design/build programs that aspire to bridge between the imagination of the studio and the material realities of construction. Gathered together in this manner, the decathlon experience seems a reasonable partner, sharing many of the same educational aspirations of other design/build programs. In his essay *Sore Shoulders, Bruised Ethics*, Scott Wing notes of design-build projects that; "*when situated in conditions of social consequence, [they] provide an educational platform on which to present architecture as a complex structure of ethical positions and actions. As students confront material consequences and cope with physical exhaustion, struggle to reconcile the divergent missions of clients and classmates, and ponder the limits of time and money, they experience the act of construction as a process of 'doing the right thing.' Rather than a professor 'teaching' a predetermined code of conduct, ethical conduct emerges from the student's confrontation with difficult choices.*"[4] Wing's comments are prefaced with a similar reading of the pedagogical divide suggested in the opening paragraph of this paper, wherein service-centered design-build projects are set in opposition to traditional, professor-led studios. While the majority of design/build programs tend to direct their service efforts towards the immediate needs of a local client and context, the decathlon reaches for a much larger impact on the building industry as a whole. Since its inception in 2002 by the U.S. Department of Energy, nearly 200 teams have competed in the solar decathlon, building a

community of over 25,000 decathletes who walked away with a deep understanding of the "requirements of designing and building energy-efficient, solar-powered houses."[5] This reach alone outpaces even the most long-standing of design/build programs, more so when intersected with the public spectacle that surrounds the competition.   With visitors to each decathlon competition counted in the tens of thousands and compounded by the expansion of the competition into mass media, no other design/build experience can argue for greater visibility in the public eye.

In this regard, the decathlon must also be understood as being a rather peculiar bedfellow to other design/build programs, particularly within the boundaries of pedagogical expectations, outcomes and reflections. This is perhaps the advantage of smaller design/build projects as the scale and scope of work can be tailored more easily to the constraints of curriculum and resources, in turn allowing for a better assessment of the pedagogical benefits. That being said, effective pedagogical outcomes can be difficult to predict on small projects, let alone a project with the complexities of a solar decathlon house.

Between Ends and Mean

Anthony Schuman suggests that the essence of service-learning lies in two principles; reflection and reciprocity. Schuman positions reciprocity as the "crux of engagement," and as such weighs the collective benefits of learning and production. In comparison, Schuman holds the idea of reflection as "the hallmark of pedagogy," focusing it with the rhetorical question, "What intellectual underpinnings inform the process and how is the field experience used to challenge and refine thinking?"[6] This notion of reflection is embraced in the work of Donald Schön as well, particularly his ideas of reflection-in-action in the design process, wherein Schön employs the exchange between an architecture student and faculty as a muse to demonstrate this principle.[7] Schön focuses on the immediacy of exchange between faculty and student, while Schuman, in contrast, recognizes that reflection at the terminus of a project can allow for reconsideration and revision of the system as a whole. In this regard, both orders of reflection are essential and operate best when bound together, but are more easily understood as uncoupled and will be explored as such, beginning with the internal reflections.

In the Trenches

Schön characterized reflection-in-action as an immediate, internal kind of process, aligning it with a range of colloquialisms with similar meanings; "Phrases like "thinking on your feet," "keeping you wits about you," and "learning by doing" suggest not only that we can think about doing but also that we can think about doing something while doing it."[8] These kinds of statements strongly align with our methodology of studio teaching, mirroring Schön's tenet of "learning by doing", which we rephrase as "thinking through making." Our students embrace this principle fully, sharing in our insistence on an iterative process, whereby the products of that process become both the evidence of a distilled thought and a springboard that anticipates and/or instigates the next iteration. Thus, Schön's usage of the architecture studio as a demonstrative scenario is, for us, self-evident. As faculty, we have had the same kind of exchange with students that Schön explores, where feedback is intended, in part, to expose the "problem of this problem," so that the student can refocus their efforts to untapped opportunities or alternates approaches to the issues at hand. [9]

It is critical to note that this feedback is not merely aesthetic judgment, but rather is rooted in refining the systems in play, including among other issues the alignment between conceptual intent of the student within their work and the constraints and requirements of the project itself. In this regard, any design project offers hundreds, if not thousands, of opportunities for reflection-in-action to occur, whether in conversation with a studio critic or classmate, or in an unspoken dialogue directly between the student and their work. In this regard, the decathlon project is much like every other project, enrobed by a tapestry of common design challenges, such as the relationship between building and site, or the influence and interpretation of program as both a generator and constraint. Other challenges, however, are unique to the decathlon as an event and seem oddly intent on forcing collisions, confusions, and incongruencies between the principles of good design as defined in a typical studio and the needs and expectations of an elite decathlon entry.

In or Out

A number of the decisions in our 2010 Solar Decathlon Europe house showcase this kind of incongruency and we offer forward two that resulted in confusing the refection-in-action process.   First, each decathlon competition offers an extensive set of rules and regulations to which each team is accountable. These rules contain a great deal of information and offer guidelines, requirements, limitations and instructions regarding the design and construction of the house.[10] In the 2010 SDE competition, one of the rules defined the maximum square-footage of the house, which was to be capped at 796 sf (74 m^2). This rule was accompanied with additional directions regarding the method of measurement and what components would be included in that measurement, such as any projection that might shade the house, regardless of whether that extension was occupied or conditioned. Other parts of the rules commented on the building envelope and the restrictions on shading systems, which left the student team uncertain of how to interpret the overall building footprint calculations. Preliminary design work was well underway, including an operable wooden screen system

that served as the outermost layer of the building skin. The team had interpreted the rules in a manner that would allow these moveable screens, recognizing that they would create horizontal projections on the north side of the house, but would not shade any portion of the building envelope within the specified hours of the competition. With this interpretation in mind, the team moved forward with the bi-folding screen, folding above each exterior doorway, as well as at the north and south openings of the breezeway that separated the living and bedroom modules. The majority of the folding screens were oriented to the north side of the house, extending to the north deck and stitching together the interior and exterior spaces.. The screen over the southern breezeway opening, however, would shade the house if it folded outward, which meant that this screen would need to operate in an counterintuitive and inconsistent manner, opening inward to the breezeway.

Fig. 2. Construction well underway on the competition site (photographs by Clay Anderson)

The constraints of schedule offered no idle time and the team knew that the screen system was a risk, but they felt this system was a critical part of the overall tectonic expression of the house. More so, the system had been developed to comply with the competition rules per the team's interpretation, so the project moved forward to pre-construction, shipping, and reconstruction in Spain before any ruling from the SDE organizers was provided (fig 2). Once the house was on the competition grounds, the organizers determined the screens to be in violation of the rules. They permitted the team to compete with the screens in place and allowed the screens to open for juried contests, but required that the screens be down for all of the measured contests. The team accepted the ruling without debate, as the race to complete construction was paramount.

The first contest was Architecture, a juried contest. In presenting the significance of the breezeway, the students explained its origins in the vernacular traditions of North Florida, how it extended the entry from the south through to the north deck, how it could contribute to cross-ventilation and natural lighting, and how the screen system folded to allow for this space to be enclosed (fig 3). One jury member made note of the folding screens, with particular concern to the one, south-facing inward-folding screen, asking the student

team if they understood why that one screen was an anomaly to the rest of the system.   The team acknowledged that the screen was inconsistent with the screen system proper and the principles of solar shading in passive design, offering the defense that the rules had effectively forced the screen to fold inward in order to avoid violating the maximum allowable footprint.

Fig. 3. Student Leaders presenting to the Architecture Jury on the first morning of the competition (photograph by Clay Anderson)

This moment with the jury highlights the confusion the team faced when trying to reconcile the competing demands of the design fundamentals and competition constraints. On the one hand, the students were aware that the inward-folding screen was inconsistent with larger screen system and the design principles that it was attempting to embrace. This awareness affirms that their prior studio lessons had been understood and could be drawn upon and redirected to new problems. More so, the team was nimble and candid with their answer to the jury, confirming that they had fully digested the complexities of the skin and felt compelled to champion the architectural vision at the risk of exposing a conflict within the rules of the competition. This seemed to resonate with the jury, and while they held Team Re:Focus accountable to the design of the screen, they also offered a scolding critique of the rules during the closing comments of the architecture awards, noting that fundamental sustainable design thinking should not be displaced by narrow and arbitrary constraints.

At the time, this modest vindication helped assuage the disappointments the team felt, though in retrospect, the jury's insight revealed that the challenge was not with the design intent of the screen, but rather the ability to integrate that strategy within the narrow limits defined in the competition. This dilemma left the students struggling to reconcile two competing needs and with few experiences from which to draw for insight.

The Remarkable Weight of Adaptability

The second example we wish to examine addresses the broader issues of assembly. The students were fully

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aware that this project would be built and thus become real beyond any of their other studio projects. They also know that the house was eccentric in so many ways that conventional design thinking would be inadequate. Everyone recognized that the house would go through multiple and repeated stages of construction, moving, deconstruction, and packing, and that the logistics and resources involved in this process would be immense. The students pursued this issue head-on, looking into a multitude of ideas for modular, demountable systems and shipping methods, only to discover that there was no ideal method, but a wide range of options, each with its own consequences and constraints.

The challenge here became one of resolving a method of modular assembly that could be adapted to meet a range of shipping methods. The students were quick to establish the limits of shipping dimensions and weights, intersect this data with the design constraints from the competition brief, and arrive at a preliminary nominal building module that was nominally 8' wide by 16' long by 11' high. In terms of moving along roadways, this module could be shipped as a single piece without crossing into the complexities of an exceptional move. More so, this module, when repeated in six bays abutting along the 16' edge, would yield an overall building footprint near, but below, the maximum building footprint. The concern of the mating edges could be resolved, as could a range of assembly methods and material logics, all of which could be wedded to a rigid frame developed to minimize the structural obligations of the envelope.

As this strategy continued to develop and donations of steel for the frame were secured, the remaining concerns of building envelope were reconsidered. The team had decided that structural insulated panels (SIPs) would be used to construct the walls, floor and roof, but finding a supplier had become unexpectedly challenging. The initial manufacturer's bid was deemed too high for the project budget, which led to conversations with a second company who went out of business just prior to fabrication, which in turn led to selecting a third company who worked with great haste to meet a rapidly compressing construction schedule. Each of these shifts required the team to rethink the connections and overall fit of the SIP panels to the existing modular logic while juggling the impact these shifts might have on the logistical strategy for shipping the house.

At this point, the team had determined that the house would need to be flat-packed into five shipping containers for its trip from Florida to Madrid. Once there, the team would begin reassembling the house on a remote site prior to moving it to the competition site. The erection team had developed an alternate moving process that used the two larger modules of the house, each composed of three of the original 8'x16' modules. Each of these larger modules could be craned onto a special trailer, moved from the remote pre-build site outside of Madrid to the competition site and craned

into placed. This new strategy required a higher level of logistical choreography, incorporating the restrictions of an exceptional move, a more robust lifting process and a reconsideration of schedule, as the move could only happen between 10pm and 5am. The benefit to the approach was rooted in the efficiency of the move. If everything went as planned, the two modules could be in place by the morning of the second day of the 10-day build period, leaving the remaining time open to completing, detailing and staging the house for the competition. Alas, fate would interfere in a near-catastrophic manner. One miscommunication in the weight of the modules left the spanner beams undersized, which failed on the first lift. Upsized beams were fabricated overnight and the second lift was successful, but a host of complications following the move created a 72-hour delay, in turn reeking havoc on the carefully planned construction schedule (fig 4).

Much of this might have been avoided with a more thorough review of the submittals to the logistics team, but the weight of the house was already excessive, largely the result of the need to remain nimble early on. Though the team's reflection-in-action process proved efficient at wrestling with the uncertainties of the building structure, module and envelope while they remained in flux, but was was interrupted once the steel was ordered. Distracted by other issues, the team simply failed to recognize that the new logistical strategy did not require as much structure, which meant that early decisions had led to structural redundancies, in turn leading to an excess of material and weight and no effective process by which this excess could be revised or reduced.

Fig. 4. Lifting and placing the living room module (photograph by Clay Anderson)

The Big Picture – and a Longing for the Sea

We often tell our students that they should avoid evaluating the lessons of a studio until they are several months away from it. This recommendation may seem counter to the reflection-in-action principles of Schön, as reflection-in-action finds its greatest purchase when a process is underway and a full range of issues and

relationships are actively in play. The more distant view, in comparison, allows for a broader type of reflection that can tease out, in Schuman's terms, the intellectual underpinning of thinking in the project.[11]

For our purposes, this distant view is critical in rethinking our pedagogical process, particularly as we begin designing our entry for the 2015 Solar Decathlon competition being held in Irvine, California. In just under two years, we will again be in the throes of constructing a house that is currently in the nascent stages of design. Looking back, we can see that the some of the struggles the team faced could be avoided with a rethinking of process, but we would be hard-pressed to say that all of them were the result of inadequacies in this process. More so, the pedagogical strategy that we employed, though imperfect, was rarely at fault for the conflicts that arose. Curricular collisions were bound to happen, and while we could argue for a more elastic curricular structure, we would not want the decathlon to become a primary driver in the development of curriculum. Rather, our primary critique and concern as we move forward is rooted in learning to communicate. The most confrontational moments seemed to be bound up in the team's collective inability to consistently address the issues at hand openly and fairly. It is on this point that we will redouble our efforts.

Looking back, we are confident that the underlying principles of our pedagogical approach are well situated. Giving the students the helm established buy-in to the project that might otherwise have remained tenuous. Similarly, the strains this created also gave the team the opportunity to experience the full collision of egos, attitudes and agendas that frequent collaborative work. We make no claim to orchestrating all of the lessons discovered during Project Re:Focus, nor would we argue that this is even possible. Designing and constructing a house hides within it numerous lessons that cannot be taught, and it is these lessons that often find the greatest purchase.

If the ultimate goal of the decathlon is to educate "students and the public about the money-saving opportunities and environmental benefits presented by clean-energy products and design solutions,"[12] then its radiant shadow is the unbridled enthusiasm that it fosters. Every decathlete walks away from the competition a better student and architectural steward. It is easy to imagine the atmosphere at the final awards ceremony. The crowd of decathletes is humming with an infectious sense of anticipation. Extremes of elation and disappointment accompany the announcement of each award, but just below the surface courses the palpable feeling that each person in the room has endeavored to be a part of something bigger than themselves, they are in it together, and has become a bigger person because of it. Our contribution to this process is rooted in this sentiment, and it is from here that we humbly move forward once again with the assurance that our efforts operate with the spirit of

Saint-Exupery's words that opened this paper, as the longing for the sea is in the decathlon is undeniable.

Notes

[1] http://wordsmith.org/words/mainstay.html

[2] The composition of the UF Solar Decathlon Europe 2010 team was developed from four academic units of UF's College of Design, Construction and Planning (DCP), the College of Engineering, the College of Business Administration and the College of Journalism. The primary faculty advisor was Dr. Robert Ries, faculty in the Rinker School of Building Construction. Additional faculty advisors included, Mark McGlothlin and Bradley Walters (Architecture), Dr. Maruja Torres-Antonini (Interior Design), Dr. James Sullivan and Russell Walters (Building Construction), and Diana Pelfrey (Public Relations). The bulk of the student team was drawn from the DCP, with other units contributing in smaller numbers of students: architecture (11 students); building construction (15 students); Interior Design (3 students); Landscape Architecture (1 student); College of Engineering (3 students); the College of Business Administration (1 student), and the College of Journalism (3 students). It is important to note that a complete listing of student contributions would be nearly impossible, though the number would easily exceed 150 including the student team.

[3] As far as we are aware, John Quale coined the title "recovering decathlete." Quale was the faculty sponsor to the University of Virginia Solar Decathlon house, which competed in the inaugural Solar Decathlon Competition in 2002. Having talked with John on several occasions over the years, it is surprising to note he continues to refer to himself as a recovering decathlete when discussing his experiences.

[4] Wing, Scott. "Sore Shoulders, Bruised Ethics: The Unintended Lessons of Design-Build," in *From the Studio to the Streets,* ed. Mary C. Hardin, Richard Eribes, and Charles (Corky) Poster (Sterling, VA: Stylus Publishing, LLC., 2005), p. 91.

[5] Http://www.solardecathlon.gov/about.html.

[6] Schuman, Anthony. "Introduction: The Pedagogy of Engagement," in *From the Studio to the Streets,* ed. Mary C. Hardin, Richard Eribes, and Charles (Corky) Poster (Sterling, VA: Stylus Publishing, LLC., 2005), p. 1-3.

[7] Schön, Donald. *The Reflective Practitioner* (New York: Basic Books, 1983), 76-104.

[8] Schön, 54.

[9] Schön, 104.

[10] Solar Decathlon Europe 2010 Rules and Regulations, Draft 3.0. 2009-07-10, 31-37.

[11] Schuman, 3.

[12] http://wordsmith.org/words/mainstay.html