Rutgers, The State University of New Jersey

14:650:388 – CAD in Mechanical Engineering

Spring 2025

VENDING MACHINE

DESIGN REPORT

By Wesley Chang, Kyle Motta, Hannah Pak, Rohin Prajapati, Avanthika Vuppala

EXECUTIVE SUMMARY

This project focused on the design of a user-friendly, energy-efficient snack vending machine. Our design priorities were reliability, simplicity, and cost-effectiveness. Some key parts include a welded tube frame, bill acceptor, keypad interface, dispensing mechanism, and front door.

The design of some components and assembly involved usage of advanced features within the SOLIDWORKS software, including advanced mates, advanced hole tools, 3D sketching, feature patterns and mirroring, surface modeling, appearances and decals.

1. INTRODUCTION

The modern vending machine has existed since the 1980s, serving as an automated point of sale station for all types of products. Even though vending machines have existed and have

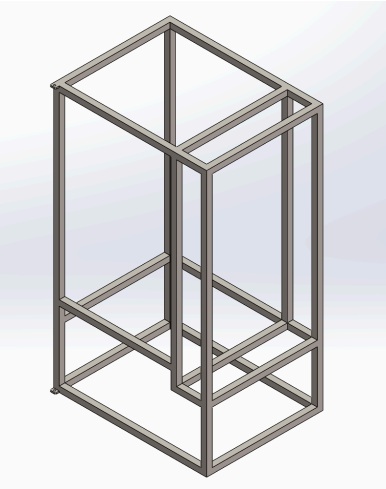
been improved on for decades, the newest models still have problems. Product jams and complex touchscreen interfaces are ruining the modern vending machine user experience, reducing customer satisfaction and possibly profits from machines. Rather than packing the system with touchscreens and advanced vending mechanisms that complicate use, we emphasized on an intuitive interface, reliable dispensing mechanics, and visual feedback. The result is an easy-to-use, energy-efficient snack vending machine designed to meet the practical needs of users in spaces such as dorms, campuses, offices, and public spaces.

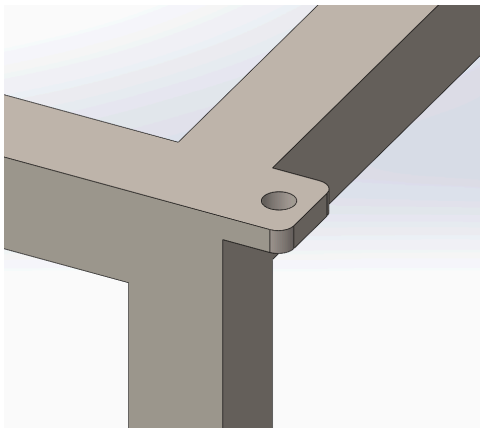
2. DESIGN

2.1. Design Overview

The vending machine was designed in SOLIDWORKS using a step-by-step approach. The first component to be designed was the frame, which is what all other parts are modeled around. Sheet metal parts within the assembly are welded together, which decreases manufacturing costs. Components that need to be modular such as the front panel, including electronics, are mounted with removable hinge pins and screws, allowing these components to be exchanged if necessary.

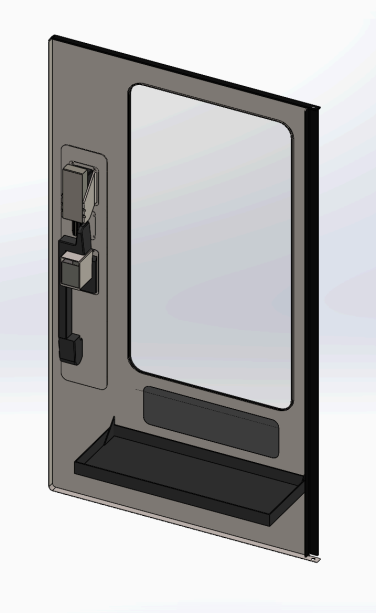
2.2. Notable Components

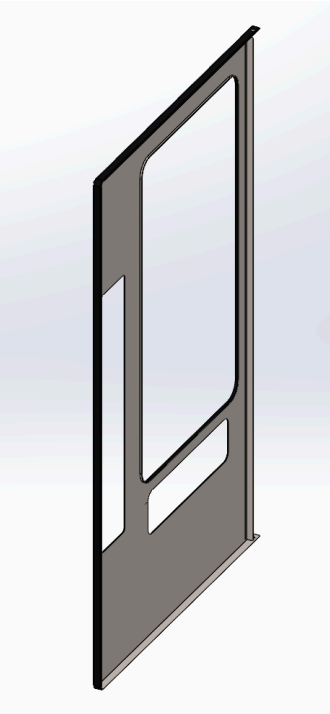


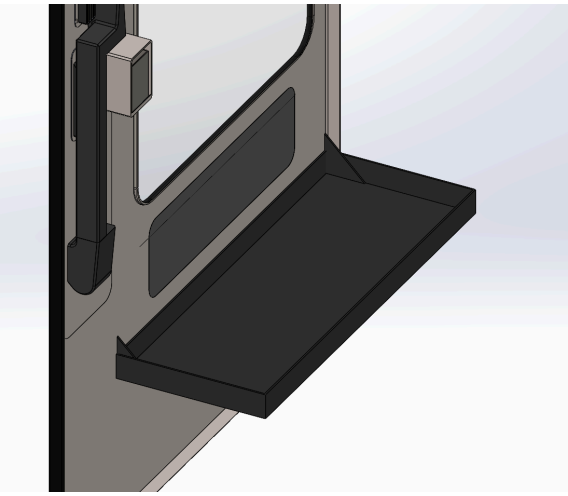


1. FRAME

The frame is the structure of the vending machine, the outer panels, and the majority of the interior panels mount to it. It is approximately 71 inches tall and 41 inches wide, and is designed to be welded out of 1.5” thin-walled square steel tubing. The vertical posts provide rigidity and flat mounting surfaces for the outer and inner panels to mount to. The horizontal portions support the bottom panel of the interior, separating the primary vending compartment of the machine from the bottom. The offset tube is to accommodate the chute and delivery door. There are tabs to allow pins to secure the front door. This part was created with extrude and cut features. This design is straightforward to manufacture and is low-cost. The feet consist of a loft feature, are made of hard rubber, and mount to the bottom of the frame.







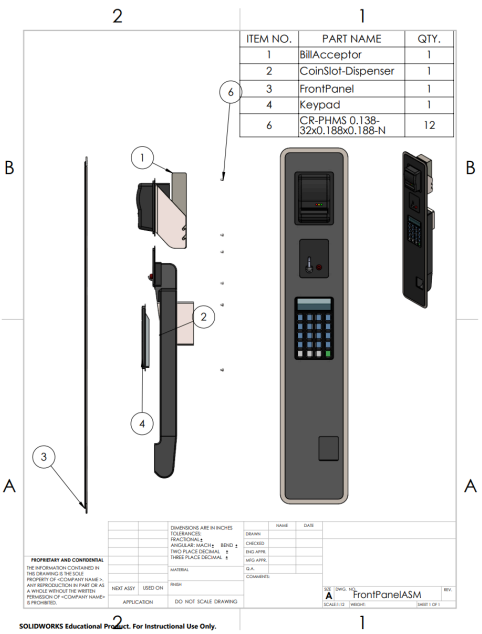
2. FRONT PANEL SUB-ASSEMBLY

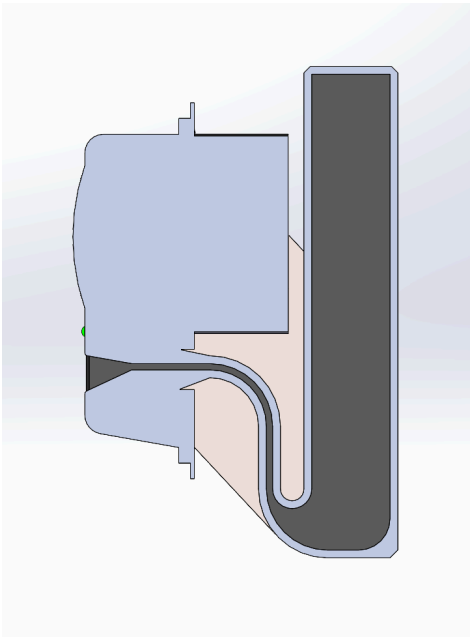
a. Front Panel

The front panel is what the user sees, it is the facade of the machine. It has a glass window for customers to see items and cutouts for the delivery door and electronics panel. It is designed to be made out of a piece of stamped steel sheet. It is made with simple extrusion, cut, and fillet features.

b. Delivery Door

The delivery door is used so that the user can retrieve the product they have ordered. It is designed to open only one way, so that the door can only open inwards “into” the machine. This too, is designed to be made out of a piece of stamped steel sheet. It was made using a simple sketch and extrusion. A limit distance mate was used in the assembly to make sure the door could not swing “outwards”.





3. ELECTRONICS PANEL SUB-ASSEMBLY

Left to right: Electronics Panel Assembly Drawing, Bill Acceptor Section View, Keypad Front View

a. Electronics Panel & Assembly:

The Electronics Panel is made of sheet metal and sheet plastic. The sheet metal portion includes #6-32 tapped holes to secure the bill acceptor, coin slot, and keypad. This part consists of extrusions, cuts, and fillets. Each part mounts to the Electronics Panel includes with an outer metal flange, utilizing #6 screw holes from in order to attach to the rear face of the panel. SolidWorks Toolbox was used in assembly to insert the fastening hardware. The outer metal flange of the Electronics Panel is welded to the interior face of the Front Panel.

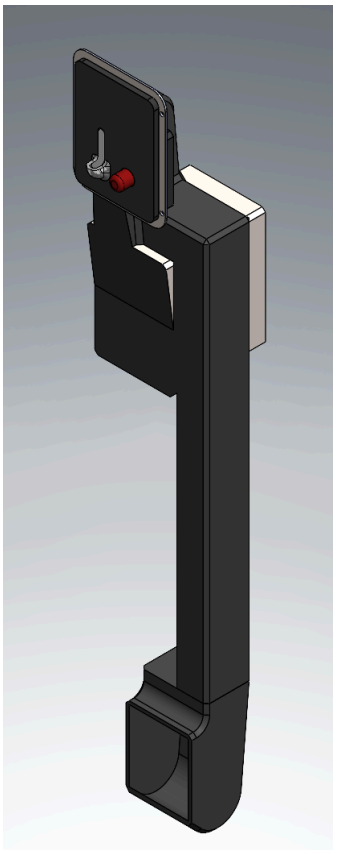
b. Bill Acceptor:

The Bill Acceptor is the primary payment mechanism for users, it accepts cash and tap-to-pay credit card payments. It does not include a magnetic stripe reader due to it being

outdated, and most people no longer use it. The integrated LEDs provide feedback to the user of their purchase: red representing denied, yellow for processing, and green for successful payment.

Modeling the Bill Acceptor began with researching commercially available bill acceptor units and reviewing public CAD models. It was determined that it should be able to fit approximately two hundred bills. The bill path is long enough for sensors to evaluate the bill, and for a belt system to relocate the bills to storage. There is a computer housing with grilles on the back, which connects to the internet with a cellular modem. The overall structure was modeled with basic features such as extrusions, revolutes, and fillets. Construction geometry was used to mirror elements to produce symmetry, and a linear feature pattern was used to pattern the LED domes that stick out of the housing. Appearances were utilized to differentiate different materials and to show the colors of the LED. These design and CAD modeling choices ensured that the component aligned with our goal of keeping modern capabilities, such as digital feedback and contactless payment, prioritizing ease of use.

c. Coin Slot & Return:



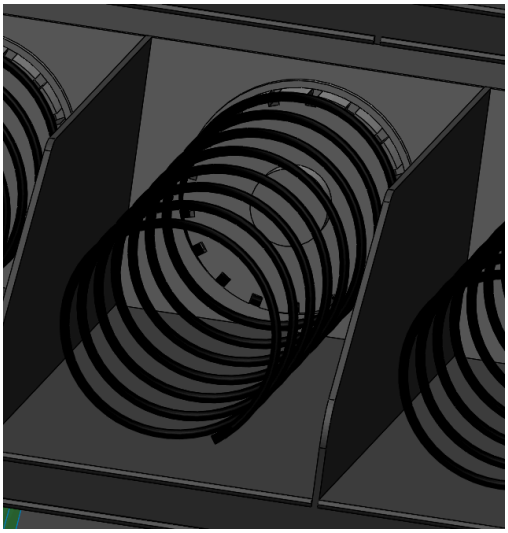
The Coin Slot & Return is a secondary payment and refund system for customers who want to use pocket change and to receive change for cash transactions. There is a collection bin for accepted payments, and a tray at the bottom for refunds. The bottom of the tray extends below the opening so that coins do not exit the tray after being dropped, and is big enough for the user's whole hand to grab the coins, instead of two fingers. The red button signals to the computer to return the deposited coins or to dispense change from a cash transaction. This part was modeled using a series of features,

including extrusions, revolves, drafts, mirroring, shells, chamfers, and fillets. The split feature was also used to separate the button so that it moves in the subassembly.

d. Keypad & Screen:

The Keypad is the primary interaction point for users, it is how the user selects their items. In order to decrease the steps for users to purchase items, the top four rows of the keypad correspond to individual items. The bottom row of the keypad can be used to key in the less-popular products from the bottom row of the machine. The green button is used to confirm a purchase. This layout was chosen to simplify the decision-making process, reducing confusion and saving time for the user. The Keypad was modeled using sketch patterns, extrusions, fillets, and appearances.

4. VENDING MECHANISM



a. Coil

The coil was modeled using the Helix feature to replicate the spiral design commonly used in vending machines. A 2.25-inch pitch was selected to match the average thickness of standard snack items like chip bags, allowing products to sit evenly between each turn. The coil's dimensions were set to ensure consistent spacing and proper alignment with the base and shaft.

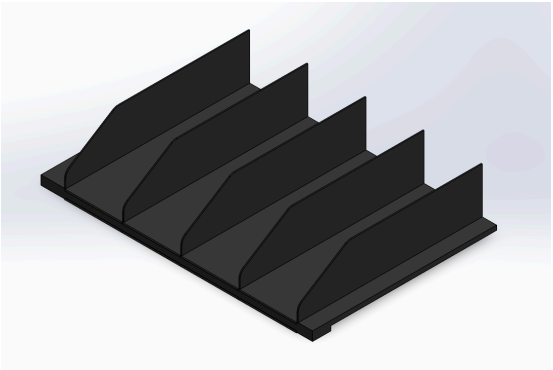
This component visually represents the mechanism that rotates to release one item at a time, and it was placed carefully to ensure a balanced appearance when connected to the shaft.

b. Motor

The gear was designed as a cylindrical part with evenly spaced rectangular cutouts around the edge to simulate teeth. It represents the part that would connect to a motor and rotate the coil to dispense items. I used a circular pattern tool to create uniform gear-like features. While the gear is not mechanically functional, its shape conveys the concept of motor-driven rotation. A challenge I faced was maintaining symmetry when sketching the teeth layout, which was solved using pattern tools instead of manual placements. The gear size was estimated to match the central axis of the coil so that it could visually "drive" the rotation. The simplification was intentional to reduce complexity while still illustrating the motion concept in the overall mechanism.

c. Base

The base was constructed using a rectangular extrusion with a circular cut in the center to seat the coil. The flat structure represents the vending shelf and is designed to support the weight and position of the coil mechanism. The cutout was dimensioned based on the coil's diameter to ensure a secure fit. This also allowed for consistent assembly alignment. Positioning the circular cut precisely was important to maintain the coil's balance, and it was solved by using reference geometry centered on the part. This design ensures that the coil remains stable during operation and is mounted securely within the vending compartment.



5. INTERIOR

a. Light Bars

To make the light bars, we took into account that they would need to be able to fit alongside the inside walls. The sketch was made up of a curved profile, extrusions, and cuts. The light bar is wide and long enough to provide enough rays of light to illuminate the whole vending machine.

b. Shelving

The shelves used in our vending machine are very similar in resemblance to the average, dry non perishable product vending machine. The dimensions are compatible with commonly sold products such as the standard 1.5 oz chip bag, a 5 oz candy box (both of which the samples were modeled after), and most products reasonably smaller than those listed. Each shelf space is large enough and of appropriate dimensions to house the coil and motor which work together to dispense the product. The shelves go to the end of the machine, but are shorter so they guarantee enough clearance for a variety of products to fall through, ensuring that products will not get stuck, as is the problem with current vending machine models. While it does limit the amount of product housing, the high placement of each shelf again, ensures that there will not be any

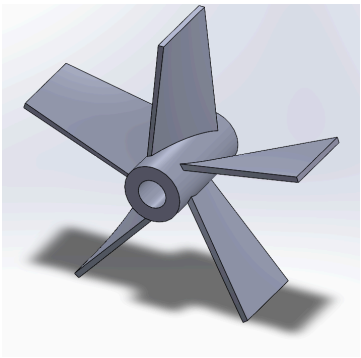
obstructions while the product is being dispensed. The shelves were made with simple cuts and extrusions, then filleted for a smoother and more visually appealing look.

c. Product Models

SampleProduct and SampleProduct2 were modeled after 1.5 oz chip bags, with the correct height, length, and width taken into account. There is some overlapping of product and shelving, but if considering how products crinkle and can be readjusted in real life in relation to shelving, there wouldn't be any problems. Techniques apart from what was learned in class were used for these samples, where a drawing was turned into a plane, and then the freeform tool was used to create the curved and wider center, while the borders stayed relatively thin. SampleProduct3 follows the same dimensions as a 5-oz box of candy to add some variation to the display, and fits without a problem on the shelves. This was created with a simple extrusion, appearances, and decals.

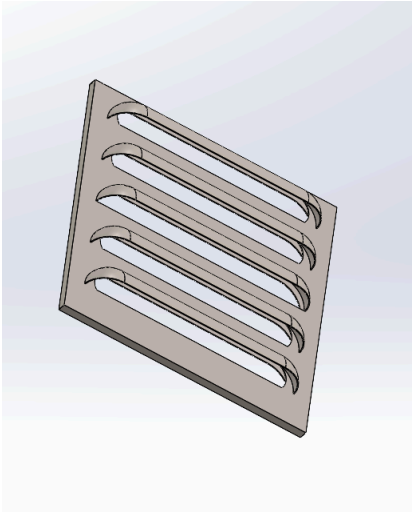
6. REAR OF MACHINE

a. Fan



The fan was made by first creating a cylinder in the middle, which will act as the center of it. Then the curved fin part of the fan was added, and the circular pattern feature was used.

b. Vent



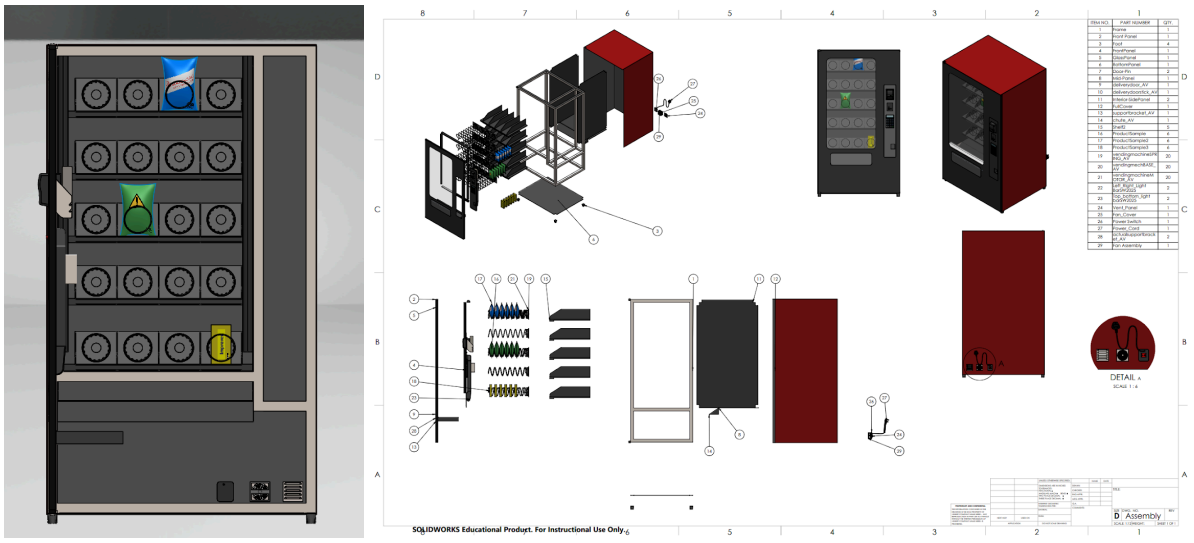
For the vent panel an extruded rectangular body was made, then the curved vented holes were added on. To make the holes for the vents, the extruded cut feature was used. The ellipse tool was used to make the sketch for the vent holes, and then linearly mirrored so that each of the vents had

equal spacing between them. Lastly, for the mates, we used the coincident mate to put it on the side of the vending machine.

c. Power Switch & Cord

To make the power switch and cord, we kept in mind the real-life representation of what that could look like. Some features that were used were chamfer and fillet to make the head of the power cord more similar to what it looks like in real life. Lastly, for the cord, the sweep function was used, and then coincidentally mated the ends of the plug and the plug-in. The power cord was made so that it could be connected to the power switch and then connected to the vending machine.

2.3. Assembly



Front view and assembly drawing

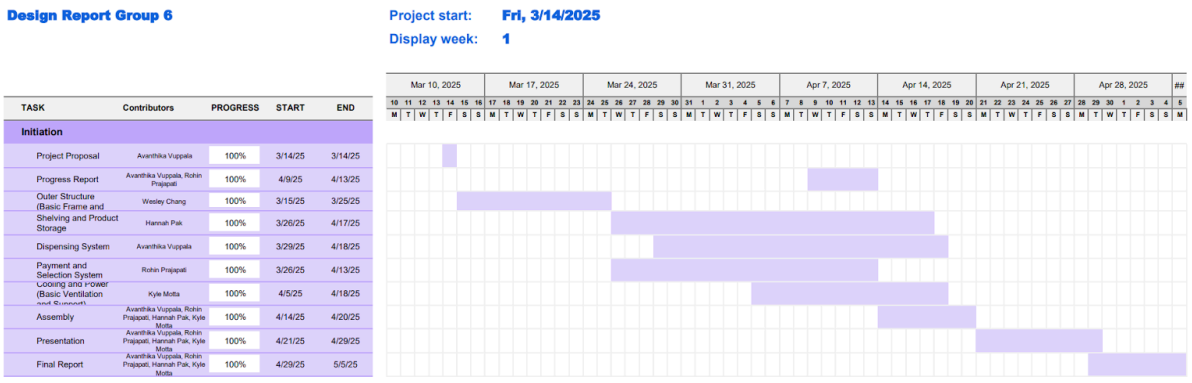
The full and final vending machine assembly was worked on by every member of the

group and consists of standard and advanced mates. Limit angle mates were used to prevent the door from swinging past a realistic or reasonable envelope. Shelving and product models were placed into the assembly using linear component patterns. The front door is mounted on a hinge that opens 90 degrees, and the delivery door is on a hinge that opens 75 degrees inwards. Most mates involved coincident surfaces, planes, or lines, and concentricity, allowing the assembly to be visually pleasing and functional. Difficulties encountered when trying to achieve a mechanical movement included: the entire assembly breaking when using the mechanical hinge mate, and to resolve the issue, coincident, concentric, and limit angle mates were used instead.

For the animation, a specific animation copy of the assembly was made to be sure that the animation would not break the assembly, and to add specific changes just for the animation. Specific changes for the animation version of the assembly include the removal of a component pattern for the green chip bag product sample and an assembly sketch for a path mate involving the product sample. The script for our animation begins with a front view, then transitions to a right view with isometric in between. Then, the assembly spins for a 360 view, and ends at a front view. The front door opens to allow the viewer to see the inside of the vending machine. An exploded view begins at the front view, and as the assembly is exploding, the camera moves to an isometric view. The product samples disappear, then the light bars and shelving are brought out of the machine. Then, the camera switches to a left view as the assembly collapses. While the assembly collapses and product samples reappear, the camera switches to isometric, the front door closes, and the camera ends with a front view. The camera switches to a custom perspective view, a motor spins one of the vending mechanism coils, and a bag of chips falls into the tray. A second custom perspective view appears, picturing the delivery door. The delivery door opens, the chip bag disappears, and the door closes. The camera then returns to an isometric view.

3. PROJECT MANAGEMENT

In order to distribute the workload, the project was broken down into different categories that each member was responsible for completing. Our team divided the project into five key areas: the outer frame, shelving, dispensing mechanism, payment system, and the support/cooling section. Each member was responsible for creating five CAD parts related to their assigned section. We communicated through an iMessage group chat to share progress updates, screenshots, and ask questions. For file sharing and real-time collaboration, we used Box, which allowed everyone to access the latest versions of the files and keep everything organized. All team members contributed to documentation, progress updates, and the final assembly. We began by finalizing our project idea and writing the proposal together. Once the tasks were divided, each person worked on modeling their parts while regularly checking dimensions to make sure everything aligned properly. One person managed the main assembly file to avoid version conflicts, and the rest of us submitted our updated parts to Box for easy access and integration.



Design Report Group 6

Project start: **Fri, 3/14/2025**
Display week: **1**

TASK	Contributors	PROGRESS	START	END
Initiation				
Project Proposal	Avanthika Vuppala	100%	3/14/25	3/14/25
Progress Report	Avanthika Vuppala, Rohin Prajapati	100%	4/9/25	4/13/25
Outer Structure (Basic Frame and	Wesley Chang	100%	3/15/25	3/25/25
Shelving and Product Storage	Hannah Pak	100%	3/26/25	4/17/25
Dispensing System	Avanthika Vuppala	100%	3/29/25	4/18/25
Payment and Selection System	Rohin Prajapati	100%	3/26/25	4/13/25
Cooling and Power (Basic Ventilation	Kyle Motta	100%	4/5/25	4/18/25
Assembly	Avanthika Vuppala, Rohin Prajapati, Hannah Pak, Kyle Motta	100%	4/14/25	4/20/25
Presentation	Avanthika Vuppala, Rohin Prajapati, Hannah Pak, Kyle Motta	100%	4/21/25	4/29/25
Final Report	Avanthika Vuppala, Rohin Prajapati, Hannah Pak, Kyle Motta	100%	4/29/25	5/5/25

Mar 10, 2025 | Mar 17, 2025 | Mar 24, 2025 | Mar 31, 2025 | Apr 7, 2025 | Apr 14, 2025 | Apr 21, 2025 | Apr 28, 2025

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4. CONCLUSIONS

Important lessons have been learned from this project, including communication, organization, and time management. Throughout the project, it was clear that communication held a huge impact on our finished product. This is because when assembling all parts, only one person can have the assembly file opened at a time, which pushes the person on the file to communicate with other group members to ensure that the pieces are put together correctly. Additionally, there were pieces of the vending machine that had to be completed first, which required our group members to communicate about when certain parts were going to be completed. This also requires all group members to manage time properly to ensure that their parts get done, which allows other group members to start and complete their work. Organization is another lesson learned from this project. As stated, our group used *Box* to share all files, which allowed everyone to share actively updated parts. The software also allowed us to group all work based on the person, and made every part easy to find when needed. Organization is important because there are a lot of pieces that go into an assembly. Without proper file management, it would make collaborating on the project difficult.

REFERENCES

Dimensions.com. (n.d.). ***Snack vending machine (large)*****.** Retrieved April 23, 2025, from https://www.dimensions.com/element/snack-vending-machine-large

Microsystem Controls (n.d.). *ST1C Bill Acceptor - Bill Validator* [CAD model]. GrabCAD. Retrieved April 26, 2025, from https://grabcad.com/library/st1c-bill-acceptor-bill-validator-1

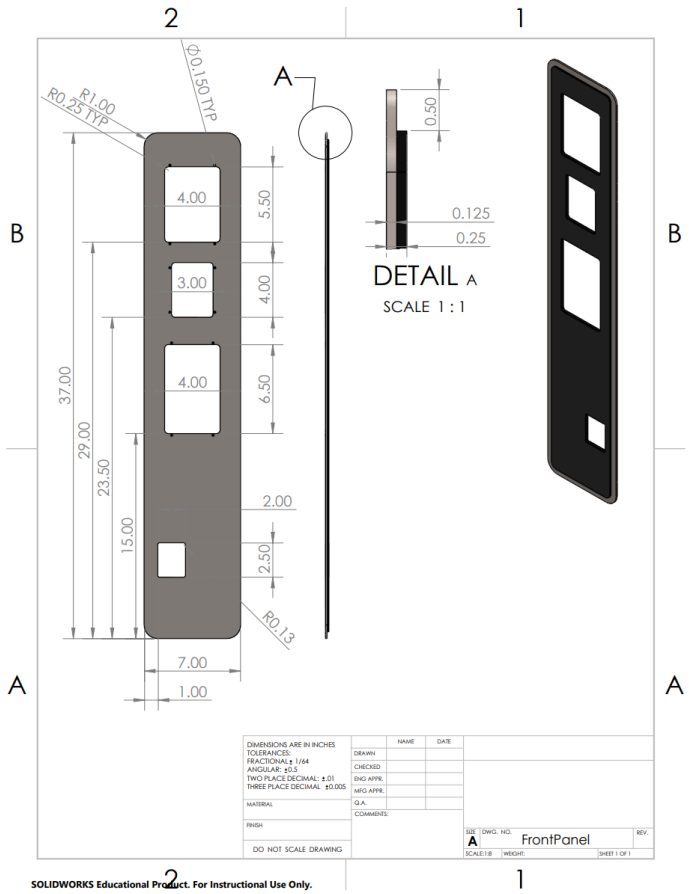
Appendix A. FILES AND AUTHORS

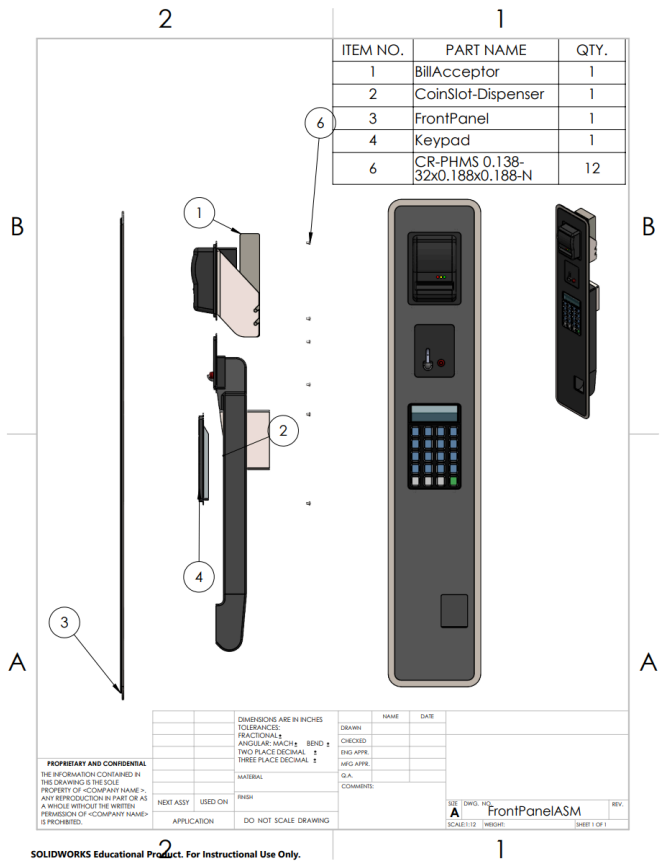
TABLE A.1: *The submitted files and their authors*

File Name	**Author(s)**
Fan.sldprt	Wesley Chang
Fan housing.sldprt	Wesley Chang
Foot.sldprt	Wesley Chang
Frame.sldprt	Wesley Chang
Front Panel.sldprt	Wesley Chang
Fan Assembly.sldasm	Wesley Chang
Fan_Cover.sldprt	Kyle Motta
Left_Right_Light BarSW2025.sldprt	Kyle Motta
Power Switch.sldprt	Kyle Motta
Power_Cord.sldprt	Kyle Motta
Power_Cord_EndSide.sldprt	Kyle Motta
Top_bottom_light barSW2025.sldprt	Kyle Motta
Vent_Panel.sldprt	Kyle Motta
Power_Cord.sldasm	Kyle Motta
Door-Pin.sldprt	Hannah Pak
FullCover.sldprt	Hannah Pak
ProductSample.sldprt	Hannah Pak
ProductSample2.sldprt	Hannah Pak
ProductSample3.sldprt	Hannah Pak
Shelf2.sldprt	Hannah Pak
BillAcceptor.sldprt	Rohin Prajapati
BottomPanel.sldprt	Rohin Prajapati

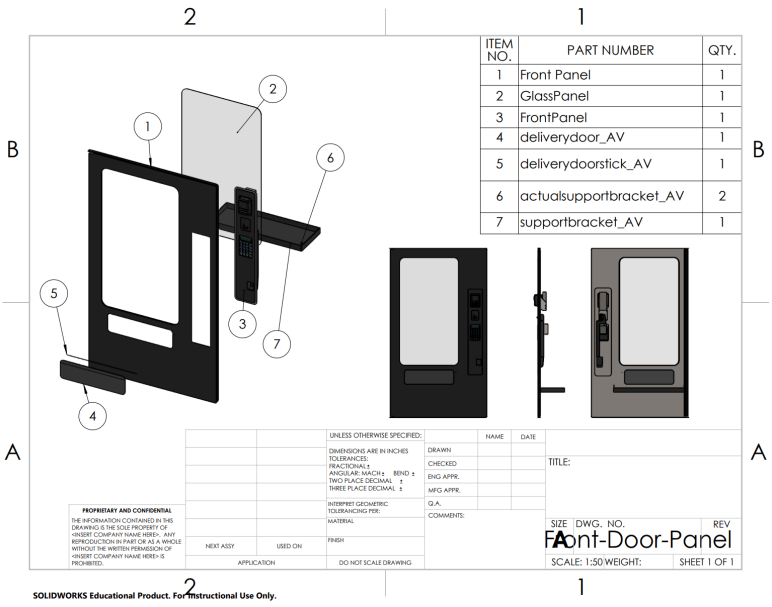
Coin-Button.sldprt	Rohin Prajapati
CoinSlot-Dispenser.sldprt	Rohin Prajapati
FrontPanel.sldprt	Rohin Prajapati
GlassPanel.sldprt	Rohin Prajapati
Interior-SidePanel.sldprt	Rohin Prajapati
Keypad.sldprt	Rohin Prajapati
Mid-Panel.sldprt	Rohin Prajapati
Front-Door-Panel.sldasm	Rohin Prajapati
FrontPanel.sldasm	Rohin Prajapati
Front-Door-Panel.pdf	Rohin Prajapati
FrontPanel.pdf	Rohin Prajapati
FrontPanelASM.pdf	Rohin Prajapati
Assembly.pdf	Rohin Prajapati
actualsupportbracket_AV.sldprt	Avanthika Vuppala
chute_AV.sldprt	Avanthika Vuppala
deliverydoor_AV.sldprt	Avanthika Vuppala
deliverydoorstick_AV.sldprt	Avanthika Vuppala
supportbracket_AV.sldprt	Avanthika Vuppala
vendingmachineMOTOR.sldprt	Avanthika Vuppala
vendingmachineMOTOR_AV.sldprt	Avanthika Vuppala
vendingmachineSPRING_AV.sldprt	Avanthika Vuppala
vendingmechBASE_AV.sldprt	Avanthika Vuppala
vendingmechASSEM.sldasm	Avanthika Vuppala
Assembly.sldasm	Entire group

Appendix B. ENGINEERING DRAWINGS

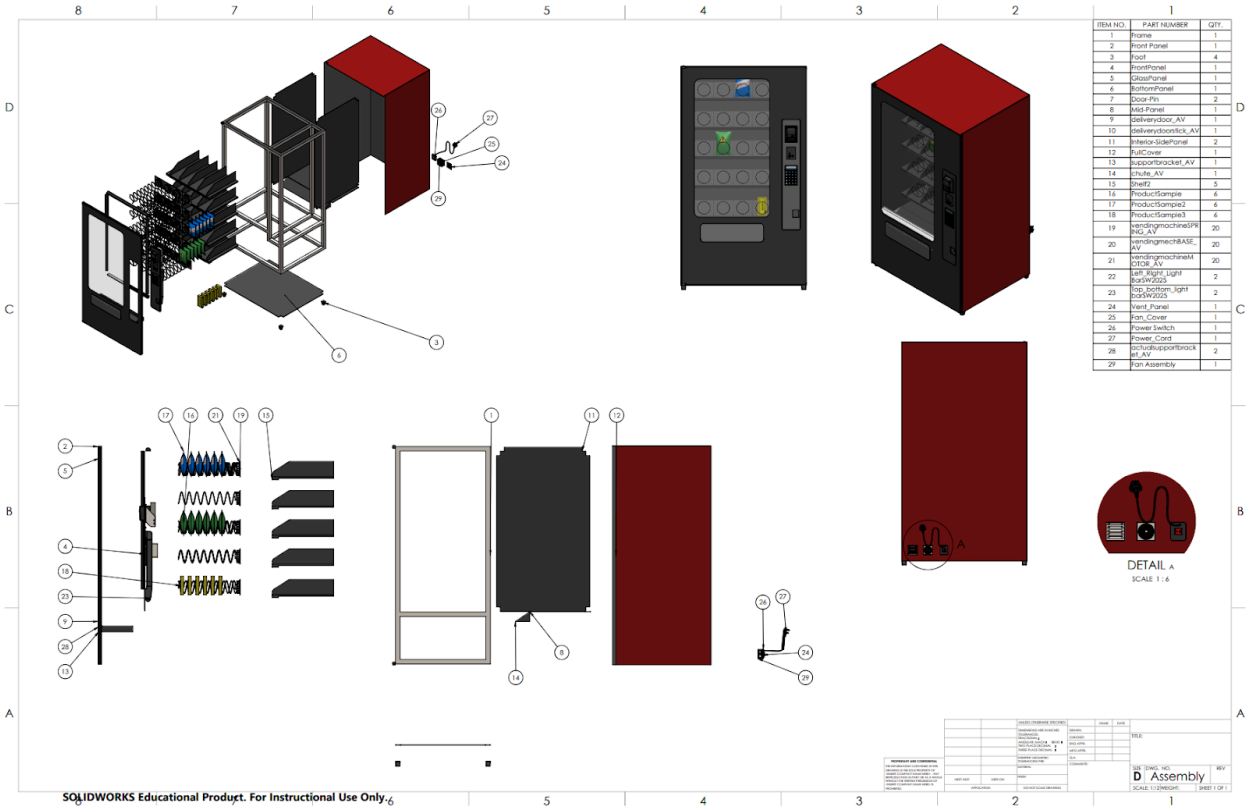




ITEM NO.	PART NAME	QTY.
1	BillAcceptor	1
2	CoinSlot-Dispenser	1
3	FrontPanel	1
4	Keypad	1
6	CR-PHMS 0.138-32x0.188x0.188-N	12



ITEM NO.	PART NUMBER	QTY.
1	Front Panel	1
2	GlassPanel	1
3	FrontPanel	1
4	deliverydoor_AV	1
5	deliverydoorstick_AV	1
6	actualsupportbracket_AV	2
7	supportbracket_AV	1


ITEM NO. | PART NUMBER | QTY.
1 | Frame | 1
2 | Front Panel | 1
3 | Foot | 4
4 | FrontPanel | 1
5 | GlassPanel | 1
6 | BottomPanel | 1
7 | Door-Pin | 2
8 | Mid-Panel | 1
9 | Deliverydoor_AV | 1
10 | deliverydoorstick_AV | 1
11 | Interior-SidePanel | 2
12 | FullCover | 1
13 | supportbracket_AV | 1
14 | chute_AV | 1
15 | Shelf2 | 5
16 | ProductSample | 6
17 | ProductSample2 | 6
18 | ProductSample3 | 6
19 | vendingmachine3SPRING_AV | 20
20 | vendingmechBASE_AV | 20
21 | vendingmachineMOTOR_AV | 20
22 | Left_Right_Light Bars1W2020 | 2
23 | Top_bottom_light bars1W2020 | 2
24 | Vent_Panel | 1
25 | Fan_Cover | 1
26 | Power Switch | 1
27 | Power_Cord | 1
28 | actualsupportbracket_AV | 2
29 | Fan Assembly | 1
DETAIL A
SCALE 1 : 6
SOLIDWORKS Educational Product. For Instructional Use Only.
D Assembly
SCALE: 1/12WEIGHT: SHEET 1 OF 1