For both the practitioner and student, the physical model is a manifestation of ideas. Modeling presents the opportunity to test, explore, speculate, compose, capture, iterate, and further the design process. Physical model making is central to architectural education and its design studios, a course type required each semester for undergraduate and graduate architecture, landscape architecture, and interior design majors. These studios and closely related fabrication courses are project-based and the primary means for students to develop their design skills. Sustainability, including social, environmental, and economic factors, is a core focus of the School’s curriculum and a key operational principle of the larger University community. However, waste generation from repeated design iterations, inefficient fabrication practices, and unclear or absent disposal guidelines stands in opposition to the sustainability envisioned by the School and UT Austin.¹ Questions of waste generation are often considered low-priority, and the problems created by the large volume and material diversity of UTSOA waste have not been holistically tackled yet.

In response to these concerns and the University of Texas at Austin’s 2020 Campus Zero Waste Goals, a research project at UTSOA was initiated in Fall 2014 to: study the current waste stream and corresponding studio culture; identify new strategies to reduce, reuse, and divert waste; and increase awareness on the issue while educating stakeholders.² Through waste audits, interviews and collaboration with stakeholders, a student survey, an art installation, and a waste bin assessment the project team was able to determine current challenges and opportunities to accommodate and reduce the atypical waste (e.g. chipboard, concrete, plaster, wood, mixed material models) created during the model-making process at the School of Architecture. In the first phase of research, the potential effectiveness of a material sharing program became apparent and strategies to implement this program were developed; the
second phase includes the execution of a new Material Exchange to be completed during the summer of 2015. Further, the project raises awareness for zero waste strategies among students and will institute a new set of procedural guidelines for the School’s studio clean-out process conducted at the end of each semester.

The following report outlines several activities undertaken by the project team during the 2014-2015 school year, including a waste audit of UTSOA studios and fabrication facilities, an installation constructed from models surrendered by students during the end of semester studio clean out process, a waste bin assessment, and the construction of a new Material Exchange to permanently house a give-and-take program at UTSOA. The project team concludes that other departments and schools within UT Austin and in peer institutions that also have atypical waste streams will benefit from a similarly systemic look into zero waste strategies by utilizing waste management approaches like those outlined in this research.

Waste Audit

The project focused its waste audit on four distinct areas of waste generation in the School of Architecture. Waste composition was measured in a sample of six studio classrooms (of UTSOA’s 18), the woodshop / fabrication lab, the laser cutter room, and a basement work station in Sutton Hall. Each area chosen represents unique challenges and contributes atypical waste to the overall composition of UTSOA’s waste.

The six studio classrooms together generated between 85 and 90 lbs. of waste each day of the audit; 34.70% of this waste was recyclable, while 51.37% was landfill waste and only 13.93% was potentially compostable. Over 80% of waste generated in studios was post-consumer material, such as disposable food and beverage containers, and could be easily captured in UT Austin’s standard waste disposal streams with contracted providers for landfill disposal and recycling. The project team determined that the lack of physical model-making materials in the composition of studio waste was most likely attributable to a shift in recent years to digital fabrication techniques housed in other areas of the School and therefore that waste minimization and diversion strategies should focus on those other fabrication spaces.

The fabrication space with the highest percentage of potentially recyclable materials was determined to be the laser cutter room, in which 96.37% of waste audited was recyclable. The laser cutter room contains two large beds in which computer aided lasers burn through sheet materials such as cardboard or chipboard (a common model-making material similar to thin, flexible paper pressboard). Recyclable sheet goods explain the high percentage of recyclables found in this space. Further, anywhere from 20 to 33 lbs. of waste were generated each day in this space. While some of the waste generated in the laser cutter room is genuinely scrap material too small to be...
useful for model-making, too frequently students do not optimize their files for the laser cutter beds, which results in extra waste generation. Figure 1 shows an example of both an inefficient layout and an efficient laser cutter layout side by side; the left example results in over half of the sheet material being wasted. Although laying out model pieces to be cut efficiently can be time consuming, UTSOA IT Support Staff advised the project team that software is available that uses packaging algorithms to achieve good layouts. This type of software could be incorporated into mandatory training students complete before using the machine and into the wider course curriculum of UTSOA.

The third area of waste generation examined was the Sutton Hall basement fabrication space. Previously serving UTSOA as a computer lab, it now functions as a small group meeting area and contains the large format plotters. Waste in the Sutton Hall basement was primarily office and poster paper, as well as a small amount of post consumer materials, and virtually no model-making materials. Recycling composed 56.92% of the waste in this area, but only 13 lbs. of waste were collected over two days of the audit. Sorting behavior in this area was highly accurate; due to effective sorting and low total waste generation the project team chose not to focus more attention on waste minimization strategies for this area.

The final space audited, the woodshop, presents its own challenges to zero waste initiatives as the main source of lumber scraps in UTSOA’s waste stream. The fabrication area contributes an average of 40 lbs. of waste each day, of which 41.97% is potentially compostable solid wood, lumber, and sawdust. Engineered wood was not considered by the project team as inherently compostable due to unknown glues present to adhere layers together; students purchase their own supplies from many vendors and retailers in the Austin area and it is impossible to ascertain the adhesive component’s chemical composition by simply observing the waste. For this reason, engineered wood was considered as part of the landfill-bound waste, which in total accounted for 49.64% of the woodshop’s waste stream. As no university-wide compost contractor is currently available, the potential diversion of wood scraps is not feasible at this time. Further, sawdust from CNC routing machines—machines that also process dense foam for model-making—may be contaminated with non-compostable particles that would prevent it from being composted. Most notably, the woodshop already utilizes a give-and-take system of small scraps for students throughout each semester. The scrap bin prevents some waste generation and also partially reduces the economic burden on students during the model-making process; therefore, the woodshop’s system became the basis for a larger Material Exchange for non-lumber model-making materials.

Installation

The project team chose to visually communicate the vast amount of waste produced at the end of each semester by constructing an exhibit entirely from waste surrendered by students cleaning out their personal space in studio classrooms. While the team initially planned to utilize all models and model-making materials surrendered as waste, the volume gathered would have completely filled the exhibition space in Goldsmith Hall’s South Lobby. Thus, any material deemed usable for future model-making was set aside to be given back to students who attended the exhibit’s opening night material giveaway.

With discarded models and materials in-hand, the project team set out to design and construct a one-week temporary installation to raise awareness about waste and visually communicate data collected during the project activities. The installation relied on
the psychological effects of cognitive dissonance, proven to be the most impactful method of affecting behavior around waste and recycling. The project team's primary objectives were to celebrate model-making and assembly, highlight materials and their use, create a temporary, transportable installation, and construct the installation in one week.

Ten material towers were constructed through on-the-fly assembly to meet these primary objectives and communicate the volume of the waste streams produced. Each tower was composed of an individual material and shaped by the characteristics of the waste itself. As a collection, the towers capture the proportions of these materials in the waste stream, with cardboard and chipboard being the majority. Holding to prescribed dimensions (32” x 32” x 7’) for easy transport, the project team built collaboratively and quickly over a one-week period to communicate the diversity of waste in its size, scale, and material. With the exception of glues and hardware, no materials were purchased for the installation. Figure 2 below depicts the material towers.

In Spring 2015, the project team conducted a brief inventory of the waste receptacles available in every studio classroom in the School. The goal of this activity was to determine whether some classrooms were inadequately equipped with waste receptacles and to suggest appropriate ratios of bins for both landfill waste and recyclables. During Fall 2014’s waste audit and end of semester clean out process, the project team observed that many studios either lacked recycling disposal bins or had an overabundance of landfill disposal bins. By making recommendations to UTSOA faculty, administration, and custodial staff for bin allotment within studios, the project team hoped to encourage recycling through waste diversion from landfills, as well as to increase efficiency in waste collection for custodial staff.

Studio classrooms are typically equipped with 32-gallon plastic gray cylindrical receptacles for landfill waste. The School has 74 of these distributed throughout studios. Also in use are 23-gallon plastic gray square and rectangular landfill bins and several small 3-gallon office-style landfill bins, totaling 18

Figure 2: Material towers created from discarded student models and model-making materials
smaller receptacles for landfill waste. While the waste is emptied every night by custodial staff, the project team observed that bins were often less than 1/3 full of waste when emptied. Therefore, with 18 studio spaces in use as classrooms, it is suggested that each studio have two to five 32-gallon large landfill bins. Some studios house three sections of a course and those spaces would need more waste receptacles than a studio with fewer students. Any remaining unused landfill bins could be visually converted into recycling bins through paint or signage, and the smaller bins could be distributed throughout studios to close any gaps found after implementing this change.

UTSOA only had 24 recycling bins in total of all sizes. The largest option available in studios for recycling is a 23-gallon square or rectangular blue receptacle; at the time of survey there were only 18, or one for each studio classroom, although many studios had zero. Six 3-gallon office-style bins were found in studios—most likely brought in by students for personal use. Moreover, the bins available for recycling are generally not suitable in shape for the recyclable waste produced through the model-making process. The majority of waste volume is due to sheet goods such as those in Figure 1 above, which are incompatible in shape and size with 23-gallon square bins and quickly fill 23-gallon rectangle bins. It is likely that students, perceiving a bin to be full, will instead put recyclable materials into a landfill bin and fail to divert it. It is suggested that the school begin slowly purchasing larger, wheeled 50-gallon square blue bins to encourage more recycling in studios by students; however, the top priority for bin expenditures would be to place more of these 50-gallon recycling bins in fabrication spaces.

Material Exchange

The culmination of research, stakeholder interviews, an extensive student survey, and an enthusiastic response to reusable materials given away at the installation opening led the project team to propose and implement a new Material Exchange program at UTSOA. Based on a give-and-take mentality, the exchange will be permanently housed in the Sutton Hall Basement and serve students throughout the school year as a source of scrap and gently used model-making materials. It also accomplishes waste minimization, a major goal of this research initiative, as well as increasing awareness around zero waste issues in the student body.

The main component of the Material Exchange, units of cabinetry in Sutton Hall basement, will hold the central storage for model-making materials. Designed by UTSOA M. Arch students Justin Fleury and Elizabeth Farrell, the cabinetry units fit the size, shape and relative quantities of materials gathered every semester during the end of semester studio clean out process. The cabinetry also houses plastic rolling carts previously purchased by the project team that can be used for collection or transport of materials whenever necessary. Figure 3 below depicts the nearly completed Material Exchange “home base” ready to be implemented starting in the 2015-2016 school year.

In addition to the main cabinetry structure in Sutton Hall basement, the Material Exchange program also incorporates two moveable storage stations designed to contain smaller materials and more frequently used items. These movable units will be deployed in both Goldsmith and Sutton Halls, closer to studios so that students may more easily take or discard model-making materials mid-design process.

UTSOA IT Director Eric Hepburn and Desktop Support Specialist Chelsea Cowley have agreed to take ownership of the Material Exchange as part of Information Technology’s ongoing sustainability initiatives through the help of its student staff members. The UTSOA Materials Lab has also agreed to co-sponsor the ongoing use of the Material Exchange in subsequent years. Graduate teaching assistants from Information Technology will oversee the cleanliness and orderliness of materials placed in both the main cabinetry unit and the moveable cart units, restocking the Material Exchange with more gently used materials as they are made available and continuing to educate students informally on which model-making materials are able to be recycled.

Conclusions

Model-making waste is concentrated within fabrication spaces at UTSOA, with post consumer materials making up the majority of remaining waste generated. Through improved training in the use of the laser cutter beds, evenly distributed waste bins in studios, and the addition of a Material Exchange program in Fall 2015, UTSOA and the project team have made and will continue to make great strides in the team’s goals of waste minimization and diversion related to the model-making process. Already the School is benefiting from increased communication and collaboration concerning waste management issues, and awareness of new procedures and norms expected regarding physical model-making has been raised among the students in UTSOA. While it is too early to quantify the gains made thus far, a future retrospective study could be conducted to determine the effectiveness of this comprehensive
waste management project. Further, while other departments, schools, and colleges within the University of Texas at Austin and other peer institutions have different waste streams and organizational models, this study presents a multi-faceted approach to institutional waste research that can be employed with other waste streams in different contexts. The basic formula is simple: conducting a waste audit and receptacle assessment, engaging and educating constituents, and implementing practical solutions that have wide-reaching impact potential. Holistically exploring waste generation aligns values of sustainability with institutional practices for communal gains.

References:

1. For the purposes of this project, waste is defined as any discarded or surrendered material, including items that may be compostable or recyclable. Waste that is neither compostable nor recyclable is referred to as landfill waste to distinguish it from the broader term encompassing these three disposal methods.

2. The Zero Waste Goals as described here may be found in the Natural Resource Conservation Plan authored by the President’s Sustainability Steering Committee as amended April 9, 2012. All research for this paper was completed by the author and her lead faculty advisor, Sarah Gamble. The full report, as well as all pertinent data on this project, can be requested from the author.

Figure 3 below depicts the completed Material Exchange “home base” implemented starting in the 2015-2016 school year.