REDESIGNING CAMPUS DINING TO IMPROVE SUSTAINABILITY AT THE UNIVERSITY OF OREGON

by

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Universities across the United States, including the University of Oregon, have shifted to promote sustainable thinking and living. However, these large institutions also produce an incredible amount of food and packaging waste every day—two of the largest categories contributing to municipal solid waste in the United States. As universities shape future generations of leaders, it is important that they implement systems and products which uphold sustainable living practices and reduce their environmental impact.

My research and design aims to provide strategies, system and product redesigns that will reduce the significant amount of food and packaging waste produced by thousands of consumers at UO Dining halls every day. I provide a multi-pronged approach which includes reusable and biodegradable products, educational campaigns, peer support, food waste diversion strategies and additional key steps, informed by research, observations and case studies. In addition to a dining system redesign plan, I propose three food container design solutions: a reusable lid for existing dining hall receptacles, an organic and biodegradable single use container and a complete reusable container design.

Acknowledgements

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Chapter 1: Introduction

The inspiration for analyzing and redesigning the University of Oregon campus dining system originated from a sustainable design studio I took in Spring 2023, as part of my undergraduate product design course requirements. Design Professor Jessica Swanson assigned our class of product design students to participate in a two-week "Zero Waste" challenge, during which we collected all the trash (from all our activities, including anything we purchased or consumed) we produced over the course of two weeks and were required to carry it around with us each day. The idea behind this challenge was to make us aware of the exact amount of trash we produce each day by inconveniently carrying it around, and to motivate us to minimize it. During the challenge, I felt frustrated at the amount of packaging waste I produced each day. I lived on campus as a residential assistant, and therefore ate all my meals in the dining halls on campus on my point-based meal plan along with about 5,338 freshmen students (Murez 2023).

Fig. 1. Dining waste collected after 2 week Zero Waste Challenge.
Source: Created by author

The image above shows only a portion of the trash I collected over the two-week challenge. Yet, I still collected a significant amount—almost all of which came from eating from the dining halls. This exercise made me contemplate how much trash I must have been producing within a year, and then consider how much must be produced by the thousands of students who eat on campus every day.

In a recent article from the university's student newspaper, The Daily Emerald, journalist Tristin Hoffman illustrated the significant amount of materials and food used and discarded in campus dining, stating that UO Dining "prepares more than 12,000 meals per day for roughly 4,000 students" according to representatives from UO Dining Services (Hoffman 2023). Based on data provided by UO Dining, this results in at least 71,000 plastic or "compostable" single use containers and cups that are discarded in landfills each year.

According to a US News Report on the class size at the University of Oregon, in fall 2022, about 29% of the total undergraduate class of 19,565 students lived in on-campus housing ("University of Oregon Student Life" n.d.). Most students living on campus also eat from the dining halls, in addition to those who eat on campus but who do not live in the residence halls, creating a significant need for distributing well over 12,000 meals a day.

1.1 Food and Packaging Waste in the US and in Universities

This data led me to wonder about the impacts of food and food packaging waste on a broader scale regarding dining-related waste in the United States. According to a 2018 report from the US Environmental Protection Agency that broke down US Municipal Solid Waste (MSW, or waste that goes to landfill), 21.6% of total MSW came from food waste. This was the second largest category of MSW after paper and paperboard waste at 23.1%, while plastics made up 12.2% as the third largest category ("Guide to the Facts and Figures Report about Materials, Waste and Recycling | US EPA" 2017). Municipal Solid Waste is known more commonly as trash or garbage, and includes product packaging, food scraps and other everyday waste created in homes, hospitals and businesses (EPA,ORD 2022).

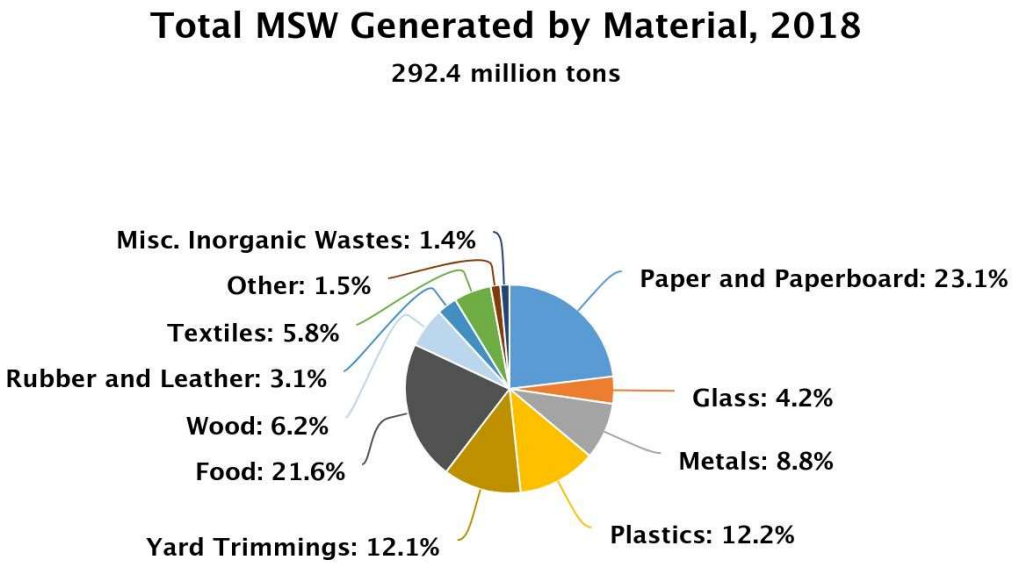


Fig. 2. Total MSW Generated by Material, 2018.
Source: Guide to the Facts and Figures Report about Materials, Waste and Recycling | US EPA 2017

The kinds of waste created in dining halls all contribute to the top three US MSW categories: food, paper and paper board, and plastics. Food waste alone is a significant environmental issue that global organizations such as the United Nations, the US Department of Agriculture (USDA) and the US Environmental Protection Agency (EPA) are working to reduce, as food waste generates negative environmental impacts such as increasing greenhouse gas emissions and pollution to air, water and soil (Ahmed et al. 2018). In 2015, the Environmental Protection Agency (EPA) and US Department of Agriculture (USDA) created a national goal to cut food loss and waste in half by 2030 by improving sustainable food management practices to reduce pollution, food insecurity, economic losses and conserve resources (EPA,ORD 2022). According to the EPA, about one-third of food produced in the US goes uneaten. Food waste creates environmental impacts before reaching consumers during the production, processing and

delivery of food. Once food is discarded in landfills to decompose (whether by distributors or consumers), it produces methane and carbon dioxide as byproducts of the decomposition process. Methane, a powerful greenhouse gas, captures heat and contributes to global warming (EPA,ORD 2022). In the US, MSW landfills are the third largest contributor of methane emissions. Food waste in MSW landfills contributes 58% of total methane emissions created in landfills, more than all other categories of landfilled materials (US EPA 2023).

Large institutions such as universities, which must prepare and distribute significant amounts of food for large-scale dining, play an important role in the creation and regulation of food waste. In fact, researchers estimate that about 3.6 million tons of food waste is created from universities each year in the US (Alattar and Morse 2021). Furthermore, food waste is mostly discarded as MSW or waste that goes to landfill, instead of composted or diverted for other uses (Leal Filho et al. 2021). In fact, researchers have studied food waste created at universities and its direct translation to greenhouse gas emissions. In "Food Waste in Campus Dining Operations," researchers Christine Costello et. al., measured the environmental impacts of different types of food waste (both pre- and post-consumer waste) from various university settings and illustrated how these equated to greenhouse gas emissions. Pre-consumer food waste refers to the food from kitchens or distributors, before it reaches the consumer. Post-consumer food waste refers to the waste that consumers discard after they have purchased and/or eaten the food. The researchers found that meat and protein (both pre- and post-consumer) were a significant greenhouse gas contributor, especially beef, which created 60.7 g CO2e per customer in post-consumer waste. Grains were the second-largest contributor, creating 3.4 g CO2e per customer (pre-consumer) and 5.7 g CO2e per customer (post-consumer). Fruit and vegetables contributed 1.4 g CO2e (pre-consumer) and 3.3 g CO2e (post-consumer) per customer, while

dairy products were estimated to generate 2.7 g CO2e (pre-consumer) and 3.2 g CO2e (post-consumer) per customer (Costello, Birisci, and McGarvey 2015). To put these food waste greenhouse gas metrics into greater perspective, the EPA estimated that food waste in the US creates emissions equivalent to more than 42 coal-fired power plants (US EPA 2021).

Aside from food waste, food packaging waste (much of which consists of plastics) also has significant environmental impacts. According to the Center for International Environmental Law (CIEL), it is estimated that the global production and incineration of plastic in 2018 will result in 850 million metric tons of greenhouse gas emissions added to the atmosphere, which is equivalent to emissions from 189 coal power plants (Hamilton and Feit 2019). The packaging industry is responsible for the consumption of the largest amount of plastics produced globally, and is the main contributor of plastic waste to the environment (de Kock et al. 2020). While there are few studies that cite the exact volume of plastic waste generated by universities, it is estimated that the average student creates up to 75 pounds of plastic waste per year (Lancen 2022). The importance of addressing packaging waste in universities is shown by the numerous initiatives to reduce waste that have taken place across college campuses, such as the "Campus Race to Zero Waste" competition, during which US colleges and universities collectively worked to divert 380 million of pounds of plastic from landfills (Jones 2020).

Despite being a better alternative to regular plastic options, “compostable” and recyclable plant-based plastics are not a simple solution and come with their own environmental impacts. “Bioplastic” products could mean that they are biodegradable or are made of bio sources, but they do not always ensure composability (Ncube et al. 2020). For example, Polylactic Acid (PLA) based plastic, a commonly used sustainable biobased plastic packaging material used in most container products at the University of Oregon, does not always break down as easily as

expected. Studies show that PLA has a slow rate of degradation that can last up to 3–5 years, depending on various content properties including crystallinity, molecular weight, water absorption, and stereoisomeric content. Additionally, differing environmental conditions create differing degradation rates for PLA (Emadian, Onay, and Demirel 2017). This presents difficulties for composting and recycling facilities, causing them to reject bio and plant-based plastics and other sustainable plastic alternatives because they take too long to break down completely and leave behind harmful microplastics in the environment (Goto et al. 2020).

Universities are large institutions that essentially operate as mini-cities and contribute significantly to overall waste in the US. They also have the potential to create significant ripple effects in terms of promoting sustainability thinking and behavior through influencing generations of students and leaders on university campuses. Given the importance of reducing food and packaging waste globally, in addition to my personal experience creating food waste at the University of Oregon, I wondered if our campus dining system could be better designed to minimize food and packaging waste and promote sustainable behavior.

1.2. Waste Impact for the University of Oregon

More generally, reducing waste in campus dining is an interesting topic for the university community because most University of Oregon students and community members seem to share an interest in improving sustainability efforts (Concina and Frate 2023). According to the University of Oregon Office of Sustainability, the term sustainability means "meeting our current resources needs without compromising the ability of future generations to meet their own needs" ("About the Office of Sustainability | Campus Planning & Facilities Management" 2024). According to the University of Oregon Materials Tracking Report for the 2022 Fiscal Year, the University of Oregon produced 2,773.67 tons of material in total; 1,051.00 tons were sent to

landfill, 1,587.54 tons were recycled, and 135.13 tons were reused. About 214.56 tons of the total material came from food compost and metal and plastic dining materials. While UO's diversion rates (rate of diverting materials from landfill) have steadily increased to 62% in FY22, there is still significant progress to be made in reducing the amount of dining-related waste created each year ("Oregon Materials Tracking Report FY22" 2022).

1.3 Objectives of the Study

Reducing Waste and Promoting Sustainable Lifestyles through Design

If sustainability suggestions from this thesis prove to be useful at the University of Oregon, they could later be implemented at other universities across the country and create a more significant impact. At the community-wide level, diverting food waste from landfill to instead donate could largely benefit food-insecure students and community members. The topic of sustainability in campus dining is incredibly relevant to university students and anyone who eats at university dining halls, as they are the direct producers of food and food packaging waste. Additionally, aside from producing a tangible product redesign, this thesis will explore the reasoning behind our current dining system and the results of this analysis can provide insight on how to improve it systematically. For my professional future, this topic is particularly compelling as I am interested in using design thinking to improve sustainability efforts. This research would allow me to explore these topics deeper while working to improve systems and products that my peers and I interact with daily. I hope to contribute towards designing for sustainability, as this seems to be one of the most relevant and significant design constraints for designers to focus on given our climate crisis.

Product design is an uncommon major in most universities and an even more uncommon academic concentration for a thesis project. However, product design offers a unique, human-

centered lens and approach through which to use design to solve everyday problems. It expands beyond simply designing physical products, but also can incorporate the research of human behavior and psychology, identifying user needs, designing user experiences, considering the life cycle of a product and its impact on the environment from production to the end of its use, analyzing how users interact with interfaces or products, how they interact with service systems and where designers can minimize pain points and waste throughout the journey of a product or service. When considering all these aspects of product design and where we encounter them in our daily life, it becomes apparent that the design of physical and digital products and systems is inextricable from our everyday lives. The products and systems we use every day were all designed by someone, and thus can always be evaluated and improved.

In this thesis project, I aim to explore ways to reduce food waste and food packaging waste produced within campus dining halls at the University of Oregon through product and system redesign. The goal is to create a consultation for University of Oregon Dining that contains suggestions for food container and system redesigns based on the typical design process: user research, ideation, prototyping, mockups and presentation.

These redesigns will be based on: 1) observations and analysis of the current products and systems used within UO dining halls; 2) research on dining hall products and systems that have proven to produce less food and food packaging waste based on existing studies from other universities across the United States and other countries; 3) observations of perceptions and experiences interacting with dining systems and on sustainability initiatives at University of Oregon; and 4) interviews with dining hall staff and campus dining directors on the current dining system.

The sub-questions I aim to answer in the process of creating a redesign proposal are as follows:

1. How much waste is generated from university dining halls and from dining at the University of Oregon?
2. What has UO Dining done in the past to improve sustainable dining?
3. What are the current dinnerware items used at the UO, where are they sourced and what are their benefits and drawbacks?
4. What is the current disposal system used at the UO?
5. What methods and initiatives have other universities used in the past to reduce food and packaging waste from dining on campus?
6. How can we redesign or replace current disposable packaging used in UO Dining halls to reduce packaging waste and eliminate single use containers?
7. How can we apply sustainability practices, based on research, interviews and observation, to reduce food waste in UO Dining, across all dining locations?
8. How can efforts to reduce food waste contribute to alleviating food insecurity among students at the University of Oregon and in the local community?
9. How can university dining halls and larger residential organizations eventually adopt a similar redesign strategy in their dining halls to reduce their food and packaging waste?

Chapter 2: Understanding The Dining System at UO

To improve the UO Dining system, it is first necessary to understand its current state. As of June 2024, the University of Oregon has 13 different dining venues or markets, each offering unique food options: Watershed, Bullseye Taco, Duck's House, Steam, Tamarind, Hearth & Soul, Drake's Deli, Agate Street Market, PNW Café, Freshmarket Café, DUX Bistro and Carson Dining. These venues are located in five different buildings on campus: Unthank Hall, Global Scholars Hall, DUX Bistro, Living Learning Center and Carson Hall. Each venue serves different foods options, which are distributed in a mix of reusable and single use containers.

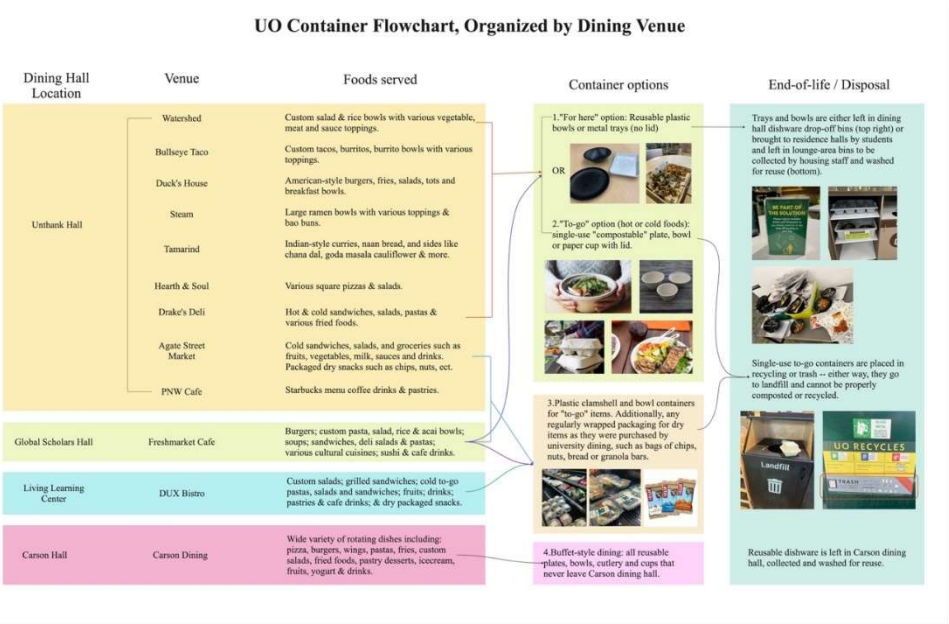


Fig. 3. UO Container Flowchart, Organized by Dining Venue.
Source: Created by the author.

Figure 3 illustrates the journey of UO Dining containers: where they are distributed, where they are taken and where they are discarded at the end of their use, in addition to showing the kinds of foods they typically hold. Market-style venues (Freshmarket Café, Dux Bistro and the Agate Street Market) typically sell packaged foods and to-go items in clear plastic clamshell

containers. Freshmarket Café, Dux Bistro and most venues within Unthank Hall also serve hot and cold foods, either in reusable containers (bowls, plates or trays) to be eaten on site or in single use disposable containers if the consumer wishes to take their food to-go. Any food that can be ordered in person at these venues can also be ordered on the Grubhub mobile food ordering app and picked up at the dining hall in a single use container in a paper bag.

2.1. UO Dining and Sustainability Resources and Programs

To further understand the reasoning behind current UO food packaging, containers and disposal systems, I spoke with staff and leaders from UO Housing and Dining Services, the Zero Waste Program and the Office of Sustainability. The University of Oregon Zero Waste Program is a student-staffed program that implements waste-management techniques on campus, aimed at reducing waste and greenhouse gas emissions ("About the Office of Sustainability | Campus Planning & Facilities Management" 2024). Their team manages all solid waste across campus, in addition to waste from university residence halls, residence hall kitchens, off-campus housing and graduate student and family housing. They are the primary program that manages food and food packaging waste from the dining halls.

Members from the Office of Sustainability were also valuable resources in my research on UO-specific waste management, as the Office of Sustainability informs and guides UO policies regarding sustainability practices through monitoring sustainability progress, setting goals, supporting students and faculty and making policy recommendations to continue improving sustainability projects, programs and outreach efforts.

Lastly, I gained helpful insight through speaking with representatives of UO Housing and Dining Services, such as Brian Burroughs (General Manager of the PNW Public Market). These

conversations helped explain the reasoning behind the current dinnerware and systems being used at the University of Oregon dining, where dinnerware items were sourced, and the general distribution and collection of dinnerware from the Housing and Dining Services. They also provided insight on the future directions that UO Dining hopes to pursue regarding improving sustainability efforts.

According to UO Housing and Dining Services, the current mix of reusable and single use dinnerware items is a result of the aftermath of the COVID-19 pandemic. In fact, prior to the pandemic, UO Dining had made efforts to incorporate more reusable dinnerware into the dining halls to replace single use compostable products. This change from using single use compostable plastics to reusable dinnerware items was enacted in response to a statement released by Oregon composting companies in early March 2019. In this statement, Oregon composting facilities collectively decided to stop accepting single use compostable items (Rexius Compost and Organics et al. n.d.). This collective included Rexius Compost & Organics, the primary local composting facility that had been accepting single use compost items from the University of Oregon. In the statement, titled 'A Message from composters serving Oregon: Why We Don't Want Compostable Packaging and Service ware,' Oregon composting facilities detailed nine reasons explaining their decision to stop accepting compostable packaging:

1. Compostable service ware does not always compost as fully or as quickly as needed.
2. Accepting compostable products invites contamination, as many consumers mix compostable with non-compostable-look-alike items (this was the case within UO Dining).
3. Contaminated compost diminishes resale quality, given that the compost is often contaminated with non-compostable packaging and service ware.

4. Contaminated compost also hinders composting facilities from selling compost to organic farmers, as it will not meet national standards that control the quality of soil used to grow crops that are certified 'USDA Organic.'
5. Contaminated compost threatens human and environmental health, as it contains packaging particles with chemicals that end up in finished compost, which transfers to ground and surface waters and into plants.
6. Compostable packaging adds water, energy and other resources that increase costs to the composting process with often little value added.
7. Compostable service ware has often been found to have a larger environmental footprint compared with non-compostable service ware (when considering an entire life-cycle analysis).
8. Sometimes it is less wasteful to recycle packaging into new products or new packaging rather than attempting to compost packaging.
9. While compostable items are more expensive, they may not benefit the environment in proportion to their cost, and these funds could be better spent elsewhere.

For the previous reasons, Rexius Compost & Organics, along with many other Oregon composting facilities, refuse to continue accepting post-consumer compost form the UO Dining halls. This meant that, after March 2019, all the single use compostable products purchased and used by UO Dining halls end up in landfills.

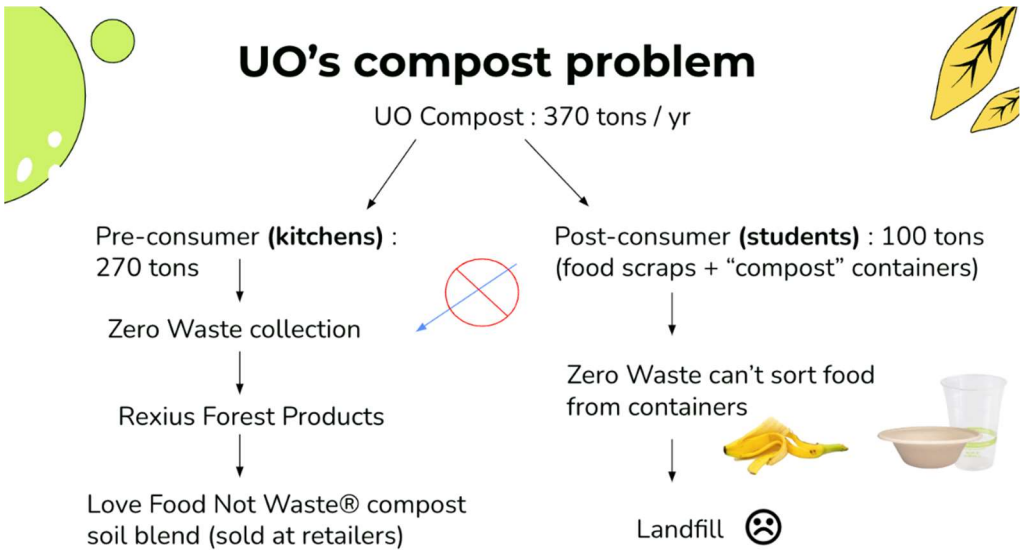


Fig. 4. University of Oregon's Compost Problem: Pre vs. Post-consumer Food Waste

Source: Created by author

2.2 Incorporating the Use of Reusable Dinnerware

Shortly after this statement, UO Dining launched a pilot study in Freshmarket Café partway through the academic year, according to UO Dining management. During this pilot project, UO Dining incorporated reusable dinnerware items such as metal cutlery and reusable bowls and plates to replace single use service ware in the Freshmarket Café. However, this pilot project was unsuccessful, as many students disposed of metal cutlery and reusable dinnerware into trash bins rather than returning them to the dining hall for washing and reuse. The following academic year in fall 2019, UO Housing partnered with the Sustainability Office to attempt the project again. This time, the Sustainability Office hired upperclassmen to serve as student waste ambassadors and train freshmen students at the beginning of the year on how to properly return their reusable dinnerware to the dining halls. Student ambassadors were stationed in each dining facility and explained to freshmen where to place their reusable dinnerware after use.

This method proved to be more effective, as it resulted in only a fraction of the dinnerware being lost in comparison to the previous year's pilot project. By introducing reusable

dinnerware and instructing freshmen on where to return it on their first day of school, freshmen students did not need to unlearn previous ways of dining and relearn new dining habits. Rather, they were guided by older classmates on the campus expectations to return their dinnerware items back to the dining halls from their very first day. This second pilot attempt showed that implementing peer-to-peer encouragement on correct dining protocol at the start of the academic year proved to be an effective method for reducing unreturned dinnerware. Furthermore, UO Dining representatives stated that the cost of the lost reusable dinnerware at the end of the year was still less expensive than the cost of purchasing single use disposable items every year. Essentially, UO Dining found that implementing reusable dinnerware proved to be less expensive (after the first year of implementation) despite product losses and created less environmental impact overall compared with using single use "compostable" dinnerware.

Despite progress towards adopting reusable service ware, UO Dining was forced to shift back after March 2020 and exclusively implemented single use disposable to-go containers to minimize the spread of COVID-19 on campus, as dining halls closed. Since allowing students to gather without masks to eat in dining halls increased the risk of spreading the virus, UO Dining strategized ways to have students take their food to-go to eat in their dorms and social pods while minimizing contact. This entailed distributing only single use to-go containers and having students order and pick up their food through Grubhub, a mobile food delivery app. The reusable service ware that had been previously introduced had to be removed during the pandemic, as it presented too many health and safety risks to have students return their used dinnerware to the dining hall for wash and reuse. Yet, even after the rates of COVID-19 cases decreased and the dining halls reopened at UO, students had grown accustomed to the convenience of ordering

food through the Grubhub app, and it remained the primary method of ordering food for several years.

However, according to UO Dining, at the beginning of the 2023 academic year, the Grubhub food ordering system crashed for all first-year students and was not repaired until halfway through the year. This technical failure in the Grubhub system forced first-year students (who make up most of those living in the residence halls and eating on campus) to order their food and pick it up in person. This caused numbers of Grubhub orders to significantly diminish. After the Grubhub ordering system was repaired in January later that year, numbers of Grubhub orders increased again, but they never returned to similar rates of previous years. This time, freshmen had grown accustomed to ordering in person due to the initial inaccessibility of Grubhub. The resistance to changing dining habits among students that was observed from 2018 to 2023 demonstrated an important insight on establishing new systems: the initial experience and first impression of using a particular method or system significantly influenced the future actions of its users. Users introduced to a certain method or system are hesitant to change to a new one, so it is more effective to implement a system change at the start of an academic year to solidify it as a habit among users and increase participation.

After in-person activities resumed and the dining halls reopened, single use compostable to-go containers remained an option in dining halls and were exclusively distributed in all Grubhub orders due to their transportability and convenience. Meanwhile, reusable bowls, plates and trays were slowly reintegrated into UO Dining halls as they reopened, but these reusable service ware items did not offer the same convenience for transporting food as their single use counterparts due to their lack of lids. Today, single use “compostable” containers continue to be offered as a more mobile and convenient alternative to reusable bowls and plates at all dining

venues (except for Carson Hall dining, which offers only buffet-style dining). Like other aspects of daily modern life in the US, the lifestyle changes and innovations that were adopted in response to the COVID-19 pandemic permanently altered ways of living. Lifestyle changes aimed at reducing contact, such as ordering mobile food, taking to-go containers, working remotely and shopping online, remained in practice simply because of their convenience even after the height of the pandemic. However, the continued use of single use compostable to-go containers, as pictured below and seen in my Zero Waste challenge collection, creates unnecessary waste and confusion surrounding correct disposal practices in UO Dining.

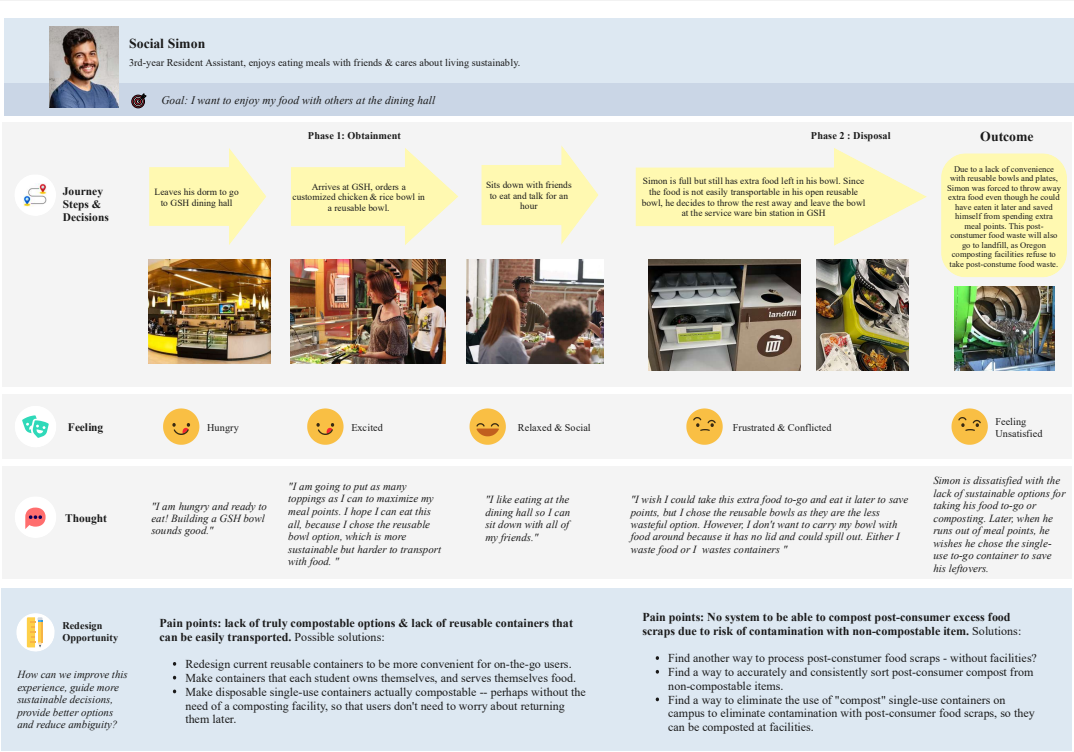


Fig. 5. User Journey 1: Social Simon.

Source: Created by author.

In Figure 5, Social Simon is an example of the user journey that includes choosing the reusable option, as he is most motivated by sustainability. His experience is based off the

experiences of myself and peers who have lived and eaten on campus for several years. In his scenario, he chooses to eat in the dining hall and use the reusable bowl or plate dinnerware. However, the drawbacks of this choice are that it is difficult to take the reusable bowl or plate with food anywhere else outside of the dining hall, as they have no lids to prevent food from spilling while in transport. Therefore, this reusable option leads him to throw away extra food he might otherwise save and eat later or overeat to avoid losing the meal points he spent. Ultimately, this option creates more unnecessary food waste to be taken to the landfill compared with the single use to-go container.

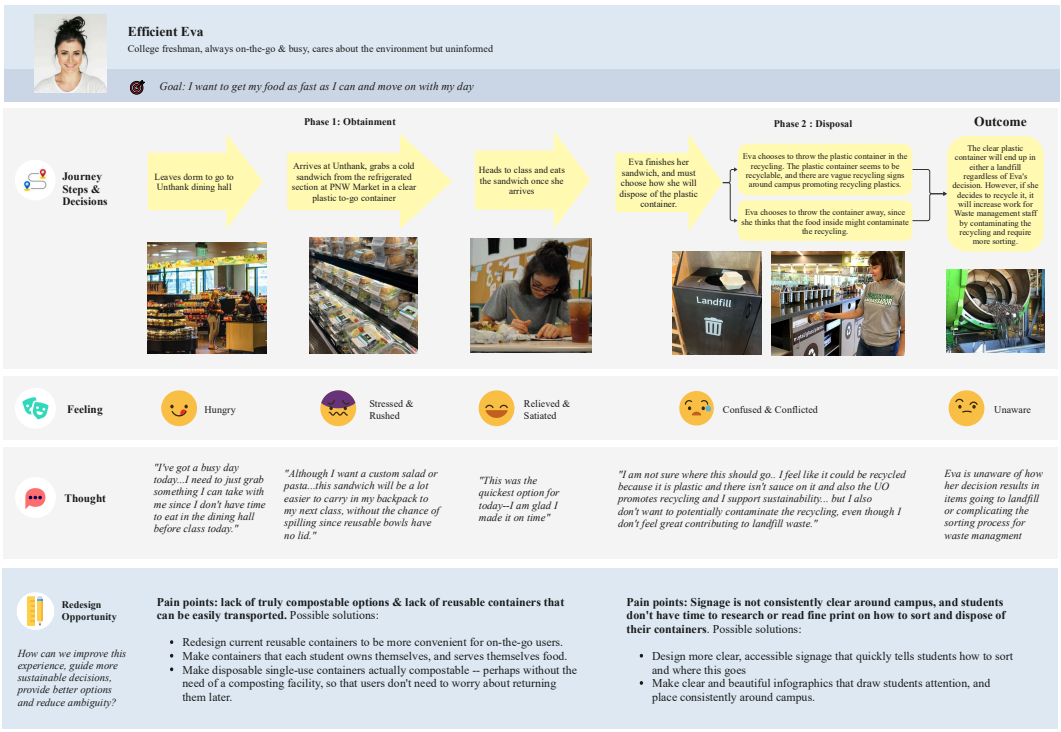


Fig. 6. User Journey 2: Efficient Eva.

Source: Created by author.

In Figure 6, Efficient Eva illustrates the user journey of a user who chooses the single use "to-go" container option. Like many busy college students, she is primarily concerned with convenience, mobility and speed. Since she does not have time to order in person and customize

her own bowl, she quickly grabs a pre-packaged sandwich (or a sandwich she has ordered form the Grubhub mobile delivery app) that she can take to class to eat. Due to the inconsistent signage and misconceptions regarding single use containers that appear to be recyclable or compostable, Eva is confused about where to place her plastic container after use. She could decide to throw it away or recycle it, but either way it will still end up in a landfill because all the single use containers end up in either the Georgia-Pacific JUNO landfill in Toledo, Oregon or the Coffin Butte Landfill in Corvallis, Oregon (Hoffman 2023). This is because, according to their representatives, the Zero Waste program does not have the capacity to sort food scraps from recycling for it to be properly recycled, nor separate the food scraps from single use "compostable" containers.

2.3 Analysis of Current Dinnerware used at UO Dining

Fig. 7. Current Packaging Product Analysis of Single Use “Compostable” Dinnerware items at UO.

Source: Created by the author.

2.3 Analysis of Current Dinnerware used at UO Dining

Fig. 8. Current Packaging Product Analysis of Reusable Dinnerware at UO.

Source: Created by author.

2.5 Analysis of Current Disposal Systems and Practices at UO Dining

As previously mentioned, the Zero Waste program is the main service that handles MSW waste and recycling at the University of Oregon. Since many Oregon composting facilities have stopped accepting single use compostable service ware items, UO sends these items, along with

all post-consumer food waste, to landfill. According to the recent report by Tristin Hoffman from The Daily Emerald, the University of Oregon scored just 3.83 points out of 8 in a 2020 report ranking waste minimization and diversion practices—falling behind other Oregon universities including PSU and OSU (Hoffman 2023).

According to interviews with former student dining workers in Hoffman's report, UO Dining workers are told to throw unpurchased food away and order excess food to fill up display cases. Additionally, all hotline food (served at most dining venues) is thrown away at the end of the day. Only a relatively small portion of discarded food is donated to Food for Lane County, a local food bank in Eugene, Oregon. While UO Dining staff may collect food compost from the kitchens, all post-consumer food compost is directed to landfill, along with single use compost containers, since Rexius and other composting facilities refuse to accept it. Once discarded, 45% of UO's landfill waste is sent to Georgia-Pacific JUNO facility in Toledo, Oregon, which extracts fiber, metals and liquids. The rest of the landfilled waste, containing dining hall food waste, is sent to Coffin Butte Landfill in Corvallis, Oregon (Hoffman 2023).

My conversations with UO Dining regarding their limitations with composting single use containers, their past efforts to implement reusable dinnerware and the impact of the COVID-19 pandemic on the use of single use compostable containers provided key issues to address in improving sustainable dining at UO. Additionally, my observations of student behavior and conversations with peers added insights to the motivations driving student decisions and behaviors in dining. The issues I found helped me identify specific opportunities to improve the UO Dining food packaging and systems to improve their end-of-life outcomes. After learning about the amount of food and plastic waste created from UO Dining, then weighing the benefits

and drawbacks of current dinnerware used at UO, and finally analyzing the user journey pain points, this led me to ask:

What methods and initiatives have other universities used to reduce food and packaging waste from dining?

Chapter 3. Examples of University Initiatives for Reducing Food and Food Packaging Waste

3.1 University Initiatives for Reducing Food Packaging Waste

I first researched past initiatives that other universities have used to address specifically food packaging waste. There have been several sustainability initiatives among other university and college campuses around the world aimed at reducing food packaging waste that can provide insight on sustainability steps for UO Dining.

At William & Mary (W&M) University in 2019, W&M Dining services phased out, and eventually eliminated, all single use plastics including straws, plastic cups, and cutlery from several dining halls on campus and transitioned to using reusable alternatives as part of the university's five-year Sustainability Plan. Straws were eliminated with no alternative provided, which received little pushback, according to an interview with Stephen Moyer, the W&M Sadler Center Court Operation Manager (Williams 2020). Similarly, Cornell University dining decided to ban all single use "compostable" service ware, as it was not able to be broken down effectively in their compost and replaced it with only reusable service ware ("Food Waste & Compost | Sustainable Campus," n.d.).

Meanwhile, at Vanderbilt University, Vanderbilt Campus Dining partnered with 'Fill it Forward' in 2022 to launch a reusable container program reducing the use of disposable to-go containers at two of their dining venues. As part of the Fill it Forward program, each undergraduate student received one free personal container that they could use in all-you-care-to-eat (buffet-style) campus dining locations. With this system, students return their container to be cleaned after use, and through the Fill it Forward app, they can log their return and scan a code to rent a new container. Additionally, if students need to buy an additional container, they can

purchase one for $5 at dining hall cashier stands. In addition to renting and returning food containers, students can use the Fill it Forward app to track the waste diverted from using their personal reusable water bottles. This app system implements gamification techniques to promote user engagement through unlocking a donation each time users scan their container, and notifies users of their positive environmental impact each time they divert a single use item from the landfill (Caroll 2022).

The University of Washington Housing and Food Services (UW HFS) also recognized that compostable single use containers often ended up in landfills. In response to this, UW HFS has implemented a similar reusable container system by partnering with OZZI, a company that specializes in reusable container systems. UW HFS first began implementing the OZZI reusable container program at two of their dining venues. In this program, residents first receive an OZZI token at the start of the year. When they order their food at the cashier, they present their token, which allows them to pick up their take-out meal in a reusable 6 x 9" container. After use, the resident rinses the container, and then returns it to an OZZI Drop N' Go collection machine at one of the participating dining venues in exchange for another token that will allow them to check out a clean container to pick up their next meal. Residents are incentivized to return their container for a token to check out their next container, otherwise they must pay a $5 fee which offsets the product cost from the university. To disincentivize residents from choosing compostable packaging over their free reusable container, residents must pay an additional 50 cents (except for items that cannot be carried in the OZZI container, such as soups and drinks) (University of Washington Housing and Food Services n.d.).

Overall, these university initiatives to eliminate the use of single use packaging involved adopting reusable service ware that students were encouraged to take and return using a token

and/or rental system. This allows universities to track the reusable items lent out and control the sanitation of reusable containers to ensure standardized and adequate sanitization. This rent and return system could be more realistically accepted by UO Dining, as UO Dining management indicated a need for reusable containers to be adequately sanitized by industrial dishwashers rather than have students be responsible for washing and reusing their own containers (due to health and safety risks). Additionally, users are incentivized to comply with these systems to save money and receive positive feedback about reducing their environmental impact by recognizing and rewarding their efforts to live more sustainably. Furthermore, these systems are designed so that the financial burden does not fall on the universities to pay for lost or unreturned reusable items, as students are expected to pay for any item that is lost as it is tracked to their account. Finally, all initiatives were implemented gradually (two venues at a time rather than all dining venues) and at the start of the academic year, to start the year with clear expectations about reusable container systems at certain venues. Implementing new container systems at certain dining venues rather than the entire campus allows the university to test whether a system will truly work before relying on it as the sole method of distributing food.

3.2 University Initiatives for Reducing Food Waste

Other universities have specifically focused on initiatives to reduce and effectively manage pre- and post-consumer food waste. Researchers have studied methods for reducing food waste in both all-you-care-to-eat dining (applicable for reducing food waste at Carson Hall dining), and standard dining hall pick-up styles within university settings (applicable for all other dining halls on UO campus).

In 2021, researchers studied the impacts of plate size and shape on the amount of food waste produced by university students in a self-serve “all-you-care-to-eat” style dining hall.

Their findings showed that altering the dish shape and size to be smaller oval platters can significantly reduce individual plate waste in a university dining hall, because students initially select less food and are thus less likely to grab more than they need. While educational campaigns generally cost less than new dishware, the study showed that the altered dish size and shape also showed to be more effective in reducing waste than what had been observed in educational campaigns in dining halls, and therefore the cost of diverting food waste from the new smaller dishware could potentially offset its cost over time (Richardson, Prescott, and Ellison 2020).

In 2022, researchers Zhang, Wenhao, and Junehee Kwon implemented trayless dining from an all-you-can-eat style buffet at a dining facility of a university located in the Midwest region of the U.S. The study evaluated the impact of trayless dining in a large university dining center on the amount of food selected, consumed, and wasted, along with assessing college diners' attitudes toward sustainability and food waste. The results showed a significant reduction in the amount of food selected and consumed. This is also particularly relevant for reducing food waste at the Carson buffet dining location on UO campus.

Cornell University has also worked to reduce food waste through implementing both trayless dining and investing in composting on campus as part of their campus dining sustainability initiatives. As supported by previous research, trayless dining at Cornell prevented students from taking more food than needed. Cornell dining also diverts both pre- and post-consumer food waste to Farm Services, Cornell's compost facility, which takes about 4,000 tons of organic waste each year to turn into nutrient-rich soil ("Farm Services & Compost Facility" n.d.). Due to Cornell's commitment to banning "compostable" service ware, they can effectively

convert more food waste to be composted without decreasing the quality of their compost soil due to “compostable” service ware that fails to properly or quickly break down.

Meanwhile, Boston University (BU) dining uses a technology called LeanPath to identify and reduce pre-consumer food waste in kitchens and dining halls. This system allows kitchen and dining staff to more accurately track the amount and type of food wasted and the reason it was discarded (trim waste, overproduction, expired, spoiled, poor quality, handling or catering failures, for example). This data informs BU dining on how they can adjust their food storage practices, the amounts of food they order, use excess food in new recipes and better estimate how much food to prepare per meal. While UO Dining currently uses LeanPath, members from UO Dining management have expressed that its implementation is not widespread nor consistent throughout campus dining venues. Additionally, BU dining donates surplus food to local partners such as Food for Free, Rosie’s Place and BU’s Student Food Rescue Program. Through these donation programs, BU donated about 8,500 lbs of food from campus in 2022 (“Waste Reduction and Diversion | Dining Services” n.d.). Based on Hoffman’s article on current disposal practices of excess food within UO Dining, these could also be improved to match those of BU Dining and alleviate food insecurity on campus and in the local community.

3.3 University Initiatives for Reducing Waste through Educational Efforts

Educational messaging plays an important role in several university waste reduction initiatives. This is because it is highly important for students to understand the environmental impacts of their dining decisions to promote awareness and behavior change that allows more sustainable dining systems to be effectively implemented.

In the journal ‘Written Messages Improve Beliefs and Edible Food Waste Behaviors in a University Dining Facility,’ researchers found that educational messaging proved to be effective

in reducing food waste among university students. Researchers specifically measured the efficacy of simple instructive messaging and its impact on food waste reduction among university students. They found that simple instructive messaging correlated with a 15% reduction in food waste among a population of 540 university students who ate on campus (Whitehair, Shanklin, and Brannon 2013). This research suggests that simple and direct educational messaging can increase students' awareness of food waste and result in decreasing post-consumer food waste.

Cornell University (CU) dining has invested in educational resources to create awareness among students surrounding their food waste. To help educate students about proper composting practices, CU Dining employs students to be Residential Compost Managers. Residential Compost Managers monitor kitchen compost bins on campus and provide peer-to-peer education on proper composting practices, in addition to sorting through compost bins each week to ensure that compost is not contaminated before it is sent to their campus compost farm ("Residential Compost Program | Sustainable Campus" n.d.). This strategy aligns with the success UO Dining has seen in the past with employing sustainably ambassadors to educate first-year students on proper use of the dining materials to reduce waste.

Meanwhile, BU Dining Zero Waste Guides implement an educational event called 'Weigh the Waste' throughout the term in dining halls on campus. During these campaigns, students can see the weight of their post-consumer food waste throughout day in real time at dining halls. This makes students more aware of their food waste while they make food selection decisions and informs BU dining to strategize changes to reduce food waste. As a result of this campaign, BU dining measured over 50% less food waste generated per resident after just one semester ("Waste Reduction and Diversion | Dining Services" n.d.).

Fig. 9. Weigh the Waste Graphic.

Source: Waste Reduction and Diversion | Dining Services n.d

In addition to the 'Weigh the Waste' campaign (see Fig. 9), BU dining displays signage promoting resident awareness of food waste along with tips for reducing food waste, shown in Figure 10.

Fig. 10. Promotional graphics used at BU for reducing food and packaging waste.

Source: Waste Reduction and Diversion | Dining Services n.d

Simply engaging in collegiate competitions and campus-wide challenges with other universities promotes awareness and innovations for reducing general waste. Many colleges and

universities mentioned in this dining waste reduction research have implemented similar initiatives to universities and colleges that participate in programs such as the Campus Race to Zero Waste (RecycleMania) competition. This is an eight-week collegiate competition that promotes waste reduction and recycling to educate and challenge residents of college campuses to create their own ways to reduce waste ("Climate Change Impact" n.d.).

3.4 Holistic University Dining Plans for Food Waste Reduction

These methods all appear to be beneficial towards reducing food and packaging waste on college campuses, and it is likely that reducing as much food and packaging waste as possible will require a blend of multiple methods: reducing food waste and food packaging waste through product changes, system changes and educational messaging. In fact, there are studies measuring the impacts of implementing a mixture of different methods among several universities.

In "Meeting the food waste challenge in higher education," Selena Ahmed and other researchers detail their findings on a study aimed to reduce food waste in a university dining hall and the impacts of educating students about sustainability on food waste reduction in 2017. In the study, students conducted a needs assessment, implemented a food waste reduction intervention (smaller portions, reusable utensils and increased sustainability education), and saw a 17% reduction in total food waste, mainly in post-consumer waste (Ahmed et al. 2018). This study demonstrates the potential for reducing food waste and providing students with valuable experiential learning opportunities related to initiating sustainability initiatives in their own dining system.

In 2022, the University of Rhode Island (URI) dining staff implemented sustainability initiatives to address the problem of food waste, food insecurity and packaging waste in the wake of the COVID-19 pandemic. In "University Creates New Initiatives to Reduce Food Waste in

Dining Halls," Claudia Stephein writes about the detrimental impacts of COVID-19 on sustainability efforts at universities including URI, which is relevant to the University of Oregon based on interviews with UO dining directors that have confirmed the pandemic's detrimental impact on food packaging and food waste. While the COVID-19 pandemic increased food and food packaging waste at URI, the dining services have since implemented several systematic strategies to reduce post-consumer food waste in 2022. The dining services at URI, serving 2 million meals in a typical year, faced challenges due to COVID-19 that resulted in the use of disposable plates and cups. In the article, Stephein addresses the difficulty in quantifying daily food waste but emphasizes its importance in minimizing over-preparation and food waste. Some of URI's initiatives also involved leftover food being either donated to the Elisha Project, which provides 33,000 meals annually to local community members facing food insecurity, or composting through a partnership with their local compost plant that diverts 15 tons of food waste from landfills each year (Ph.D 2023).

URI also implements sustainability into educational initiatives by offering a course on food waste and the environment and encouraging community involvement in sustainability efforts. While on-campus composting introduces logistical challenges such as the odor of food waste and regular transport of excess food, URI addresses these issues through initiatives such as eliminating trays to reduce food waste and exploring the use of a digester to accelerate composting (Scrogum 2021).

Lastly, Harvard University Dining Services (HUDS) has implemented sustainability initiatives that address food and packaging waste through a variety of methods, helping them earn the '2024 Greenest University' award from the Green Restaurant Association. HUDS green dining initiatives include: sourcing locally grown foods, offering 33% vegan or vegetarian

dishes, implementing reusable dishware, offering compostable and recyclable disposables and incentivizing a reusable mug and water bottle program through offering refill discounts. Additionally, HUDS donates salvageable, perishable food to a local food organization called 'Food for Free,' which distributed over 45,000 meals in the 2014-15 school year. On campus, student Food Recovery Fellows lead the 'Heats-N-Eats' Program, where student volunteers prepare microwavable single-serve meals made from excess dining hall food and distribute 'Heat-N-Eats' meals to food-insecure individuals at local residential hotels and shelters. HUDS also implements educational campaigns such as post-consumer food waste audits in undergraduate dining halls to promote consumer awareness about their own food waste. Lastly, student members of Harvard's Food Literacy Project (FLP) help educate and engage the community to promote awareness and behavior change regarding food issues ("Harvard University Dining Services" n.d.).

3.5 EPA Guidelines for Reducing Wasted Food & Packaging

Finally, I consulted the EPA's 'Reducing Wasted Food & Packaging: A Guide for Food Services and Restaurants' which significantly aligned with many of the sustainable initiatives shown in previous case studies at university dining halls. This resource provides step-by-step order of actions for commercial kitchens and food establishments, from sourcing to disposal, to reduce food and packaging waste. For reducing food waste, the EPA offers a 'Food Recovery Hierarchy,' which outlines actions for managing food waste, from most to least preferred in terms of sustainability (see Fig. 11).

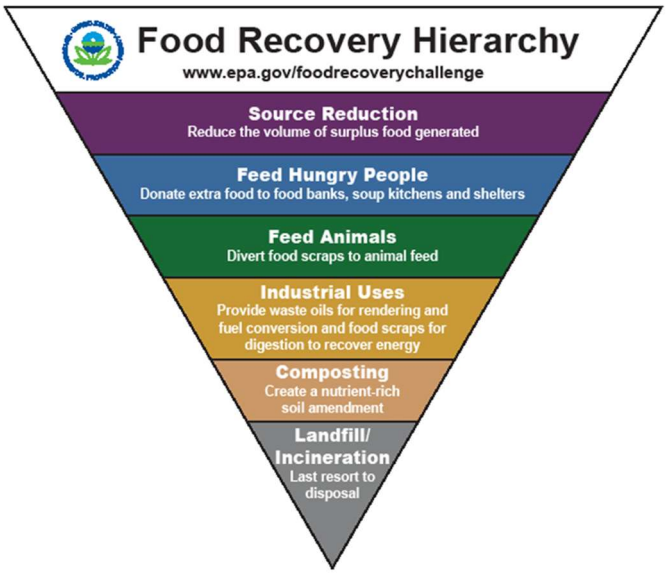


Fig. 11. EPA's Food Recovery Hierarchy Graphic

Source: United States Environmental Protection Agency 2014

Below are the EPA's preferred order of actions for reducing both food waste and packaging waste according to their guide, and how these might translate to actions taken to reduce food and packaging waste in a university dining hall:

1) Tracking and Assessing: Use food waste tracking systems and assessments (such as LeanPath).

2) Source Reduction: Reduce the overall amount of food bought and distributed by university dining through using a "just-in-time" purchasing system, practicing effective food storage practices, menu planning that incorporates food reuse/repurposing and educational campaigns. Properly train staff on food preparation, serving sizes (using tray-less systems) and waste reduction efforts.

2) Feed Hungry People / Feed Animals: Donate excess non-perishable and unspoiled perishable food to food-insecure students, staff, community members and local organizations. Then donate vegetable and fruit scraps to local farmers for animal feed.

4) Industrial Uses/Composting: Donate fats, oil and grease for biodiesel to a local refiner. Practice effective composting through proper sorting by working with trained staff and students to help bring adequate compost to local gardens, farms and industrial compost facilities.

5) Packaging Reduction Strategies: Replace single use dinnerware with reusable products to reduce costs and environmental impact associated with transportation and purchase of single use products. Practice effective sorting for recyclable items and eliminate compostable products that contaminate compost.

6) Disposal: If no other strategies can be applied, pulping food waste for disposal can decrease its volume and weight by removing water.

4. Design Ideation & Development

4.1 Research Insights

After analyzing past and present dining systems and products at UO, reviewing food and packaging waste initiatives at other universities and evaluating the EPA's 'Reducing Wasted Food & Packaging' guidelines, I gathered insights to guide my design solution addressing the question: How can we redesign current UO Dining products and systems to reduce food and packaging waste?

UO Dining's current single use "compostable" food containers have shown to be wasteful, as they end up in landfill. Their inclusion in the dining system also creates unnecessary food waste, as these compostable food packaging items contaminate post-consumer food scraps due to their misleading labelling and render it impossible for the Zero Waste program to collect post-consumer food scraps. UO Dining's current reusable dinnerware also results in unnecessary food waste because consumers cannot save their leftovers for later, nor transport their food, pushing them to opt for single use compostable food containers instead. Therefore, implementing inexpensive and reusable food containers could eliminate these issues, allowing for saving food leftovers and making it more feasible for Zero Waste to collect pure post-consumer food scraps to bring to Rexius Composting. However, reusable dinnerware must accommodate the variety of foods, distribution methods and locations at UO Dining: being served by dining staff, picking food up at the market, eating food at the dining hall and ordering food to-go.

UO Dining's previous initiatives to implement reusable dinnerware provided two key strategies for effective implementation of a new product and system: 1) implement the new system at the beginning of the academic year and 2) provide peer education and training to guide students' decisions in adopting the new system. Other university case studies revealed more

strategies for implementing reusable container systems: 3) students receive food in a reusable food container distributed by the dining hall, which they must later return to the dining hall to be cleaned in exchange for a new sanitized container the next time they grab food, 4) students use an app to track their container use and receive positive feedback for choosing reusable containers over disposable ones, 5) students are disincentivized to use single use containers through extra fees, 6) consumers are guided by student sustainability ambassadors and simple educational messaging campaigns, 7) students must return their container or pay for its loss and 8) the new container system should be implemented at a few dining halls at a time instead of the entire campus.

4.2 Design Objectives

Based on my research insights and analyses, I aim to create a reusable container design to be implemented at UO and eliminate the need for single use "compostable" containers. Additionally, I aim to create a design that could be easily transported and tracked for rental, inspired by other university initiatives for reusable container rentals.

In addition to creating a container solution, the dining system redesign would include the use of an app to track reusable dinnerware and ensure students are returning it to be sanitized before they check out another container, otherwise they face extra fees. Students would be disincentivized from using single use or recyclable (not compostable) options by paying an extra fee to use one. The UO Dining system redesign would incorporate educational campaigns about reducing food waste, encouraging students to take less food or save it for later and accurately sort their meat and vegetable food scraps separately. Furthermore, student sustainability ambassadors would help guide other students to ensure they are accurately sorting food scraps so they can be included in compost and return their reusable containers to the dining hall for

sanitization, starting at the beginning of the academic year. Lastly, these student ambassadors could volunteer for credit or work as part of a campus job, to ensure excess food is brought to those in need and food scraps are brought to campus gardens, local gardens and farms for compost if not collected by a compost facility.

Based on goals for creating an affordable reusable container option, I created a list of Constraints, Objectives and Directives for my food packaging design solution.

Constraints – solution must:

1. Securely close for convenience
2. Be food-safe
3. Accommodate various types of foods served at UO Dining
4. Not contribute to landfill at end-of-life cycle

Objectives – solution should:

1. Carry reusable silverware as a set
2. Be durable enough to be used and rewashed multiple times
3. Allow their users to see their food
4. Have an identifying code that facilitates rental and return system
5. Be stackable for mass storage efficiency

Directives – solution should ideally:

1. Be simple and minimal, discouraging stealing
2. Have UO branding to communicate permanence
3. Have a convenient and transportable carrying system (eliminates use of paper or plastic bags)

4.3 Ideation

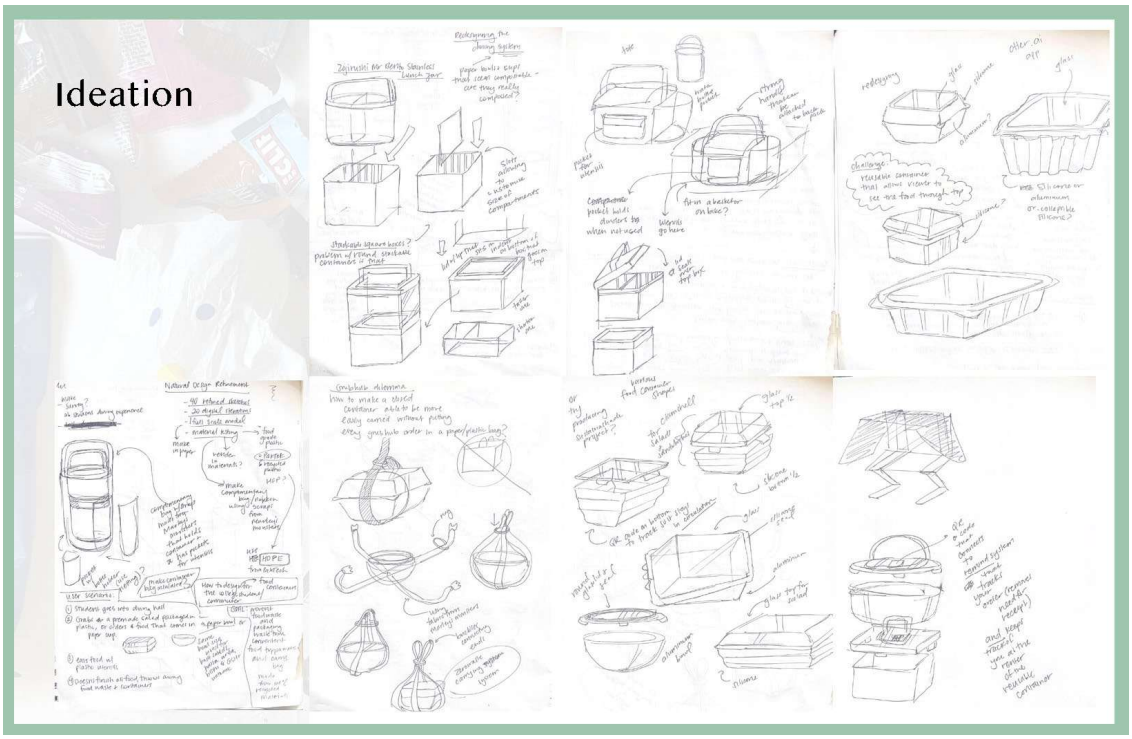


Fig. 12. Initial ideation sketches for reusable container design.

Source: Created by the author.

I began by ideating through building mood boards and sketching, exploring various forms of a food container design. While I explored full container redesign ideas, I also explored the idea of just designing a lid that could fit on existing reusable dinnerware items already in use at UO to minimize the need for additional materials.

4.4 Concept Development

Throughout this thesis, my ideation led me in different directions to solve for designing a food container solution that would minimize food and packaging waste. After research and interviews with UO stakeholders, I developed three different concept directions for my food packaging design solution, which I explored at different points in the thesis project.

4.4.1 Option 1: Reusable Lid

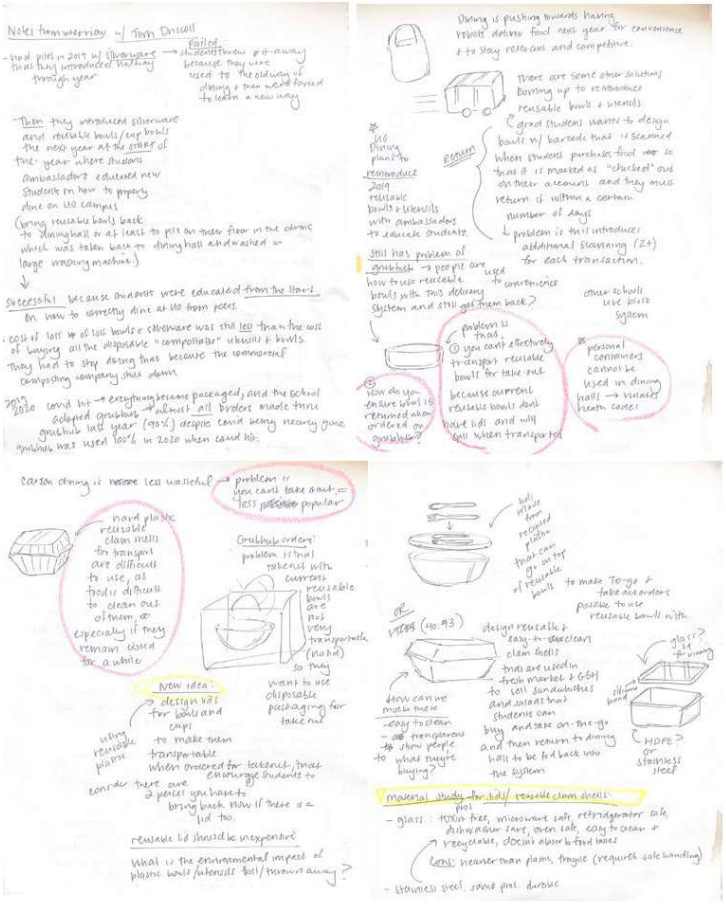


Fig. 13. Design research and sketching for option 1: Reusable lid design.

Source: Created by author.

After considering various container forms (see Fig. 13), I narrowed my first concept to a reusable lid design for existing dinnerware at UO. This decision was informed by conversations with leadership at UO Dining regarding the past and current initiatives to reduce waste on campus, which revealed that UO Dining prioritized affordability and cost analysis in their container purchasing decisions. Since UO Dining already has implemented some reusable

dinnerware items such as bowls, plates and trays, this first container solution would entail creating lids that fit on the existing dinnerware items to reduce additional materials, cost and system changes needed to implement this solution. Minimizing the costs and materials needed for adopting a reusable container seemed to be the most feasible, fast and affordable way to eliminate single use containers and adopt reusables.

Fig. 14. Photo of the reusable bowls, plates and trays I will be designing around for the reusable lid.

Source: Created by the author.

UO Dining provided three reusable containers to design around, as these were the main containers used on campus (see Fig. 14).

4.4.2 Option 2: Bioplastic Container

Inspired by a materials design course I took as part of my product design coursework, I began researching bioplastics design. I wondered if there might be another solution that allowed students to still use and discard single use containers—could I create a container made from

organic material that could feasibly break down into compost, perhaps even without the need of a composting facility? What if students did not want to be responsible for bringing back their reusable container, or failed to do so when bringing food off campus? Could there be an alternative single use option that did not contaminate post-consumer food compost and allowed composting on campus or allow facilities like Rexius to accept UO post-consumer food scraps? If there is excess food waste created from the dining halls, could there be a way to use this excess resource to create something renewable? I sought to find a way to create truly biodegradable containers that could replace single use plastics. I began by researching bioplastic recipes from resources such as 'Bioplastic cookbook' by Margaret Dunne and 'Recipes for Material Activism' by Miriam Ribul to find basic bioplastic recipes (Dunne 2018; Ribul 2014). Additionally, I created mood boards to see how a bioplastic might translate in a food container design (see Fig. 15).

Fig. 15. Bioplastic Design Moodboard.

Source: Created by author, images sourced from Pinterest.

4.4.3 Option 3: Complete Container Redesign

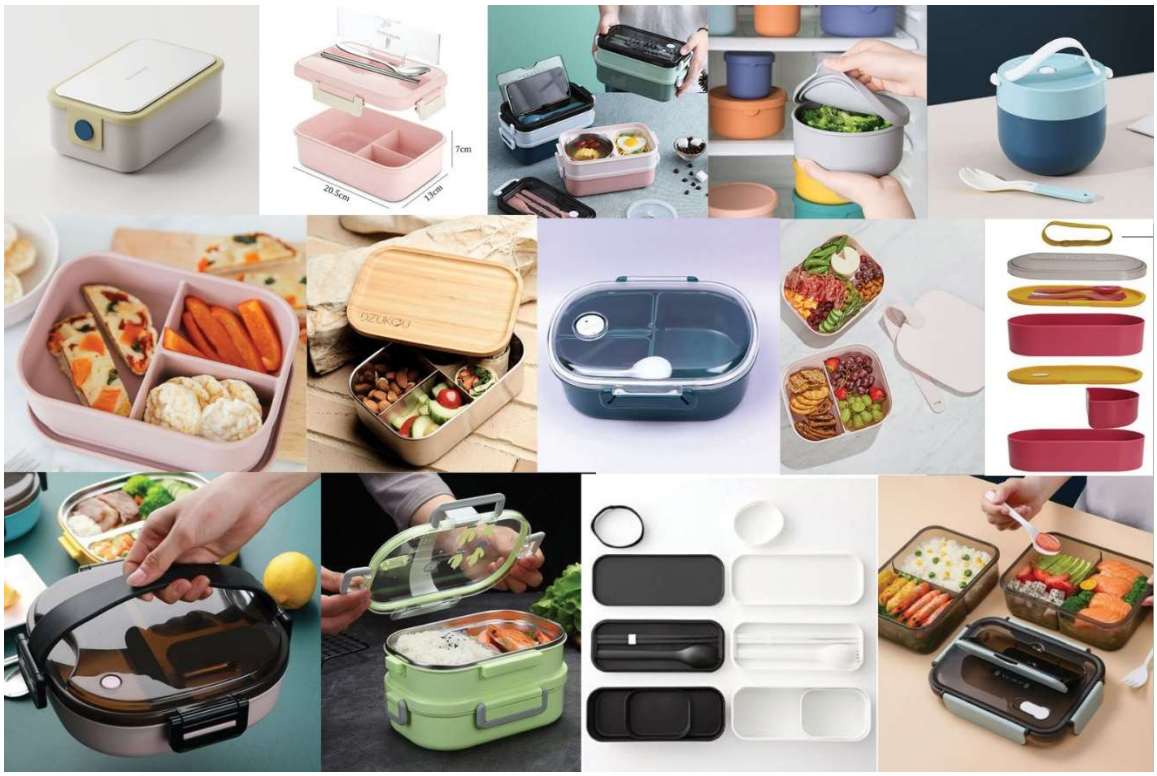


Fig. 16. Complete Container Redesign Moodboard.

Source: Created by author, images sourced on Pinterest.

After exploring the lid design and bioplastic container solutions, I continued exploring ideas for a complete redesign of a new food container to be implemented at UO as a more expensive, yet more attractive and durable reusable option (see Fig. 16). This option might allow for a more durable and modular design that also aligned with UO branding and communicated permanence. Additionally, this option seemed to align with most other university solutions for implementing reusable containers in other university case studies.

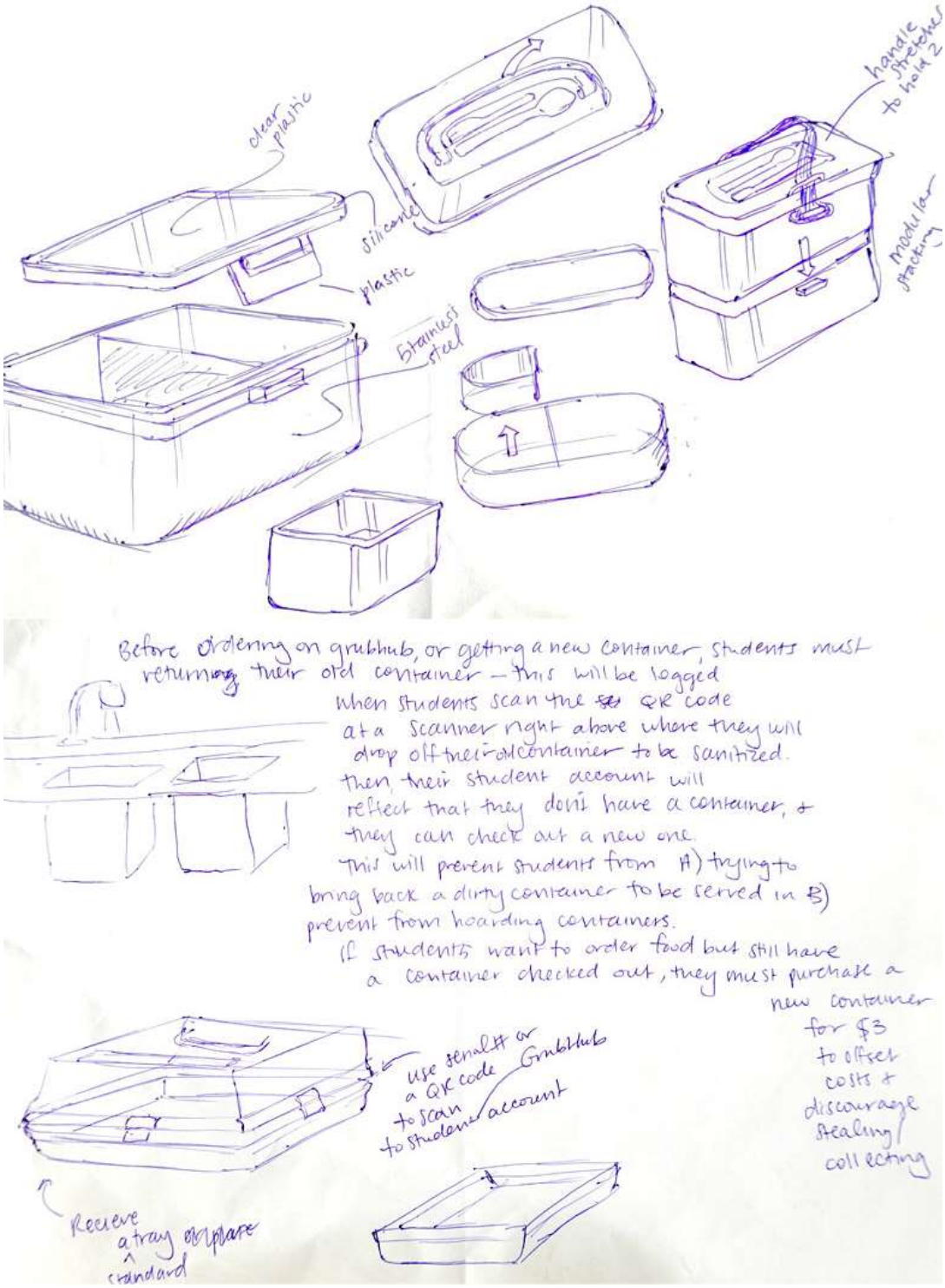


Fig. 17. Complete Container Redesign Initial Sketches

Source: Created by author.

4.5 Evaluative Research

4.5.1 Option 1: Reusable Lid

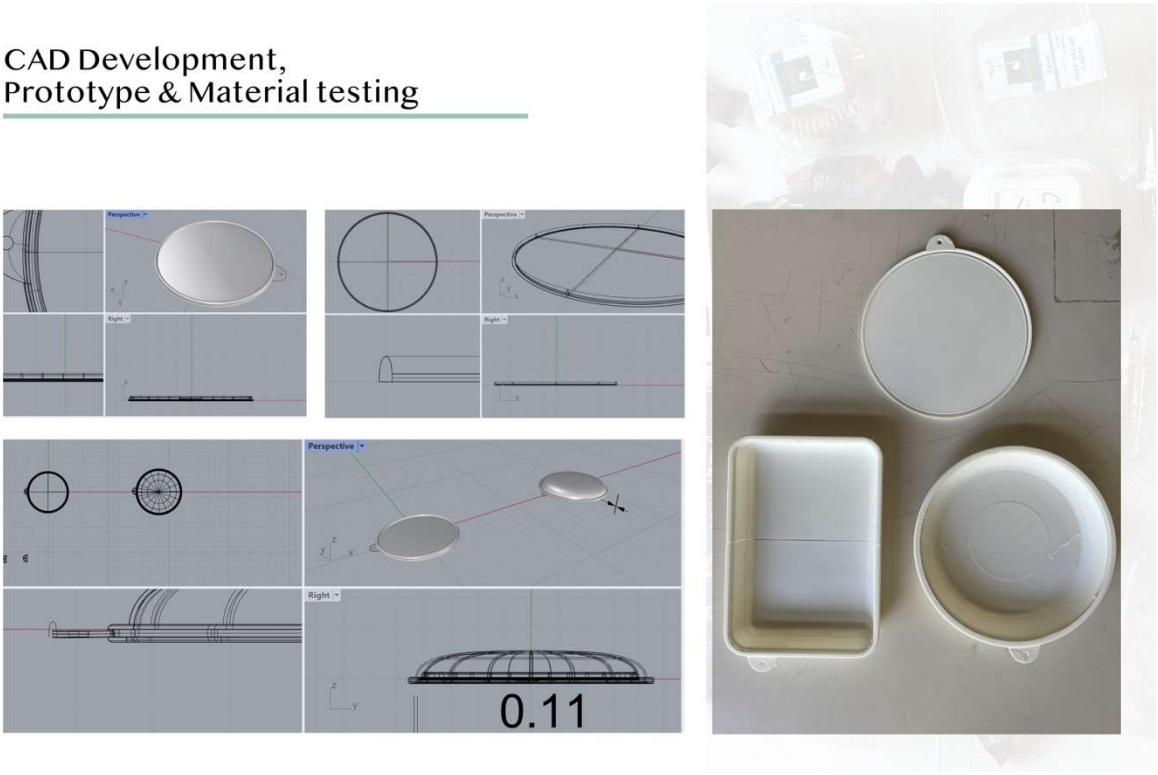


Fig. 18. CAD Development of Reusable Lid Option

Source: Created by the author.

After creating designs for the lid options based on measurements of current bowls, plates and trays, I 3D-printed initial prototypes (see Fig. 18) for feedback from design professors like Jessica Swanson and design classmates, who suggested to think about ways that this lid and container set would be carried and tracked.

Based on this feedback, I decided to add a carrying method and pursue other materials in which to prototype my lid design. I needed something sleeker and able to securely fit the existing

reusable containers. Using opaque plastic PLA 3D-printed material did not allow for users to see their food, and this PLA material was much too brittle to fit over existing dinnerware.

4.5.2 Option 2: Bioplastic Container

In my early bioplastics experimentation, I created initial bioplastics made of organic ingredients such as water, glycerin, agar powder, gelatine powder and corn starch based on basic recipes found in my research (Dunne 2018). Feedback from my design professor in the materials design course, in addition to design peers, pushed me to continue searching for ingredients that would make the biocontainer more rigid. Additionally, I was encouraged to research which ingredients might make it difficult to implement this biomaterial into a dining system: for example, using gelatine might introduce issues as some consumers cannot eat animal products. I began to focus on finding the right proportions of agar powder as the vegan alternative to gelatine and experimented with adding fruit peels after reading studies in which researchers used orange peels in the content of their innovative bioplastic materials. I found that adding blended fibrous fruit peels to the base bioplastic recipes added more rigidity to the material (see Fig. 19).

Fig. 19. Early Bioplastics Material Experiments for Option 2.

Source: Created by the author.

4.5.3 Option 3: Complete Container Redesign

After developing the reusable lid and bioplastic concepts, I continued meeting with professionals at UO involved in design, waste management, food and sustainability to discuss potential solutions for reducing food and packaging waste. Additionally, I gleaned insights from casual conversations with students on campus to learn more about general student dining hall habits and pain points, which helped me better understand the user experience at UO Dining halls. Overall, most students seemed to prefer the idea of having a reusable container rather than a single use one. They confirmed that the current "compostable" containers on campus were confusing, especially because there was no composting available on campus, and signage was not always clear. Additionally, developing a container design that had both the top and bottom easily scanned and tracked seemed to be an important aspect of successful university initiatives for introducing reusable food containers. Lastly, I wanted to design the securing strap to be more easily removable than the reusable lid concept and made from an easily washable material like silicone, based on feedback from UO Dining staff who raised concerns about the sanitation of fabric straps of the previous lid designs. Based on this feedback, I focused on refining a design for a new reusable container (see Fig. 20).

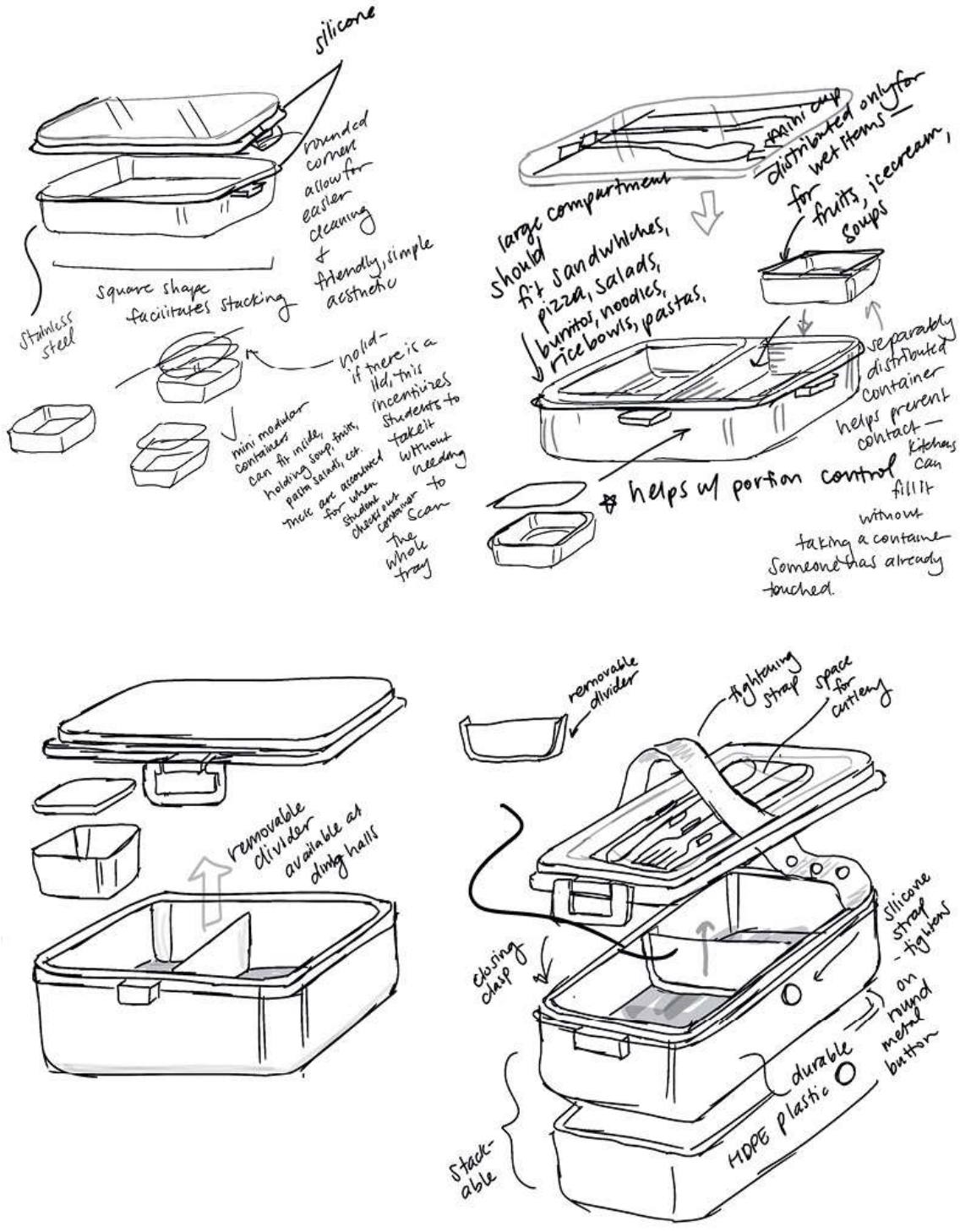


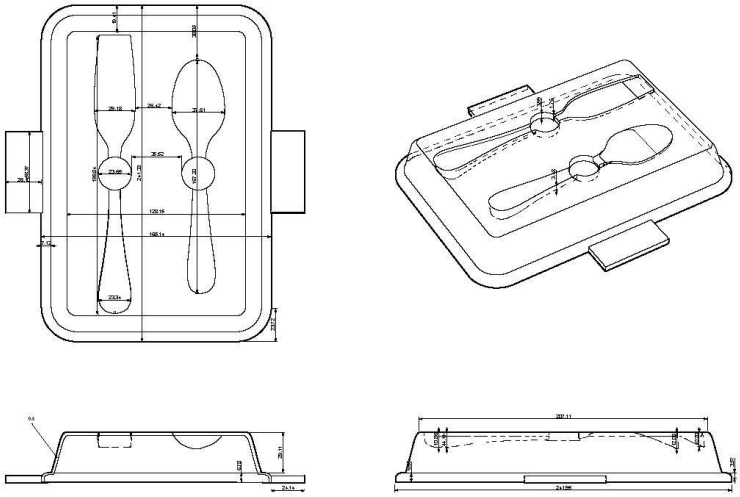
Fig. 20. Concept Sketches for Option 3 – Reusable Container Redesign

Source: Created by author.

4.6 Prototyping Three Options

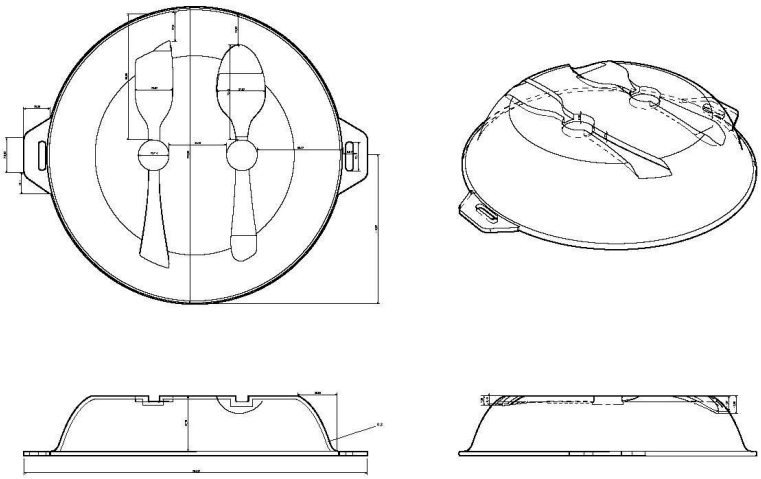
4.6.1 Option 1: Reusable Lid

Tray Lid Measurements



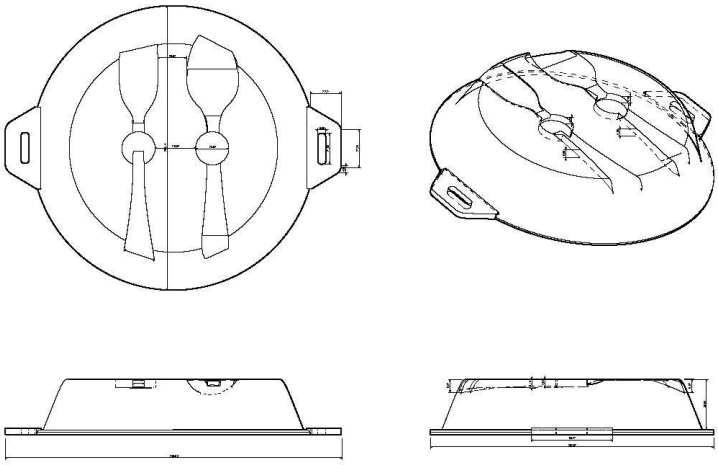
All dimensions in mm
Scale : 1 mm = 1/2 mm

Plate Lid Measurements

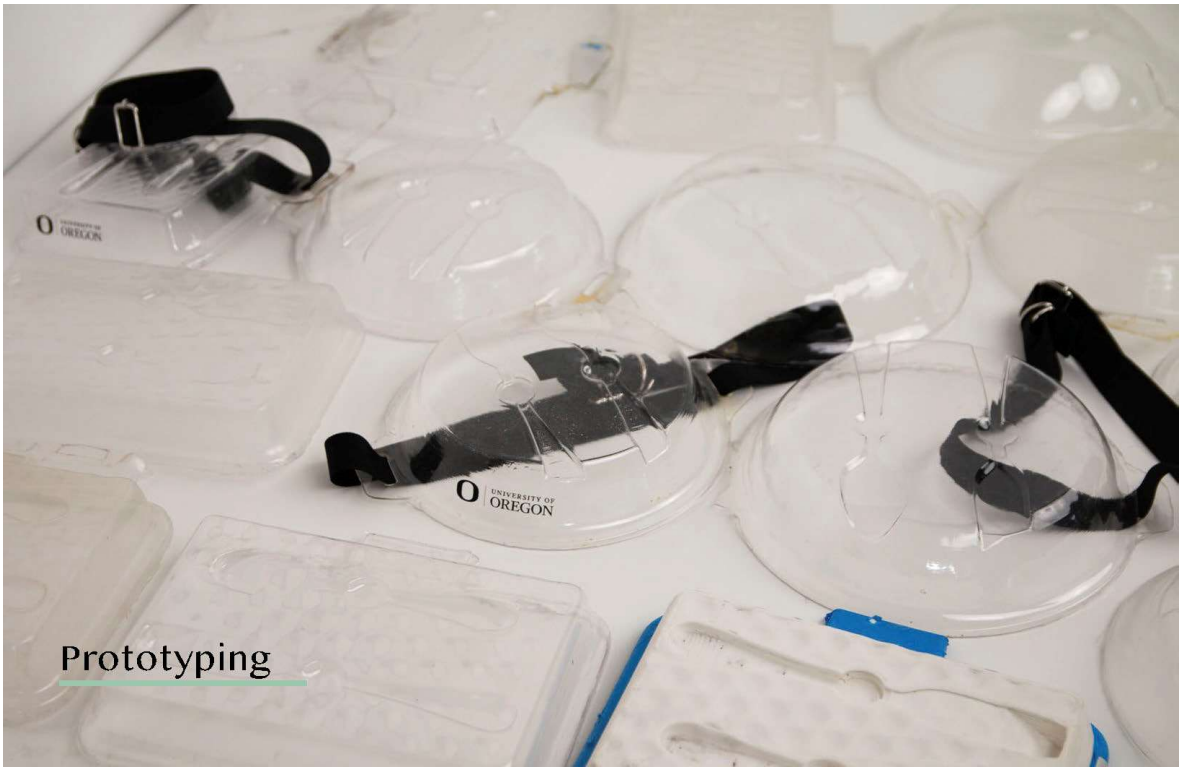


All dimensions in mm
Scale : 1 mm = 1/2 mm

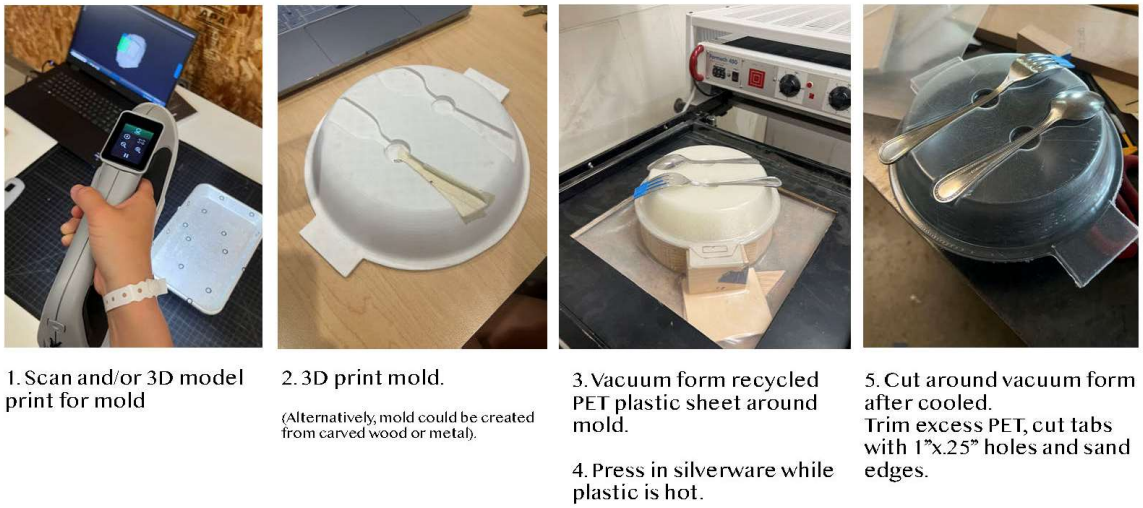
Bowl Lid Measurements



All dimensions in mm
Scale : 1 mm = 1/2 mm

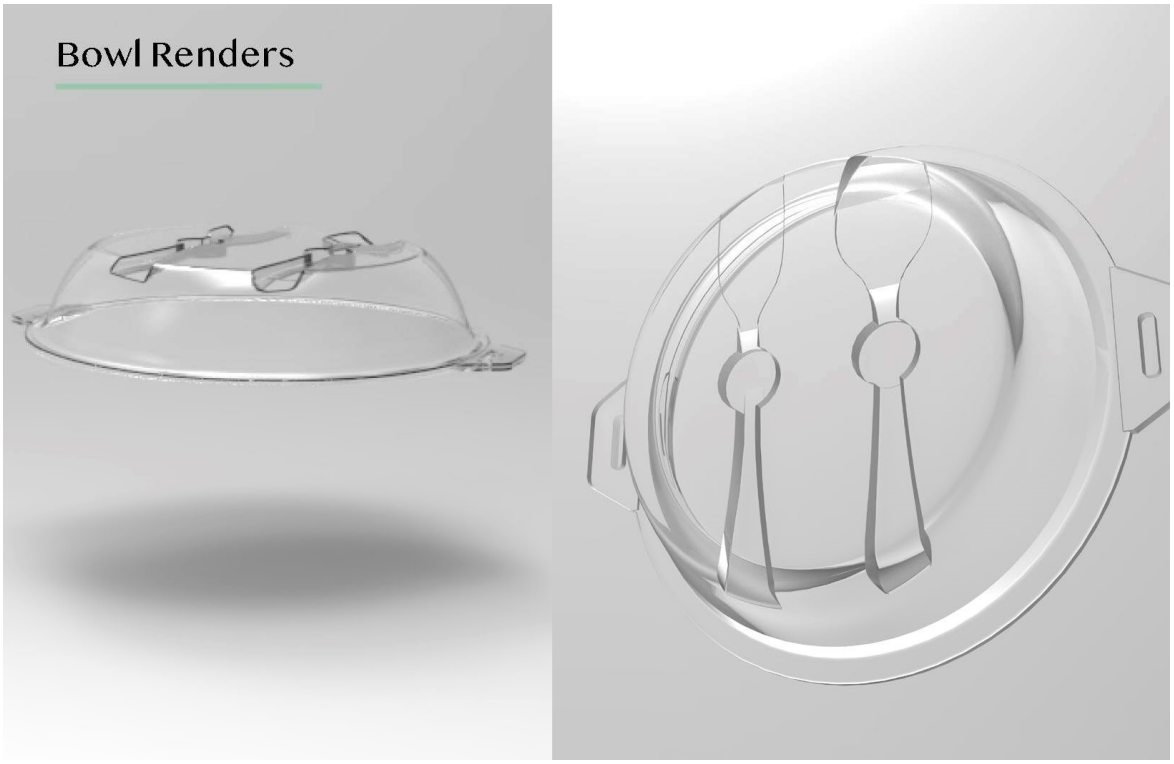


Prototyping



For the reusable lid design, I found that using PET plastic was useful for prototyping, as this plastic was able to be vacuum-formed around existing forms to tightly fit around them and securely close. Additionally, it could be melted down and molded into entirely new forms at the end of its life as a container, aligning with the project's focus on sustainability throughout a product life cycle.

I first 3D-printed the shape of the lid I wanted by modeling the dimensions of its respective container and then creating a cavity that was the shape of the reusable utensils that I wanted it to hold. I then vacuum-formed the PET plastic around the 3D-printed model of current containers, pressing in the reusable cutlery to create a secure fit that allows users to snap their cutlery into the reusable lid when not in use. Additionally, I left small tags on either side of each lid to provide loops through which to attach carrying straps for easy transport, in response to earlier feedback–eliminating the need for a paper or plastic bag.

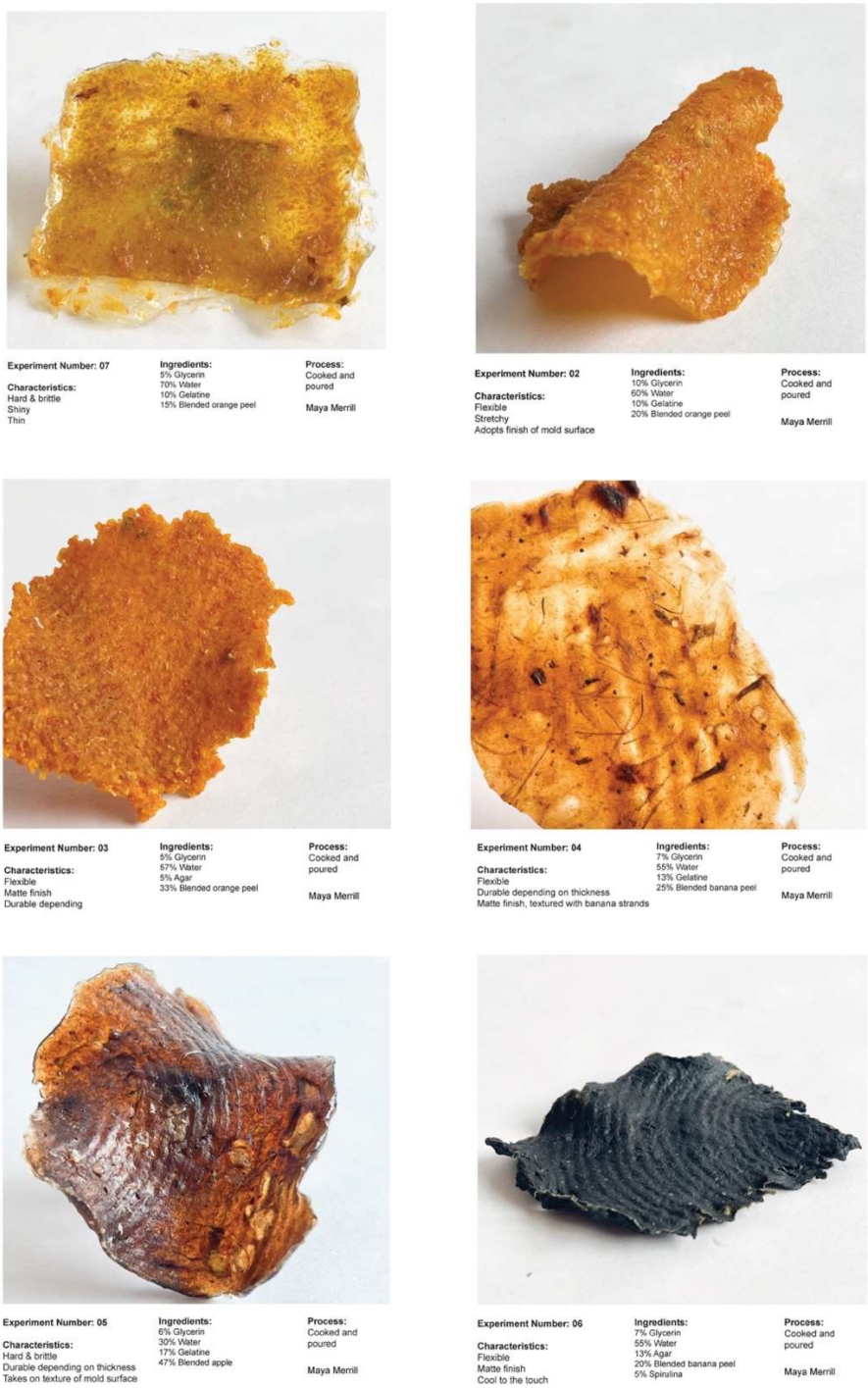

Bowl Renders


Tray Renders

4.6.2 Option 2: Bioplastic Container

After finding that adding fruit to the biomaterials mix increased rigidity in my experiments, I continued incorporating fruit peels into my bioplastic recipes in my prototyping. However, I realized that I could draw from a constantly replenishing resource right on campus rather than continue to buy my own fruits: the UO kitchens. Thanks to support from Brian Burroughs and UO Dining, I was able to continue my bioplastic experiments using discarded fruit peels from the dining halls that were byproducts of smoothies and other meals with fruits prepared by UO Dining, which would otherwise go to compost. Instead, I could intercept the byproduct fruit scraps and give them one more product use before they were composted. I solidified the proportions of each recipe and focused my material experiments on using gelatine or agar powder as bonding agents, while adding orange, apple or banana peels to increase

rigidity. Each experiment resulted in slightly different material properties, and I documented the best ones into a small material library to reference (see image below).



Experiment Number: 01

Characteristics:
Hard & brittle
Shiny
Adopts finish of mold surface

Ingredients:
5% Glycerin
60% Water
10% Gelatine
25% Blended orange peel

Process:
Cooked and poured

Maya Merrill

Experiment 1 seemed to be one of the most rigid materials, and I continued basing future recipes off of these proportions for my later form prototypes.

Fruit Compost Bioplastic

Maya Merrill

ENVIRONMENTAL STATEMENT

In 2020, the University of Oregon produced 1,260 tons of solid waste and 227 tons in food waste. Currently, there is no system for collecting post-consumer food waste from the dining halls to compost at UO, and this results in tons of food waste contributed to landfills. Additionally, much of the "compostable" single-use food containers from the UO dining halls require transport to a composting plant, yet end up in landfills due to the lack of adequate composting systems. In the US, the top three waste categories contributing to over 50% of US total waste are food, plastic, paper & paper board -- much of which is created by large-scale food venues such as universities.

What if we could create completely biodegradable single-use food containers made from tons of post-consumer food waste that don't require transport to, and processing at, a separate recycling plant to break down and replenish soil?

MATERIAL

RAW INPUTS

Orange & Gelatine:	Orange & Agar:	Gelatine & Apple:	Gelatine & Apple:
5% Glycerin	5% Glycerin	6% Glycerin	7% Glycerin
60% Water	57% Water	30% Water	55% Water
10% Gelatine	5% Agar	17% Gelatine	13% Gelatine
25% Orange Peel	33% Orange Peel	47% Apple	25% Banana

MATERIAL PROCESS

Orange Peel & Gelatine process for one biotray:
1. Mix together:
- 3 tsp (or 1 tbsp) glycerine
- 24 tbsp water
- 4.5 tbsp gelatine
- 10 tbsp orange peel (blended with food processor)
2. cook in pan at level 5 medium for 22 min, stirring occasionally.
3. Pour into mold and let sit for 24-48 hours before peeling out. Then air dry.

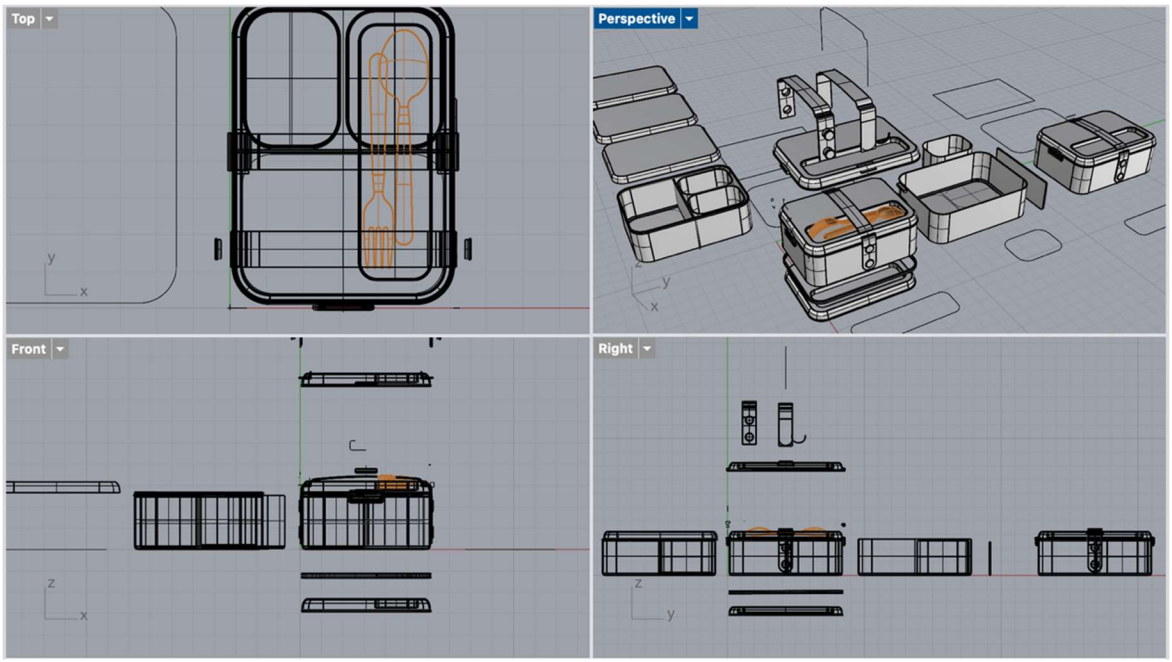
MATERIAL CHARACTERISTICS

- Fruit bioplastics with gelatine and fruit peel (banana and orange specifically) harden into a sturdy and brittle shape (with noted proportions)
- Fruit bioplastics with agar and fruit peel remain flexibile, sensitive to moisture in the air
- Whole apple, when mixed with gelatine, remains fairly flexible.
- When touched by water, these bioplastics degrade easily or mold.
- Gelatine bioplastics retain less fruit smell than agar-based bioplastics

MANUFACTURING POTENTIAL

- Gelatine bioplastics made from banana and orange peel can create hard material for trays, other food containers and single time use disposable objects that require rigidity and structure
- Agar-based and apple-based bioplastics tend to remain flexible, offering potential for bioleathers/bags/cup sleeves
- Potential ability to recook an old mold into a new object

4.6.3 Option 3: Complete Container Redesign



Using Rhino 3-D modeling software, I focused on creating rectangular bento-box style shapes for my reusable container prototypes to maximize their ability to be stacked, stored and transported effectively.

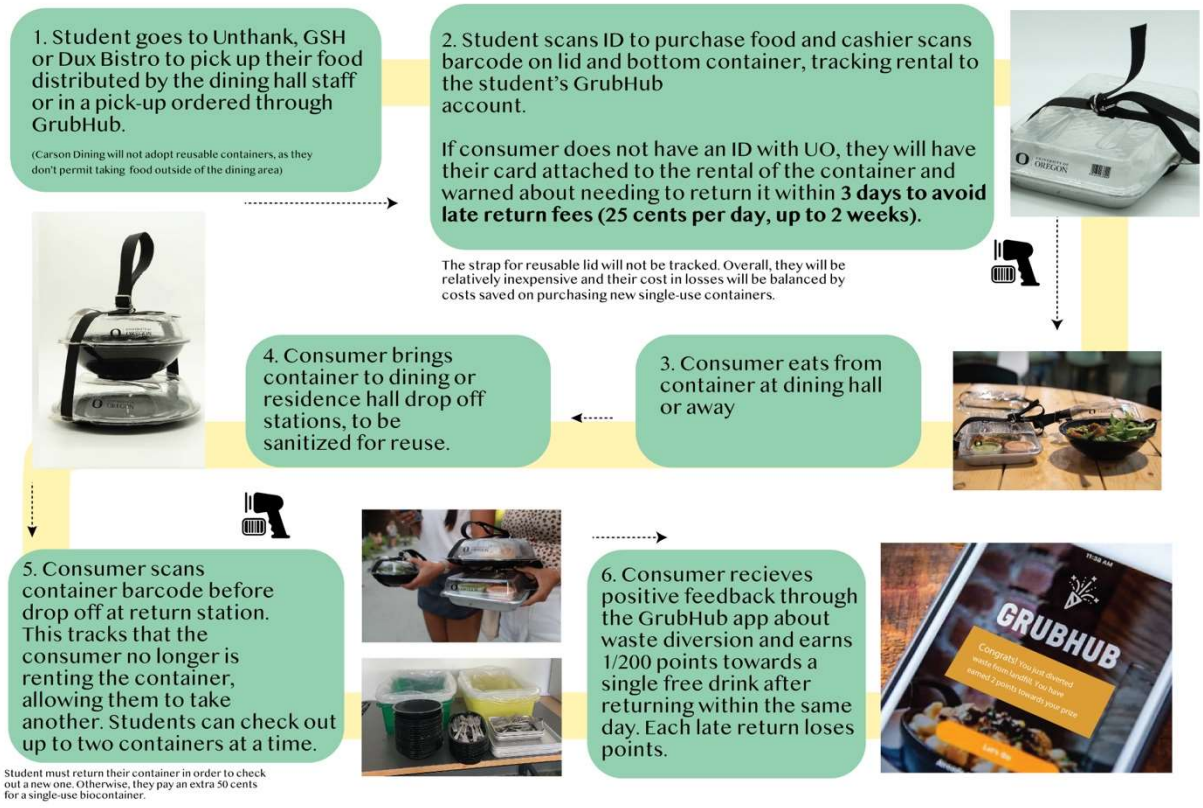
4.7 Presentation & Feedback of Three Options

4.7.1 Option 1: Reusable Lid

UO waste management professionals and design professors provided feedback on the reusable lid design, which helped inform the later design of the complete reusable container: it

was important to have a carrying system, but the strap should be easier to clean and remove to minimize sanitizations risks. Feedback from design professors such as Hale Selek identified that the plastic lid material may be confused with a disposable item, and could be designed to look more permanent to avoid accidental disposal.

Reusable lid Implementation



Inspired by past university initiatives (Vanderbilt University and University of Washington) to implement reusable containers, this reusable lid design includes a bar code on each reusable lid and bottom receptacle to track containers within the UO Dining system. Each time a student scans their card to pay for a meal, the cashier also scans the container barcode to rent that container to the student. The barcode of the top and bottom of the container is tied to student's GrubHub account when they pay at the cashier, and they then become responsible for

returning it to the university dining hall to check out a new sanitized container at their next meal. Students may only have two containers checked out at a time to ensure that containers remain circulating through the dining system, preventing food from molding within a used container. If two sets of the lid and bowl are not returned to the dining hall (tracked through the student account), students cannot grab another sanitized container for their meal and must opt for a single-use option for an extra 50 cents. If not returned after 3 days, the lid and container rental will begin accruing late return fees at 25 cents per day, for up to two weeks (at the end of which, the student will have paid for the price of the container). Once students bring back their lid and bowl, it will be washed, and students can rent out another set when they pick up their next meal. Each time a student uses and returns a container set, they get points towards a free drink from the dining hall and are informed of their diverted waste from landfill through the GrubHub app. Additionally, similar to Cornell University and to past UO pilot efforts, UO will once again employ waste management ambassadors at the start of the academic year to educate students on proper dining hall protocol and management of their containers.

Materials & Okala Impact Factor

Cradle to Cradle: Thermoform plastics like PET can easily be melted and reformed into new objects using methods such as vacuum forming, allowing for the lids to be repurposed at the end of their product life cycle, and created into lids from something else.

	Part	Material	Weight (lbs)	Material Factor	Material Impact	Process	Process Factor	Process Impact	Finish	Quantity
	Bowl Lid	Recycled PET	0.1	1.4	0.14	Thermo Forming	1.4 / lb	0.14	Natural	1
	Plate Lid	Recycled PET	0.12	1.4	0.168	Thermo Forming	1.4 / lb	0.168	Natural	1
	Plate Lid	Recycled PET	0.1	1.4	0.14	Thermo Forming	1.4 / lb	0.14	Natural	1
	1" Fastener	Stainless Steel	N/A	N/A	N/A	Sourced	N/A	N/A	N/A	1 (per lid)
	1" D ring	Stainless Steel	N/A	N/A	N/A	Sourced	N/A	N/A	N/A	2 (per lid)
	1" black webbing	Nylon	N/A	N/A	N/A	Sourced	N/A	N/A	N/A	20 inches

Fig. 21. Okala Impact Factor for Option 1 - Reusable Lid Design

Source: Created by author.

The Okala Impact Assessment tool measures the environmental impact of each material used in the product, from the start and end of its life cycle ("Okala Practitioner - Industrial Designers Society of America" 2013).

4.7.2 Option 2: Bioplastic Container

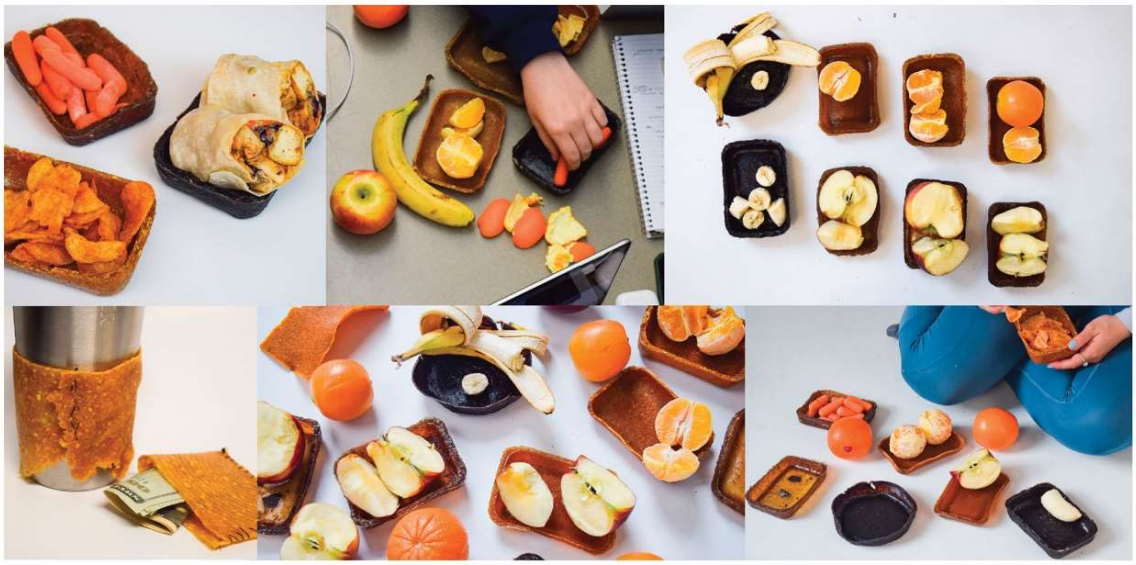
Biodegradable food containers & packaging

Maya Merrill

ABOUT THE CONCEPT

This material utilizes the by-product waste created from the three most commonly used fruits in the UO dining halls: oranges, apples and bananas. By collecting the preconsumer (peels tossed out by the kitchen staff) and post-consumer (tossed by students) fruit peels from each fruit, in addition to the fruit that would otherwise be discarded due to blemishes, I created four different biomaterials: banana peel + gelatine, apple + gelatine, orange peel + gelatine and orange peel + agar. Each material has unique properties that alter their flexibility, lending themselves to different product uses such as bioplastic trays or fruit leathers.

DESIGN APPLICATION



PRODUCTION PROCESS

For the biocontainers, I continued collecting discarded fruit peels from the dining halls, blending them, mixing them with other organic ingredients, cooking them in dorm kitchens and molding them around simple glass tray shapes to create a food container shape. This method of production could be replicated on larger scale, perhaps even creating more student jobs on campus in the process.

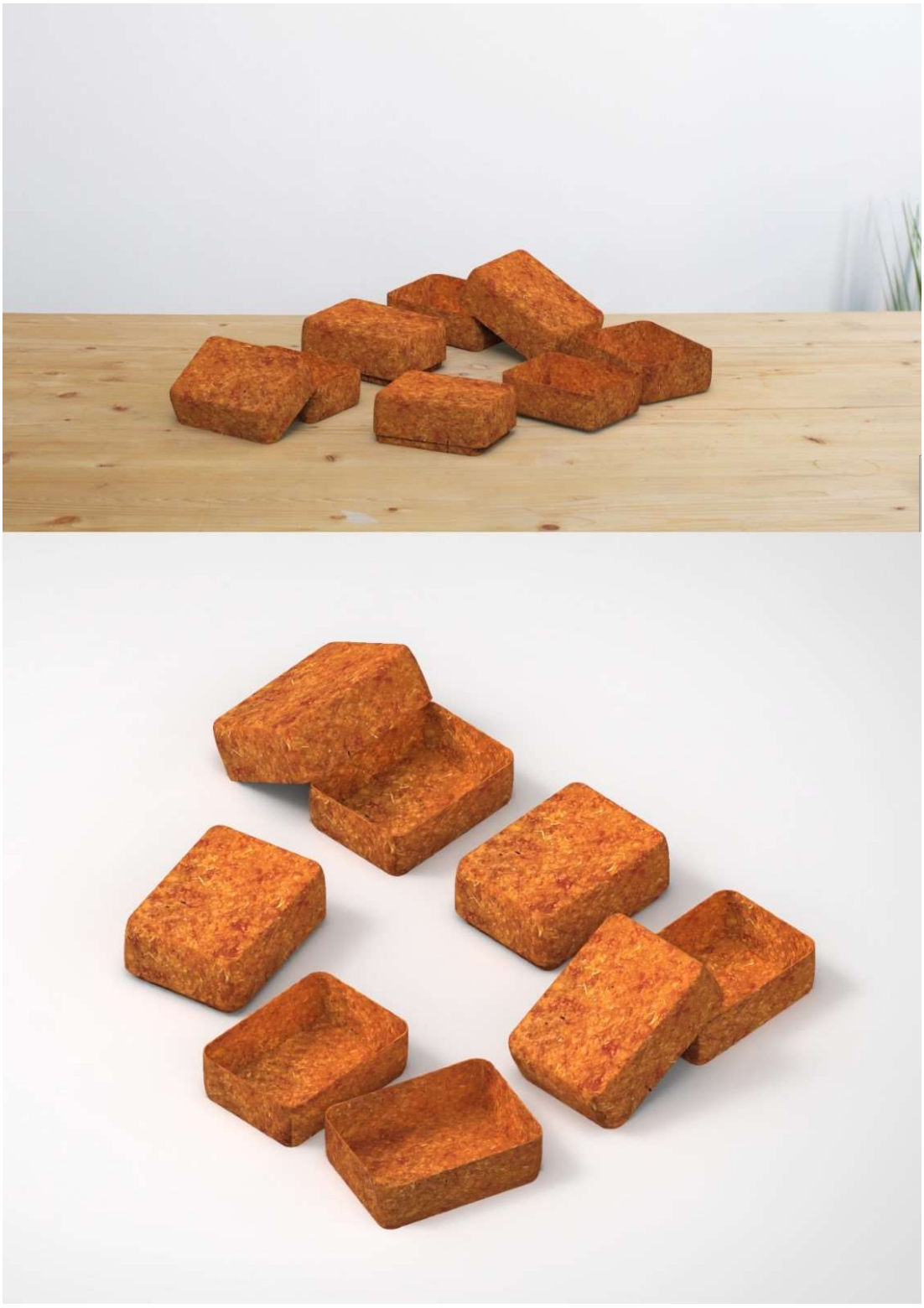


Fig. 22 Biocontainer Renders

Source: Created by author.

Professionals in UO waste management and the Senior Vice President at Rexius, UO's main composting facility, provided feedback on my material recipes. After researching the ingredients list in my material experiments, Rexius leadership confirmed that the integration of these bioplastic ingredients into food waste compost at Rexius is technically feasible. The only exception was that agar is not always considered acceptable for "organic certification," which does not limit it to being included in food waste compost but may not allow this compost to be used to grow specifically organic certified foods. This solidified my decision to continue using both gelatine and agar, the two most successful bonding agents from my experiments, in my concept presentation—unlike agar, gelatine could be used to produce both certified organic and regular compost soil, yet agar could provide a vegan alternative for consumers.

Bioplastics can address two needs in one product: using the excess food waste discarded from the dining halls (specifically fruit peels from oranges, apples and bananas) both from UO kitchens and consumers (eliminating a portion of post-consumer food waste that might otherwise go to landfill) to create a bioplastics which easily biodegrade, with or without a composting facility. Students could use containers made of fruit-based bioplastic material, and once finished, discard them in compost bin with proper guidance and education. Then, student sustainability ambassadors, in partnership with Zero Waste, bring the compost to larger pre-consumer compost pile for Rexius composting to pick up. Otherwise, the biocontainers can be brought to a local garden on campus or a nearby farm to nourish the soil. The fruits used for smoothies and other campus dishes that require oranges and apples could also be sourced from local farms, used on campus, and then be returned to local farms to create a smaller resource transportation loop.

Biocontainer Implementation

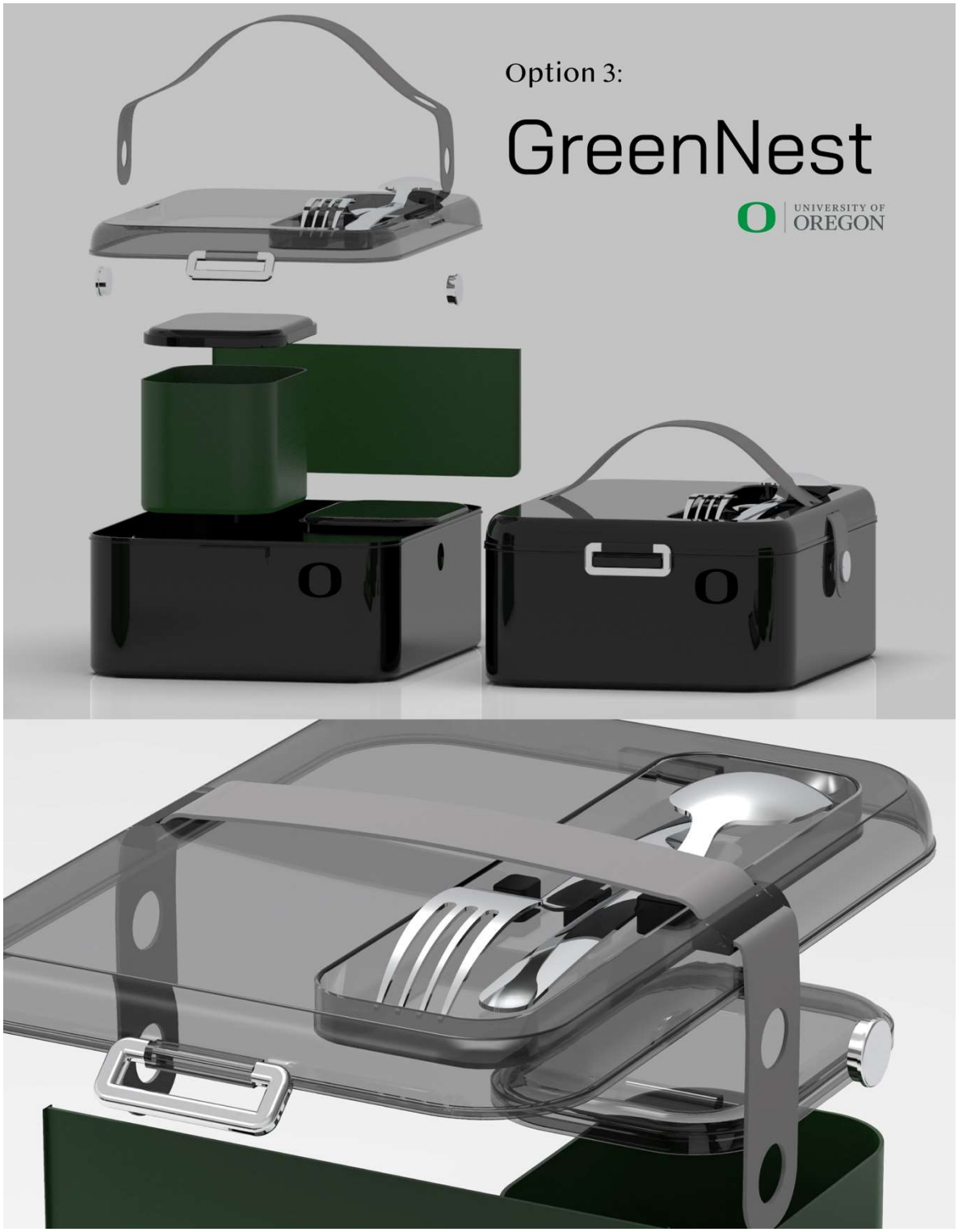
Using byproduct fruit peels, biocontainers can be produced on campus and distributed as the single use option, for an extra 50 cents. With the guidance of student sustainability ambassadors and simple campus signage, students will be guided and encouraged to accurately sort their biocontainer and food scraps into a compost bin on campus after they are done eating. Then, student sustainability ambassadors (in partnership with Zero Waste and the Office of Sustainability) will ensure that compost bins are sorted and brought to compost piles to be taken to Rexius Composting. Otherwise, they may also be taken to a local garden to break down.

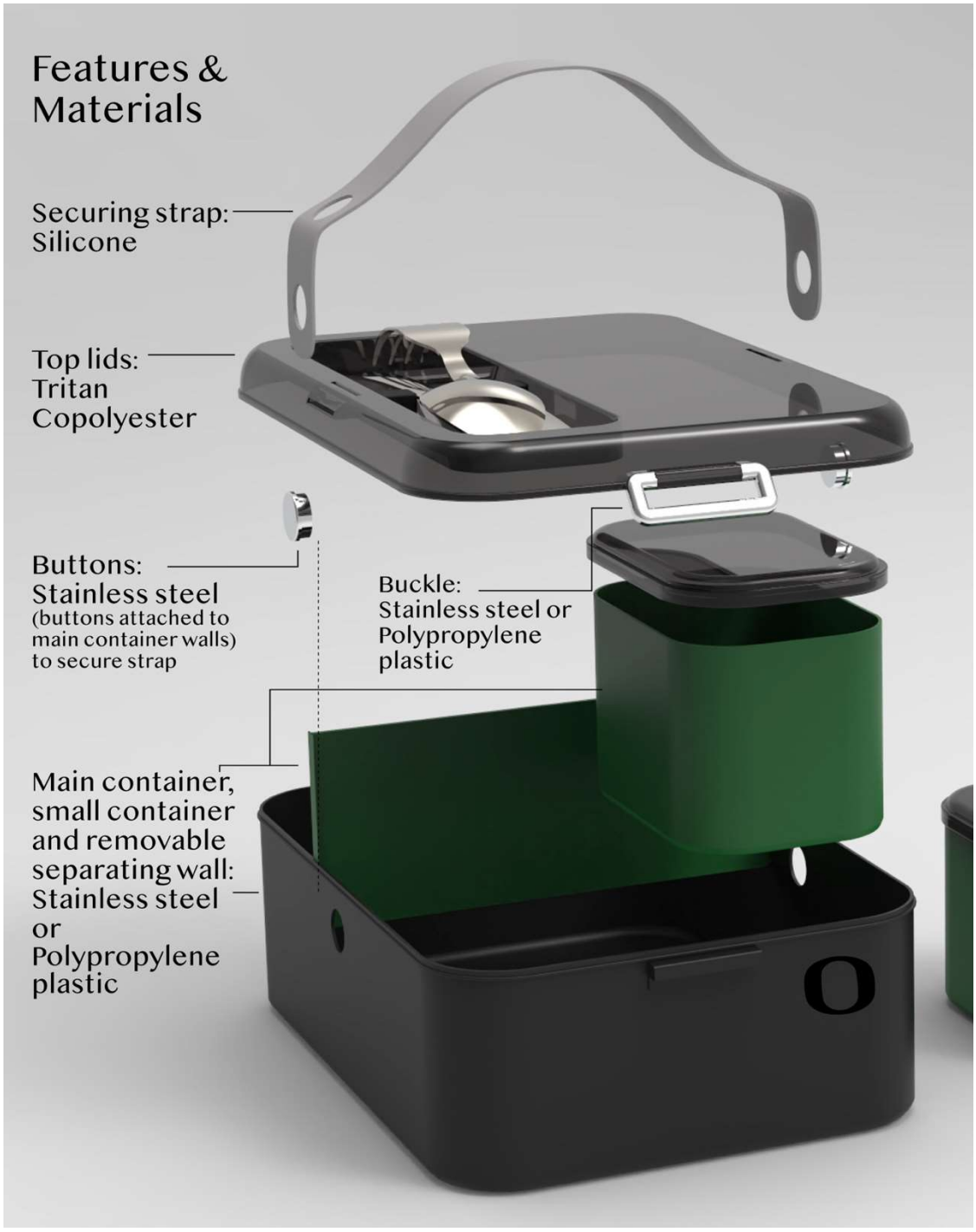
Fig. 23. Biocontainer degradation from July 29-August 26

Source: Created by author.

I conducted informal material testing to measure the speed of the biocontainer degradation process. After less than a month of the biocontainers sitting in a garden, they had nearly broken down completely into the soil, without any specific aeration practices or added carbon mix to facilitate the biodegradation process. This experiment indicated that the biocontainers could easily be broken down in a compost facility, and even be brought to local gardens near or on campus to break down.

4.7.3 Option 3: Complete Container Redesign

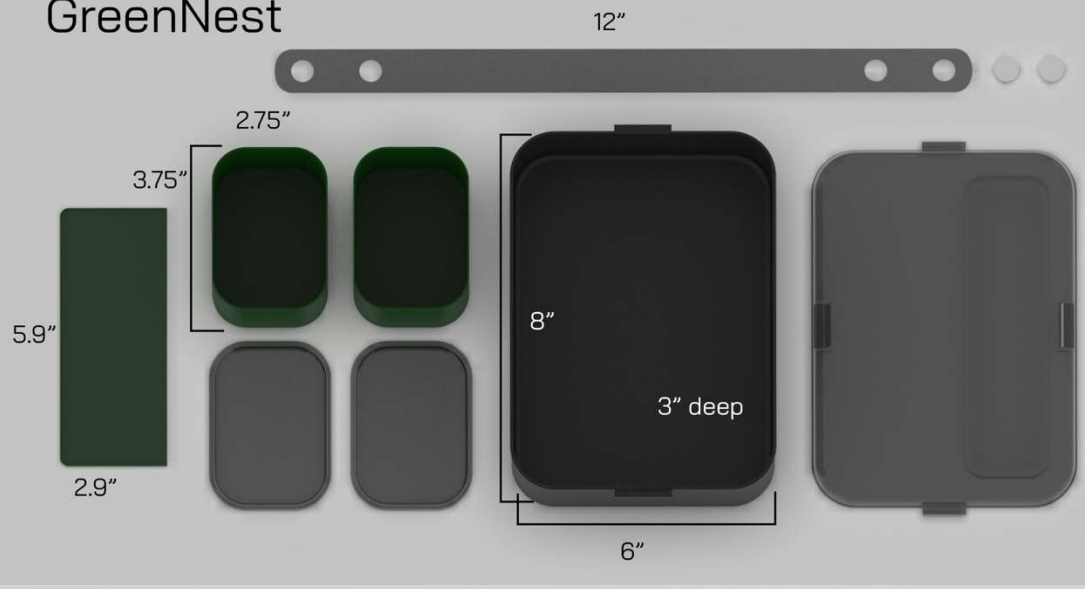



Features &
Materials
Securing strap:
Silicone
Top lids:
Tritan
Copolyester
Buttons:
Stainless steel
(buttons attached to
main container walls)
to secure strap
Buckle:
Stainless steel or
Polypropylene
plastic
Main container,
small container
and removable
separating wall:
Stainless steel
or
Polypropylene
plastic

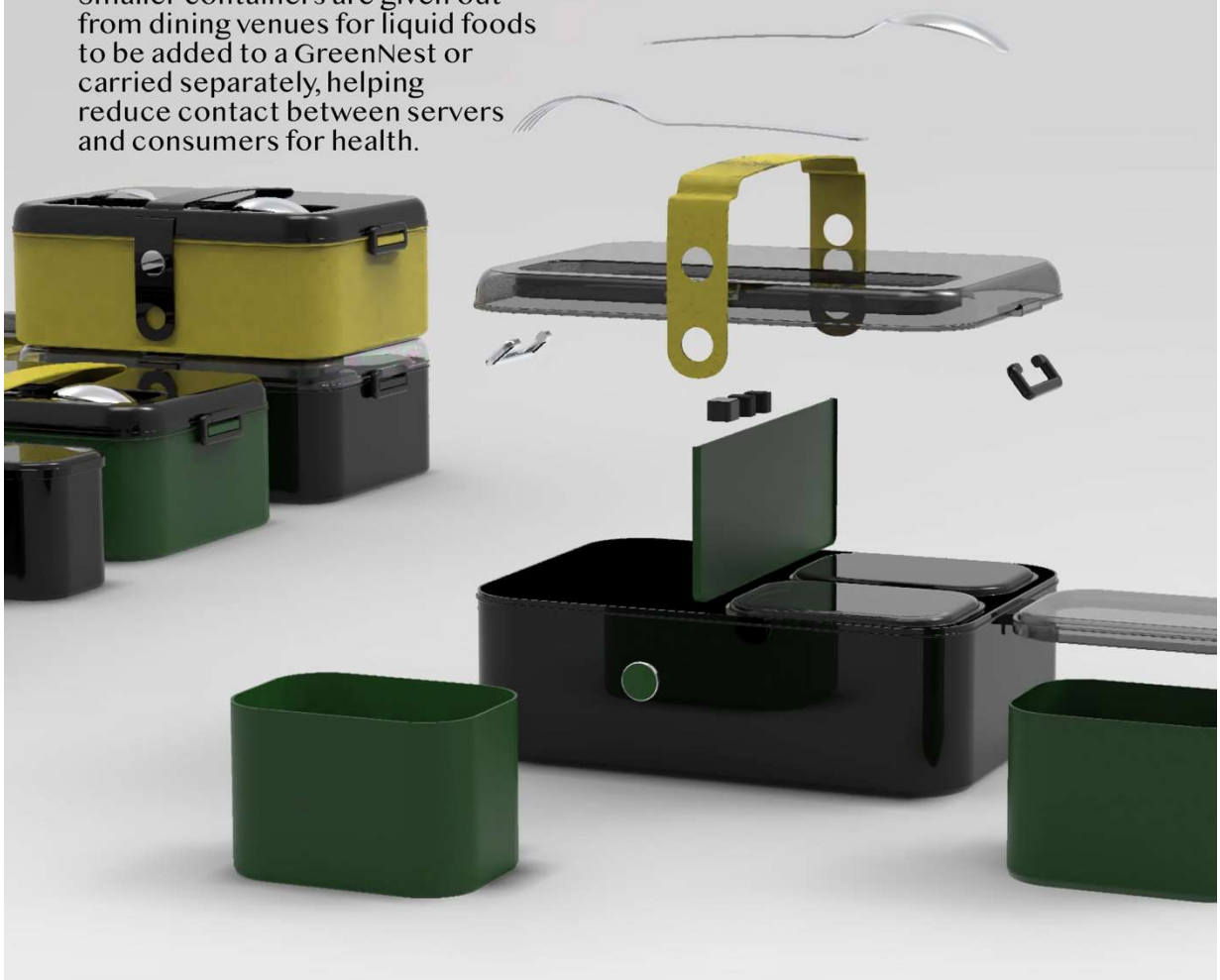

Strap stretches and secures two GreenNests for seamless stacking and transport
Cavity with ridges to hold reusable silverware
O
Stackable

Reducing food waste through smaller portions

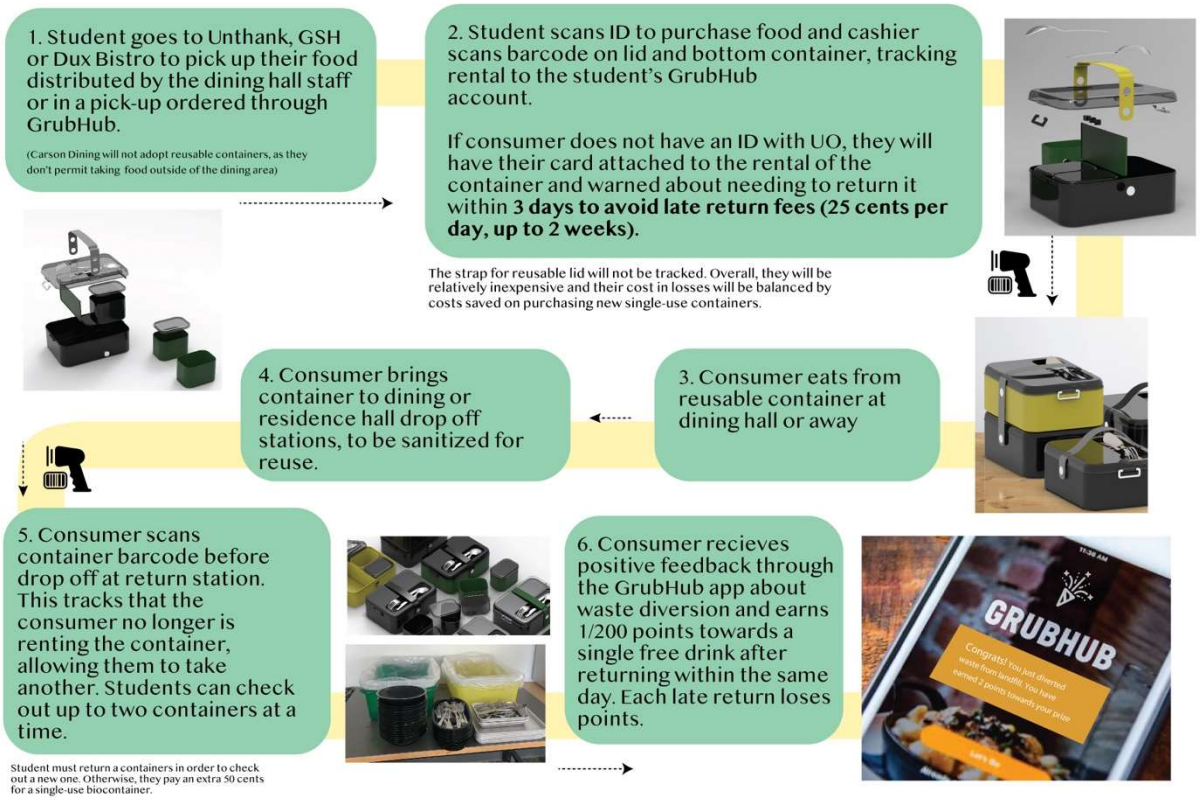
Components & Dimensions of a GreenNest



Smaller containers are given out from dining venues for liquid foods to be added to a GreenNest or carried separately, helping reduce contact between servers and consumers for health.



GreenNest Implementation



The GreenNest implementation is similar to that of the reusable lid design. Each time a student scans their card to pay for a meal, the cashier also scans the container barcode to rent that container to the student. The barcode of the top and bottom of the container is then tracked to the student's GrubHub account when they pay at the cashier, and they become responsible for returning it to the university dining hall (scanning it back in) to check out a newly sanitized container at their next meal. Students may only have two containers checked out at a time to ensure that containers remain circulating through the dining system and there is not enough time for any mold to build within a used container before it is washed. If two sets of the lid and bowl are not returned to the dining hall (tracked through the student account), students cannot grab another sanitized container in which to buy their next meal and must opt for a single use option for an extra 50 cents. If not returned after 3 days, the lid and container rental will begin accruing

late return fees at 25 cents per day, for up to two weeks (at the end of which, the student will have paid for the price of the container). Once students bring back their lid and bowl, it will be washed, and students can rent out another set when they pick up their next meal. Each time a student uses and returns a container set, they earn points towards a free drink from the dining hall and are informed of their diverted waste from landfill through the GrubHub app.

4.8 UO Dining System Redesign Steps

Fig. 24. UO Dining System Redesign Graphic.

Source: Created by author.

While a significant portion of this redesign has been dedicated to the packaging solution designs (addressing steps 4 & 5), the system redesign should also include improved tracking and assessing (1), source reduction (2) and donating food to people and animals (3).

Step 1: Tracking and Assessment. Based on my initial conversations with UO Dining management, LeanPath is not consistently enforced in practice as part of the UO Dining work tasks. For improving tracking and assessing, UO Dining should increase investment into adequately training kitchen staff to track food waste in LeanPath, promoting the shared goal of reducing overall food waste and discouraging any excess food purchases. This entails menu planning and proper food storage, as recommended by EPA guidelines.

Step 2: Source Reduction. UO Dining can more accurately make menu planning and purchasing decisions based on more accurate food waste tracking. They can also improve portion sizing through using the GreenNest reusable containers, which have portion control built into its design. Additionally, kitchen staff can be instructed to standardize their portions or serve less upon student request. Trays can be removed from Carson Dining buffet, based on case studies that have demonstrated this to be effective in reducing food waste. Lastly, educational campaigns through visual advertising and peer guidance can help guide consumers take only as much as needed.

Step 3: Feed Hungry People / Feed Animals. Based on case studies from other university outreach efforts to fight food insecurity, UO Dining can increase their efforts to donate excess food to food insecure students and local organizations. Student sustainability ambassadors can volunteer or work to prepare hot microwaveable meals from excess food from the dining halls at the end of each day (including excess hot food from Carson Dining), in addition to donating non-perishable foods. This food can be distributed to student food pantries, Food for Lane County

and various emergency shelters in Lane County. Lastly, UO Dining can adopt a system to distribute excess meal points from residents to donate towards food-insecure students or purchase non-perishable foods for community members in need.

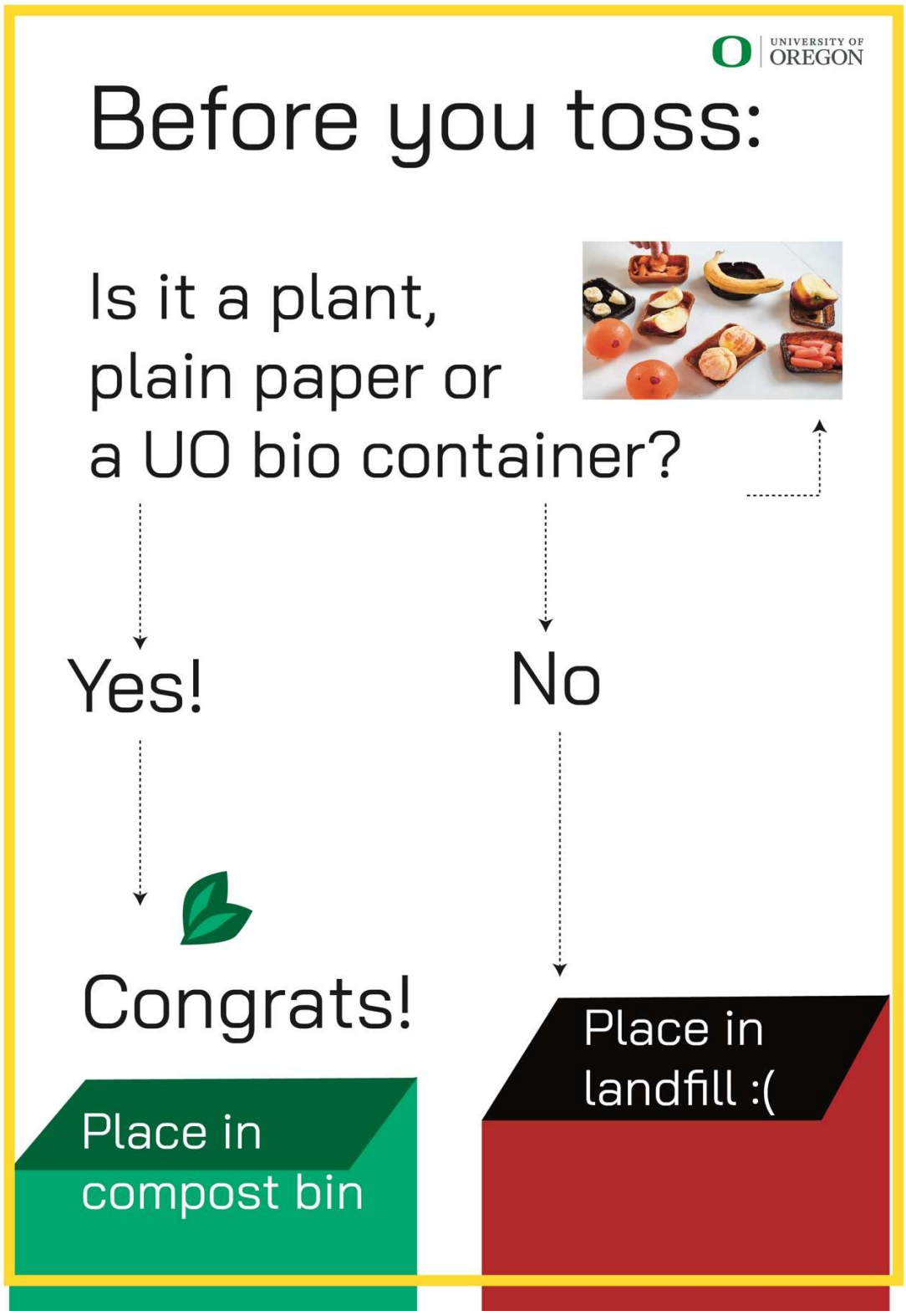


Fig. 25. ComPoster Guide for Educational Messaging.

Source: Created by author.

Fig. 26. Digital Display Example of Student Sustainability Ambassador Advertising

Source: Created by Author.

As shown by previous UO initiatives to implement reusable containers and other university case studies, student ambassadors play a key factor in helping to gain the support of their peers to comply with the reusable container and composting systems. Providing opportunities for student leaders to serve their campus and community through acting as sustainability ambassadors instills a sense of agency and responsibility in the campus community towards improving sustainability practices overall.

Chapter 5: Conclusion

My suggestions for reducing food and packaging waste at UO can be summarized in Figure 24 and the three design options presented: 1) the reusable lid, 2) the biocontainer and 3) the reusable GreenNest container design. The system redesign plan is organized into steps based on the EPA's 'Reducing Wasted Food and Packaging: A Guide for Food Services and Restaurants.' The steps for UO Dining incorporate valuable strategies tested in other university case studies on effective food and packaging waste reduction, encompassing: better food waste tracking using LeanPath, removing trays from Carson Dining buffet, implementing simple and direct educational graphics on food waste reduction and waste sorting (see Fig. 25), implementing initiatives that involve student volunteers and waste ambassadors (rewarded through course credit, volunteer hours or campus job wages) to help guide students on effective composting and helping prepare meals from excess hot and cold food for donation, eliminating single use "compostables" to allow post-consumer compost collection and finally implementing a reusable dinnerware rental system that uses incentives through the GrubHub app.

Overall, my three designs achieved some or most of my design objectives. The reusable lid meets some of the listed CODs as a more affordable option, while the reusable GreenNest container meets most CODs and is the more expensive option. Both options could be complemented with the biocontainer design as a single use option that can enables post-consumer food waste collection for composting.

5.1 Future Directions

While I have attempted to address a wide variety of strategies to reduce food and packaging waste at the University of Oregon, much work remains to be done to make these

suggestions feasible. Feedback from leadership within UO Dining, Zero Waste and design mentors provided valuable next steps to improve the three packaging solution options:

1. Make the reusable strap more sanitary and easily removable on the reusable lid.
2. Make the biocontainer more attractive for commercial use, in addition to ensuring it meets necessary food and product certifications and conduct user testing to determine its shelf life.
3. Prototype and produce the GreenNest reusable container design to determine materials, cost of production and conduct user testing for additional feedback on its usability.
4. Meet with UO Dining, Zero Waste and the Office of Sustainability to further refine and eventually implement sustainable dining recommendations provided in this research.

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