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Breakfast Machine

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Washington University in St. Louis
SCHOOL OF ENGINEERING & APPLIED SCIENCE

Executive Summary

This project is a machine that automatically makes a breakfast. The breakfast consists of a simple bowl of cereal with milk and a glass of juice. The machine works by having a wooden frame that a cart moves through.

The cart is moved in a line from one end of the machine to the other by a pulley that is connected to a motor. The motor is controlled by an Arduino board. The cart stops at different stations, where bowls, cups, cereal, and liquids are dispensed. The dispensers are powered by servo motors, which are also controlled by the Arduino board. After all of this is done, the cart moves to the opposite end of the machine from where it started. There, it stops for a while, so that the breakfast may be picked up. Then, the cart moves back to its original position.

This machine is intended for either cafeteria or domestic purposes. It was designed to make the preparation of breakfast easier. It can hold enough cereal, milk, and juice for at least 10 people. It is not very portable, and it is intended to be kept on a tabletop.

MEMS 411: Senior Design Project

Breakfast Machine

Blake Hallman

Tim Keenoy

Darius Rucker

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1 INTRODUCTION AND BACKGROUND INFORMATION

1.1 INITIAL PROJECT DESCRIPTION

The purpose of this project is to design a machine that prepares a simple breakfast including a bowl of cereal with a glass of orange juice.

1.2 EXISTING PRODUCTS

Figure 1 Existing Toaster Oven

https://www.webstaurantstore.com/hatco-tq-10-toast-qwik-conveyor-toaster-2-opening-120v/413TQ10A.html?utm_source=Google&utm_medium=cpc&utm_campaign=GoogleShopping&gclid=Cj0KCQjw3MPNBRDjARIsAOYU6x_5MtQHOH_SMaFsw8vHbPehRqf8C38WAmPLDJqY_2Qko_yeaSz2RScaAtjdEALw_wcB

Description: This device involves bread moving down a conveyor belt and coming out as toast. Bread is put into the top of the toaster, it moves down the conveyor belt, and it comes out on the bottom.

Figure 2 Existing Juice Dispenser

https://www.webstaurantstore.com/bunn-37900-0025-jdf-2s-2-flavor-cold-beverage-juice-dispenser-with-dual-dispense/234379000025.html

Description: This product is a juice dispenser. First, a glass is placed under the dispenser. Then, a button is pressed on the dispenser. While the button is being held, liquid flows out from the dispenser and goes into the glass.

Figure 3 Existing Dishwasher

http://www.archiexpo.com/prod/meiko/product-11590-1742645.html

Description: This is a dishwasher on a conveyor belt. The dishes move slowly through the washer, and clean dishes come out of the other side clean. The conveyor belt makes it much easier to wash dishes in bulk.

1.3 RELEVANT PATENTS

1)

Patent #: US7238921

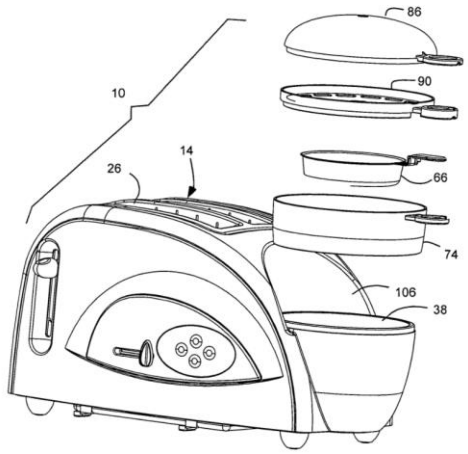


Figure 4 Existing Bread Toaster and Steamer

Description: This device is a “Combination bread toaster and steamer device with shared wattage and method”. The device prepares toast in a toaster compartment and can warm food in another steamer compartment.

2)

Patent #: US6321639B1

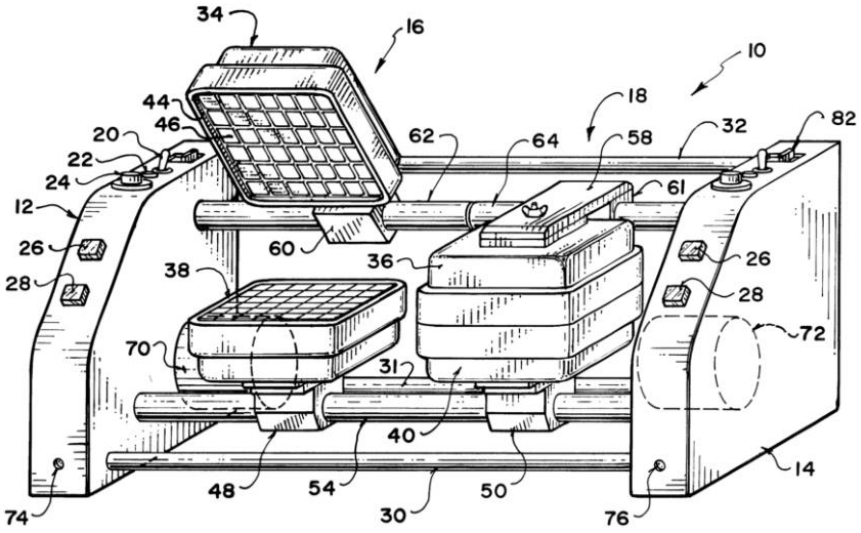


Figure 5 Existing Waffle Maker

Description: This machine is used to make ice cream waffle cones and grilling paninis. It is done by pressing the two hot griddles together. It can also press close enough, if necessary, to make waffle cones.

1.4 CODES & STANDARDS

1) Section 5.13.1. NSF Commercial Powered Food Preparation Equipment – 2012.

2) Section 5.14. NSF Commercial Powered Food Preparation Equipment – 2012.

1.5 PROJECT SCOPE

1) Project Overview/Purpose: The purpose of this project is to design a machine that makes breakfast in less than 2 minutes. The machine will place a tray on a cart, followed by silverware, cereal, milk, and orange juice.

2) The customer for our eventual product would likely be large cafeterias, where we would need a machine to serve breakfast and reduce manual workload.

3) The value of this product to the customer is that it streamlines preparing breakfast, reducing labor and increasing speed and efficiency.

4) Project goals:

- Put a bowl of cereal and a glass of orange juice onto a tray.
- Have the trays on carts to cycle through dispensing stations.
- Do multiple trays in a continuous manner.
- Capable of doing 100 trays in a row and scalable.
- Should be able to prepare one breakfast in less than two minutes.
- Should work without manual input for up to 100 servings.
- Keep food in an edible state.
- Don’t make a mess, easy to clean.
- Easy maintenance and access to components
- Provide user choice of cereal
- Detect malfunctions, ie. jams
- Monitor resource levels
- Cleaning the trays
- Provide other choices, such as toast

5) In Scope:

- Design the cart for the trays.
- Pour cereal, milk and juice.
- Dispense tray, cup or bowl, cereal, and milk or OJ
- Design Movement system (provide motion, detect location)

1.6 PROJECT PLANNING

Machine that makes life easier. We intend to meet up on Saturday afternoons to work on it.

1.7 REALISTIC CONSTRAINTS

1.7.1 Functional

Must be able to prepare a breakfast without human assistance.

1.7.2 Safety
Should not cause injury, and food should not be contaminated.

1.7.3 Quality
Breakfast should be fresh.

1.7.4 Manufacturing
Can be made in the machine shop.

1.7.5 Timing
Relatively quick. Many people need breakfast.

1.7.6 Economic
Affordable enough where a typical middle-class person can buy it.

1.7.7 Ergonomic
Can be easily operated by a person who has a disability.

1.7.8 Ecological
Minimal environmental impact. Use some renewable resources

1.7.9 Aesthetic
Looks good. Be able to view breakfast being made.

1.7.10 Life Cycle
Should be able to make at least 50 breakfasts before breaking.

1.7.11 Legal
Doesn’t infringe on any other patents.

1.8 REVISED PROJECT DESCRIPTION
The purpose of this project is to design a machine that makes a simple breakfast, consisting of a bowl of cereal with milk and a glass of orange juice on a tray. The machine dispenses the bowl, cup, cereal, milk and juice.

2 CUSTOMER NEEDS & SPECIFICATIONS

2.1 CUSTOMER INTERVIEWS

Table 1 Customer Interview

Customer Data: Breakfast Machine Customer: Josh Norlin Address: Washington University Date: 17 September, 2017			
Question	**Customer Statement**	**Interpreted Need**	**Importance**
How many trays do you want the machine to make?	I would like at least 10 trays to be made for my a capella group.	Make at least 10 trays.	5
How many choices of cereal do you want?	3 types of cereal is fine.	Have cereal options for customers.	3
How long should it take to make the breakfast?	Quick enough so that if finishes while setting up after practice.	Prepare each tray in less than 2 minutes.	4
What food sanitary concerns do you have?	I don't want my food getting debris on it.	Components should be shielded. [1]	4
Do you have a preference of drink?	Orange juice preferred, but I wouldn't mind additional options.	Have drink options for customers.	2
How long do you intend for food to be out for?	No more than an hour.	Food needs to be kept fresh.	5
How long would you like it to take for food to be replaced?	I wouldn’t want it to take too long, but I shouldn’t need to replace it often.	Food needs to be quickly replaced in machine.	2
Would you like the machine to be automatic or require a button pressed?	I like buttons. Let's do that.	Have a manual start mechanism.	2
How heavy would you like the machine to be?	Less than 50lb, if possible. A capella members don't have much upper body strength.	Weigh less than 50lb	4

2.2 INTERPRETED CUSTOMER NEEDS

Table 2 Interpreted Customer Needs

Need Number	Need	Importance
1	Make at least 10 trays	5
2	Different cereals	3
3	Different drinks	2
4	Prepare tray in 2 minutes or less	4
5	Components should be shielded. [1]	4
6	Food needs to be kept fresh.	5
7	Food can be quickly added and removed.	4
8	Have a manual start mechanism	2
9	Have machine weigh less than 50lb.	4

2.3 TARGET SPECIFICATIONS

Table 3 Target Specifications

Metric Number	Associated Needs	Metric	Units	Acceptable Value (or range)	Ideal
1	1	Number of Trays	Integer	>10	>50
2	2,3	Food Choice	Integer	1	3
3	4	Time to Prepare	Minutes	<3	<1
4	5	Shielded? [1]	Binary	Yes	Yes
5	6	Food fresh? [2]	Binary	Yes	Yes
6	7	Time to replace food	Minutes	<20	<5
7	8	Manual Start Mechanism	Binary	No	Yes
8	9	Lightweight Machine	lb	<70	<40

3 CONCEPT GENERATION

3.1 FUNCTIONAL DECOMPOSITION

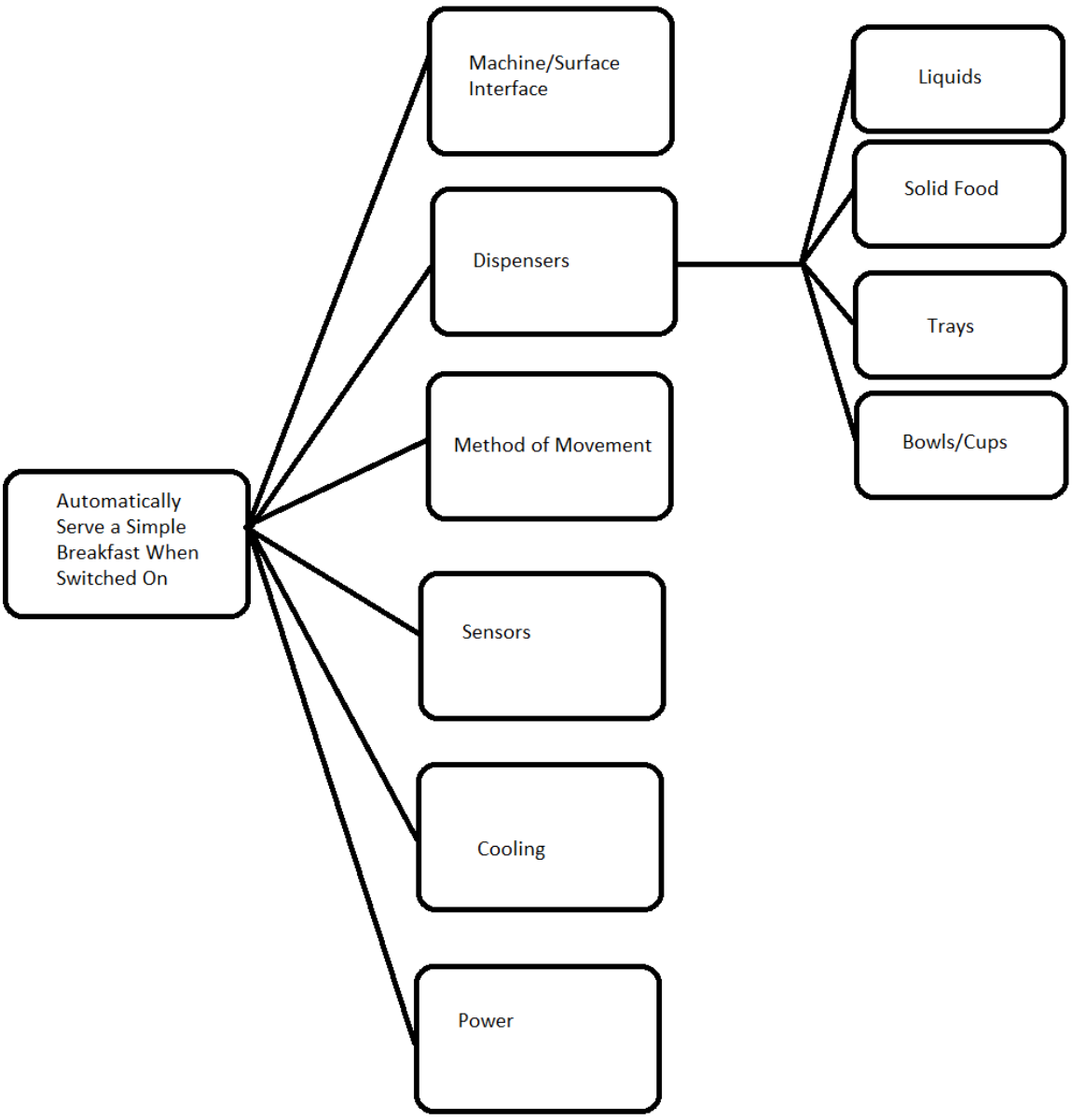
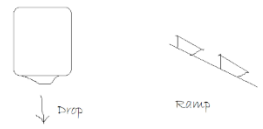
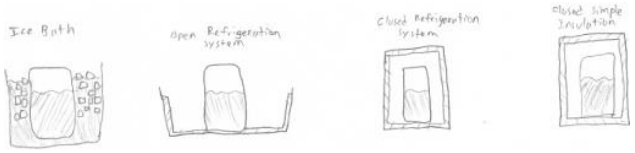
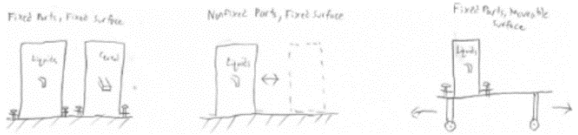
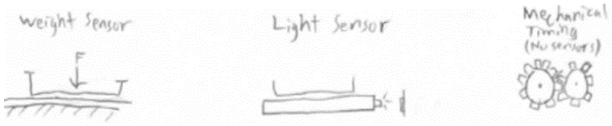
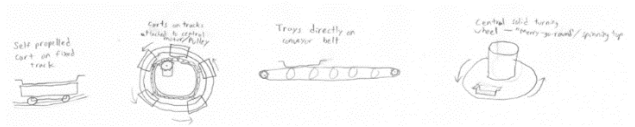
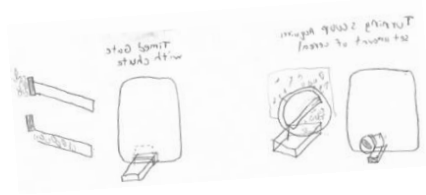


Figure 6 Function Tree

3.2 MORPHOLOGICAL CHART

Table 4 Morphological Chart

Tray, Bowl, and Cup Dispensers	
Cooling	
Machine and Surface Interface	
Power	
Sensors	
Method of Movement	
Liquid Dispensers	
Cereal Dispenser	

3.3 CONCEPT #1 – "LINE BREAKFAST MACHINE"

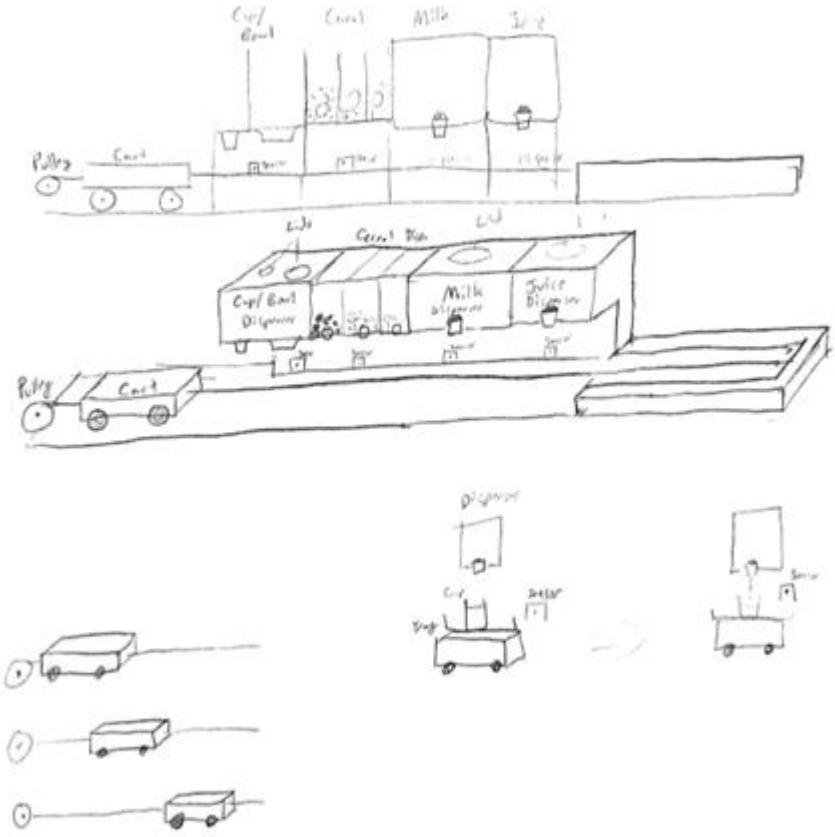


Figure 7 Line Breakfast Machine

Description: For this device, a tray is put on a motorized cart. The cart is pulled along by a pulley. It stops intermittently at stations, where utensils, milk, cereal, and juice are dispensed. Then, it moves to the end of the station, where it is ready for pickup.

Solutions:

1) Tray placed on cart. Bowl is dispensed by dropping.
2) Food is cooled by being surrounded by ice.
3) Cart is not fixed. Dispensers are fixed.
4) The machine is powered by batteries.
5) Light sensors are on the machine. However, sensors might not be necessary.
6) The method of movement is through a cart.

7) The liquid is dispensed from a jug with a faucet.

8) Cereal is dispensed from a turning scoop.

3.4 CONCEPT #2 – "STATIONARY BREAKFAST MACHINE"

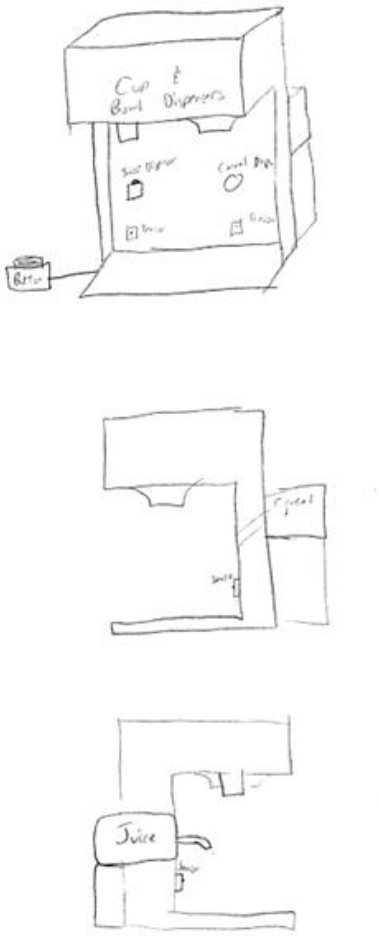


Figure 8 Stationary Breakfast Machine

Description: A tray is placed in the designated area on the device. From there, utensils, milk, cereal, and juice are dispensed.

Solutions:

1) Tray placed under the machine. Bowl and cup are dispensed by dropping.

2) Food is cooled by being surrounded by ice.

3) Machine is fixed in place

4) The machine is powered by batteries.

5) Light sensors are on the machine.

6) There is no movement in this machine.

7) The liquid is dispensed from a jug with a faucet.

8) Cereal is dispensed from a chute.

3.5 CONCEPT #3 – "CIRCULAR TRACK BREAKFAST MACHINE"

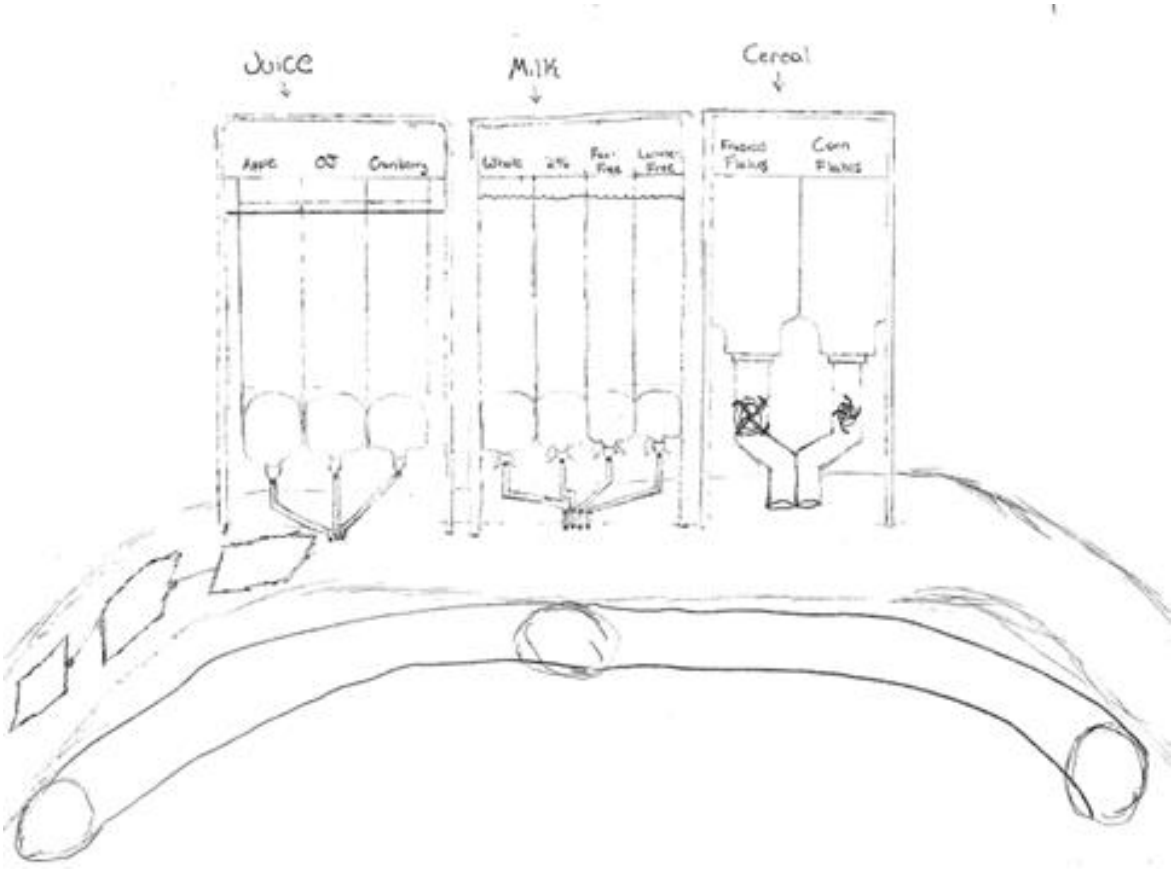


Figure 9 Circular Track Breakfast Machine

Description: Multiple trays are placed on carts on a circular track. As the carts move along the track, they stop at stations where they each get filled with milk cereal, or juice. Sensors indicate whether the tray has objects on it, so that it knows whether or not to dispense. This is intended for multiple trays.

Solutions:

1) Tray placed on cart. Bowls and cups are dispensed by dropping.

2) Food is cooled by being surrounded by ice.

3) Carts are not fixed. Dispensers are fixed.

4) The machine is powered by batteries.

5) Light sensors are on the machine. However, sensors might not be necessary.

6) The method of movement is through multiple carts moving in a circle.

7) The liquid is dispensed from a jug with a faucet.

8) Cereal is dispensed from a turning scoop.

3.6 CONCEPT #4 – "BOX BREAKFAST MACHINE"

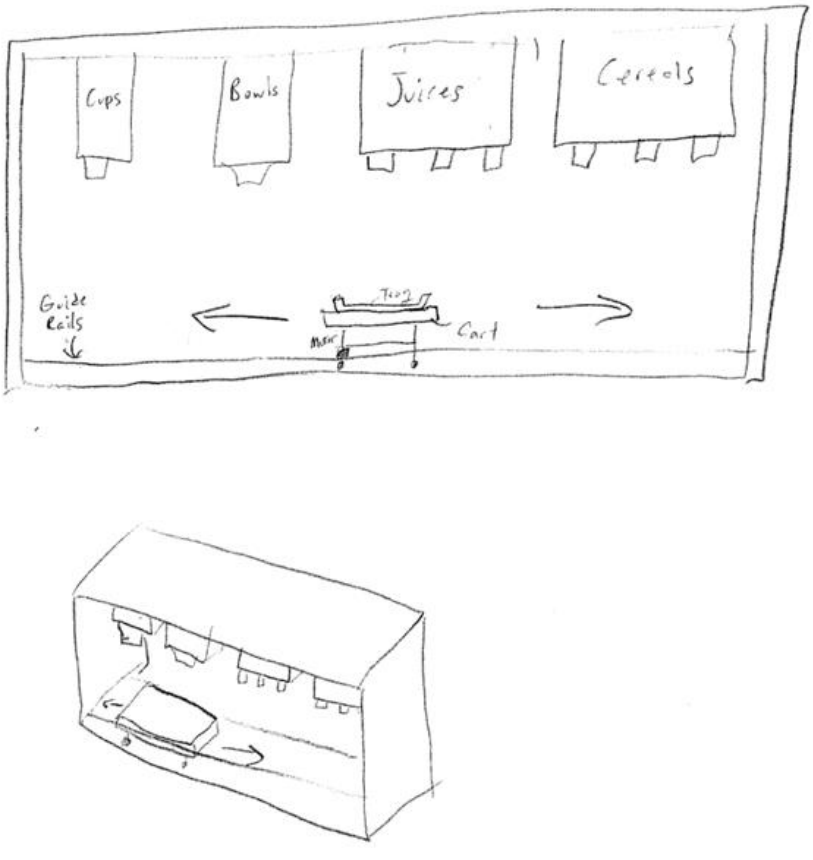


Figure 10 Box Breakfast Machine

Description: A tray is placed on a cart in the device. The cart moves back and forth to each given station, where it gets filled with essential items.

Solutions:

1) A tray placed on a cart. Bowls and carts are dispensed by dropping.
2) Food is cooled by being surrounded by ice.
3) Cart is not fixed. Dispensers are fixed.
4) The machine is powered by batteries.
5) Light sensors are on the machine. However, sensors might not be necessary.
6) The method of movement is through a cart moving back and forth.
7) The liquid is dispensed from a jug with a faucet.
8) Cereal is dispensed from a turning scoop.

3.7 CONCEPT #5 – "SPINNING TOP BREAKFAST MACHINE"

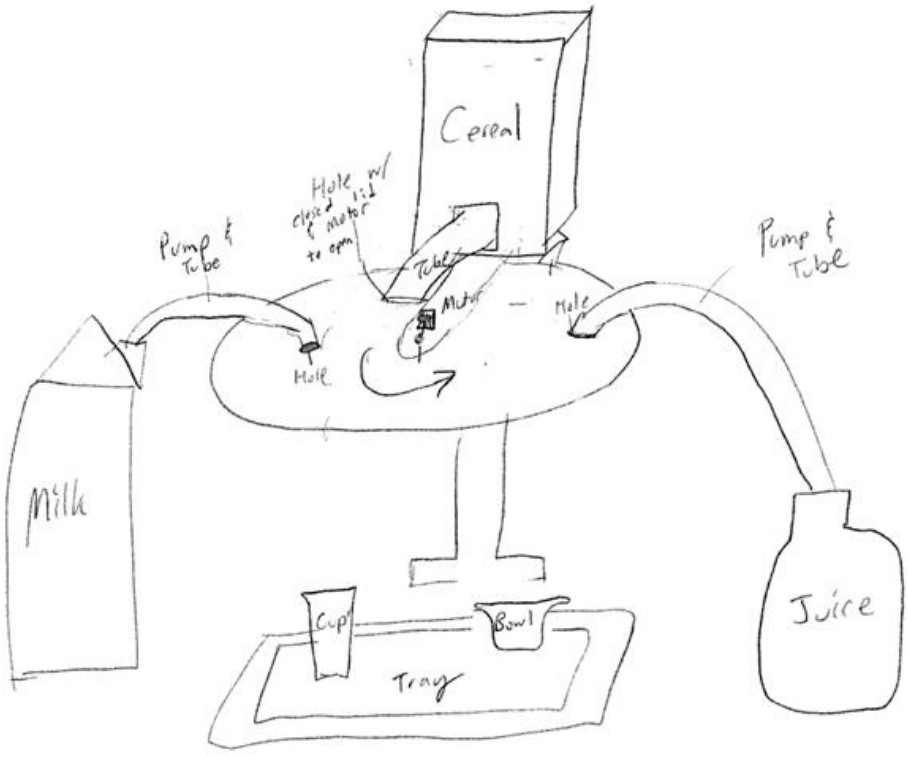


Figure 11 Spinning Top Breakfast Machine

Description: For this machine, the tray is placed under a rotating disk. The disk has nozzles attached to it. After the disk spins a fixed angle, the device can then pump milk or juice into the respective glasses. A cereal container is on top with a wide tube. The tube has a lid that can open and close, so that the device can open the lid and pour cereal into the bowl when necessary.

Solutions:

1) A tray is placed under the machine. Bowls and cups are placed in advance.
2) Food is cooled by being surrounded by ice.
3) The tray is in a fixed location, but the dispenser moves.
4) The machine is powered by batteries.
5) No sensors are on this machine.
6) The method of movement is through a cart.
7) The liquid is dispensed into cups and bowls from a tube and a pump.
8) Cereal is dispensed from a chute coming from a box.

3.8 CONCEPT #6 – "GEAR OPERATED BREAKFAST MACHINE"

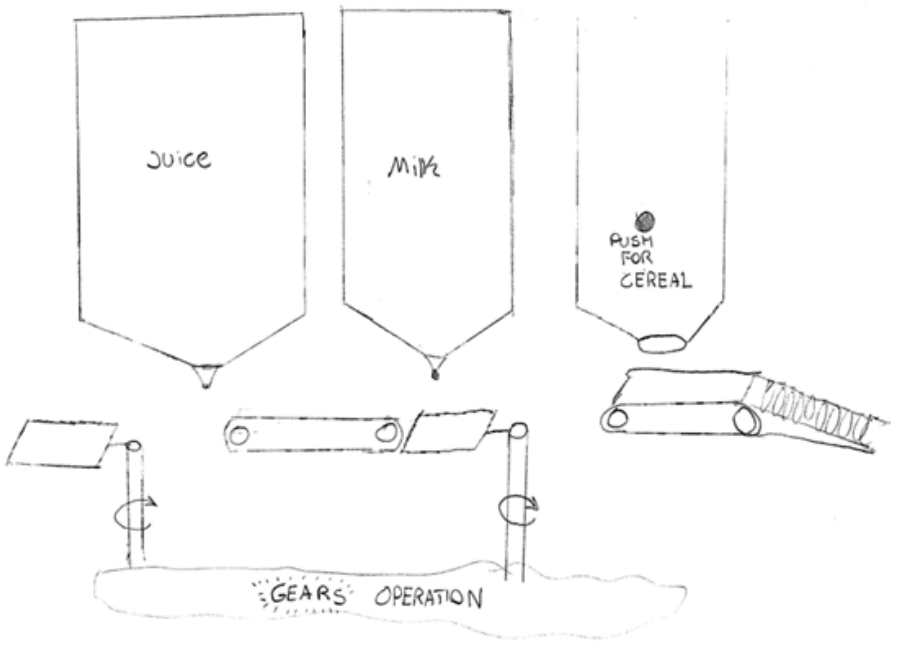


Figure 12 Gear Operated Breakfast Machine

Description: A tray is placed on the device. Then, gears turn the tray to move it, so that it goes under each respective dispenser.

Solutions:
1) Tray is placed on the platform. Bowls and cups are placed in advance.
2) Food is cooled by being surrounded by ice.
3) The platform is not fixed. Dispensers are fixed.
4) The machine is powered by batteries.
5) No sensors are on the machine.
6) The method of movement is through a gears that move platforms.
7) The liquid is dispensed from a jug with a faucet.
8) Cereal is dispensed from a turning scoop.

4 CONCEPT SELECTION

4.1 CONCEPT SCORING MATRIX

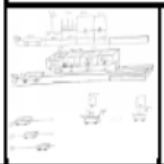
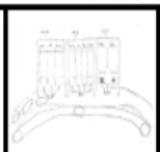
		Alternative Deisgn Concepts											
													
Selection Criterion	Weight (%)	Rating	Weighted	Rating	Weighted	Rating	Weighted	Rating	Weighted	Rating	Weighted	Rating	Weighted
Time to prepare meal	18.32	3	0.55	4	0.73	3	0.55	3	0.55	2	0.37	2	0.37
Weight of machine	1.69	3	0.05	5	0.08	1	0.02	4	0.07	3	0.05	2	0.03
Cost	13.31	3	0.40	3	0.40	2	0.27	3	0.40	3	0.40	2	0.27
Availability of parts	9.46	3	0.28	3	0.28	2	0.19	3	0.28	2	0.19	3	0.28
Food capacity	6.5	3	0.20	2	0.13	4	0.26	2	0.13	4	0.26	4	0.26
Consecutive Trays	9.71	3	0.29	1	0.10	4	0.39	1	0.10	1	0.10	4	0.39
Surface area of machine	1.46	3	0.04	4	0.06	2	0.03	4	0.06	3	0.04	2	0.03
Number of moving componer	8.7	3	0.26	4	0.35	2	0.17	4	0.35	2	0.17	1	0.09
Amount of coding required	6.36	3	0.19	2	0.13	3	0.19	3	0.19	3	0.19	4	0.25
Moving tray	20.65	3	0.62	1	0.21	4	0.83	3	0.62	1	0.21	4	0.83
Durable	3.95	3	0.12	3	0.12	2	0.08	4	0.16	2	0.08	2	0.08
	Total score	3.003		2.586		2.969		2.902		2.057		2.874	
	Rank	1		5		2		3		6		4	

Figure 13 Concept Scoring Matrix

4.2 EXPLANATION OF WINNING CONCEPT SCORES

Concept 1 was chosen as over concept 2 and 3 due to the satisfaction of each criterion we decided on for the design. This design is one of the cheapest to produce and satisfies the objective to move a tray through stations to make breakfast. We felt that the pulley system was a better way to move the tray rather than a conveyer belt and the others ways which would have cost most of our budget. This design structure was very simple and we considered that linear movement was the best for efficiency and production. We concluded that it would be a difficult challenge to have consecutive trays for the design which is why Concept 2 fell under this concept. One criteria this concept failed to do the best in was the surface area and the weight of the design. Concept 3 ranked the best in weight and surface area due to its compact size and portability. Overall, this concept satisfied the criteria without underachieving or overachieving.

4.3 EXPLANATION OF SECOND-PLACE CONCEPT SCORES

Concept 2 felt like the most productive design built out of all the alternative concepts. Even though this concept was the most efficient, it is also the least affordable. Having a conveyer belt in a shape in a semi-circle and the multiple parts required for the machine would cost more than $800 which is way out of budget. We also concluded that coding we be difficult for this concept as well due to the fact we have to stop each tray at each station one at a time, consecutively. Another problem with the design is that weight and surface area of the concept would be difficult to move around. Although this concept has its flaws, the functionality and efficiency surpasses both concept 1 and 3. If the material and parts for the concept wasn’t expensive and lighter in weight this concept would be on par with concept 1. Overall, concept 2 showed the best in functionality, yet flawed in implementing the design in real life due to the cost of material.

4.4 EXPLANATION OF THIRD-PLACE CONCEPT SCORES

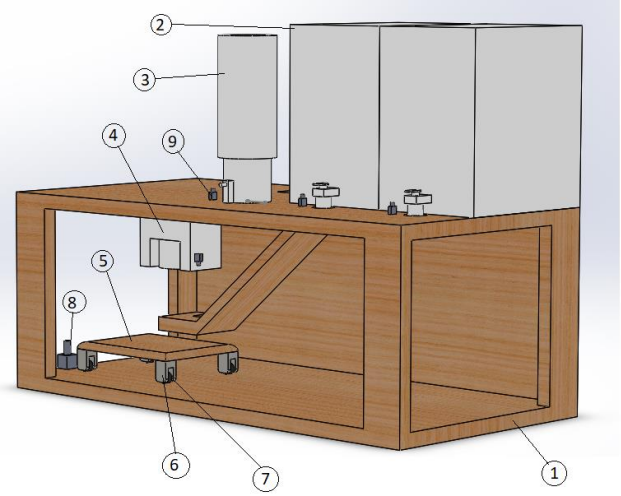
Concept 3 shows a lot of similarities when compared with concept 1 due to its linar movement of the tray. The main difference between the two is that concept 1 uses a pulley system to move the cart, while concept 3 uses guided rails that are powered to move back and forth. Like concept 2, the availability of parts would be hard to come by since we would have to purchase the rails and the electrical components to make the concept operate. This concept will also have difficulties to be implemented for real prototype due to its mechanism and coding. Overall, this concept has similarities to concept 1, but the mechanism it contains separate them apart.

4.5 SUMMARY OF EVALUATION RESULTS

Overall, we decided that Concept 1 was the most successful concept, because it had the most needed features. Concept 2 and concept 3 were also good, but they did not meet as many of the standard.

5 EMBODIMENT & FABRICATION PLAN

5.1 ISOMETRIC DRAWING WITH BILL OF MATERIALS



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	BreakfastMachineFrame		1
2	Water Dispenser		2
3	Cereal Dispenser		1
4	Cup Dispenser		1
5	Cart Base		1
6	Wheel Holder		4
7	Cart Wheel		4
8	Stepper Motor		1
9	Servo Motor		3

Figure 14 Isometric Model with Bill of Materials

5.2 EXPLODED VIEW

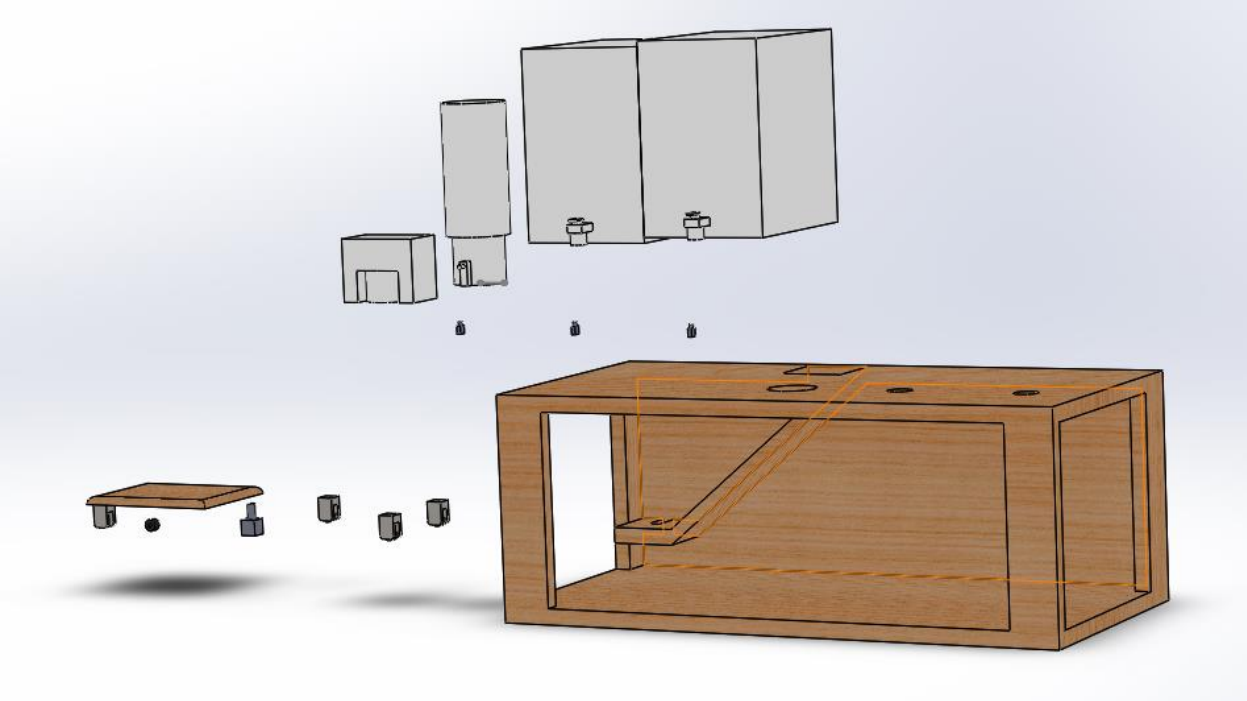


Figure 15 Exploded View

5.3 ADDITIONAL VIEWS

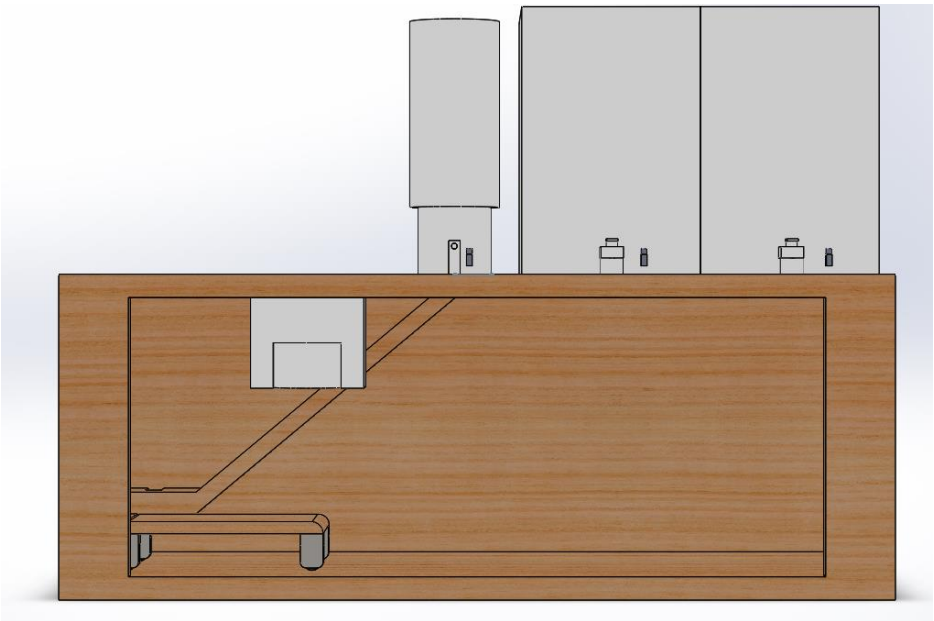


Figure 16 Front View

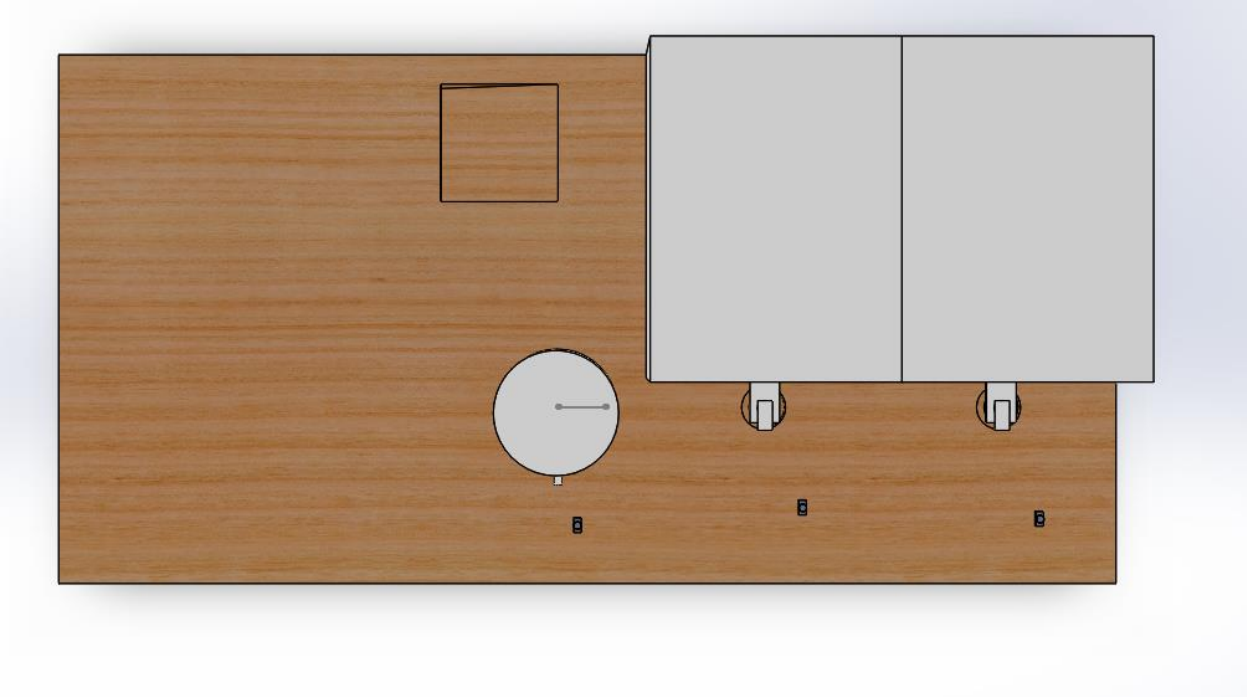


Figure 17 Top View

6 ENGINEERING ANALYSIS

6.1 ENGINEERING ANALYSIS RESULTS

6.1.1 Motivation

The two codes and standards we stated during our early concept of the design were that the machine would be shielded and that the containers would keep the food fresh. When we stated that the machine should be shielded, because we wanted overall safety for the user and the machine. For the need to keep the food and drinks fresh we purchased containers with lids to avoid contamination. These codes and standards are important to the design process at this time of project build because these target specifications are carried through the whole build of the project and often create more implementations in the project. The information we expect to obtain from our project would be through the method of trial and error. Through this method, we conducted different ways to dispense our material until we found the best technique.

6.1.2 Summary Statement of the Analysis

Our project did require some mathematical computations for movement of the devices, but most of our analysis were based off specs from our motors. The motors power could be adjusted through arduino code. We set all the motors to maximum power to help reduce time and better efficiency. After setting the motors for max power, we came to the conclusion that some devices need more powerful motors due to the fact some operations required more power when added with food. Our project is based on dimensions and types of materials to hold a large amount of mass of the containers with food and fluids. The material and dimension of the base will be later discussed in the section below.

6.1.3 Methodology

Our analysis was performed through the use of Solidworks. The most important aspect of our analysis was making sure that all of the parts moved in sync. This was because the breakfast machine required precise timing for both the breakfast and the cart. We tested the servo motor arm and its displacement over time in order to make sure that the motor for activating the device. Additionally, we wanted to ensure that the frame would hold the weight of the water jugs. We approximated the strength of the frame by doing a stress test of the frame under an evenly distributed pressure of 1000 N/m^2, which totals at approximately 94lb.

6.1.4 Results

<u>Motor Arm Position</u>

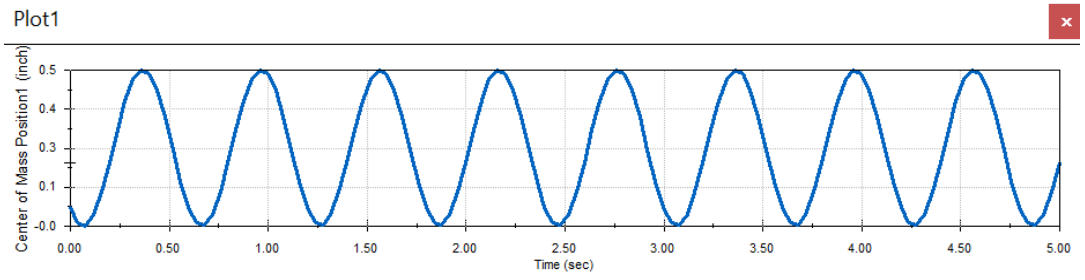


Figure 18 Graph of Motor Arm Position Over Time

Stress Analysis of Wood Frame Under 1000 N/m^2

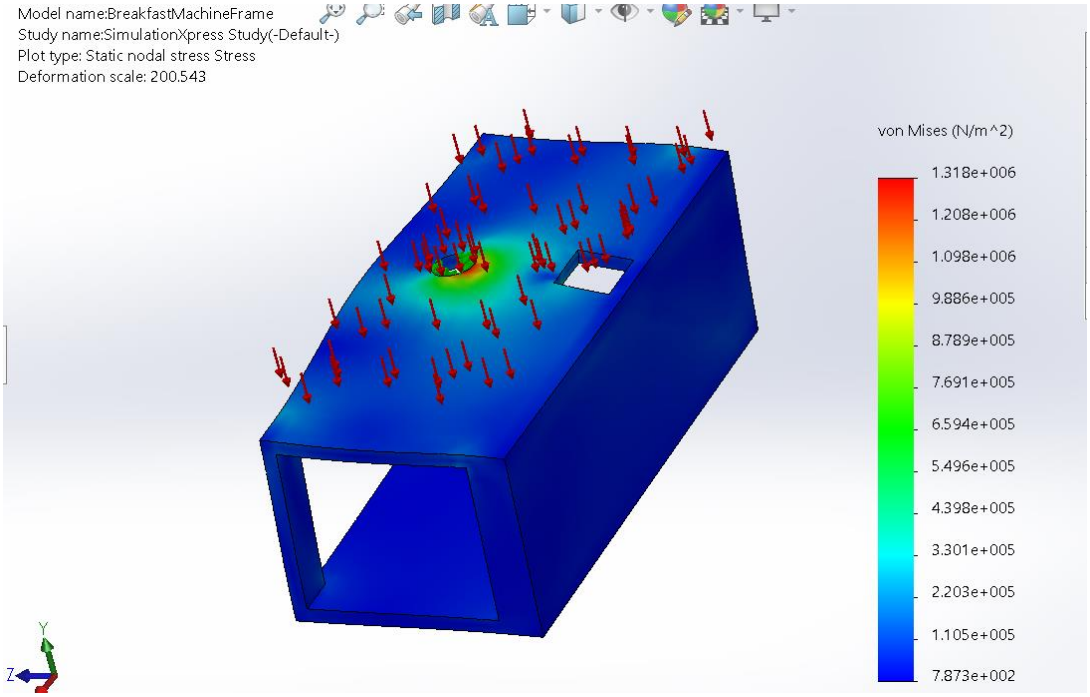


Figure 19 Stress Analysis of Wood Frame

The results of these tests make sense, as the motor moved steadily. Additionally, we found that the frame was more than strong enough to support the equipment. This confirms our approximations, that the design would hold, and it makes sense, as the design was easily capable of holding up the materials.

6.1.5 Significance

The material we decided to use for the prototype provided no problems or failure. We did decide to change the shape of the cart due to it hitting the standing block of the bowl and stepper motor. This can be shown in the draft analysis for the cart in the next section below. If we decide to make the machine more compact with small dimensions, we could've met one of our performance goals to have it under 20 lbs. If we would've gone with a plastic base instead of wood, it will also play a factor of the weight of the machine. Also with a more compact prototype will also decrease time to make each breakfast. These are things we should've thought of during our building stage, but we made do with the scrap material instead of wasting our budget for base materials.

6.2 PRODUCT RISK ASSESSMENT

6.2.1 Risk Identification

Table 5 Risk Identification

What is the risk?*	Describe the identified risk	How is risk currently managed?**	Comments/Concerns	Impact	Likelihood	Impact	Likelihood	Risk Score	Do you need to do anything else to reduce or control the risk?	Responsible Person/Job
Example: Serving food	Preparing and serving food to 100 people during event (food is not being prepared or served by vendor)	- Students are required to wash their hands before handling food. - On-site refrigerator for proper food storage. - Ensuring all equipment, dishware and utensils are clean and sanitary before use.	- Some people attending event may have food allergies. - Want to ensure food is cooked adequately.	Moderate	Low-Medium	3	2	6	- Print signage that warns of food allergens and place in front of food station. - Purchase thermometers to check the food temperature.	John Smith
Food Spoilage	Food could potentially be left out for extended periods of time while operating and in between uses.	Prototype has low capacity in dispensers, so turnover rate for food is high. All food is removed from dispensers prior to packing up machine. Dispensers are kept closed when full.	Significant impact as spoilage renders the finished product inedible. Spoilage will occur naturally, but can be easily prevented.	Significant	Medium	4	3	12	Design refrigeration or other method of keeping liquids cool.	Tim Keenoy
Food Handling	Food handling by unwashed hands when serving meals could transfer disease or spoil the food.	Food is served entirely by automated components.	Less impact than spoilage beccause short handling by users will not introduce as many problems as full spoiling.	Moderate	Medium	3	3	9	Place see-through barrier at front of machine to prevent users from touching food before being served.	Blake Hallman
Injury from Machine Body	The frame and various components of the machine were assembled with nails, screws, and wood. These parts have sharp corners and potential to splinter.	Sharp edges are filed down and checked for splintered wood. Screws and nails are made flush with the components being secured.	Mild impact because the parts are only capable of causing splinters and minor cuts.	Mild	Low-Medium	2	2	4	Finish the wood components with some coating to prevent splintering. Cover nails with putty or tape.	Tim Keenoy
Food Contamination	Loading the dispensers could allow contaminants into the food. Food being dispensed must travel through machine components to reach the tray and may experience splashing/spillage.	Operator washes hands and secures loose clothing before loading dinspensers. Routes from the dispenser to bowl/cup are lined by food grade plastic funnels and tubes.	Similar impact to food handling because most contaminants around the machine would not cause toxicity, but are still unwanted in a finished product.	Moderate	Medium-High	3	4	12	Create loading chutes and dispensing tubes to ensure food does not interact with unsafe parts of the machine or other foreign objects.	Darius Rucker
Cleanliness	Parts that are not cleaned properly could lead to spoiling in future operations. Small nooks and crannies can be difficult to completely clean.	All parts that hold or interact with food can be detached from the body for easy cleaning.	Significant impact because poor hygiene in food production can cause serious health problems.	Significant	Low-Medium	4	2	8	Seal small nooks and corners that could accumulate waste. Use tubes to pipe the food and liquids directly into cups/bowls to avoid splashing.	Blake Hallman
Moving Components	The machine contains several moving components that could cause injury to users.	The motors being used are low torque and were checked to ensure they stall when provided with resistance. The components being moved by the motors are light-weight. The motors operate at slow speeds.	Mild impact because the parts are light with low momentum, so they are unlikely to cause injury.	Mild	Low	2	1	2	Isolate moving parts from end users. Use sensors to stop machine if foreign object enters the work area.	Darius Rucker
Heavy Components	The dispensers can be heavy when filled, and the body of the machine is heavy by itself. Heavy objects can fall and cause injury.	Supports were chosen to be strong enough to hold larger loads than the filled dispensers. Only authorized users will be moving the frame or components.	Moderate impact because heavy components can cause injuries, but these components aren't heavy enough to cause serious harm.	Moderate	Low	3	1	3	Create hand grips or mobile base for easy movement of machine.	Tim Keenoy

6.2.2 Risk Heat Map

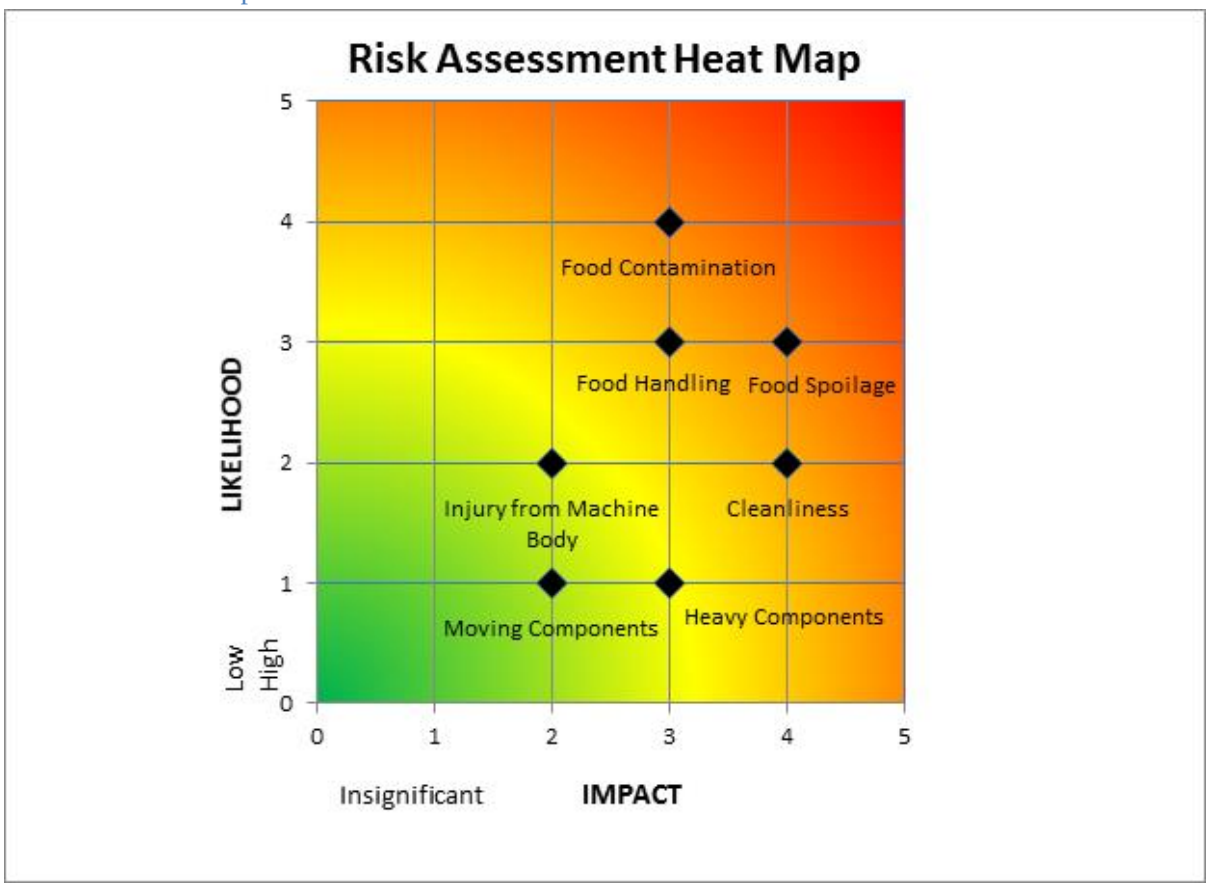


Figure 20 Risk Assessment Map

6.2.3 Risk Prioritization

1. Food Contamination
2. Food Spoilage
3. Food Handling
4. Cleanliness
5. Injury from machine
6. Heavy components
7. Moving components

7 DESIGN DOCUMENTATION

7.1 PERFORMANCE GOALS

1. Machine must be able to make one breakfast in less than 2 minutes.

2. Prototype must be able to contain enough cereal, milk, and juice to make 10+ breakfasts.

3. Machine (empty) must weigh less than 20 lb.

4. Machine must dispense
   - 1 cup cereal ± ¼ cup
   - 8 oz juice ± 2 oz
   - 4 oz milk ± 2 oz

5. Machine must make 3 breakfast in a row without manual adjustment apart from placing the tray onto the cart.

7.2 WORKING PROTOTYPE DEMONSTRATION

7.2.1 Performance Evaluation

Overall, the machine was successful in setting out to do what it was proposed to do. It served a breakfast on a plate. However, only some of the performance goals were met. It managed to make a breakfast in less than 2 minutes, it contained enough food to make over 10 breakfasts, and it could make more than 3 breakfasts consecutively. However, the machine weighed more the 20 pounds and the machine did not dispense 8oz of juice.

7.2.2 Working Prototype – Video Link

https://www.youtube.com/watch?v=jwYYbJtGQeQ#action=share

7.2.3 Working Prototype – Additional Photos

Figure 21 Picture of the Machine

7.3 FINAL PRESENTATION – VIDEO LINK

https://youtu.be/bAKNceMvjTU

8 DISCUSSION

8.1 DESIGN FOR MANUFACTURING – PART REDESIGN FOR INJECTION MOLDING

8.1.1 Draft Analysis Results

Before:

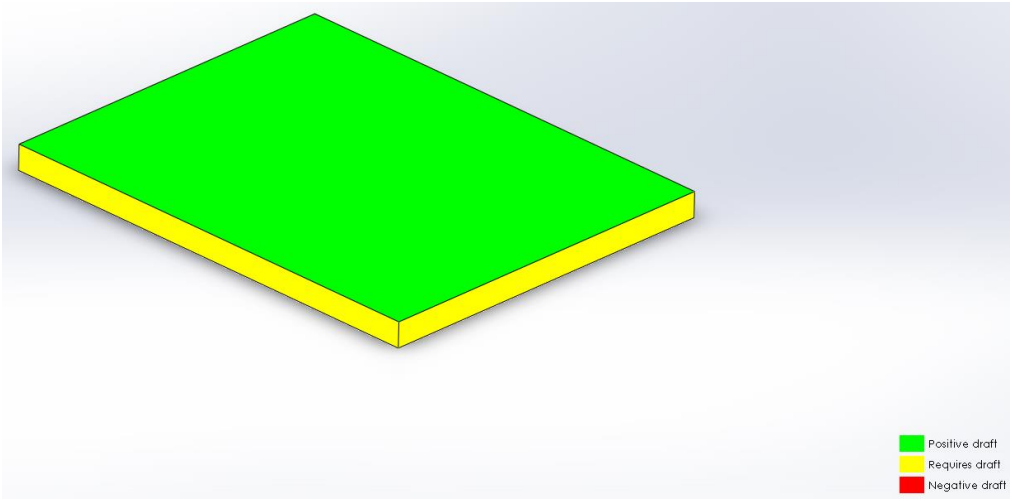


Figure 22 Initial Cart Top

After:

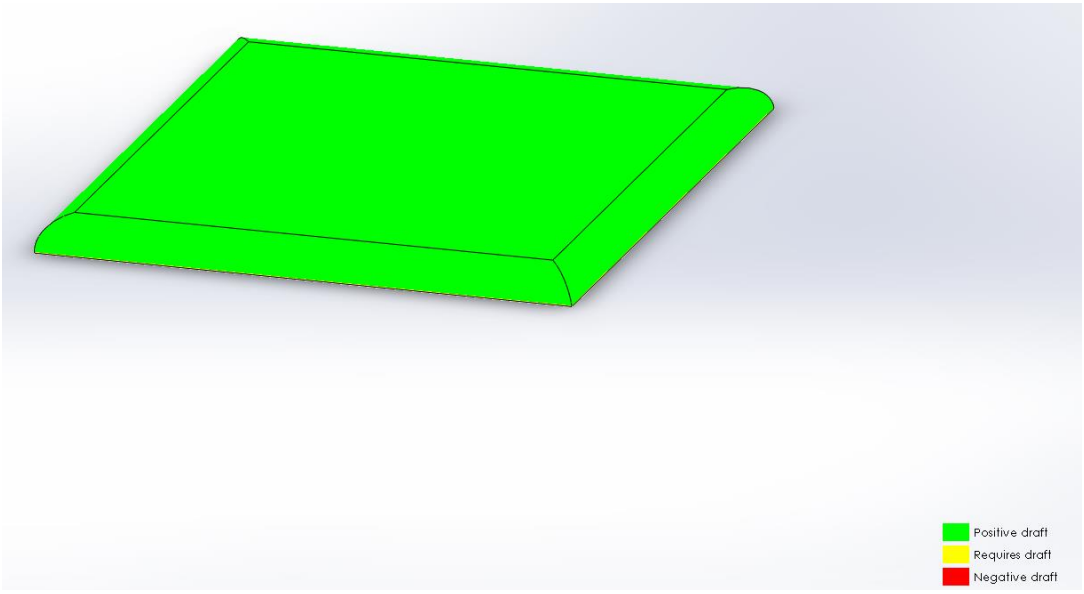


Figure 23 Final Cart Top

8.1.2 Explanation of Design Changes

The cart for this project was originally designed with simplicity in mind. Instead of making a self-propelled cart that required additional materials such as tracks, the simplest and most effective design was to attach fixed wheels to a solid rectangular cart. The draft analysis shows that introducing a slight fillet along the vertical edges of the cart base improves the design. The rounded

edges also improve the manufacturing process for a mass-produced part as the injection molding method works well if sharp corners are eliminated.

8.2 DESIGN FOR USABILITY – EFFECT OF IMPAIRMENTS ON USABILITY

8.2.1 Vision

Poor vision should not impact the ability to use this device. As long as you are capable of picking up the tray at the well-lit end of the machine, you should be fine.

8.2.2 Hearing

Not being able to hear will not impact the ability to use this device.

8.2.3 Physical

The machine automatically makes breakfast. As long as you can press a button to turn on the machine, impairments should not be an issue.

8.2.4 Language

Language is not an issue with this machine.

8.2 OVERALL EXPERIENCE

8.2.1 Does your final project result align with the initial project description?

Yes. The project automatically makes a simple breakfast consisting of a bowl of cereal with milk and a glass of juice.

8.2.2 Was the project more or less difficult than you had expected?

In some ways, the project was much less difficult than expected. For example, making the frame for the machine and having the liquid and cereal dispensers work was quite easy. They were very straight forward to make and did not take much time at all. However, making cup and bowl dispensers work was much more difficult than anticipated, because it was hard to have a dispenser put out one bowl and cup at a time.

8.2.3 In what ways do you wish your final prototype would have performed better?

The final prototype only distributed 3oz cups instead of 8oz cups, because there were difficulties dispensing the 8oz cups. I wish the final prototype distributed 8oz cups instead.

8.2.4 Was your group missing any critical information when you evaluated concepts?

The greatest missing information was knowledge of coding and weight of the machine. When looking at the plans before building the machine, we were unsure of what would be involved with those features.

8.2.5 Were there additional engineering analyses that could have helped guide your design?

If an analysis could have been done to determine how the liquid would fall as it left its dispenser, that would have also been helpful, because the liquid did not always dispense the most evenly.

8.2.6 How did you identify your most relevant codes and standards and how they influence revision of the design?

We identified the most relevant codes and standards by seeing which ones would most directly impact the breakfast experience. We ended up deciding on shielding, because we didn't want the breakfast to have germs on it.

8.2.7 What ethical considerations (from the Engineering Ethics and Design for Environment seminar) are relevant to your device? How could these considerations be addressed?

When making the machine, we wanted to have the machine be environmentally friendly. Because of this, we decided to use materials that were mostly renewable. For this reason, the frame for the machine and the cart were made out of wood.

8.2.8 On which part(s) of the design process should your group have spent more time? Which parts required less time?

We should have spent much more time on concept generation and less on building the prototype. This was because we did not plan well how to design successful cup and bowl dispensers. If we had planned those out better in the concept generation process, we could have saved a large amount of time when building.

8.2.9 Was there a task on your Gantt chart that was much harder than expected? Were there any that were much easier?

A task on the Gantt chart that was much harder than expected was dispenser concept generation, while a part that was easier was building the prototype.

8.2.10 Was there a component of your prototype that was significantly easier or harder to make/assemble than you expected?

A component of the prototype that was significantly harder to make than expected was the bowl dispenser. A component that was much easier to make than expected was the frame.

8.2.11 If your budget were increased to 10x its original amount, would your approach have changed? If so, in what specific ways?

If the budget was 10x its original amount, we would have definitely bought more powerful motors, because some of the motors had trouble moving the dispensers, because they were too weak. Additionally, we could have put a screen in front of the machine to provide more shielding of the food.

8.2.12 If you were able to take the course again with the same project and group, what would you have done differently the second time around?

If we were able to take the course again, we would have likely been smarter in making our Gantt charts and spent more time generating concepts.

8.2.13 Were your team member's skills complementary?

Yes, our team member's skills were complementary. Darius was good at programming, so he did the coding for the Arduino, Blake was flexible with his time, so he did a lot of building for the prototype, and Tim had a car, so he was able to run many necessary errands. Everybody worked well and thoroughly.

8.2.14 Was any needed skill missing from the group?

Nope.

8.2.15 Has the project enhanced your design skills?

The prototype has enhanced our design skills by showing us the many different parts of the design process and helping us learn all it takes to design a prototype.

8.2.16 Would you now feel more comfortable accepting a design project assignment at a job?

We have all concluded that we would feel more comfortable accepting a design project assignment at a job.

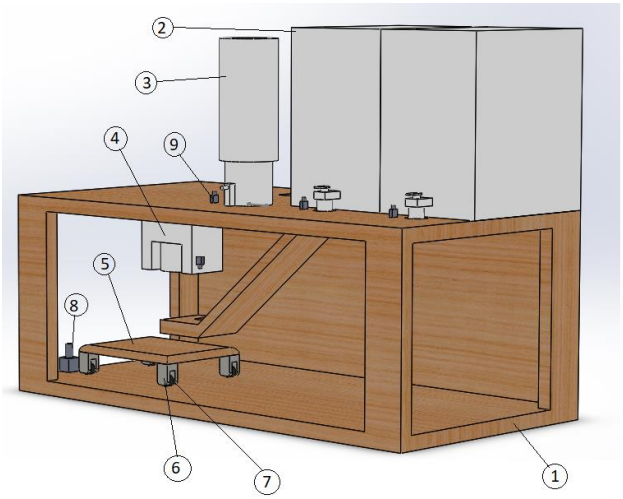
8.2.17 Are there projects you would attempt now that you would not have attempted before?

Not at the current moment.

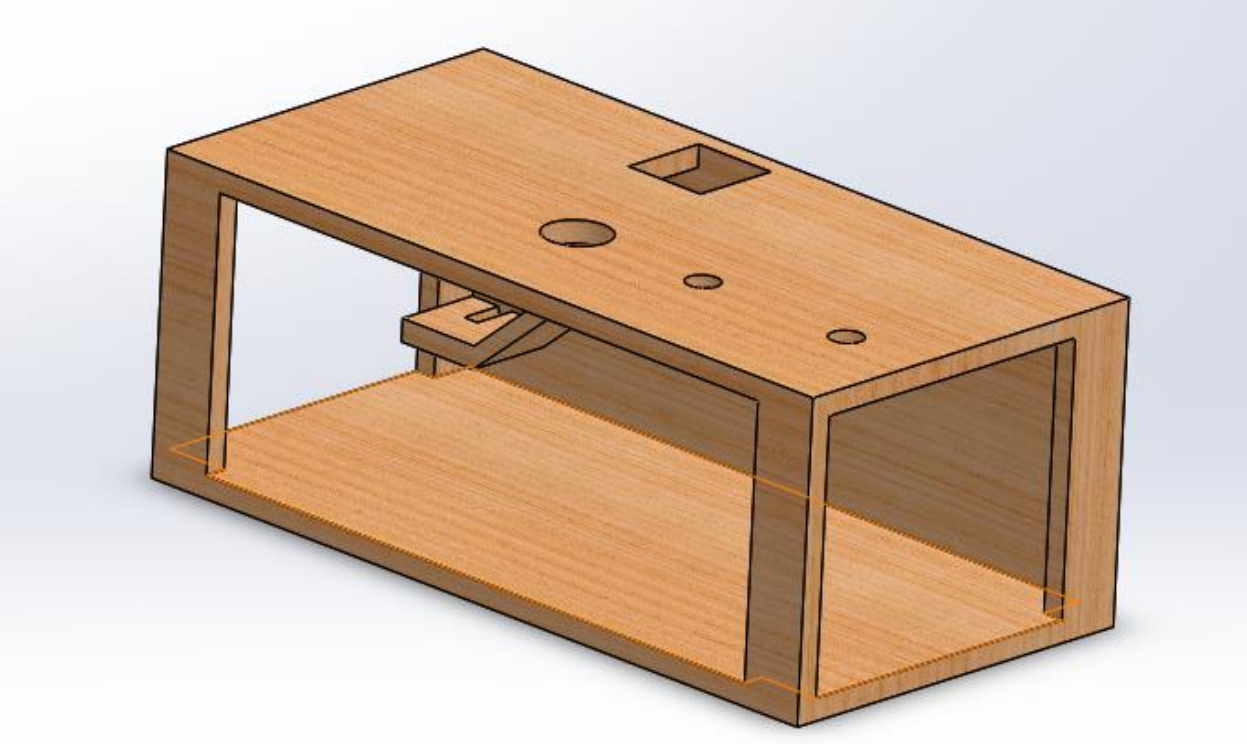
9 APPENDIX A - PARTS LIST

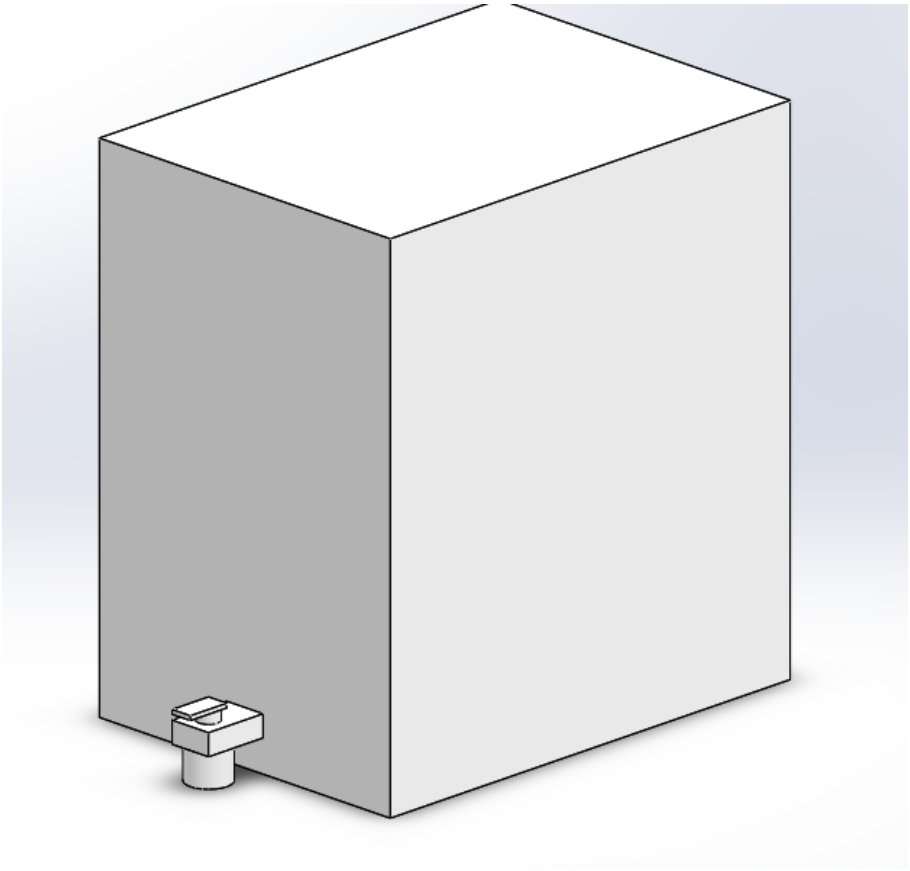
	Part
1	Servo Motor
2	Stepper Motor
3	Stepper Motor Driver
4	Cereal Dispenser
5	Water Jugs
6	9V Power Supply
7	Arduino
8	Wires
9	Pulley Belt
10	Wood
11	Nails, Screws, etc.

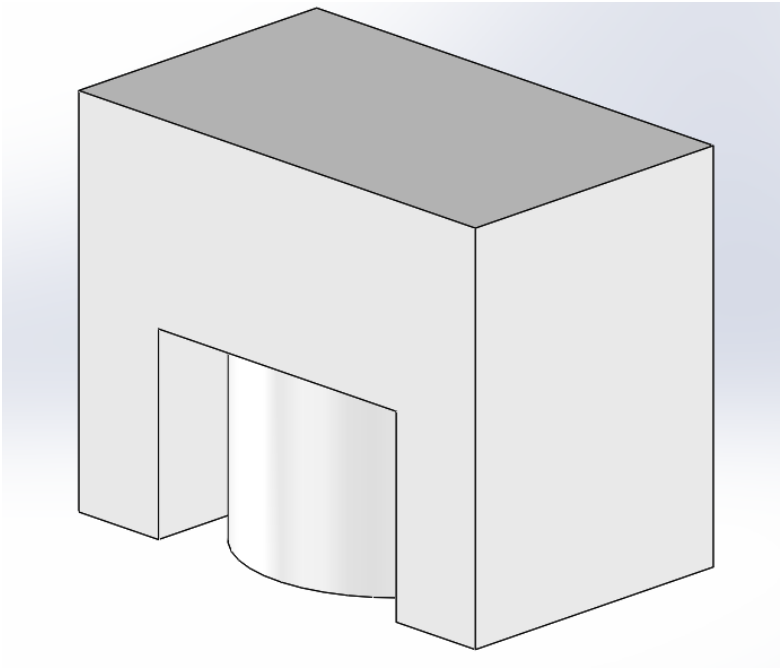
10 APPENDIX B - CAD MODELS

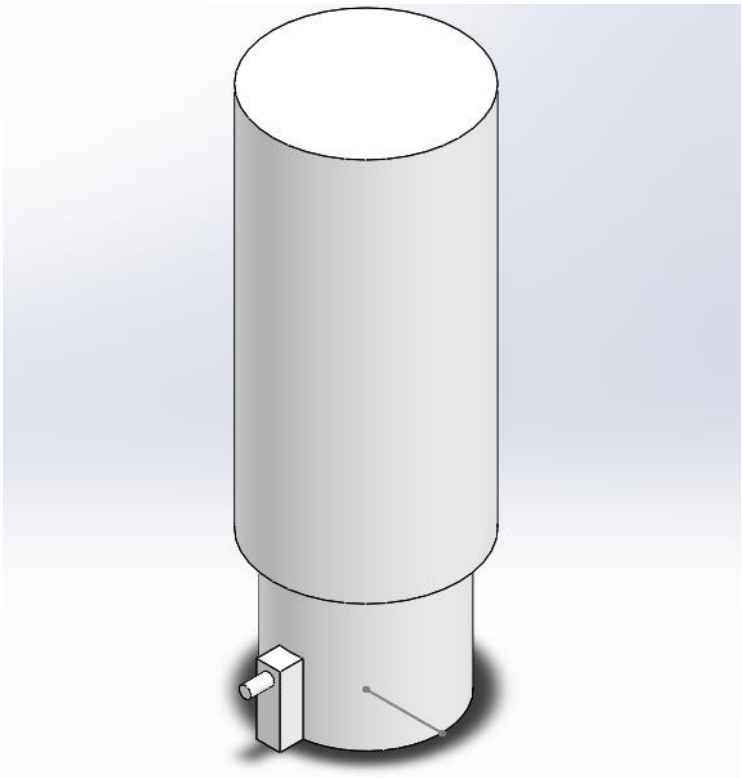


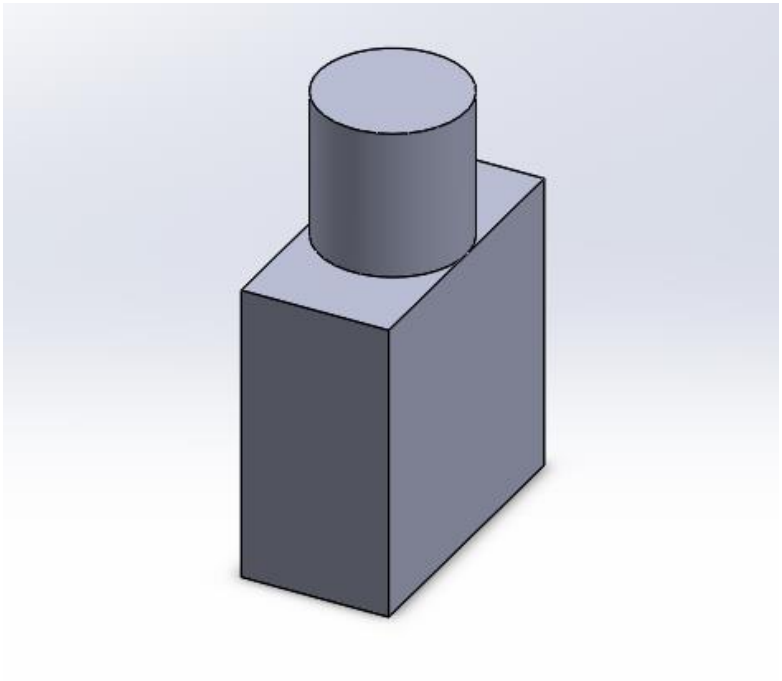
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	BreakfastMachineFrame		1
2	Water Dispenser		2
3	Cereal Dispenser		1
4	Cup Dispenser		1
5	Cart Base		1
6	Wheel Holder		4
7	Cart Wheel		4
8	Stepper Motor		1
9	Servo Motor		3











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