Teaching Sustainability: Applying Studio Pedagogy to Develop an Alternative Post-Hurricane Housing Solution Using Surplus Shipping Containers

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Abstract: This paper illustrates the use of studio teaching as a technique for promoting an interdisciplinary approach to teaching students about sustainability. It emphasizes an iterative decision-making process to help students think ‘outside the box’ when exploring sustainable solutions. The paper focuses on a particular case adopted by a combined studio of architecture and landscape architecture students to help provide sustainable housing solutions for post-hurricane victims. The studio format provides a student-centered learning environment where students, faculty, and industry professionals work together to propose alternative post-disaster housing and community restoration strategies. The students gained a heightened understanding of the need to address global challenges in an interdisciplinary manner, which is key for solving sustainability problems.

The focus of the paper is to explore the advantages and disadvantages of using the studio format that is most often associated with the design disciplines as an alternative educational pedagogy for teaching sustainability in real estate programs. Specifically, this paper will illustrate the application of an interdisciplinary approach for teaching sustainability concepts in programs focused on the built environment. A case study of the Sustainable, Environmental and Economical Development (SEED) Alternative Post-Disaster Housing project, which was developed for a studio course taught in the fall of 2009, will serve as an example of how the studio approach can be used to tackle real estate problems and teach the basic principles of sustainability. A multi-disciplinary group of students representing architecture, landscape architecture, city planning, and welding disciplines worked together in a studio setting throughout the research and development of the housing prototype and its implementation strategy. Issues were addressed through open discussion, desk critiques by the faculty, and studio ‘pin-ups’ with guest critics and industry professionals helping to make sure the students understood the various facets of the problem and that they came up with viable solutions. Industry partners were also actively engaged with the students throughout the process, offering a business perspective to influence their decision-making process, mentorship, and industry contacts for future employment.
In addition, it is important to note that the studio setting, focused on applied problem solving, can be a way to build a network with industry partners and raise external funding and recognition for the university. For this case, an industry partner, Container-It, Inc., brought the idea to the studio, donated the container to the studio for students to be able to build a prototype and test their design solutions, and provided additional funding to cover expenses associated with the studio. Other industry partners were instrumental in providing information during the research phase and/or services and materials during the construction phase. Additional funding was provided by an Environmental Protection Agency (EPA) P3: People, Prosperity and the Planet Student Design Competition for Sustainability Award. The competition was designed to engage students in focusing on the P3 concepts of sustainability, to create solutions benefiting people, promoting prosperity and protecting the planet through innovative designs to address challenges to sustainability in both the developed and developing world (www.epa.gov/P3).

Specifically, students in the course designed post-disaster housing solutions for hurricane victims where ‘People’ would benefit from affordable housing, increased hurricane safety, community involvement with the reuse of displaced surplus containers, and a healthy and productive landscape. ‘Planet’ challenges were addressed by studying the effect of hurricanes on the islands of the Caribbean in general, looking at sustainable agricultural strategies for the Commonwealth of Dominica, reducing resource consumption and creating alternative water and energy sources. ‘Prosperity’ is envisioned to be promoted through an increased life-cycle and affordability of housing, the development of jobs associated with building and implementing SEED homes, and the implementation of sustainable agricultural practices for the islanders.

**Literature Review**

**Teaching Sustainability in the Classroom**

Since the Declaration of the United Nations Conference on the Human Environment, more commonly known as The Stockholm Declaration (UNEP, 1972), there has been an increased national and international interest in incorporating sustainability literacy, skills, attitudes, and concepts into higher education courses in a wide range of disciplines (Wright, 2002). This is certainly true of education in the built environment disciplines where incorporating sustainability concepts is often a course goal. However, for educators that task can be daunting when confronted with a surfeit of literature on sustainability. To confound matters further, there is a large variation in the way experts conceive of and explain the general concepts of sustainability (Filho, 2000; Robert et al., 2002; Carew and Mitchell, 2008).

Sustainability is commonly defined using the Brundtland Statement, “‘Humanity has the ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs,’” (WCED, 1987). This definition was further evolved in Agenda 21,
which was adopted at the 1992 United Nations Conference on Environment and Development (UNCED, 1993), and in the UN 2005 World Summit Outcome document, which referred to the “interdependent and mutually reinforcing pillars” of sustainable development as economic development, social development, and environmental protection. The latter report further stated that “poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base of economic and social development are overarching objectives of, and essential requirements for, sustainable development,” (UN, 2005). The vast literature on sustainability further expands and evolves this definition by describing the inter-relationships of the three sub-concepts and representing them either as pillars, embedded circles (also known as the ‘bulls-eye’ diagram) or in some variation of the popular Venn diagram of three overlapping circles. McDonough and Braungart (2002) take the concept one step further by introducing the concept of cradle-to-cradle, thus extending the use, and sustainability considerations, of objects into a second lifecycle. Crofton (2000) suggests that this conceptual debate opens the door for a broader range of starting and ending points, which sustainable decision-making processes may work from and towards allowing us greater flexibility to adapt to distinctive contexts and to embody an array of stakeholder perspectives.

Sustainability issues are difficult both to teach and to study. Conventional lecture and seminar formats alone cannot adequately teach the necessary skills to understand the complex social and ecological risks associated with sustainability. They need to be supplemented with active, experiential learning methods (Truscheit and Otte, 2004/5). The studio format, most often associated with the design fields, is ideal for this type of active, experiential learning because it inherently incorporates the four basic steps of the experiential learning model cycle as outlined by Svoboda and Whalen (2004/5): act, reflect, reframe, and apply. For application in the studio setting, and as used in the SEED case study, these steps were modified slightly and applied as: concept development; act; reflect and assess; reframe; and apply and rework. These steps are then re-iterated several times through the design and development phase of the studio. The use of studio pedagogy is an appropriate avenue for exploring and developing solutions to sustainability challenges because, in contrast to the more linear form of thinking that is encouraged in lecture formats and multiple choice exams, the studio environment encourages an iterative decision-making process and incorporates interdisciplinary work as part of the process of developing creative solutions. In addition, studio courses expand the knowledge and skills sets of students by giving them the opportunity to engage in real-world projects that challenge them to think about their work and their solutions in new ways (Heathcott, 2007).

Container Housing

There has been a limited amount of academic research on the reuse of shipping containers for housing; most of the research has been exploratory in nature and undertaken by private firms looking to create a niche market. The largest of these efforts was undertaken by TempoHousing and resulted in the construction of Keetwonen, a student housing project in Amsterdam. Originally intended as a five-
year temporary solution to create 1,000 units that would house students attending universities in Amsterdam, Keetwonen has been so popular with the residents that the relocation has been postponed until 2016. Other projects by TempoHousing include: the luxurious Hotel Yenagoa in Nigeria, Diemen Student Housing in Amsterdam, Skaeve Huse in Denmark for mentally challenged residents, and the Labour Hotel, which has been fully booked since its opening in 2008 through 2013. Most recently, TempoHousing has developed a solution to service the post-earthquake victims in Haiti (www.tempohousing.com/projects).

Future Shack, designed by Sean Godsell, is among the first attempts to address the use of container modification for emergency housing. Future Shack can be fully assembled in 24 hours, makes minimum cuts in the container, and addresses all the basic human needs. However, the cost of this proposal is in excess of $30,000 (Helsel, 2001; www.seangodsell.com/future-shack) and is therefore not a solution that would be suitable for a post-disaster situation in a developing country.

Global Portable Buildings offers a more finished alternative for container housing and specifically addresses both disaster recovery and temporary housing solutions on their website. These units can be customized or they offer several standard ‘series.’ But like Future Shack, the starting costs of these units were in excess of what low-income families in the Caribbean could afford (www.globalportablebuildings.com).

Arieff and Burkhart (2002) were among the first to bring attention to the history and range of efforts related to prefabricated housing. Among the efforts highlighted were several examples of container housing alternatives. However, none of these projects addressed disaster relief or post-disaster community rebuilding. More recently, Levison (2006) provided a thorough history of the shipping container and its impact, but he also does not discuss the growing interest in its potential for alternative uses such as housing or disaster relief.

After disasters people want to go home to their communities and start rebuilding their lives (Honychurch, 2009). Standard protocol in the United States is for governmental and non-governmental agencies to provide disaster housing relief to people displaced due to property damage or destruction. This relief often comes in the form of mobile home trailers, as occurred post-Katrina in 2005. Unfortunately, FEMA only allows use of a trailer or mobile home for 18 months for those needing disaster-related housing needs (FEMA, 2006). This policy does very little to rebuild the communities that are devastated by the disaster. The more resources that are poured into temporary arrangements, the less are available for permanent reconstruction efforts (Rybczynski, 2005). Container homes provide a more feasible solution than just offering temporary housing. Instead people would be offered temporary housing that could evolve into a permanent housing solution and aid in the rebuilding of their community.

The SEED project is the first study we are aware of that encourages a system of creating not only emergency post-disaster housing but also aims to create a sustainable, long-term strategy to provide a more permanent housing solution to
help restore the disaster-struck communities in developing economies. In addition, it promotes principles of sustainability by reusing surplus shipping containers that have been abandoned in ports where there are trade imbalances and it is too costly to remove the empty shipping containers.

**Why Use a Studio Format for Teaching Sustainability?**

Very little has been written about the best methodology for teaching sustainability in a real estate curriculum. Historically, traditional real estate classes are designed with a lecture/seminar format that is confined more to the “chalk and talk” or PowerPoint slide pedagogy rather than the active, experiential teaching and learning format that is typically found in the studio. Graaskamp (1976) argued that “[r]eal estate education should be eclectic, but traditional real estate departments do not subscribe to integrated education.” Some real estate educators attempt to expand real estate education by including case studies in the classroom (Rose and Delaney, 2007). More recent studies have shown that teaching critical thinking and the ability to deal with complicated situations (Tu, Weinstein, Worzala, and Lukens, 2009), incorporating an interdisciplinary focus and combining theory and practice (Weinstein and Worzala, 2008) are important concepts that are found in successful real estate education programs. Therefore, case studies alone cannot meet the needs of today’s real estate students who are struggling with the complex and multidisciplinary issues associated with sustainability.

While conceptually the case study approach is similar to the studio in some ways, it differs markedly in its execution. In a studio, students apply theory learned in their other coursework to a live project that brings ‘real world’ challenges into the classroom. Many studio-format courses are taught as multidisciplinary studios with multiple professors bringing expertise from their various disciplines. This is an ideal format when teaching students to wrestle with the inter-connected sustainability concepts that must be understood. Rather than the linear analysis taught in the traditional case study approach, the studio encourages a cyclical process. The studio format involves a dynamic, iterative approach where the students create solutions and then get feedback on those solutions during ‘pin-up’ presentations from expert guest critics, project clients, classmates, and faculty. In addition, students get regular one-on-one desk critiques with their professor.

Each project begins with preliminary background research of the live project, the suitability of the site and program are then analyzed, an iterative design and development process is then engaged, implementation strategies are explored, and finally solutions are presented. Throughout the project development, after each feedback session, students reassess their solution, reframe their next steps, and evolve their solution to incorporate information from the feedback loop. This cycle is repeated throughout the project so that students are forced to return to the initial project challenge and ensure that their solution directly addresses the identified issues as they advance with the development of their project solution. The iterative process of the studio challenges students to think critically and develop innovative solutions to complex problems. When integrating this format for teaching
sustainability in the real estate curriculum, the studio would ideally be interdisciplinary and encourage cross-collaboration, engaging students from all of the various disciplines involved in the real estate process, including the traditional finance and/or real estate development students, as well as other business, planning, architecture, and construction science students.

Real estate problems are inherently multidisciplinary (Dasso and Woodward, 1980). For this reason, the studio format may benefit the real estate curriculum in many ways; however, it is particularly suited for addressing the issues of sustainability, which is, by its very nature, an interdisciplinary challenge. Its complexity invites the participation and contribution of multiple disciplines to solve the plethora of issues facing the real estate industry. The collaborative atmosphere of the studio allows synergistic results to emerge that better address the challenges of sustainability. However, even single discipline studios have advantages over traditional lecture format courses because they encourage student interaction and iterative ‘outside the box’ thinking. Boulanger and Brechet (2005) describe the five most important criteria that should be considered for modeling sustainability issues from a policy perspective, specifically: (1) use of an interdisciplinary approach; (2) managing uncertainty; (3) having a long-range or intergenerational point of view; (4) applying a global-local perspective; and (5) stakeholder participation.

A holistic consideration of these criteria creates a methodology that can be applied and easily implemented when teaching sustainability in a studio environment. This educational approach of service-based or active, experiential learning using real world problems can easily be applied to the more traditional real estate classroom, and provide real estate students with hands-on experiences solving complex sustainability issues. Multi-disciplinary teams encourage interdisciplinary work where often a synergistic solution is the result of incorporating the viewpoints and goals of multiple disciplines, as well as using the diverse input to manage uncertainty in the development of the solution. The studio approach also considers the long-term impact by exploring both the global and local impacts of the solution. Ideally, there are also opportunities for stakeholder participation meetings that inform the development of the solution. Depending on the project location, stakeholder participation is not always possible.

The studio format offers additional educational benefits for students tackling the challenging and complex issues associated with sustainability by offering opportunities for: (1) active, engaged learning; (2) work on ‘live’ projects/problems; (3) understanding and resolving conflicting viewpoints and goals in the design/development process; and (4) understanding how other coursework concepts are integrated and applied in real “live” projects.

One of the potential shortcomings of the interdisciplinary studio approach as applied to real estate education is that many students in real estate, particularly those in programs that are housed in the finance departments of business schools, are often taught to problem solve to one-answer solutions for most of their academic careers. The iterative nature of the studio process encourages students to reevaluate their solutions to ensure that they align with the studio objectives,
reframe their objectives, then move into further development of the solution, re-evaluate, and potentially start the process over again. Many typical real estate students are linear thinkers and want to step through a logical progression of answers and are not accustomed to playing “what if” games or considering “have you thought about this” comments. Therefore, they are uncomfortable with the breadth of solutions expected to come out of a studio investigation and unaccustomed to making changes and reanalyzing their work as additional ideas are cultivated. Hopefully this discomfort will only be an initial reaction, but educators should be mindful of addressing this potential area of concern upfront when explaining and establishing the studio format and process in an effort to overcome any hesitations.

Interdisciplinary Student Participation: The Case Study Process

The nature of the SEED project brought together a number of inter-related but contrasting viewpoints from multiple disciplines. The challenge for the students working on the SEED project was to gain an understanding of the multi-faceted requirements of the project, bring their individual disciplinary skill sets and knowledge to the group discussions (multidisciplinary work), and then collaborate in an interdisciplinary manner to create a synergistic solution to address the sustainability concerns explored in the studio setting. A typical studio is designed with students first identifying the project challenge and scope. Then there are typically three phases including preliminary research, design and development of a solution, and implementation strategies. The preliminary research phase further refines the project and establishes the questions that the design development phase will aim to solve. The implementation phase tests the viability of the solution. The three phases are cyclical in that the students continually return to assess alignment with the project challenge and scope (please see https://sites.google.com/a/g.clemson.edu/pernille-christensen-teaching/ if you are interested in more details about the studio class, its syllabus, and how the course was set up).

Within the SEED studio project, the first step of the process was for the students to identify the sustainability challenge and project parameters that would guide them in the preliminary research phase. To do this, they examined the various facets of the project scope and identified the elements of sustainability that needed to be addressed both for the client and for the EPA P3 competition. For the SEED project, the sustainability challenge was to examine the use of a global surplus item, the ISO shipping container, as an alternative housing solution for post-disaster hurricane victims. Therefore, the students began by investigating the global/local dichotomy of hurricane devastation, shipping container usage and its potential for localization, containers being a global waste product that are given a second life in the project by examining their potential for localized adaptation for housing in hurricane-affected areas.

Upon identifying the sustainability challenge, the first phase involved preliminary research, where the students explored a broad spectrum of issues to gain an
understanding of the larger global issues and the contextual implications within the locality of study. The students analyzed the social, economic, and environmental impacts for each research topic. Specifically, students began this phase by understanding the hurricane phenomenon at the macro scale of the Caribbean and then narrowed their focus to understand the impact of hurricanes on Dominica. After gaining a perspective of the devastation caused by hurricanes and the challenges of post-disaster rebuilding, the students studied the container and its structural qualities to determine whether it would be able to fulfill the goal of creating hurricane-resistant housing. Having determined that the shipping container met the criteria, the students studied the local cultural dynamics to gain an understanding of local lifestyles and daily living activities, existing housing stock conditions and styles, and cultural norms. Would the container even be acceptable as housing to the local population? 2

The second phase of the studio involved the design conceptualization, development, and construction of a prototype. This phase involves the iterative process previously discussed in a manner that encourages students to work together to create a test solution, reflect on the solution to evaluate whether it meets the sustainability challenge criteria, reframe the direction for further development, and improve their solutions based on feedback obtained through a series of ‘pin-ups’ (where guest speakers and experts give critical feedback on the proposed solution), internal reviews (where students present to each other for feedback and collaborate with each other to create a synergistic final design), and desk critiques with the studio professors.

The third phase looks at the macro scale and the implementation of the solution, if applicable, at the larger community scale. Throughout this process, the success of the studio is predicated upon the multiple disciplines interacting and students sharing their varied knowledge and skills to produce solutions that one discipline alone could not achieve. In the end, the input from multiple disciplines creates a better, more thoughtful and thorough response to the challenge being studied. In particular, sustainability challenges benefit from this interdisciplinary process because there are so many factors involved. In the case of the SEED project, the sustainability challenge encompassed the myriad factors involved with developing a sustainable solution for reusing surplus shipping containers as a housing solution for hurricane victims in the Caribbean.

Due to time constraints for the studio course, students were unable to finalize any cost estimations for the container modifications, provision of components, and transport to the site, which would itself vary depending on terrain and location. Had the studio been able to continue working on this project for another semester, the next stage would have been to complete the costing and feasibility analysis.

The goal of the project was to design and develop a strategy of modification that could produce a housing unit for less than $5,000. Preliminary research related to cost estimation and feedback from industry partners indicated that the goal was attainable based on calculations that included purchasing the surplus containers at a break-even cost, ranging from $1,500 to $2,000 (the remainder of the value could be used as a charitable tax write-off for the ‘donating’ corporations), and
building the various utility components in bulk, ranging from $200 to $500 each, depending on the component.3

Identifying the SEED Studio Sustainability Challenge

The SEED project that was developed in a studio environment in Fall 2009 will be used to illustrate the studio pedagogy applied to find sustainable solutions. In a nutshell, the students proposed to reuse retired International Standards Organization (ISO) shipping containers as a safe and secure housing alternative for people in the hurricane-prone region of the Caribbean. This project was rooted in the double-edged sword of globalization and the increasing awareness by the world’s population of our interconnectedness. The shipping container is perhaps the ultimate representation of our global interconnectedness because of the role it plays in consumption and the ability to ship goods around the world cheaply and securely. Currently, when a shipping container is retired, it is classified as “waste.” In the spirit of Cradle to Cradle by McDonough and Braungart (2002), who call for the transformation for human industry through ecologically intelligent design and of closing the life-cycle loop on current business practices, the SEED project was developed.

ISO containers were invented by a forward-thinking trucker named Malcolm McLean in 1956 in an effort to increase efficiency and reduce the costs associated with loading and unloading of cargo. His standardized dimensions for shipping containers made it faster and more organized to load-unload freight—reducing the costs by more than 90%—ultimately leading to a significant reduction in the prices of consumer products. “In 1956, loose cargo cost $5.86 per ton to load. Using an ISO shipping container, the cost was reduced to only .16 cents per ton. The shipping container invention of Malcolm McLean has certainly changed the world and thus, it has changed the lives of every human on the planet,” (www.isbu-info.org). The aim of the SEED project was to capture the spirit of McLean and use surplus containers to further change “the lives of humans on the planet” by developing a safe, hurricane-proof, low-energy, low-cost, sustainable housing alternative for areas affected by natural disasters. The challenge was to discover a strategy to locally inflect these mass standardized objects to provide safe, secure, culturally appropriate housing. Intermodal containers are global, ubiquitous, standardized, structurally strong, adaptable, and affordable.

While the ISO container was originally developed to streamline the shipping industry to make it more sustainable and efficient, it has now, ironically, become a waste item sitting idle in ports. This is because it is more expensive to transport an empty container than it is to build a new one. Large numbers of ISO intermodal containers arrive daily to the Caribbean, but few leave with export goods. This pattern causes a surplus of shipping containers to accumulate in regional ports (Levinson, 2006). Currently, these excess shipping containers are either shipped empty to another port, recycled (down-cycled) into steel, or simply remain warehoused in Caribbean ports (Boile, Theofanis, and Mittal, 2004; Stangel, 2009). None of these strategies are economically effective or sustainable nor do they take advantage of the potential of the ISO container as a building module.
Simultaneously, there is a tremendous need in the Caribbean region for affordable, hurricane-resistant housing. The studio approach to the challenge was unique in that it identified the sustainability problem both at the micro and macro scales as an “ecology,” and proposed an adjustment to the ecological system to return it to balance.

The catalyst of the SEED project idea was a conversation with John Stangel, the CEO of our industry partner, Container-It, Inc., who expressed a desire to help these Caribbean communities create better housing options while also reducing the company’s costs of removing the empty containers from the region (Stangel, 2009). While much research has been done on the strength and reuse possibilities of the ISO container in recent years (www.isbu-info.org), these benefits have yet to be fully explored in the hurricane-affected islands of the Caribbean where homes and businesses are regularly devastated by the high-force winds associated with hurricane seasons. While it is unavoidable that the Caribbean islands will be struck by natural disasters with some regularity, even the slightest bit of stability during the aftermath is welcomed by the victims. The island communities of the Caribbean often lack the financial means to construct adequate housing, and the result is regular rebuilding of a mediocre product after a hurricane hits (Honychurch, 2001, 2009). According Davis (1978), “survivors priorities in order of importance are: to remain as close to their damaged or ruined homes and means of livelihood, to move temporarily into homes of families or friends, to improvise temporary shelters as close as possible to the site of their ruined homes (these shelters frequently evolve into rebuilt houses), and to occupy emergency shelters provided by external agencies.” The function of emergency shelter is manifold beyond protecting individuals from the elements but also provides emotional security and fills the need for privacy (UNDRO, 1982).

The goal for the studio was to develop a container modification strategy that re-utilizes the ISO containers and resolves the challenge of creating housing that meets immediate post-disaster emergency housing needs but that is also flexible enough to evolve over time into a permanent hurricane-resistant housing solution for families in the Caribbean. The studio project had a number of phases, each of which cycle back to constantly reference the studio sustainability challenge. During the semester-long studio, students developed the SEED project, which proposed a sustainable housing solution by:

1. Applying the *Cradle to Cradle* philosophy and giving shipping containers a second life by transforming them into homes in the wake of hurricanes.
2. Tackling the long-term challenge of providing permanent hurricane-resistant homes for under-served families in the Caribbean region, resulting in a reduction of catastrophic property loss in the face of future hurricanes.
3. Proposing a sustainable strategy of site design and implementation that would help get displaced people back into their neighborhoods quickly, working together to rebuild their communities and their food supplies.
4. Creating self-sufficient housing to function ‘off-the-grid’ until post-disaster devastation of infrastructure is restored to neighborhoods—and possibly long-term.
Phase I: Preliminary Research

The studio research phase began by exploring the devastation caused by hurricanes throughout the Caribbean to gain an understanding of the macro phenomenon, and then the students narrowed their focus more specifically to examine the impact of hurricanes on the Commonwealth of Dominica. The Commonwealth of Dominica was chosen as the case study location for several reasons. First, it falls in the mid-range for number of hurricane landfalls, monetary damage, and death counts caused by hurricanes, as well as being in the mid-range for density, socio-economic conditions, and population diversity. Secondly, the combination of Dominica’s level of poverty (IMF and IDA, 2006), geography, vulnerability to natural disasters (UNDRO, 1982), and need for a more sustainable living environment led the students to choose this island as the test site. In addition, the topography of Dominica offers a unique opportunity to explore three very different site conditions for the adapted container, the feasibility of locating shipping containers in different terrain conditions, and to investigate innovative methods for securing the ISBU to the ground in various conditions to resist being overturned by high-force winds. This research is important because, in addition to addressing the immediate needs of the population in Dominica, it also provides a test bed for transferring the use of containers as an alternative post-disaster housing solution to other disaster areas.

Having gained a grasp of the hurricane phenomenon and the devastation of housing and farming it annually causes in the Caribbean region, the studio next analyzed whether the ISO container would be able to maintain its structural integrity and withstand the wind forces of a Level 5 hurricane. This research also spurred investigations into local construction constraints, how to package all the necessary modification materials into one of the ISO containers, and the possibility that a threshold quantity of units sent simultaneously to the island may be more cost-effective for both the industry and the community in which they are being built. The possibility that communities may be constructed entirely using this prototype also allows for the creation of “Business in a Box” opportunities within the community to support the construction of SEED homes and the people living in them (www.cubicinspirations.com).

Recognizing that the ISO container is a mass standardized object, the students began to wonder about the cultural appropriateness of using the container as housing in the Caribbean. For this part of the project, the students explored strategies to customize the containers. By creating opportunities for individualization of each SEED home, residents are able to create more culturally sensitive and appropriate housing by infusing local character into the final design. To gain an understanding of the local cultural attitudes and living conditions, students grouped themselves into multi-disciplinary teams and compiled an immense amount of data about the Caribbean, including: disaster protocols, relief programs, container routes in the Caribbean, local ports, container surplus locations and quantity, government structures, demographic information, economic and industry information, labor forces, temperatures, rain fall patterns, solar availability, local materials, vernacular construction, growth and production rates.
of local foods, nutritional values of local foods, farming strategies, available and alternative technologies, cultural patterns, family and living structures, daily routines, and lifestyles of the local population to better understand the diverse settings found on the island to which the students’ proposed solutions would need to adapt in order to be effective.

The advantages of the multi-disciplinary teams during this phase are that the students who come from different disciplines tend to interpret information differently; therefore, the compiled data are richer and more diverse. The thought process and evolution of the preliminary research phase (Phase I), as well as the catalyst questions that emerged from the research to guide Phase II, are outlined in Exhibit 1.

*The Hurricane Phenomenon: Addressing Sustainability.* Dominica has a long history of being devastated by hurricanes; its “geographic location and topography make it vulnerable to natural disasters,” (www.reliefweb.int). Most recently, Dominica was hit by Hurricane Dean in 2007 and Hurricane Omar in October 2008. In both cases, there was significant damage to infrastructure, roads, and bridges as a result of landslides and fallen trees, and housing communities were hard hit by the devastation. The banana crops were ‘wiped out’ by Hurricane Dean (http://www.iht.com/articles/ap/2007/08/21/business/CB-FIN-Hurricane-Dean-Bananas.php) and although Dominica was indirectly hit by Hurricane Dean, the “hurricane force winds, torrential rains and high sea swells resulting from its passage affected several sectors of the Dominican economy. Swollen rivers, flash floods and landslides caused extensive damage to agriculture, housing and infrastructure. The United Nations’ Food and Agriculture Organization (FAO) reported a loss of over 70 percent of total agricultural production,”

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**Exhibit 1 | Thought Process and Evolution of Phase I: Preliminary Research**

Note: Topics and questions explored in Phase I are in blue; Phase II catalyst questions generated from the research are in red.
In addition, the Office of Disaster Management in Dominica reported that 771 houses were damaged, while 43 houses were completely destroyed after Hurricane Dean.

The students’ preliminary research identified a dire need for a sustainable housing alternative for populations throughout the Caribbean that are affected by hurricanes on an annual basis. This need is further compounded by the economic and political instability within many Caribbean countries, cities, and communities, which result in poor housing standards. The students’ design of the SEED prototype directly addresses this need for sustainable hurricane-resistant housing. In addition, the students proposed the integration of hurricane-resistant planting as part of the edible landscaping design, which provided a strategy to reduce the environmental degradation often created by hurricane winds. Their solution also provides for a renewable food source for residents, many of whom live below the poverty line. The economic benefits of the SEED housing alternative includes improved, low-cost, hurricane-proof housing for local residents, job opportunities related to the construction of the container housing and the potential for low-cost, hurricane-proof “business in a box” opportunities.

**ISO Intermodal Containers: Addressing Sustainability.** The ISO intermodal container is the backbone of international trade as we know it today. The students focused on the most common type of container, the GP-40, because it is widely available in every nation throughout the Caribbean. The GP-40 is a 40’ long × 8’ wide × 8.5’ high steel moment frame (a structurally rigid box) comprised of 12 steel sticks welded at 8 corner connections to form a steel box weighing slightly more than 8,000 pounds and entirely constructed of rust-proof weathering steel. It is the strongest modular structure—mobile or stationary—in the world (www.isbu-info.org). While the corrugated steel used for the walls and roof is of a relatively thin gauge, it is welded continuously and uniformly, making it waterproof and incredibly strong. Unaltered, it can withstand 140 mph winds. A large portion of the corrugated steel can be cut and removed without compromising its structural integrity (www.isbu-info.org). Together these qualities provide an ideal building module for affordable housing because they are resistant to water, fire, mold, wind, and vandalism.

A unique element incorporated in the SEED project development is the consideration of locality while using a global waste product. In the development of the prototype, opportunities for infusion of local character were noted, so that the final product would ultimately blend with the vernacular case house and chattel house architecture of the islands. The integration of the SEED prototype into its new locality becomes an interdisciplinary challenge in which students must address a spectrum of sustainability requirements including large-scale community rebuilding, individual unit siting, container individualization and localization, plant selection, and landscape design strategies.

In keeping with the *Cradle to Cradle* philosophy, the re-use of the ISBU effectively and efficiently extends the life-cycle of the product, giving it a second life by providing a new use. The reuse gives the container a second life-cycle, beginning from a new ‘cradle’, and eliminates the need for the removal and
shipping of empty containers to another location, thereby reducing overall fossil fuel consumption and greenhouse gas emissions (Levinson, 2006). Globally, this reduces the negative environmental impacts of high energy costs and the mitigation of disposal associated with traditional recycling. Locally, the use of ISBU housing reduces resource consumption over the long-term as the structures are hurricane-resistant, eliminating the need for residents to continually rebuild after hurricanes.

In addition, the students worked to address the pressing post-disaster needs of energy availability, reliable clean water supplies, and basic sanitation at the scale of the individual SEED home. The studio designed a series of ‘pod’ components that applied a limited use of advanced technologies, as well as taking advantage of the abundant water, solar, and wind resources that exist in the Caribbean. The ‘energy pod’ enables the container to capture solar power and run ‘off-the-grid’ with the expectation that power may be unavailable to remote residents following a hurricane. A water filtration system uses an adaptation of Manz’s BioSand Water Filter (Manz, 2006, 2007) in the re-use of another surplus item in the Caribbean islands, the 55-gallon metal drum. The system allows captured rain water to be filtered through the BioSand Water Filters constructed in three 55-gallon drums on the roof into separate holding drums for potable drinking water and use in the ‘water pod.’ Previous experiments utilizing the Manz BioSand Filter have indicated a 65%–90% removal rate of bacteria and contaminants, with some systems filtering 100% over time once the biolayer is fully formed (Manz, 2006, 2007). The water pod gravity feeds water from the holding drums on the roof to a shower and sink, as well as providing a composting toilet. By considering such a broad spectrum of needs for the end-user, the students’ holistic, interdisciplinary approach hopes to improve each resident’s quality of life while ultimately reducing the overall environmental impact of the project.

Cultural Dynamics: Addressing Sustainability. The cultures, traditions, economics, and politics of the countries that comprise the Caribbean are diverse and heterogeneous. It is common for a family of six to share a house of one or two rooms equaling no more than three to four hundred square feet. The majority of the cooking and socializing happens either directly outside or within an interstitial space like a covered or screened porch. Semi-enclosed/private spaces are defined by walls of wood or corrugated steel and are primarily for sleeping and family living. Due to a lack of available and affordable glazing, openings are permeable or perforated via material connections. The highly permeable surfaces that are used to define space in the Caribbean vernacular allow for a high degree of ventilation and some natural lighting. This strategy of passive cooling was one the students aimed to integrate into their solution as well (Honychurch, 2009; www.lennoxhonychurch.com).

Understanding the basic daily lifestyles and living conditions of the local population raised questions of appropriateness. How could the container be modified to not only fulfill basic living needs, but also be accepted by the local population as a permanent housing solution? Throughout the design and development phase, the students constantly returned to this question and their preliminary research in an effort to create physical modifications to the container
that were in keeping with indigenous architectural style and incorporated possibilities for individual unit customization.

Farming: Addressing Sustainability. Farming is one of the main economic engines in Dominica and was hard-hit by Hurricane Dean. Students researched local farming practices, as well as sustainable farming solutions to gain a better understanding of the advantages and disadvantages of promoting and diversifying local farming. Increasing and diversifying local agriculture will contribute to a reduction in worldwide gas emissions associated with the production and distribution of food products. According to the Earth Policy Institute, an ecological economy think tank, the process of worldwide food production and distribution is the single largest producer of greenhouse gas emissions (www.earth-policy.org). This should be no surprise when one considers the enormous fossil fuel budget integral to the conventional industrial food chain in the form of fertilizers, pesticides, operation of machinery, refrigeration, transportation, and processing. Based on their preliminary research, students proposed sustainable agricultural strategies for both city planning and residential site design.

In addition, local cooking habits were researched to determine common food needs. “A wide diversity of annual and perennial food species will help to ensure a more prolonged harvest, will provide a wider spectrum of taste and nutrients, and will be more resistant to pests, weather conditions and other stresses,” (www.cityfarmer.org/Berezan.html). The nutritional value, growth rate, and productivity cycle of a variety of commonly planted vegetables and fruits, edible trees and shrub species, and herbs were analyzed and are detailed in Exhibit 2. This research was completed to ensure that the students learned how to assess the appropriateness of chosen plant species for a given environment, in this case—Dominica.

This analysis led to a recommendation for a post-disaster replanting and food network strategy that would enable local families to become self-sufficient more quickly while also regaining access to undamaged nutrient-rich foods from unaffected areas of the islands. Because the topsoil pH balance is damaged from hurricane flooding, it was necessary to identify agricultural areas that were unlikely to be flooded by the sea and rains. In addition, the students proposed the development of an emergency garden for each SEED home to facilitate the replanting of edible vegetation while topsoil rebalancing efforts were executed post-disaster.

Phase II: Design and Development of the Sustainability Challenge Solutions

The SEED project proposes a design to cut across regional variations while at the same time providing an open framework for the home to “grow” over time and localize (to become culturally appropriate for its specific locality). While an ISO container makes an intelligent building module because of its structural integrity and resistance to water, mold and pests, it is not a home. The students’ primary objective was to transform the shipping container from an incredibly robust, global ‘packaging’ commodity/waste product into a home. At the larger scale, the objective was to develop an implementation strategy that allowed the modified container homes to become the ‘seeds’ that rebuild the community.
**Exhibit 2 | Example of Nutritional, Growth, and Productivity Analysis**

Note: Analysis performed on 15 planted vegetables, 15 planted fruits, 15 food-producing trees, 15 food-producing shrubs, and 15 herb/spice plants found locally in the region.
The process applied in Phase II for design and development of solutions to these objectives follow the five steps of the modified experiential Svoboda and Whalen (2004/5) model as illustrated in Exhibit 3. The students developed two distinct design strategies that would be combined to accomplish the first objective. The first design strategy is the physical modification of the container. This strategy includes the work directly on the container through cutting and welding operations. The second design strategy was to develop a series of “plug and play” components that would provide necessary human comfort and meet basic needs of nutrition, drinking water access, and hygiene.

*Container Modification.* The container modification strategy was guided by a design ethos of producing the maximum benefit with the minimum means. The cuts into the container are the first step in transforming the container into a home. The welding students were instrumental in helping the design students decide how to make the various openings and also maintain the structural integrity of the container. First, the welding students conducted a welding seminar for all the design and planning students working on the project so that they could gain some first-hand knowledge of the process and understand the options for how the different types of cuts could be made. A big part of the studio culture is that students learn from each other’s strengths. The interaction of the students at this stage is an example of how the studio format can enrich the learning experience by allowing students to disseminate knowledge to each other in an active, engaged, hands-on manner rather than have the instructors be the only ones teaching. Finally, the cuts were made on the prototype container by the welding students.
using hand-held plasma cutters from a reusable, prefabricated jig that was fitted to the container. The cuts open the container to provide adequate access to light and air for the occupants. There are two types of openings: major openings, which expand the living space, and secondary openings, which allow the container to ‘breathe.’ The students designed the placement of these openings to allow for cross-ventilation/passive cooling to occur, which eliminated the need for environmentally insensitive artificial cooling devices.

Components. The second design strategy for transforming the containers consisted of a series of prefabricated ‘plug and play’ components designed. The five components are:
- Energy pod
- Water pod
- Water filtration system
- Emergency garden
- Canopy
- Root system-scissor foundation

The students considered how each of these components could be most efficiently and sustainably manufactured and brought to the disaster-struck port for use in the modified containers. All components are based on principles of flat packing and modular sizing based on pallet sizes for transport efficiency. The pods are designed as pallet-sized or half-pallet sized modules that can be mass prefabricated and shipped to the disaster-affected areas. The pallet-sized pods can be shipped 20 pods to a single container while the half-pallet-sized pods can be shipped 40 pods to a container. The idea is to store these components at disaster relief staging areas throughout the Caribbean so that they are ready to transport immediately after a natural disaster, enabling all useable ISO containers that are on-hand in local ports to be transformed rapidly into housing. The students identified the components to meet user needs and to further transform the container from an industrial surplus item into a home once the openings have been made. The water filtration system and emergency garden utilize 55-gallon drums that can double stack into the container and can be shipped 160 to a container. In addition, residents can use surplus drums available in the disaster-struck port and/or community. The canopy and root systems are designed in such a manner that they are flat-packed (like an IKEA item) and easily assembled upon arrival at the final site destination.

The energy pod and water pod were designed as half-pallet-sized and pallet-sized crate modules, respectively. By using pallets, which are also globally standardized, prefabricated industrial elements, as the base for the ‘pod’ components, the modules can be efficiently mobilized to disaster areas. The students have begun making contacts in the crating industry to discuss the further development of the ‘pod’ prototypes as semi-finished structural crates. These two components provide essential human biological needs of access to energy and water. For more details on the sustainability and real estate solutions developed and the iterative process used during Phase II of the studio, see Exhibit 4a and Exhibit 4b. In addition, we
Exhibit 4a | Design and Development Process for ‘Pod’ Component Solutions and Associated Sustainability Components

<table>
<thead>
<tr>
<th>Design and Development Process for ‘Pod’ Component Solutions</th>
<th>Sustainability Component</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Pod:</strong> Developed primarily as a group effort among the architecture students with input from students in other disciplines.</td>
<td><strong>Off-the-grid energy</strong></td>
</tr>
<tr>
<td><strong>Concept Development:</strong> Efficient packaging and transport; provide off-the-grid power source; meet basic cooking needs.</td>
<td><strong>Reuse of surplus ‘waste’ material</strong></td>
</tr>
<tr>
<td><strong>Act:</strong> Utilize standardized pallet; inclusion of 60 watt thin film solar panel; powers minimum lighting, cooling, and at-home business.</td>
<td></td>
</tr>
<tr>
<td><strong>Reflect and Assess:</strong> Appears cold; mass-produced object like shipping container.</td>
<td></td>
</tr>
<tr>
<td><strong>Reframe:</strong> Provide opportunity for individualization of unit.</td>
<td></td>
</tr>
<tr>
<td><strong>Apply / Rework:</strong> Semi-finished packaging as waterproof ‘crate’ allows end-user localization; flexibility for roof or roof canopy mounting.</td>
<td></td>
</tr>
</tbody>
</table>

**Water Pod:** Developed collaboratively between architecture and landscape architecture students.

| **Concept Development:** Efficient packaging and transport; uses captured rainwater to provide off-the-grid hygiene and sanitation solution. | **Reuse of captured and filtered rain water** |
| **Act:** Utilize standardized pallet; includes shower and composting toilet; gravity feed water from water storage drums on roof. | **Reuse of surplus ‘waste’ material** |
| **Reflect and Reassess:** Bulky, appears cold; mass-produced object like shipping container. | |
| **Reframe:** Expandable unit; provides opportunity for individualization of unit. | |
| **Apply / Rework:** Pallet-sized unit expands to width of container upon insertion; semi-finished packaging as waterproof ‘crate’ allows end-user localization; connects to water filtration system for potable water in sink. | |

*Note:* This is not a linear thought process as implied by the table format. Refer to Exhibit 3 for an illustration of the cyclical process of the design and development phase of a typical working studio.

have noted which disciplines were primarily responsible for each solution although for most solutions the problems were solved with input from the other disciplines, highlighting the importance of interdisciplinary studios to come up with more creative and well thought out solutions.

The water filtration system and emergency garden are a linked system designed to get families back to a level of self-sufficiency in terms of drinking water and food supply. They are designed to utilize surplus 55-gallon drums, which have been cleaned and sealed to prevent leakage of any rust or toxins from the drum into the soil and water contained in the drums. The water filtration system and emergency garden components enable families to regain their self-sufficiency for both clean water and food production, creating a reduction of reliance on post-
**Exhibit 4b | Design and Development Process for ‘Drum’ Component Solutions and Associated Sustainability Components**

<table>
<thead>
<tr>
<th>Design and Development Process for ‘Drum’ Component Solutions</th>
<th>Sustainability Component</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water Filtration Strategy:</strong> Developed primarily as a group effort among the landscape architecture students with input from students in other disciplines.</td>
<td>Purification of water for potable and non-potable use</td>
</tr>
<tr>
<td></td>
<td>Capture and reuse of rain water</td>
</tr>
<tr>
<td></td>
<td>Capture and reuse of grey water</td>
</tr>
<tr>
<td></td>
<td>Reuse of surplus ‘waste’ material—55-gallon drum</td>
</tr>
<tr>
<td><strong>Concept Development:</strong> Reuse of 55 surplus gallon drums; simple modification; provide potable water for drinking and cooking as well as clean water for basic hygiene needs.</td>
<td>Purification of water for potable and non-potable use</td>
</tr>
<tr>
<td><strong>Act:</strong> Utilize standardized 55-gallon drum; adaptation of Dr. Manz’ BioSand filtration system.</td>
<td>Capture and reuse of rain water</td>
</tr>
<tr>
<td><strong>Reflect and Assess:</strong> Increase water supply; safety of water stored in previously used drums; secondary filtration at ground level for cleaner potable water and better accessibility; also capture &amp; reuse of grey water for garden.</td>
<td>Capture and reuse of grey water</td>
</tr>
<tr>
<td><strong>Reframe:</strong> Need water storage units for excess water; how to clean drums; accessibility to potable water.</td>
<td>Reuse of surplus ‘waste’ material—55-gallon drum</td>
</tr>
<tr>
<td><strong>Apply / Rework:</strong> Link with canopy to capture and filter rainwater; development of different drum designs to either store water or filter water; include percolation filter to protect bio-layer and slow water entry speed; cleansing and sealing of drums in port prior to use; two-tier water filtration to improve accessibility.</td>
<td>Restoration of local food production network</td>
</tr>
<tr>
<td></td>
<td>Reuse of surplus ‘waste’ material—55-gallon drum</td>
</tr>
<tr>
<td></td>
<td>Capture and reuse of grey water</td>
</tr>
<tr>
<td></td>
<td>Reduction of GHG emissions with reduction of food aid shipments</td>
</tr>
</tbody>
</table>

**Emergency Garden:** Developed primarily as a group effort among the landscape architecture students with input from students in other disciplines.

| Concept Development: Efficient packaging and transport in surplus 55-gallon drums; provides a ‘starter garden’ to aid families in regaining self-sufficiency; protects food production from flooding by placing on roof of container. | Purification of water for potable and non-potable use |
| Act: Consider possibility of bio-remediation strategy for filtering soil; analyze local produce and herbs for nutritional value, growth, and production rates; possibility for permanent ‘starter’ garden in place. | Capture and reuse of rain water |
| Reflect and Assess: Excess weight/distribution issue with all drums being filled with soil for water filtration; determine which produce and herbs should be included in garden; how to protect produce for next hurricane. | Capture and reuse of grey water |
| Reframe: Separate from water filtration system; consider timeline for food production; how to move drums off roof into container. | Reduction of GHG emissions with reduction of food aid shipments |
| Apply / Rework: Preassemble and ship garden in sealed 55-gallon drums for easy assembly on site; design optimum soil depth and design ‘soil shelf’ to lighten weight; consider pre-planting and packaging of emergency garden; pulley system in canopy to move drums into container in the event of approaching hurricane. | |

Note: This is not a linear thought process as implied by the table format. Refer to Exhibit 3 for an illustration of the cyclical process of the design and development phase of a typical working studio.
disaster food aid and thereby reducing the green house gas emissions associated with the long-term shipment of food to the island. Larger-scale sustainable agricultural strategies were also proposed to help return the ecology of food production to a ‘balanced’ state quickly in a post-disaster situation and to create a food network that would bring in ripe produce from unaffected areas.

The canopy, developed collaboratively by the architecture students and another industry partner, Sargent Metals, serves the multiple purposes of shading the container, to reduce heat gain inside the unit, and guiding captured rain water to the water filtration system. A repetitive pattern of slots are digitally pre-cut into large Cor-Ten steel sheets to maximize the configuration flexibility for the homeowners and allow a variety of materials to be attached for customization. Assembly on-site consists of pulling the pieces apart, using the slots to create the desired configuration, and attaching to the container roof. All components are shipped flat-packed.

The ‘roots’ of the container were designed as a collaboration between the architecture students, the landscape architecture students, and the welding students. The Scissor Foundation is made of laser-cut, corrosion-resistant Cor-Ten steel for ease of welding to the ISO container in the port. It is designed to unfold from below as the container is being placed on site to allow the foundation to adjust to varying topographies. In addition, the foot pads use low-impact foundation technology to ensure that the system will work in most soils. Pipes driven through the foot pads create a structural wedge with the soil while resisting uplift in the case of high winds.

**Phase III: Implementation: An Emergency Scenario—Logistics and Site Planning**

Phase III is the development of implementation strategies for the solutions derived in Phase II. This phase tests the viability of the solution and may raise questions about some of the decisions made during Phase II; when this occurs, the students must return to Phase II for further design and development. The SEED concept from implementation is unique in that it combines an approach of reutilizing dormant, surplus shipping containers in ports throughout the Caribbean with ‘emergency packets’ containing prefabricated infrastructural elements (energy pod, water pod, water filtration system, emergency garden, canopy, and scissor foundation), which lay dormant and ready to ship in shipping containers at staging areas throughout the Caribbean until a disaster strikes. In Phase III, the students created a synergistic implementation strategy that considered a range of obstacles that might emerge and proposed solutions to them. By working in a collaborative manner, students from outside one of the disciplines were encouraged to ask questions that brought to light questions that those inside the disciplines may not have considered or had, out of habit, for which they had assumed definitive solutions. The final implementation solution proposes a timeline for implementation of various container modifications, site clean-up, and community rebuilding steps that are detailed below.

The first stage involves having the component elements lying “dormant” in staging areas as first-aid ‘kits’ to transform containers in the port of any hurricane-
affected country. Staging areas are located such that all potentially serviceable islands are within 3–4 day travel by container vessel. The students chose these staging areas based on the assumption that in the days following a hurricane, container vessels would be made available to relief agencies to get much needed supplies to victims in need and that the pods would be among those supplies.

The students identified ports as the best place to set up temporary modification facilities following a hurricane. Ports are the place where the greatest resources (power, welding equipment, forklifts) are concentrated, where the shipping containers are warehoused, and where the equipment for moving them is located. Their solution proposes that temporary modification facilities be set up in the local ports. Additionally, the ‘emergency packets’ described above will be shipped directly to the ports and the containers’ transformation can be completed without excess movement of these components. While these emergency housing ‘packets’ are in transit to the port, the openings are cut into the containers.

Simultaneously with the modification occurring in the port, debris removal is occurring in neighborhoods, at home sites, and along major roadways to facilitate transportation of the SEED housing. In the port, the pod components of the emergency kit are fitted into the modified containers. Each container receives an energy pod, water pod, water filtration system, emergency garden, canopy, and scissor foundation. The SEED home is then either airlifted by helicopter or loaded onto a truck and transported to the homeowner’s cleared site and placed onto its deployable scissor foundation. The canopy, water filtration system, and emergency garden are installed by the homeowner in their preferred configuration and the family moves in. A unique aspect of the SEED implementation strategy as designed by the students is that families are returned quickly to their communities and are able to work together to rebuild their neighborhoods. This solution is a direct reaction against the conditions the students uncovered while researching the post-Katrina rebuilding efforts. While the SEED container design is initially considered as a post-disaster emergency shelter, the uniqueness of the students’ final design is its ability to transform into a permanent residence over time due to the adaptable nature of the design elements, as well as its ability to help restore the social and physical health of the community.

Conclusion

This paper summarizes the efforts of an interdisciplinary group of students that envisioned a sustainable solution to a world problem: the need for hurricane-resistant housing. Dubbed the SEED project, we have demonstrated that students from multiple disciplines are able to work together to create synergistic solutions to sustainability issues raised within an interdisciplinary studio environment. The SEED project addresses the relationship between industrial waste, global trade, housing, and basic human living needs by proposing a process to convert surplus shipping containers into hurricane-resistant housing in the Caribbean. The students’ solution connects an international surplus of shipping containers with a tremendous need for safe, affordable housing for the poor.
Much has been made of using shipping containers as housing; however, most approaches overlook the complex economic, social, and logistical challenges of utilizing shipping containers as dwellings, and even fewer focus on the further complexities associated with emergency relief housing. The studio approach brought together a multidisciplinary team from both academia and industry to gain a full understanding of not just the object (shipping container) but also the processes surrounding it (when it becomes a waste product in a developing economy prone to natural disasters). The SEED project provides a hurricane-resistant “framework” for people affected by disaster to rebuild on their own home sites in their own communities ... to the places they call “home.” It orchestrates the complex logistics of securing unused containers, their modification and eventual deployment as housing. The “SEED packs” provide a safe secure home, along with inexpensive “off-the-grid” infrastructure for electricity and water.

It is recognized that the proposed solutions have yet to be cost-estimated or tested in the field but, ideally, this would be the next stage. The benefits of the classroom and single-container prototype construction in a ‘no crisis’ condition is that it shows how students from different disciplines can bring varying and complementary skills and knowledge to a project to create the first stage of a sustainable solution.

The SEED analog is an example of the creativity that often develops from the interactions within the interdisciplinary studio environment. The SEED logo (as shown earlier in Exhibit 1) addresses the idea that the housing initiative is a beginning for people rebuilding after the devastating loss experienced during and after a hurricane, a seed of hope. It grows roots (foundations) and canopy over time as it localizes with the customization of each individual homeowner. Ultimately, it is designed to become permanent housing that helps avert loss during future natural disasters.

This project increased the exposure of students to the concepts of sustainability through the interdisciplinary nature of the design studios, collaboration with private corporations’ intent on implementing ‘green’ strategies in the real world, and through exposure to the community in Dominica, which is directly affected, through the increase of hurricane devastation, by global warming. The emphasis of the educational experience was to make clear to the students the important role that design plays in bridging between disciplines, as well as between industry and academia; this bridge is necessary to meet the increasingly complex challenges when addressing client design goals while also attempting to maintain an awareness of the economic, social, and environmental impact of decisions.

It has been illustrated through the SEED case study that the interdisciplinary studio environment works when exploring some of the sustainability challenges facing the built environment disciplines, such as material reuse and recycling, water capture and filtration, sustainable agriculture, etc. This paper suggests that the studio environment can be adapted for use within the real estate education process for the same purpose. Real clients, acting as guest critics and mentors during the process, provide a live project that can be used to explore these challenges associated with teaching sustainability. The process is further enhanced by
integrating student participation from other disciplines, as well as guest speakers from outside disciplines. A few examples of how this approach might be integrated into a real estate curriculum include the valuation, cost-estimating, and capstone project courses. Ultimately, students will benefit by being challenged, through the iterative process inherent to the studio process, to think ‘outside the box’ for solutions to a multitude of critical issues that face the real estate industry today.

Endnotes

1 In this particular project the EPA P3 grant provided $10,000 for studio support. Students were invited to Washington, DC to compete for a second phase of funding that would result in an additional grant of $75,000 to further develop the prototype and bring the solutions to market. This provided an excellent experience for the students to compete on a national level.

2 Additional information on resources used in Phase I are available upon request.

3 Recent developments of the application of SEED in Haiti are highlighted in an article by Banerjee. A modified prototype was built in Canada in 10 days for $8,000–$10,000. It is expected that this cost will be significantly lower in Haiti when using local labor.

References


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