Designing and Building with Plastic Waste

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Keywords: Architectural Education, Design Process, Materials Research, Digital Fabrication + Technology

INTRODUCTION
The Big Blue Bench (figure 1) is a furniture piece and public art installation that serves as prototype to demonstrate the reuse of plastic waste as building material (figure 2). The product is the result of research funded by the 2021 University of Kentucky (UK) Sustainability Challenge Grant Program to generate new uses for the abundance of discarded plastic produced by the UK healthcare facilities and serve as a model for designing and building with sustainability in mind.

PROJECT OVERVIEW
This project serves as a tool to teach students about the potential of incorporating recycled material into their design proposals and as a proof of concept to demonstrate a design process and philosophy of designing and building with material conservation and reuse in mind. The potential of this process and philosophy is that it could be translated to apply to multiple materials and scales of building.

COURSE DESCRIPTION
This design proposal was developed over the course of the Spring 2022 semester in a design build elective, Fabricating Play, that explores the use of the systematic processes of digital design and fabrication directed towards the development of large-scale interactive objects or a “micro-architecture.” These constructed objects consider the relationship to human scale and proportion, materiality, and method of fabrication and assembly. The project evolved through research, discussion, and fabrication over the course of 14 weeks. The projects for this course are traditionally funded for a variety of outside sources and this semester was funded by the UK Sustainability Grant.

SUSTAINABILITY CHALLENGE GRANT
The UK Sustainability Challenge Grant (SCG) program is designed to encourage the creation and implementation of ideas that will promote the three pillars of sustainability: 1. Economic vitality, 2. Ecological Integrity, and 3. Social Equity. It engages multi-disciplinary teams and encourages student involvement. The Big Blue Bench emerged from a proposal to present sustainable solutions to the university’s plastic waste issue with a focus on single use plastics discarded from university healthcare.

Figure 1. Big Blue Bench. Courtesy of author.
Figure 2. Plastic wrap waste and resulting tile. Courtesy of author.
PLASTIC WASTE
For this semester, the class was charged with developing concepts for use and new implementation of plastic waste generated by the healthcare facilities on campus. The students began with a tour of the recycling facilities (figure 3) to understand the amount of waste produced and discover potential materials for use in their proposals. After experimenting with multiple materials, they selected a blue plastic wrap used to keep equipment sterile before its use and that is produced in boxloads daily in a near limitless supply (figure 4).

THE BIG BLUE BENCH
The final design proposal from the course participants is the Big Blue Bench (figure 7), a large-scale furniture piece that is both an art piece, demonstrating the reuse of the discarded material on its topmost surfaces and satisfying the needs of the SCG, and a functional bench and table for students to use daily for their off time between classes, satisfying the design build course requirements. The proposal is a set of horizontal shifting and undulating plates allowing multiple zones of varying sizes for sitting and holding a variety of items from laptops to coffee cups. The final construct was designed as one of three pieces that could be distributed as small units or lock together into one massive furniture island (figure 5).

RECYCLED PLASTIC TILES
The top layers of the Big Blue Bench are comprised of 106 custom cut tiles produced from the CNC milled blanks. The blanks are created by shredding the plastic wrap into small strands that could be easily melted into the tray of a small electric grill (figure 6). This process was suggested by one of the grant team members who had tried this previously after watching a tutorial on YouTube. The process took around 3 hours per tile with ~720 grams of material. This produced 8” x 10” x 1/2” thick tiles conforming to the size and shape of the grill tray. The bottom surface of these tiles is smooth and flat with an uneven top surface that is milled level before the final shapes are cut and attached to a stack of horizontally laminated sheets of plywood (figure 8).

BLUE WRAP
The surgical blue wrap utilized for this project is made with polypropylene (PE). “The U.S. Environmental Protection Agency estimates it accounts for 19 percent of all operating room waste” and that “255M lbs. of blue wrap (is) thrown away annually.”

Figure 3. Recycle Center visit. Courtesy of author.
Figure 4. Discarded polypropylene wrap. Courtesy of author.
Figure 5. Big Blue Bench, three distributed objects, and combined island. Courtesy of author.
Figure 6. Recycled tile production process. Courtesy of author.

Figure 7. Big Blue Bench. Courtesy of author.
The blue wrap is “which is lightweight and durable – and also incredibly non-biodegradable.” “PE is recyclable due to (its) thermoplastic nature. PE can be identified with the number 5 stamped on objects made from it, and... can be recycled up to four times... and despite this recyclability, the vast majority of plastics are not recycled, and simply end up in landfills or in the ocean.” Unlike PVC and PA, PE is “the safest plastic to melt... because it is low in cyclic compounds and they are essentially refined wax.” With this in mind, students working on the project still wore respirator masks and worked in well ventilated areas when producing the tiles.

FABRICATION WASTE
The student team worked hard to reduce the amount of waste generated by this project. Scrap from the milled plastic blanks could be melted into new tiles and the untreated plywood scrap from the cut sheets of the base was picked up by the university recycling center to be shredded into mulch.

SUCCESSES IN EDUCATION
The project was successful in having students confronting the issue of waste. By engaging this project, they also learned about the underutilized departments that manage waste and recycling on campus and how to better engage them in their future projects and now have a better understanding of the staggering amount of waste produced by the university and the space and infrastructure needed to manage it.

FUTURE
The project is not without its faults and there is room for improvement. In discussion with the students, it was concluded that ideally the fabrication would have been entirely built from the plastic, but given the time frame and demands of the course, only so much material could be produced with limited time for experimentation. Other materials utilized, such as the wood, could also be extracted from salvage. It also became clear to them that the embedded energy needed to produce one tile seems counterproductive at this scale, but if the process were to be scaled to larger production, it may be potentially more cost, time, and energy efficient.

ENDNOTES