

TMU

AER 222

Eng. Design and Graphical Comm.

AIRCRAFT SERVICE DOLLY

Design Project



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Aircraft Service Trolley Design Report

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1. ABSTRACT

The aircraft food dolly is an important piece of equipment used to move perishable goods such as food and beverages throughout an aircraft. Brought into use in the late 1960s, its build, materials, and design have been about the same for many decades. Using the dolly has many benefits as it is simple and cheap to manufacture and maintain. Though, simple and cheap come with a lot of lost opportunities and disadvantages. With this, the design has been needing updates for maximum efficiency, user experience, and safety.

There were a couple of major things that could be improved on, the main two being the transportation method and the door mechanism. Taking these factors into consideration and remembering the cost, we created a new design, outlined in depth in this report. Using cheap materials, we designed a trolley that moves on ceiling-bound tracks with large doors that allow a greater view of the whole contents.

The costs of this project are high, but with equally high returns in terms of better user experiences, features, and functionality. Many future considerations have also been taken such as new, high-tech features and more cost-friendly materials. But all this is not realistic at the moment, since the materials necessary are not readily available.

Ultimately, our new design gives a better experience, increases efficiency, and provides greater ease of use while also being cost-effective.

2. INTRODUCTION

In airplanes, smaller seats and less legroom for customers are a result of pressure on the airline industry to expand capacity and save costs. Because of this, the cabins are now packed, which is made worse by beverage carts that obstruct the small aisles and limit passenger movement. Our team is developing a dolly to address this issue that can accommodate the same quantity of food and beverages as current carts while still being portable and safely stowed.



Figure 1 - Aircraft Cabin

The three main design objectives are mobility, maintenance cost, and space. The product must also be made of lightweight, high-strength materials and secure safely to the ceiling. The objective of this project is to create a cart that will allow flight attendants to offer food and beverages to passengers without disrupting their movement down the already constrained aisle more than it needs to, by providing a more efficient alternative.

3. Review of Past Designs

Currently the aircraft dolly is used in all commercial aircrafts around the world making it one of the most used equipment on an airliner. However, the traditional food trolley has been long overdue a redesign as it is currently outdated and is full of defects. To begin, the current catering cart is small and difficult to store pre-prepped meals in. Due to the size of the dolly, multiple are required which increases transportation costs of the dolly on and off airplanes. The storage which the trolley is equipped with, restricts the size of meals and drinks which can be stored. To continue, the current user experience is poor as the cart is bulky and a hassle to move around. This can be seen as the trolley is equipped with rubber wheels which can get stuck on groves and aisles causing tripping hazards and an overall poor user experience.

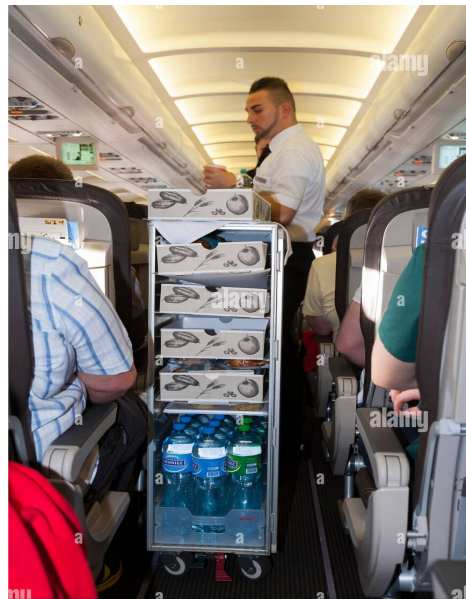


Figure 2 - Current food cart in use actively taking up majority of aisle space. [10]

Moving on, alongside the immobility of the serving cart, the storage inside is also insufficient. The storage requirements of a food trolley include being able to store drinks, snacks, and meals which are easily accessible so they can be given to passengers. The existing iteration of the cart stores all of these items in a stacking formation which causes the cart to be very upright and potentially unstable. Alongside it being unstable, it can also be a potential tripping hazard for everyone who are in close proximity to it. The storage of these carts takes up a valuable amount of space which can be utilized in better ways for companies.

Food dollies are also known to be quite heavy and difficult to maneuver, they run on basic rubber wheels which are prone to becoming stuck in grooves and imperfections on the floors as shown in Figure 3. Due to all these restrictions and flaws which the food trolley possesses, we have re-engineered and designed a new concept for a food trolley that takes all these points into consideration and enhances the product in great ways.



Figure 3 - Traditional food dolly used in current aircraft with rubber wheels. [11]

All aircraft in service today seem to use the same standardized form of a food dolly as seen below in Figure 4.

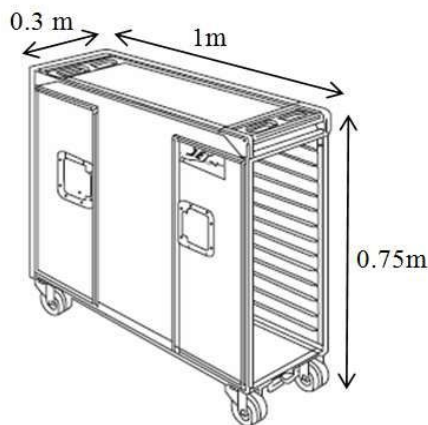


Figure 4 - Standard food dolly used in current airplanes with dimensions.[12]

Since this is the standard used by all aircraft companies it is best to design a food dolly around these measurements as it will not only breathe some fresh air in terms of innovation surrounding aircraft dollies but also involve some familiarity to cabin crews around the world. This gives an advantage as the companies purchasing this product spend less time training crew.

4. DETAILED DESIGN

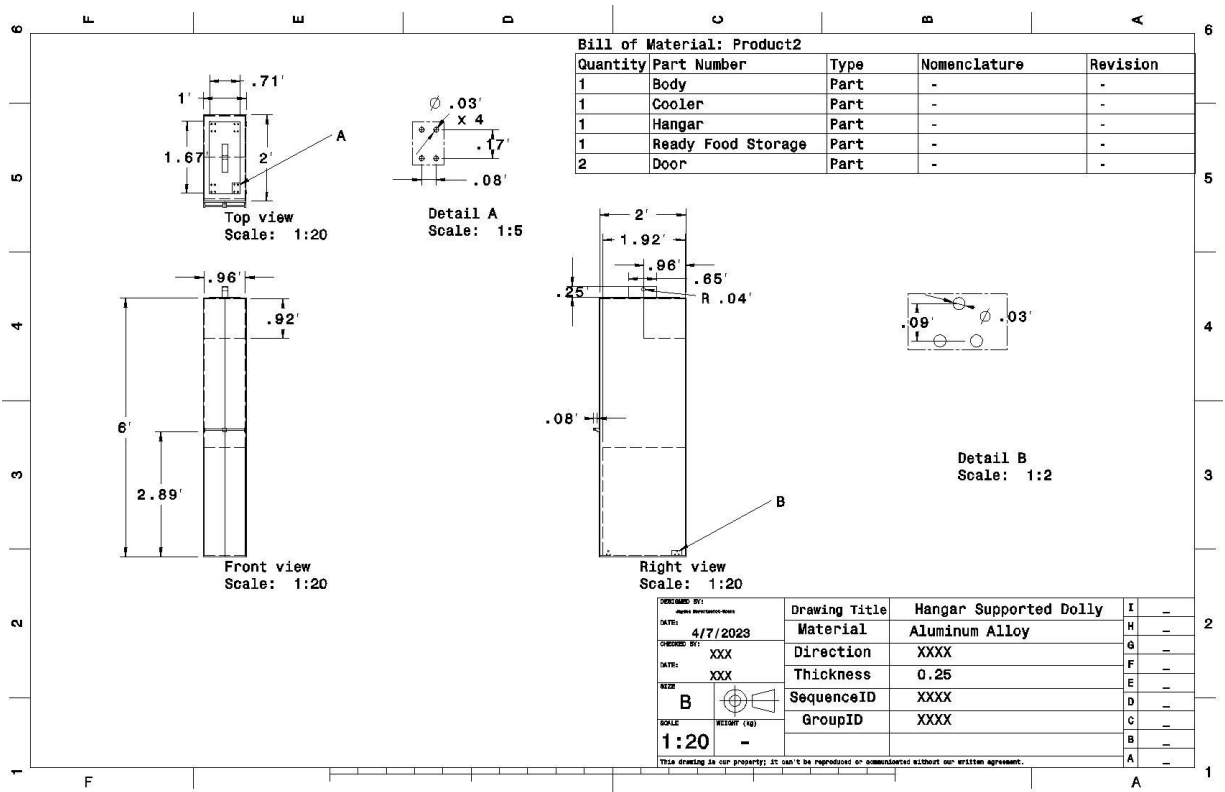


Figure 5 - Hangar Supported Dolly

This new design improves on the standard in a couple of ways, and has a few key features. Firstly, this dolly is obviously much larger than a typical dolly, this is so that the dolly can be used as a small cupboard, having storage for everything that could be needed, in terms of snacks and drinks, in one trip for the flight attendant. This makes it less frustrating for passengers and attendants by eliminating the time it takes to back up and restock before continuing for the other half of the plane. This gives flight attendants more time for their other jobs and could even help the company save money by not having to hire as many flight attendants, and allows for a more streamlined experience for anyone who may be stuck by the dolly when they want to walk the cabin. Because it is larger, it would also be heavier, so tracks which do not intrude on luggage space will be installed onto the ceiling. These tracks, with 2 wheels can support 250 lbs together. This weight is therefore taken off the wheels and the attendant who must push it, and it will feel similar to pushing a regular dolly. The hangar supported dolly is 6ft tall, so a caveat is that it requires two attendants to use, because the one pushing cannot see in front of the dolly, and should receive instructions from the one in front, but two attendants sometimes team up for a regular dolly-run to increase efficiency, so it would not be an impairment on the team.

As indicated on the drawing, there are 3 distinct sections inside the dolly when it opens up. These are additional features which include a ready-made food compartment on the top, a cooler for beverages on the bottom, and an area for modular shelving in the middle.

1. Ready-Made Food Compartment

The ready-made food compartment is made of an insulating material, like a small cooler. This will keep any hot food that is inside it's sealed door hot and will be satisfying to customers who may be used to getting lukewarm food on an airplane if they sit in the middle.

2. Cooler

The drink cooler on the bottom is to keep drinks fresh and cold. This cooler is larger than the one for food, because most often on flights, people would get a free beverage, and this takes most of the use for the original dolly, which means it is preferable to have plenty of space for drinks.

3. Modular Shelving Area

The modular shelving area is for general storage of snacks, cups, plates, or whatever else may be needed on a dolly at any given moment, just at arms reach from an attendant using this new design.

5. DESIGN PARAMETERS

5.1 Materials and Cost

Our materials are separated into two groups, the box, and the railings. In our research, we found that the most commonly used material in aircraft service trolleys is high-grade aluminum alloy [2].

Aircraft (Structure/Tube)	2014	2024	5052	6061	7075	General Fabrication	1100	3003	5052	6061
Architectural	3003	6061	6063			Machined Parts	2011	2014		
Automotive Parts	2014	2024				Marine Applications	5052	6061	6063	
Building Products	6061	6063				Piping	6061	6063		
Boat Building	5052	6061				Pressure Vessels	3003	5052		
Chemical Equipment	1100	6061				Recreation Equipment	6061	6063		
Cooking Utensils	3003	5052				Screw Machine Products	2011	2024		
Drawn and Spun parts	1100	3003				Sheet Metal Work	1100	3003	5052	6061
Electrical	6061	6063				Storage Tanks	3003	6061	6063	
Fasteners & Fittings	2024	6061				Structural Applications	2024	6061	7075	
General Fabrication	1100	3003	5052	6061		Trucks Frames & Trailers	2024	5052	6061	6063

Table 1 - Potential Aluminum Grades [2]

There were two main alloys we researched. The first is Alloy 3003. This alloy is the most widely used of all aluminum alloys for its high strength. It is also an aluminum-magnesium mix [3]. This means it is one of the most lightweight aluminum alloys, which is great for our design. The only problem with this alloy is that it has a lower ductility - the ability to be hammered thin or stretched out. The second alloy we took into consideration was Alloy 7075. This alloy is heavily used in the aerospace industry, for its high ductility, and strength. The problem with this one is its cost.

For a 0.25" thick sheet:

An 36" x 12" 7075 aluminum alloy costs approximately \$204.73. [4]

An 36" x 12" 3003 aluminum alloy costs approximately \$81.02. [4]

Keeping in mind that the more we buy, the cheaper the prices get, we concluded on using Alloy 3003, because it is still much higher in ductility than the average material. The inside of the box will be made of a different material to decrease cost as it is not necessary to have metal on the insides as well. We decided on plywood because it is cheap yet very dependable as it is used in many everyday objects.

Moving onto the railings, we were looking to attach our box to wheels attached to an plate and fully covered railings for extra safety (as shown in figure 6).



Figure 6 - 16SR in covered railing (right) and 16ST (left) [7]

Keeping the Boeing 737 in mind, the average cabin length is about 82 ft. This means that our railing would also have to travel this length for maximum capabilities. Three different suppliers were looked into for prices, and we concluded that we could get one railing, one wheel attachment, and multiple ceiling mounts (every 5 ft) for \$448.07. The three main supplier we looked into are shown in Table 2 below.

MAIN SUPPLIERS			
Design Features	AKON	GRAINGER	McMASTER-CARR
Length	3.5 ft	12 ft	10 ft
Comes with I-Beam	Yes	No	No
Cost	\$42.69	\$163.83	\$289.29
Final Cost	\$449.89	\$978	\$2314.32

Table 2 - Main Suppliers Comparisons

The final cost refers to having railings throughout the cabin, which, again, is 82ft in length. The rest of the materials can be found in *Table 1*. This shows the total materials list and cost.

AIRCRAFT SERVICE TROLLEY				
#	ITEM	MATERIAL	SPECIFICATIONS	COST
1	Outside Shell	3003 Aluminium Alloy	¼ in. × 6ft. × 1ft. ¼ in. × 6ft. × 2ft.	76.97 × 2 145.85 × 2
2	Inside Shelves	Red Oak Plywood	¼ in. × 2ft. × 4ft.	\$29.70 × 2
3	Shelve Slides	Mount Ball Bearing (100lb capacity)	22 in.	\$31.98 × 3
4	Railing*	Galvanized Steel	82 ft	\$460
5	Railing Wheels*	16ST Wheels x 2	125lb capacity	--
6	Bottom Wheels	Rubber Caster	5 in. × 15/16 in.	\$12 × 4
TOTAL				\$1098.33

**Note: Railing price includes wheels, wheel attachment and ceiling mounts*

Table 3 - Materials and Costs List [multiple sources]

In total, our design would be around \$1100.00. Compared to the average \$500-\$600 food dolly, our design has a higher load capacity, easier to move around the cabin and extra features for better usage of the dolly. When looking at the costs, it must be understood that the railings are a one time payment, while the dolly would be the only thing needing to be replaced. This would mean that the actual dolly would cost around \$500.

5.2 Disadvantages and Limitations

The clear disadvantage of using this over the normal food dolly, is the price. But the price can be understood when all the new features are taken into consideration. Our design heavily improves the user experience, increasing efficiency and ease of use. This dolly sets new standards in the market.

When looking at constraints, three main constraints have been improved on for our design. These are safety constraints, quality constraints and life-cycle constraints.

Quality Constraints

Quality constraints are the biggest factor in the creation of this design. The average dolly was hard to move and stop, had very little storage space, and the doors made it difficult to use and uncomfortable for both the attendants and passengers. Our design eliminates these problems, with sliding side doors with a turn- to-unlock mechanisms, large shelves for extra space and break mechanisms. With the addition of extra insulated compartments, our dolly is a great improvement from the previous models.

Safety Constraints

Safety has been a top priority for this design. The average dolly is not very user-friendly, and high turbulence can cause it to tip over, run over passengers and further impede user experience. Our design greatly reduces these constraints, with wheels on top and bottom to increase structural stability, and an aluminum 3003 alloy shell for increased sturdiness. The addition of the hold-to-move mechanism further increases safety.

Life-Cycle Constraints

Life-cycle constraints are an important note in our design. While the average dolly is replaced every 5 years, the lifecycle of our dolly could be decades, if used and maintained properly. This is due to the materials used in the shell. On top of this, the railings would not need to be replaced, therefore replacing our dolly would cost less than the average dolly.

6. FUTURE DESIGN CONSIDERATIONS

The aircraft food dolly is an important piece of equipment used to move perishable goods such as food and beverages throughout an aircraft. Brought into in the late 1960s, its build, materials, and design have been about the same for many decades. Using the dolly has many benefits as it is simple and cheap to manufacture and maintain. Though, simple and cheap come with a lot of lost opportunities and disadvantages. With this, the design has been needing updates for maximum efficiency, user experience, and safety.

There were a couple of major things that could be improved on, the main two being the transportation method and the door mechanism. Taking these factors into consideration and remembering cost, we created a new design, outlined in depth in this report. Using materials that are cheap in cost, we had designed a trolley that moves on ceiling bound tracks with drawer-like doors that are only unlocked once the handle is turned.

Looking into the future many things will have changed and the food dolly will no doubt be one of them. It was our job to come up with ideas on what these potential changes will be and how they will be implemented. Some could easily be done today while others have a way to go in terms of logistics and functionality.

The drawings in Appendix 1.1 and 1.2 are clear examples of this. This food dolly functioned the same as our proposed idea of an overhead dolly but with other features. The dolly came equipped with a drinks dispenser with a touch screen to choose said drinks on either side of the passengers. With reference to the diagrams, the mechanism works exactly like the commercial vending machines which means that the parts are relatively inexpensive for maintenance and allows the flight attendant to focus on giving out the meals.

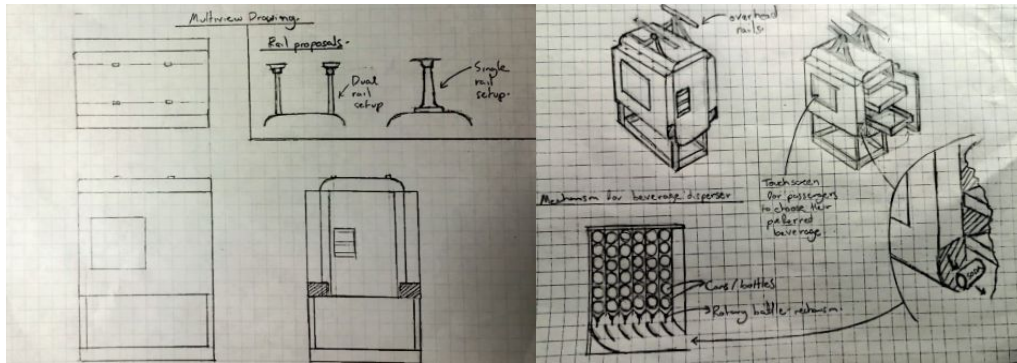


Figure 7 - Future Designs [Appendix 1.1-12]

The main thought that came from this is since the drinks are already automated can't the whole food dolly be automated? This would mean that a whole new design on how the food will be provided through automation and how the automated food dolly would move around. As a result, we had to park this idea as it is too unrealistic to be implemented today.

7. CONCLUSION

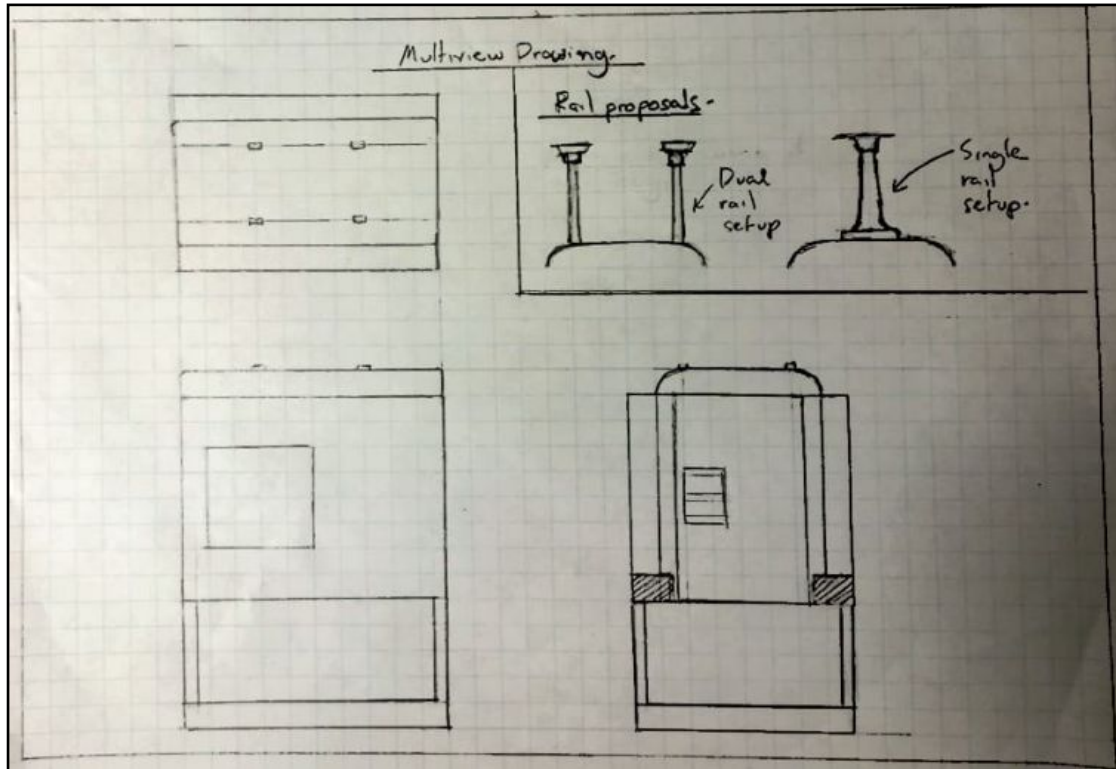
Food catering carts bring quite a bit of benefit to the industry such as efficiency and consistency. Airplane catering has to be done with precise planning as different passengers have different preferences which need to be catered to. Traditional food trolleys take this into consideration as they can be customized and loaded off the plane, and can be brought in before the flight departs.

Unfortunately, along with the benefits, the food cart also has disadvantages which are solved using our innovative new design. Some of these disadvantages include, space, mobility, appearance and materials. With our design we eliminate most of these factors by performing a complete redesign of the cart. This redesign includes a brand new mechanism which allows the cart to be hung from the ceiling making mobility around the plane easier, new materials which are more cost efficient, and with a greater ease of use which helps to lower maintenance costs and finally overall, provides a better appearance.

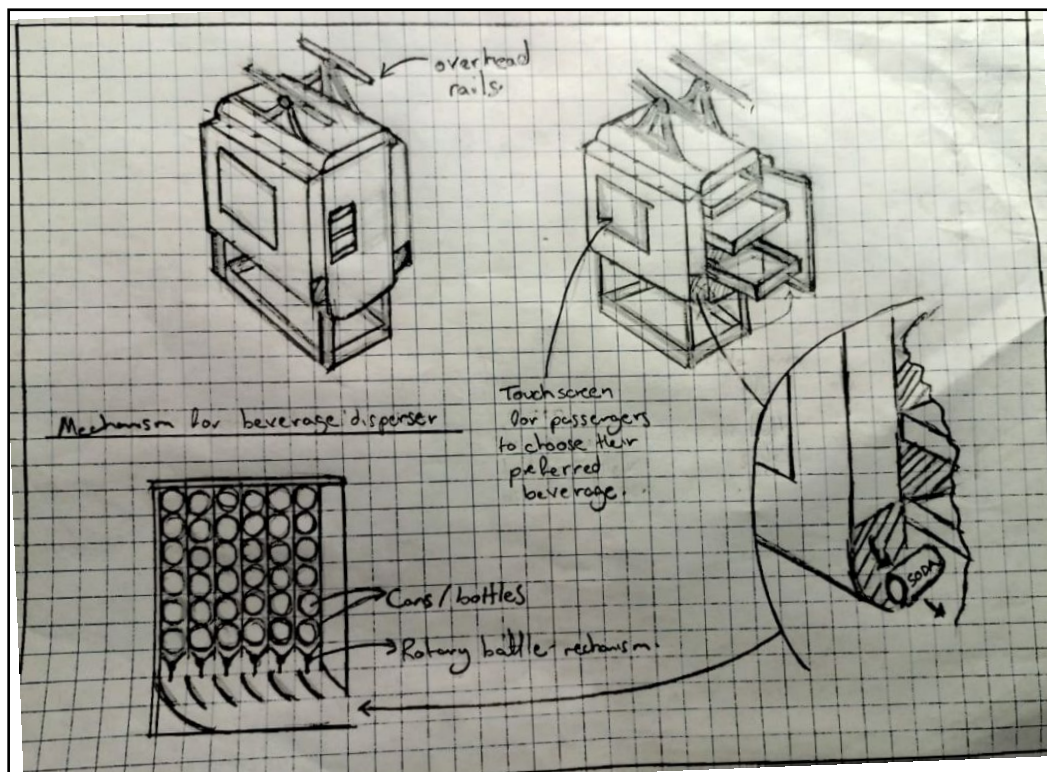
Taking all these innovative benefits into consideration, our redesign of the traditional food dolly assists with eliminating most, if not all of the inconveniences which the current catering cart presents to the airline industry.

8. APPENDIX

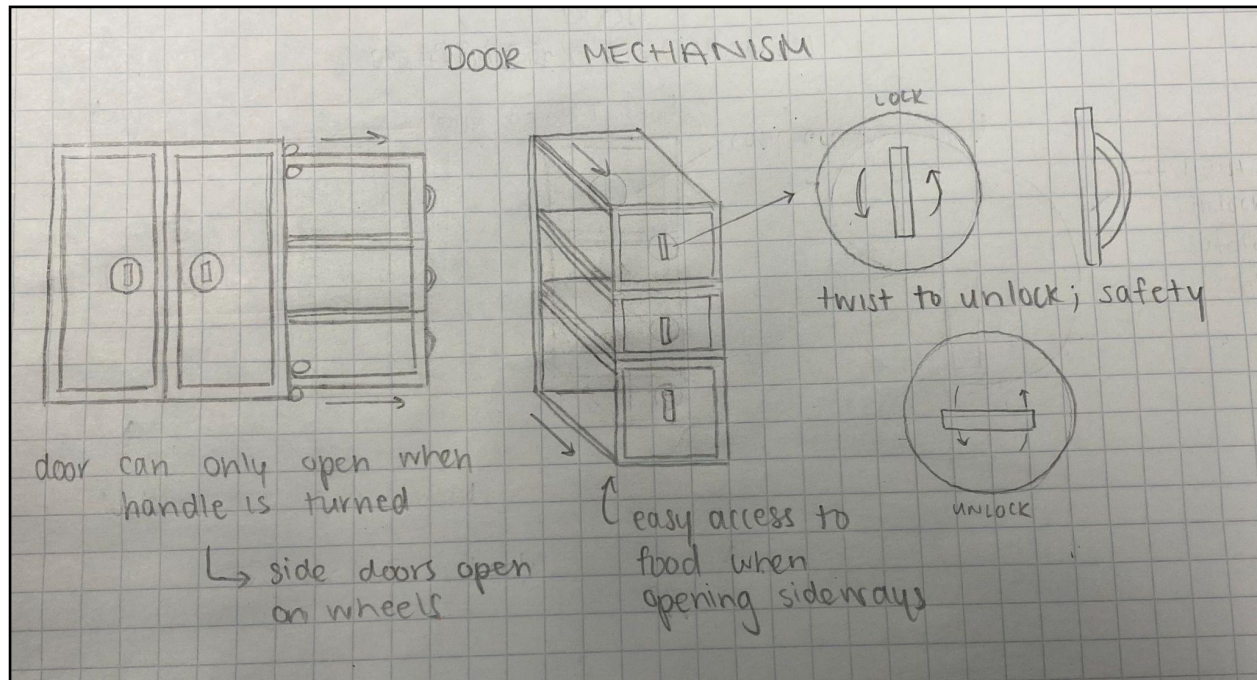
Appendix 1.1 - Drawing Drafts



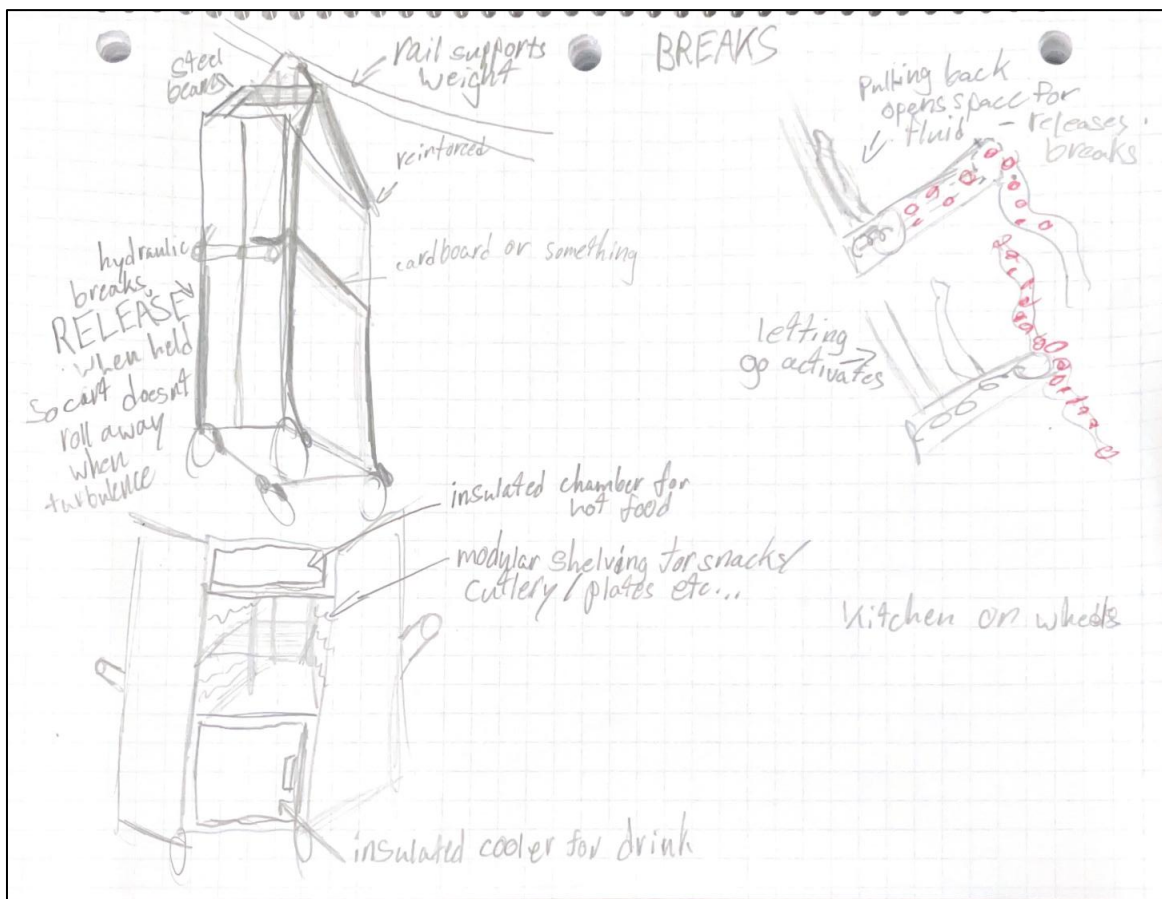
Appendix 1.2 - Drawing Draft



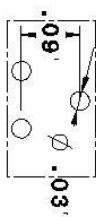
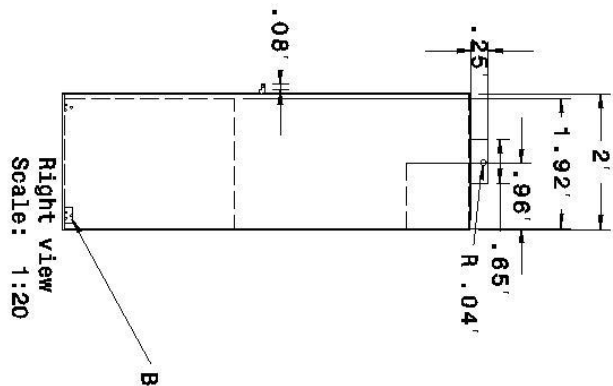
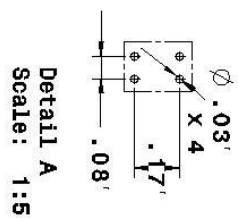
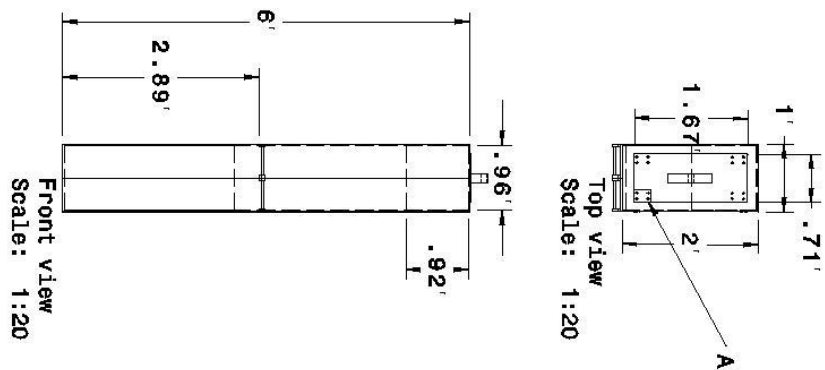
Appendix 1.3 - Drawing Draft



Appendix 1.4 - Drawing Draft



Bill of Material: Product2			
Quantity	Part Number	Type	Nomenclature
1	Body	Part	-
1	Cooler	Part	-
1	Hangar	Part	-
1	Ready Food Storage	Part	-
2	Door	Part	-




ORDER/LEAD BY: Angela Henderson-Hess		Drawing Title		Hangar Supported Dolly	I	-
DATE: 4/7/2023		Material		Aluminum Alloy	H	-
ORDERED BY: XXX		Direction		XXXX	G	-
DATE: XXX		Thickness		0.25	F	-
SIZE: XXX		SequenceID		XXXX	E	-
B				XXXX	D	-
SCALE		WEIGHT (kg)			C	-
1:20		-			B	-
					A	-

Figure 5 - Hangar Supported Dolly Drawing

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