Exotic Constructions: Incorporating Invasive Species in Design-Build Studio

The effects of invasive species are both disruptive and formative. Alien intruders disrupt the local ecologies of regions often pushing some endemic species to extinction, while also establishing new relationships and expanding possibilities through constructive adaptation. This paradox came to life while investigating the useful potentials of the Melaleuca tree as a construction material. While management officials work to eradicate the Melaleuca from the Everglades, teams of graduate students at the School of Architecture at Florida International University adapted the invasive species into various Design-Build proposals that aimed to adapt the nuisance species into constructive prototypes.

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INTRODUCTION

Drive twenty miles west from downtown Miami, and you'll land in the Florida Everglades, where the "river of grass" is overrun by stands of invasive Australian Melaleuca trees. South Florida is unlike any other place in that approximately twenty-six percent of all fish, reptiles, birds, and mammals residing in this ecology are considered exotic—more than in any other part of the United States—and the region has the highest number of exotic plant species in the world.[1]

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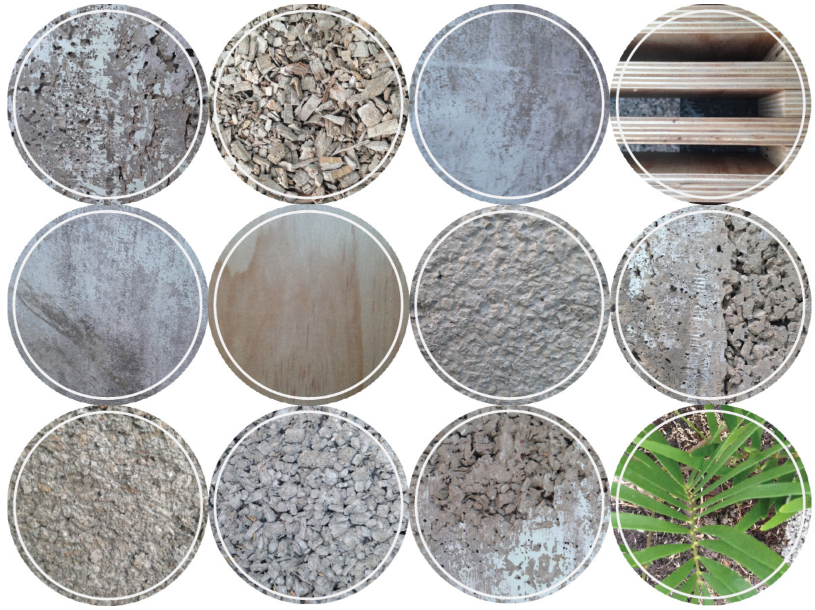
By taking trees that are systematically removed from the landscape, the class attempted to forge a feedback system to create a demand for this alien material, thus linking a local craft-based practice to a foreign building material.

An industrial sponsor provided a proprietary process for chipping the tree-trunks and then mineralizing the woodchips, which facilitated experimentation and research into the performance of invasive aggregates in cast concrete applications.



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A state park in North Miami allowed students to design and build proposals for a public garden. This project became the program for a graduate level studio co-taught between the landscape architecture and architecture departments. Students designed applications ranging from the single-user to collective spaces, and from the mass-produced to the custom. They considered landscape applications as well as conventional architectural solutions for structures and enclosures.

Students not only had to design and build their proposals, but they were required to test and evaluate them through a series of performance markers including compression testing for strength based on formula variations, as well as making observations of cosmetic and textural characteristics, ranging from texture and porosity to color. Not only did they need to design spaces, but they were required to define the material itself, adjusting the formula for certain effects.

The studio marked the first time this melaleuca/concrete composite material was extensively tested in the US, which has not yet been used in the US building market. Ultimately, this prototypical investigation which incorporated the use of an invasive plant as building material, explored the very basic relationships between design, material, ecology, and form. The studio showcased how alien building materials can redefine the idea of locally sourced, highlighting the potential to reorganize building practice, representation, and pedagogy, by utilizing Design-Build to think outside of existing conventions and ecologies.

While Invasive Species are a serious environmental problem; they have also provided a new global opportunity by relieving the pressure placed upon many of the native species used as local building materials. Specifically this paper presents data on the invasion and environmental impact of the Melaleuca Tree on the Everglades and its potential as a construction material, combining local craft with exotic invasive materials to produce a new type of Invasive Materiality, in this case Alien Concrete.

NEW FLOWS

As the problem of climate change has become widely established, certain cities, such as Chicago, are actually considering the advantages of non native species for their ability to handle anticipated local changes. Rather than pouring greater resources into some idea of preserving a historical natural habitat, Chicago is modifying its planning for a new reality. Chicago has already changed from one growing

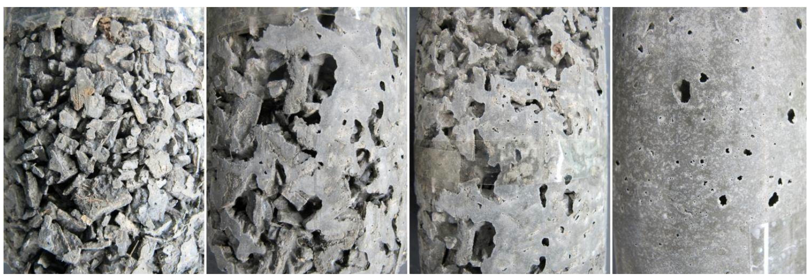
Figure 1: Material exture options

zone to another, and city planners have removed 6 of the most common tree species from their planting list as they won't be able to endure hotter conditions. In fact, the state tree of Illinois, the White Oak, is expected to be extinct from the region within decades. They have begun planting non-native species from southern regions such as Swamp White Oaks and Bald Cypress, for their ability to flourish in hotter temperatures.[2] (KAUFMAN, 2011)

As seen in the Chicago case study, not only can non-native species thrive in regions with warming temperatures, however in some cases these new species can help to reduce the impact of climate change and use invasive species to our advantage.

INVASIVE MELALEUCA

Melaleuca Quinquenervia also known as Melaleuca, Paper Bark, Punk-Tree, and White Bottlebrush Tree is a member of the Myrtle family native to Australia and New Guinea. It is a hardy and fast-growing evergreen, often used as an ornamental tree for its white bristly flowers and flaky paper-like bark. Melaleuca was introduced to Florida in 1906 and was scattered by aircraft over the Everglades in the 1930's to



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dry up "useless swamplands." In its native Australia, Melaleuca grows in low-lying flooded areas and is especially well adapted to ecosystems that are periodically swept by fire. These are common conditions in south Florida, making the region an ideal habitat for establishment.[3] (FERRITER, 8E-11)

While they were considered excellent landscaping trees as late as 1970 and planted along canals to stabilize soil or act as windbreaks, Melaleuca was quickly found to be one of the greatest enemies of the Florida Everglades ecosystem, as all of the qualities which made it an appreciated ornamental tree soon produced much disruption in the everglades ecology. It is an extremely fast-growing tree producing very-dense stands of trees which displace native plants and animals, not allowing for wading birds with large wingspans to fly between. Additionally they reproduce at an alarming rate and are difficult to contain, it is estimated to take over 15 acres of saw grass fields each day.[4] (FLORIDA BATTLES, 2004)

In 1990 the south Florida Water Management District began an aggressive campaign to lower Melaleuca populations in south Florida, resulting in a dramatic reduction of acreage on public lands, however the 60-100 foot tall trees continue to spread at such a high rate on private property that there is little cumulative decrease in acreage. This is a result of the high volume of lightweight and easily windblown seeds in the Melaleuca canopy, estimated at near 20 million at any moment. Additionally, stress on the trees causes them to open the capsules and release the seeds. Any stress such as fire, cutting, or spraying causes millions of seeds to fall from the canopy and germinate rapidly.[5] (FLORIDA BATTLES, 2004) During the dry season in South Florida, huge forest fires aggravated by the high oil content of Melaleuca leaves scorch thousands of acres. In this case the trees, both facilitate fires and are

Figure 2: Texture experiments

resistant to them, thus only fueling their spread.[6] (FLORIDA BATTLES, 2004)

As a result, more complex management measures have been developed specifically for these trees, including Integrated Pest Management (IPM). Three insects were imported from Australia, to help control the population including the Melaleuca Leaf Weevil. In 1997 more than 8,000 weevils were distributed to 13 Melaleuca infested locations in south Florida, and in 2004, it was estimated that millions of the quarter inch long weevils were devouring the young leaves of Melaleuca tree, resulting in tip dieback, defoliation, and reduced flowering. This combination of spraying, cutting and IPM have yielded promising reductions in the past decade.

3

CLASS UNIVERSITY SPONSORED RESEARCH AND PEDAGOGY

Much of the research into the material applications and ecologies of practice were conducted during a graduate-level university studio sponsored by an industrial partner who provided as much mineralized Melaleuca tree-based building material as we could use for experimentation in building applications and pedagogy.

Our industrial partner uses a comparable product in Europe and is interested in fine-tuning material formulas for south Florida's subtropical region. Several failures were encountered during early attempts to duplicate a mix developed in Belgium. These included a lack of adhesion in preliminary casts, most likely due to changes in climate conditions. Various mixes were cast and tested for compression strength, charting how performance was affected by varying the proportions of mixed ingredients.

CONSIDERATIONS

The course was introduced with what was to most students and faculty a mystery material. Our industrial partner had developed a proprietary process for taking trees from local forests in Belgium, first chipping them, then mineralizing the wood chips before casting them into precast concrete shapes, such as wall panels. This process effectively petrifies the outer layer of the wood chips, turning an organic material into something more like inorganic petrified wood. Our task was to investigate its material possibilities.

Figure 3: Full size mockups

We began the class with roughly 20,000 lbs of material we had received in many industrial-size pallet bags. Students were asked to think of ten basic questions, such as how strong the material would be if mixed with cement? How much would it weigh? Would it Burn? Could you cut it? etc. We then jumped right in to mixing it and casting samples to try to find answers to our questions.

We investigated the material's physical properties and considered its practical applications by asking: What were its inherent advantages? What precedents existed that we could emulate? What alternatives could it provide that would relieve the demand for other, more resource-incentive building materials? One clear benefit was the LEED incentive to use local and regional materials from within 500 miles of a project site. All materials including wood sourced or manufactured within 500 miles receive the Materials and Resource credit, one of six, green building categories addressed in the 2009 version of the Leadership in Energy and Environmental Design(LEED) rating system by the US Green Building Council.[1] (USGBC, 2009

4

Figure 4: Full size mockups

WOOD OR CONCRETE?

We immediately began the material investigation by making prototypes which we developed iteratively over the course of the semester. Each sample was tested, evaluated and compared to standard concrete. We measured compression strength and looked for as many comparable products as we could find. Although the material looked like concrete block, it was noticeably lighter and porous. During an early meeting with the inventor, he exclaimed, "This is wood!," so we began experimenting with a truly hybrid material whose shared wood and concrete properties warranted comparison.

We tested over 30 custom mixes of the material, casting industry standard cylinders for compression tests. Slight variations in quantities not only produced visual results in surface texture but also differences in performative results. Four student teams explored four loosely overlapping thematic categories: Vertical, Horizontal, Stackable, and Surface. The inclusion of integral color dyes, textured formwork, and various material inclusions, additionally provided a range of new material possibilities.

Student teams approached the evaluation of the material from alternate perspectives, each bringing a range of demands to suit their design objectives, as informed by the studio agenda. Each student developed scaled versions of details that explored vertical, horizontal, stackable and surface configurations. The teams developed an architectural kit of parts over the course of the semester and a partnership with a Florida state park, interested in creating a butterfly garden, allowed students to build full scale mockups of walls, seats, ground, planters, screens, and other architectural elements. The material's ability to accommodate a range of uses from loose mulch, to masonry modules, to porous pavement meant that the building material could assume hybrid roles, based on programmatic needs.

CONCRETE

Concrete is one of the most widely used materials globally, and while much of it is mixed locally, many ingredients are shipped or imported from distinct geographic regions. While much research has been done recently to reduce the carbon footprint of concrete production, the introduction of wood chips from invasive species as an aggregate substitute for producing a wood/concrete hybrid material, presents several performative advantages over traditional concrete, as evidenced by the work of the studio.

5

Concrete is a truly global building material. The usage of concrete, worldwide, is twice as much as steel, wood, plastics, and aluminum combined. Concrete's use in the modern world is only exceeded by the usage of naturally occurring water. [1] (CEMENT TRUST, 2013) Some of the issues associated with concrete in the built environment are its heat capacity at a large scale, leading to the phenomena of the Urban Heat Island Effect. The wood composition of our material, means that it remains less dense and is more insulating than concrete. It is able to resist the absorption of heat throughout the day, therefore offering the potential to reduce the Heat Island Effect in the urban environment.

Concrete is additionally a hard material which, as noted in the Chicago case study, can lead to surface runoff which can also overwhelm storm sewer systems. The hybrid wood-based aggregate material is able to be cast as a dry pervious mix, simply by adjusting the quantities of ingredients. Concrete also produces much CO_2 during the production of cement. The innate insulating qualities of our material obviates the need, expense and impact of insulating regular concrete. Our material is additionally carbon negative because of its wood core; it absorbs CO_2 throughout its life and the only way that CO_2 would be released from it would be if it were burned. The mineralization process locks the CO_2 in by essentially fireproofing the material.

As seen in the Chicago case study, not only is the availability of typical building

Figure 5: Design montage by Anna Drescher

materials becoming more scarce, but they are increasingly affected by changes in climate. The White Oak, which is the state tree of Illinois, for example, is expected to reach extinction by the end of this century due to warming temperatures. Over the course of our class, we suggested that the very material needing to be controlled, could actually fill some demand in the building industry and help to take pressure off of typical species used for building material.

This class and the subsequent research attempts to rethink the threat of global ecological disruption as an opportunity for constructive exchange among architectural practice, entrepreneurship, material research, and pedagogy. This course represents a new type of Ecological Design-Build, which takes the critical position that to build well requires being proactive in considering the implications and opportunities that result from environmental disruption. Grappling with this new reality and this new normal presents fertile opportunities for collaboration among engineers, ecologists, landscape architects, architects, practitioners and scholars.

While the term “invasive” implies damage and detriment, the term “alien” may be more appropriate, referring to species that spread beyond their native range, and when introduced to a new context, establish themselves and thrive. (Jeschke and Strayer 2005) The prototypical investigation of this new wood/concrete material demonstrates the potential of how the global invasiveness of an alien species can in fact be a platform for reorganizing architectural pedagogy and practice. By looking at the hybrid properties of “alien” materials, one can embrace the global reality of constant disruption, and rethink, reorganize and reimagine new modes of architectural craft and design thinking.

ENDNOTES

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