Something from Nothing: Extreme Re-purposing and Material/Construction Processes in First-Year Studio

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For more than twenty-five years, beginning architecture students at Penn State have designed and built small-scale constructions and follies as the culmination of their first-year studio education. This tradition (1) serves as a synthesis event in pedagogy that introduces new students to drawing and representation at the start of each academic year; (2) progresses through design considerations related to spatial composition, detail, and craft through winter and early spring; and (3) ends with 6–8 weeks of exposure to material practices, project management, and 1:1 scale-construction processes in the school's building yard through April. A great majority of these projects over the years have been executed through restricted budgets limited funding provided to first-year studio by the Department of Architecture, or through small internal grants administered through the department's governing college. The constructions/follies have largely been executed in wood (timber and lumber), as the Department of Architecture has traditionally used wood and woodcraft as entry material/techniques for shop training and discussions related to craft in the first year.

During the 2011–2012 school year, first-year students were invited to collaborate as a class (65 students) on the design and construction of a small outdoor education/visitors center for Penn State's Recycling and Waste Management Center—an operation that recycles nearly 60% of all trash generated on campus and stockpiles unused supplies and materials (construction, laboratory, athletic) that have been designated for the trash heap, but are, in fact, surplus. Inspired by the "client's fanatical commitment to keeping usable/recyclable material out of landfills, one section of four first-year students was instructed to design and construct a modular perimeter wall to define and screen the outdoor space using only post-consumer/post-product materials available through the client, or scavenged from trash receptacles on campus or in the surrounding community. In a move calculated to engender an architectural work ethic founded on self-reliance,

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Figure 1: Photographs of the site taken during the first student visit. Dumpsters to the right would be relocated, creating an open space for the outdoor Education/Visitors Center. Power lines, utility poles, center, and casting shadow in the foreground left, bisect the site. Photograph by the author.

instigate "crafty" technological invention, create an appreciation of labor, and explore sustainable practices for a near-future of *less,* the students were further instructed to move all materials and prefabricated construction elements to and from the site (approximately 2 miles away from the School) without the use of petroleum-powered machinery.

For the facilitating faculty member, this project in extreme repurposing and material /technological invention motivated by scarcity was very much informed by a careful calculation of excesses (financial and material) experienced in previous campus construction projects, and by the amount of concrete-related waste that two previous projects had generated. Within Penn State's Architecture Department, the first-year faculty as a body also holds a strong belief, that educational experiences in the first year shape a design student's identity and ethos, preparing them for their further studies in the Department of Architecture—and providing an ethical basis for their professional practices in the future. The faculty member facilitating the design-build screening wall had in mind an "action research" project motivated by restricted resources, work that might foster future "development activist" architects—designers attuned to post-industrial, holistic approaches to the complexities of doing more with less.[1] For the fourteen student participants given this project (Section 01), the brief essentially called for 65 to 100 linear feet of impermanent concrete block construction with no budget, to be made from material waste, material surplus, or materials that had already existed as "something" through at least one product cycle. The work was initially received by the students with severe trepidation and angst, as an impossible project doomed to fail through its restrictions. Unable to recognize potential building materials in resources that existed in post-use form (such as broken plastic stadium seating and cracked garbage cans), the student's initial reaction was, *we got nothing*.

The end results—which continue to inspire the students, and other efforts school wide—are characterized by pride, a plentitude of innovative ideas on how to "close the loop" through recycling waste as construction materials, newfound realizations of building-as-empowerment, and community outreach through an educationally enhanced University Recycling and Waste Management Center. This paper will detail the project as an empirical search for commodity, firmness, and delight using a site and materials that had been relegated to waste. The success of the project includes inventiveness, ingenuity, and opportunism that describe both the finished product, *and* character qualifications imparted upon the students through

an intensification of recycle/reuse, and restrictions imposed on materials and resources.

SITE: THE UNIVERSITY DUMP EVOLVES INTO A RECYCLING CENTER

Students inherited a site that had been a university dumping pit for decades—eventually the pit became a small hill of refuse overlooking the picturesque agricultural lands that surround the campus (figure 1). In their analysis of the site, the students discovered a history of environmental damage linked to faulty economic practices that became unsustainable as the pit filled and grew into a "trash hill" that required clean up and capping. Shortly after closing the hill to dumping, a strategy of sending Penn State's garbage to landfill in a neighboring state also became prohibitively expensive—escalating trucking costs and rising fuel prices imposed limits on the amount of trash sent "off campus." These failed and damaging practices, which compounded manufacturing pollution by spoiling the air and soil through additional forms of disposal pollution, led the university to reevaluate their trash collection and recycling processes, and to set ambitious goals for reuse, repurposing, and recycling campus-wide. Eight years later, at the start of this campus construction project, Penn State's Recycling and Waste Management Center (operating out of a repurposed construction trailer on top of the capped trash hill) had become a model of recycling success for other universities worldwide. The evolution of the refuse pit into a model of recycling /repurposing—one that actually generates money for the University through the sales of materials to market recycling industries—instigated the need for a visitor center; an outdoor space where the Waste Management team could host visitors from other institutions, make presentations to the public, and run educational workshops for students and faculty.

As a class, the first-year students were determined to construct a project with four integrated components: (1) a curved screening wall that defined the space and framed views of the adjacent land, (2) a screen for projecting PowerPoint presentations, (3) a meeting table and chairs for forty people, and (4) a hard surface that further defined the space, made of recycled brick collected when the university's former School of Architecture building was demolished.

COAL CLINKER BLOCK AND RECYCLED CARDBOARD FORMWORK

This project marked a third consecutive year in which at least one section of first-year students would explore the processes and potential of prefabricated concrete in their campus construction project. Two previous groups of students had worked with the material, producing a large gate wall made of fabric-formed blocks, and a well house for collecting rainwater for use by gardeners at a university-sponsored community garden. In both of these projects, concrete use had generated a significant amount of post-fabrication material—ad-hoc formwork in the first project (canvas and OSB) that ended up cycling through the university's waste system, while more conventional wooden forms used in the well house construction (a considerable investment in materials and labor) were cleaned and stored for future

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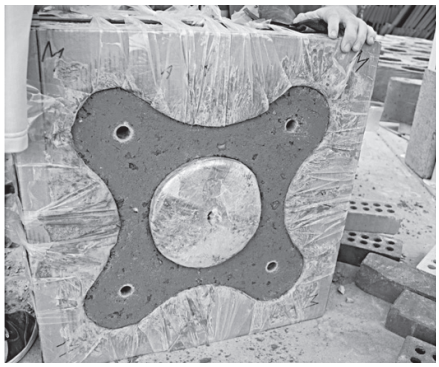
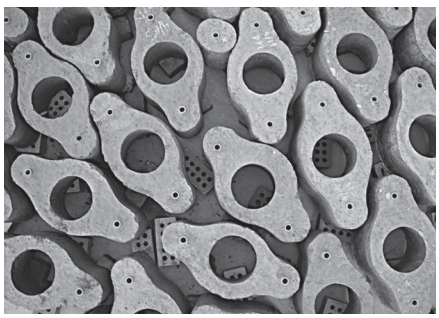
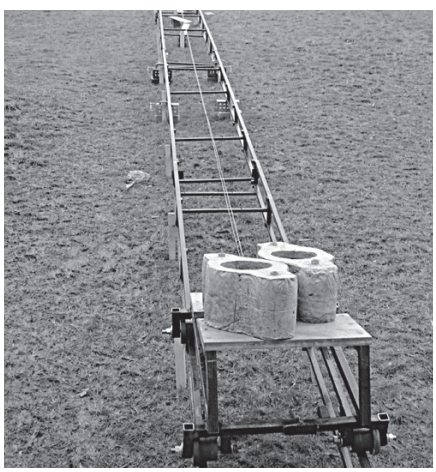
Figure 2: Three years of concrete block work in first-year studio progresses from landfill-bound formwork (left), to a substantial investment in wooden forms (center), to formwork made of discarded corrugated cardboard, recycled trash bags, and construction tarps salvaged from dumpsters (right). Photographs: Marcus Shaffer and Andy Nguyen .







construction, repair and expansion. Although concrete is the most common manmade building material on the planet, its production and use is tied to air and water pollution, and wooden formwork used in concrete construction is commonly disposed of as landfill. In the project for the University Recycling and Waste Management Center, students were asked to take the excesses of concrete construction into consideration, and to do better in contributing to more sustainable concrete practices. Their design for the screening wall required a modular block that would employ post–product cycle materials in making formwork. Section 01 was also required to design a mix formula that would recycle a maximum amount of coal "clinker" material from the Penn State's coal fire generator plant (surplus sand, gravel, and Portland cement were supplied to the students by the client). Finally, with an eye toward eliminating pollution and waste associated with transporting concrete materials and finished concrete building elements to a site, the students were prohibited from using gas-powered machinery to move their materials/products.

After a period of testing, trial, and error, the students determined that they could make formwork by collecting, stacking, and shaping broken-down corrugated cardboard boxes retrieved from dumpsters across campus (figure 2). The cardboard forms were initially held together and lined with recycled garbage bags, which were tailored and shrink-wrapped onto the cardboard with hair dryers. Later, in an empirical process of continuous design-innovation-through-production, the students began wrapping the cardboard forms with worn-out construction/painting tarps salvaged from physical plant trash cans, and holding the forms together with punctured bicycle inner tubes collected from bike shops in the community.

BLOCK FABRICATION AND MATERIALS TRANSPORT: A SOCIAL EFFORT

Isolation is one of the ironies of plentitude, whereas scarcity seems to foster community. Purchasing materials in the Information Age can be an isolated activity devoid of human relations; online-ordering and random delivery-drops to unmanned construction sites negate many of the conversations and relationships that were once considered beneficial or essential to building. As the first-year students involved in designing and constructing the University Recycling and Waste Management Education/Visitors Center searched for resources that could be used to build or enhance their project, they simultaneously forged relationships with people across campus who were interested in their efforts and helping them succeed. Not only did restrictions on materials and methodologies force students to become more innovative designers and clever industrious workers, the restrictions also made them become more social and communicative, inspiring in them a narrative of satisfying work contextualized by scarcity, recycle, and reuse—which proved indispensable when out looking for material support and knowledge across the university campus and in the local community.

As the first-year students repeatedly poured blocks, knocked cured blocks out of forms/molds, stripped the formworks, and then prepared them again, they were constantly confronting logistics problems—how to transport raw materials to the school's Building Yard, how to move the still-green concrete blocks out of the yard (a full one and a half stories below street level),

and how to move blocks to the site two miles away. The answers to many of their problems came by way of a relationship that continues beyond their efforts. The Departments of Architecture, Landscape Architecture, and Graphic Design share a sub-campus with the university's School of Theater which produces between four and five shows in an academic year—all of them requiring original sets. In making and breaking their sets, the School of Theater routinely sent dumpsters full of 1" square steel tube stock (hundreds of linear feet four to five times per year) and wood products to the Recycling and Waste Management Center year after year, all of it sold to market recycling firms. While working for the Recycling and Waste Management Center, involved students and faculty from the Department of Architecture offered to aid in striking one of these sets (in the middle of the night), which yielded a great deal of quality steel for construction use. One of the first-year sections used the steel in constructing a base for their table for the Education/Visitors Center. Section 01 students were taught how to weld by their faculty instructor, went to the neighboring School of Visual Arts for welding facilities, and then began to design and fabricate "machinery" to expedite their construction processes (figure 3). A rail cart was spontaneously built to move water-laden block from the Building Yard to street level. Once there, the blocks were loaded onto a trailer—lashed between two bicycles—for transport to the building site. While many of the strategies and actions taken by Section 01 architecture students might have appeared absurd or extremist just ten years ago (in a period of time marked by national economic expansion and nascent popular awareness of what decades of consumerism had done to our environment), other students from the school and across campus took a sincere interest in their construction activities, and were interested in the work primarily as a means of achieving more with less through communal/cooperative human effort.

At this point in time—five weeks into the project—the (more optimistic and opportunistic) students had begun "see" potential in materials and conditions that would have once been considered vacant or detrimental; their resourcefulness had become infectious and habitual. One example: on site, what had always been thought of as an unfortunate/unsightly obstruction—two utility poles slicing the outdoor presentation space in half—was imaginatively turned into a mechanism that greatly enhanced student construction efforts. Routine access (walking, bicycling, driving) to the sight involved a slow, spiraling gravel road that was heavily scarred by constant trash truck traffic, adding considerable length and burden to travel distances for those driving to the construction site. Section 01 students were able to bypass this route and move their blocks and construction materials directly from a roadside drop zone to the top of the trash hill by running a zip line between the two poles (borrowed cable and pulleys). A line drawn between the poles allowed them to "fly" blocks from the base of the trash hill/site to the construction area.

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Figure 3: Section 01's block-making process included formwork made of recycled cardboard and trash bags, which they used in cyclically producing 144 blocks. "Green" concrete blocks still laden with water (60—70 lbs.) were hauled out of the school's Building yard on a cart made of salvaged steel from the nearby School of Theater. Students took turns bicycling blocks two miles across campus to a meadow adjacent to the construction site. Finally, a zip line strung between two utility poles onsite aided in moving the blocks from their drop point to the site on top of a repurposed trash hill. Photographs: Andy Nguyen, Peter Leatherman, Marcus Shaffer.

RESPONSIVE CONSTRUCTION

On-site assembly of the concrete screening wall began as students simultaneously cast blocks and transported materials to the site. One significant

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Figure 4: Blocks arrive at the construction site via zip line. Jig-like instruments for placing the blocks were made of recycled steel from the university theater sets and broken football stadium seats. The blocks were stacked and pinned together in staggered courses using the same stadium seating steel. The lower right image presents a detail showing plastic leveling shims/washers used to level or build up blocks between points of contact. Photographs: Andy Nguyen, Peter Leatherman, Marcus Shaffer.

result of concrete block-making through repeated use of corrugated cardboard (i.e., paper) formwork was a slow change in the dimension of the blocks over the course of production. Despite measures developed to prolong the effectiveness of the formwork, which included removing the blocks from the forms while still relatively wet and taking great pains to cover the vulnerable cardboard with water-shedding plastic (repurposed garbage bags and then polypropylene tarps), curing concrete caused the formwork to absorb moisture and to contract/collapse over time. Repeatedly wrapping plastic sheeting around the damp cardboard compounded the gradual compression of the forms, pressurizing them to the point where the last blocks made were a full ¼" smaller in dimension Z when compared to blocks fabricated in the early days of production.

While the outside dimensions of the blocks mutated over time, one constant in their production was the careful placement of recycled ½" I.D. (inside diameter) PVC tubing in the formwork/molds prior to filling them with wet concrete. In construction, ½" O.D. (outside dimension) steel tubing salvaged from the broken stadium seating was used to pin staggered blocks together,

one course on top of the other. Blocks in contact with the ground were pinned down with uncut lengths of steel tube. While the artificially flattened topography of the capped trash hill was relatively level, this pin connector system (developed through extensive modeling) permitted students a great deal of flexibility in placing the individual blocks—and in describing the eventual perimeter of the outdoor Education/Visitors space as contained by the screen wall. This pin connector—specifically a common dimension of tube protruding from every block—also presented the solution to constructing a masonry wall comprised of blocks that were irregular in dimensional height. Amongst the piles of post-consumer objects/materials that had stacked up at the Recycling and Waste Management Center over time was a small mountain of broken buckets and garbage cans. The Center's director was particularly eager for the students to address this pile in making something useful for the Center's Education/Visitors space. In addressing the discrepancy between blocks, students hit upon the idea of cutting up broken garbage cans, and using the rubbery-plastic material to produce flexible "washers" or shims that would compensate for variation in the blocks at critical points of contact/assembly (figure 4). In constructing the wall in this revised manner—what amounted to the last great "eureka moment" in this repurposing/reuse project—Section 01 students used all of the broken garbage cans available to them.

CONCLUSIONS

In her recent book, "Architecture for Rapid Change and Scarce Resources," Sumita Sinha provocatively suggests that environmental, economic, and socio-political conditions in the near-future will require radical changes to architectural education and practice, as well as a corresponding redefinition of the role of the architect. She describes a scenario of architectural activism—development, fundraising, management, reciprocal design, itinerant practice, hyper-resourcefulness, and self-motivation/reliance—as means of addressing twenty-first century complexities, uncertainties, and needs in the built environment. In subscribing to a position of expansive architectural practice, I agree with her: as educators we are now responsible for imparting requisite skills, critical thinking, and a fortitude that facilitates architectural action and accommodation that will transcend office-bound practice. The project described above—a full-scale confrontation with post-consumption repurposing and scarcity—put creative thinking, empirical processes, resourcefulness, and engagement front-and-center as primary qualifications for the future architect. While beginning design projects often involve or demonstrate creativity through material or process restrictions, this project was enhanced through its recycle/repurpose context, full-scale construction, and community engagement.

The project's major successes include the creation of an educational environment that literally illustrates the potential inherent in materials assumed to be trash. In using the space for presentations, the director of Penn State's Recycling and Waste Management Center delights in directing guest's attention to the screening wall, where he points to the concrete that recycled industrial waste from the university's coal fire plant, blocks

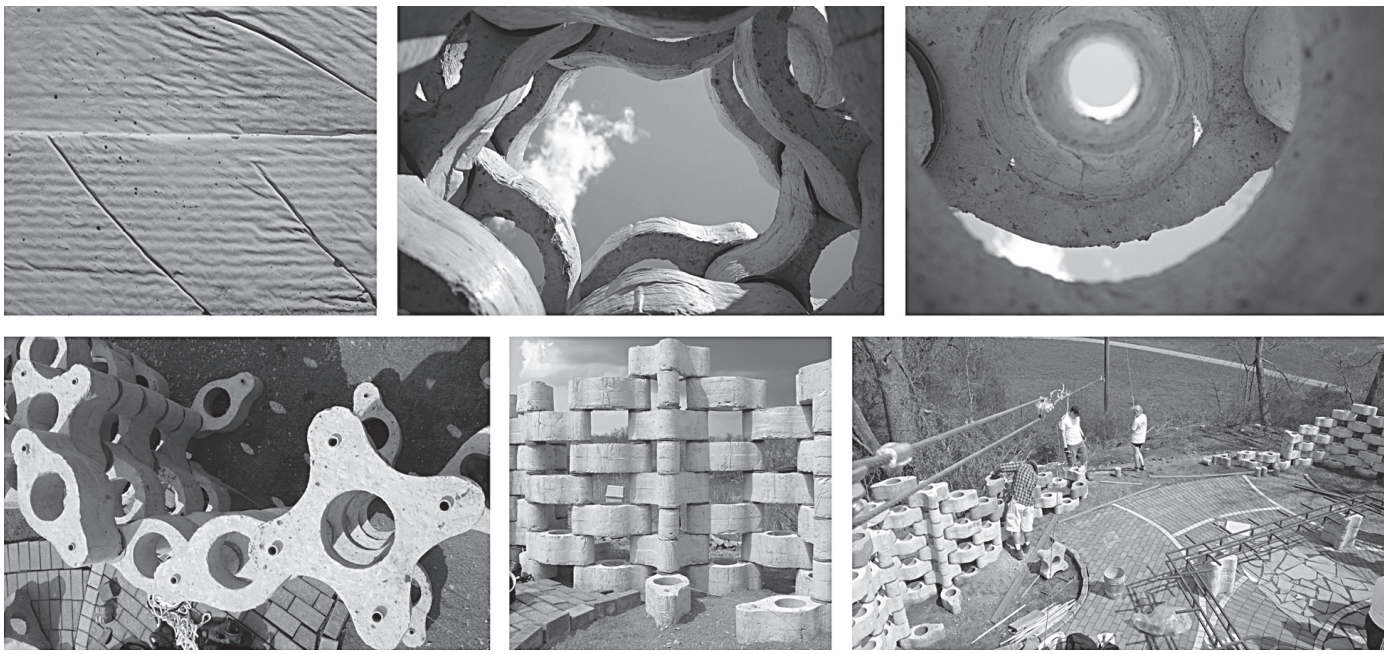

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Figure 5: The completed screening wall composed of 144 concrete blocks. Evidence of the corrugated formwork and recycled polypropylene form-liners are recorded in the blocks (top left). The system of blocks was designed so as to produce integral structural columns along the length of the wall (center bottom). The wall frames a view of the adjacent farmlands (bottom right). Photographs by Andy Nguyen, Peter Leatherman, and Marcus Shaffer.

that show evidence of having been formed in cardboard retrieved from the university's trash cycle, and washers/shims that were critical to solving a considerable construction problem, but had formerly existed as a pile of broken garbage cans (figure 5). He then further enhances the transformation of these materials as he walks groups through the piles of materials that continue to accumulate at the center. The block designed by the students has garnered interest from other areas on campus; as potential means for creating temporary construction barriers, and as a product of coal-fire refuse that could be used to contain clinkers and ash at the coal-fire plant. Visiting critics from other schools of architecture remarked on the ingenuity involved in using cardboard formwork.

Other significant successes can be measured in feelings of empowerment-through-design that are still apparent in the students who participated in the project. Through the work they were gifted with a "can-do" positivism that distinguishes their class. The design methodology that they forged in devising, fabricating, and constructing the wall and its component machinery—one that embraces complexity and addresses it through community, resourcefulness, and more-sustainable practices—has given them a unique confidence in the school. Their experience and their approach to architecture has noticeably created our future student leaders, and their priorities appear to be focused on education through engagement, design-build, and rethinking an architecture that operated on consumption and produced considerable waste. One of the participating students recently remarked, "We are still riding on the pride and momentum of having done something we didn't think possible. It was a life lesson." ◆

ENDNOTES

Sinha, S. *Architecture for Rapid Change and Scarce Resources* (London, Routledge, 2012), p.4