UNMOORED ARCHITECTURE: ON MODULES, MOBILITY AND MANUFACTURING IN THE RE: FOCUS HOUSE

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INTRODUCTION

> A man who carries a cat by the tail learns something that can be learned in no other way. - Mark Twain[1]

Architects can be described through many shared characteristics… epigrammatic prose is not among them. And so it should be of little surprise that the beloved humorist Mark Twain was able to capture with laconic precision the fundamental predicament of design/build pedagogy. Twain's jocular imagery offers an undeniable clarity to the act of learning through direct experience. While we can admire and perhaps long for Twain's pithy wit, we also, as academics, understand that there is equal importance in looking beyond the obvious and trying to explore, in very specific terms, what can be learned about design through full-scale building.

In many classic variants on design/build as implemented in our schools, architects learn how to build or builders learn how to design, with individuals expanding their skill sets laterally such that they are able to understand more aspects of the design and construction processes. This is most readily accomplished when the building assemblies or design objectives are more conventional or modest in size, scale, and scope.

As design and/or technological proposals become more complex, however, greater expertise is required in the particularities of each system, often requiring specialized design skills, fabricators, and/or installers. As the different systems become more intricate, it becomes more difficult for single individuals to be able to understand the nuances of them all, and most often results in specific individuals within a team who are charged with specific tasks, based on their unique abilities and skill sets. As a design/build project, the student learning outcomes in this model shift from more general to more specific. Students are able to develop a greater depth of research in particular areas, but largely by sacrificing the ability to work laterally across multiple subject areas, systems, and/or project goals.

In terms of design, there is often some concern about a contraction of the process, about getting to an end too quickly, about closing possibilities, and an aversion to the perceived finality that comes with larger-scale constructions. In schools without exhaustive shop and fabrication facilities, the limitations imposed by tools and/or students' abilities can also be a concern, especially if these limitations lead students to construct fictional parodies of their projects, simply to be able to make them with accessible materials and/or hand tools.

Part of our challenge in evaluating design/build methodologies is that we have tended to operate with the understanding that all design/build programs are directed to similar pedagogical ends, and therefore can be collected without concern under the same conceptual umbrella. This approach, while perhaps effective in offering a sweeping survey of architectural education as a whole, overlooks the peculiarities and eccentricities that define each design/build program – and it would be hard to find a more peculiar program than the U.S. Department of Energy's Solar Decathlon experiment.

DESIGN PEDAGOGY AND THE SOLAR DECATHLON

First conceived in 1999, the Solar Decathlon program grew in response to a fundamental interest in bridging between the solar industry and building industry, "to fully integrate solar technology into the design of buildings." A working group comprised of representatives from the solar industry, the Department of Energy (DOE), the National Renewable Energy Laboratory (NREL), and Sandia National Laboratories (Sandia), jointly developed the "Zero Net Energy Buildings Outreach and Action Plan," including the specific task to of holding a "Design Competition for Prototype ZNE [Zero Net Energy] Buildings."[2] This task served as the guiding objectives for what would become known as the Solar Decathlon beginning in 2000.

It is interesting, and significant, that while a principal objective centered on binding together the solar and building industries more closely, the initiative was born almost entirely out of the solar industry. The building industry is negatively characterized based on energy use while the solar industry is positively characterized, based on reduced energy use, lower emissions, increased health of occupants, and increased energy security.[3] We see in the initial position paper the creation of a certain technological problem-solving bias, one that favors the ameliorating role of solar over deleterious and inefficient building practices. The reformation of buildings (and those who make them) is an overt mission of the project.

The U.S. Department of Energy sponsored its first Solar Decathlon in 2002. Fourteen collegiate teams each created fully functional, solar-powered houses that then competed in a series of ten different competitions and categories.

Over the years, the mission of the program has grown somewhat, such that today collegiate teams are challenged, "to design, build, and operate solar-powered houses that are cost-effective, energy-efficient, and attractive. The winner of the competition is the team that best blends affordability, consumer appeal, and design excellence with optimal energy production and maximum efficiency."[4] The decathlon, now in its sixth bi-annual cycle in the U.S, and complimented by parallel decathlon competitions in Europe and China, is clear in the centrality of educating the public at large to the potentials of energy efficiency at the scale of the house and in expanding solar energy markets around the world.

The question of design learning and thinking is a part of this mission, but secondary to the principal work in the creation of new solar-powered building prototypes. The DOE, writing about the event in 2001, suggested that, "student competitions are an excellent way to engage students in problem solving beyond the classroom and laboratory. Students will gain through real-world experience what they can't always learn in the classroom."[5] Today, the DOE further suggests that the decathlon experience "provides participating students with unique training that prepares them to enter our nation's clean-energy workforce."[6]

The Solar Decathlon introduces a number of peculiarities into the design/build process, including offsite fabrication, issues of place/placelessness, greater emphasis on technological solutions, performative requirements, and the contests and measurement. Given the nature of the contests, it also is a somewhat more product-oriented approach that can at times become an overarching commodification of the house.

ORGANIZING THE TEAM

While the RE:FOCUS house certainly represents the University of Florida School of Architecture's most complex foray in a design/build project in recent years[7], the ideas of full-scale construction have bubbled intermittently in smaller, bounded projects for over three decades.[8] Our curriculum has evolved over many years, itself a rich synthesis of early regionalist concerns about building techniques and strong influences regarding craft, material and process drawn from the Bauhaus.[9] Robert McCarter, during his tenure as Director, framed three characteristics of the studio work of Florida as follows:

> 1) the student work is characterized by an exceptional level of craft in its construction and in its spatial articulation, 2) the discussions and criticism in the studio center on the questions of how design is determined by the nature of inhabited space, and 3) the curriculum itself is constantly being remade, subjected to criticism and development, yet simultaneously allowing for innovation in design methods and experimentation in spatial definition.[10]

In this regard, the ideas of the decathlon should have meshed quickly with the larger design pedagogy of the school, embracing the opportunity for our students to extend beyond the limitations of the page and inhabit the material world. However, our curriculum tends to develop slowly and the sudden opportunity created by decathlon offered little time for strategic curricular integration.

Designs and Decisions

The faculty team determined early in the process that we would embrace the suggestions of the decathlon organizers to let the project be led primarily by the students. We felt that this approach would increase the students' sense of ownership of the house, and subsequently increase their confidence in the process that was to unfold. We also felt that this team structure might help bridge disciplinary divisions. In retrospect, we could have managed this process more smoothly, though our intentions were sincere as we hoped to tap into the innocence of students and circumvent the common divide between builder and designer. Our discovery that the shared disdain between designers and builders forms early was unfortunate, but not entirely unpredictable. As Colin Davies notes: "Architects and builders may be able to rub along together on a professional level but culturally they are worlds apart. They speak different languages, they have different aims and tastes, they are educated differently, and they have different histories."[11] It became clear that team unity would need to be fostered in another way and that schedule pressures would push the bulk of decision-making on the design students.

In terms of student involvement, our team was heavy on designers and builders, but lean on engineering, creating a critical gap in technical prowess, book-ended by the poetic ambitions of designers and the hammer-swinging eagerness of the builders.[12] It was also clear that reinforcements in engineering would be slow coming, which left the architecture students taking on the lion's share of design decisions, many of which were well beyond their level of expertise.[13]

In trying to help mentor the students through the maze of challenges that they now faced, we asked them to familiarize themselves with the decathlon rules, how the various contests worked, and then to try to hold at bay the temptation to have our house cleverly "solve" each and every regulation stated in the rulebook. The rules offered by the decathlon organizers were daunting and establishing the critical constraints was essential, but equally so was finding a way to preserve a sense of imagination under these constraints.[14] We convinced the students that trust in process was essential, something that each of them had heard numerous times in earlier studios, as well as a barrage of complementary ideas of our studio culture: find conceptual clarity; iterative work over singular brilliance; when uncertain of an idea, make it; we won't talk about what isn't there…you have to build it. While all of these adages were repeated with enough frequency as to teeter towards cliché, none brought the groans to the discussion table more so than "…you have to build it."

Our studios tend to champion the physical over the theoretical. Though we encourage conceptual thinking throughout the curriculum, we also value the precision of thinking that can only come through making, with the understanding that architectural ideas deposited in drawings and models are speculations towards a more tangible architectural construct, one that words alone cannot supply. The immediacy of making was critical to the decathlon team, as the studio work became the focus and vehicle for discussion, decision-making, and forward movement. We expected that studio conversations, if approached openly and honestly by all, would give much needed direction to the project. While that direction eventually emerged, the debates in the studio revealed a different kind of friction within of our team structure, but more so our curricular structure, as the team struggled to find shared positions on the basic tenants of space, place, and materiality.

Permanence Versus Mobility

Studio sequencing can be directed by many things – scale, program, typology, material palettes to name but a few, and in most instances it is likely that the pedagogical direction and sequencing of studios is shaped by the simultaneity and continuity of ideas. Our curriculum follows this model, with the ideas of place making and spatial thinking firmly rooted in each studio. This approach builds in intensity with upper-level studios, where the issues of context are addressed head on. The specificity of place is wrestled with over and over, with the academic goal of helping our students establish a systemic approach towards context. The process of understanding a site, drawing influence from it, and offering something meaningful to it is revisited and reframed, with continual reinforcement that a careful, analytical approach towards site will reveal more possibilities than are understood on the surface. Our students come away from these studios with a clear understanding of context as a multilayered, cultural fabric, and that broad architectural questions should not cloak the important of precise thinking about place, but rather draw forward the specific characteristics of the place that make it meaningful.

Figure 1. Rendering of the northwest corner of the RE:FOCUS house.

The decathlon project, if viewed as existing for only the eight-day duration of competition, could be targeted in very precise terms to that specific place and moment in time. However our team, like nearly all of the decathlon competitors since the inauguration of the competition, recognized that the house would need to have a life well beyond the competition if the investment in resources, materials and sweat were to be justified. This introduced a wrinkle in the question of site and how to address it, as the house no longer could be attached to a single site, but rather as having multiple sites, each broadly defined, requiring many generalizations and limiting the ability and shape exterior spaces, respond to cultural motivators, and provide appropriate responses to dissimilar climatic conditions.

The unmooring of the house from the traditional influences of context disrupted the students' conventional thinking and sparked a heated debate about the direction the house should take. One group of students was adamant that the house should reflect the identity of the school, carrying with it the regional influences of central Florida. They reinforced this attitude by questioning the longevity of the project, expecting that the house would return to the UF campus after the close of the competition and therefore some contextual response was warranted. The opposing view was to separate the house from these geographic influences and instead focus on the technological aspirations of the competition. The competition's emphasis on showcasing emerging technological systems was abundantly clear and a brief survey of previous decathlon houses reinforced the critique that the poetics of space and place making were not equitable to technological prowess.[15]

The resolution to this debate was quite straightforward. Both arguments were valid but not diametrically opposed, which offered the opportunity for rephrasing the conceptual question while also looking for opportunities for overlap and synthesis. The team knew that the house would be constructed multiple times and alternative construction methods would need to be considered. Several of these methods relied on a moveable structural armature and insulating envelope, which left the interior and exterior finish materials open-ended. The team opted to separate the interior envelope and the exterior cladding, redressing the earlier contextual concerns through the integration of local material systems, while also leaving open the potentials for incorporating more advanced technologies and materials as part of the overall tectonic language. As the design process regained its momentum, the concerns of context receded, though they were quickly replaced with new concerns about the armature, envelope, and skin.

MATERIALS AND MODULES (ALL HANDS ON DECK)

Douglas Coupland's teases, "If a building looks better under construction than when its finished, then it's a failure"[16] reminding us in a rather cheeky manner, that the public's perception of success in building can be surprisingly shallow, more often than not steered by an appreciation of product, not process. This logic parallels a similar cliché more common to job sites, comparing construction and sausage making – the consumer doesn't really want to know what goes

into it. To be fair, both of these quips are more truthful than we may wish to admit, certainly if architectural success is ultimately to be judged in the public form. The decathlon competition, however, is a different beast requiring the houses to be constructed, competed and deconstructed within a three-week timespan.[17] The pressures on schedule are immense, requiring a construction process that is nimble, efficient, and highly orchestrated – nothing like making sausage.

The issue of constructability was a bedeviling one for the design team. Our students had a limited understanding of materials systems and constructional logics, and though we benefited immensely from the knowledge of the building construction students, their knowledge was limited to the conventions of permanent construction. Complicating this further was the challenge of shipping the house overseas, which limited the options for material systems and constructional methods.

Figure 2. The two house modules prepared for the initial lift. The spanner beams had failed the previous evening. Photo by David To, Arganda del Rey, Spain, 2010.

We had the advantage that the team had arrived at a clear schematic design employing simple modules. The house would be developed as six 8'x16' structural modules, abutted along their long edge to yield a 768 square foot building footprint. Three bays would be connected to hold the basic living functions of the house, with two more bays connected to hold the bedroom, bathroom and mechanical room. The remaining bay served as a breezeway between the programmatic modules.

In concept, this modular approach offered many benefits: a consistency in measure and proportion for rapid design develop; repeatable assemblies, joinery and details; ability to break the house in numerous pieces for ease of movement and assembly; and the flexibility of choreographing the assembly process in different stages. Though the design team wished for more advanced fabrication systems and material, the limitations of budget and resources quickly revealed that we would need to reconsider. Our most plentiful resource was labor, mostly unskilled, which meant that we needed to adapt the building systems and components to the skills of the students. The modular approach could be modified to allow for this shift in logic, as could the basic tectonic palette of the house, which consisted of three primary materials: steel for the armature, structurally insulated panels for the envelope, and wood for the flooring, interior articulation and exterior screens.

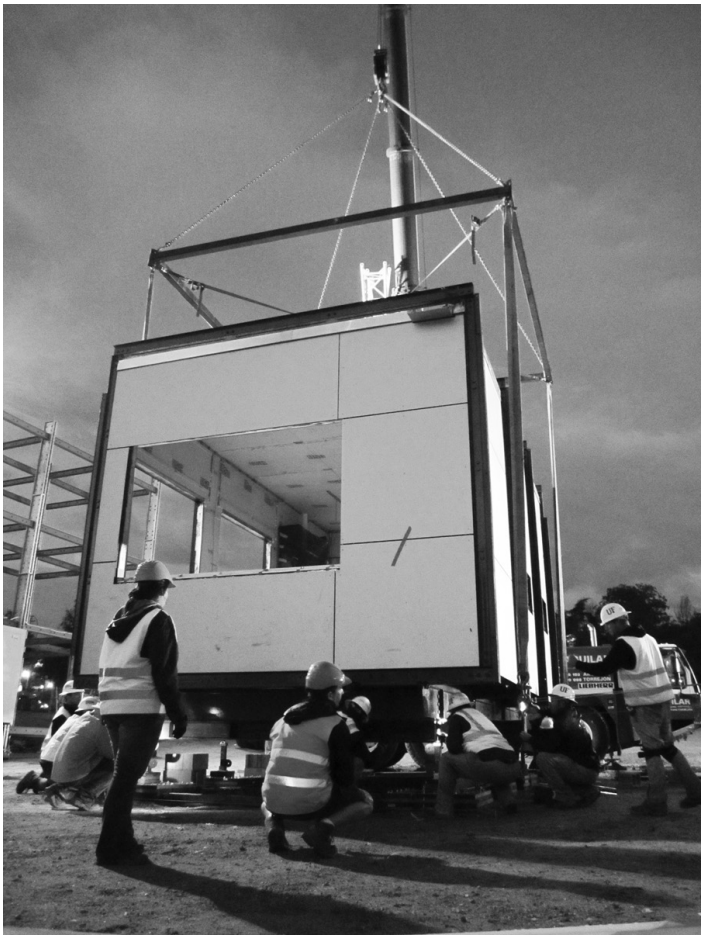

Figure 3. The living room module being lifted with a borrowed spanner "halo" and new spanner beams below. Photo by Clay Anderson, Madrid, Spain, 2010.

Working with these materials was relatively quick. The building construction students were familiar with steel construction and could assemble the modules and armature with surprising speed. The SIP's presented unforeseen challenges in procurement, but once on site were also quick to assemble. The primary wooded systems were prefabricated on campus, flat-packed and shipped. In essence, the house became a kit of parts prepped for rapid re-assembly.

Building and Rebuilding

The final push started at a designated pre-build site outside of Madrid. The logistical arrangements had shifted to moving the house in two pieces that could be lifted and positioned on the competi-

Figure 4. Failed spanner beams with the RE:FOCUS house in the background. Photo by David To Arganda del Rey, Spain. 2010

tion site. The goal was to have both house modules moved and positioned within a 24-hour window, the team knew that this would require many independent events to work in perfect coordination. As the build week opened, the construction team took action, with one group preparing the competition site, staking and setting foundations, while the other group returned to the pre-build site to prep the first house module. Everything was proceeding as scheduled, up to the point of the first lift. Due to a miscommunication, the logistics team had designed two spanner beams that were undersized for the weight of the housing modules. As they attempted the first lift, the spanners failed. The team was lucky that the failure happened before the house was airborne, but the impact to an already tight schedule was dramatic. In the lag of getting new beams fabricated, new permits for the move (which could only be done between midnight and 5am) and complications within the move, the build schedule was set back nearly 3 days. The improvisational process that followed was controlled, but chaotic, as the build team was forced to work around the clock for the remainder of the build week. It was at this point that the early design strategies revealed an unrecognized value. The modular strategies of the envelope and screen were simple to understand, which allowed idle team members to move quickly and fluidly between tasks. This simple logic, coupled with the unbounded will of the students and faculty, finished the project just in time for competition.

CONCLUSION: CLARITY OR COMPROMISE?

Operating within a variable field and itself being motivated by many different hands, the RE:FOCUS House shows some of the possibilities and pitfalls of collaborative architectural design processes. It also reveals certain complexities of modular, off-site construction strategies and design/build pedagogical models. In reflecting on the University of Virginia's Trojan Goat house, John Quale's notes that;

> "The competition offered unique challenges as a teacher. The engineering advisors and myself had to manage collaboration amongst our own students, and across the two disciplines. We could not waste a lot of time with unrealistic or unworkable solutions. I found myself constantly thinking of ways to encourage good decisions and clear communication. It was probably the toughest professional assignment I had ever faced."[18]

Quale's reflections resonate closely with our own experiences, albeit with a different cast of characters. While the UVA team was confronted with the difficulties of bridging between different disciplines, we faced ideological divides even within the design team. The architecture students understood the necessity of making thoughtful decisions, but were unprepared to think critically about the complex questions they faced. Their positions were myopic at times, unable to evaluate competing ideas and project demands. This was particularly pronounced in instances where there was no objective determination of right, wrong, better, or worse. Each decision carried with it trade-offs, each with its own down-stream implications. Quale comments on this challenge as well, noting that, "Decisions that require careful consideration of trade-offs become more complex when they have to be made by a diverse team of people – each with their own experiences, interests and agendas." [19]

While some of the difficulties can be attributed to youthful naiveté or inexperience, the project also revealed fissures and voids within the broader architectural discourse. The discipline itself is somewhat unmoored, moving within a fragmented discourse, or in a field without a consistent ground. At moments, architectural work has a body of its own, or an integrity to selected components but a looseness of relationships with other (competing) frameworks and/or modules.

In athletic competitions after which the Solar Decathlon in named, we find startling parallels. As Frank Zarnowski writes, "In the decathlon the opponent is rarely another athlete. The struggle is against time, distance, fatigue and one's inner fear of weakness or failure and the scoring tables. The opponent is oneself."[20]

Figure 5. Professors McGlothlin and Walters, in a momentary lapse during deconstruction. Photo by Clay Anderson, Madrid, Spain, 2010.

ENDNOTES

1 Goodreads. Accessed July 12, 2012. http://www.goodreads.com/quotes/show/515877

2 "Zero Net Energy Buildings Outreach and Action Plan: January 1, 2000," U.S. Department of Energy, accessed October 16, 2000, http://www.eren.doe.gov/solarbuildings/pdfs/zne.pdf

3 The building industry is negatively characterized as follows: "Buildings use two thirds of all electrical energy consumed in the United States and are responsible for one third of peak electrical demand." This is contrasted with solar buildings, that are described in strictly positive terms, as they "meet their own energy needs by utilizing solar or other renewable resources; have no on-site or off-site carbon emissions; reduce utility peak electrical demand; optimize the health and productivity of their occupants; and provide energy security from natural disasters and extended power outages." See "Zero Net Energy Buildings Outreach and Action Plan: January 1, 2000," U.S. Department of Energy, accessed October 16, 2000, http://www.eren.doe.gov/solarbuildings/pdfs/zne.pdf

4 "U.S. Department of Energy Solar Decathlon," Office of Energy Efficiency & Renewable Energy (EERE), accessed July 12, 2012, http://www.solardecathlon.gov/.

5 "Benefits for Students: Real-World Experience," U.S. Department of Energy, accessed July 10, 2001, http://www.eren.doe.gov/solar_decathlon/real_world.html.

6 "About Solar Decathlon," U.S. Department of Energy, accessed July 13, 2012, http://www.solardecathlon.gov/about.html.

7 The composition of the UF Solar Decathlon Europe 2010 team was expansive and layered, incorporating four academic units of UF's College of Design, Construction and Planning, 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 (Architecture), Bradley Walters (Architecture), Dr. Maruja Torres-Antonini (Interior Design), Dr. James Sullivan (Building Construction), Russell Walters (Building Construction), and Diana Pelfrey (Public Relations). The bulk of the student team was composed of to the two largest units, namely architecture (11 students) and building construction (15 students), followed in turn by Interior Design (3 students) and Landscape Architecture (1 students). Students from the College of Engineering (3 students), the College of Business Administration (1 student), and the College of Journalism (3 students) also contributed as team members. It is also fair to note that a complete listing of student contributions would be nearly impossible, though the number would easily exceed 150 including the student team.

8 The idea of large-scale projects has been a part of the curriculum for many years, but many of the projects focus construction as an individual act. Examples of these types of projects include the luminaires project in ARC4620 Environmental Technology 2, and the installation projects emerging from ARC3181 Advanced Topics in Digital Architecture. Collaborative building projects have also been offered as a part of other coursework or independent projects, such as ARC3463 Materials and Methods of Construction 2 and the perennial Sukkot project. Design/build studios have been infrequent, though two vertical studios were offered by Dr. Charles Hailey.

9 The University of Florida School of Architecture was established in 1925 within the College Engineering, under the directorship of Rudolf Weaver, FAIA. Bernard F. Voichysonk, a graduate of Yale University and a student of Josef Albers was hired to revitalize the undergraduate curriculum, working in parallel with Harry Merritt, a Harvard graduate and former employee of Paul Rudolf.

10 McCarter, Robert, *Constructions: Studio Work from the Department of Architecture*. (Gainesville, FL: University of Florida School of Architecture, 1993), 5.

11 Davies, Colin, *The Prefabricated Home*, (London, UK: Reaktion Books, 2005), 8.

12 To clarify, the contributions of our engineering students was superb, but the team did not have enough student support from the College of Engineering to develop more rigorous research into the engineering components and systems. We do not fault the College of Design, Construction and Planning, College of Engineering. Design and Engineering students rarely cross paths, due in part to the size of the UF campus and the positioning of the two Colleges within it, but also because the design curriculum has few overlaps with that of Engineering.

13 Attempts were made to integrate students from the Building Construction and the Interior Design into the early design reviews, though we found that these moments produced inconsistent feedback. The building construction students struggled to understand the concepts, processes and language of the studio, while the interior design students were focused more directly on specific interior conditions that had not been determined. Students from both units played significant roles later in the development and construction of the house.

14 To offer a sense of comparative complexity, the rulebook for the 2010 Solar Decathlon Europe was 155 pages in length, while a typical studio project brief may be 10 pages in length.

15 John Quale noted a more severe variant of this prejudice in the 2002 Solar Decathlon competition. His work at this stage was instrumental

in raising the status of architecture within the competition. See: Quale, John D., and Kenneth Frampton. 2005. *Trojan Goat: a self-sufficient house*. (Charlottesville, VA: University of Virginia School of Architecture), 18-20.

16 MLQuotes. Accessed July 12, 2012. http://www.mlquotes.com/authors/doug_coupland/

17 The competition schedule ran just over three weeks: build period 7-17 June; competition 18-27 June; disassembly 28 June - 2 July. The RE:FOCUS house used a pre-build site in Arganda del Rey prior to the competition, beginning approximately 10 May. Interestingly, the team was able to deconstruct and repack the house into 5 shipping contains in roughly 4 days.

18 Quale, John D., and Kenneth Frampton. 2005. *Trojan Goat: a self-sufficient house*. (Charlottesville, VA: University of Virginia School of Architecture), 25.

19 Quale and Burns, 24.

20 "The Nature of the Decathlon," DECA: The Decathlon Association, accessed July 12, 2012, http://decathlonusa.typepad.com/deca/nature.html.