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An Interactive Qualifying Project

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Food Eating, Entertainment and Distribution Kitchen

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ABSTRACT

The goal of this Interactive Qualifying Project is to design a food truck that is able to provide food for 500 people per day. It has to present an aspect of entertainment, and be aesthetically pleasing. This food truck will be able transport itself to any location and serves food while entertaining customers. This mobile kitchen is 10 feet long, 8 feet wide, and 8 feet high when it is fully expanded and it is designed to be mounted to the chassis of a truck. The design of the food truck has been constructed in SolidWorks to illustrate the three-dimensional model of the mobile kitchen unit. The working environments for food truck operators are usually very limited. They are forced to work in a cramped environment throughout their working day. Most street vendor food trucks today do not provide any level of entertainment and are not aesthetically pleasing. This is not favorable because both aesthetics and entertainment are important to attract customers to the increase the sales for the food truck. To provide a better working environment for operators, an expanding mechanism is incorporated into the food truck. In which, the passenger side of the food truck would expand outward when it is in the operating condition. Furthermore, a television and speakers are integrated to increase the amount of stimulus received by the potential customer. A higher profile mobile kitchen is more likely to become noticed by pedestrians walking by. This design of the food truck will be the next step in the evolution of mobile kitchens.

TABLE OF CONTENTS

<i>Abstract</i>	i
<i>List Of Figures</i>	iv
<i>Acknowledgements</i>	vi
CHAPTER 1. INTRODUCTION	1
CHAPTER 2. BACKGROUND	3
2.1 History	3
2.1.1 Types of Restaurants and Their Menus	5
2.1.2 Food Trucks and Food Truck Menus	9
2.2 Appliances.....	16
2.3 Entertainment.....	21
2.4 Existing Designs	21
2.4.1 Carlin Manufacturing	22
2.4.2 U.S. Mobile Kitchens	23
2.4.3 Coastal Concessions & Mobile Kitchens Inc.....	24
2.4.4 Dauser.....	25
2.5 Truck Chasses.....	26
2.6 Expanding Concepts.....	27
2.7 Regulations	29
2.8 Food Safety	31
CHAPTER 3. FINAL DESIGN	32
3.1 Mobile Kitchen Unit Frame.....	32
3.1.1 Bottom Frame.....	32
3.1.2 Main Frame.....	33
3.1.3 Slide-Out Frame	34
3.1.4 Slide-Out Mechanism	36
3.1.5 Mounting Mechanism.....	37
3.2 Food Truck Water Tanks	38
3.3 Possible Menu	40
CHAPTER 4. CONCLUSIONS	41

REFERENCES	44
APPENDICES	50
A.....	50
B.....	61
C.....	62
D.	70

LIST OF FIGURES

Figure 1-(A) the chuckwagon used by the cattlemen. (B) A mobile canteen used by the British to deliver food for bomb-damaged suburbs.....	4
Figure 2- Modern day White Castle (left), one of the first White Castle buildings (right) [3]	6
Figure 3- Picture of a modern day Panera Bread restaurant (14)	7
Figure 4- An example of a high-end restaurant [11].....	9
Figure 5- St. Louis Cardinals Food and Beverage cart, which sells hot dogs, soda, water, and beer [12] .	10
Figure 6- An example of a sandwich offered at the Grilled Cheese Truck [14]	11
Figure 7- A picture of a Bollywood Bites Truck [15]	11
Figure 8- A picture of the Baby's Badass Burgers food truck [16]	12
Figure 9- Food Shark food truck [17]	13
Figure 10- The Green Truck [17]	13
Figure 11-BBQ Smith food truck located in Boston, Massachusetts [20]	14
Figure 12- a picture of the Momogoose food truck in Boston, Massachusetts with a customer ordering [21]	15
Figure 13-the Bon Me truck with the server handing the customer his order [23].....	15
Figure 14- GE 24.6 cubic foot refrigerator [26].....	17
Figure 15- Uniworld UGR-3E Griddle [27].....	17
Figure 16-Vulcan 24" electric burner and oven [28].....	18
Figure 17-Globe Food Equipment 10 lb. deep fryer [29]	19
Figure 18-Regency 3 compartment sink [30].....	20
Figure 19- Regency Hand Washing Sink [31]	20
Figure 20- Bose Environmental 251 outdoors speakers	21
Figure 21-These are some of Carlin Manufacturing's Food Trucks; (A) DiGiorno Pizza Truck [32] and (B)Salvation Army Mobile Kitchen [33]	22
Figure 22-Layout and all of the features of the 10' disaster relief cube van by Carlin Manufacturing [35]	23
Figure 23-(A) Examples of USMK's mobile kitchens; and (B) the layout and all of the features of the 20' mobile kitchen [36].....	24
Figure 24-(A) A photograph showing one view of a CCMK mobile kitchen, while (B) is a photograph that shows another side of the same mobile kitchen [37].....	25
Figure 25- Dauser's mobile kitchen in use	26
Figure 26- 2012 Dodge Ram Chassis Cab truck [40]	26
Figure 27- (A) A smoothie stand operator is working in a very tight space, which isn't very aesthetically pleasing either. (B) Two Halal Food vendors are working inside a trailer	27
Figure 28-Some examples of RV's with slide out rooms [42] [43] [44].....	28
Figure 29-Lippert Component's slide-out systems—hydraulic (A) [48] and mechanical (B) [49].....	28

Figure 30-United Trailer’s mobile trailer framework [51]	29
Figure 31-The bottom frame of the kitchen unit.....	32
Figure 32- The main frame of the kitchen unit.....	33
Figure 33- Shows the support rail housing and the bottom extension for the slide-out mechanism	34
Figure 34- Slide-out frame showing the window dimensions	35
Figure 35- Layout of the different components of the slide-out mechanism.....	36
Figure 36- An example of mounting mechanism arrangement of an ambulance sub-frame to a vehicle chassis.....	37
Figure 37- The bottom frame with mounting brackets	38
Figure 38- (A) Locations of the supply tank and the holding tank. (B) Fresh water filler pipe from outside of the kitchen unit (The wall of the kitchen unit is suppressed). (C) A view of the drain pipe with a shut-off valve from under the kitchen unit.....	39
Figure 39- the layout of the kitchen unit, view from the rear	41

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Food Eating, Entertainment and Distribution Kitchen

CHAPTER 1. INTRODUCTION

As society progresses and becomes more sophisticated, so does the technologies that surround society. Throughout the history of modern society, today's cities started off as small towns which then have flourished into large landscapes with buildings towering over the millions of people below that inhabit the city. Because society has exponentially grown to become what it is today, so has the fast paced movement of the inhabitants of cities. Peoples' jobs and activities have a need to accomplish more in a day. With this increase in productivity, the spare time of the individual has decreased over time. People now have less time to go into a sit-down restaurant for food. During their lunch hour and rush hour, there are often long lines into restaurants that people do not have the time to wait for. Thus, the mobile food kitchen came about. In the form of street vendors, such as hot dog stands, these mobile kitchens gave the people of the city the ability to get food in spite of their busy day.

However, some of these street vendors look out of place in context to the city. They do not offer any aesthetically pleasing aspects nor any sort of entertainment to improve the atmosphere of the street vendor's customers. Our goal for this interactive qualifying project is to create a street vendor mobile kitchen that can blend into various environments, be aesthetically pleasing, provide some aspect of entertainment, and have the ability to be easily transported for those who use the mobile kitchen. This street vendor mobile kitchen should be able to transform from its original form to an expanded configuration when it is in use. In its compacted form, the kitchen should not exceed the dimensions of 10 feet x 8 feet x 8 feet and the transformation should not transcend twice the width of the compacted form. This expansion should not impede upon the area, but instead blend into the surrounding environment. Taking a look at cities today, there are various designs of street vendors that populate street corners, parks, and many other locations. Many of these, however, do not take into account the surroundings. So much so, that the street vendor becomes an eyesore. Most street vendors utilize materials such as aluminum and stainless steel. The application advantages of using aluminum or stainless steel are vast in terms of weight savings, maintenance, and strength to weight ratio. The disadvantages, on the

other hand, are that they are aesthetically displeasing and do not blend into many environments. Choosing the right material for this project is very important because the perfect combination between function and aesthetics is required to not only meet, but exceed the current design of street vendors today. If the visual appearance of the mobile kitchen is enhanced, the likelihood of increased business is also higher. Having a street vendor that is appealing to consumers is a fundamental characteristic of our project because that is the first aspect a customer would observe. Not only does improving the appearance of the street vendor increase business, but also providing a source of entertainment increases business. The entertainment does not directly draw attention to a mobile kitchen's main function. But by captivating a potential customer with stimuli, such as a touch screen display in which one could order off the vendor's menu which is displayed, or music to attract passerby's and keep those in line calm and patient. Expanding the food menu improves the functionality of the street vendor mobile kitchen by allowing the everyday buyer more options into the food they buy. The importance of this is that if the vendor serves too much of the same thing, the customer will eventually lose interest in that street vendor and look elsewhere for new variety.

The contents in this report will include four chapters. The first chapter will be composed of the introduction. In the introduction, our inspiration as well as our goals and objectives for this project are stated. The second chapter is comprised of the research that we have gathered, and how our research is incorporated into the designs that we come up with. In our research, we took a look into what current street vendors use and how those designs are incorporated in today's society. In addition, we took all of the concepts from existing vendors that we wanted in our design along with the concepts that we came up with and meshed them all together to disclose our own list of parameters to follow when creating our own design. In chapter three, we take the ideas of existing designs and the parameters that we produced, along with our intuitions here at WPI, to create our own design for our street vendor mobile kitchen. Chapter four will conclude our project through all of the data collected and observations throughout the project along with the design of the final product.

CHAPTER 2. BACKGROUND

2.1 History

As society expands, so does the speed of productivity of civilization across the globe. With this, as well as through the increase in pace of globalization and tourism gives rise to street vendors, with their market being the speed and accessibility to provide food to the consumer. Street food has become popular around the world. Street food is food or drink sold in the street or other public places, by a vendor or hawker. The food is usually sold from a portable stall, a food cart, or mobile kitchen. Street vendors usually serve both finger and fast food. While both are served in a speedy manner, the main differentiation between finger food and fast food is that finger food, as the name implies, can be eaten with your fingers being the main utensil, while fast food is usually eaten with a man-made utensil for foods like noodles and rice. The cost of food sold from street vendors is usually less than a restaurant meal. According to the Food and Agriculture Organization, 2.5 billion people consume food sold on the street every day [1]. Street vendors are also associated with take-out, junk food, and snacks. The advantage of the street vendor is that the consumer has the ability to purchase food on the street without having to enter a building, while fast food and take-out are often sold from counters inside buildings.

A food truck, mobile kitchen, mobile canteen, or catering truck is a mobile vehicle that sells food. These mobile kitchens can be used as ice cream trucks, or full on meal kitchens for restaurants. Other examples of what a mobile food kitchen can be is a breakfast truck, lunch truck, beverage truck, snack truck, and break truck or taco truck. Mobile food kitchens can also serve as disaster relief vehicles, cater for special events such as carnivals, provide food at construction sites, sporting events, college campuses, office complexes, and even prepare food for military personnel and bases in foreign countries as well as in the U.S. The mobile kitchen can also be used as a ground for advertisement, such as that used by DiGiorno Pizza shown in Figure 21. By brandishing their company name on the mobile kitchen and selling or handing out new or different products produced from the company, it can potentially increase profit for that company.

The origin of the street vendor came soon after the American Civil War. After the war, there was a mass expansion to move westward. The movement created a huge market for beef, especially in Texas. Cattlemen needed to herd cattle to different parts of the country that did not

have railroads leading to many months of travel to reach their destination. Thus, the chuckwagon was introduced to cope with the demand of food for the cattlemen (Figure 1A). The chuckwagon was the first tool implemented to provide food on wheels for the Americans. In 1866, a cattle herder named Charles Goodnight realized how hard it was to cook meals during the cattle drives and took an old Army wagon and put shelves and drawers inside. He stocked the wagon with utensils and tableware, as well as spices. On the lower shelves were the pots and pans. In the bed of the wagon was where the food was kept. Food consisted of dried beans, coffee, cornmeal, and other easily preserved foods. Cloth-wrapped bacon, salted pork and beef were the meat that they ate. There was no perishable meat, eggs, fresh fruit or vegetables. The wagon had a water barrel as well as wood to provide fuel to cook the food [2].



A



B

Figure 1-(A) the chuckwagon used by the cattlemen. (B) A mobile canteen used by the British to deliver food for bomb-damaged suburbs.

In the late 1950's, mobile canteens were created (Figure 1B). These mobile canteens were authorized by the Army of various countries to provide food for both soldiers and war victims [3]. Some of today's mobile food kitchens are gourmet trucks that serve high end cuisine. The menus have a large variety of creative dishes that offer customers a flavorful experience. In big cities across the United States, mobile kitchens are becoming more and more popular. Food trucks are evolving in urban and rural areas of the United States. So much so that in some places, it has become part of the culture there. Mobile kitchens or food trucks are a common sight at special events such as weddings, school dances, birthday parties, retirement parties, and public gatherings such as art and music festivals. For cities such as New York City and Boston, street vendors are great for people limited with time. People can order from the mobile kitchen and leave without having to wait rather long for a sit down restaurant.

2.1.1 Types of Restaurants and Their Menus

There are many different types of restaurants that customers attend to other than food trucks. The different types of restaurants are determined by their menu style, food preparation methods, food pricing, and how the food is served to the customer. Some main types of restaurants are fast food, fast casual, casual dining, family style, and fine dining. There are also subtypes of fast casual dining restaurants or casual dining restaurants. Buffets, cafes, cafeterias, coffeehouses, pubs, diners, food courts, and raw bars are a few subtypes of restaurants out of many.

A quick service restaurant, or fast food restaurant, is a kind of restaurant characterized by its fast food service and by minimal table service [4]. Fast food restaurants usually have a limited menu selection and the food is cooked in bulk in advance and then stored hot. Food is usually cooked quickly and then served quickly. Many quick service restaurants have a drive-through. A drive-through is where a customer can drive their vehicle up to a service window where the customer can order and receive their food. Drive-through fast food restaurants started in the 1930's and the communication systems for taking orders at the drive-through began in the 1950's. In the 1980's, double-drive-through windows were used by many fast food restaurants [5]. Fast food restaurants are usually part of a restaurant chain, or franchise operation, in which they prepare and deliver food through controlled supply channels.

One of the first fast food restaurants was founded in 1921 in Wichita, Kansas, called White Castle. White Castle was formed by Walter Anderson, who was a professional cook, and Edgar Waldo Ingram, a local real estate and insurance agent. The burgers from White Castle were sold at fairs, circuses, lunch counters and carts. Anderson developed a different method of preparing a hamburger sandwich. The new method involved flattening a ball of ground meat and cooking it with onions on a hot griddle for a shorter period of time compared to the old method [6].



A

B

Figure 2- Modern day White Castle (left), one of the first White Castle buildings (right) [3]

Above in Figure 2A is a picture of a present day White Castle building with its logo on the side and on the building. To the right, Figure 2B is a picture of one of the first White Castle building with a picture of its employees and their uniform below. White Castle offered curb service from the 1950's through the 1970's, which was replaced by the drive-through service, along with an expanding menu. The company also replaced its five stool hamburger stands in favor of larger buildings. White Castle continued growing and expanding and even built new restaurants in suburban areas to expose more people to White Castle. The company developed White Castle Distributing Inc., to help advertise its new line of frozen, microwavable hamburgers. The White Castle fast food chain is still owned by the Ingram family and remains a privately held company which owns and operates approximately three hundred restaurants [6].

White Castle has a variety of food from its menu usually sold in many fast food restaurants; from bacon, to ham, or sausage. Hash browns, orange juice or milk for breakfast are also common on the breakfast menu. Burgers, French fries, chicken sandwiches, fish sandwiches, and onion rings are usually on the lunch and dinner menus. These are some common types of food on White Castles menu and many other fast food restaurants. White Castle is just one out of many fast food restaurants in the world. Some other popular quick service restaurants, or fast food restaurants, include McDonald's, Burger King, Wendy's, Taco Bell, Subway, KFC, Dunkin' Donuts, and Sonic. Each restaurant has its own menu with similar service and preparation time. Another variation of the fast food restaurant concept is mobile catering.

Fast casual restaurants are another type of restaurant. A fast casual restaurant does not offer full table service, but these types of restaurants do offer higher quality food and a better atmosphere than a fast food restaurant. However, even though fast casual restaurants offer higher end food, with ingredients such as gourmet breads and organic ingredients, they only provide disposable utensils and plates. Open kitchens are popular with fast casual chains, where the customers can see their food being prepared. The typical cost per meal in a fast casual restaurant in the United States is eight to fifteen dollars. Paul Barron, the founder and publisher of *fastcasual.com* is credited for coining the term "fast casual" towards the end of the 20th century, while the company Technomic Information Services was responsible for defining the term "fast casual restaurants" as a restaurant with, "Limited-service or self-service format, average meal price between seven and eleven dollars, made-to-order food with more complex flavors than fast food restaurants, and upscale or highly developed decor." [7]

Panera Bread is one example of a fast casual restaurant. In 1981, the Panera Bread was first known as Au Bon Pain Co., Inc. which was founded by Louis Kane and Ronald Shaich. The company started spreading along the east coast of the United States, and even gained ground internationally throughout the 1980's. The company became well known and prospered as a bakery café. In the early 1990's, Au Bon Pain Co., Inc. then went on to purchase the Saint Louis Bread Company, which consisted of about twenty different bakery-cafes, all of which were located in and around the St. Louis area. Several years later, the company name changed to Panera Bread.



Figure 3- Picture of a modern day Panera Bread restaurant (14)

Panera Bread has since been expanding, and as of December 2011, 1,541 different bakery cafes in 40 different states, as well as Ontario, Canada, have been established. Panera Bread has a bakery menu and a cafe menu. The bakery menu includes pastries and sweets, breakfast food, freshly baked breads, bagels and spreads, and breakfast sandwiches. The cafe menu includes hand-tossed salads, sandwiches, soups, Panera food for kids, and drinks [8].

Casual dining restaurants are the most popular types of restaurants in the United States. Casual dining restaurants are also known as family style dining and offer moderately priced entrees. Casual style can have many different themes such as the restaurant Olive Garden, which has an Italian theme, Red Lobster being an example of seafood, and many more [9]. Family style restaurants offer table side service and non-disposable dishes. Some casual restaurants have a full bar with separate bar staff, offering various types of beverages that can include but is not limited to beer and wine. They are frequently part of a wider chain, particularly in the United States. Some popular casual restaurants are Denny's, T.G.I. Friday's, Red Robin, Texas Roadhouse, Outback Steakhouse, and many more.

The highest priced types of restaurants are fine dining restaurants. Fine dining offers the highest quality food, quality service, and superior atmosphere which are the three most important characteristics of a fine dining restaurant. Since many people usually go to a place like this for a special occasion, fine dining restaurants often provide a menu that is unique to their restaurant. Some fine dining restaurants change their menus on a regular basis to accommodate to the changing seasons [10]. Wine and liquors that are provided in fine dining restaurants typically are very expensive but of the highest quality. The atmosphere is usually fancy and creative. Every material in the restaurant is at its highest quality. Below, in Figure 4, is a picture of the interior of a fine dining restaurant showing the atmosphere, table, glassware, napkins, dishes, utensils, etc.



Figure 4- An example of a high-end restaurant [11]

These restaurants often times provide services not seen in a lower class restaurant. Some of these services include holding the chair for women, escort customers to the restrooms, clearing off the table in between courses, and replacing napkins if a customer leaves the table. All of the staff members are professionally trained to answer any question about the menu or drinks and make a menu recommendation if asked.

2.1.2 Food Trucks and Food Truck Menus

For those who can't afford to eat a fancy restaurant or have enough time for it, another common type of dining experience is available. Mobile restaurants strategically place themselves to provide food for those who are on the go. There are two main categories for mobile restaurants—ones that need another source of power to transport, and ones with drive terrains in them. Trailers that do not have a motor, or food carts, can be hauled by automotive trailer hitch, bicycle, or by hand to the selling site, often a public sidewalk or park. Modern day food carts are made with stainless steel, fiber reinforced plastic, and aluminum. Some foods and drinks served from these food carts are generally foods that can be consumed with one hand because mobile kitchen do not provide seating areas for customers. Figure 5 shows an example of such food cart from St. Louis.



Figure 5- St. Louis Cardinals Food and Beverage cart, which sells hot dogs, soda, water, and beer [12]

Food trucks are another form of a fast food restaurant. Food trucks are usually a modified van or truck with a kitchen inside. The kitchen of a food truck can consist of a grill, fridge, freezer, deep fryer, sinks, or other cooking equipment depending on what the truck is serving. Ice cream trucks are common across the United States. In the kitchen of an Ice Cream truck, would consist of only freezers. Each food truck's menu is unique in its own way. Food trucks usually sell only one kind of food such as tacos, BBQ food, desserts, breakfast food, ice cream, ethnic food, organic food or vegan food.

The Kogi BBQ food truck serves Korean BBQ in tacos, quesadillas, and burritos with some other blends. Short rib, spicy pork, chicken, and tofu can be included in the tacos or burritos. Kogi BBQ also sells sweet chili chicken quesadilla, Pacman burger, and other assorted foods. Soda and water are sold for drinks, while the chocolate tres leches cake and the sriracha bar available as desserts. The quality of Kogi's food is high while the prices are low. Kogi operates five trucks in the streets of Orange County, L.A [13].

After competing in L.A.'s 7th the annual Grilled Cheese Invitational, Chef Dave Danhi created the Grilled Cheese Truck [14]. There is a selection of bread and cheese the customer can choose for their grilled cheese. The customer can choose from cheeses like American cheese, sharp cheese, double cream brie, gruyere, and habanero jack on French or wheat bread. This truck not only serves many different kinds of grilled cheese, but other side dishes. Shown in figure 6 is a picture of French onion soup melt on onion bread. French onion soup melt consists

of gruyere with French Onion soup onions and a parmesan crust. It comes with onions soup broth for dipping. Some of the side food includes tomato soup in a cup, mac and cheese in a cup, pickles, dipping sauces and tater tots with sea salt. Other additions include BBQ pork, bacon, sliced apple, avocados, Fritos, sliced red onion, Graham Crackers, toasted marshmallows, Nutella, and more.



Figure 6- An example of a sandwich offered at the Grilled Cheese Truck [14]

The Bollywood Bites Truck is another food truck created by Sanjay Patel, former chef to Michael Jackson. This truck offers popular Indian street fair and a combination or restaurant favorites. Sanjay Patel's attends to where there are international movie stars, politicians, and famous public figures around the Los Angeles area, cooking high quality Indian food [15]. Bollywood is known for its movie industry and wide variety of foods.



Figure 7- A picture of a Bollywood Bites Truck [15]

Above, in Figure 7, is a picture of the Bollywood Bites Food Truck from side view, showing an open service window and some cold drinks and snacks. Bollywood Bites food truck serves Indian cuisine which includes vegetarian and vegan snacks, curries and sweets, and some dry snacks. Some meals from the main course include lamb vindaloo, lamb keema, chicken tikka, chicken jeera, eggplant, and cauliflower with peas and much more. Fish, assorted appetizers, and a few desserts are also sold.

Another food truck is Baby's Badass Burgers also located in Los Angeles, California. Beautiful women serve lunch to the customers who provide a source of entertainment and excitement (Figure 8). Many types of burgers are served at a high price of about ten dollars. One such burger is called “She's Smokin’”, which has smoked cheddar, lettuce, tomato, pickles, and baby's special sauce inside the burger [16]. Turkey sandwiches and veggie burgers are part of the menu. Some of the sides include curly fries, spiced chili, sweet potatoes fries, and assorted chips.



Figure 8- A picture of the Baby's Badass Burgers food truck [16]

Food Shark truck from Marfa, Texas is an old school lunch truck that is a plain metal truck with hand-painted lettering along its sides, shown in figure 9. Even though the design and aesthetics of this food truck are simple, the menu serves good quality Middle Eastern and Mediterranean food. On the menu is the “Marfalafel” which is a large tortilla filled with falafel balls, fresh romaine lettuce, tomatoes, cucumbers, red onion, tahini, yogurt and harissa sauces with hummus. Hummus and veggie wrap, combo plate, smoked turkey sandwich, and a “Fatoush” salad are the main food on the menu. The drinks sold are Mexican Coca-Cola, Blue Sky Natural sodas and “Topo Chico” mineral water, iced tea and bottle water.



Figure 9- Food Shark food truck [17]

The Green Truck from Venice, California is an eco-friendly food truck. The truck runs on vegetable oil and bio-diesel, while serving food that is locally grown and one-hundred percent organic. This food truck, as the name would suggest, serves healthy food options like fresh salads, or free-range chicken and mercury free tuna tacos. Being the “Green Truck”, the kitchen is solar-powered, and all of the packaging and utensils used are recyclable or compostable. Also, all of the cooking utensils used in the Green Truck are made out of potato starch. After the utensils are used and the open packaging is collected, they are sent back to the farms from where the Green Truck gets their ingredients. The collected compost is then used to grow more food, therefore making an environmentally friendly cycle [18].



Figure 10- The Green Truck [17]

BBQ Smith from Boston, MA is another food truck that serves smoked meats mixed with unique sauces and sides. BBQ plates with meat, pickles, onions and a choice of both chicken and pork, or beef is one main dish. Tacos with smoked pork, chicken or beef on corn tortilla roasted tomato salsa pickled vegetables and avocado lime puree is another main dish. Chili, classic slaw, roasted squash with maple and curry, and garlic kale with pepper vinegar are some of the side orders [19].



Figure 11-BBQ Smith food truck located in Boston, Massachusetts [20]

There are several kinds of sandwiches, one which is smoked pork with soft onions, garlic pickles and BBQ sauce. Another sandwich sold from the BBQ Smith truck includes smoked chicken, Greek yogurt, roasted tomato, pickled veggies, salsa verde, and chicken chips.

In 1989, Momogoose (Figure 12) was founded by MIT alumni, which was the United States' first food truck social enterprise. Momogoose specializes in gourmet, healthy Southeast Asian cuisine. Some food categories that this food truck serves are vegan, vegetarian, and non-vegetarian food. The food produced by Momogoose has its main focus on the taste of the food, but also makes the effort to minimize the calories and fats in their food.



Figure 12- a picture of the Momagoose food truck in Boston, Massachusetts with a customer ordering [21]

The name “Momagoose” might sound like an arbitrary title that has no meaning, but the word "Goose" in the name came from Poppa and Goose's old Cambridge, Massachusetts restaurant. "Momo" came from the phrase “more eating, more sharing”. The more people eat, then the more donations are made throughout the year [22].

Another food truck from Boston, Massachusetts is the Bon Me Truck (Figure 13). The name Bon Me came from a non-authentic sandwich called the “banh mi”. The truck got its name after winning first place in a Boston food truck contest. Pat and Ali, husband and wife, are Bostonians that own and operate the food truck.



Figure 13-the Bon Me truck with the server handing the customer his order [23]

Bon Me serves Vietnamese cuisine that includes noodle salads, rice bowls, and noodle soups. From the noodle salad the customer can choose between buckwheat soba or rice noodles, seasonal greens, bean sprouts, cilantro, carrot, red onion and a choice of their dressing. The choices for dressings include Vietnamese vinaigrette, spicy peanut, and toasted sesame [24].

2.2 Appliances

Through the process of choosing appliances for our mobile meal kitchen, our group went through many different appliances and iterations of appliance combinations that could possibly be put into the mobile meal kitchen that would best suit the needs of potential customers and potential employees. The group thought that commercial appliances would best suit the mobile meal kitchen because they are designed to supply larger quantities of food. The group needed to find appliances that would minimize energy consumption and minimize space usage while maximizing food production. Also, all of the appliances should meet or exceed standards set by the Food and Drug Administration (FDA).

Since the mobile meal kitchen is 10 feet x 8 feet x 8 feet, space to put appliances is limited. Also, the mobile meal kitchen will need to feed 500 people for a day, thus a 24.6 cubic foot refrigerator is needed to store the necessary food. The group also decided that the mobile kitchen should also have one griddle, a stove, an oven, and a deep fryer for cooking and food preparation. According to FDA regulations, a refrigerator must maintain a temperature less than 41°F, and freezers should maintain a temperature less than 0°F. Also, the sinks for dishwashing need to be 10 inches deep and have a volume of 1.2 cubic feet [25]. The group thought that the main prerequisite for the appliances in the mobile kitchen is that the appliances should run on electricity.

The group then set out to find appliances that fit the given criteria. One appliance that the group thought was important was the refrigerator. The GE Profile PSIC5RGXBV Refrigerator was one of the refrigerators researched. The group likes this refrigerator because it does not take up too much floor space, but has enough storage space inside because it stands up tall.



Figure 14- GE 24.6 cubic foot refrigerator [26]

This particular refrigerator has 24.6 cubic feet of storage space capacity, with a fresh food capacity of 15.26 cubic feet, 9.32 cubic foot freezer space, and can maintain a temperature of 38°F for the refrigerator portion and 0°F in the freezer. The refrigerator has a power consumption of 120 volts and 15 amps [26]. Also, this refrigerator has stainless steel and anodized aluminum exterior for a long lasting and easy to clean surface, built in ice dispenser, and this refrigerator is ADA compliant.

Another appliance the group researched was the griddle. The griddle is a good appliance because it is so versatile and can be used to cook many different products. One particular griddle that the team thought fit the given criteria was the Uniworld UGR-3E griddle.



Figure 15- Uniworld UGR-3E Griddle [27]

The griddle features a 3.3 square foot surface top for cooking which is big enough to cook most food products, three inch wide grease trap, dual thermostat controls that have a range of 150°F to 500°F to vary the heat for each half of the cooking surface, and the griddle is also ETL and NSF approved. The griddle also takes up a total of approximately 3.85 cubic feet [27].

To increase the versatility of the mobile meal kitchen, a stove can increase the amount and range of food product the food truck can produce. By increasing the amount and range of food product produced by the mobile meal kitchen, productivity increases as well.



Figure 16-Vulcan 24" electric burner and oven [28]

The above appliance also includes an oven as well. This further increases the versatility of the mobile food kitchen because it also has the ability to cook food products in the oven as well as the use of the stove. The stove requires 208 volts for operation, and includes four 9.5 inches round French style plates with infinite heat control switches. The appliance is made out of stainless steel for most of the exterior, and the frame for the appliance is made out of MIG welded aluminized steel and is NSF compliant. The included oven has an area of 4.29 cubic feet

with 4 tray slots. The thermostat for the oven has a range of 200°F to 500°F. The overall dimensions for the Vulcan appliance is 24 inches wide, 34 inches deep, and 58 inches high [28].

The group thought that a deep fryer could also benefit the mobile meal kitchen as it does add a different food preparation method, thus making the mobile kitchen that much more versatile. The group chose the Globe Food Equipment countertop electric deep fryer for the job.



Figure 17-Globe Food Equipment 10 lb. deep fryer [29]

This deep fryer features two nickel-plated frying baskets with insulated handles, built in basket nesting hooks, an oil capacity of 10 lbs., and the deep fryer is entirely made out of stainless steel. The appliance runs on 120 volts and 15 amp outlet, and the thermostat for the deep fryer has a range from 70°F to 375°F. The total weight for this appliance is approximately 20 lbs., and the dimensions are 17.5 inches long, 11.2 inches wide, and 15 inches high [29].

The Food and Drug Administration states that a three compartment sink is required for “manually washing, rinsing, and sanitizing equipment and utensils.” Therefore, the group chose a three compartment sink that would satisfy this requirement. The Regency three compartment stainless steel sink would be a good choice for the mobile kitchen.



Figure 18-Regency 3 compartment sink [30]

The three compartment sink features three sinks that are 14 inches deep, 12 inches wide, and 21 inches long. The overall dimension of this three compartment sink from Regency is 36 inches wide, 41 inches high, and 24.5 inches from the front to the back of the appliance. Also, the entire sink is constructed with 16 gage type 430 stainless steel [30].

Because the Food and Drug Administration requires there to be a separate sink from the three compartment sink for washing hands, the group chose the Regency wall mounted hand sink. The Regency hand sink is 10” wide and 14” long, with a depth of 5.5”.



Figure 19- Regency Hand Washing Sink [31]

This hand sink has an overall length of 17 inches and an overall width of 15 inches, and the sink has an overall height of 13.5 inches. This sink was chosen because it complies with NSF regulations, and it is easily mounted to any position on a wall [31].

2.3 Entertainment

To provide entertainment for the surroundings, 2 components are considered—visually acoustically. A television will be incorporated into the final design, as well as speakers to play soothing music. It is decided that the size of the television must be at least 36 inches, large enough to attract passersby, and not unnecessarily big. Some research is done to find the best speakers that can be equipped outdoors. One very credible candidate for this task is the Bose Environmental 251 speakers shown in Figure 20.



Figure 20- Bose Environmental 251 outdoors speakers

These speakers have the dimensions of 12.5 inches high, 4.5 inches wide and 8 inches deep. They are tested to be able to withstand extreme temperatures, snow, rain and salt. Three-dimensional models of all the appliances with their dimensions are presented in appendix A. To supply the power for all of the appliances in the food truck, a power connection between the kitchen unit and an external power source (i.e. outlet from a nearby building) is needed since immense amount of pollution will be created in a populated area if the power is generated using the vehicle's engine. Arrangements between the food truck owner and the owner of the building with the power source are required for the operation of the food truck.

2.4 Existing Designs

As the mobile kitchen solidified their existence in today's society, designs of the mobile kitchen has developed in unison with the growing technologies of society present today. There are many different designs of the street vendor mobile kitchen used today that make the mobile

kitchen possible as a food vendor. All of these come in various shapes and sizes that serve different purposes, with their interior design optimized to perform that purpose. They can be used as ice cream trucks, or as a street vendor seen in various cities such as New York City and elsewhere.

2.4.1 Carlin Manufacturing

One company that makes mobile meal kitchens is Carlin Manufacturing. With over twenty five years of experience, they have created designs that have been proven to be effective for mobile meal kitchens. The mobile kitchens that Carlin Manufacturing produces have been used throughout the world for fast food chains, such as Burger King, Pizza Hut, and McDonald's, and for the military, American Red Cross, as well as Salvation Army. They also produce disaster relief vehicles and modular kitchens. Some examples of Carlin Manufacturing's mobile kitchens are shown below in Figure 21.



A



B

Figure 21-These are some of Carlin Manufacturing's Food Trucks; (A) DiGiorno Pizza Truck [32] and (B) Salvation Army Mobile Kitchen [33]

One of their kitchens is their 10-foot disaster relief cube van, shown. This mobile kitchen is 13 feet by 7 feet and features a 6.5 KW generator, 3 compartment sink for dish washing, a separate sink with a soap dispenser for hand washing, as well as a full length closet on top of the generator. The kitchen also includes a service window, upright refrigerator, 24 inches four burner stove, fire suppression system, microwave, a coffee maker, two retractable canopies that provide shade for customers at the service window and rear exit door, and stainless steel counters [34]. The layout of this vehicle is shown in Figure 22. This disaster relief van can be used by almost anyone because of how easy it is to operate it. All of the functions, such as the food service equipment can be operated without any special training.

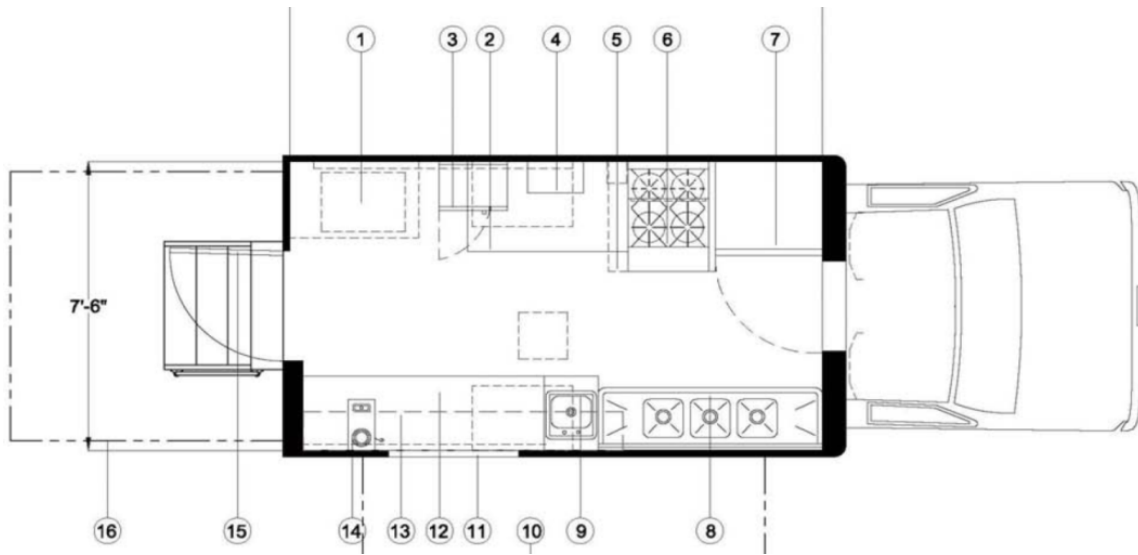


Figure 22-Layout and all of the features of the 10' disaster relief cube van by Carlin Manufacturing [35]

In addition, the other features required to operate the mobile kitchen like the power, water, and fuel will perform reliably every time the mobile kitchen is used. The materials used also add to the durability of the disaster relief van. The interior's floor, walls, and ceiling are made out of aluminum which in itself is resistant to corrosion. It is not uncommon for the aluminum to be anodized or painted white as well which further acts to protect the aluminum from any wear. The countertops are made out of stainless steel, which has similar corrosion resistance as aluminum, but it is stronger, thus better for bearing loads such as food and food preparation equipment. Aluminum and stainless steel are widely used in the restaurant industry.

2.4.2 U.S. Mobile Kitchens

Another company that makes mobile kitchens is U.S. Mobile Kitchens (USMK). Similar to Carlin Manufacturing, USMK has been providing mobile kitchens for over twenty years, and also provides for disaster relief, various branches of the military, as well as special events. However, U.S. Mobile Kitchens only provide to North America. One of USMK's mobile kitchens is their 20-foot mobile kitchen. Unlike Carlin Manufacturing's mobile kitchen, this one is a trailer style instead of a food truck, which means it needs a truck or a vehicle in general to tow the mobile kitchen to its destination.

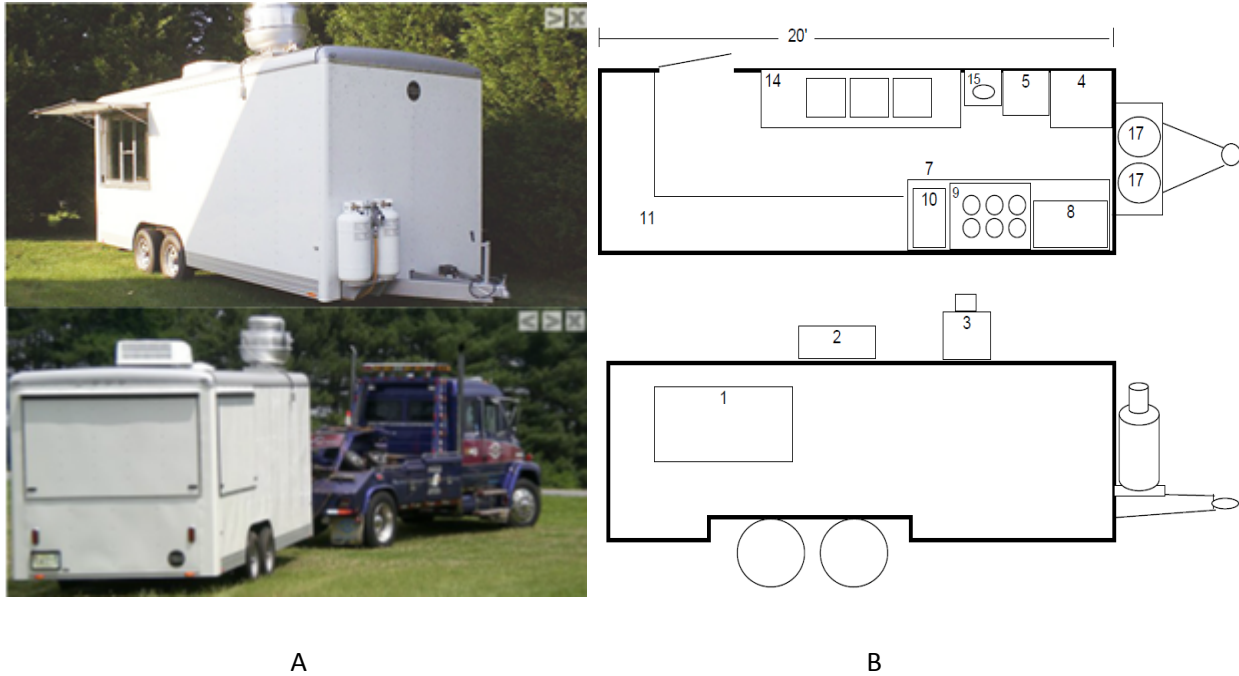


Figure 23-(A) Examples of USMK’s mobile kitchens; and (B) the layout and all of the features of the 20’ mobile kitchen [36]

The mobile kitchen is equipped with a 3 compartment sink for dishwashing, a separate sink for hand washing, fire suppression system, and stainless steel tables which are consistent with that of the Carlin Manufacturing mobile kitchen. This mobile kitchen, being larger in size, contains more food preparation equipment, such as a 6 burner range stove, a 36” flat top griddle, 40 lb. fryer, two service windows, propane tanks, and a HVAC unit (heating, ventilation, and air conditioning) [36]. Also, the stainless steel table is much larger in this mobile kitchen than in the mobile kitchen made by Carlin Manufacturing, especially because the stainless steel table wraps around the inside of the mobile kitchen in an “L” shape. Unlike the mobile kitchen from Carlin Manufacturing, the walls and floors of this mobile kitchen are made out of vinyl, but serve the same purpose as the aluminum used in Carlin Manufacturing’s mobile kitchens. USMK’s mobile kitchen also features an exhaust fan that vents fumes that are produced from the cooking appliances up and out through the roof.

2.4.3 Coastal Concessions & Mobile Kitchens Inc.

Coastal Concessions & Mobile Kitchens Inc. (CCMK) also designs mobile kitchens. CCMK also designs anything from concession trailers to barbeque smoker trailers. The mobile kitchens made strike a resemblance to those made by U.S. Mobile kitchens. Coastal Concessions & Mobile Kitchens’ mobile kitchens have many of the same features as well. Their 14 feet by 8

feet by 7 feet mobile kitchen is a mobile kitchen from CCMK that is small and well equipped for the job.



A

B

Figure 24-(A) A photograph showing one view of a CCMK mobile kitchen, while (B) is a photograph that shows another side of the same mobile kitchen [37]

Coastal Concession & Mobile Kitchens also provide many options for the mobile kitchen, such as stainless steel counters, a 10 KW to 15 KW generator, above cabinets, propane tanks, HVAC's, tanks for fresh water and waste water, water heater, fire suppression system, 3 compartment sink for dish washing, a separate sink for hand washing, and an aluminum floor. The mobile kitchen uses fiberglass for the walls [38].

2.4.4 Dauser

This German restaurant based out of Dusseldorf, Germany use a mobile kitchen to provide food at different events, and they can even provide a catering service. Most mobile kitchens employ just a service window for providing food to customers, but Dauser does not do this. Instead, the mobile kitchen opens up on most of the sides to reveal a small kitchen with only a few appliances and countertops for customers to pay and pick up their food. There are also high countertops to allow for some customers to enjoy their food while standing up.



Figure 25- Dauser's mobile kitchen in use

The Dauser mobile kitchen definitely makes getting food an interesting experience because the customer can actually see everything that goes on in the kitchen. The customer can also see their food being made and all of the ingredients that go into the food as well as the cooking techniques of the mobile kitchen staff [39].

2.5 Truck Chasses

Trucks are essential to many businesses. Trucks can be modified to fit the specification for various purposes they might have. For example, trucks chassis are used as the base vehicle of ambulances are manufactured separate from the actual truck chassis itself. Truck manufacturers such as, Ford, Chevrolet, GMC, and Dodge all provide the option of purchasing the “cutaway” version of some of their utilities vehicles, as shown in Figure 26.



Figure 26- 2012 Dodge Ram Chassis Cab truck [40]

Several different models of utility trucks were researched and compared. The data collected from each vehicle had been compiled and was put into appendix B.

2.6 Expanding Concepts

This mobile kitchen trailer unit must be transported to its destination relatively effortless through cities' traffic, tunnels, and under bridges. According to the Massachusetts Department of Transportation, vehicles and their loads cannot exceed 8 feet and 6 inches in width, and 12 feet and 6 inches in height. Otherwise, they are considered as an oversized load [41]. However, with all the different appliances cramped into the span of 8 feet is rather small for a person, sometime multiple people, working inside the unit to operate comfortably. This confined space also limits the storage space of products and ingredients, and therefore, can affect the vendors' capability to make the most profit out of their businesses.



A

B

Figure 27- (A) A smoothie stand operator is working in a very tight space, which isn't very aesthetically pleasing either. (B) Two Halal Food vendors are working inside a trailer

A possible way to improve the working space of a street vendor is expanding walls—collapsed during transportation or when not in use, and expanded when open for business. Such mechanism can be found in some Recreational Vehicles (RV's); they are called the *slide-out* system, which are equipped usually only in the higher-end models (Figure 28). There are two types of the slide-out system, mechanical and hydraulic systems. Both types require 12-Volt DC electricity from the RV battery.



Figure 28-Some examples of RV's with slide out rooms [42] [43] [44]

The hydraulic system uses a motor-driven hydraulic pump to actuate a cylindrical rod, which pushes and pulls on the slide moving the room in and out. Utilizing an electric motor, the mechanical system has two basic types, rack and pinion and ball screw mechanisms [45]. Both mechanisms are very similar and cost relatively the same. Although, the hydraulic system can handle a heavier load, more reliable and usually has a longer lifespan, it is more complicated to repair than the mechanical system. In addition to its complexity, the hydraulic system is generally more expensive. Hence, the mechanical system is more widely used in the RV industry [46]. A company called Lippert Components provides both hydraulic and ball screw systems (Figure 29) [47].

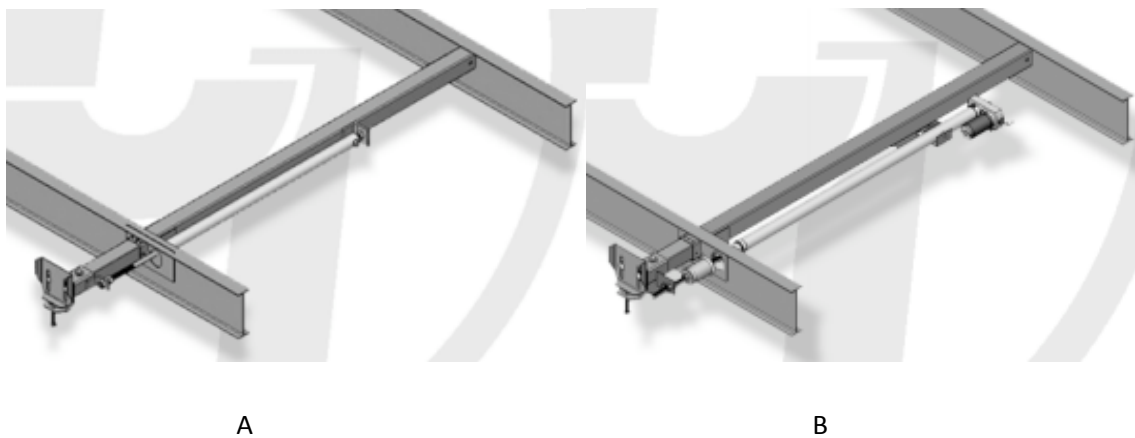


Figure 29-Lippert Component's slide-out systems—hydraulic (A) [48] and mechanical (B) [49]

The rack and pinion mechanism comprises a pair of parallel, rigid rails secured to the chassis of the vehicle. Another pair of parallel slide rails to support the slide out section. Within these rails there is a gear arrangement, a drive shaft, and an electric motor. The gears are

arranged in such way that they will convert the rotational motion of the motor to the linear motion along the gear rack secured to the rail, driving the slide out and retract [50].

Another way to create more space for the operator in the street vending mobile kitchen unit is to have the ceiling and the roof extend upwards. Much like the idea of expanding the sides of an RV, the ceiling itself would expand upwards once stationary. The advantage to this is that employees who are taller would be able to work without needing to be hunched over the entire time they are inside. In order to put this feature into a street vending mobile kitchen unit, the framework of the trailer must be redesigned. The existing frame, for example from United Trailers (Figure 30) is simply a rigid box with wheels on it.



Figure 30-United Trailer's mobile trailer framework [51]

Building from the framework, it is possible to modify the chassis to include the expanding features. That is one way of possibly incorporating trailer expansion into the design of a mobile kitchen.

2.7 Regulations

To start a food truck business in Boston, MA, the vendor will need to follow the laws and regulations. The Mayor's Office, Public Works, Transportation, Inspectional Services

Department (ISD), and Fire departments created an application process for Mobile Food Vending Vehicle Permits. With the proper application process through various departments of the state of Massachusetts, vendors can obtain their food truck permit through Public Works to ensure the safety and health of the vendors and customers. Detailed guidelines for the application process can be found on the Official Web Site of the City of Boston under the Mobile Food Vending section [52]; only the overview is described below.

To receive a permit from the ISD, a vendor must submit a copy of the Inspectional Services Department health permit, and have an ISD inspector's signature on the permit application. To obtain a Health Permit from Inspectional Services Department every mobile food truck must meet and pass a vehicle inspection. Before the vehicle inspection, vendors must provide a sample food menu for the truck, proof of service by a commissary kitchen, proof of certified food protection, use of premise permit, completed health permit application, and a health permit fee of one hundred dollars. At the time of the inspection, a vendor must have completed a Health Division permit application and provide the required supporting documents and licenses. Before the design of a new food truck, ISD encourages vendors to schedule a vehicle review with the Health Division. The vendor will need the equipment plans and specifications, and complete the Health Permit application. Plan reviews are needed for the already existing vehicles that made any changes.

There are also Boston Fire Department (BFD) requirements for a food truck permit. The vendor will need to have a copy of permits issued by BFD and a BFD inspector's signature on the permit application. In order to get a Boston Fire Department permit, every mobile food truck must meet and pass a vehicle inspection by the Boston Fire Department. During the time of the inspection, the applicant will have to submit a completed BFD application for open burning/cooking operations (submitted every year), and an application fee payment of thirty-eight dollars (fee paid every year). To schedule an inspection, vendors must complete the BFD's annual permit application for open burning/cooking operations. The Inspectional Services Department's Health Division will inspect the truck at the same time the Fire Department does. Inspectional Services Department will coordinate with the Boston Fire Department. The purpose of this inspection is to check the safety of the fire suppression system and the type of generator. If open flame is being used, then the vehicle must be equipped with a fire suppression system

and a fire extinguisher. Mobile food trucks that have an in-line generator do not need a permit. All other generators will need a permit and for it to be inspected. Also, standalone or separate fill gasoline-powered generators are not allowed at any public event or venue.

Vendors need a Hawkers and Peddlers license from The Commonwealth of Massachusetts. A copy of the license is required to complete the final permit application process to Public Works. After the Hawker and Peddler license application is complete, the vendor will need to bring the application to the Police Station in the city or town in which the vendor lives in and have the Chief of Police sign the Certificate of Character as required by state law. Next, return the application to the Official Website of the Office of Consumer Affairs and Business Regulation (OCABR) with a fee of sixty-two dollars. A criminal record check may be required by the vendor's local police department in the application process. A Health Certificate obtained from the local Board of Health is required for any food selling.

2.8 Food Safety

The safety of handling, preparing, and storing food will help prevent foodborne illness. Foodborne illness is any illness from the consumption of pathogenic bacteria, viruses, parasites, contaminated food, and chemical or natural toxins [53]. There are many different routines that should be followed to avoid serious health hazards. Diseases from food can travel from one person to another that can cause food poisoning. There are five key principles of food hygiene developed by the World Health Organization to help prevent from food poisoning. One is to prevent pathogens that can spread from people, pets, and pests from coming in contact with the food. Two, is to separate cooked and raw foods so the cooked foods will not become contaminated. Three, is to cook foods for the correct time and at the correct temperature to kill pathogens. Four, is to store food at the right temperature. The last principle of food hygiene is to use safe water and cooking materials [54].

A food system by the United States is regulated by numerous federal, state and local officials. A Food Code is published by the Food and Drug Administration which is a model set of guidelines and procedures that assists food control jurisdictions for regulating the retail and food service industries, including restaurants, grocery stores, and institutional foodservice providers [55].

CHAPTER 3. FINAL DESIGN

3.1 Mobile Kitchen Unit Frame

From all of the research data that are gathered, a design of the frame of the kitchen unit and the layout of all the appliances are developed. WPI's facilities, especially the Higgins Computer Laboratory 230, are utilized. All of the parts of the design are constructed using the SolidWorks 2011 x64 Edition software on Dell OptiPlex 980 computers.

3.1.1 Bottom Frame

A strong support structure is needed to sustain the load from all of the components and the operators in the food truck. The structure also has to be able to withstand the force of an impact to an extent in case of any collisions or accidents. The dimensions for all framing structures follow the American Society of Testing and Materials (ASTM) standards [56].

The bottom frame of the kitchen chassis consists of two aluminum rectangular tubes, and smaller aluminum square tubes. The two rectangular tubes have the same thickness of $\frac{1}{4}$ inch, and 4 inches high by 2 inches wide as their cross section dimensions. As shown in Figure 31, the rectangular members are positioned lengthwise parallel to each other 30 inches apart. These rectangular tubes will sit right on top of the vehicle's chassis when the kitchen sub-frame is mounted on to it. There are a total of five, $1\text{-}\frac{3}{4}$ inch aluminum square tubes acting as cross support members for the frame. The five cross members are equally spaced along the two main rectangular members.

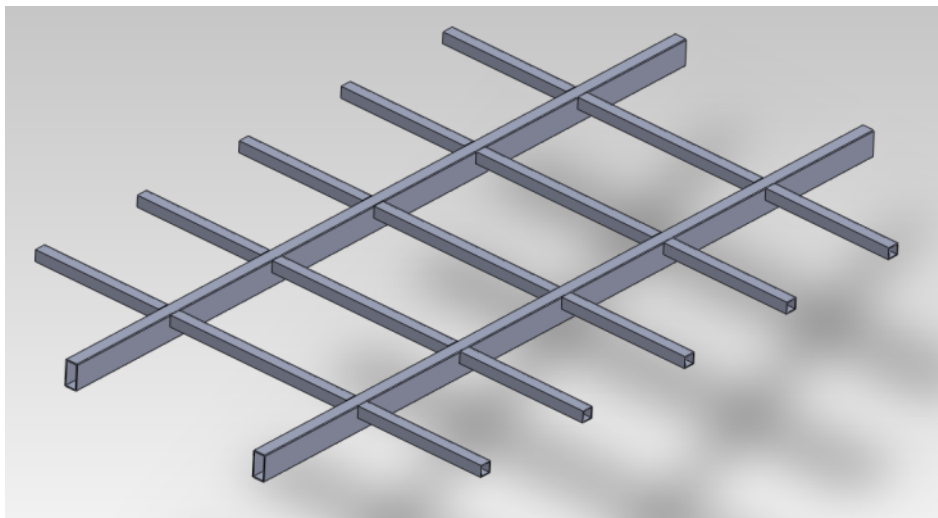


Figure 31-The bottom frame of the kitchen unit

3.1.2 Main Frame

The main housing frame for the kitchen unit is constructed with numerous aluminum square tubes welded together. The main columns positioned along each corner are 2x2 inches square tube. The overall dimensions of the kitchen unit frame without the roof and the slide-out section are 120 inches long x 80 inches wide x 96 inches high (Figure 32). In the insides of these columns, excluding the slide-out side, consist of a network of 1x1 inch square tubes. These 1-inch square members provide extra strength and rigidity to the walls and the kitchen unit as a whole, thus offering reliability to the owner. There are multiple (different amount for each sides) of vertical members connecting the bottom column the top column. Between the vertical members, there are horizontal members connecting two vertical members together.

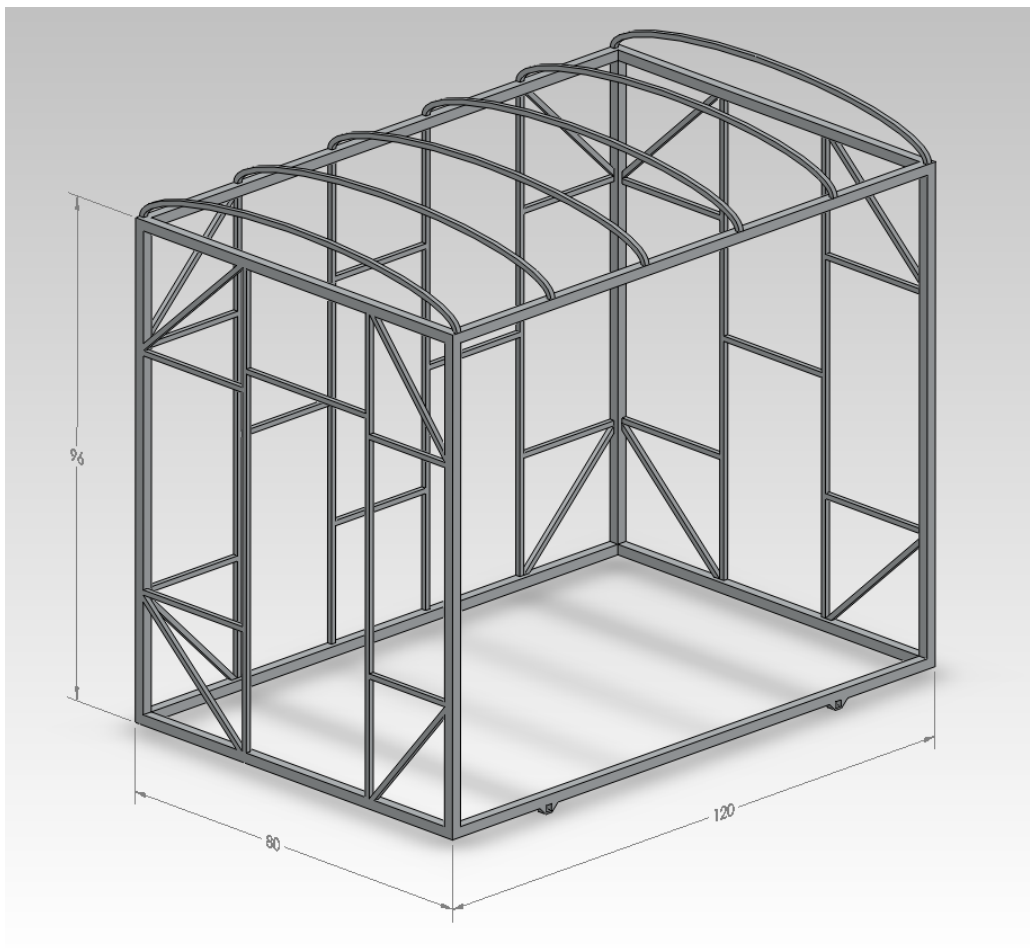


Figure 32- The main frame of the kitchen unit

On each corners of the walls, support members are designed for reinforcement. A door is designed to be put on the rear side of the unit with a width of 30 inches and a height of 72 inches. The frame for the roof of the kitchen unit is designed with aestheticism in mind. The roof arches over the top of the main frame between the driver side and the passenger side, which adds 8 inches to the total height. On the bottom of the passenger side (the slide-out side) of the unit, two extensions were fabricated for the slide-out rack support, shown in Figure 33. Toward the top of the main frame, there are two housings for the support mechanism for the slide-out frame on the insides of the front and rear wall, also shown in Figure 33.

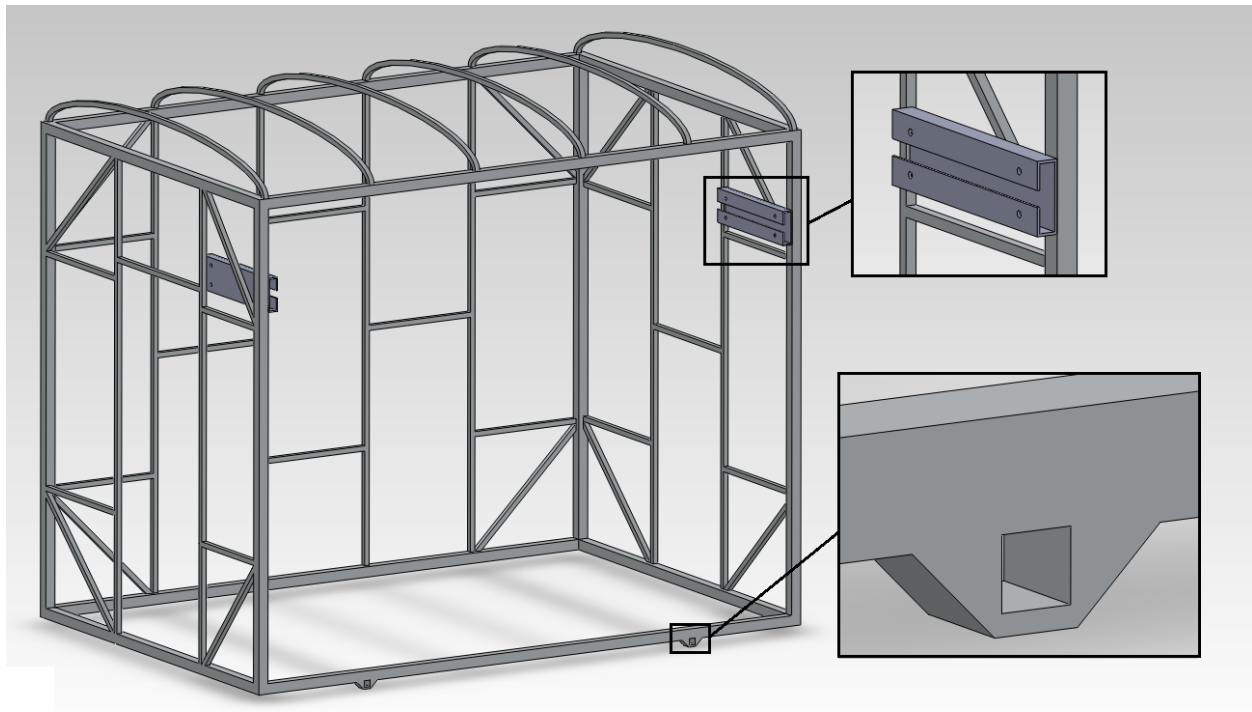


Figure 33- Shows the support rail housing and the bottom extension for the slide-out mechanism

The support mechanism each has four heavy-duty roller bearings total. Two bearings are designed to support the top of a slide-out support rail, and two bearing on the bottom for the similar purpose. The displacement between the top bearings and the bottom bearings is designed so that the slide-out rail would fit precisely in it, providing rigidity.

3.1.3 Slide-Out Frame

To provide more working space for the operators inside, a slide-out section is integrated into the kitchen unit. It occupies the entire passenger side of the kitchen unit, which is able to

extend out for the maximum of 16 inches. The frame of the slide-out section is similar to the main unit frame, as shown in Figure 34, with larger members as the main structure and smaller members for support. The top and bottom main members are 3x1½ inch aluminum rectangular tubes to sustain the lateral load on the slide-out section. The vertical columns on each side are 1½x1½ inch aluminum square tube. Both the horizontal and vertical members have the thickness of ¼ inch.

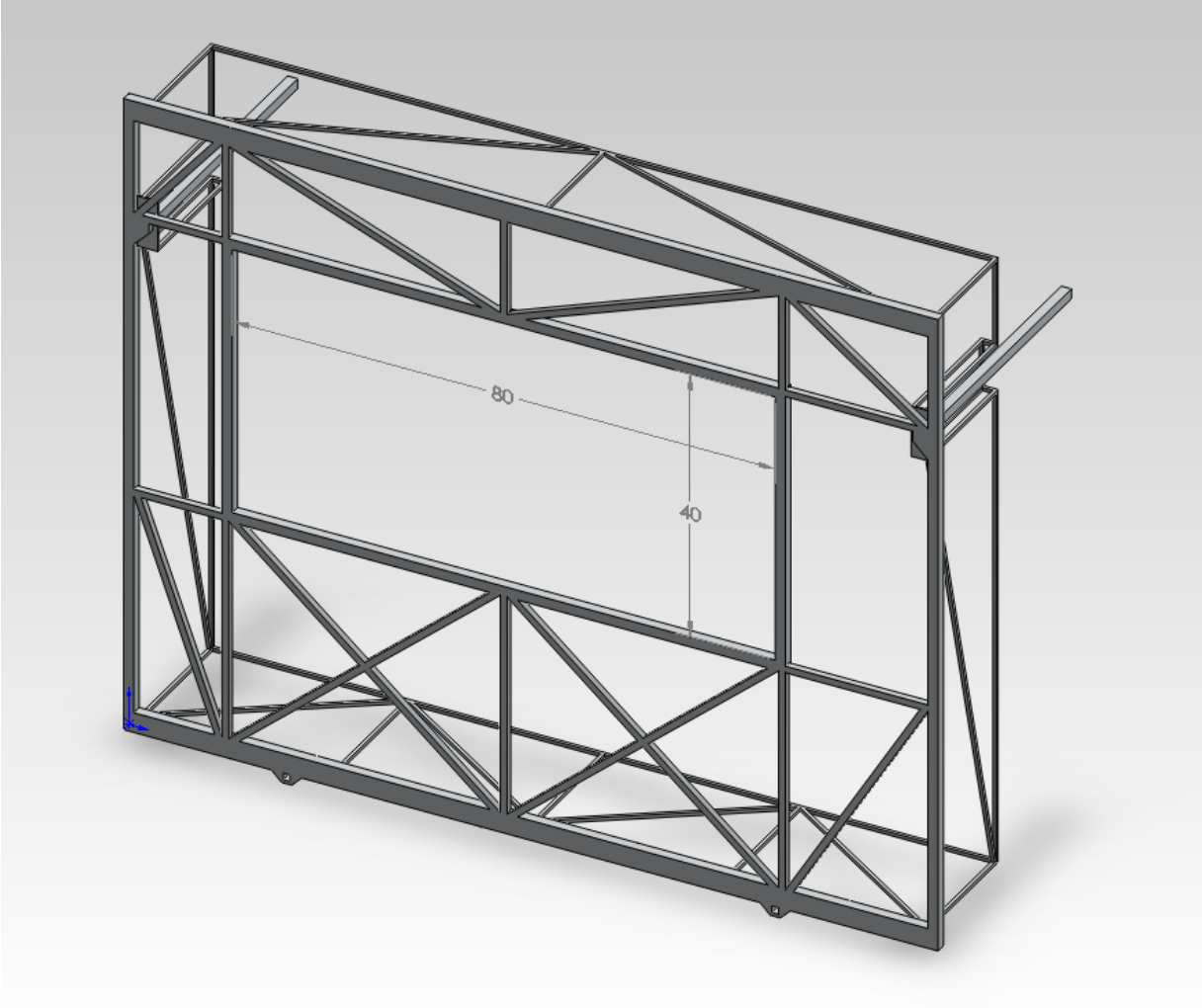


Figure 34- Slide-out frame showing the window dimensions

The slide-out wall is designed to have an opening for a window, where the food will be ordered and served. The window frame is constructed with 1½ inch aluminum square tubes with opening of 40 inches high and 80 inches wide (Figure 34). Reinforcing the main columns and the window frame, 1 inch aluminum square tubes with a thick ness of 1/8 inches were carefully

design for optimum support. There are two support bars for the structure located on each side towards the top, which are solid 1½x1½ inch aluminum bars with the length of 41 inches. The support bars are designed to precisely fit into the support bearing mechanism described in the earlier section. Similar to the main frame, the bottom of the slide-out frame also have extensions for the slide-out mechanism. The frame for the wall panels of the slide-out sections are constructed using ½ inch aluminum solid square bars extending 20 inches from the main slide-out frame. It leaves 4 inches of overlapping length when the slide-out section is fully extended to provide a smooth slide when the slide-out is being contracted.

3.1.4 Slide-Out Mechanism

The slide-out mechanism consists of two main contraptions, a driving mechanism and a synchronizer mechanism. The design of the slide-out mechanism is based on the Lippert Components’ electric slide out system described in CHAPTER 2. An electric motor is used in the driving mechanism along with a gear box that transfers power to a ball screw, which translate rotational motion to linear motion. The main motor housing, including the gearbox, is attached to the bottom chassis of the kitchen unit, shown in Figure 35. And the ball screw connects the slide-out section to the motor.

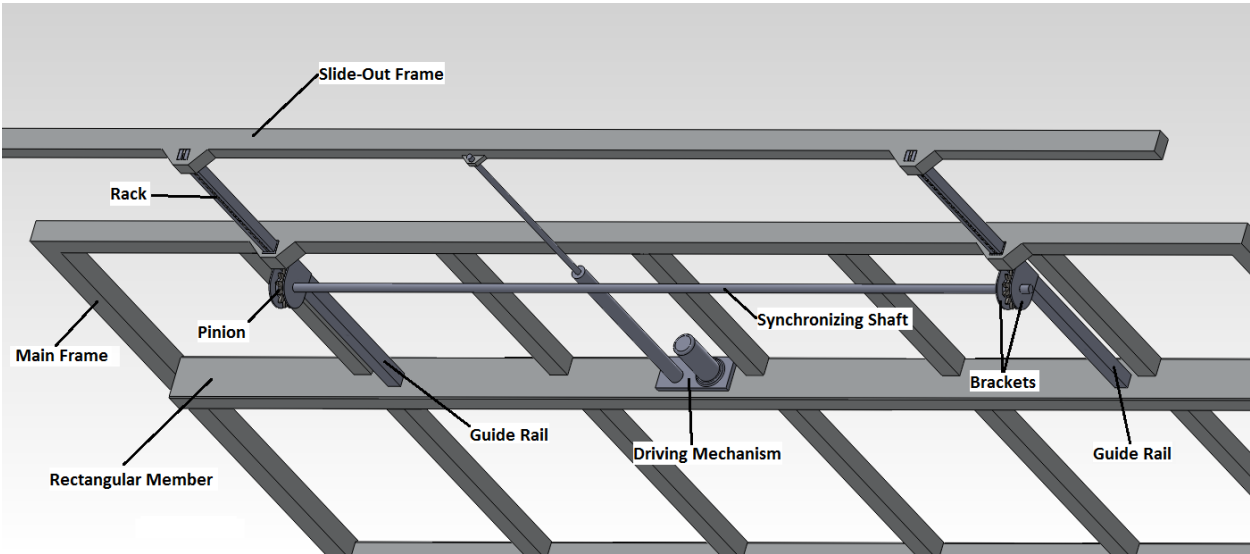


Figure 35- Layout of the different components of the slide-out mechanism

A synchronizer is essential to a slide-out system, which creates smooth and even movement to the two sides of the slide-out section without any interference. The synchronizer utilizes a rack and pinion mechanism. There are two racks attached to the bottom extension of

the slide-out and two pinions on the main frame. A guide rail is designed for each of the slide-out rack, which are attached to the main frame. These guide racks are fixed to the extensions at the bottom of the main frame. They would guide the racks through the rectangular member, which they are also attached to. The pinions are attached to these guide rails with brackets design for the purpose. A cut-out is also designed on the guide rails where the rack and pinion intermingles. Finally, a metal rod connects the two pinions together thus both sides move harmoniously.

3.1.5 Mounting Mechanism

The kitchen unit is mounted on to the vehicle's chassis using steel mounting brackets, similar to those used in ambulances, as shown in Figure 36 picture of bracket. These brackets can either be welded on or bolted on each chassis. There are four mounting brackets attached to the rectangular members of the bottom chassis on the kitchen unit. The locations of the brackets on both the vehicle and the kitchen can be adjusted if necessary.



Figure 36- An example of mounting mechanism arrangement of an ambulance sub-frame to a vehicle chassis

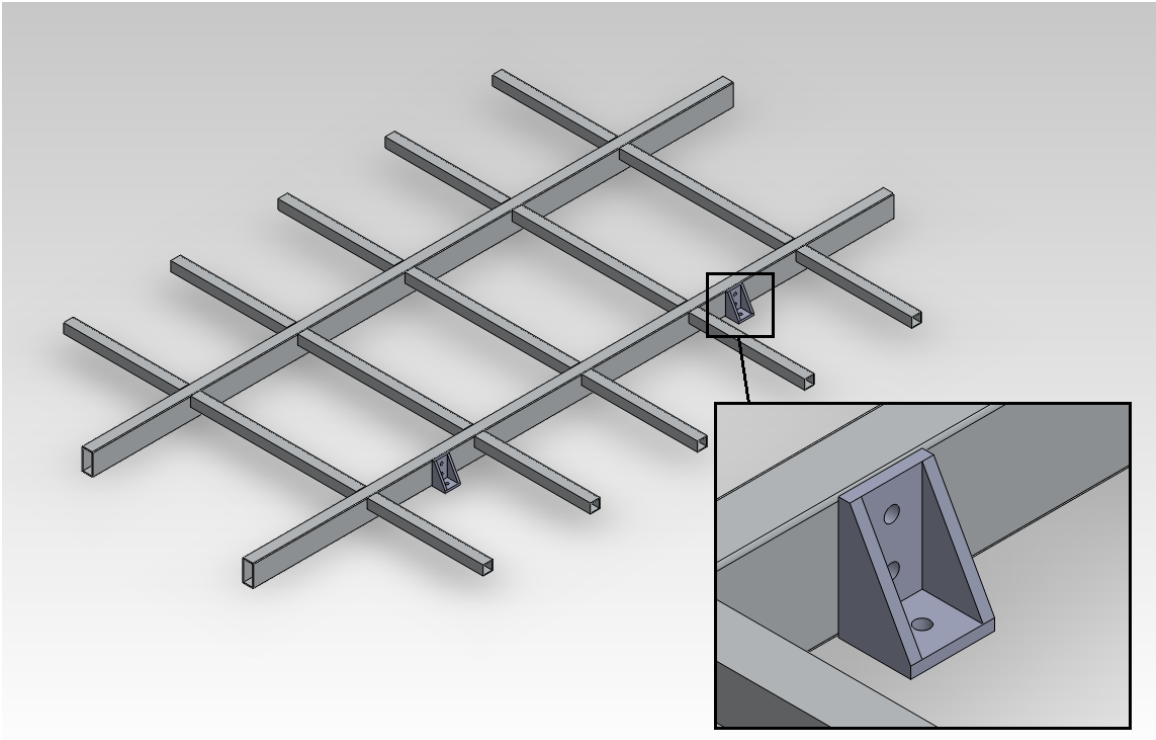
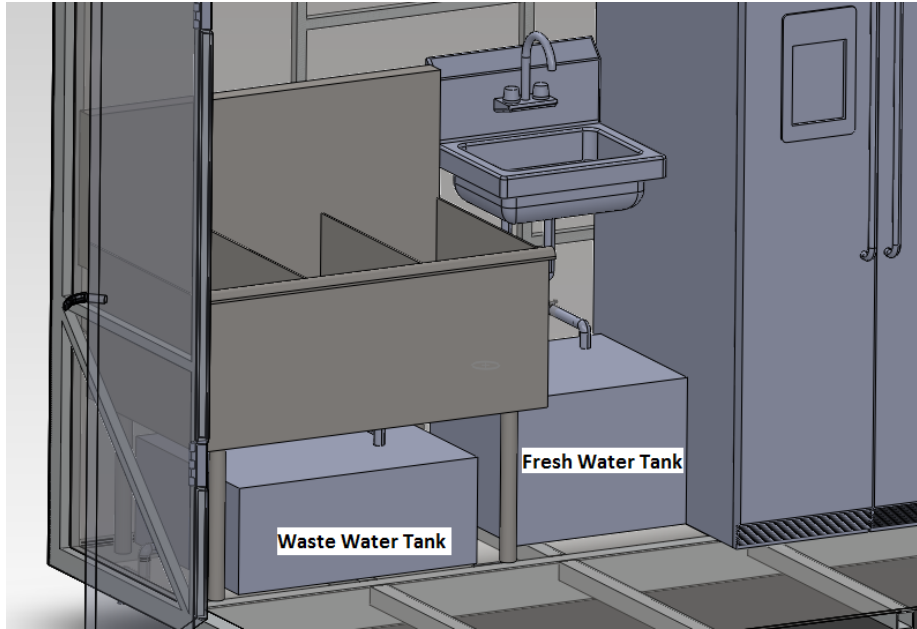


Figure 37- The bottom frame with mounting brackets

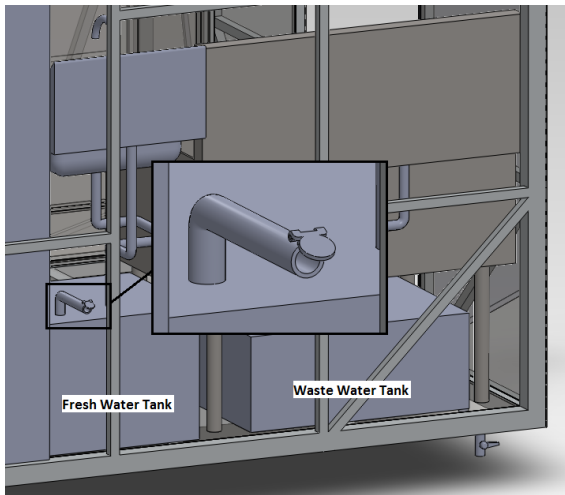
The brackets have a total height of 4 inches, 2 $\frac{3}{4}$ inches wide, 2 $\frac{3}{8}$ inches deep, and the thickness of $\frac{3}{8}$ inches. In this design, eight mounting brackets are used—four on the vehicle’s chassis and four on the kitchen unit (Figure 37). They are attached to onto the frame using fasteners.

3.2 Food Truck Water Tanks

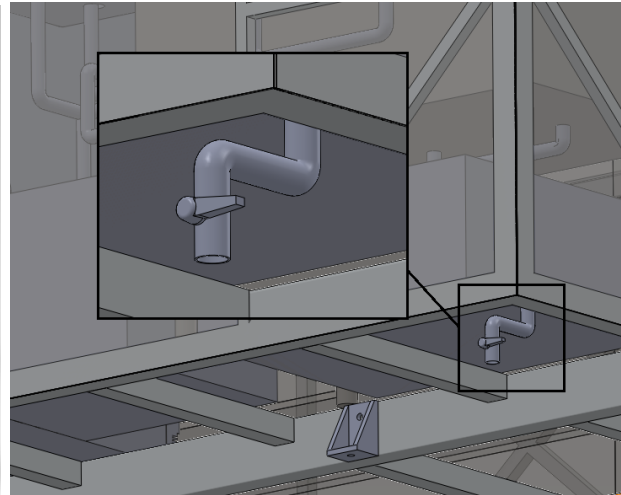
Water is a necessity in a food service facility. Other than being used to cook certain kinds of foods, water is mainly used to terminate any contaminants that could be harmful to humans from cooking equipment as well as the food itself. The supply of water in any mobile kitchens must be sufficient for any purposes it might have. For its limited cooking capacity, this food truck has a fresh water supply that can hold 15 gallons of water. As shown in Figure 38A, the supply tank is located below the hand washing sink, with the dimensions of 17 $\frac{1}{2}$ inches long, 16 $\frac{3}{4}$ inches wide and 13 $\frac{3}{4}$ inches tall. The water supply tank is strategically place where minimal piping length is needed; also no interference with the operators will occur. The tank can be refill from the outside of the kitchen unit through a filler pipe, as shown in Figure 38B.



A



B



C

Figure 38- (A) Locations of the supply tank and the holding tank. (B) Fresh water filler pipe from outside of the kitchen unit (The wall of the kitchen unit is suppressed). (C) A view of the drain pipe with a shut-off valve from under the kitchen unit.

According to the City of Boston's Regulatory Requirements for Food service Establishments [57], as sewage holding tank must be at least 15% larger than the fresh water supply tank. And its drain must be at least 1 inch in inner diameter, with a shut-off valve. Thus, the capacity for the waste water holding tank of this specific food truck is 18 gallons, making it 20% larger than the supply tank. The grey water is located under the 3-compartment sink with a 1-inch diameter drain pipe. The drain pipe goes through the floor of the kitchen unit with a valve

at the end (Figure 38C). A drain hose can be connected to the drain pipe when emptying the holding tank to keep the surroundings as clean as possible.

3.3 Possible Menu

The mobile kitchen food truck will mostly be employed in large cities across the United States; therefore the menu has to accommodate the majority of the population in order to gather as many customers as possible. To keep the price range of the menu low, all of the raw materials and ingredients used must be available locally for a low cost. Also, food offered has to be relatively easy to consume, preferably without using any utensils, since no seating areas will be provided. This food truck is capable of cooking a broad range of different types of foods. It has all of the essential appliances needed to cook most foods. The griddle can be used to cook hamburgers, hot dogs, sausages, eggs, and of course, bacon. Pizzas, calzones, potatoes, and bread can be baked in the oven. Some of the America's favorite side dishes include French fries, chicken fingers, onion rings, and fried dough, which can all be cooked in the deep fryer. Sandwiches such as cheesesteaks and grilled cheese can also be served from the food truck, using bread that has just been freshly baked in the oven. In terms of beverages, bottled water and sodas can be served. However, the menu is not limited to only these items. There are infinite types of dishes that can be prepared in the food truck. The menus will be unique to each food truck owners depending on their creativity.

CHAPTER 4. CONCLUSIONS

The lives of people today have evolved into a rapid-pace working day for the middle-class workers. A quick source of good eats is needed to provide energy for the workforce to keep up with the society. Hence, came about the food trucks. They are commonly seen in major cities throughout the United States. There are numerous manufacturers of food trucks varying in designs and layouts. These food trucks rarely provide any source of entertainment to their customer, and are usually an eyesore to the surroundings. In addition, manufacturers tend to neglect the working environment of the food truck operators, providing very limited working space. A unique design is developed to improve the common current conditions food trucks have. A slide-out mechanism is incorporated into the design to provide more working space for the operators, improving their working conditions.

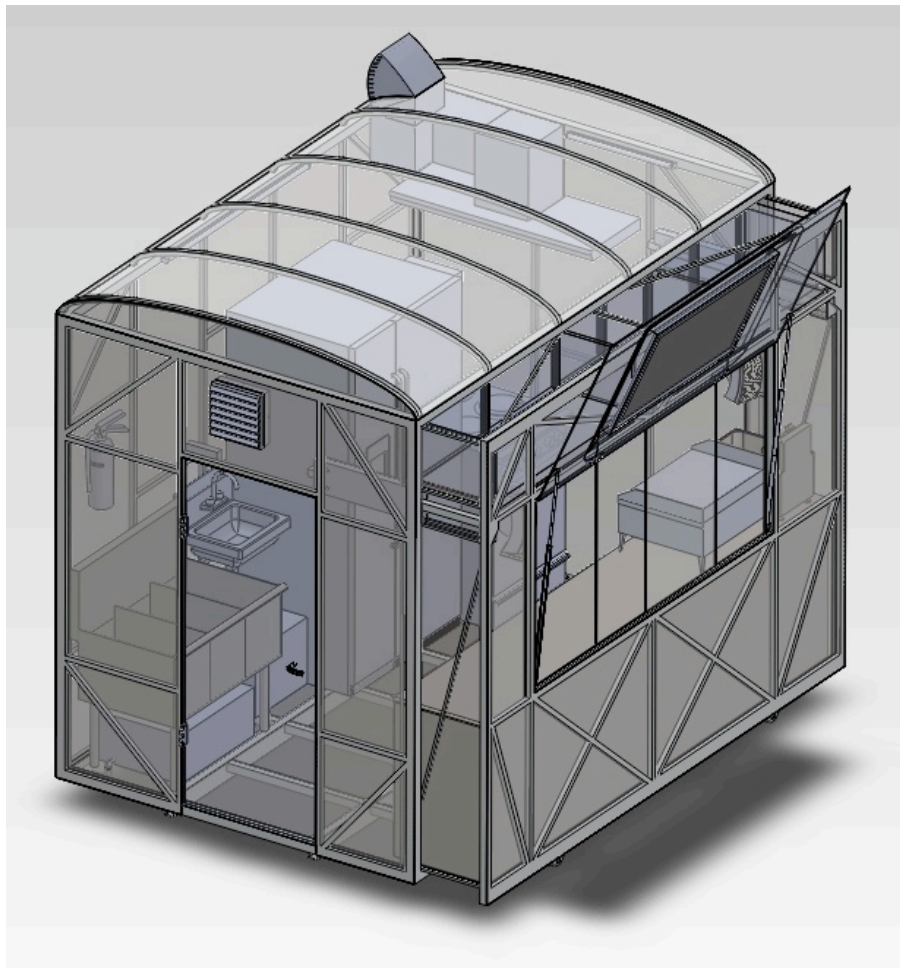


Figure 39- the layout of the kitchen unit, view from the rear

The kitchen unit has the total exterior length of 10 feet, height of 8 feet, and width of 8 feet when the slide-out section is fully extended. Essential kitchen appliances are put in to the kitchen unit, which include refrigerator, griddle, deep fryer, stove, oven, 3-compartment sink, and hand washing sink. Other appliances such as a vent hood, fire extinguisher, lights, and ventilation fans are added to the design to provide a safe environment for the operator, as well as the customers. A television and a set of speakers are also equipped on the food truck to entertain and attract potential customers. The complete three-dimensional model of the kitchen unit is shown above in Figure 39. A more detailed layout is available in appendix C.

Cabinets are incorporated into the slide-out section for both top and bottom. The cabinets are design to provide a sufficient storage space for one full day of operation, restocking of the food truck may be required every day prior to the opening. The vent hood is located towards the front of the kitchen unit where most of the cooking appliances are located. An air duct leads the contaminated air from the vent hood to the outside. An exhaust located at the end of the air duct can be open or closed depending on the operating condition of the food truck. When closed, the exhaust blends in beautifully with the arched roof. A ventilation fan is added to increase airflow inside the kitchen unit if required. It is located at the top of the rear wall. There are a total of 3 light sources in the kitchen unit. A 2-foot fluorescence light bulb is located at the top of each the front and the rear wall. And a 4-foot fluorescence light bulb is generating light at the center of the driver side wall toward the top. The entrance of to the kitchen unit is located at the rear wall with the height of 6 feet and the width of 30 inches. The door itself is designed to be self-closing to minimize the amount of contaminants entered through the door way. The roof paneling is made out of transparent fiberglass to provide ambient lighting inside of the meal kitchen which will help save energy during the day as less lighting is needed, and the transparent roof provides a spacious atmosphere. The speakers have been placed on either side of the service window facing out of the mobile kitchen, and the television is mounted to the underside of the service window panel. When the service window panel is closed, the television is facing the inside of the mobile kitchen, but when the window panel is open, the television is raised above the service window facing out towards where the customers would be. Equipment included in the food truck and the layout may vary depending on the owners and the types of food to be served. Similarly, the owner may decide what is being displaying on the television, as well as the types of music played through the speakers.

The biggest limitation the group had through the duration of this project was coming up with a combination of appliances and appliance layout that would maximize the efficiency of the mobile kitchen. The dimensions of each appliance weighed heavily on the different appliances that could have been put into the design layout. The expanding side also made this constraint all the more important. The appliances that could have been put on that side of the mobile kitchen were limited to the dimensions as well as the requirements to operate those appliances. Appliances that require plumbing, for example, could not occupy space on the side of the slide out mechanism because providing tubing to run water to and from that appliance would be problematic. In future redesigns of this mobile kitchen, space saving appliances should be looked into as it could greatly benefit the overall layout of the mobile kitchen. Also, a full scale model of this mobile kitchen would be beneficial because the model would give a perspective of how it would operate and any prominent flaws can be dealt with very quickly. It would also allow for any redesigns to be implemented rapidly.

If this mobile kitchen is put into effect, it could very well change how mobile kitchens are viewed and used in today's society. Seeing as the food truck staff in many food trucks do not have much space, and do not provide entertainment, the mobile kitchen design discussed in this project may be able to change all of that.

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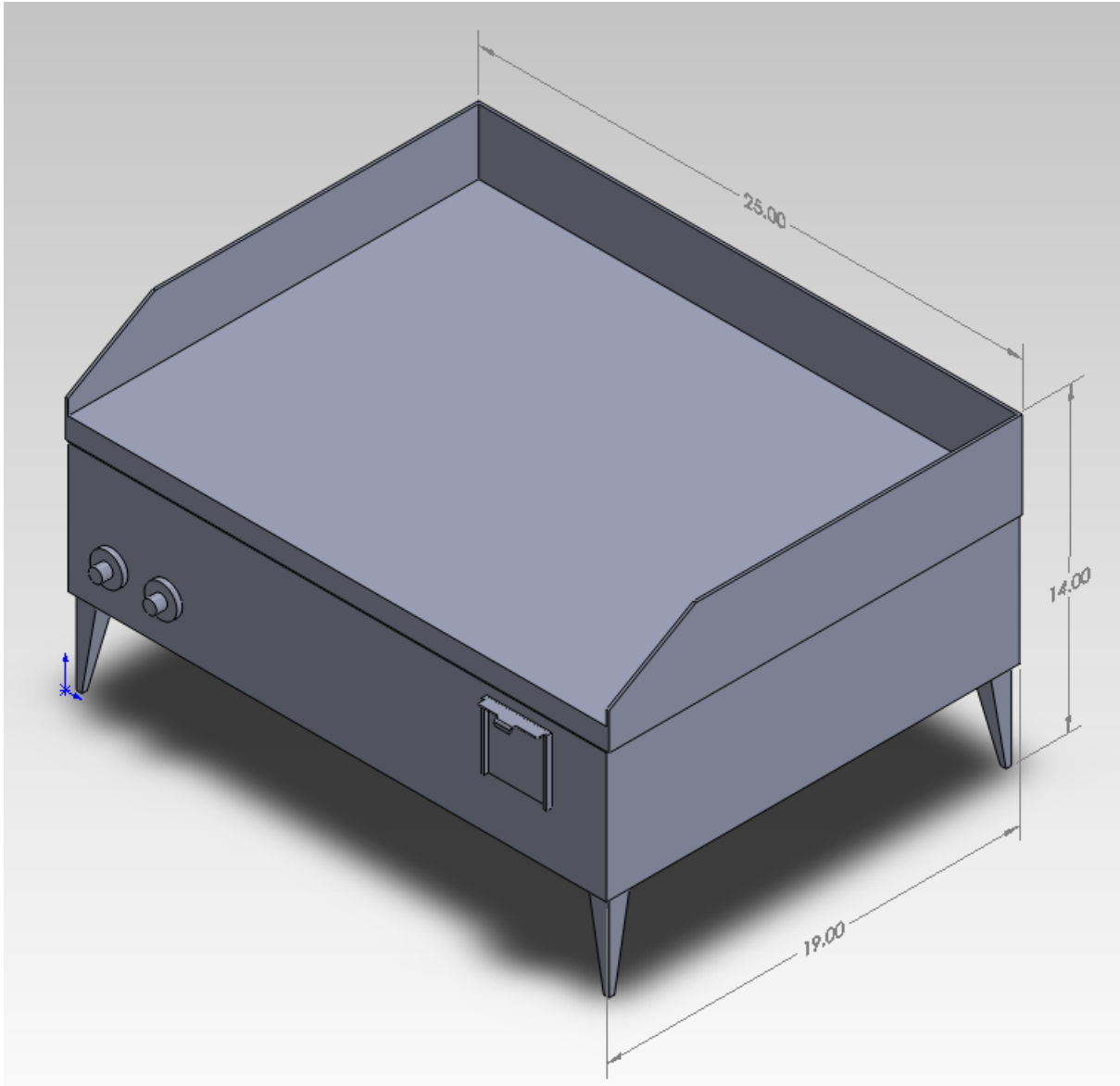
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APPENDICES

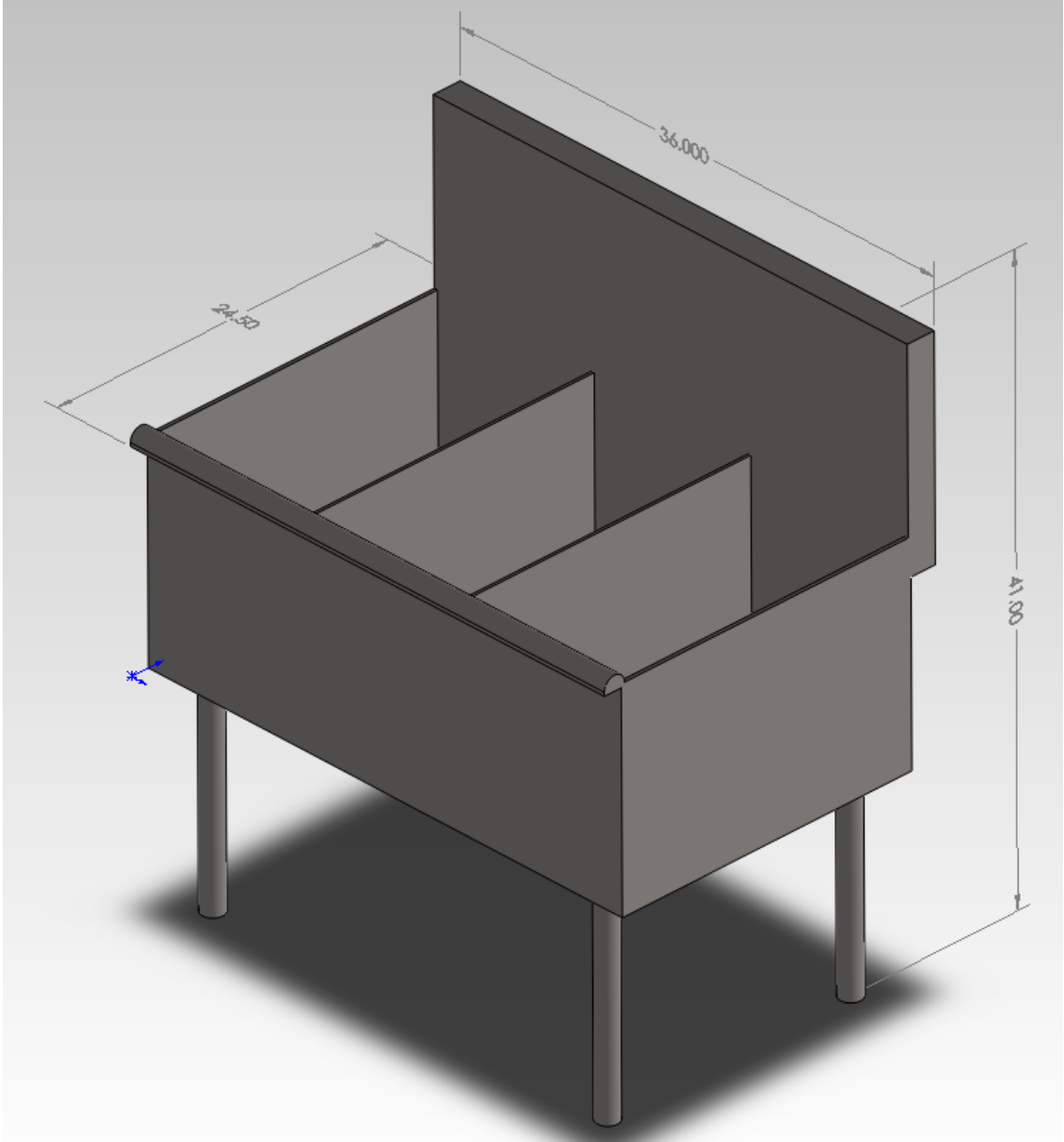
A.

Specifications for researched appliances

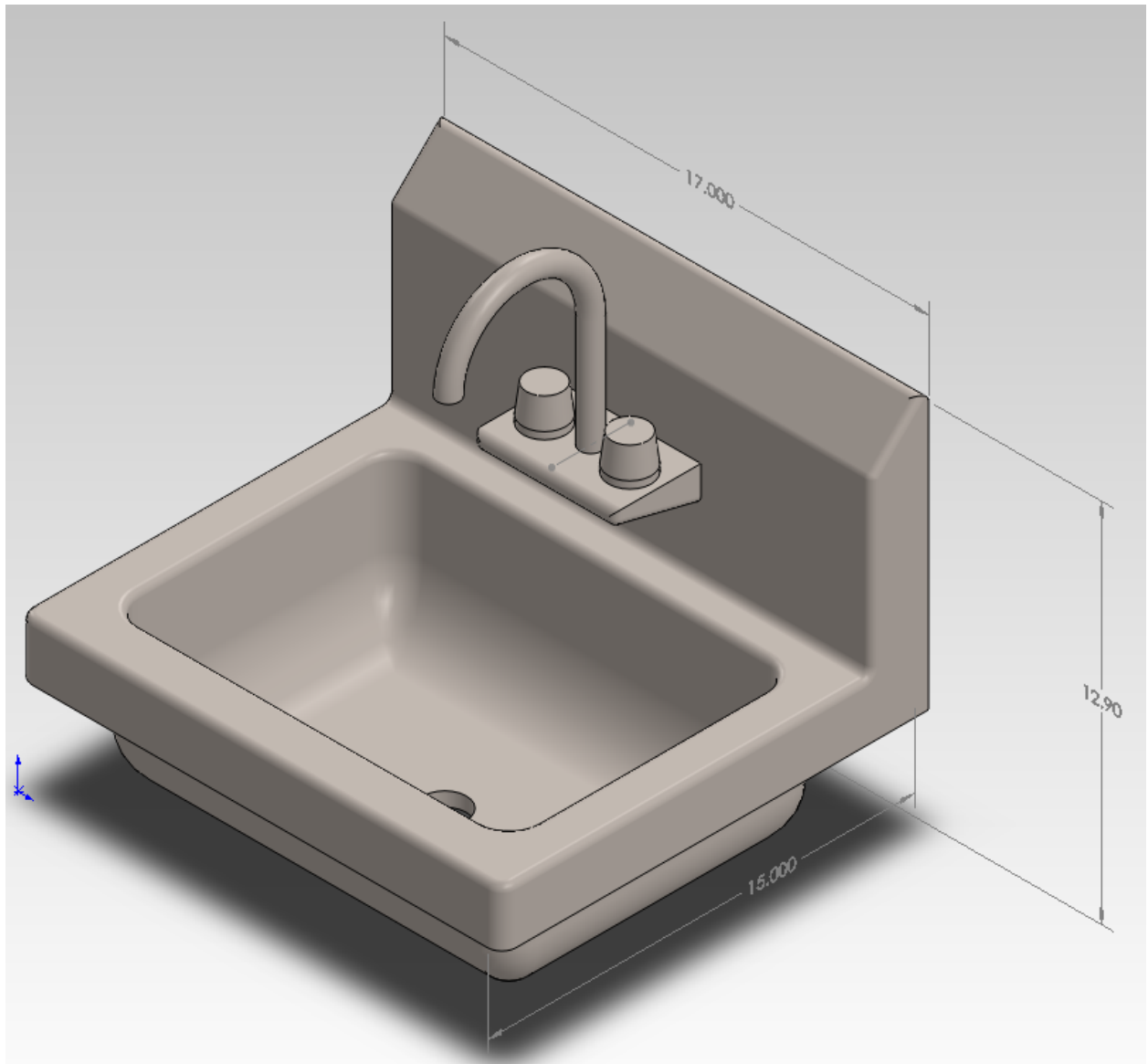
Appliance	Item #	Company	length (in)	width (in)	height (in)	weight (lb.)	Power Consumption (if Applicable)
Griddle	UGR-3E	Uniworl	25	19	14	65	220v, 3800w, 17 amps
3 Compartment Sink	600S31221	Regency	36	24.5	41	72	N/A
Hand Sink	600HS17	Regency	17	15	13.5	12	N/A
Vent Hood	48" Shade Wall	Futuro Futuro	45.5 (w/o glass)	16.625	18	70	110-120 V / 60Hz / 4.0A / 940 CFM
Refrigerator/Freezer	Profile PSIC5RGXBV	GE	28.75	35.75	72.125	394	120V, 15 amp, 60 Hz
Stove and Oven	EV24-S-4FP-208	Vulcan	34	24	58	325	208 volts
Deep Fryer	PF10E	Global Food Equipment	17.5	11.2	15	20.3	120v, 15 amp
Fire Extinguisher	Pro 210	Kidde	Diameter = 4.5		15.7	7	100 psi
Television	42PT350	LG	Depth = 2	39	24.2	44.1	100V ~ 240V, 50/60 Hz, 103 W
Speaker	251 EnvironmentalSpeakers	Bose	8	4.5	12.5	8	200W



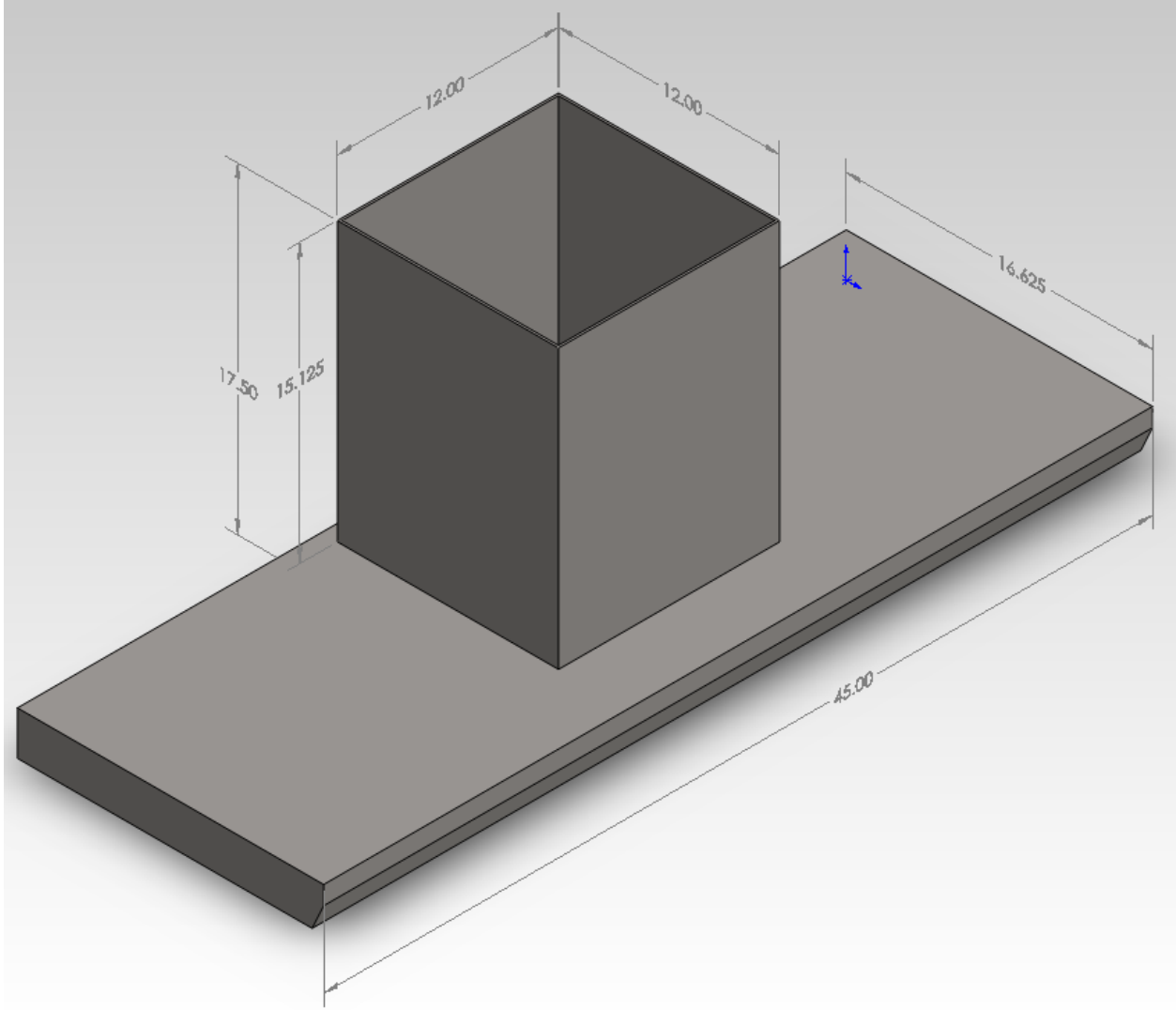
Griddle



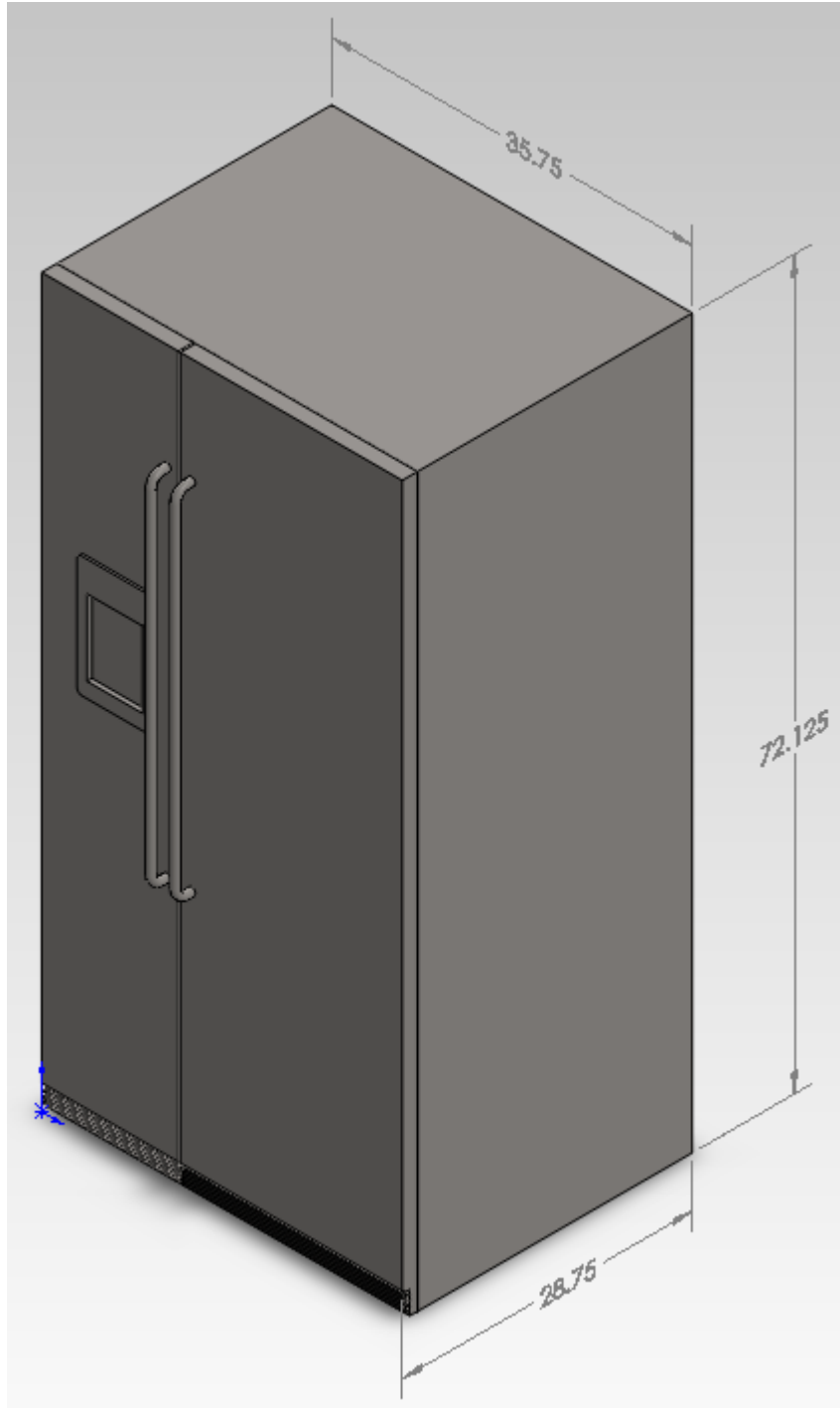
Three Compartment Sink



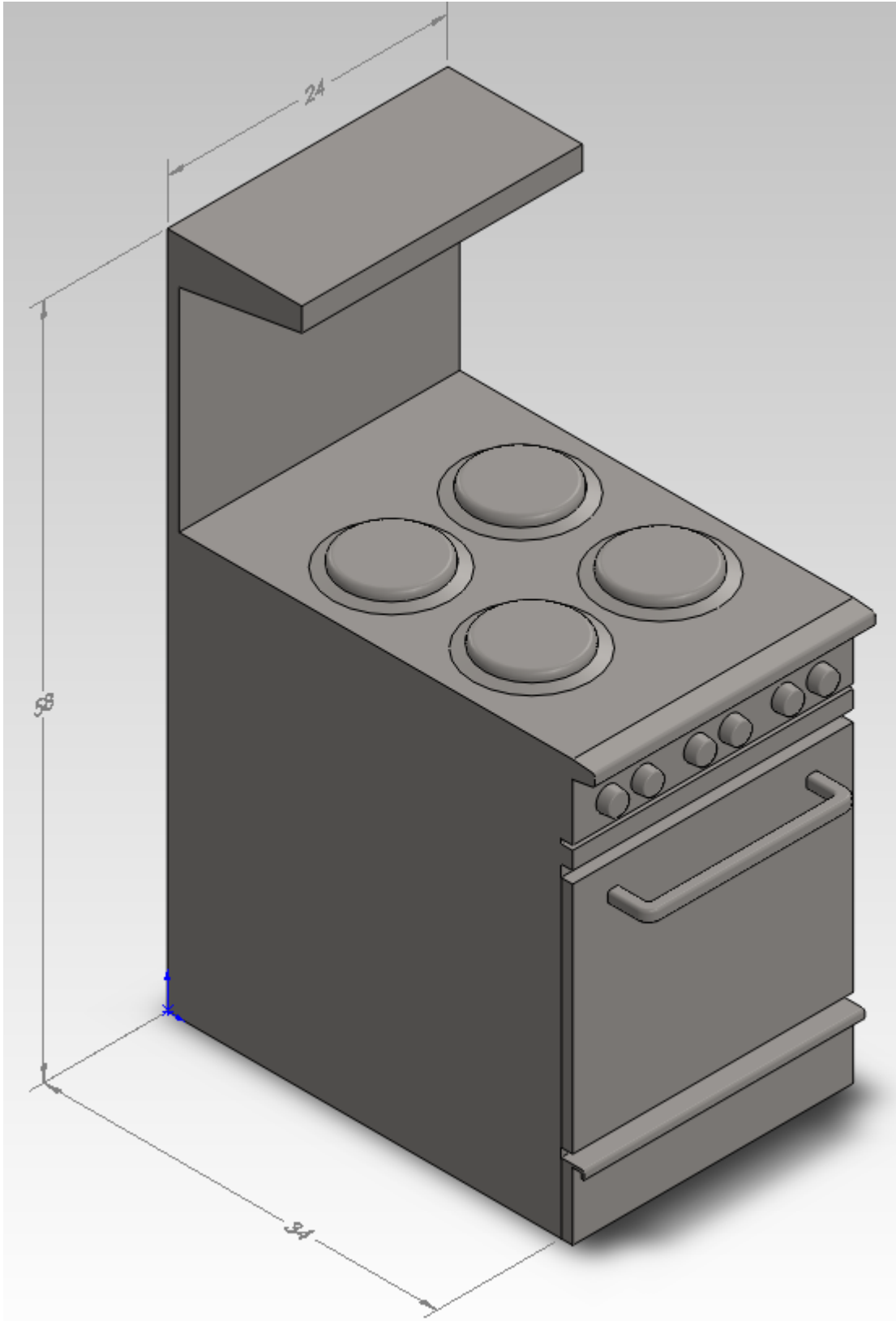
Hand Washing Sink



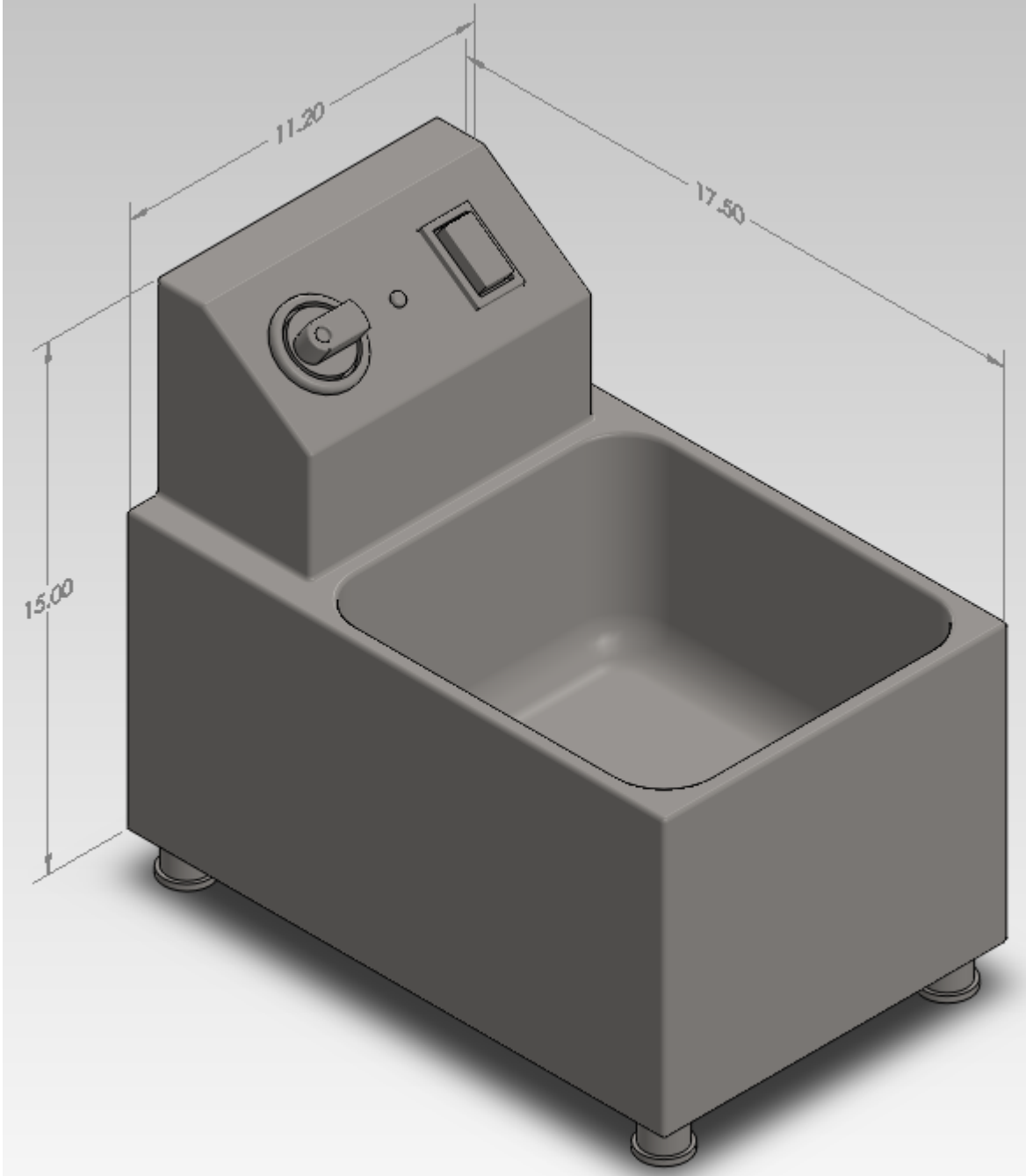
Vent Hood



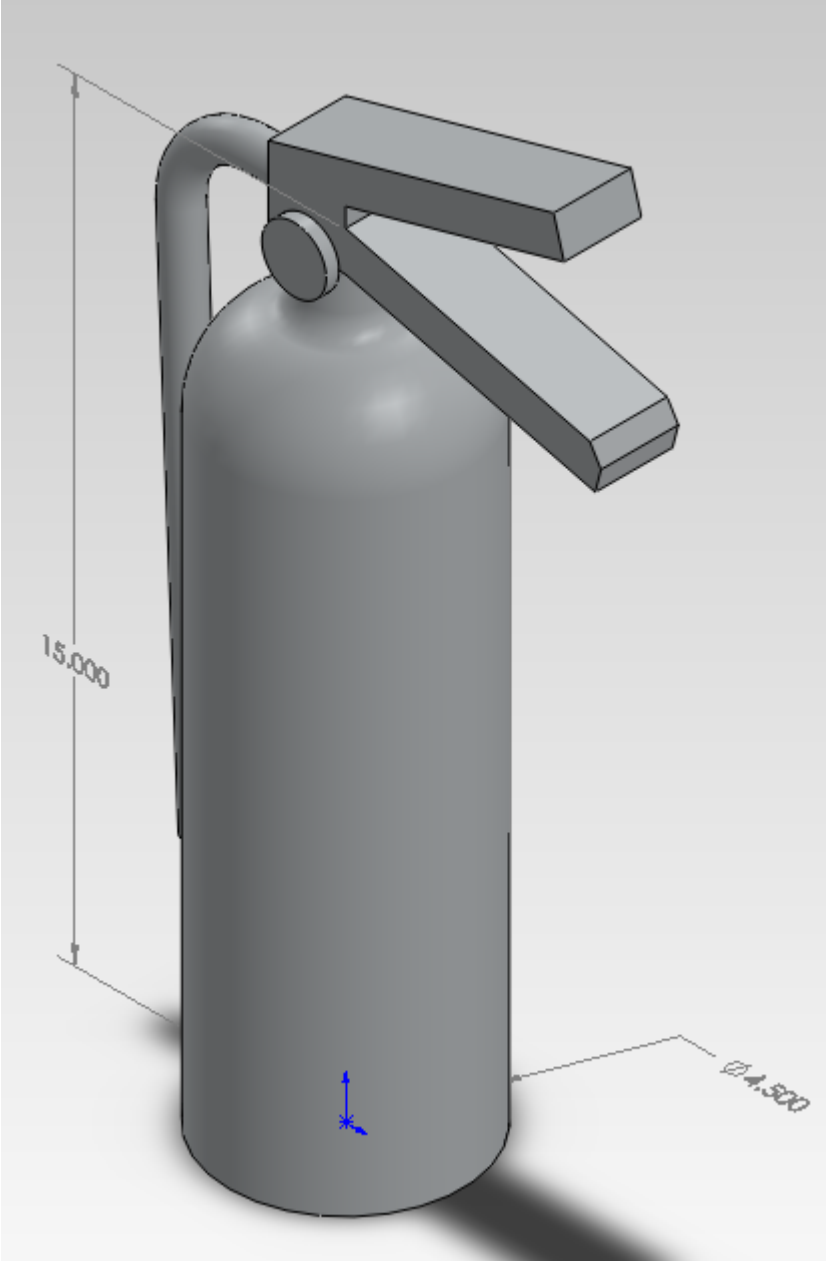
Refrigerator/Freezer



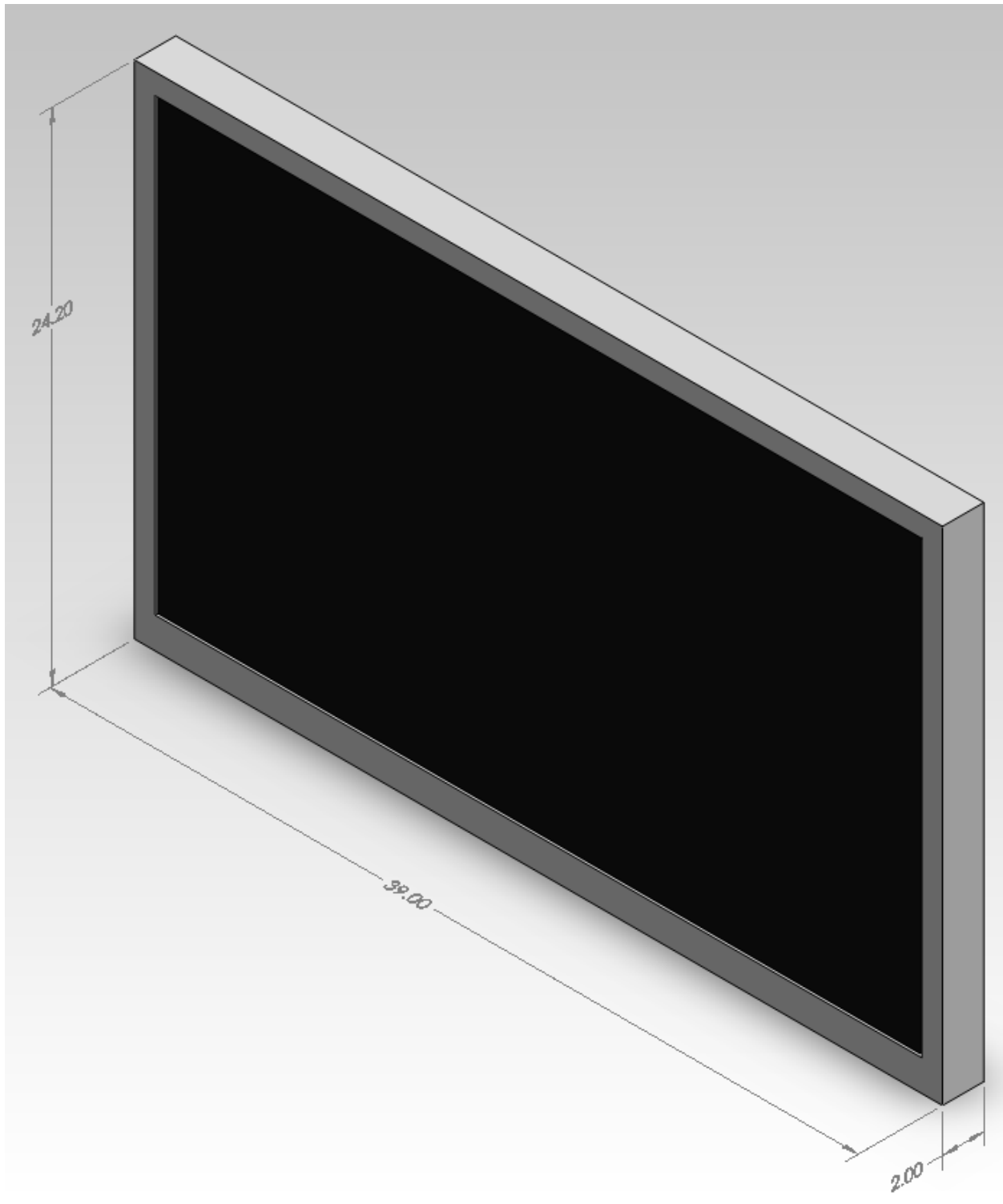
Stove/Oven



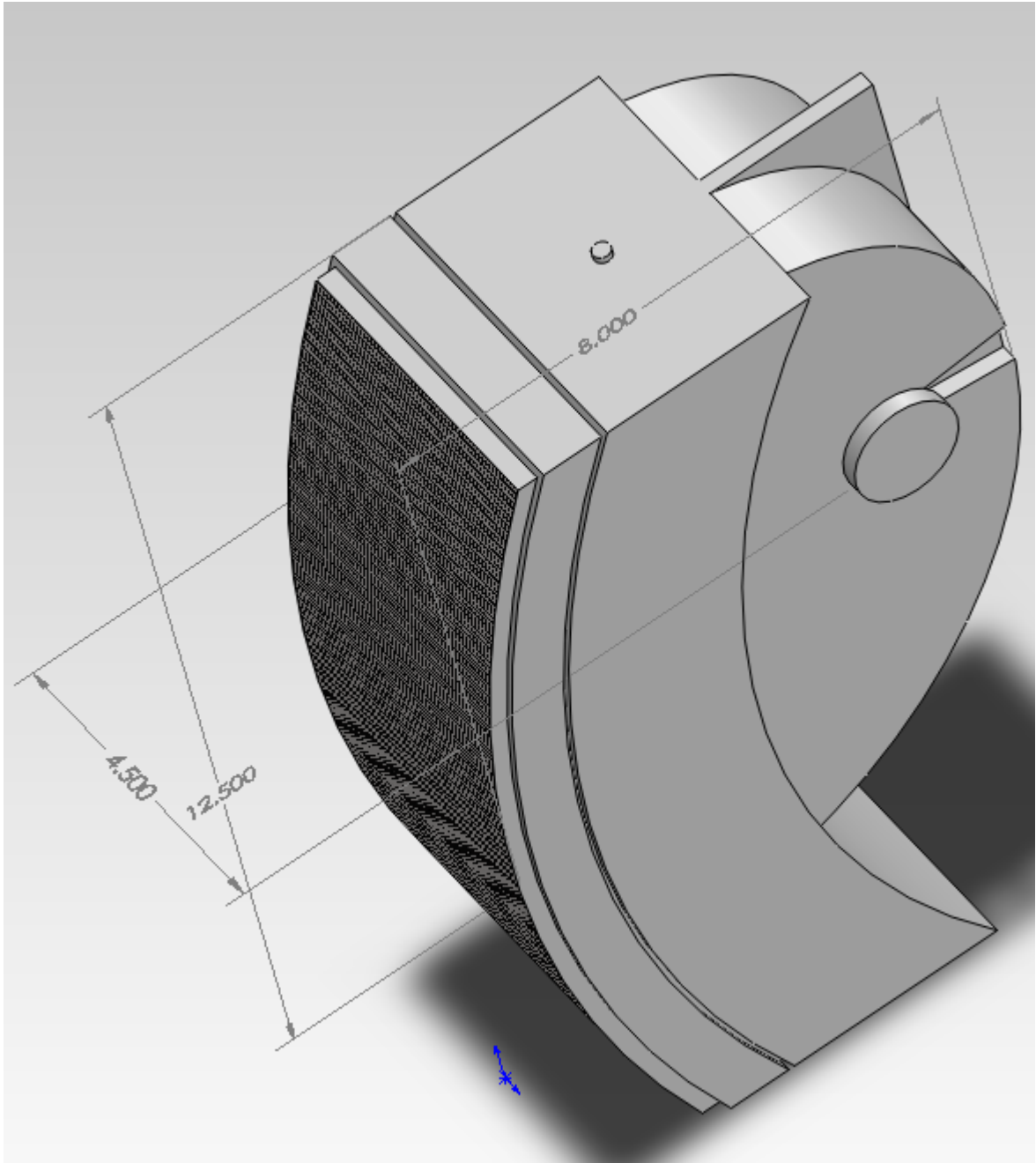
Deep Fryer



Fire Extinguisher



Television



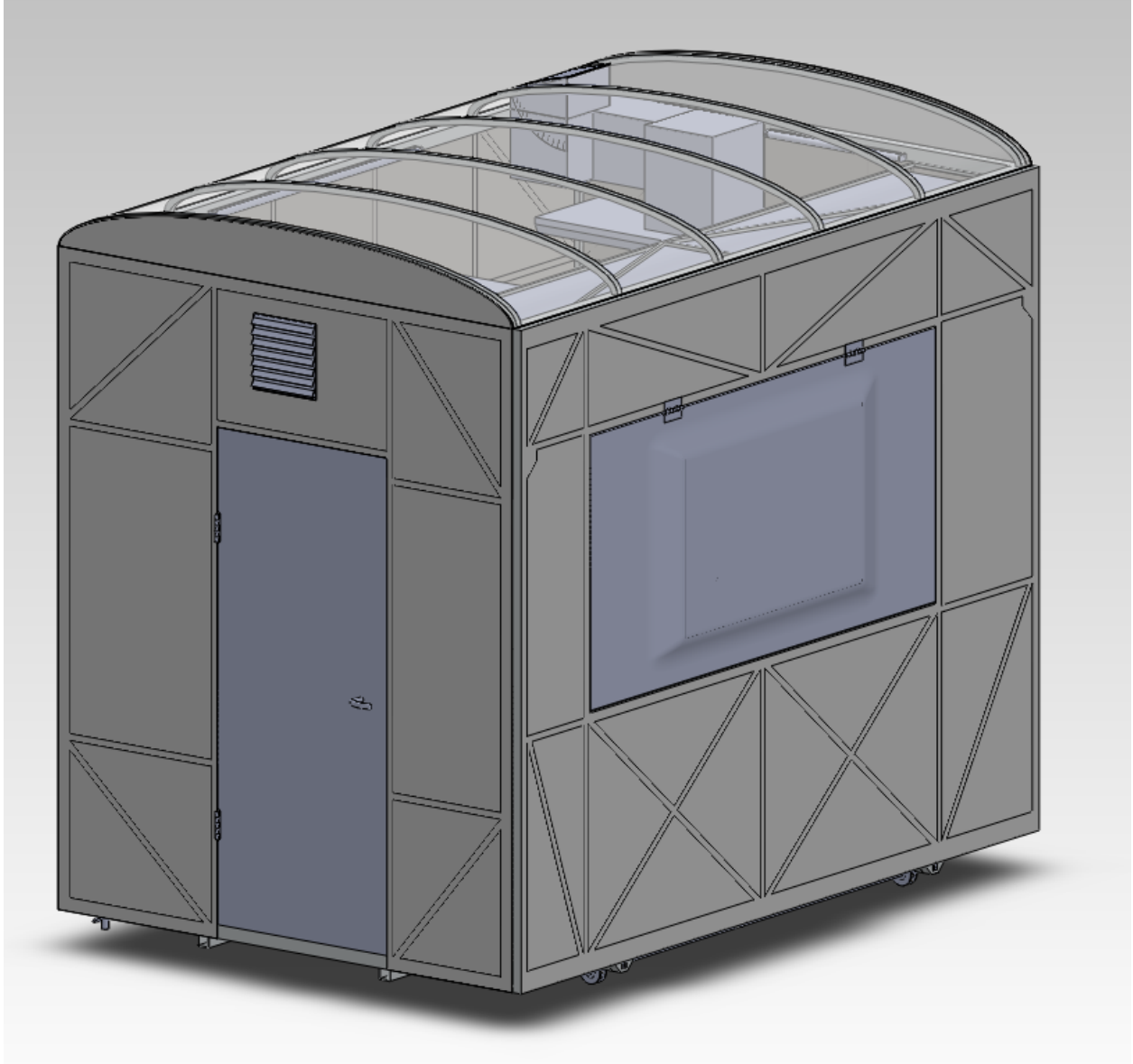
Speaker

B.

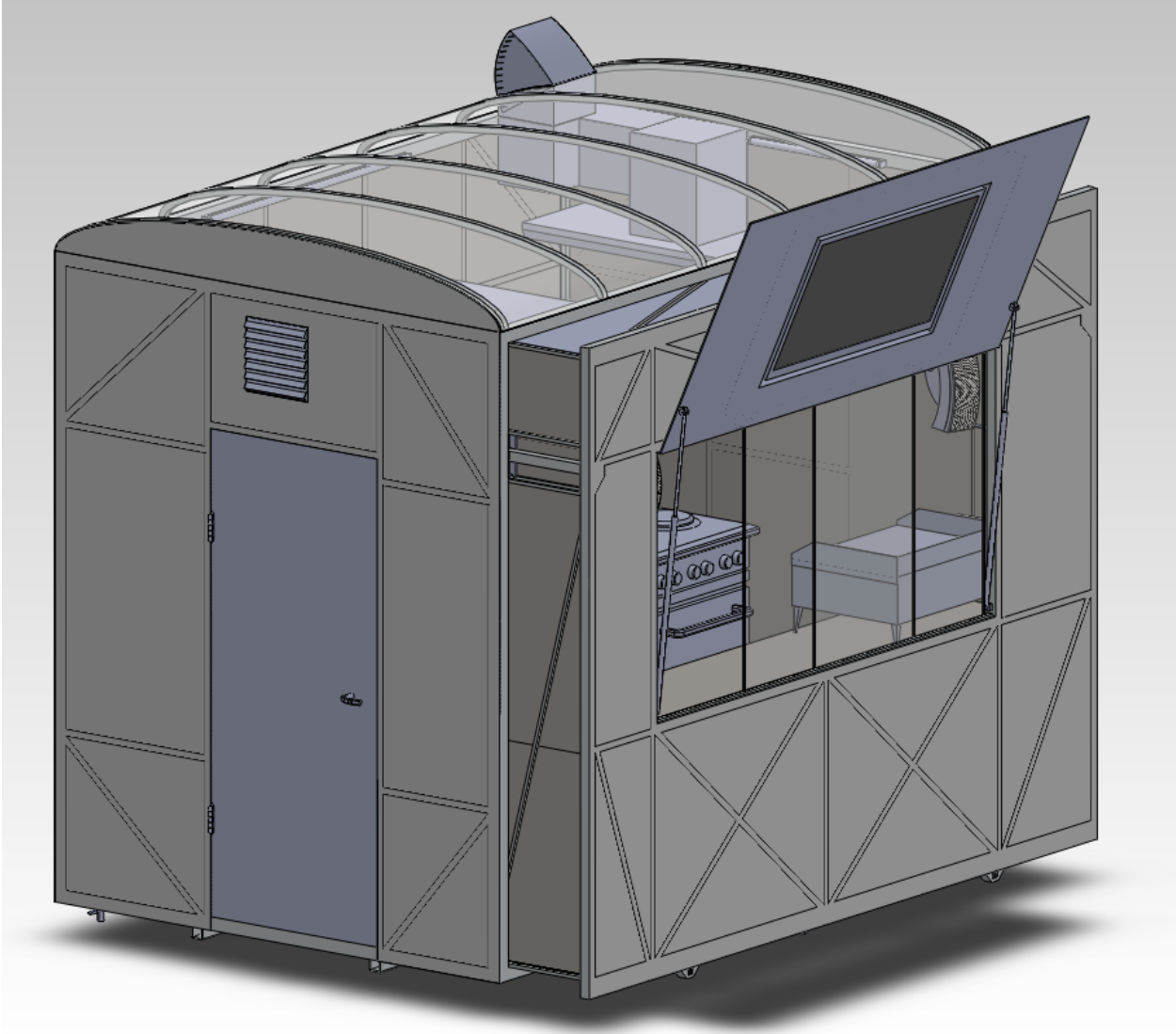
Specifications for various truck models

Model	Payload Capacity	Length (overall)	Cab Length	Rear Length	Width
2012 Chevrolet Express	n/a	246.7 in	98.1 in	143.5 in	79.1 in
Chevrolet 3500HD	n/a	229.5 in	116.5 in	113 in	80 in
2012 Dodge RAM 3500 ST	6493 lbs.	234.3 in	n/a	n/a	78.9 in
2011 GMC Savanna 3500	n/a	246.7 in	98.7 in	148.5 in	79.1 in
2012 Ford E-250	4318 lbs.	241.1 in	92.5 in	149 in	79.4 in
2012 Ford E-350	5268 lbs.	241.1 in	92.5 in	149 in	79.4 in

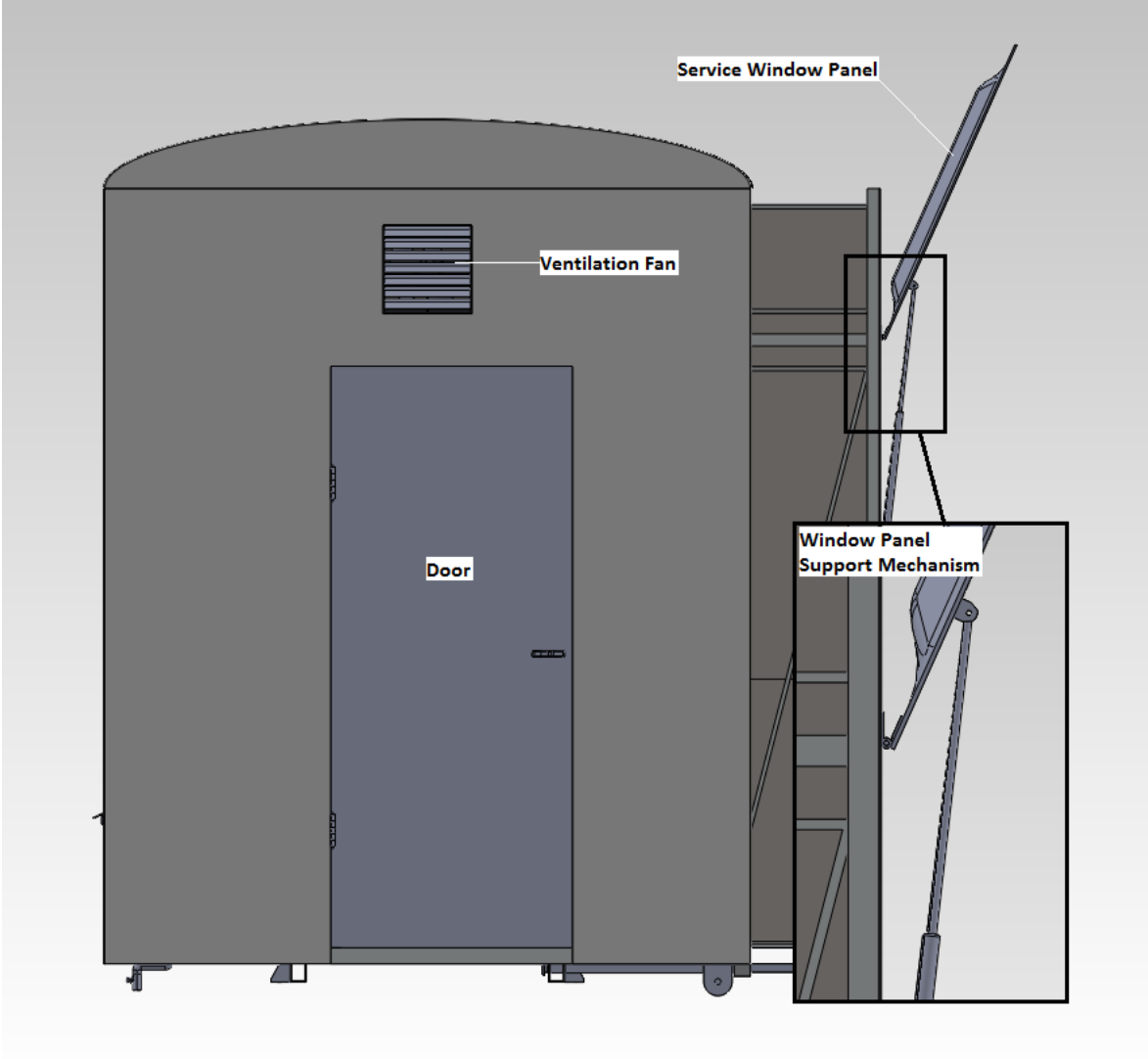
C.



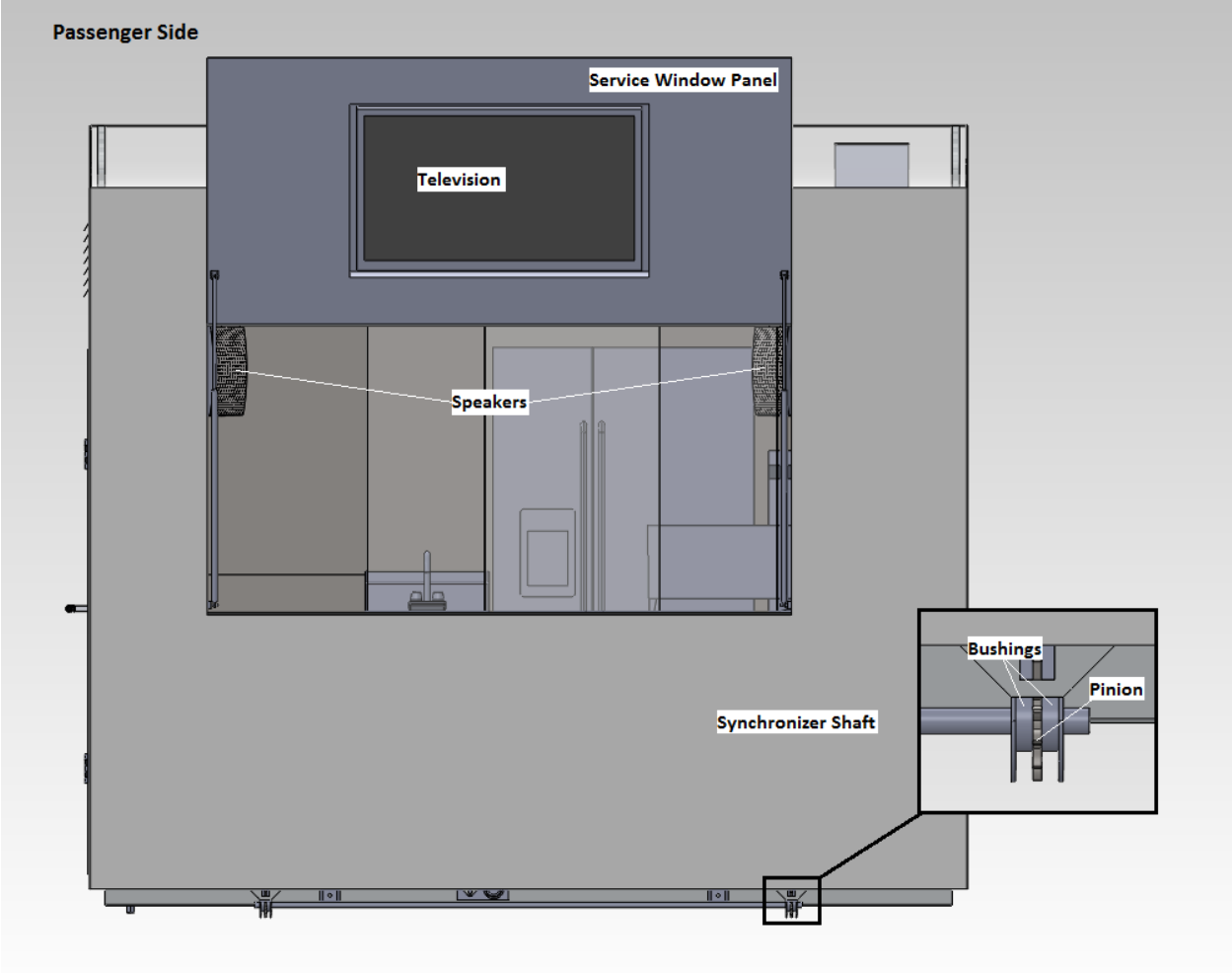
Outside view of the kitchen unit in its collapsed condition



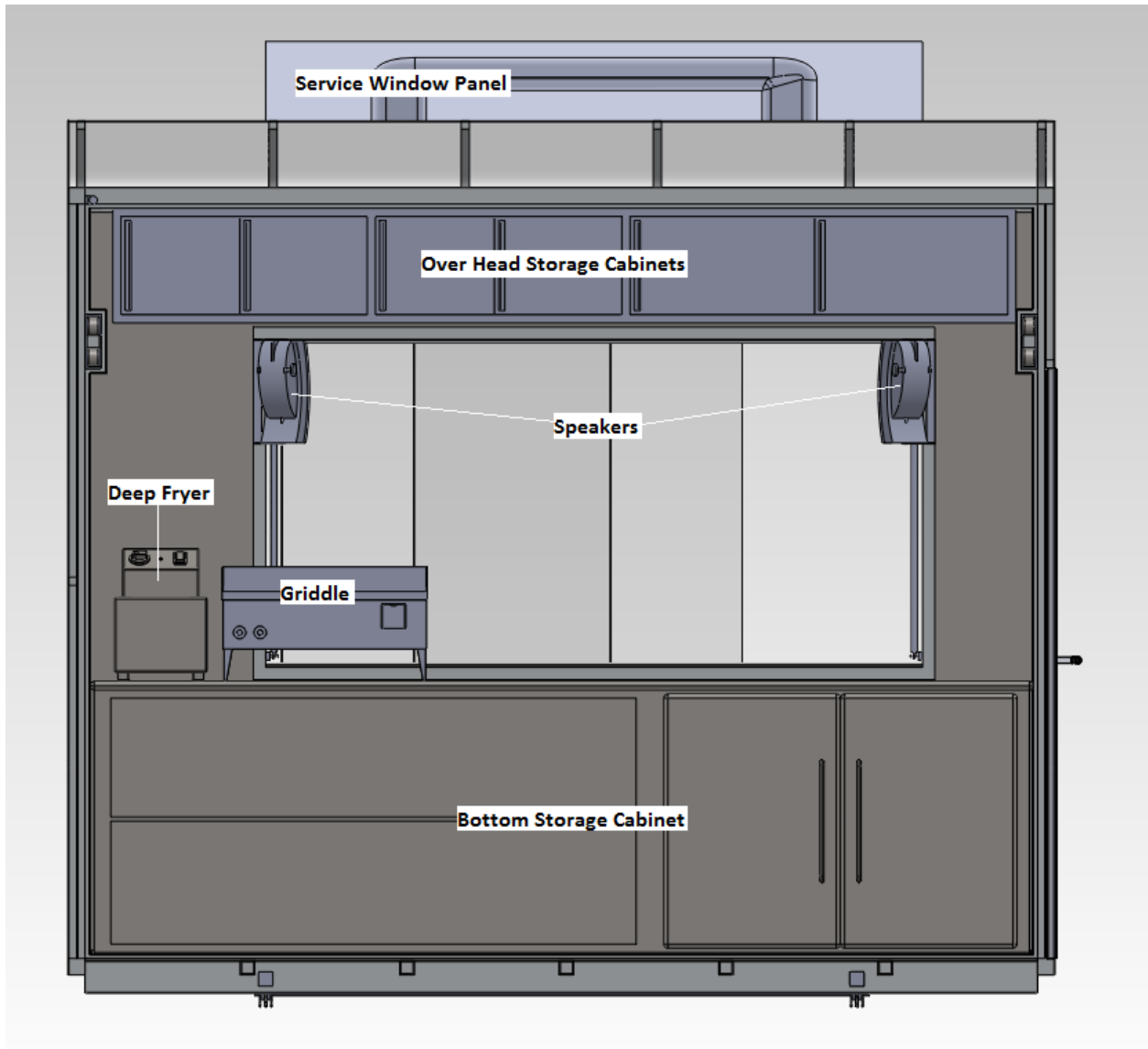
Outside view of the kitchen unit in its expanded condition



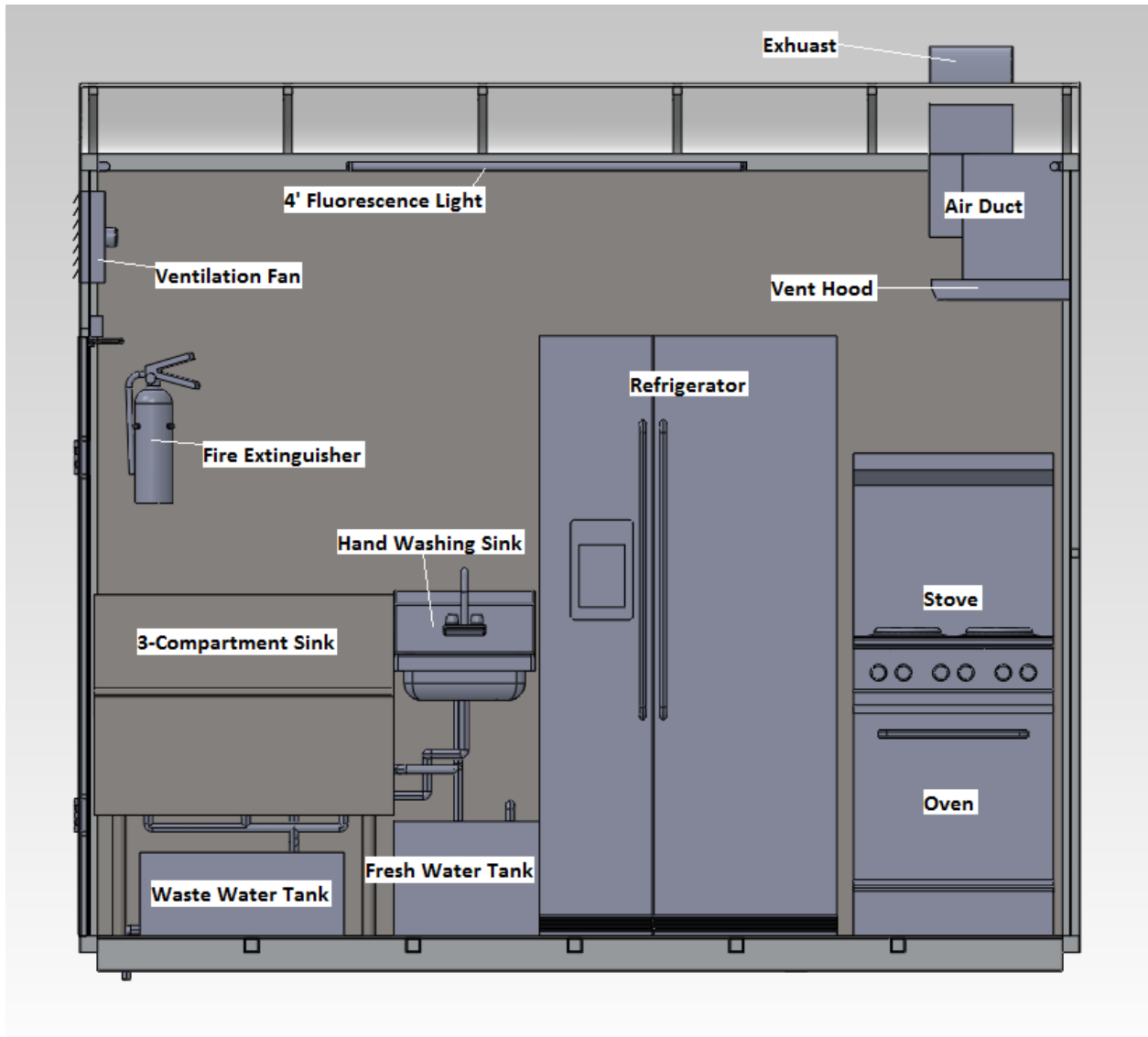
Back view of the kitchen unit from outside with a detailed view of the supporting mechanism for the service window panel



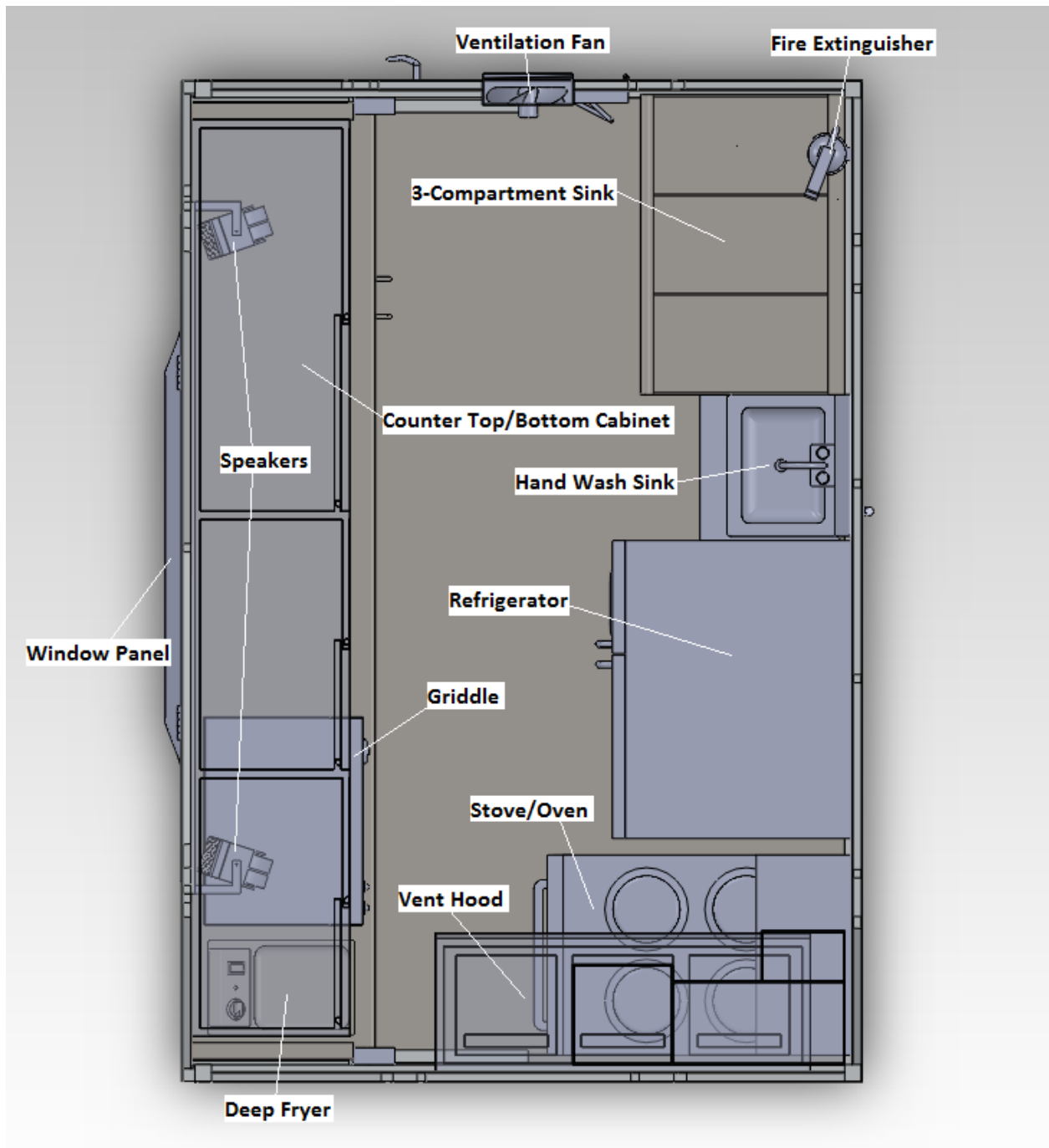
Outside view of the passenger side of the kitchen unit with the service window panel open



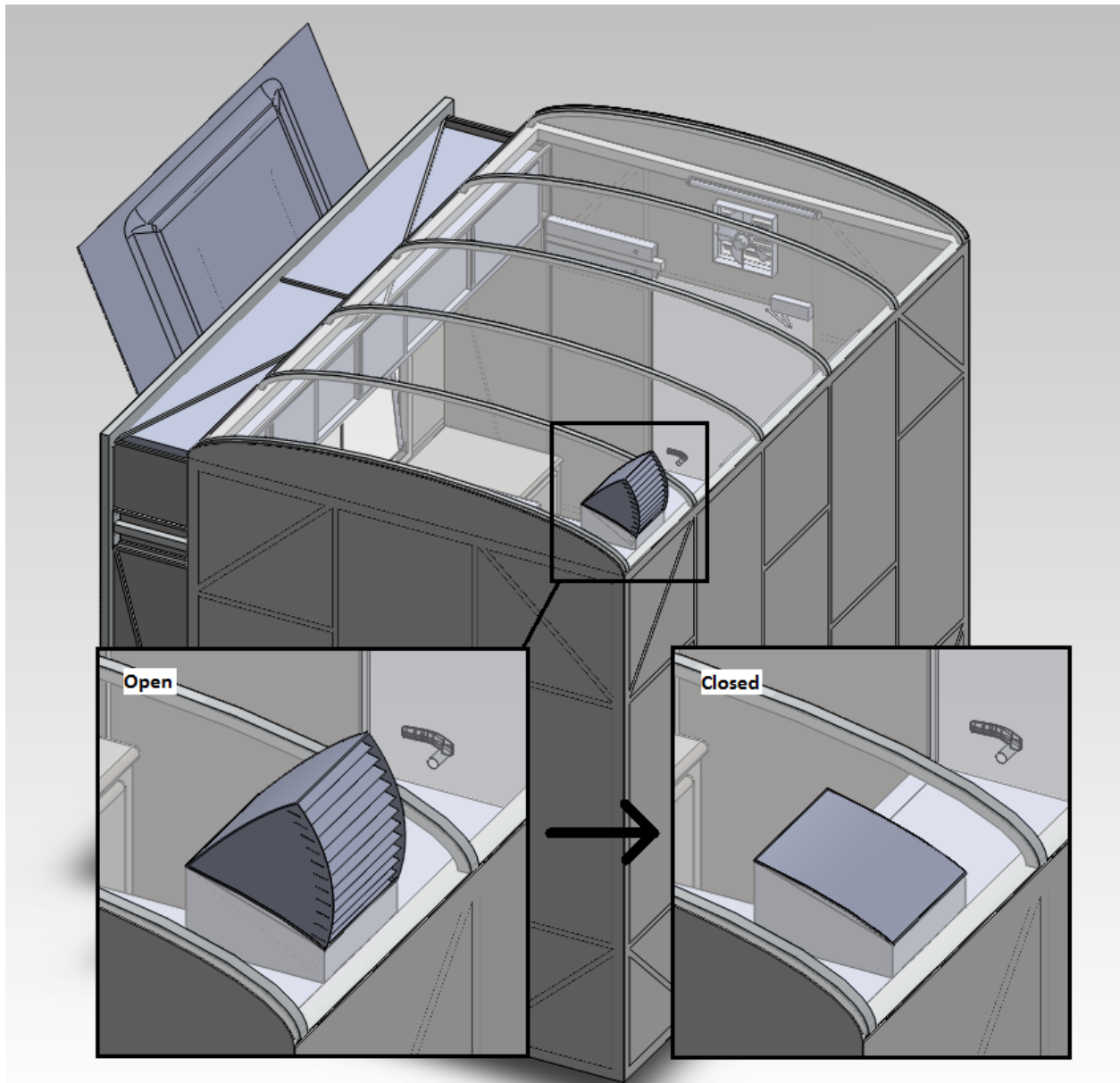
Layout of the passenger side of the kitchen unit



Layout of the driver side of the kitchen unit

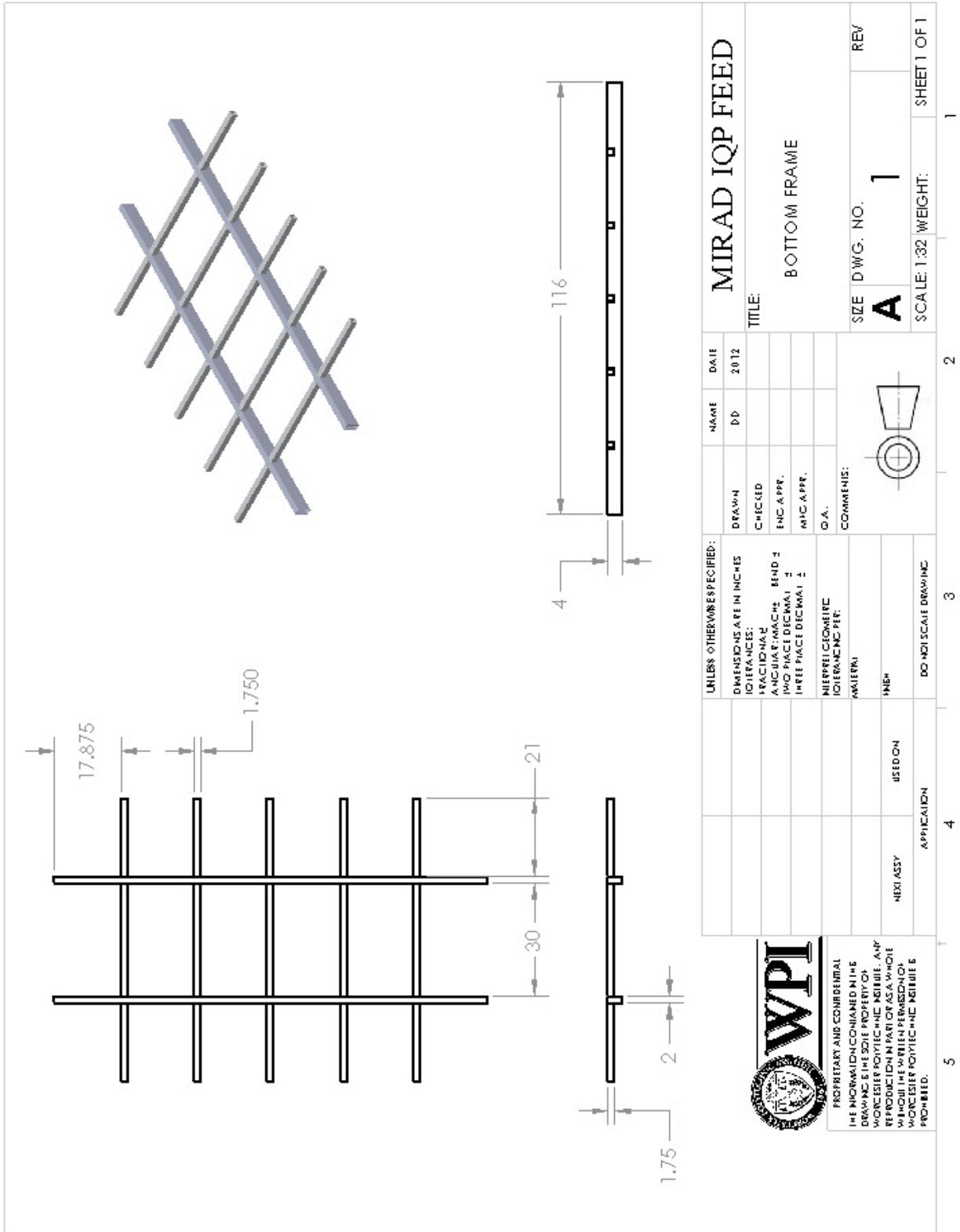


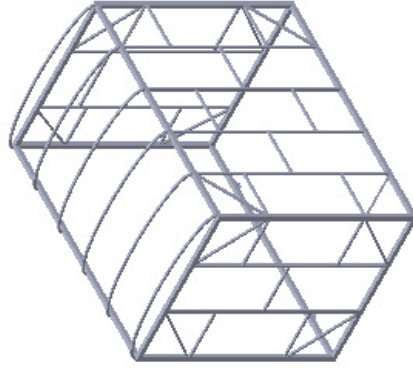
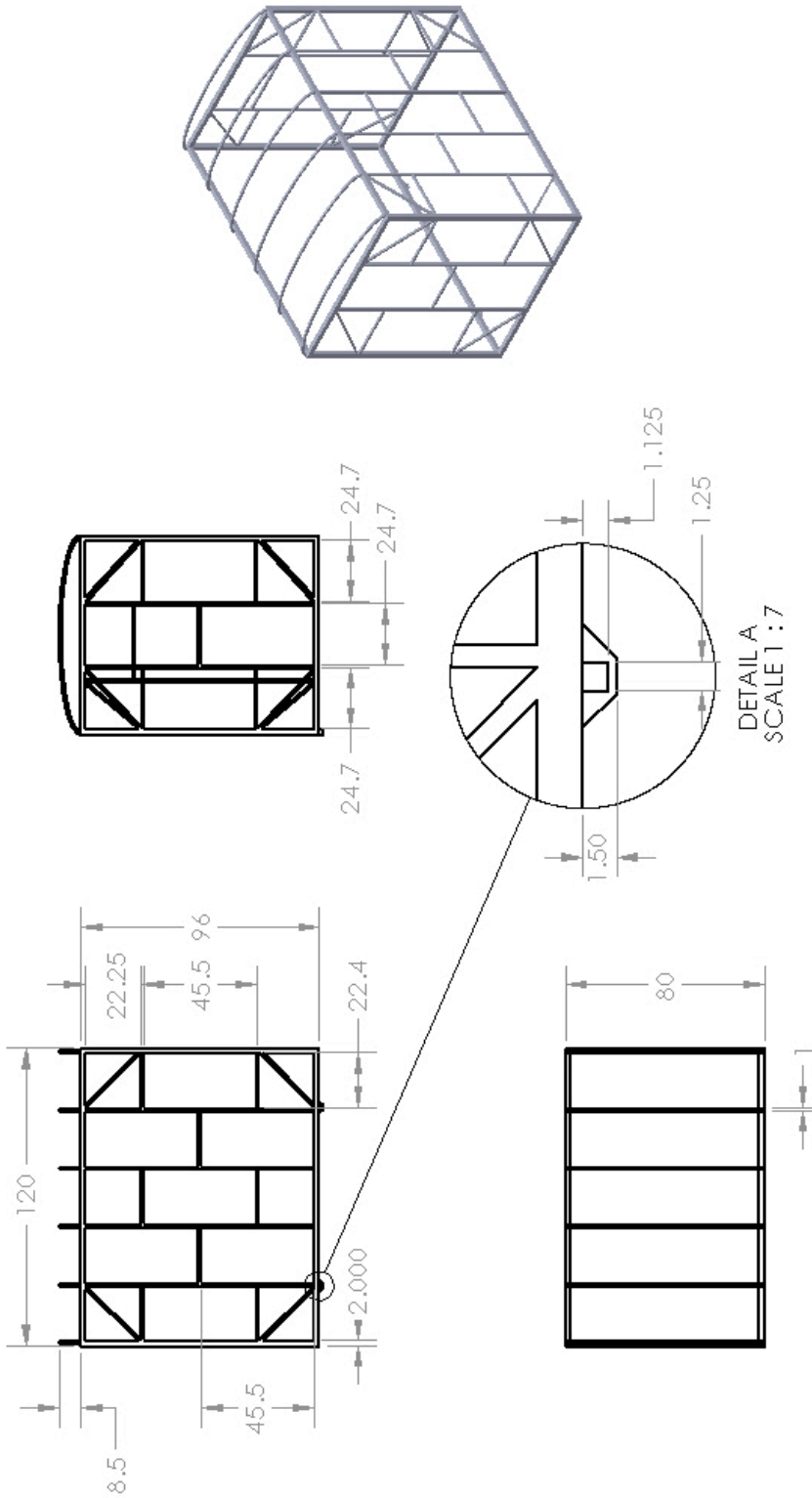
Layout of the kitchen unit viewed from the top



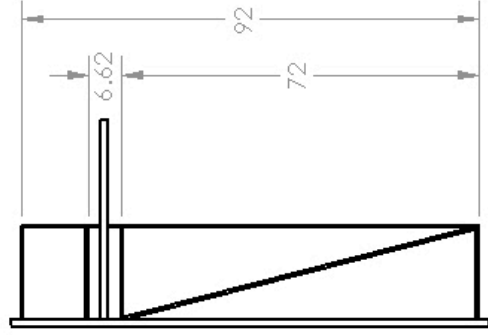
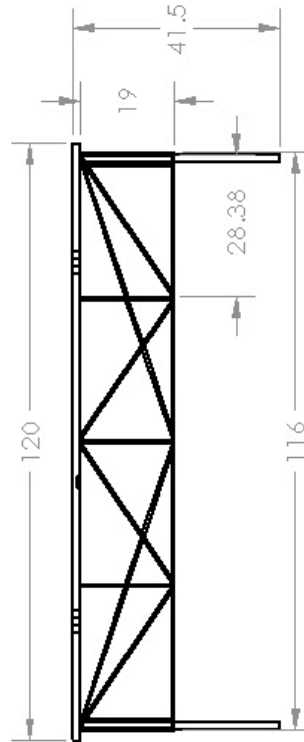
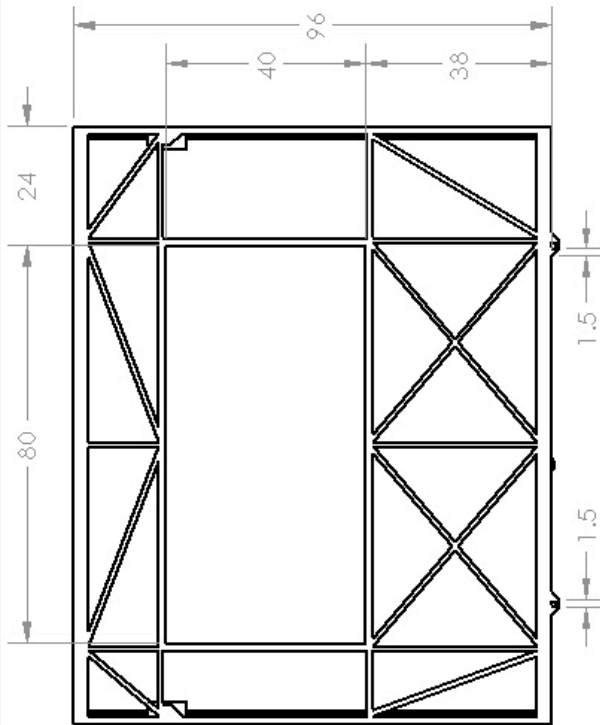
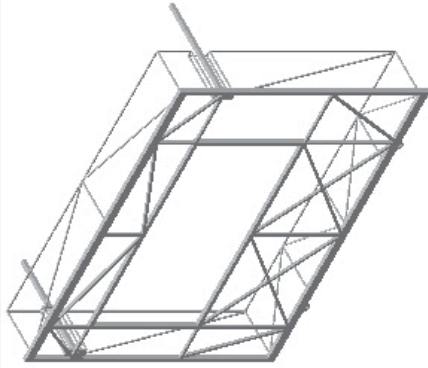
Air duct exhaust in the open and closed positions

D.





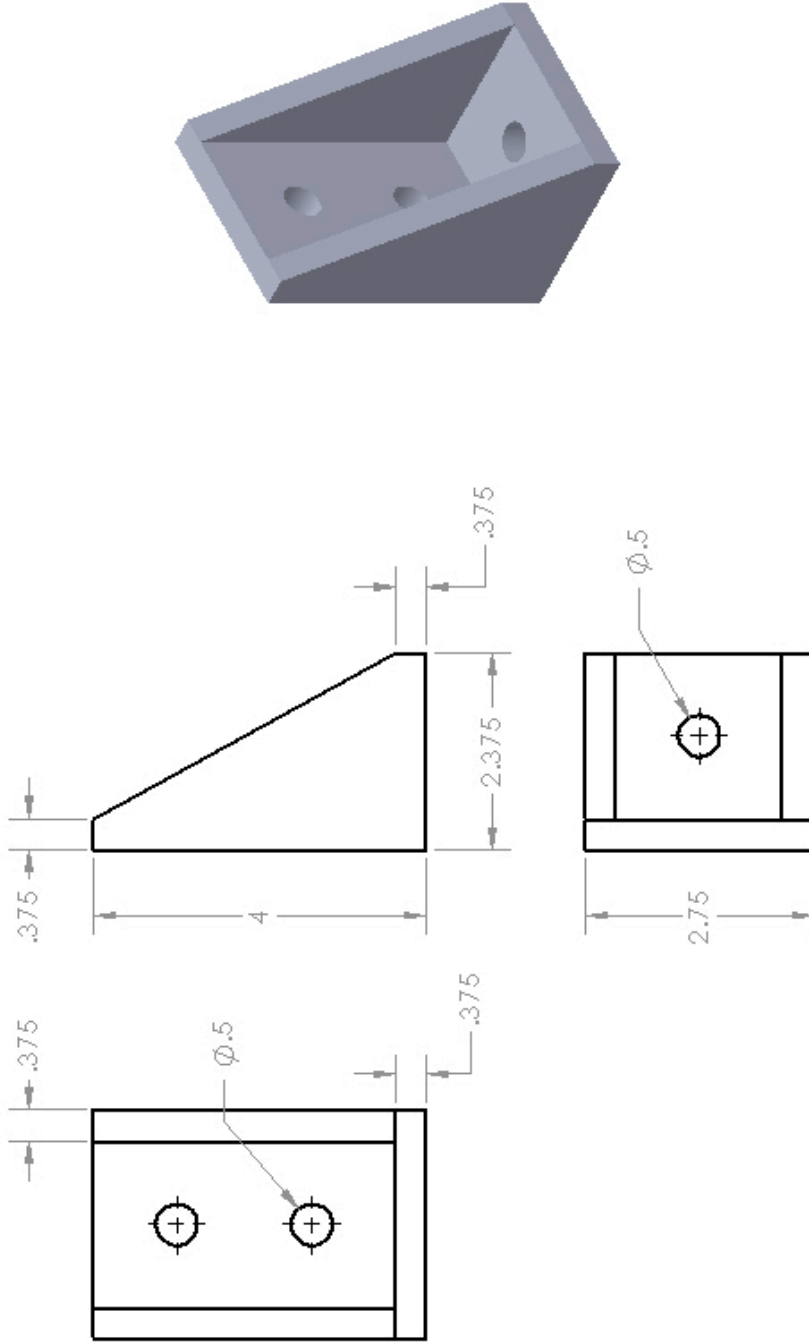
		PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF WORKCENTER POLYTECHNIC INSTITUTE. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF WORKCENTER POLYTECHNIC INSTITUTE IS PROHIBITED.		APPLICATION		DO NOT SCALE DRAWING		COMMENTS:		MATERIAL: ALUMINUM		FINISH		NEXT ASSY		USED ON					
		UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL: ANGULAR: BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ± INTERPRET GEOMETRIC TOLERANCING PER:		DRAWN CHECKED ENG APPR. MFG APPR.		NAME J.N.		DATE 2012		TITLE: MIRAD IQP FEED		SIZE A		DWG. NO. 2		REV					
TITLE: Kitchen Subframe		SCALE: 1:64		WEIGHT:		SHEET 1 OF 1		APPLICATION		DO NOT SCALE DRAWING		COMMENTS:		MATERIAL: ALUMINUM		FINISH		NEXT ASSY		USED ON	



UNLESS OTHERWISE SPECIFIED:		DRAWN	NAME	DATE	MIRAD IQP FEED
DIMENSIONS ARE IN INCHES		CHECKED	JN	2012	TITLE:
TOLERANCES:		ENG APPR.			SLIDE OUT FRAME
FRACTIONAL: 1/8		MFG APPR.			SIZE DWG. NO. 3
DECIMAL: .005		Q.A.			SCALE: 1:32 WEIGHT: SHEET 1 OF 1
TWO PLACE DECIMAL: .01		COMMENTS:			
THREE PLACE DECIMAL: .001					
INTERPRET GEOMETRIC TOLERANCING PER:					
MATERIAL: ALUMINUM					
FINISH:					
NEXT ASSEMBLY:					
APPLICATION:					



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MIRAD IQP FEED
 MOUNTING BRACKET

NAME	CR	DATE	2012
DRAWN		CHECKED	
ENG APPR.		MFG APPR.	
Q.A.		COMMENTS:	

UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS ARE IN INCHES
 FRACTIONAL ANGULAR: 1/16 CH. BEND 1
 TWO PLACE DECIMAL 2
 THREE PLACE DECIMAL 3
 INTERPRET GEOMETRIC TOLERANCING PER:
 MATERIAL: ALUMINUM
 FINISH: USED ON

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USED ON
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SIZE DWG. NO. REV
A 4
 SCALE: 1:2 WEIGHT: SHEET 1 OF 1