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Pour-Over Coffee Stand with Warmer

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POUR-OVER COFFEE STAND WITH WARMER

by
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A thesis submitted to The University of Mississippi in partial fulfillment of the requirements of the Sally McDonnell Barksdale Honors College.

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ABSTRACT

FRANCESCA GATUZ PATAWARAN: POUR-OVER COFFEE STAND WITH WARMER
(Under the direction of Eddie Carr)

This project sought to demonstrate the process of bringing a new product into the market, from the initial design and prototyping stage to marketing and, ultimately, mass production. As part of the curriculum of The Haley Barbour Center for Manufacturing Excellence (CME), the project team manufactured fifteen Pour-Over Coffee Stands with electric heating components. We first created a 3D model of the proposed design, ensuring that all components fit together in an assembly. Next, we worked with the lab technicians to create a prototype of the product. Then, we refined the manufacturing process to eliminate waste where possible. Throughout the project, we also kept track of financials and discussed marketing strategies to ensure that this would be a profitable venture. This project was the culmination of the past four years at the CME—solidifying my knowledge in engineering, business, and accountancy.

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1. INITIAL CONCEPT AND DESIGN

1.1 Production Ideation

As a sleep-deprived college student, nothing keeps me going better than a fresh, hot cup of coffee. When doing research, I found several options for pour-over coffee stands, but none that kept coffee warm. The built-in warmer in this product ensures that the coffee will sustain the heat of a mug or carafe, making for a warm cup of coffee every time. Additionally, an even temperature prevents the taste of the coffee from being altered from being burned.

This product seeks to fill a gap in the market for coffee-making accessories by integrating an electric heating component into a traditional pour-over coffee stand. Combining two existing products that are widely used into one product that has yet to be made before increases its attractiveness in the market. With a straightforward but structurally sound design, the goal is to streamline the manufacturing process on the back end while ensuring ease of use on the customer end. Figure 1 shows the initial 3D model I submitted to the faculty and the individual products that inspired mine.

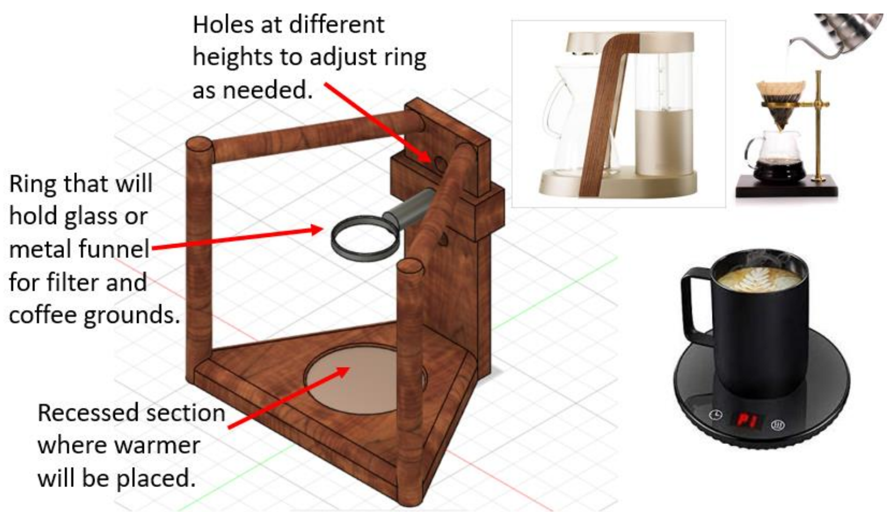


Figure 1: Initial mode and inspiration for product proposal

To create a three-dimensional model, I used a computer-aided design software called *Solidworks*. Some of the functionalities of this rendering program include modeling parts, making assemblies (separate components put together to make one product), making dimensioned drawings, and getting the bill of materials for a particular assembly. Figure 2 is an example of a dimensioned drawing one would make for a component. Because departments beyond the design team will see documents like this, the team must ensure that it is easily understandable across the board. The information boxes below show the design owner, material information, changes made, scaling, and much more. Additionally, including the correct units are critical to understanding the full context of the component.

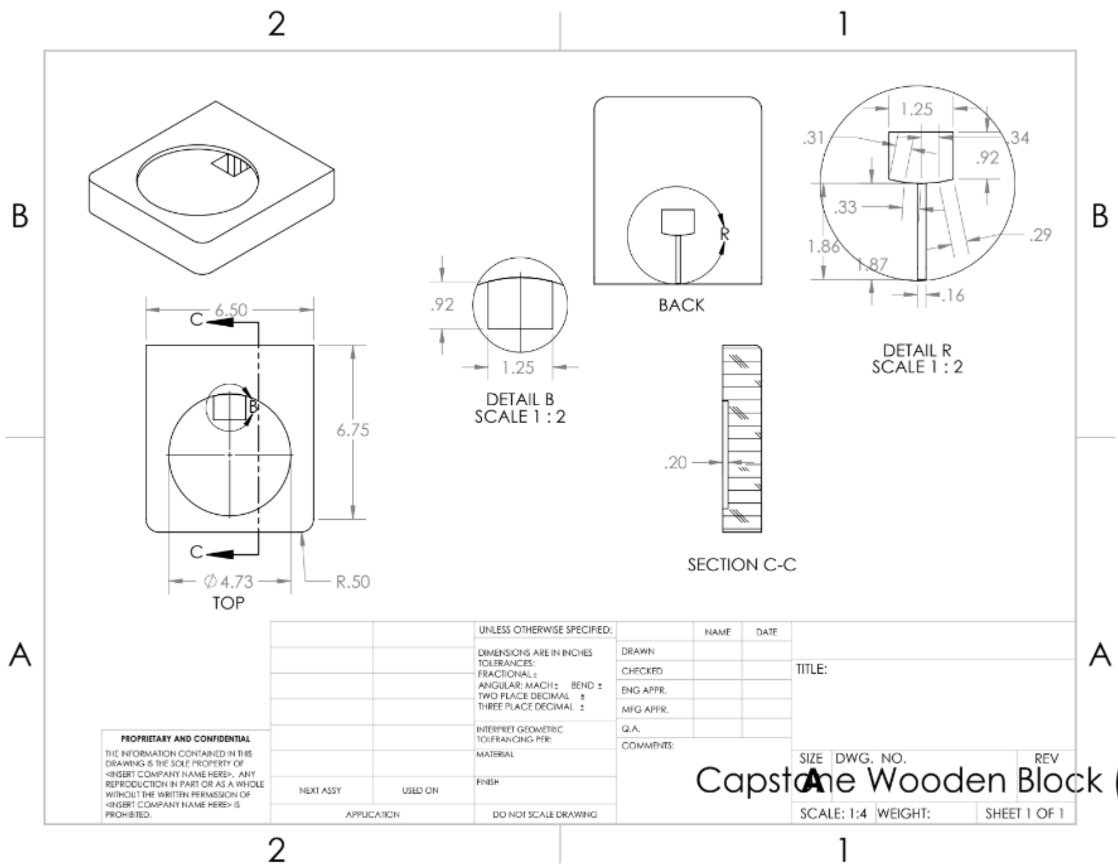


Figure 2: Example of dimensioned drawing for a component

2. PROTOTYPING PROCESS

2.1 Initial Prototype

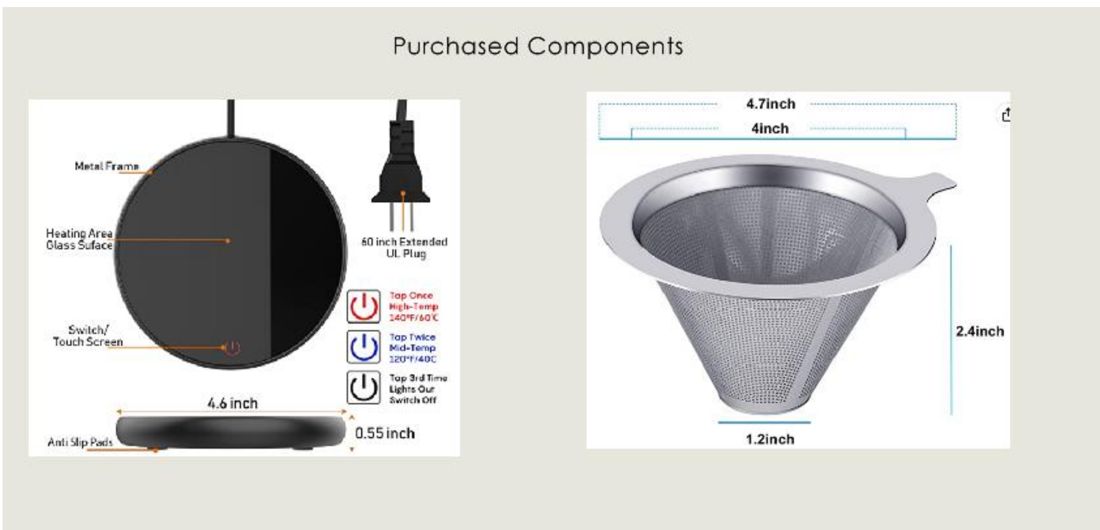
In the Spring of 2022, my team embarked on the initial prototyping process. This step is crucial in researching and developing new products as it allows the designers to determine positive points and areas of improvement. Figure 3 shows the first 3D rendering of the Pour-Over Coffee Stand. The components we manufactured in the CME include a metal frame and a wooden block. The purchased components were the stainless steel coffee filter and cup warmer (see Figure 4 for dimensions).

Figure 3: Assembled product with original dimensions

We designed the sheet metal frame to be 23” long, 6.5” wide, and 0.0625” thick. The corners of the sheet had a radius of 0.25”. The free-standing upper portion had a bend radius of 2.5”, while that of the bottom radius was 0.25”. At the top of the frame, we cut out a 3” diameter circle for the coffee filter. Finally, the bottom of the frame consisted of a 0.25” channel for the cord.

For the wooden base, a 7.5” x 6.5” x 0.75” block of wood was designed to attach to the bottom of the frame. There were two different routing settings for the edges of the wooden block. A router table is a stationary workbench with an attached rotating blade[1]. It is widely used in

woodworking to create holes, round edges, and joints. To manufacture the initial prototype, we planned to use three separate routers. One was used on three sides at a radius of 0.25”. The second setting was at 0.25” for the face touching the metal frame. Doing so would ensure that the block would sit flush with the 0.25” bend radius on the bottom of the frame. Another hole was cut out with the exact dimensions of the cup warmer. As a result, the cup warmer would be flush with the wood’s surface. Underneath that cut were more holes and channels for the cord to fit through; the channel was 0.25” wide. Overall, the initial prototype had a width of 6.5” and sat at
8” tall.



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
3	Cup warmer	4.6 x 0.55 in.	1
4	Coffee filter	4.7 x 2.4 in stainless steel	1

Figure 4: Dimensions of purchased components

2.2 Material Selection Process

Initially, we intended to use a more high-end wood for the design. We considered walnut wood was considered due to its color, grain pattern, and water resistance[2]. However, one significant competitive advantage was to allow for product customization. Whether it be a custom powder coat color or wood stain, it was important that customers would have some options in the buying experience. Therefore, the team concluded that we could offer customization through various powder coat colors and wood stains. With walnut wood having a sleek appearance on its own, we decided not to pursue that material if we were going to stain and coat the base with polyurethane.

Ultimately, we chose poplar wood due to its resistance to shrinkage and relatively low cost[3]. Poplar was also a better option because of its lighter color; it would be easier to stain, and a wide variety of stains would appear more clearly on this wood than walnut.

When evaluating metals to use for the frame, we considered several factors. The first factor was how different metal thicknesses would react to the bend the sketched prototype had. The bottom of the frame would have a 90-degree angle, and the top would have a bend radius of 2.5”. We decided that 16-gauge cold-rolled steel (0.0625” thick) would be the best option since it could bend easily but also keep a stable structure. We found that anything thinner than that caused the top bend to spring up and down.

The second factor was the type of sheet metal. Stainless steel was the preferred choice. However, since we decided to go for powder coating, there would have been no point in using stainless steel only for it to be covered up. Powder coating is a finishing process where the powder is fused to the surface of a material using an electric charge[4].

We also considered using a stainless-steel powder coat, but some issues would have occurred. When bending and laser cutting metal, scars could appear on the exterior of the metal and ruin its finish. Once an imperfection develops, it would be more challenging to return that to its original state. With the high costs associated with stainless steel, the idea of using cold-rolled steel became permanent. Even if there were scars during the laser cutting or bending process, a sandblaster would fix those issues. Sandblasting is a finishing process in which compressed air blasts micro-abrasives against the surface of a material[5]. This process takes off the top layer of a given material, leaving a smooth surface as is or for further finishing.

2.3 Final Prototype and Lessons Learned

For the most part, the group was pleased with the design of the prototype. Most components functioned to their anticipated capacity. Most changes that the group made dealt with cosmetic features of the product. For instance, the stainless-steel coffee filter did not sit flush with the top of the frame. We also found that the channel we designed for the heating element cord was too narrow; this was a potential safety concern, as fraying of the cable over time may cause a fire. Another problem we encountered was the bend radius at the top of the frame. The 2.5” bend radius was challenging to reproduce using a manual press brake. Press brakes are used to bend sheet and plate materials. The operator places the material over a V-shaped die, which is then formed into shape by an overhead punch[6]. As a result, we analyzed different methods to make the manufacturing process as consistent as possible.

To make the process quick and consistent, we decided that the 2.5” radius bend should be eliminated. Instead, the top and bottom bends would have a 0.25” radius. This way, the same angle and procedure could be used for both sides of the laser-cut piece. For the prototype, we initially used the manual brake press. The radius came out to be 0.25”, as expected. However, the manual brake press was highly inefficient. Each time the metal was bent, we had to manually mark the sheet metal to remember where to bend it. On top of that, no measures were in place to produce the same angle each time.

It was at this point that the hydraulic brake press came into play. The hydraulic press could automatically select certain distances to bend the sheet metal and bend specific angles (we included spring back in the calculations). The hydraulic press took two weeks to figure out, but it was well worth it. The only issue with the hydraulic press was that the bend radius was set at 0.125” instead of 0.25”. Therefore, another router had to be set at a radius of 0.125”; as a result, the block could once again be flush with the curvature of the frame. Other backstops were experimented with for each routing table to see which ones would fit with the design. These backstops ensure consistency for each Pour-Over Coffee Stand made.

To prevent the cord from fraying, the diameter of the cord channel was increased in both the wooden block and the sheet metal frame from 0.125” to 0.25”. Figures 5 (isometric view) and 6 (rear view) show the updated model. Similarly, we modified the wood and sheet metal dimensions to overlap both channel slots. One last touch that was introduced was non-slip pads on each corner of the bottom frame. We implemented these pads not only to stabilize the product but also to protect any surface that it laid upon.

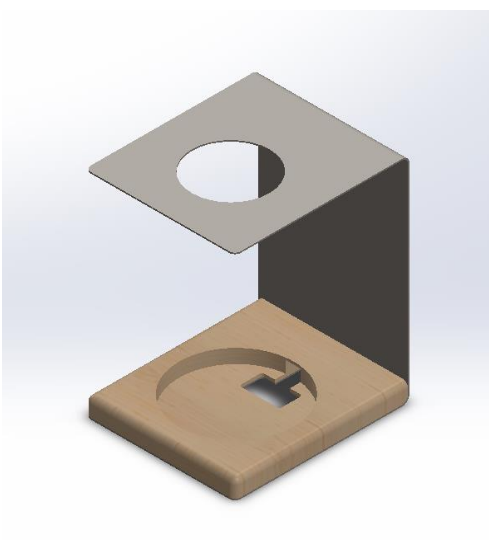


Figure 6: Updated design (isometric)

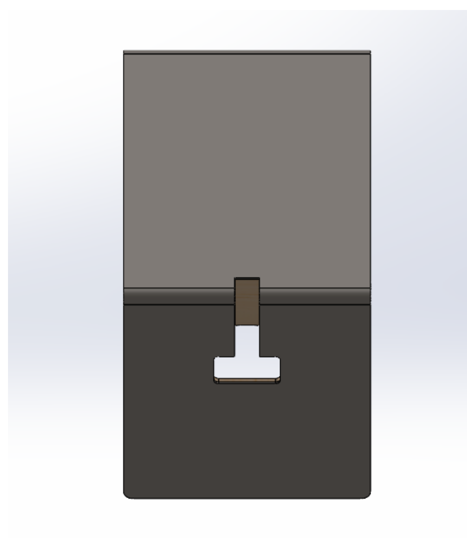


Figure 5: Increased cord slot width

3. MARKET RESEARCH

In developing any new business, it is vital to establish strategic management processes that will allow the business to succeed in the market. This includes understanding existing competitors and their business models (e.g., how their products are priced and marketed). Having this information will allow us to come up with an edge that sets us apart from similar products already in the market.

3.1 Existing Competitors

Two competitors stood out on the market. One is the Yangbaga Pour-Over Coffee Makers Set with a coffee filter holder. It lacks the actual filters itself and the cup-warming aspect. The product runs for $17.99 and is made from wood. The Yangbaga is shown in Figure 7 below.

Figure 7: Yangbaga Pour-Over Coffee Maker Set

Another competitor is the Melitta Senz V Smart 2-Cup Pour Over Device. The product has built-in sensors that manage coffee-to-water rations for optimal temperatures and timing; the system tracks the brew and predicts the final taste. It can also brew 2 cups at a time. While this product has high-end technology with apps built into the system, it does not have the exact features that our product offers.

While the technology in this product is appealing, it is steeply priced at $130. A picture of the Williams Sonoma device is shown in Figure 8 below.

Figure 8: Melitta Senz V Smart 2-Cup Pour-Over Device

<u>*3.2 Customer Surveys*</u>

An initial marketing survey was conducted in March 2022 to gauge customer demand for the proposed product. Out of 56 responses, 39 answered that they often have to reheat their hot beverages after they have been sitting out for a while. Additionally, the team asked customers how much they would pay (this was before prototype completion; customers were not shown a picture of the proposed product). Figure 9 shows that most responses pointed towards the $25-$40 price point.

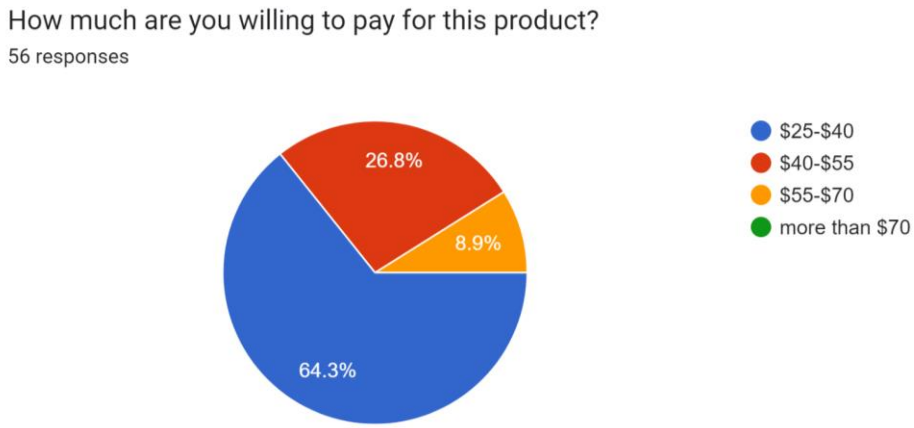


Figure 9: Initial Cost Survey Responses

A secondary survey in September 2022 allowed the team to determine a retail cost for our product. A comparison was also provided between the product and competitors in the market, listing different features and price points. This time, customers could see what the team's final prototype looks like before making their judgment (Figure 10). As shown in Figure 11, out of 79 responses, 30.4% answered that they would pay $40-$55. Knowing that one unit of our product costs $18.86, we can price our product anywhere between $25-$55 and still make a profit.

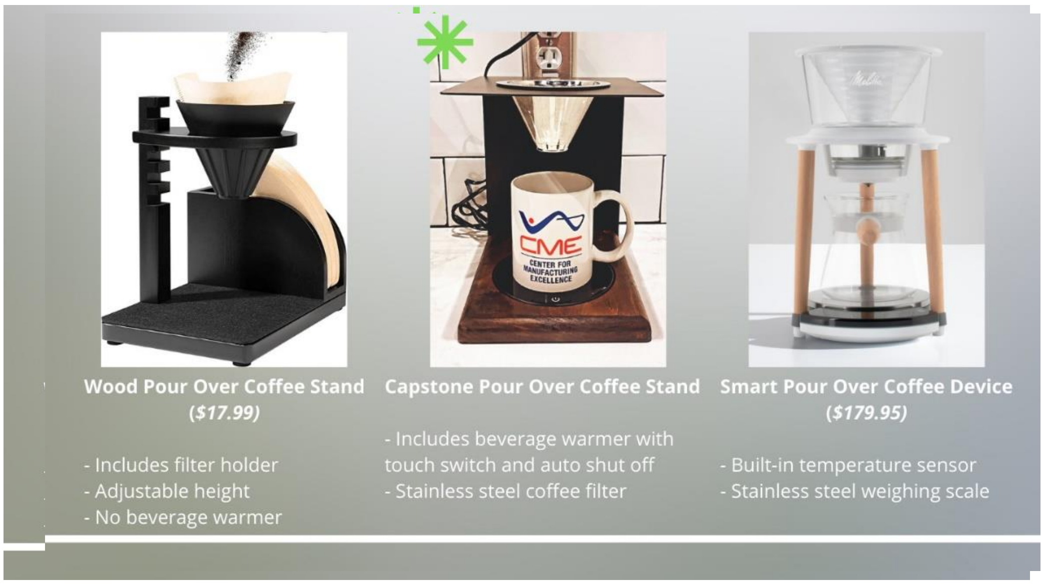


Figure 10: CME-Manufactured Product vs. Competitors

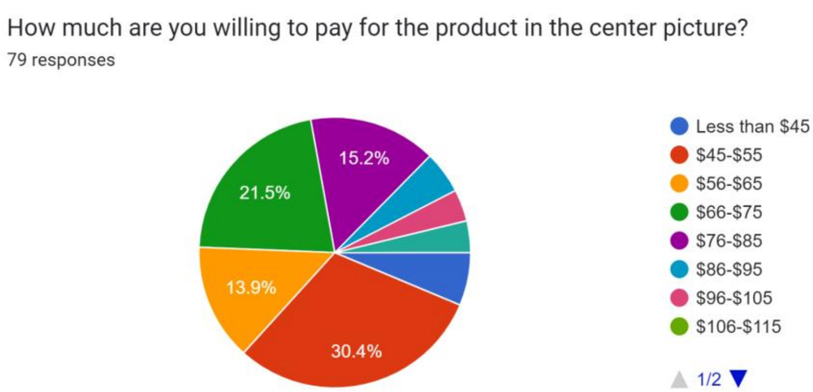


Figure 11: Final Cost Survey Responses

4. PRODUCTION PLAN AND MANUFACTURING PROCESSES

The production plan consisted of three main parts—one for each metal and wood component. The third part was the final assembly of the wood and metal, along with adding the heating element, filter, and final touches. Lastly, we ensured that quality checks were regular parts of our process.

4.1 Metal Frame

The initial production plan for the metal frame was to cut the blanks using a water jet cutter[7]. Water jet cutters take micro-abrasives and mix them with water at high pressure. A mixing tube delivers this combination and fires it into the material, creating clean cuts and smooth edges. Our plan to use this machine changed after a metalworking business purchased the waterjet cutter from the CME. As an alternative, we sed the IPG laser cutter. Rather than using water and abrasives, laser cutters use concentrated photons and CO2 gas to cut through material[8].

The laser cuts the hole for the coffee filter and the cord channel for the heating element. From one 8’ x 4’ sheet of 16-gauge stainless steel, we could cut out 7-8 blanks. The next step of the process was to bend them to our specifications. Initially, the plan included using the manual press brake. This process was much slower and less consistent than a hydraulic one. So, once again, we modified the process to account for the hydraulic brake. The metal was bent 90 degrees at 7.5” away from both the top and bottom edges of the blank. Figure 12 below shows the brake setup.

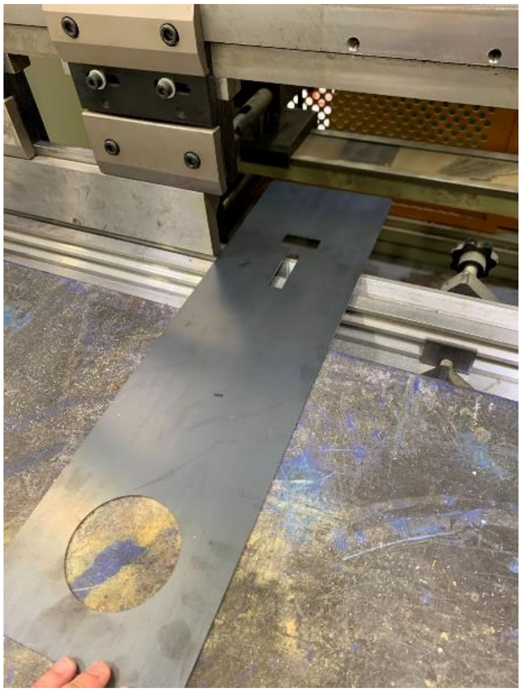


Figure 12: Hydraulic press back stop and table setup

We then cleaned the metal with acetone to remove rust, grease, and other contaminants before placing it in the sandblaster. This process ensures that any sharp corners or burrs left from the laser cut are smoothed out, preparing the blank for further finishing. Sandblasting was also done to ensure that sharp edges would not cut or injure the operators.

We then took the bent and surface-prepped frames to the powder coating stations. Copper wires were hooked through the top hole and hung onto metal rack. A flat black powder coat was sprayed onto the frames and adhered using static charge created by passing an electric current through the part. Once sufficiently coated, the frames were placed into a walk-in oven set at 400º F for 20 minutes and cooled afterward. There was an inspection on the metal pieces to ensure that the powder coat was consistent and that there were not any remaining rough edges or corners. If these exist, they were either recoated or ground off before the piece advanced to assembly.

4.2 Wood Base

The production of the wood piece had several more steps and was less automated. First, the initial boards from the lumber yard were screwed onto a sacrificial board at each end with a countersink drill bit and screws, shown in Figure 13 below. We chose to use a sacrificial board because the Haas CNC Sheet Router would have cut through the table itself if we did not. This way, we could set the cut depth the same, but instead of piercing the table, it would go through the scrap plank. We used the CNC machine to cut the general shape of the wooden base, which includes the rounded edges, part of the cord slot, and the recess for the cup warmer.

Figure 13: Wood mounted on sacrificial board

The wooden pieces were then routed on three different routers. The first had a 0.25" corner rounder bit, which passed through the top face of the front and sides of the board. The side that touched the metal frame was not routed in this step. The next router was for this side that touched the metal frame. It was a 0.125" rounded bit that cuts the wood to fit in the 0.125" radius curve on the metal element of the product. This was done on the bottom of the back side only. The last router cut was the cord slot conjoining the recess for the cup warmer and the board's exterior. The initial setup had a 0.625” straight bit to cut this slot. However, making such a wide cut with even the biggest router bits was difficult.

Other options included a Dado blade, a smaller bit, and a jig to slide the board between. The Dado blade was ruled out due to being too big and cutting into the wood too far and safety concerns. After much trial and error, the 0.625” straight bit was put back into use. This time, instead of running one pass and attempting to cut a large amount of wood at once, the same bit would be used but with a two-pass system that would cut 0.3” each pass.

After completing the routing processes, the wood was inspected and sanded to see if any points should not be there, such as from the vibrations from the CNC machine. If these were spotted, they were sanded down with either a rotary or belt sander. All pieces were sanded with a rotary sander before they were stained. The stain was applied liberally with a cloth, set for a few minutes, and then wiped off. This process was repeated 2-3 times for each wood base. Due to natural variations in wood, multiple coats were necessary to achieve a uniform color. The ease of applying stain allows for several different colors to be utilized in production, which broadens the options for sale and entices more people to buy this product. A honey color was only utilized initially; however, there were plans to increase this to a cherry and possibly a third color.

4.3 Assembly

Once the sheet metal was formed, powder coated, and baked, and the wood was stained, two-part epoxy was used to assemble this product's two primary components. When the parts were joined, four circular foam pads were placed on the bottom of the base to prevent the metal from scratching surfaces and give the overall product a level stand. The heater was then placed into the recessed portion of the wood base, and the cord was wired through the specific cut-out hole in the base. Lastly, the filter was placed into the top of the sheet metal, and the heater was plugged into the wall for its final inspection.

4.4 Jigs and Fixtures

There was one fixture and one jig in this production set-up. Jigs are devices that support a workpiece and guide cutting tools[9]. Fixtures work similarly, except they do not guide cutting tools. The coupled use of these two allows for a more repeatable manufacturing process overall. A jig was created for cutting the slot on the wooden piece, as shown in Figure 14. It was a simple stop along the left side of the router table to prevent the slot from being cut too far or too short. The backstop of the router table was also utilized in this step to ensure the slot was cut in the center of the piece of wood.

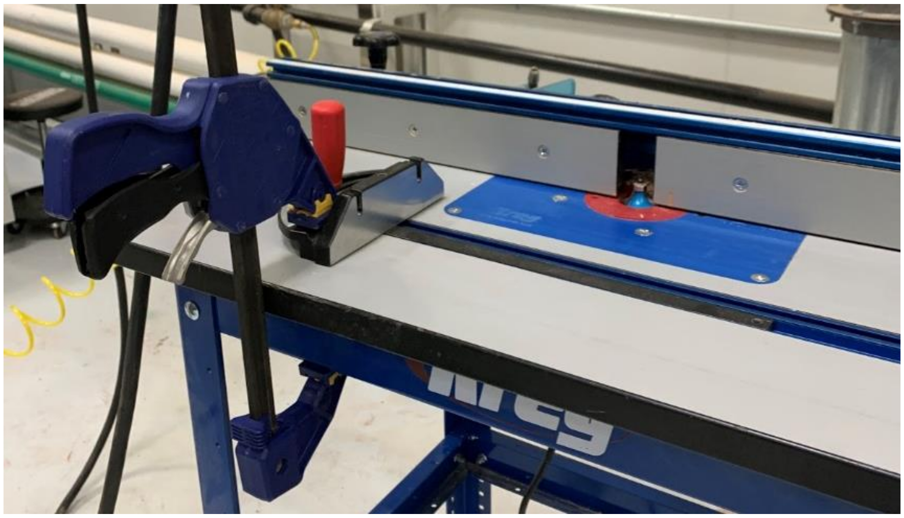


Figure 14: Router setup showing backstop and side stop for cord channel

On the press brake, a fixture was used to hold the metal piece at the correct height with the press brake (Figure 15). This ensured the metal hit the backstop and the bend was in the correct place.

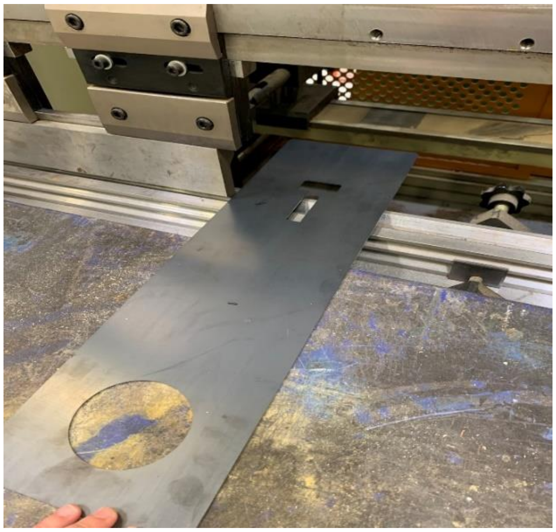


Figure 15: Press brake setup showing lift table and back stop for bending

A third "stamp" was created from a scrapped metal blank into which holes were drilled (Figure 16). This stamp ensured that the four feet were placed the same each time. The holes allowed a scoring tool to be pushed through and make a small mark. When the stamp was removed, four marks were left behind to show where the center of each of the feet should be placed (Figure 17).

Figure 16: Stamp on powder coated metal to show how it aligns

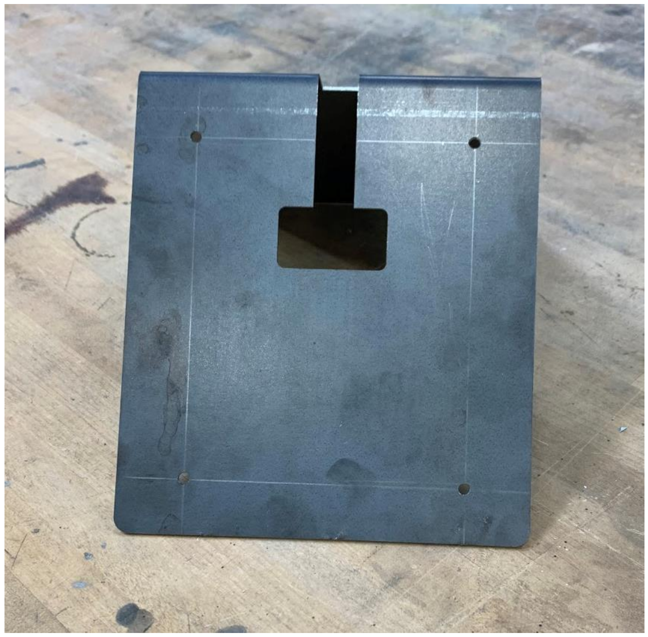


Figure 17: Top view of stamp showing holes for feet marking

A piece was also made to ensure the cord protector pieces were all cut to the same length (Figure 18). There were two different size pieces of cord protectors used, with two long pieces and a single short piece for the left and right sides and the top, respectively. This was made from a piece of scrap wood with pen marks. However, there were also plans to remake this and cut grooves for scissors to make each piece more uniform.

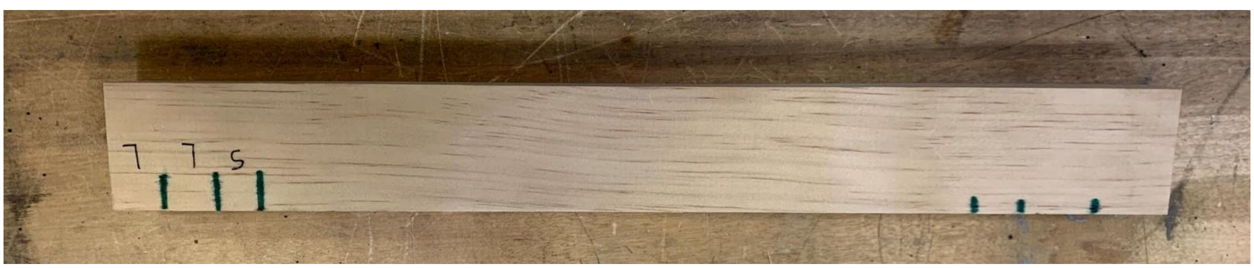


Figure 18: Fixture for measuring corner guards

Once assembled, the product can be packaged and shipped to either wholesalers or individual customers. Figure 19 shows the final product in a kitchen setting.

Figure 19: Final Pour-Over Coffee Stand in use

4.5 Quality Checks

The primary goal with this project was to have a consistent and high-quality product. This would be achieved by having quality control stations throughout the production area. These would be primarily visual inspections during multiple steps for both the wooden base and shell. The first one for the wooden base would occur when the piece exited the CNC router. This would be a visual check to ensure that the piece does not have rough edges and is cut correctly. If the piece had rough edges, it would then be sanded until these are smooth. The second would occur after all three of the routers; this would be done to ensure that the routers did not create chips that broke off of the base. If these chips were present the base cannot be used if they are large. The final quality inspection for the wooden base would be after the piece was stained to ensure that it was even.

For the metal shell several other inspections would similarly occur. The first would be after the blank comes out of the laser cutter. This was to ensure there were no rough edges and deburr them if necessary. The second would occur after the metal piece was bent on the hydraulic brake press to ensure that the bends were correct. The third and final inspection for the separate metal shell occurred when the piece left the oven and cooled down. This was another visual inspection of the piece to ensure that the powder coat was even and covered the entire piece. If it did not, it was sent back in the process to be redone. The other quality inspections occurred on the heating element before it was inserted into the assembled piece. This was just plugging the element in and turning it on to ensure it works. This was done to ensure a faulty product does not go to the consumer. The final inspection is done as a last step to confirm that the product was of the highest quality. All of the inspections with the exception of the heating element were visual. Ideally, audits would occur where other checks to make sure these pieces are actually being inspected or a system created where someone signs off that each piece has been inspected.

5. PROPOSED PLANT LAYOUT

In order to determine the most appropriate size plant to rent, each different type of machine that was used during the manufacturing process was measured on the CME floor. In that way, the group could come up with a plant layout as well as spaghetti diagrams for each cell. Spaghetti diagrams are used to visualize the continuous path of an item through a process[10]. After including every machine involved as well as office and warehouse space, the square footage came out to 10,165 ft^2. However, that number was rounded to 11,000 for precautionary reasons in case more office or warehouse space was needed. The plant layout and spaghetti diagrams can be seen in Figure 20 below.

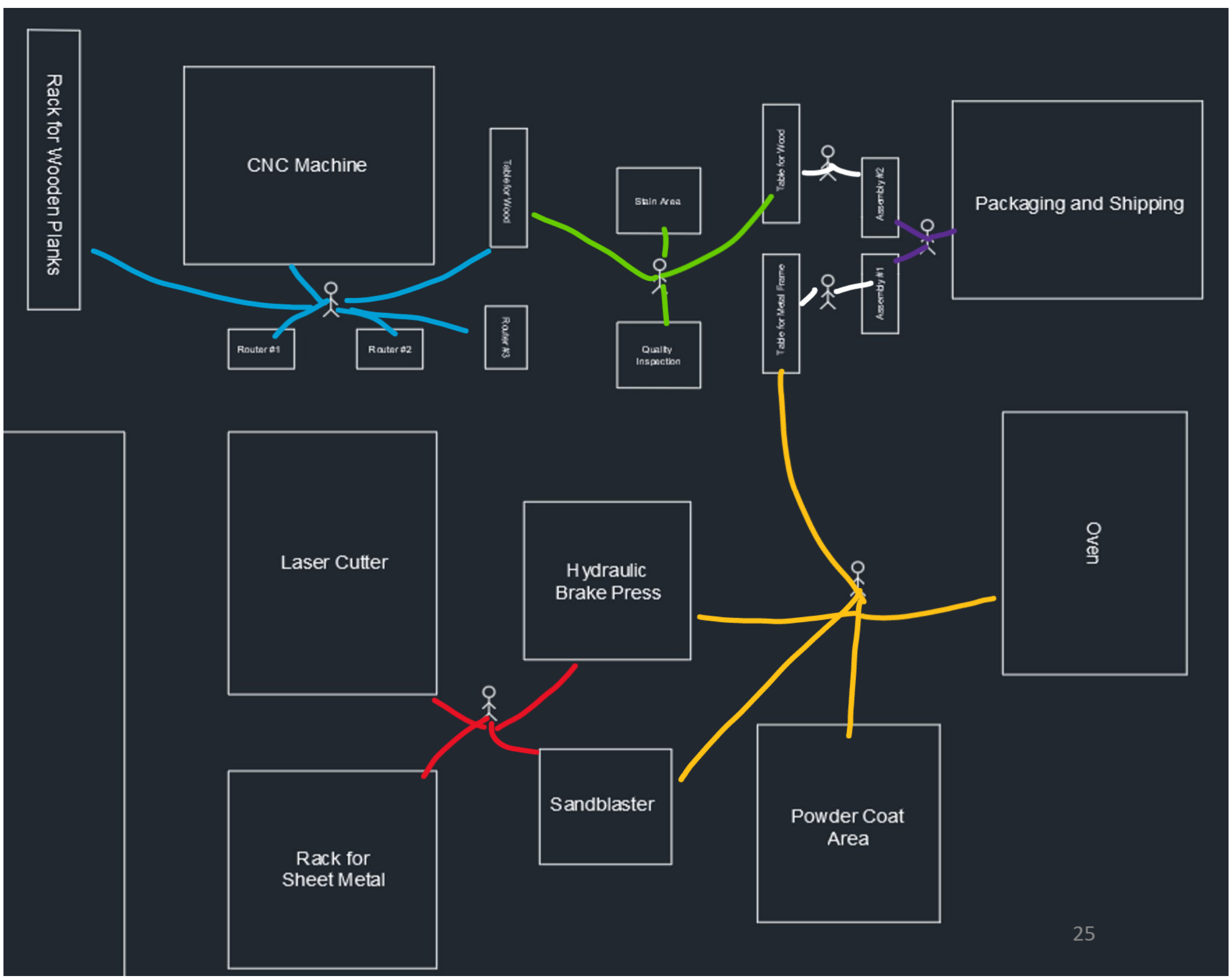


Figure 20: Entire plant layout with spaghetti diagrams in each cell

Figure 21 shows the cell layout for the wooden base manufacturing process. The operator takes an unprocessed wood plank, then takes it through all three routers. Once the wooden base has been stained, it will go through quality inspection.

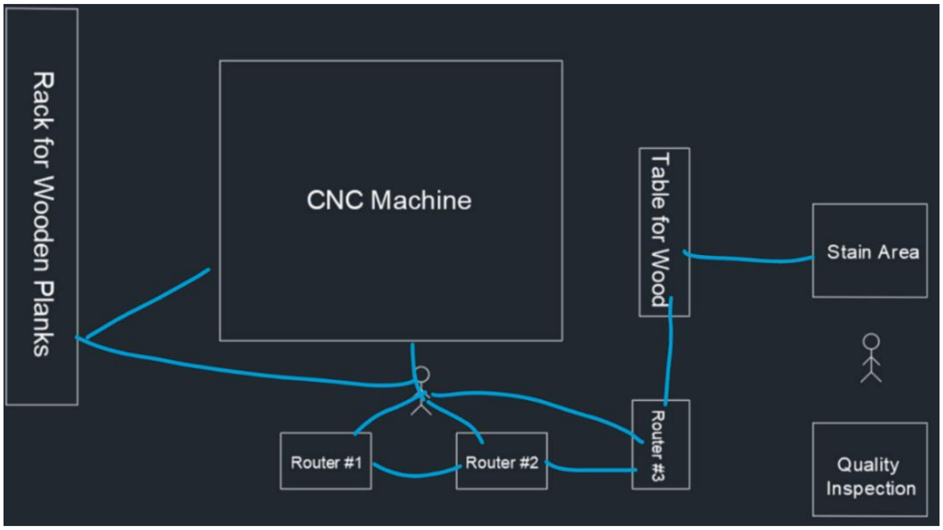


Figure 21: Wooden base cell

Figure 22 shows the steps to process the metal frames. One operator takes the sheet metal and runs it through the laser cutter. The same operator will then bend the blank on the press brake and smooth the surface on the sandblaster. A separate operator will take the sandblasted piece, powder coat it, and bake it in the oven.

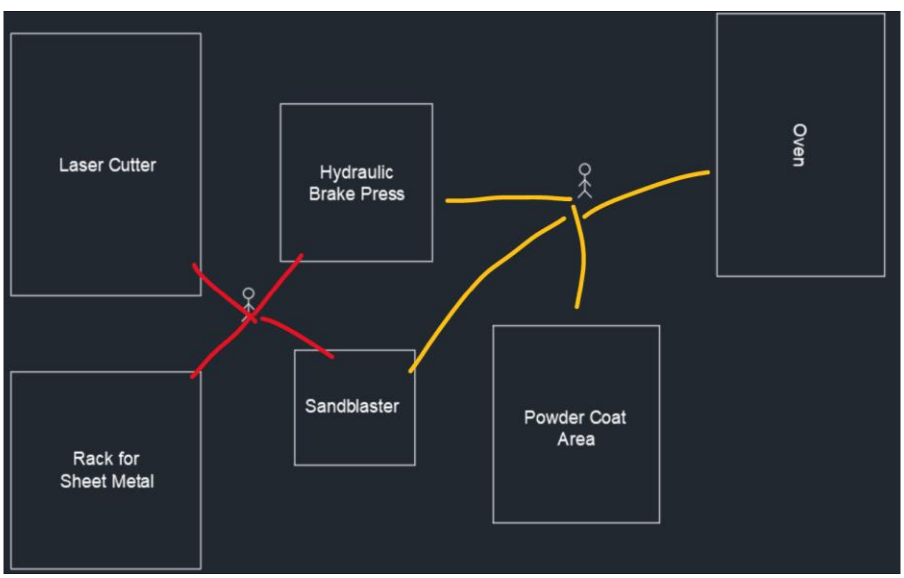


Figure 22: Metal frame cell

Lastly, Figure 25 shows the packaging and shipping cell, which requires two operators.

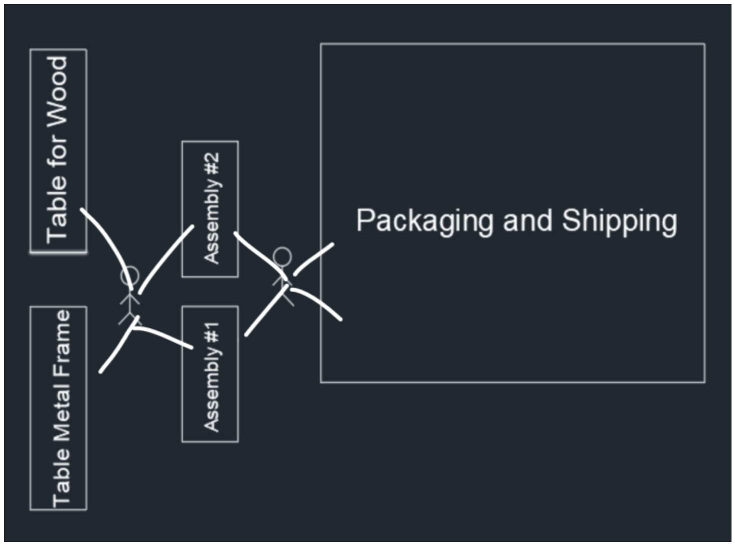


Figure 23: Shipping and assembly cell

6. FINANCIALS

6.1 Initial Budget and Expenditures

While we did not prepare an initial budget for this project, we kept our $1,000 dollar limitation in the front of our minds throughout the process. We were well under our budget, and still had room to acquire additional materials for our final production run. Table 1 shows the expenditures for our project as of October 9th, 2022.

Table 1: Expenses from February 2022 to November 2022

Product	Price	Delivery/Extra Fees	Total Price
1x8x14 poplar plank	$65.00	$25.00	$90.00
Coffee Warmer A	$21.99	$ -	$21.99
Coffee Warmer B	$12.99	$ -	$12.99
Coffee Warmer C	$21.99	$ -	$21.99
Coffee filter	$7.49	$ -	$7.49
Smith Lumber 1"8"x13' poplar	$53.99	$ -	$53.99
Bottom Skid Protector	$17.97	$ -	$17.97
Rubber Corner Protector	$12.99	$ -	$12.99
Coffee Warmer A x15	$329.85	$ -	$329.85
Coffee Filter x15	$112.35	$ -	$112.35
1x8x14 poplar plank	$116.26	$50.00	$166.26
Cherry Wood Stain	$23.99	$ -	$23.99
		TOTAL	**$871.86**

6.2 Projected Unit Cost

The projected unit cost changed somewhat drastically over the course of this project. As materials and methods changed, so did the cost. Additionally, as bulk-pricing was for some of the materials, the cost decreased. Table 2 shows the projected unit cost:

Table 2: Cost Breakdown for One Unit

Item	Cost per 1 Item	Rate per 1 Product	Units Can Be Made	Total Per Unit
1”x8”x14” solid poplar	$13.65		10	$1.37
4”x8” 16 ga. cold-rolled steel	$0.55/pound * 20% scrap * 2.35 pounds/unit =			$1.55
Powder Coating	$ 12.99/lb		40	$0.32
Epoxy	$ 20.28/gal		12	$1.69
Cup Warmer	$ 2.14/unit		1	$2.14
Steel Coffee Filter	$3.50		1	$3.50
Felt Bottom Protectors	$ 0.50/pack		5	$0.10
Rubber Edge Protector	$0.50		24	$0.02
Packaging	$1.00		1	$1.00
Wood Stain	$3.50		50	$0.07
Press Brake	$20.00	0.03	1	$0.67
Oven	$100.00	0.33	15	$2.22
CNC Router	$100.00	0.04	7	$0.60
IPG Laser	$40.00	0.18	7	$1.05
Spray System	$10.00	0.05	1	$0.50
Blast Cabinet	$10.00	0.05	2	$0.25
Labor	$ 15.00/hr	8 operators	30 pcs/hr	$4.00
Overhead (Fixed and Variable)	$ 30.00/hr	1 unit	30 pcs/hr	$1.00
TOTAL				$22.04

Key	Material	Equipment	Labor

The biggest cost group was the materials, coming in at $11.76/unit. The machining costs were $5.28/unit, and labor and overhead costs were $7.50/unit. The assumptions made in the table include a 30 unit/hour production rate, as well as averages in pricing for some smaller parts, as non-bulk ordering from Amazon for each part was out of the question for a real product. To improve upon the “Rate per 1 Product” (minutes required to process one unit divided by 60 minutes) column, detailed time studies were performed for each process. This increased the accuracy of the unit cost.

Two other areas of improvement lie within labor cost, and renting vs. buying machines. The labor cost was projected at $15/hour, which may or may not be feasible given the economy at present. In regards to renting versus buying machines, most of the machines utilized in the production process are better being rented than bought and amortized. However, a good candidate for purchasing would be the three router tables. Priced at $1,350/table in the machining cost spreadsheet provided by the CME, this cost would be quickly amortized (given a 1,000 unit/month estimate) and could be taken out of the unit cost. It was only $0.03/unit, but any cost taken out was beneficial, and paying $10 per hour to rent at that point was rather inane. In almost every business, the decision to rent versus buy comes into play—whether it be referring to equipment or labor. Some advantages of renting equipment include reduced property tax, reduced after-job disposal, and lower maintenance fees[11]. Smaller and frequently used equipment are typically better to purchase; oppositely, it may be better to rent larger equipment.

6.3 Sales Forecast

Figure 24 shows the team's projected 2023 Sales Forecast, assuming that the retail price of the product is $49.99. Based on the market surveys and knowledge of this type of product, the group set a goal of selling 1,000 units per month for the first five months. As the year progressed into June through September, a forecast of roughly 2,000 units per month was forecasted. Towards the end of the year, especially with the holidays coming up, it was projected that roughly 2,500 units would be sold per month from October through December. However, those sales would die down back going into January through February of the next year as the holiday season dwindled. The breakeven point could then be calculated based on that data.

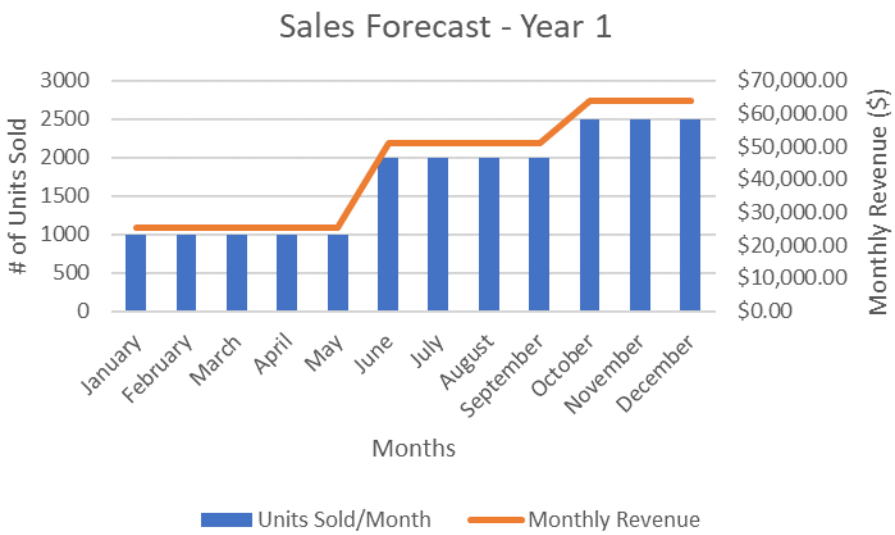


Figure 24: 2023 Sales Forecast

<u>*6.4 Breakeven Point*</u>

Figure 25 shows the projected Break Even Point for Year 1 of the production process. Signified by the green dot, it would take place roughly at the end of April or start of May. The total costs (yellow) are based on the variable costs (orange) for each unit, plus the assumed fixed costs (blue) of $114,050. Given a contribution margin on each unit at $25.52, this seemed like a reasonable simulation. In units, the breakeven point will be reached at 4,500. The breakeven point occurs when the cost to produce a product equals the sales cost[12].

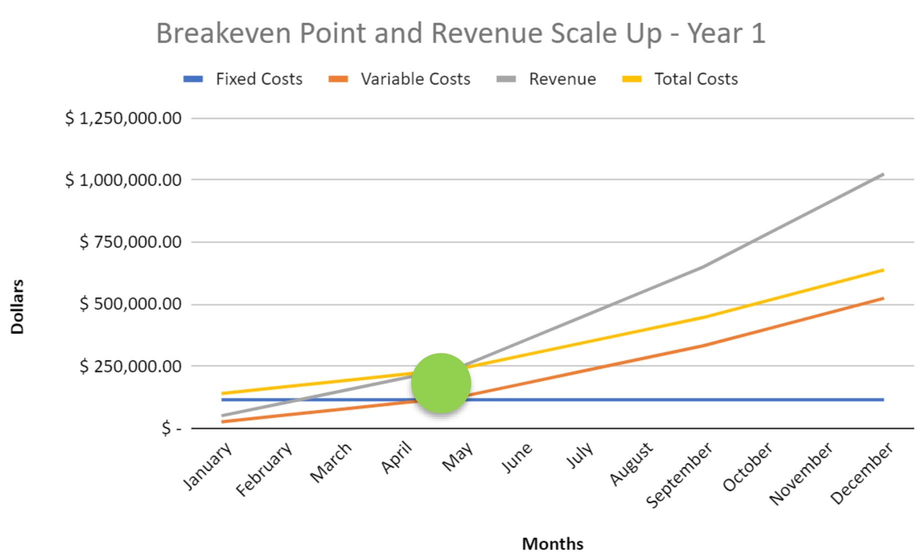


Figure 25: Breakeven point during first year of operations

Lastly, below is a pro-forma income statement detailing the assumed costs for the first year of operation is shown in Table 3. The sales reflect the units sold per month in 2023 (Table 4). Pro-forma financials take hypothetical or assumed data to forecast for future periods. This information is then used to foresee risks, project investments, and determine forecasted results[13].

Table 3: Year 1 Pro-Forma Income Statement

Sales		$1,024,795.00
Variable Costs		
	Materials	($241,080.00)
	Machining	($108,445.00)
	Labor	($133,250.00)
	Overhead	($20,500.00)
Total Variable Costs		($503,275.00)
Total Contribution Margin		$521,520.00
Fixed Costs		
	Building	($110,000.00)
	Fixed Assets	($4,050.00)
Total Fixed Costs		($114,050.00)
Operating Income		$407,470.00

Table 4: Year 1 Sales Breakdown

	Cumulative Units Sold	Fixed Costs	Variable Costs	Total Costs	Revenue
January	1000	$114,050.00	$25,540.00	$139,590.00	$49,990.00
February	2000	$114,050.00	$51,080.00	$165,130.00	$99,980.00
March	3000	$114,050.00	$76,620.00	$190,670.00	$149,970.00
April	4000	$114,050.00	$102,160.00	$216,210.00	$199,960.00
May	5000	$114,050.00	$127,700.00	$241,750.00	$249,950.00
June	7000	$114,050.00	$178,780.00	$292,830.00	$349,930.00
July	9000	$114,050.00	$229,860.00	$343,910.00	$449,910.00
August	11000	$114,050.00	$280,940.00	$394,990.00	$549,890.00
September	13000	$114,050.00	$332,020.00	$446,070.00	$649,870.00
October	15500	$114,050.00	$395,870.00	$509,920.00	$774,845.00
November	18000	$114,050.00	$459,720.00	$573,770.00	$899,820.00
December	20500	$114,050.00	$523,570.00	$637,620.00	$1,024,795.00

7. CONCLUSION

In the end, there were many takeaways throughout the manufacturing of this product. The CME Capstone Project culminated everything we learned from this program in the past four years. Whether it be classes in Strategic Planning, Manufacturing Processes, Manufacturing for Accounting, and more, every class gave each group member immense knowledge on how to start a business or manufacture a product from scratch. On top of that, having each group member come from different educational backgrounds helped out the team tremendously in the long run.

We learned many lessons from the process as well. One is that Continuous Improvement Engineers are underrated. We experienced many challenges throughout the manufacturing process that we had to learn to adapt to. There's always a manufacturing or engineering change in the real world, and Continuous Improvement Engineers are vital in making those changes go as smoothly as possible. In addition to that, another lesson learned was that it is essential to push accountability across the group. At the end of the day, a company should run as a well-oiled machine; the success of the whole depends on each part.

When designing products, we found that just because it is visually appealing does not mean it is easy to manufacture. In other words, we must learn to model the Pour-Over Coffee Stand with production in mind. The team felt very confident with the design that was in place; however, the amount of work that we put into manufacturing the Pour-Over Coffee Stand was staggering.

With that being said, I could not be happier with how the product turned out. Many people are interested in the product, so I am considering additional variations. Stainless steel was removed from the picture in the very beginning, but since we have improved our sheet metal bending process, there should be no scars that develop on the sheet metal. Therefore, there is a greater chance that we will experiment with a stainless steel version during the spring semester.

If a real business were to come out with this product, it would not only be profitable, but it would have a real edge against other competitors in the market. The sales forecast suggests that there will be substantial growth in the first year alone. While there are many other factors and expenses to consider in putting up a business, making Pour-Over Coffee Stands could be a highly profitable venture.

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