Increasing Food System Resiliency Through Mobile Meat Processing: Atlas Meats

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Abstract

Over the past five years, we have seen many Ohio State Design students tackle the food system to various degrees. These works have laid the foundation for a deeper dive into the food system. The realities of food insecurity, wasteful consumption, and unsustainable industrial farming practices are symptoms of a deeper problem: lack of resiliency and redundancy within the food system. During the COVID-19 pandemic, parts of the United States experienced meat shortages due to outbreaks among workers within meat packing plants. The concentration and consolidation of the meat packing industry into large corporations caused this system to fail quickly. It was not able gracefully extend and adapt resulting in the euthanization of thousands of animals. Introducing on- or near-farm mobile processing would allow smallholder farmers to process their own livestock, providing resiliency within the system. Mobile processing, while available in parts of the U.S., is largely disorganized and detached from the larger meat supply chain. There is a lack of standardization in regulation, business strategy, and construction among mobile processing units (MPU) across the United States. Atlas Meats' mobile processing unit and rental service promotes empowerment of smallholder farmers, humane treatment of animals, education of meat consumers, and sustainable practices. This is accomplished through a standardized unit centered around the user's contextual needs for safe, clean processing and a rental service that encourages upward mobility through comprehensive training and adaptable scalability. The concept could be expanded to meet aquaculture and game processing needs to further diversify the U.S. local food system.

Introduction

At the height of the COVID-19 pandemic, the United States experienced extreme levels of both food waste and food insecurity. Consumers living in food insecure areas struggled to access healthy food while an abundance of food was wasted due to ineffective supply chain methods. It was clear that COVID-19 had exacerbated issues in food access and food waste and revealed that the fragility in our existing food system has been a longstanding problem.

Through further research, it quickly became apparent that food waste and food insecurity were symptoms of a deeper problem: lack of resiliency and redundancy within the food system. This was especially visible in the meat industry. Here, centralization and consolidation of the meat industry into large corporations had caused a rigidity that quickly crumbled due to outbreaks among workers within meat packing plants. The concentration and consolidation of the meat packing industry into large corporations caused this system to fail quickly. It was not able to gracefully extend and adapt resulting in the unnecessary euthanization of thousands of animals while many experienced meat shortages

Introducing on- or near-farm mobile processing would allow smallholder farmers to process their own livestock, providing resiliency within the system. Mobile processing, while available in parts of the U.S., is largely disorganized and detached from the larger meat supply chain. There is a lack of standardization in regulation, business strategy, and construction among mobile processing units (MPU) across the United States. One Edible Boston article described one specific MPU as “a jumble of stainless steel contraptions mounted atop a flatbed trailer,” [21]. This makes mobile processing units and services a ripe area for design to contribute. From semi-structured interviews, online surveys, and secondary research, Atlas Meats was designed to recognize discovered pain points and address the lack of standardization and optimize adoption. Atlas Meats’ mobile processing unit and rental service promotes empowerment of smallholder farmers, humane treatment of animals, education of meat consumers, and sustainable practices. This is accomplished through a standardized unit centered around the user’s contextual needs for safe, clean processing and a rental service that encourages upward mobility through comprehensive training and adaptable scalability.

This project aims to address how design can intervene in untraditional spaces. In this document, readers will find the journey that was taken from understanding food waste and food insecurity to addressing food system resiliency through Mobile Meat Processing. Various expert perspectives ranging from animal science to community development are explored to gain a solid understanding of the underlying causes responsible for the fragility of our food system. The results and main takeaways are reported and the decision to explore increasing agency through decentralization is chosen. Concept exploration results in designing for Mobile Processing. This is followed by the conceptualization process of Atlas Meats Processing, a mobile processing unit and service designed to address food system resiliency and increase agency through decentralization.

Background

Problem Space

During the COVID-19 pandemic, reports of food waste and food insecurity both increased. Reports from farmers ranged from having to dump thousands of gallons of fresh milk, burying one million pounds of onions, leaving lettuce unharvested in the fields, unnecessarily euthanizing livestock, and more [1, 2]. Meanwhile, on the other end of the food spectrum, food insecurity rates were predicted to increase by nearly 50% or about 17 million people [3]. While tons of food were being wasted at the production level, millions were going hungry at the consumer level. From this observation, it was evident there were underlying errors at the systemic level that were causing problems to materialize at the production and consumption level. Primary and secondary research was conducted to understand the underlying causes of this dichotomy.

Methodology

Primary and secondary research was performed on the topic of food waste and food security to understand the relationship between the two issues and what caused the extreme occurrences during the pandemic. The main objectives were to gain a better understanding of our current food system, waste patterns in the United States, food security and consumption patterns, and the implications of locally produced food.

Semi Structured Interview

Semi-Structured Interviews were held with a variety of experts to get perspectives on the various pain points in our current food system. A wide scope of pain-points was gathered; however, specific attention was paid to those that may be contributors to food waste and food insecurity. Stakeholders who were interviewed involve: academics in food system design, food waste, and rural sociology for perspectives on our current food system, interviews with representatives from Buckeye Food Alliance and Charles Nabritt Memorial Garden for perspectives on food insecurity and community development, and interviews with various farmers focused on livestock and dairy as well as engineers and supply chain experts at General Mills for production and manufacturing perspectives respectively.

Online Survey

An online survey via Google Forms was conducted to better discern changing consumption patterns among consumers because of the pandemic. The aim of this information was to solidify an understanding of consumer trends that would affect utilization of the final design proposal.

Secondary Research

Secondary research was conducted to gain a holistic perspective on the problem of food waste and food insecurity as well as explore existing interventions. This research was broken down into four main subjects: Focus, Business, Science and Tech, and the Arts. A later category, Society, was added to illuminate the political and social implications that effect food access. While conducting this research, design conjectures were created as a method of rapid ideation. These design conjectures were assessed in some of the semi-structured interviews to gain expert feedback. The intention behind this was to offer a way to quickly identify preconceived misconceptions and learn from them.

Patterns, pain-points, and insights were then extracted and analyzed to determine the root causes of the breakdown in our system.

Secondary and Primary Research Results

Over the course of the past four weeks, primary and secondary research was performed on the topic of food waste and food security to understand the relationship between the two issues and their current problem scope. Information was then coded and analyzed (See Figure 1).

Main Problem Areas

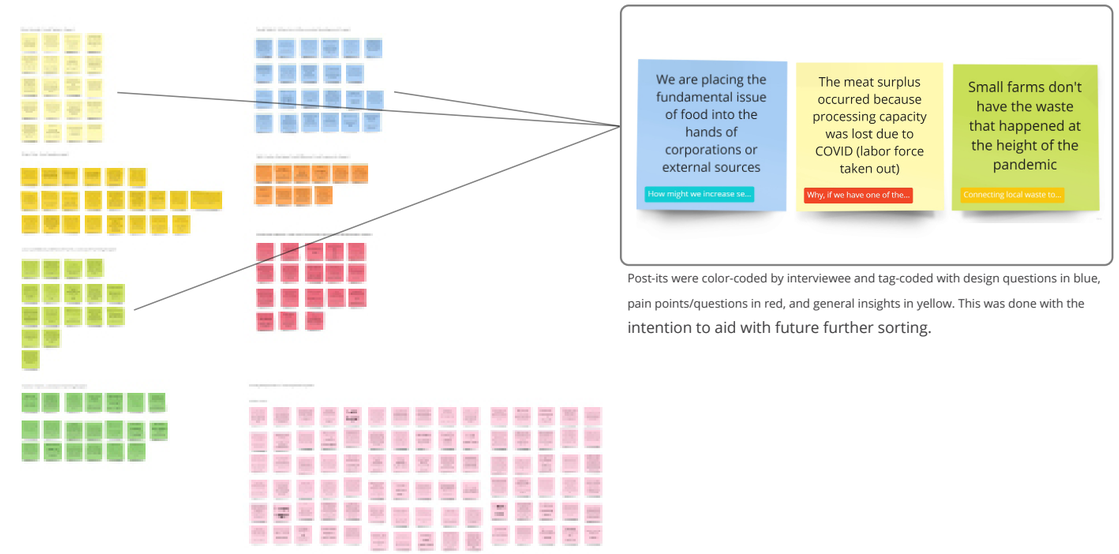
Centralization and Consolidation
In an interview with Brian Snyder executive director of InFACT a "transdisciplinary program at The Ohio State University aimed at designing and implementing food systems that are sustainable" he explains that a large issue in our current system is that it is designed with centralization and profit in mind. For example, in the case of the meat industry, in 2001 four large corporations, Tyson, Conagra, Cargill, and Farmland, owned 81% of the market shares for beef packing [4]. This means that most of the meat we encounter are the products of a few top packers. This pattern persists across a variety of food types including corn, soybean, grains, and more. With this centralization, a select few corporations oversee how food is food gets to our plates; meaning most of the power in growing, processing, packaging, and distribution is concentrated at the top. While this can be good in some respects since it results in a high quantity of cheap food, it can fall short when it comes to quality, health, flexibility, and access.

In the case of the COVID-19 pandemic, due to the nature of centralization, when one cog of the system was threatened, our entire system seemed to break down (see case study 1 and 2). Additionally, with limited other small and medium players to intervene and meet our food needs, we were left with an abundance of food with no way to get to the people who needed it.

Lack of Self-Sufficiency
A prevalence of centralization can also lead to a lack of self-sufficiency. In an interview with Paula Nabrit, the founder of the Charles Nabrit Memorial Garden an urban garden located in Columbus, Ohio, Nabrit recalls how when she was younger, everyone had something growing in their yards. Now instead, she sees people completely dependent on either supermarkets or food pantries. This is especially visible and harmful in food deserts, or as Nabrit describes the more correct term, food apartheid. Nabrit explains that the term food apartheid is more correct because "A desert is a naturally occurring environment, food insecurity is not." Food apartheid is the result of many societal factors; however, this research also argues it is indirectly a result of centralization as well. For example, with the power that comes with centralization, big grocery chains can decide where to build locations based on profitability. This leads to the existence of food deserts in lower-income areas because it is essentially not profitable to build there. Ms. Nabrit explains how profit guides the intentions of large corporations. Despite being an "avid capitalist," Ms. Nabrit laments the effect of this on the control of food, explaining that our society has, to our own detriment, put the fundamental issue of food in external hands.

Global Supply Chain and Narrow Distribution Channels
Our current food system is also characterized by global supply chains featuring narrow distribution channels. On average, our produce travels about 1,500 miles to get from the farm to our table. For contrast, that is a little more than half the length of the U.S (2,800 miles) [5,6]. This is problematic because, again, there is an external reliance on others as mentioned by Nabrit, but there is also the issue that longer supply chains are more likely to be disrupted and less resilient according to an interview with Snyder. Therefore, the way that we get our food is mainly dependent on a brittle external system. Additionally, when we have long transportation and distribution paths, the carbon footprint of the food that you eat becomes larger. This then leads to a larger negative environmental impact, especially if you purchase food from a grocery store and it goes to waste [7]. Furthermore, these narrow supply chains are often highly specialized, meaning they take very specific steps and measures to create the food that gets to our plates. With high specialization comes an inability to quickly adapt if a crisis such as blight occurs. For example, if blight takes out a crop of tomatoes designated to become ketchup, we would not be able to replace them with just any tomatoes because the process is specific to that species.

Disconnect from Consumers
Repeated patterns of a disconnect between farmers and consumers came up throughout the primary research. It was found that farmers tend to be frustrated because consumers lack sufficient knowledge about where their food comes from. Snyder advocates for education at the consumer level so customers have a better understanding of what their food is. Additionally, some advocates for ethically and sustainability raised meats feel as though many consumers do not care enough about participating



Post-its were color-coded by interviewee and tag-coded with design questions in blue, pain points/questions in red, and general insights in yellow. This was done with the intention to aid with future further sorting.

Figure 1: Data from interviews, survey, and secondary research on miro before analysis.

in ethical consumption practices. With this, they see that people are therefore, "voting with their forks" in favor of harmful industries. This is problematic because a lower connection to where food comes from may lead to increased waste at the consumer level. People do not fully grasp the amount of labor, quality of practices, or carbon footprint that go into their food.

Inadequate Labor Conditions
At the core of the meatpacking industries breakdown, was the issue of labor. Meat Packing plants proved to be a fertile ground for the spread of the coronavirus. Workers encountered "back-breaking labor for low wages" [1] consisting of "prolonged closeness to other workers for long shifts of up to 12 hours, exposure to contaminated shared surfaces (such as workstations or break room tables) or objects (such as tools), and close contact during transportation to and from work, such as in ride-share vans, carpools, or public transportation." (8)

Furthermore, in a Kaiser Family Foundation Analysis, it was found that the amount of Hispanic and noncitizen workers in the food sector was disproportionate to that of the total United States workforce. About 33% of all food production workers are Hispanic and 22% are noncitizens. This is compared to the overall U.S labor force where the numbers stand at 17% and 8% respectively. Additionally, food production workers in 2020 are likelier than all workers to have a household income that is 200% below the federal poverty line. This totals out to an income of $12,760 for an individual and $26,200 for a family of four. What's more, Hispanic and Black food production workers are more likely to be uninsured than White food production workers. 31% of Hispanic food production workers and 16% of Black food production workers are uninsured compared to 9% of White food production workers (6). This all adds up to the glaring issue that food production workers, which hold a larger majority of the Hispanic and noncitizens workforce, are more at risk for negative consequences of the COVID-19 pandemic. This is especially so, because this population of workers may face increased barriers to treatment due to lack of insurance and/or reluctance to seek medical care out of fear of "potential negative consequences on their or a family member's immigration status" (9).

So, with difficult working conditions, multiple avenues for exposure, and inadequate safety nets, food production workers face extreme risks to their health as a result of the pandemic. Consequently, when the COVID-19 pandemic hit a labor force that was more at risk for negative consequences, this greatly disrupted the American food system and led to the breakdown described previously.

Lack of Biodiversity
A lack of biodiversity in food systems can prove to be detrimental to food security, especially with the threat

of climate change. Ohioan agriculture is particularly lacking in biodiversity. Currently, Ohio's agriculture consists mainly of corn and soybeans and this has consequences throughout the whole food system. First, this has a negative effect on food security because a lack of diversity and dependence on "key crops" (10), can leave people exposed to harvest failure; especially when climate change causes the need for adaptable varieties that can cope with environmental changes. Second, Snyder touches on the effect of these two crops on the type of diet that results. Corn and soy both require a lot of processing. If these are the two main categories of food grown in Ohio, then the diet outcome is one full of processed foods— a category of food that creates risk for chronic conditions such as stroke, heart disease, and diabetes (11). Lastly, Snyder mentions that Ohio is growing crops that are mainly exported out of Ohio. This leaves us having to import our food putting us in a vulnerable externally reliant position. However, despite all of these negative consequences of a lack of biodiversity, according to an interview with Nick Fowler, the Buckeye Food Alliance Coordinator, many farmers do not partake in diverse farming because it is not profitable for them. While this problem area did not act as a core contributor to the food waste and food insecurity experienced at the height of the pandemic, it still is a key factor for food system resiliency as cases of climate change may cause a similar scenario.

Racial Inequality
According to the paper, Examining the Impact of Structural Racism on Food Insecurity: Implications for Addressing Racial/Ethnic Disparities by Angela M. Odoms-Young, Ph.D., "food insecurity rates for both non-Hispanic black and Hispanic households were at least twice that of non-Hispanic white households" (13). This stems from this country's long history with systemic racism and the implications of it that still stands today. Odoms-young categorizes racial discrimination into two categories: " (1). 'differential treatment on the basis of race that disadvantages a racial group' (disparate treatment) and (2) 'treatment on the basis of inadequately justified factors other than race that disadvantages a racial group' (disparate impact)" (13). The first of the two materializes in the form of past overt racism found in structural systems and policies that still "limits people of color's access to educational and employment opportunities resulting in social and economic consequences that could lead to food insecurity" today (13). For example, The National Housing Act of 1934 essentially "prevented Black Americans from receiving the federally backed loans guaranteed in the policy through a process known as 'redlining'" (14). This restricted Black Americans from the best way of building wealth in America, through the purchase of a home; thus, along with other multi-faceted factors, affecting social and economic consequences today which contribute to food security. The second of the two also materializes in a way that impacts food insecurity. Odoms-Young explains that "African Americans are incarcerated in state prisons at a rate that is five times that of whites. Consequently, policies that restrict employment for individuals who were previously incarcerated could disadvantage people of color, contributing to food insecurity " (13). Thus seemingly unrelated factors at first glance, actually are connected in the way that People of Color living in America interact with our current food systems.

Furthermore, Nabrit explains that the effects of slavery can still be seen emotionally in people of color today. She explains how she sees "Post Traumatic Slave Syndrome" materializing today in the form of unaddressed trauma specifically related to working in the field. She also highlights a study focused on DNA markers of stress found in descendants of Holocaust survivors and questions the same type of impact slavery may have had on Black Americans.

Overall, it is clear the implications of food insecurity and racial inequality are intertwined. An adequate understanding of our current food system requires a consistent acknowledgement of this notion to ensure all perspectives around food security are addressed further along the design process.

Disregard for Farmer Livelihood
After interviewing Matt Keener from Keener farms and Shoshana Inwood a Rural Sociologist at The Ohio State University, it became apparent that the current atmosphere for farming is not ideal. Inwood explained that farms are vital parts of communities, however, they are often disregarded when thinking about developing food systems. Keener mentions that taking care of our agriculture heritage and society is vital to development, and "if we don't, we're not going to survive." Meanwhile, it is becoming more and more difficult to sustain a livelihood as a farmer. Between 2011 and 2018, the nation lost more than 100,000 farms due to "a trade war, severe weather associated with climate change, tanking commodity prices related to globalization, political polarization, and corporate farming defined not by a silo and a red barn but technology and the efficiencies of scale" (15). Additionally, small farmers are disheartened with the consequences of centralization and the government response and feel that "The government is on the side of big farms... and is ambivalent about whether small farms can succeed" (15). Moreover, The Mental Health of farmers has suffered over these past few

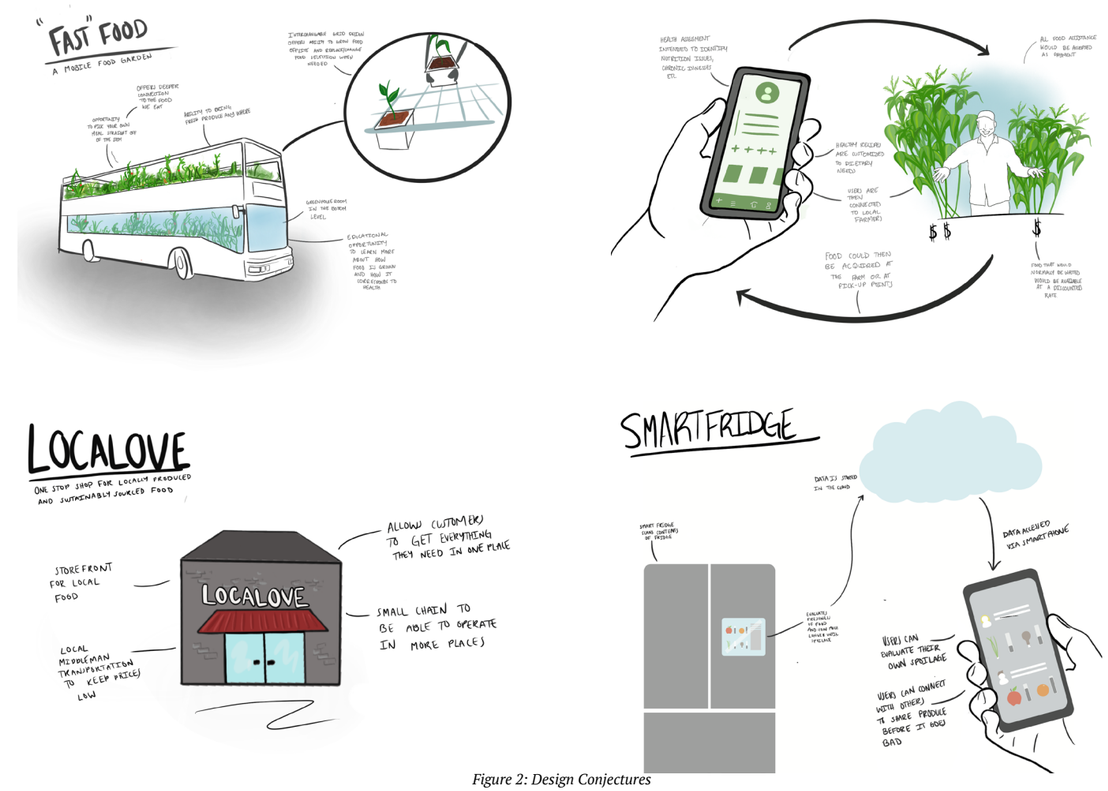


Figure 2: Design Conjectures

years. According to Alicia Harvie, director of Farm Aid's Advocacy and Farmer Services, calls to the 1-800 hotline for farmers in crisis "Were up 109% from last year to the year before" (15). From all of this, It is clearly evident that the consolidation and makeup of our current food system is causing suffering among a vital part of our society.

Design Conjectures

Design Conjectures (Figure 2) were created as secondary and primary research was conducted to explore different possible solutions and uncover any preconceived misconceptions. There were many vital takeaways from this practice. The first main takeaway was that when a system is highly dependent on many variables, it can lead to failure. Additionally, when implementing certain programs or systems, lack of Wi-Fi and transportation needs to be taken into consideration. Furthermore, through this rapid ideation process it was learned that many ideas can quickly turn into band-aid solutions that only as a temporary fix on a broken system rather than addressing the root cause. From this, a key design criterion was formulated: solution must work to address a root cause, not act as a band-aid. Lastly, it was learned that special technology could be exclusionary based on income level so creating a way for new technology to be accessible is vital.

Case Studies

Case Study: Meat Industry
At the height of the pandemic, news reports showed animals in the Midwest meat industry being unnecessarily euthanized due to a slowdown of production lines [1]. Reports also showed farmers in Ohio "dumping thousands of gallons of fresh milk into lagoons and manure pits" [2] while in California, "rows of ripe iceberg, romaine and redleaf lettuce" [3] were left unharvested. The reasons for these occurrences stem from two main factors: a highly centralized meatpacking industry and the loss of main

buyers for farmers with the close of restaurants, hotels, and schools both of which, led to an inflexible food system.

In the case of the euthanization of animals, according to Adam Clark Estes with Vox Recode, this situation may have happened due to the reduced labor force as a result of the pandemic. With such a highly centralized system, when the labor force of meatpacking plants was disrupted, production lines slowed down causing a bottleneck in production, processing, and distribution. This bottleneck materialized in the form of a surplus of animals who were scheduled to be euthanized before the pandemic but now have nowhere to go.

This is illustrated further in a Vox interview: "'If you hold them [the animals], they gain weight and you have to feed them, and that's expensive,' Mary Hendrickson, a rural sociologist at the University of Missouri, told Recode. 'And if they gain too much weight, then they're going to be too big to be processed in these very standardized meat plants, like Smithfield…So you might try to hold them up' and keep the animals waiting in a feedlot, Hendrickson added. 'Or you're going to kill them, euthanize them'" [1]

With meat processing capabilities in the United States down by about 40%, according to an interview between Vox and Jayson Lusk, an agricultural economist at Purdue University, "that amounts to 200,000 pigs that won't get sent to slaughter, [in the pork industry alone] because the meatpacking plants that would process them are closed or otherwise unavailable" [3].

Case Study: Dairy and Produce
The Dairy and Produce industries were mostly hit hard by the shutdown of schools, restaurants, and hotels. When shutdowns happened, these industries lost major buyers for their products. With a surplus of products, it was difficult for industries to quickly adapt. For example, "logistical obstacles" [4] prevented many dairy processors from quickly pivoting because machinery was designed for bulk packaging rather than retail-friendly packaging. In fact, "To repurpose those plants to put cheese in the 8 oz. bags that sell in grocery stores or bottle milk in gallon jugs would require millions of dollars in investment" [4]. Additionally, while some surplus was donated to food banks, limited storage, volunteers, and transportation acted as a constraint on the amount charities could accept. As a result, many food products were wasted.

Both situations highlight the rigidity of our current food system; once a disruption, in this case the pandemic, occurred, our current food system showed itself to be lacking in the ability to quickly adapt and be flexible. This can and will pose continue to pose issues in the future as different crises such as those related to climate change emerge.

Survey Results

Through the online survey, it was found that the circumstances of the pandemic have led to an increased reliance on ordering and food delivery services. However, despite this, there is an increased awareness and intention surrounding consumption habits as well as an increased desire to connect more to our food.

Main Takeaways

Overall, it is evident that the centralization of our food system, lack of self-sufficiency, and narrow distribution channels has led to a lack of self-sufficiency and brittleness. This brittleness then created a lack of resiliency which resulted in major breakdowns and bottleneck effects during the pandemic.

Moreover, with this current state, both citizens and our current farming communities are suffering. A solution moving forward needs to feature a decentralized product, service, or system, that empowers farmers and increases access to food.

Project Development

Problem Statement

Our current food system features a lack of resiliency that inhibits agency and growth for both consumers and farmers. Centralization and narrow distribution channels have led to a brittleness and inflexibility that are exacerbated during times of crisis. This was especially apparent during the coronavirus pandemic.

Consumers are frustrated because they are experiencing inadequate access to fresh food while small farmers are experiencing difficulties in building and maintaining their livelihoods as well as emotional well-being.

Design Brief

There is a need for decentralization within our food distribution channels. Our current system lacks flexibility in times of crisis and disempowers farmers and consumers through a dearth of access and agency. The design questions below are a result of our research and act as a jumping off point for ideation.

How might we equip people through the food system to increase their agency in society, economics, and health?

What touchpoints could be added to the existing food system to increase agency for marginalized communities (incl. All of those) in society, economics, and/or health?

Moving forward, the team recognized that we did not have the power to design and implement a new food system in 8 weeks. Therefore, we decided that it was imperative to design products and services that exist within and utilize that system. Our aim was to create an intervention that offers agency and an opportunity to increase one's social capital, economic capital, and/or increase one's mental or bodily health and wellness.

Specifically, we wanted to create a service with physical or digital touchpoints that offers an increase in agency for small farmers and/or consumers. As learned in the design conjectures and primary research, the solution should be available to those without transportation, should increase consumption of fresh foods, should educate users about where their food comes from and should not be harmful to the environment.

Additionally, since farming has experienced a decline in users, the solution should feature a low barrier to entry. Furthermore, it should be affordable to ensure it is accessible. It should be scalable for various contexts and adaptable in different scenarios and offer diversity in crops. Lastly, the solution should empower self-sufficiency, care for consumers at the forefront and have a focus on connection between farmers and consumers.

Brainstorm

Upon developing a design strategy, the scope was still too broad and the project still lacked a formalized object or service to design. Early ideation revealed a lack of consensus among the team on the project scope and the target audience. Concepts ranged from aerial drones for precision agriculture to systems for increasing biodiversity on farms to delivery apps to link local farmers to consumers. While all of these concepts would have been excellent design projects in themselves, they tended to drift from the scope of the preliminary research and did not fulfill the requirements of the design strategy in a way that satisfied the team.

Drawing on Existing Products and Systems

Advice from a mentor to look to previous innovations within the space of food system resiliency and empowering local food systems allowed the team to

break out of the insular vacuum they found themselves in during early ideation. A list from the Global Knowledge Initiative (GKI) provided an understanding of trends within the global food system and product categories where innovation was needed. This opened up a wealth needed products that the team had never heard of but fulfilled the requirements of the design brief. The GKI report also provided helpful reassurance of the team's direction and validated their assessment of the food system.

From the list, the team selected five interventions of interest: Mobile Education Centers, Cooperative Packaging Solutions, Near-Farm Mobile Processing, Modular Factories, Microwarehousing/Shipping. These interventions were analyzed against the constraints of the project and their alignment with the design criteria. Near-Farm Mobile Processing was chosen because of the opportunity to open discourse through design about empowering farmers, reconsolidating the food system, educating consumers, and sustainable small production.

Once mobile processing was chosen as the avenue of intervention, the team had to decide what would be processed. The constraints were limited to food stuffs raised or grown in Ohio. Generally, the team had too decide whether to focus on meat, animal products (such as milk or eggs), or plants crops (such as apples, maple syrup, etc.). The team chose to focus on meat due to its environmental impact. Small animals would be the focus due to their reduced regulation, greater accessibility to a larger population, and ability to be processed in a contained mobile unit. The team considered fish, rabbits, chickens, and other poultry such as turkey, ducks, or quail. Chickens were chosen because the team was aware of issues with humane treatment of chickens and chickens are the most consumed meat in the United States.

About Near-Farm Mobile Processing

From the the Global Knowledge Index guide, the team learned what processing is, the challenges to smallholder rural farmers, and the potential impact near-farm mobile processing could have. "Processing transforms raw food ingredients into other forms, and in doing so can be used to extend shelf life, improve quality, and ease transportation challenges…" [12]. Access to processing capabilities is important for smallholder farmers because, "…access to processing can mean access to greater income and new markets," [12]. Currently, many smallholder farmers do not have access to processing capability that meets them at their scale because, "… most processing units are industrial scale…The stringent quality, quantity, and timing requirements can be hard for a farmer to meet, especially when he or she has to make the arduous journey to a center of commerce using poorly maintained rural roads,"[18]. It was clear that this was a rich area for impact within the food system.

Interview with Angela Caporelli

This led to another round of primary and secondary research. An early interview was conducted with Angela Caporelli, the coordinator for the mobile processing unit at the University of Kentucky. The University of Kentucky's mobile processing unit (MPU) was introduced in 2001. It was the first of its kind in the nation. Caporelli provided a great history of the successes and challenges faced by the team over the years. Her predecessor, Steve Skelton, financed and built the original unit for poultry processing out of pocket as part of his research. It required extensive review and new legislation with the state of Kentucky, FDA and USDA [20]. Kentucky's regulations for uninspected meat processing are higher than other states. The federal government provides a Producer\/Grower exemption for a small (relative to the industry) number of birds, from less than 1,000 to 20,000, to be processed on-farm without inspection [21].

Due to the prohibitive cost of liability and insurance, Caporelli said Skelton sold the unit to the university for a dollar in 2005. The university's insurance was better equipped to carry this load. The unit also came under greater governmental regulation around this time. It could no longer be fully mobile for processing poultry. Three dedicated sites were built that had septic capability to manage waste output. This output can be and has been used in compost rather than wasted in other states, but Kentucky would not allow this. [20].

Caporelli said that the Kentucky unit started out without a business plan. Skelton's mantra was "Build it and they will come," [20]. Fortunately, this plan worked out in Kentucky. But it has failed in other states [16]. The unit is maintained and financed through a rental cost that covers the costs for the University of Kentucky. The unit was shut down with the shutdown of University of Kentucky due to the COVID-19 pandemic. Before the shutdown, the unit had grown to service all types of domestic poultry, rabbits, and fish from pond or aquaculture farms. Rental of the unit was facilitated by phone call scheduling. All users had to undergo annual training which was facilitated in-person [20].

_At the end of the interview, Caporelli directed the team to Dr. Tony Forshey, the state veterinarian for Ohio. Forshey connected the team to Matthew Smith, the program director for The Ohio State University

Aquaculture Extension. The team did not consult Smith because integrating fish was deemed out of scope due to the time constraints of the project. Smith later reached out to the team expressing interest in the project from aquaculture producers in Ohio. There is a strong potential impact within Ohio for taking this concept and adapting it to include capabilities for aquaculture._

First Iteration

From the interview with Angela Caporelli, a rudimentary sketch prototype of the components needed and the general form-factor of the mobile processing unit was created. A blank version of the prototype was set aside for evaluating new concepts on the fly.

Evaluative Interview: Tim McDermott

A second interview was conducted with Tim McDermott, the coordinator of Backyard Poultry Extension at The Ohio State University. Tim has worked with a wide range of smallholder poultry farmers across Ohio from those just starting raising their first productive animals in urban backyards to generational small farms. He helps connect them to educational information that helps them maintain and advance their operations.

Tim helped chip off a lot of the naiveté that came with the first iteration of the unit and the budding foundations of its rental service counterpart.

Unit

- The unit should be a trailer with a hitch rather than built onto a truck. This will bring down cost of maintenance and make easier for the user to pick up.
- The trailer should be a standard hitch rather than gooseneck for greatest accessibility to the widest group of users.
- The unit should be light enough to be towed by a standard 1.5 or 2.5 ton truck.
- The unit will need to be well-ventilated.
- Keep everything inside the unit to make it easy to hitch up and leave.
- Will probably need two doors.
- Could use an open-air small trailer to make even more accessible.
- Propane for heating hot water needs to be either stored at the farm or very safely secured.
- PPE will be necessary for potential biohazards and cleanliness.

Chickens/Meat

- It is important to keep the bird stress low for both humane treatment of animals and the best quality of meat. One way to do this is keeping live birds separated from the site of slaughter.
- The carcasses will need chilled as soon as possible after evisceration to prevent bacterial growth.

Community and Outreach

- Great potential for allowing people newer to poultry to move up the chain
- People new to chickens will need help beyond processing the chickens for meat.
- The full sequence of new urban backyard grower to full-time farmer needs to be consider
- Regulation needs to be addressed

Service

- There will be a cost to run the unit.
- Waste produced must be handled properly and could potentially be used for composting.

McDermott also provided the team with the document, "Building an On-farm Poultry Processing Facility" [21]. This document helped reduce much of the engineering logistics that were fuzzy before this point, allowing the team to direct their focus toward user experience and creating a pleasant work environment. McDermott's feedback was instrumental in kicking off more refined designs.

Product and Service Development

Market Evaluation

MPU Forms
Mobile processing units in the United States are all self-built or custom works. MPUs have been constructed by individual farmers or farmer cooperatives, organizations such as universities, and mobile processing businesses. The latter are least common, pioneered by Ed Leonardi in upstate New York [21].

It was observed that MPUs lack standardization and an industry unification. This disrupts outreach and adoption, policy and advocacy, and consumer confidence with the source of their meat. Organizations such as Niche Meat Processing have hosted workshops and webinars around mobile processing and organizations such as the New Entry Sustainable Farming Project have published documents like "Building an On-Farm Poultry Processing Facility." This has resulted in the beginnings of a unified language around mobile poultry processing in the United States and extending abroad.

Equipment required for mobile processing includes crates, kill cones, a scalder, a plucker, and chill tanks. Other considerations include an electric stunning knife to render the bird unconscious prior to juggulation. Mobile processing units have also been grouped into open air and enclosed models. Open air units are typically smaller as equipment is able to be consolidated on board and then spread out at the farm. They can be transported on small units like hobby trailers that one would haul an ATV on. Enclosed units tend to be more comprehensive, with tables and appliances installed in place [21]. All MPUs tended to have fairly small windows and lacked work station interior lighting. Lighting was primarily limited to ceiling lights in the center of the unit. This unified kit of parts served as the foundation for the project.

The two units the team was most inspired by for the body of the MPU were the Massachusetts and Kentucky units. A close contact was formed with the Kentucky team and resources are abundant on their work due to its association with the University of Kentucky and its pioneering status. The Massachusetts unit had features such as a separating wall that helped inform the final design. This allowed an extra layer of separation between the cleaned carcass and the dirty barn or pasture. Overall, the existing field of MPUs revealed a need for increasing standardization, cleanliness, and user experience.

Rental And Business Plans
Current MPU rental and business plans mainly focus on the assumption that people will use the unit once it is a available. The Kentucky Mobile Poultry Processing Unit is considered the pioneer of mobile processing units. Angela Caporelli was kind enough to respond for a phone interview to tell us a little bit more about their unit. For this particular unit, "no business plan was written beyond 'build it and they will come.' Fortunately, that turned out to be true" [16]. Additionally, their plan involves all users to take a one-day facility manager training once every two years. For their processing unit, farmers process meat at one of three docking stations in Kentucky. Their model relies on approved docking stations which can be built by farmers themselves or farmers can use existing ones. The MPU cannot be used for on-farm processing. The current model has 10 regular users.

Another model, the Hudson Valley Poultry Processing unit made by Ed Leonardi was designed for personal use as well as renting out to other farmers. In order to keep costs down, Leonardi focused on externalizing most utilities onto MPPU users. An update shows that "after several years of trying to make it work, he stopped offering services to other producers, because working with other small farmers didn't pencil out. Not enough

farmers were willing to pay a per-bird fee that covered Leonardi's cash costs and the time required to work with multiple small farmers" [16].

From this initial research, a hypothesis was made that interest and utilization of a Mobile Processing Unit in Ohio could be increased through targeted training and assistance focused on growth. From the Kentucky Model, their research cites that farmers were interested in "information about feed, labor, appropriate bird types, and business planning and development" [16]. While their unit broke even, a profit could be made by offering more ways for farmers to enter processing through assistance and training. Additionally, targeted training and business development assistance may help incentivize farmers to engage with MPPU's in the case of Hudson Valley Poultry Processing as well.

Evaluative Research

Evaluative research aimed to provide feedback on the hypothesis that an on-farm mobile unit featuring easy to use tools and training and assistance catered to unique skill levels was the best way to create new opportunities for decentralization of poultry processing in Ohio.

Three interviews were conducted to assess this hypothesis. In an interview with Tim McDermott, the layout and user experience for chicken processing in a mobile unit was evaluated. In the second interview with Meat Science experts, Dr. Michael Cressman and Dr. Lynn Knipe, an initial service model (Figure 6) and user experience of the unit were evaluated. The third interview was held with Chris Ratcliffe, faculty lecturer in the Department of Engineering at Ohio State and manager of OSU's student farm the service model was evaluated here as well. In all interviews, participants were asked to evaluate the initial hypothesis and provide feedback on strengths and weaknesses.

The main takeaways obtained from these feedback sessions helped to understand how to diminish bird stress (which aids humane treatment), what kind of form factor would allow for easy transportation, how different personas needs may differ, and potential avenues for building community. In terms of bird stress, the trailer should be designed with the kill section in the back. This is important because the back is easiest to maneuver and easiest to back up right into barns or near coops Loading the birds from the back of the trailer is the easiest transfer of birds from barn to trailer. This offers an opportunity for increased humane treatment because birds remain in the barn for as long as possible, so they do not witness slaughter. Additionally, it was learned that the trailer will need to be transported by a 1.5-2.5-ton pick-up truck and the consideration that not all trucks are able to support gooseneck trailers needs to be taken into consideration. When considering the needs of users for the service, it was pointed out that incorporating a novice persona with no chickens and no experience raising chickens would shift our solution into the realm of raising training in addition to processing training. This is not necessarily a negative consequence; it just means they require additional specific assistance that parallels processing assistance. Ultimately, it was decided that the novice persona should not be included in our final design consideration to keep our scope narrow and focused solely on processing. Instead, the different types of chicken famers were broken down further to address the various needs of farming skill levels. Lastly, it was found that our hypothesis offers potential to increase community engagement and interaction and increasing the focus on building community should be considered.

Service Design Development

When designing the service, the aim was to create a final solution that empowered farmers, educated consumers and new farmers, increased humane treatment of animals, and wase sustainable.

Iteration 1

The first iteration of the service can be seen in Figure 4. This iteration was the first venture into service design and therefore, had many areas for improvement. The main goal of this iteration was to gain a grasp about all that might go into a Mobile Processing Service. However, we quickly realized that this iteration failed to specifically address any of the main criteria above. Also, this solution wanted to explore direct marketing to consumers as well as an uber-esque method for hiring butchers and transport. It was found that these ideas caused a need to narrow scope down to avoid including too much into the system. Additionally, this iteration did not specifically address humane practices or how empowerment of farmers would increase, nor did it offer avenues for education and sustainability. However, as a first attempt, the team made its first venture into service design and learned that the model still needed flushing out.

Iteration 2

The second iteration can be seen in Figure 5. It was found that this solution focused too much on the rental portion of the system, and not enough on the value-added aspect. The uber-esque labor portion and direct marketing was removed in this scenario as well as options for using trained personnel for processing. With this iteration, it was learned that while it improved upon the previous by narrowing scope and addressing two of the four criteria, empowerment through training and education through outreach, it failed to address humane treatment of animals and waste management. Additionally, the training component was found to be a more important part of the overall service, especially in terms of advancing access into the poultry processing. Therefore, training needed to be reevaluated and designed specifically for user needs.

Iteration 3

For this third iteration, initial user personas were created to create a more targeted service and training program (see Figure 6). The idea of having a service based on the various skill levels of the personas was added. Here, users are broken down into three categories, A novice, one who has no experience raising chickens but is interested in starting down the path of self-sufficiency through food, a hobbyist, one who has a full day job but raises chickens as a hobby in their backyard, and the full-time farmer, one who raises chickens for a living. These personas were then used to create the service blueprint/user journey map in Figure 7. This iteration was tested with Meat Science and Poultry experts as explained in the evaluative research. From this, it was learned that while the different user personas were valid representations of needs in the chicken farming world, the novice is distinct from the other two users in that they require more training on raising and maintaining chickens. We also got feedback from mentors that there was a large jump from the hobbyist to the farmer, therefore the farmer needed to be broken down into smaller categories. However, catering a multi-layered service to those different needs was seen as a good step forward. Through this, this third iteration succeeded in addressing empowerment of farmers through various levels to access the service, however, it again failed to address, humane treatment and sustainability through waste management. Furthermore, training was still not differentiated by skill level. Additionally, the format for visualization used in figure 7 was decided to be too complex for visual storytelling means. Therefore, it was redesigned using a method from the book Service Design By Andy Polaine, Lavrans Lovlie, and Ben Reason (17).

Iteration 4

User Personas
In this fourth iteration, the personas were finalized to be: A Hobbyist, A Part-time Farmer, A Full-time Farmer and a Chicken Whisperer (Figure 3). The novice was removed for the final iteration because it was decided our scope should focus only on empowering those who already have chickens to increase their development in the poultry industry. Eventually, the novice may be added onto the design as a potential path for expansion but for the sake of the timeline for the class, it was removed. Additionally, the farmer persona was broken down into part-time, full-time, and chicken whisperer to better represent the needs of those new to farming and those who are more experienced.

Service Blueprint
The final iteration of the service blueprint features a chart with the different touch points and options users can engage with when renting through our mobile processing service (Figure 8). Targeted training was added as well as customized crew assistance to ensure that anyone, at any level can feel confident with processing. Community engagement options were added as a way to connect farmers to each other and surrounding communities as well as a way to educate consumers about where their meat comes from. Humane treatment of animals is addressed in training modules as well as through those community engagement options. Lastly, waste management is addressed with industrial sized composting that would take place on a central plot of land at a possible office location. The waste should be able to be composted as long as there is a sufficient distance from water sources.

Features of the final service are explored more deeply in the following section.

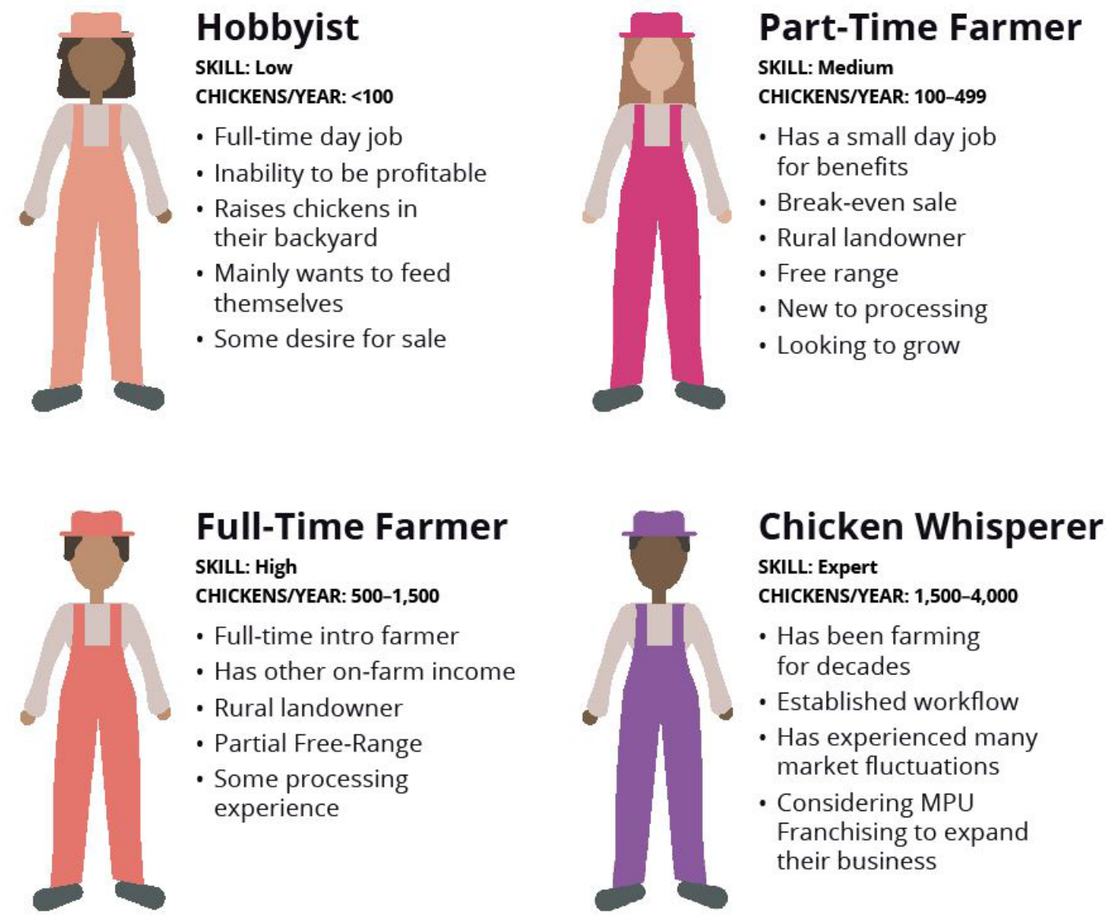


Figure 3: User Personas

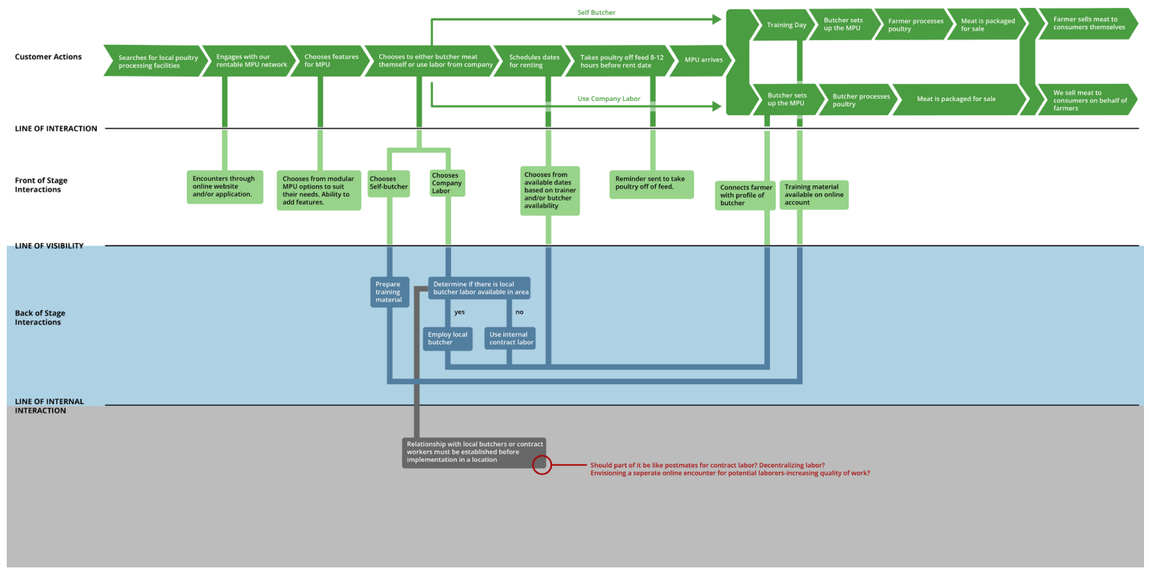


Figure 4: Iteration 1

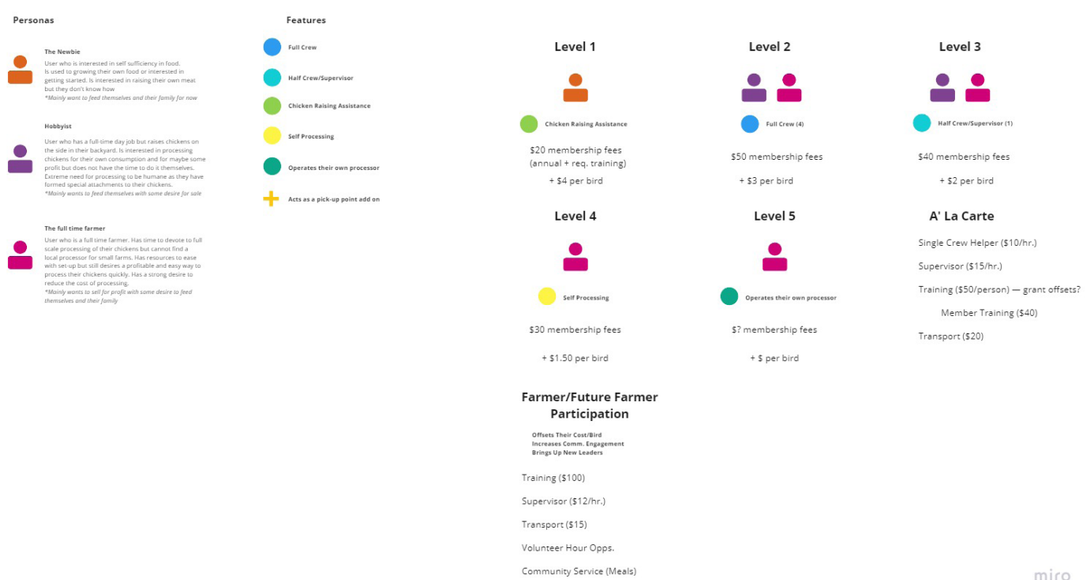


Figure 6: Iteration 3 Concept

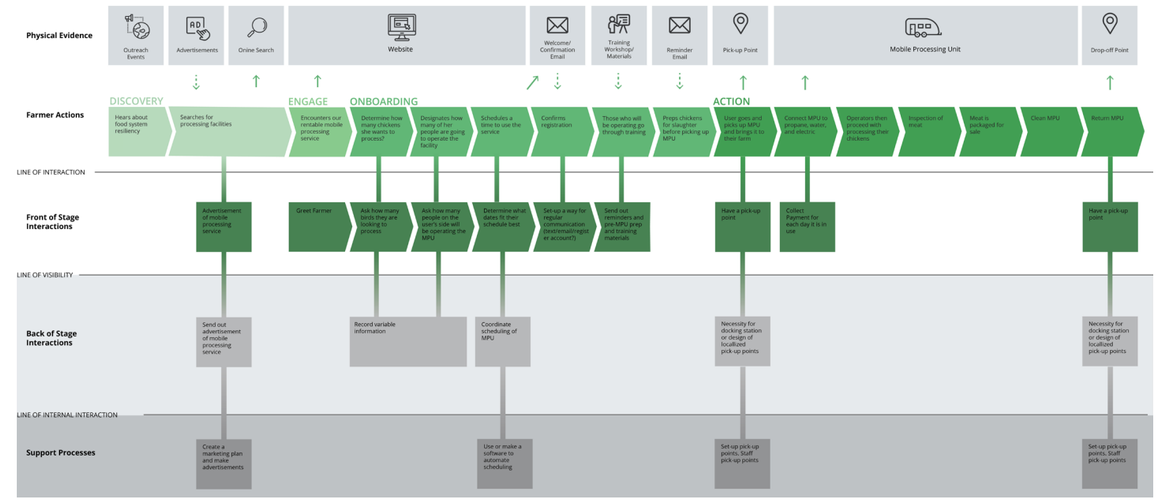


Figure 5: Iteration 2

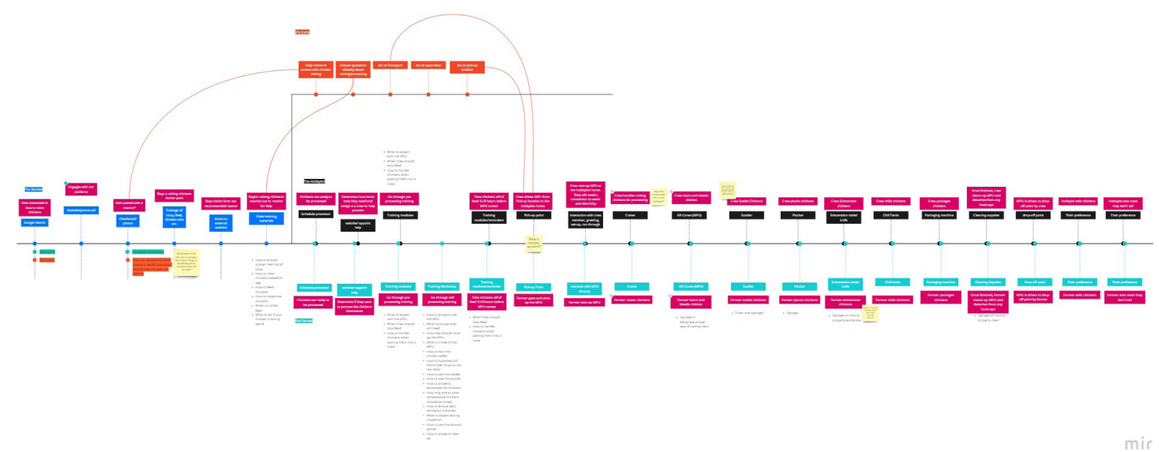


Figure 7: Iteration 3 Map

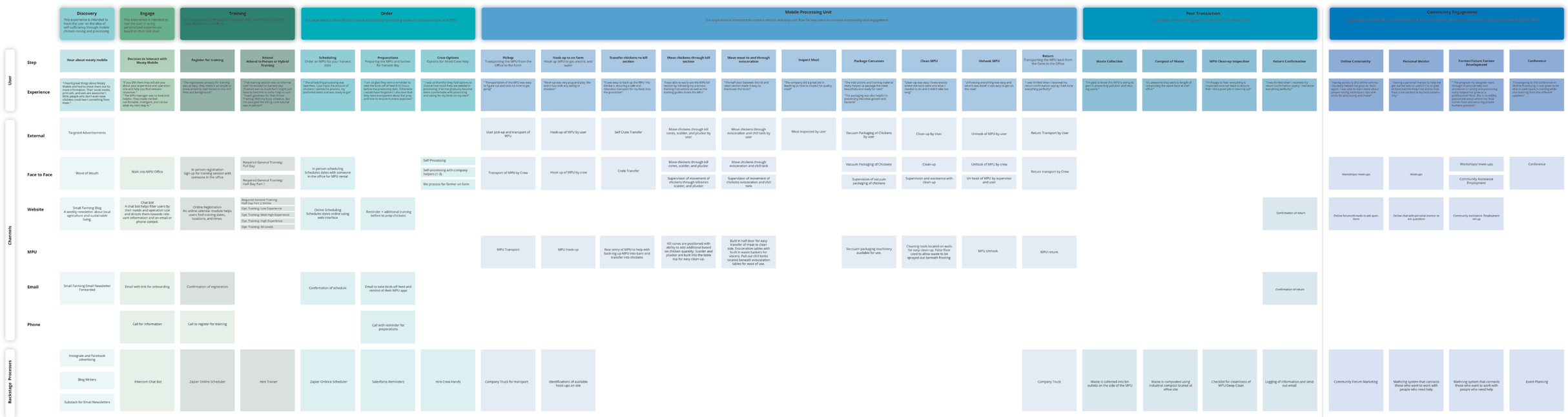


Figure 8: Final Iteration of Servcie Blueprint

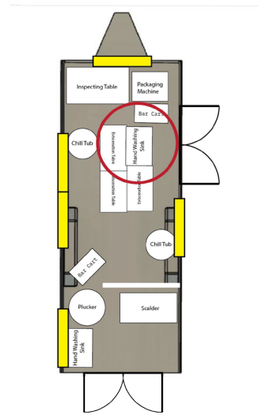
MPU Design Development

The design of the mobile processing unit consisted of three phases: determining the necessary components, creating an ideal floor plan, and integrating new features to improve the user experience.

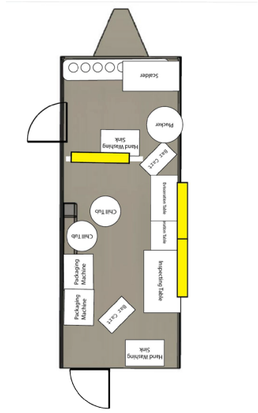
Determining Necessary Components

During the initial evaluative interview with Tim McDermott, he shared the document, “Building an On-Farm Poultry Processing Facility.” The document contained a full description of the items needed to make a do-it-yoourself mobile processing unit for poultry. Multiple case studies from across the United States showcased the diversity of ways different locales had constructed these units. An outline of the steps for processing chickens was developed and the tools needed to accomplish them.

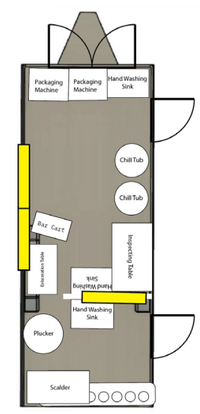
Thumbnails of an intial twenty floor plans led to three favored designs displayed in Figure 1. These designs arranged necessary components based on feedback from our early interviews and best practices and lessons learned outlined in “Building an On-Farm Poultry Processing Facility.”



- **Central Evisceration Table** allows multiple people to work around it.
- **Double Doors** allow easier movement of people and chickens/meat in and out.
- **Large windows** increase natural light inside the MPU.



- **Separator wall** keeps clean and dirty sections separate
- **Interior Window** allows a unity between clean and dirty section and increases light in dirty section.
- **Flipping the back and front sides** allows clean chickens to exit the back.
- **All waste** would leave the right-hand side for easy gathering.



- **Proximal Evisceration and Inspection** allows one person to use the space more efficiently and keeps hand washing close.
- **Double Window** in the back would allow meat product to be passed out to a truck bed.
- **Evisceration Table Close to Plucker** allows quick transfer from clean to dirty.

Figure 1: Three favored MPU concepts from early ideation and their attributes.

Progressive Sketches Using 3D Underlays

After thumbnails, a rough 3D model of the unit was developed and used as the basis for a series of iterative perspective drawings to explore the positioning and design of the items within the unit.

After meeting with Dr. Lynn Knipe and Dr. Michael Cressman, direction for the chill tanks and the need for cleanliness became clear. Due to the scale of the object, many features were expressed in notation and iterated on within the CAD program.

Features of the final MPU design are explored in detail in the following section.

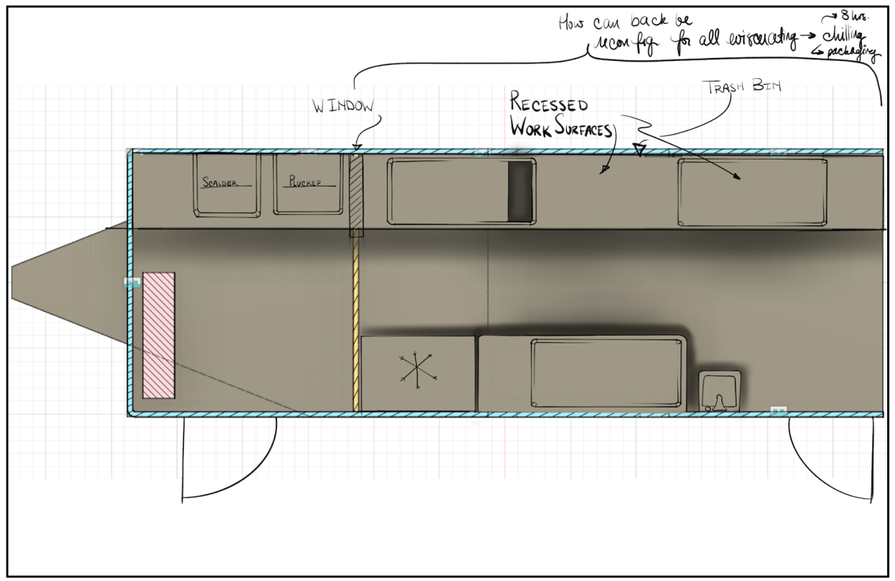


Figure 2: A plan view beginning to design the layout of the workstations and the counter.

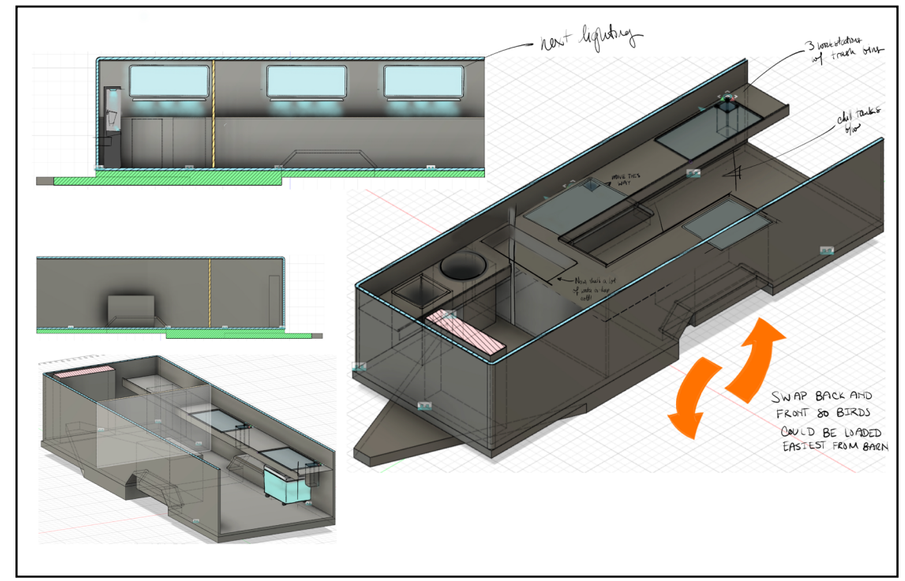


Figure 3: The CAD model was modified iteratively alongside sketch overlays.

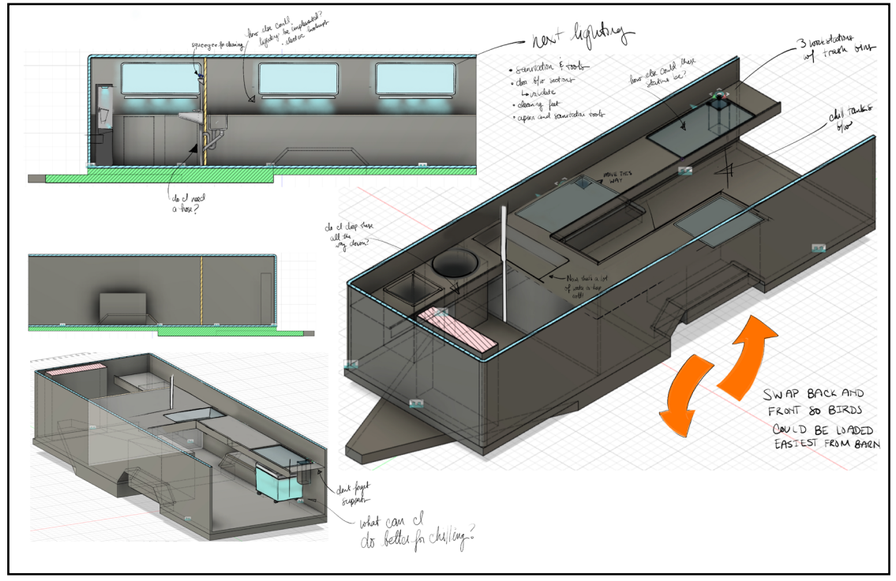


Figure 4: Planning for CAD helped determine next steps.

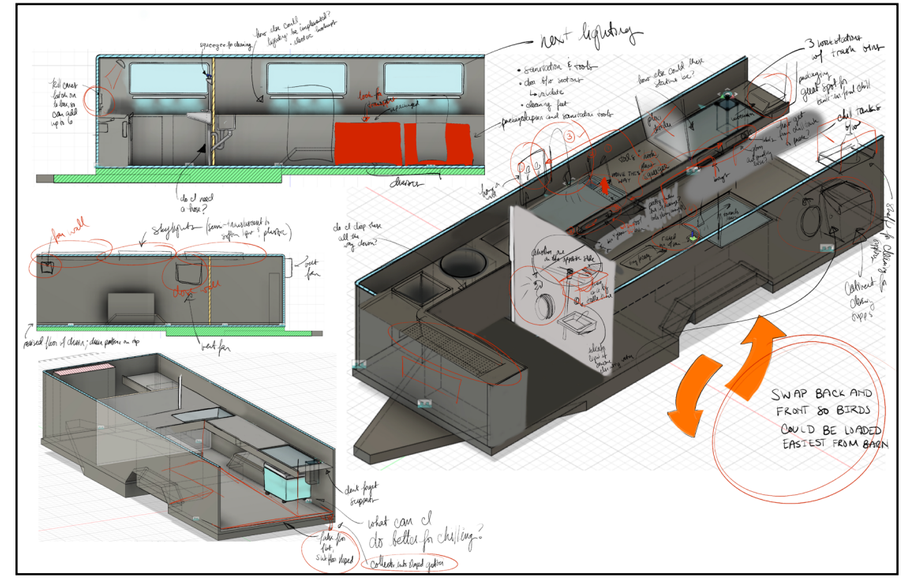


Figure 5: Final changes before CAD led to an installed drain for the kill cones and cleaning equipment.

Final Service Design

The four main goals of the service are to offer standardization in offerings to promote initial engagement, access into the poultry industry through targeted training, agency through on-farm processing, and opportunities for community expansion (Figure 1).

Feature Breakdown of the 3D Blueprint

The 3D Blueprint provides a helpful presentation tool to distill down the complexity of the Service Blueprint into a digestible form.

Standardization to promote Engagement

The service offers two main different options for engaging with different users. The first is an online website and the second is in-person interactions at an office location. The option to use an in-person facility was designed to address issues in inadequate access to Wifi as realized during the design conjectures. The purpose of this is to ensure there is a standard for first engaging with the MPU that addresses different lifestyles.

Access Through Targeted Training

The service strives to offer a platform for growth into and through the poultry industry. It does do by offering optional training modules catered to skill level. Additionally, users have the option to choose how much assistance they need. These touchpoints are meant to facilitate the transition from hobbyists to chicken whisperers if users desire.

Agency by Bringing Processing to the Farmer

This service chose to design a solely on-farm mobile processing facility to maximize agency for users. This way, users do not waste valuable time driving to processing facilities that are hours away and may be backed up or running slow.

Opportunities for Community Expansion and Engagement

The service also offers opportunities for users to have personal mentors, access to online communities, conferences, and a farmer and youth development program. Here, each of these is intended to build community as suggested to us in our evaluative research. Users can not only get to know other users but also can interact with people outside of the community and teach and learn about where food comes from. Additionally, with the development program, the aim is to offer further opportunities to educate youth and others about food systems through employment in our service.

Service Blueprint

The Service blueprint offers the holistic version of our service and all of the different touchpoints users can interact with (Figure 8).

Discovery

The first part of our service is discovery. Here is where users will first hear about Atlas Meats Processing Service. This will mainly be facilitated through targeted advertisements, small farming blogs concerning

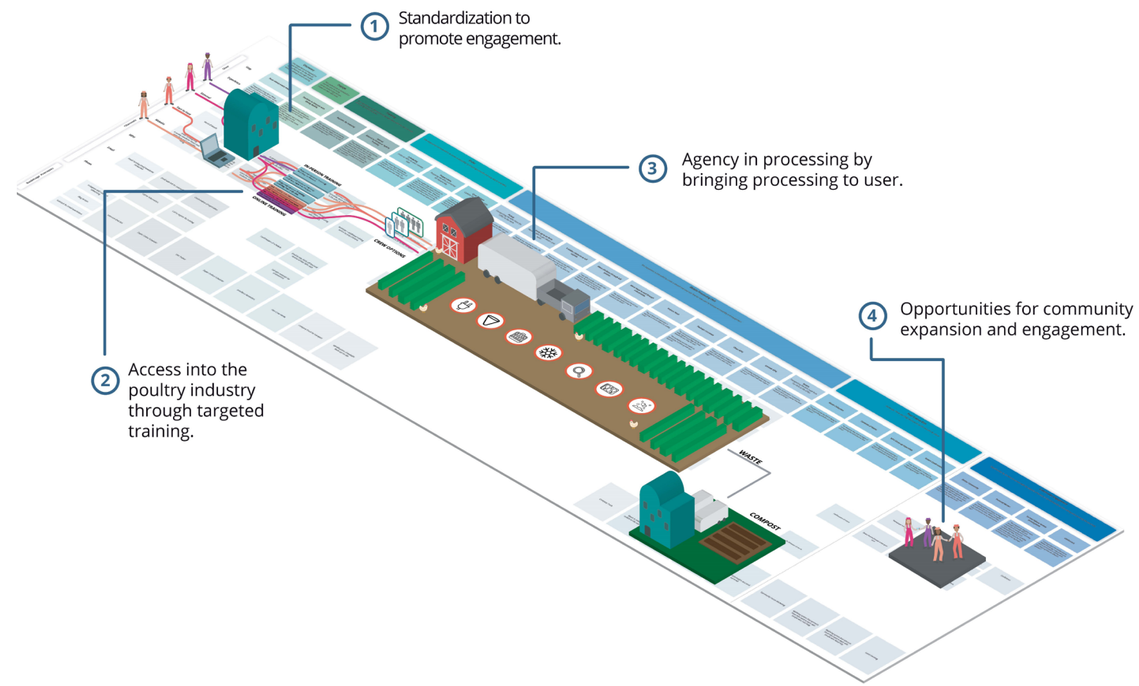


Figure 1: 3D Service Blueprint

sustainable living, email newsletters, social media, etc. The aim of this step is to illustrate the benefits of decentralized processing and its ability to increase resiliency and sustainability in our food system

Engage

The next part of our service is the engagement portion. This is where users make the decision to interact with Atlas Meats. They can do this by either heading directly to the office location, going onto the Atlas Meats website, sending an email, or calling. Again, the goal hear is to provide standard methods for interaction, so users know what to expect. The two main methods of interaction are face-to-face and the website options, however Atlas Meats would provide the other methods of communication as well for easy access purposes.

Training

After users decide to engage with Atlas Meats, they must register for training before being able to rent an MPU. The training is divided into two main categories: Required General Training and Optional Skills Based Growth Training. To rent an MPU, no matter your skill level, users to go through the required general training. This was intentional to address the education criteria. The aim here is to ensure that everyone is more educated about how processing works, even if they decide to have a crew process for them. The general training is offered as a full day all in-person training or a hybrid half in-person half online training. This was designed to offer flexibility for users of different backgrounds and lifestyles. The Optional Skills Based Growth Training was designed to offer a way for farmers to grow their skills. Here, farmers are met at their skill level and can choose modules based on experience. They can then move throughout the various experience levels to grow and build their skills at their own pace. This is intended to address the disregard of farmer livelihood seen from primary research by offering assistance and methods for business development into the poultry industry.

Order

After training, users can then schedule their MPU rental date. Here, users can choose their level of desired assistance. They can decide between self-processing, Self-processing with company helpers (1-3), or having Atlas Meats process it for them. Additionally, Users sign up for reminders here to aid in preparing their chickens for the harvest date. Users can also choose whether they would like to pick-up the MPU or if they would like a crew to transport it for them.

MPU

The MPU is then transported to users based on their preference. It is hooked up to electricity and water sources on site. Users are asked to provide propane as well. The MPU is specifically designed to aid and assist the humane processing of birds. As explained before, the MPU features various design elements to aid in the accessibility and suer experience of the unit. Kill cones in the MPU are positioned with the ability to add additional cones based on quantity. The scalder and plucker are built into the table-top for easy cleanup. There is a built-in half door, for easy transfer of meat from the kill side to the clean side. Then, evisceration tables are designed with built in waste baskets for viscera and pull-out chill tanks are located beneath the tables for ease of use. Once the meat is inspected by the user, it is packaged using a vacuum packaging machine and chilled. The MPU is then cleaned by the operators, unhooked, and returned.

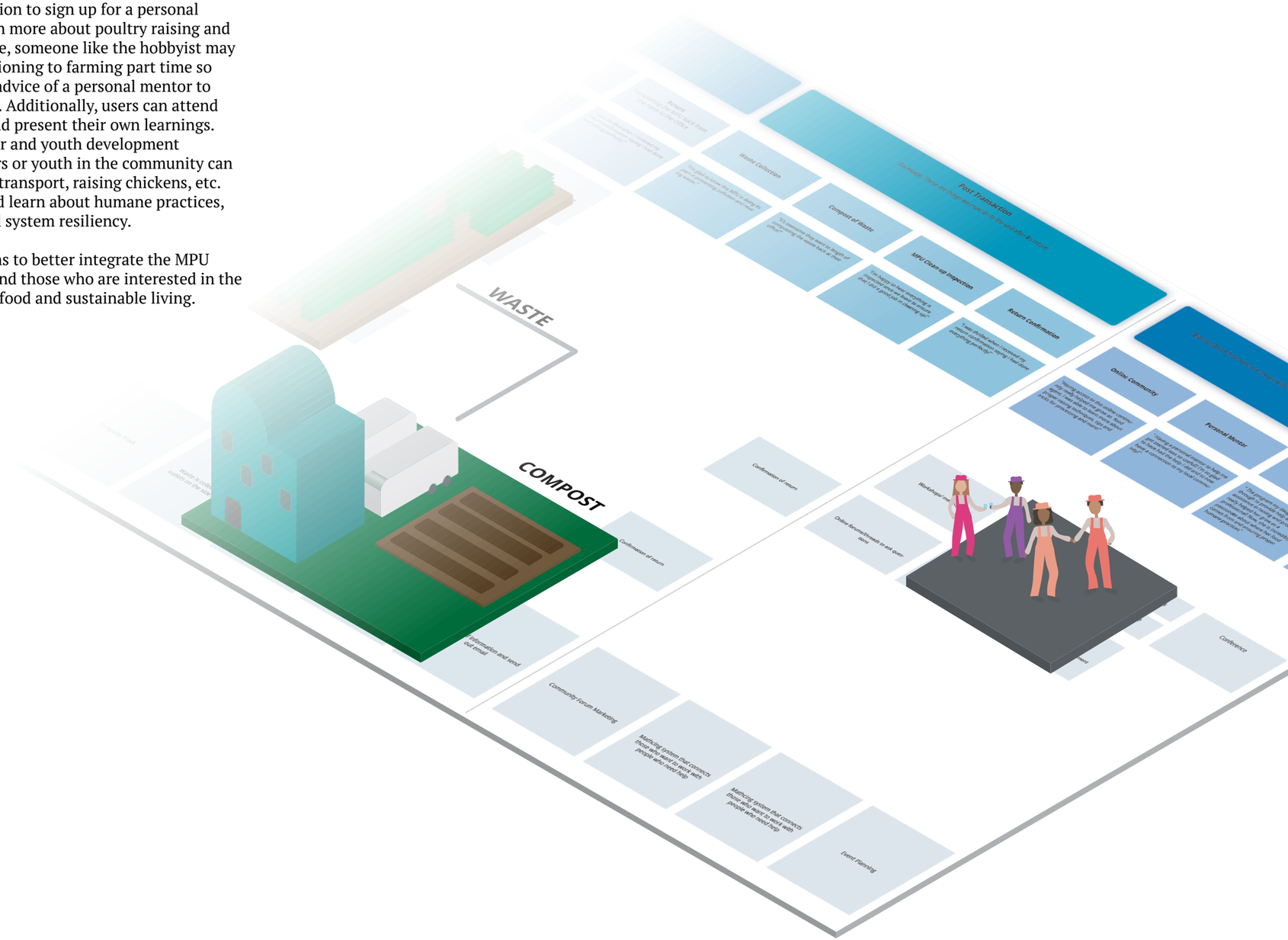
Waste Management

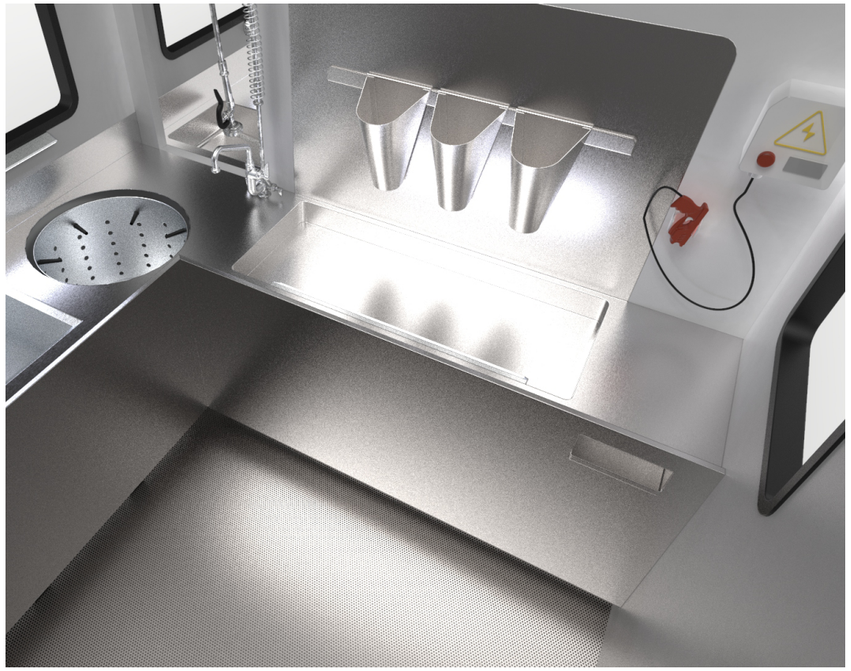
The waste from processing is then collected in outlets on the side of the MPU and transported to an industrial compost facility located at the office site. The MPU is then inspected by Atlas Meats to ensure cleanliness and users receive a confirmation of return based on assessment of MPU on return. This component of the MPU service aims to increase sustainability by composting waste.

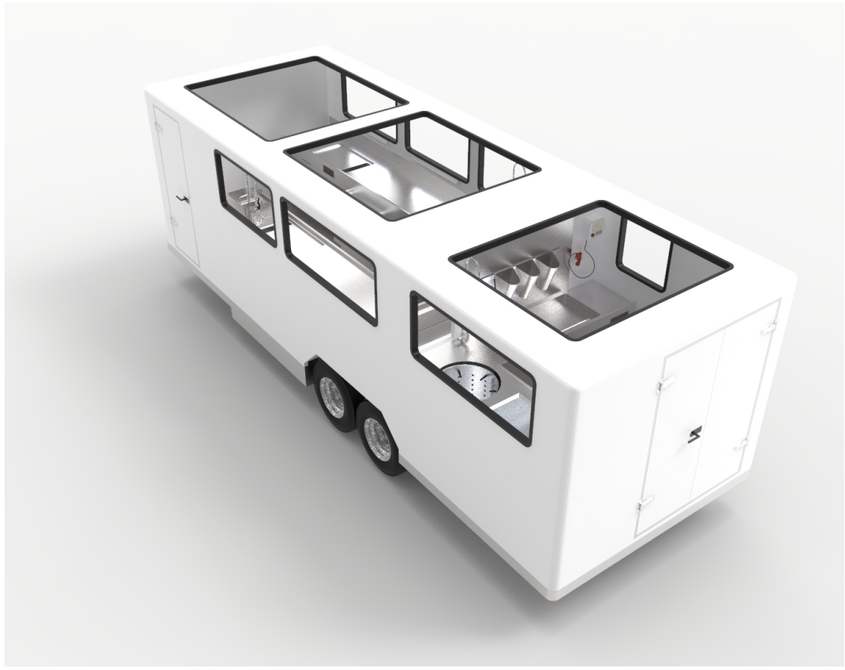
Community Engagement

Lastly, users can engage in various activities to increase community engagement. Users have access to an online community and workshops or meetups to help answer any questions they may have in both raising and processing. Users also have the option to sign up for a personal mentor to become learn more about poultry raising and processing. For example, someone like the hobbyist may be interested in transitioning to farming part time so they may seek out the advice of a personal mentor to assist them in doing so. Additionally, users can attend conferences to learn and present their own learnings. Finally, there are farmer and youth development programs where farmers or youth in the community can assist with processing, transport, raising chickens, etc. to both earn a wage and learn about humane practices, sustainability, and food system resiliency.

Overall, the service aims to better integrate the MPU with those who use it and those who are interested in the lifestyle of sustainable food and sustainable living.







Final MPU Design

The Atlas Meats MPU was designed to bring standardization and a refined user experience to near farm mobile processing. It is specifically designed to aid and assist the humane processing of birds.

Kill cones in the MPU are positioned with the ability to add additional cones based on quantity. The scalder and plucker are built into the table-top for easy cleanup. There is a built-in half door, for easy transfer of meat from the kill side to the clean side. Evisceration workstations have built-in waste baskets for viscera. Pull-out chill tanks are located beneath the tables for ease of use. Once the meat is inspected by the user, it is packaged using a vacuum packaging machine and chilled. The MPU is then cleaned by the operators, unhooked, and returned.

See following pages for detailed breakdown.

CRATE
Chickens are crated prior to bringing into the MPU

KILL CONES
Electric stunning humanely knocks out chickens

SCALDING
Hot water loosens the feathers

EVISCERATION
The intestines are carefully removed from the carcass

INSPECTION
The carcass is inspected for imperfections or disease

CHILL
Chilling in an ice bath to prevent bacteria growth

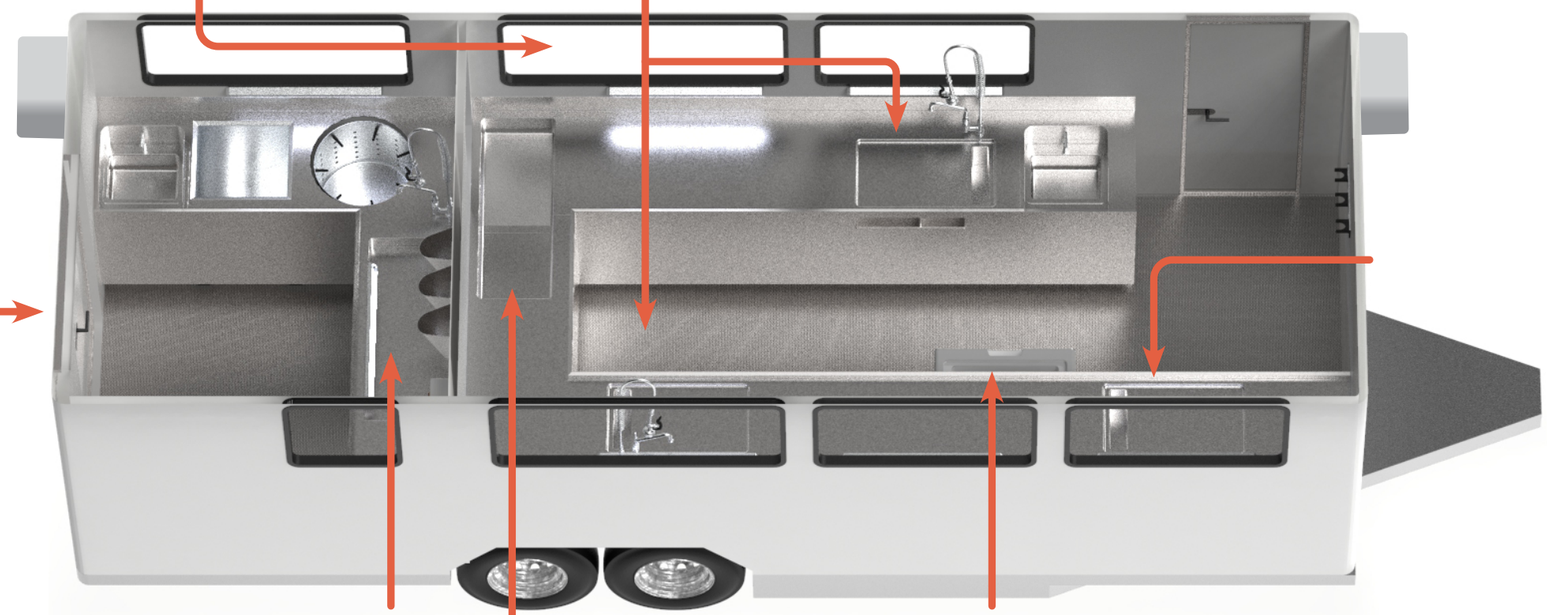
PACKAGING
Meat is vacuum sealed and chilled for the consumer

SCALDING/PLUCKING
Close proximity and a closed counter allow for efficent, clean transfer.

EVISCERATION
Recessed work stations and built-in faucets make it easy to clean the station.

INSPECTION
The carcass is inspected at the evisceration station.

VENTILATION FANS
Keep fresh air flowing for the crew.

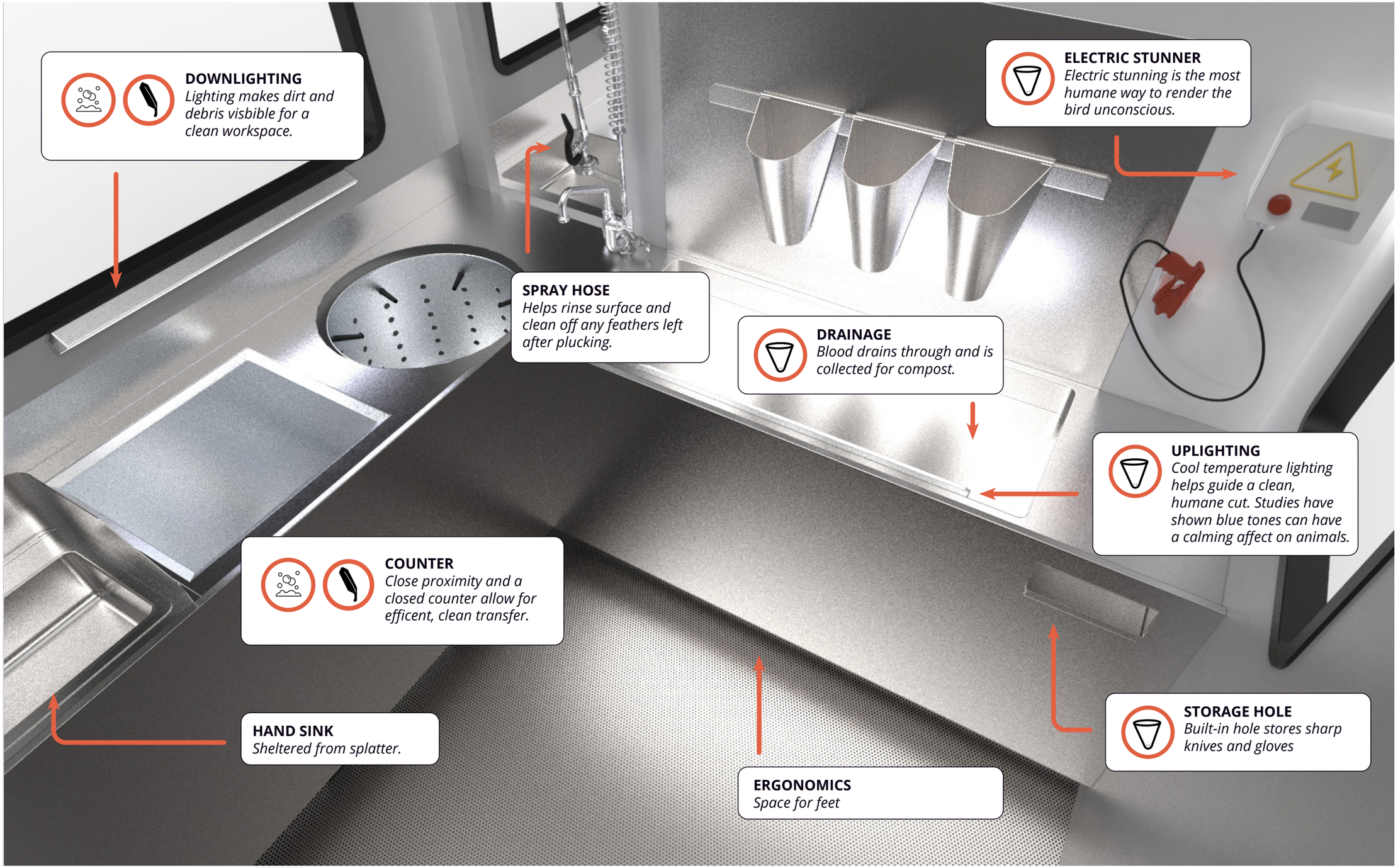


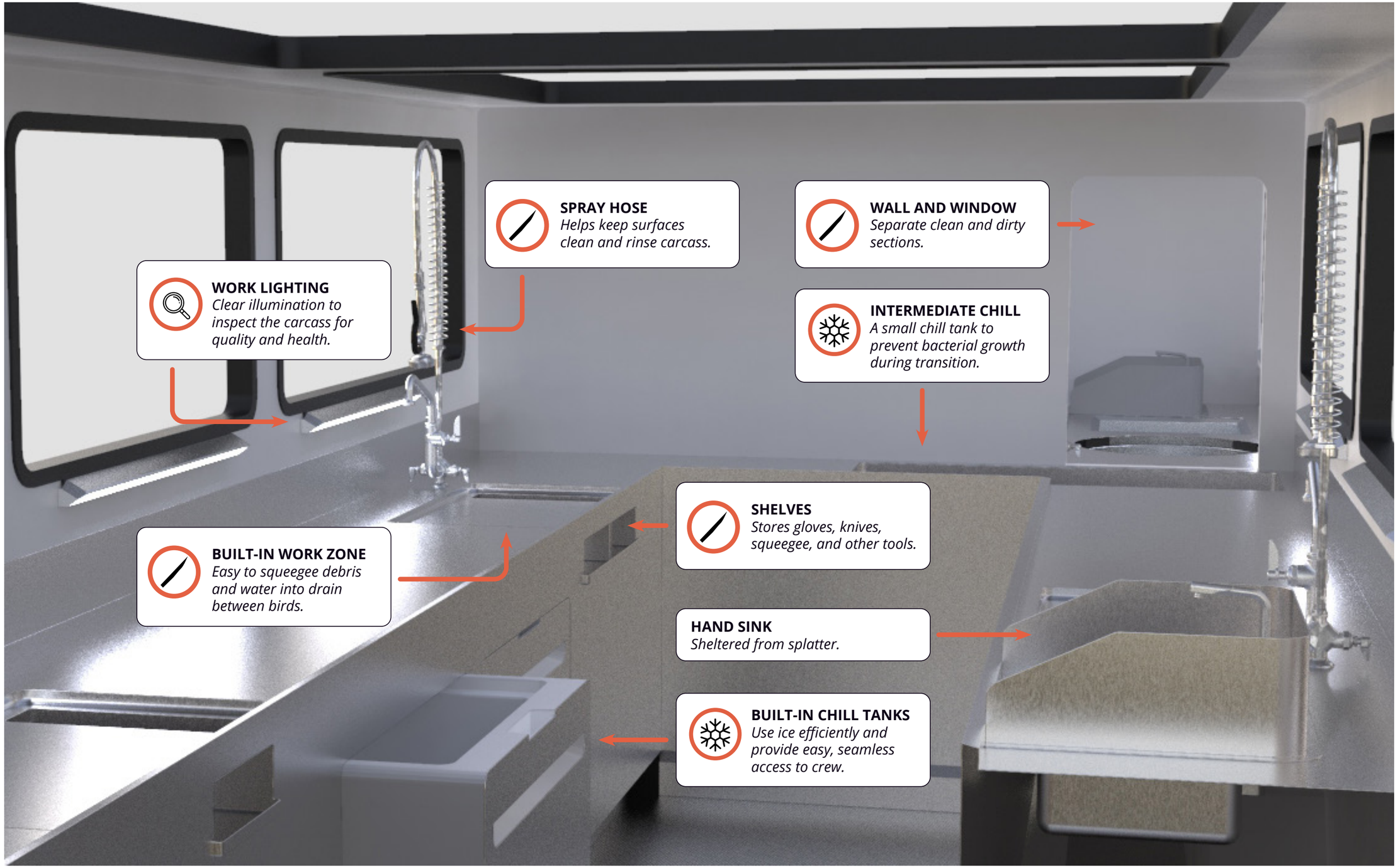
BACK DOOR
Chicken crates are brought in through the back door.

KILL CONES
Lighting helps guide a clean, humane cut.

CHILL
Built-in insulated coolers allow for easy access for eviscerators and the packer.

A bonus chill tank prevents bacterial growth between plucking and evisceration.


DOWNLIGHTING
Lighting makes dirt and debris visbible for a clean workspace.
SPRAY HOSE
Helps rinse surface and clean off any feathers left after plucking.
ELECTRIC STUNNER
Electric stunning is the most humane way to render the bird unconscious.
DRAINAGE
Blood drains through and is collected for compost.
UPLIGHTING
Cool temperature lighting helps guide a clean, humane cut. Studies have shown blue tones can have a calming affect on animals.
COUNTER
Close proximity and a closed counter allow for efficent, clean transfer.
HAND SINK
Sheltered from splatter.
ERGONOMICS
Space for feet
STORAGE HOLE
Built-in hole stores sharp knives and gloves


SPRAY HOSE
Helps keep surfaces clean and rinse carcass.
WALL AND WINDOW
Separate clean and dirty sections.
WORK LIGHTING
Clear illumination to inspect the carcass for quality and health.
INTERMEDIATE CHILL
A small chill tank to prevent bacterial growth during transition.
SHELVES
Stores gloves, knives, squeegee, and other tools.
BUILT-IN WORK ZONE
Easy to squeegee debris and water into drain between birds.
HAND SINK
Sheltered from splatter.
BUILT-IN CHILL TANKS
Use ice efficiently and provide easy, seamless access to crew.

Conclusion

A deeper dive into the food system reveals that the realities of food insecurity, wasteful consumption, and unsustainable industrial farming practices are symptoms of a deeper problem: lack of resiliency and redundancy within the food system. The meat shortages across the United States due to COVID-19 outbreaks among workers within meat packing plants revealed just how brittle this system is. The concentration and consolidation of the meat packing industry into large corporations caused this system to decompose quickly. It was not able gracefully extend and adapt, and thousands of animals were needlessly euthanized as a result. The introduction of on- or near-farm mobile processing would allow smallholder farmers to process their own livestock, providing resiliency within the food system.

Mobile processing, while available in parts of the U.S., is largely disorganized and detached from the larger meat supply chain. A lack of standardization in regulation, business strategy, and construction among mobile processing units (MPU) has resulted in low adoption. The Atlas Meats mobile processing unit and rental service promotes empowerment of smallholder farmers, humane treatment of animals, education of meat consumers, and sustainable practices. This is accomplished through a standardized unit centered around the user's contextual needs for safe, clean processing and a rental service that encourages upward mobility through comprehensive training and adaptable scalability.

Mobile processing has strong potential in Ohio. Ohio has many small poultry farms and lacks any industrial poultry processors. The concept could be expanded to meet aquaculture and game processing needs to further diversify Ohio's local food system. Dr. Tony Forshey, Ohio's state vetinarian, connected the team to Matthew Smith, the program director for The Ohio State University Aquaculture Extension. The team did not consult Smith because integrating fish was deemed out of scope due to the time constraints of the project. Smith later reached out to the team expressing interest in the project from aquaculture producers in Ohio. Future work could quickly increase the concept's impact within Ohio by adapting it to include capabilities for aquaculture in farmed and caught fish settings.

The concept speaks to larger potential within Design. Hendrik Schifferstein's work at TU Delft centralizes the conversation about Design's potential impact within the food industry.

Even though designers may carry a great potential to increse the innovative and competitive powers of the food indusry, they seem to have played only a limited role in food development process thus far...

Designers can add important activities to traditional food development process...

1. *Widen the scope of projects*
2. *Shape tools to engage others*
3. *Structure and facilitate cooperation among team partners*
4. *Expertise integration*

...

In addition, foods provide interesting design challenges to help consumers implement beneficial behavioral changes, to find engaging ways to deal with food perishabilitya nd to enable people to connect with the origins of their food: plants, animals, farmers, traders and so on [36].

Food is an oft overlooked area for innovation by Design practice and Design students. Engagement with food products opens rich opportunities for Design students to explore sensorial experience, easily accessible rapid prototyping material, promoting behavioral change, seaonality and regionality, perishability (a more explicit representation of cradle-to-cradle lifecycles), and connecting production and consumption of products [36]. Exploring organic materials and product life cycles through food allows Design students to more critically engage with the realities of production and engage more consciously with the world they consume daily.

There are few institutions better equipped for interdisciplinary work in design innovations within the few system than The Ohio State University. Few universities have as rich of a Design Research cirriculum in proximity to as rich of an agricultural college as Ohio State. With the Design department's desire to integrate the United Nation's Sustainable Development Goals, more work regarding rural contexts and the ability for people to access nutritious food around the globe. Tighter integration and interdisciplinary research between Agriculture, Rural Sociology, and Design at the institution could produce world-changing insights and innovations to promote greater standards of living across the globe.

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