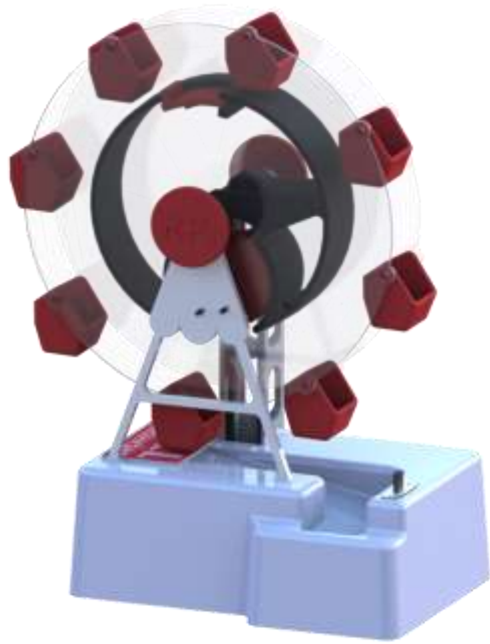
MPS II - Spring 2013 – A-Team

Technical Data Package



Ferris Wheel Candy Dispenser

Christina Pacifico
Daniel Golding
Eric Arntzen
James Robinson-Liu
Joshua Gabai
Michael Snyder
Patrick Pilvines
Robert McDonald
Seth Wraight
Trevor Burtzos
Vidyavisal Mangipudi
Vincent Terranova
Wesley Koo

Faculty Advisors: Sam Chiappone, Larry Ruff, Dan Baker

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Revision History

Version	Date	Name	Reason for Change
0.1	9/9/2012	Terranova, V.	Originated
0.2	9/12/2012	Terranova, V.	Added Rob and Christina's parts; first round of edits
0.3	9/12/2012	Terranova, V.	Updated role table
0.4	9/12/2012	Terranova, V.	Added concept pictures
0.5	9/13/2012	Terranova, V.	Added BOM, updated component listing in Executive Summary.
0.6	9/13/2012	Terranova, V.	Added image sources
0.7	9/14/2012	Terranova, V.	Added first batch of drawings, updated renders, changed "Devan Dumper" to "doser"
1.0	9/14/2012	Terranova, V.	Added remaining drawings, updated image sources, fixed formatting
1.1	10/12/2012	Browne, T.	Updated Executive Summary and Design Process
1.2	10/15/2012	Snyder, M.	Added Addendum: Power Source, and updated Design Process
1.3	10/15/2012	Snyder, M.	Updated Executive Summary
1.4	10/16/2012	Snyder, M.	Changed instances of "Tolerance" to "Fit" where necessary
1.5	10/16/2012	Snyder, M.	Added final pieces, reviews
1.6	10/17/2012	Terranova, V.	Final Compilation of TDP 1-6 milestone
1.7	10/17/2012	Terranova, V.	Added Assembly BOM, fixed table of contents
1.8	11/17/2012	Terranova, V.	Updated PIM parts shrinkage references, fixed spelling and formatting errors
1.9	11/17/2012	Browne, T.	Updated repeatability and accuracy of robots used in assembly
2.0	11/19/2012	Browne, T.	Updated format for assemblies overhead views
2.1	12/1/2012	Snyder, M.	Updated QC Gauges and CAD/CAM locations for all parts.
2.2	12/4/2012	Snyder, M.	Added AWJ and Laser SOP.
2.3	12/4/2012	Snyder, M.	Added Costing, BOM, various other edits
2.4	12/5/2012	Snyder, M.	Completed Section 4
2.5	12/5/2012	Gabai, J.	Updated Assembly Introduction, Sustainability, and Costing
2.6	12/6/2012	Snyder, M.	Updated the BOM, Exec Sum, Ownership
2.7	12/7/2012	Terranova, V.	Added last round ASM, MFG drawings
2.8	12/7/2012	Snyder, M.	Made final changes to MFG parts, fixtures
2.9	2/15/2013	A-Team	Updated all sections for Spring 2013 semester
2.10	2/22/13	Arntzen, E.	Structural changes and grammar check
2.11	3/3/13	McDonald, R.	Updated Staubli Wheel Envelope
2.12	3/3/13	Pacifico, C.	Updated Capital Costs
2.13	3/6/13	Pilvines, P.	Updated Manufacturing BOM
2.14	3/7/13	Wraight,S.	Added Manufacturing Introduction
2.15	3/7/13	Burtzos, T.	Updated Mold Drawings
2.16	3/8/13	Gabai, J.	Updated Assembly BOM
3.1	5/3/13	Arntzen, E.	Updated Product Images, Exploded View, Manufacturing & Assembly BOM & Sections

All relevant computer files can be found on the DVD attached to the inside back cover of this technical data package.

1. Executive Summary

Featuring thirty-five parts and nine manufacturing processes, the Candy Wheel is an exciting way to dispense your candy and to showcase your RPI pride. The A-Team envisions the Candy Wheel to be both well designed and unique. With the look and feel of a real Ferris wheel, including a motor-driven functionality, this product redefines the normally unremarkable experience of receiving candy from a dispenser. The user experience is enhanced due to the interactive nature of this product. Once the user turns on the motor, the wheel begins to turn. The transparent struts on the sides allow the consumer to actually see the candy as it is dispensed.

The goal of the Candy wheel project is to produce four hundred quality units while remaining under our $3,000 budget. The Candy Wheel will have a combination of parts that have been manufactured in-house as well as purchased from independent vendors. Considering that most of the components are injection molded with either ABS plastic or Polypropylene, the team has allotted a considerable amount of time and effort to optimizing the process. A-Team has two molds: Mold 'A 'holds all the parts that are made out of ABS and Mold 'B' contains the parts made from Polypropylene.

The team's biggest, and perhaps most important injection molded part is the jar, which acts as a candy reservoir. The team is taking special care with this part due to the potential for developing flow lines. The struts saddle the jar and are laser cut out of clear acrylic. Due to the number of struts required, the team has optimized the production cycle from 40min/part to 2.5min/part. The lower base is made out of Polycarbonate (Lexan) and is cut using the water jet. There are multiple parts of this project that require the use of the CNC Machine, including the plastic injection molds, the axle, and the drive belt fixture. Lastly, our upper base and a portion of our packaging will be vacuumed-formed.

Due to the sheer number of parts involved in this project, our assembly process is, simply put, intricate. The assembly team will ultrasonically weld multiple parts that have been injection molded from ABS. This team intends to use both the Adept and Staubli robots in the assembly process.

There is plenty to take away from this project from an educational perspective. Aside from learning about advanced machining techniques, the team is being exposed to the product development cycle that is seen in real manufacturing industry. The team is facing a particular challenge with regards to the complex assembly process. In addition, meeting the production deadlines is a real challenge that team members are certain to face in the industry in the future. The A-Team has been working closely with the MILL staff and is making an effort to be proactive about the challenges ahead.

2. Product Description

2.1: Product History

The history of candy dispensers is a long and sugary story, starting as far back as 1888, when primitive vending machines gave out little sticks of gum. A few decades later, the Pez Dispenser was designed in Austria. From then on, candy machines have gained enough popularity to merit an entire industry of their own; the increasing abundance of different types of candy may well have a hand in this.

Notable styles of candy dispenser include the gumball machine, a large transparent globe on top of a fairly simply dispensing mechanism:

Figure 1: "Gumball Machine" candy dispenser: the candy is held in globe and money held in armored vault.

The majority of the base area in this machine is a locked holding cell for the money used to purchase the gumballs. It is also worth noting that while this style is commonly referred to as a gumball machine, these machines can be found to contain almost any type of small candy imaginable.

Another common type of candy dispenser is the ever-ubiquitous vending machine, shown in Figure 2 on the next page. Granted, these may sell things other than candy, but a significant chunk of them are devoted entirely to candy. The first vending machine actually dates back to the first century when a man nicknamed the Hero of Alexandria built a vending machine that exchanged a coin for holy water. Today, these large, rectangular devices are often found in rows and commonly stand around eight feet tall. They boast a much larger selection of merchandise than the gumball machine, but they require electricity to function, whereas gumball machines are strictly mechanical.

Figure 2: The Vending Machine. These machines have electrical components as well as mechanical ones and can dispense a wide variety of candy.

The original Ferris wheel enjoys a history almost as old as the candy dispenser, being built by Mr. George Washington Gale Ferris, Jr. for the Chicago World Fair in 1893. While smaller "pleasure wheels" of a similar concept have existed since the 17^{th} century, the Ferris wheel was far grander and more ambitious than any of its predecessors. As such, it can obviously claim to be the namesake of the attraction.

Figure 3: A photo of the original Ferris wheel, built for the Chicago World's Fair in 1893 by RPI alumni Mr. George Washington Gale Ferris, Jr.

Mr. Ferris was a graduate of RPI class of 1881 and joined the college's Alumni Hall of Fame in 1998. It was this connection with the institute that attracted the team to the Ferris wheel design.

While full-sized Ferris wheels are fairly popular, appearing in most fairs, carnivals, amusement parks, and even downtown, miniature toy Ferris wheels aren't quite as popular. This isn't to say they don't exist, however; a few colorful models exist for toddler-aged children.

Figure 4: Example of a toy Ferris wheel for toddler-age children.

As the age range increases, however, it seems that most children lose interest in the Ferris wheel. The most common type of Ferris wheel toy for the just-older-than-toddler age range is the "Build it Yourself" kit.

Figure 5: A K'Nex "build-it-yourself" kit for a Ferris wheel.

The idea of a model Ferris wheel that *also* dispenses candy appears to be entirely novel.

2.2: Design Process

The design team worked together in order to create an effective design for a candy dispenser. The team agreed that the candy dispenser should indeed take the shape of a Ferris wheel in order to commemorate the Rensselaer graduate George Ferris. Before beginning the detailed design process of the Ferris wheel Candy Dispenser, the design team conducted some research in order to discover and understand certain existing candy dispensers.

One kind of candy dispenser the team looked at is the "Gumball Machine" candy dispenser described in the previous section. This candy dispenser was considered as it can be seen as one of the most conventional candy dispensers. The design team decided not to go through with this design as it did not seem very challenging and did not allow much leeway in insert interesting design features. Another candy dispenser considered by the team is the candy dispenser shown below in *Figure 6*.

Figure 6: An interactive candy dispenser. The user is forced to work for their candy.

This candy dispenser was particularly interesting to the team because of its focus on interactivity. Thus, the team decided that the design of the Candy Dispenser would meet the following requirements:

- Relate to Rensselaer
- Challenging to Manufacturing
- Aesthetically Interesting
- Interactive

One important feature discussed within the design team was the positioning of the candy reservoir. Three main positions were considered: inside the Ferris wheel fixture, inside the middle of the Ferris wheel, or somewhere completely separate from the Ferris wheel structure.

Figure 7: An early Ferris Wheel Candy Dispenser concept with the candy reservoir on top.

The design team decided on housing the candy reservoir in the middle of the Ferris wheel structure. The team wanted to make sure the design of the original Ferris wheel was conserved as much as possible. In the case of the candy reservoir placed separately from the Ferris wheel structure, this would change the look of the Ferris wheel too drastically. The design team also eliminated the idea of storing the candy in the Ferris wheel fixture itself as the team realized there would not be a great amount of candy capacity. Thus, the team decided to go with a candy reservoir located in the middle of the Ferris wheel structure, as shown in *Figure 8*.

Figure 8: The Ferris wheel design with the outer acrylic panel removed. Note the internal candy reservoir in the middle of the wheel.

Another important feature analyzed by the design team is whether or not the candy reservoir should move as one entity with the Ferris wheel or if it should remain fixed in relation to the rotating movement of the Ferris wheel. The team ultimately decided to choose a rotating candy reservoir for various reasons. One important reason focuses on the amount of material saved. It was noted that if the candy reservoir were to stay fixed, the candy dispenser would need two different sections: a rotating section and a fixed section. This design would necessitate more material than having one single entity rotating all together. Another reason for the chosen design was to ensure the candy would never get stuck or jammed. With a rotating candy reservoir, the candy would have fewer chances to get stuck in one area, as the candy was constantly being shifted. Finally, to keep the customer engaged, a rotating reservoir full of candy would be an eye-catching sight to any customer. Thus, the design team decided to move forward in implementing a rotating candy reservoir.

The design team also discussed various ways in which the candy would be dispensed out of the candy reservoir. The team considered one simple mechanism: the doser. This doser would grab a piece of candy and rotate this candy until it ultimately fell into one of the Ferris wheel carriages. The team considered two ways in which to aid the doser in transferring the candy: a magnet-based system and a gear system. The magnet system involved keeping the doser closed with a pair of magnets. The doser would finally be forced open with the placement of a stronger magnet in a designated location, dropping the candy at the desired area. The team decided to go with a gear system where the doser has a set of teeth that would catch on a second set of stationary teeth in a designated location, causing the doser to release the candy. The team voted against the magnets as it was considered to be a less reliable system and instead focused on the gear system.

Figure 9: The Doser. The full part (left) with two wells that hold exactly one piece of candy each.
Figure 10: A cross-section (right) showing the wells in more detail.

The design team deliberated on whether the Ferris wheel should be electrical or mechanical. The team believes that an electrical system would a better fit for the product due to the need for the wheel to turn at a constant speed. The team recognizes that producing this product with electric motors will significantly increase the manufacturing cost. For this financial reason, the design team decided to design the candy dispenser to be adaptable to both a fully mechanical and electrical system. A mechanical system would involve the user turning a knob located on the outer axle which would rotate the candy dispenser until a piece of candy fell out.

In terms of electrical dispensing, the design team considered three possible sources for electrically powering the Ferris wheel candy dispenser. Two mechanical power sources were considered along with one electrical source. In preliminary discussions, the team considered a mechanical gear system which would allow the user to control the speed of rotation of the Ferris wheel by turning a crank. This was almost immediately discarded, as jerky turning by the user would not only cause the candy to become stuck in the Ferris wheel, but may damage the components as well. With this idea discard, the team decided to turn toward a motor to power the wheel, keeping the mechanical hand crank design in mind only as a fallback.

Next, the team began researching electric motors that could be used as a power source for the Ferris wheel. A motor with a low RPM rating and high torque was needed to support the weight of the wheel. These motors presented an array of financial challenges (extra cost from batteries, battery packs, etc.) and, after consulting the instructors, MILL Supervisor Larry Ruff suggested using a windup motor. Thus, the team broadened its research to include windup motors as well as electric motors. However, it appeared as though mechanical motors would not be a feasible option for a few reasons. Mechanical windup motors are not nearly as accessible as electric motors. It was not only difficult to find the motors, but once the research team located a veritable source, acquiring a quote directly from the manufacturer took an exorbitant amount of time and was significantly higher than the electric motors. The team came to the conclusion that the Ferris wheel would be powered by a small DC electric motor from TTMotors. The motor is rated at 3V with an average loaded RPM of 34 revolutions per minute, average loaded current of 0.45A, and average loaded torque of 0.6196 inch-lb*f. At 400 units, the cost per motor is $0.80/Unit.

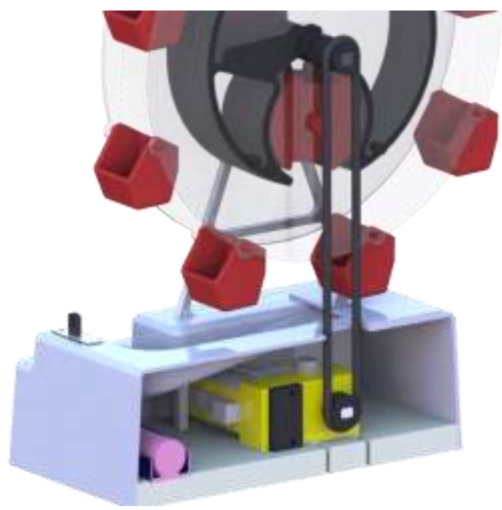


Figure 11: Back of unit with proposed drive mechanism exposed.

Finally, the last major design feature considered is the method by which the candy is delivered from the candy dispenser to the customer. The design team took into consideration whether the customer should grab the candy directly from the Ferris wheel carriages or if implementing an additional delivery system would be better. In order to increase ease of use for the customer, the design team decided to implement a gearing system which would help tip over the designated Ferris wheel carriage and dump the piece of candy out, which would in turn roll down the ramp, making it easy and obvious for the customer to access the piece of candy.

3. Bills of Materials

3.1: Manufacturing BOM

Part/ Assembly Reference Number	Category	Part Number	Drawing Number	Part Description	Material	Process	Qty
0	Main Assembly	12CandyA_CandyWheel_MA_061203	-	Candy Wheel	-	-	400
1	Component	12CandyA_Cart01_C_081126	12CandyA_Cart01_C_061206	Cart	Polypropylene	Injection molded	2800
27.2a	Tool	12CandyA_MoldB200_T200_011206	12CandyA_MoldBMoving200_T200_011206	PIM Mold B Moving	Aluminum	Machining	-
27.2b	Tool	12CandyA_MoldB201_T200_011206	12CandyA_MoldBStationary200_T200_011206	PIM Mold B Stationary	Aluminum	Machining	-
2	Component	12CandyA_JarLid02_C_051126	12CandyA_JarLid02_C_031206	Jar lid	Polypropylene	Injection molded	400
27.2a	Tool	12CandyA_MoldB200_T200_011206	12CandyA_MoldBMoving200_T200_011206	PIM Mold B Moving	Aluminum	Machining	-
27.2b	Tool	12CandyA_MoldB201_T200_011206	12CandyA_MoldBStationary200_T200_011206	PIM Mold B Stationary	Aluminum	Machining	-
3	Component	12CandyA_Struts03_C_051108	12CandyA_Struts03_C_071206	Struts	Acrylic	Laser Cut and Etched	800
3.1	Laser Code	12CandyA_Struts03_LC503_XXXXXX	-	Laser Code for Parts	-	LaserCut 5.3	-
29.3	Quality Control	12CandyA_Struts03_QC303_011203	12CandyA_Struts03_QC303_041206	Quality Control Gauge	Aluminum	Lathing	1

4	Component	12CandyA_Jar04_C_031126	12CandyA_Jar04_C_031207	Jar	ABS	Injection molded	400
27.1a	Tool	12CandyA_MoldA100_T100_011206	12CandyA_MoldAMoving100_T100_011206	PIM mold A Moving	Aluminum	Machining	-

27.1b	Tool	12CandyA_MoldA101_T100_011206	12CandyA_MoldAStationary100_T100_011206	PIM mold A Stationary	Aluminum	Machining	-
5	Component	12CandyA_FrontSupport05_C_081129	12CandyA_FrontSupport05_C_021206	Front support	Aluminum	AWJ	400
5.405	Waterjet Code	12CandyA_FrontSupport05_WJ405_021126	-	AWJ Code for Part	-	FlowPATH	-
29.7	Quality Control	12CandyA_Axle07_QC325_011203	12CandyA_Axle07_QC325_011206	Quality Control Gauge	Aluminum	Machining	-
6	Component	12CandyA_BackSupport06_C_061129	12CandyA_BackSupport06_C_071206	Back support	Aluminum	4 axis CNC Mill	400
6.1	Haas Mill CNC Code	12CandyA_BackSupport06_HM_010326	-	CNC Code for Part	-	MasterCAM	-
28.5	Process Fixture	12CandyA_BackSupportFixture500_PF500_0102024	12CandyA_BackSupportFixture500_PF500_0102024	Back Support Assembly	-	-	1
29.7	Quality Control	12CandyA_Axle07_QC325_011203	12CandyA_Axle07_QC325_011206	Quality Control Gauge	Aluminum	Machining	-

7	Component	12CandyA_Axle07_C_021016	12CandyA_Axle07_C_061206	Axle	Steel	CNC turned	400
7.1	Haas Lathe CNC Code	12CandyA_Axle07_HL_010419	-	CNC Code for Part	-	MasterCAM	-
29.7	Quality Control	12CandyA_Axle07_QC307_011203	12CandyA_Axle07_QC307_011206	Quality Control Gauge	Aluminum	Lathing	1
8	Purchased component	12CandyA_DriveBelt08_PC_021102	-	Drive belt	-	-	400
9	Purchased component	12CandyA_Motor09_PC_021108	-	Motor	-	-	400
10	Component	12CandyA_Doser10_C_071126	12CandyA_Doser10_C_061206	Doser	Polypropylene	Injection molded	400
27.2a	Tool	12CandyA_MoldB200_T200_011206	12CandyA_MoldBMoving200_T200_011206	PIM Mold B Moving	Aluminum	Machining	-
27.2b	Tool	12CandyA_MoldB201_T200_011206	12CandyA_MoldBStationary200_T200_011206	PIM Mold B Stationary	Aluminum	Machining	-

11	Component	12CandyA_UpperBase11_C_051203	12CandyA_UpperBase11_C_031206	Upper Base	Polystyrene	Vacuum formed	400
11.1	Laser Code	12CandyA_UpperBase11_LC5111_010306	-	Upper Base	-	LaserCut 5.3	-
11.2	Laser Code	12CandyA_UpperBase11_LC5112_010306	-	Upper Base Perim Fixture	-	LaserCut 5.3	-
25.4	Tool	12CandyA_UpperBase11_T400_041112	12CandyA_UpperBase11_T300_011206	Upper Base Forming Fixture	RENShape	Machining	1
28.4	Process Fixture	12CandyA_UpperBaseLaserFixture400_PF400_011206	12CandyA_UpperBaseLaserFixture400_PF400_011206	Process Fixture	ABS	Machining	1
12	Component	12CandyA_LowerBase12_C_051204	12CandyA_LowerBase12_C_031206	Lower base	Polycarbonate	AWJ cut, Machining	400
12.1	Haas Mill CNC Code	12CandyA_LowerBase12_HM_010321	-	CNC Code for Part	-	MasterCAM	-
12.412	Waterjet Code	12CandyA_LowerBase12_WJ412_031129	-	AWJ Code for Part	-	FlowPATH	-
29.12.1	Quality Control	12CandyA_LowerBase12_QC3121_011203	12CandyA_LowerBase12_QC3121_011206	Quality Control Gauge	Aluminum	Machining	1
29.12.2	Quality Control	12CandyA_LowerBase12_QC3122_011203	12CandyA_LowerBase12_QC3122_011206	Quality Control Gauge	Aluminum	Machining	1
29.12.3	Quality Control	12CandyA_LowerBase12_QC3123_011203	12CandyA_LowerBase12_QC3123_011206	Quality Control Gauge	Aluminum	Machining	1

13	Component	12CandyA_OuterGear13_C_081126	12CandyA_OuterGear13_C_051206	Outer gear	ABS	Injection molded	400
27.1a	Tool	12CandyA_MoldA100_T100_011206	12CandyA_MoldAMoving100_T100_011206	PIM mold A Moving	Aluminum	Machining	-
27.1b	Tool	12CandyA_MoldA101_T100_011206	12CandyA_MoldAStationary100_T100_011206	PIM mold A Stationary	Aluminum	Machining	-
14	Component	12CandyA_AxlePin14_C_051126	12CandyA_AxlePin14_C_041206	Axle Pin	PP	Injection molded	2
27.2a	Tool	12CandyA_MoldB200_T200_011206	12CandyA_MoldBMoving200_T200_011206	PIM Mold B Moving	Aluminum	Machining	-
27.2b	Tool	12CandyA_MoldB201_T200_011206	12CandyA_MoldBStationary200_T200_011206	PIM Mold B Stationary	Aluminum	Machining	-

15	Component	12CandyA_MainGear15_C_061126	12CandyA_MainGear15_C_061206	Main Gear	ABS	Injection molded	400
27.1a	Tool	12CandyA_MoldA100_T100_011206	12CandyA_MoldAMoving100_T100_011206	PIM mold A Moving	Aluminum	Machining	-
27.1b	Tool	12CandyA_MoldA101_T100_011206	12CandyA_MoldAStationary100_T100_011206	PIM mold A Stationary	Aluminum	Machining	-
29.15	Quality Control	12CandyA_MainGear15_QC315_011203	12CandyA_MainGear15_QC315_011206	Quality Control Gauge	Aluminum	Machining	1
16	Component	12CandyA_DriveBeltCarrier16_C_061126	12CandyA_DriveBeltCarrier16_C_061206	Drive Belt Carrier	ABS	Injection molded	400
16.1	Haas Lathe CNC Code	12CandyA_DriveBeltCarrier16_HL_216_011207		CNC Code for Pulley Fixture	-	MasterCAM	-
27.1a	Tool	12CandyA_MoldA100_T100_011206	12CandyA_MoldAMoving100_T100_011206	PIM mold A Moving	Aluminum	Machining	-
27.1b	Tool	12CandyA_MoldA101_T100_011206	12CandyA_MoldAStationary100_T100_011206	PIM mold A Stationary	Aluminum	Machining	-
28.3	Process Fixture	12CandyA_DriveBeltFixture300_PF300_011206	12CandyA_DriveBeltFixture300_PF300_011206	Drive Belt Fixture Assembly	-	-	1
29.16	Quality Control	12CandyA_DriveBeltCarrier16_QC316_011203	12CandyA_DriveBeltCarrier16_QC316_011206	Quality Control Gauge	Aluminum	Lathing, Machining	1

17	Purchased component	12CandyA_BatteryMount17_PC_021107	-	Battery mount	-	-	400
18	Purchased component	12CandyA_OnSwitch18_PC_011107	-	On switch	-	-	400
19	Component	12CandyA_MotorStrap19_C_041126	12CandyA_MotorStrap19_C_011206	Motor Strap	ABS	Injection molded	400
27.1a	Tool	12CandyA_MoldA100_T100_011206	12CandyA_MoldAMoving100_T100_011206	PIM mold A Moving	Aluminum	Machining	-
27.1b	Tool	12CandyA_MoldA101_T100_011206	12CandyA_MoldAStationary100_T100_011206	PIM mold A Stationary	Aluminum	Machining	-
20	Component	12CandyA_MotorDriveBeltCarrier20_C_051129	12CandyA_MotorDriveBeltCarrier20_C_011206	Motor Drive Belt Carrier	ABS	Injection molded	400

20.1	Haas Lathe CNC Code	12CandyA_MotorDriveBeltCarrier20_HL_220_011207	-	CNC Code for Pulley Fixture	-	MasterCAM	-
27.1a	Tool	12CandyA_MoldA100_T100_011206	12CandyA_MoldAMoving100_T100_011206	PIM mold A Moving	Aluminum	Machining	-
27.1b	Tool	12CandyA_MoldA101_T100_011206	12CandyA_MoldAStationary100_T100_011206	PIM mold A Stationary	Aluminum	Machining	-
28.6	Process Fixture	12CandyA_MotorDriveBeltFixture_PF600_011205	12CandyA_MotorDriveBeltFixture_PF600_011206	12CandyA_MotorDriveBeltFixture_PF601_011207	-	-	1
29.20	Quality Control	12CandyA_MotorDriveBeltCarrier20_QC320_011203	12CandyA_MotorDriveBeltCarrier20_QC320_041206	Quality Control Gauge	Aluminum	Lathing, Machining	1

21	Componenet	12CandyA_Funnel20_C_010409	12CandyA_Funnel20_C_010409	Funnel (Left & Right Side)	ABS	Injection Molded	400
27.3a	Tool	12CandyA_MiniMold700_T700_010415	12CandyA_MiniMold700_T700_010415	PIM Mini Mold Moving	Alumnium	Machining	-
27.3b	Tool	12CandyA_MiniMold700_T700_010415	12CandyA_MiniMold700_T700_010415	PIM Mini Mold Stationary		Machining	-
22	Component	12CandyA_Washer21_C_010412	12CandyA_Washer21_C_010412	Washer	ABS	Injection Molded	400
27.3a	Tool	12CandyA_MiniMold700_T700_010415	12CandyA_MiniMold700_T700_010415	PIM Mini Mold Moving	Aluminum	Machining	-
27.3b	Tool	12CandyA_MiniMold700_T700_010415	12CandyA_MiniMold700_T700_010415	PIM Mini Mold Stationary		Machining	-
23	Component	12CandyA_LogoPlate21_C_010502	12CandyA_LogoPlate21_C_010502	Logo Plate	Laserables II	Laser Cut	400
24	Component	12CandyA_CandyCart22_C_010502	12CandyA_CandyCart22_C_010502	Candy Cart	Polypropylene	Injection molded	400
27.2a	Tool	12CandyA_MoldB200_T200_011206	12CandyA_MoldBMoving200_T200_011206	PIM Mold B Moving	Aluminum	Machining	-
27.2b	Tool	12CandyA_MoldB201_T200_011206	12CandyA_MoldBStationary200_T200_011206	PIM Mold B Stationary	Aluminum	Machining	-

25	Purchased Component	12CandyA_OuterBox323_PC_031205	-	Outer Box	Cardboard	Laser Cut	400
25.1	Laser Code	12CandyA_OuterBox23_LC526_XXXXXX	-	Laser Code for Part	-	LaserCut 5.3	-
25.2	Laser Code	12CandyA_PackagingLaserFixture200_LC5291_XXXXXX	-	Laser Code for Part	-	LaserCut 5.3	-
25.3	Laser Code	12CandyA_PackagingLaserFixture200_LC5292_XXXXXX	-	Laser Code for Part	-	LaserCut 5.3	-
28.2	Process Fixture	12CandyA_PackagingLaserFixture200_PF200_011206	12CandyA_PackagingLaserFixture200_PF200_011206	Process Fixture	ABS	Machining	-

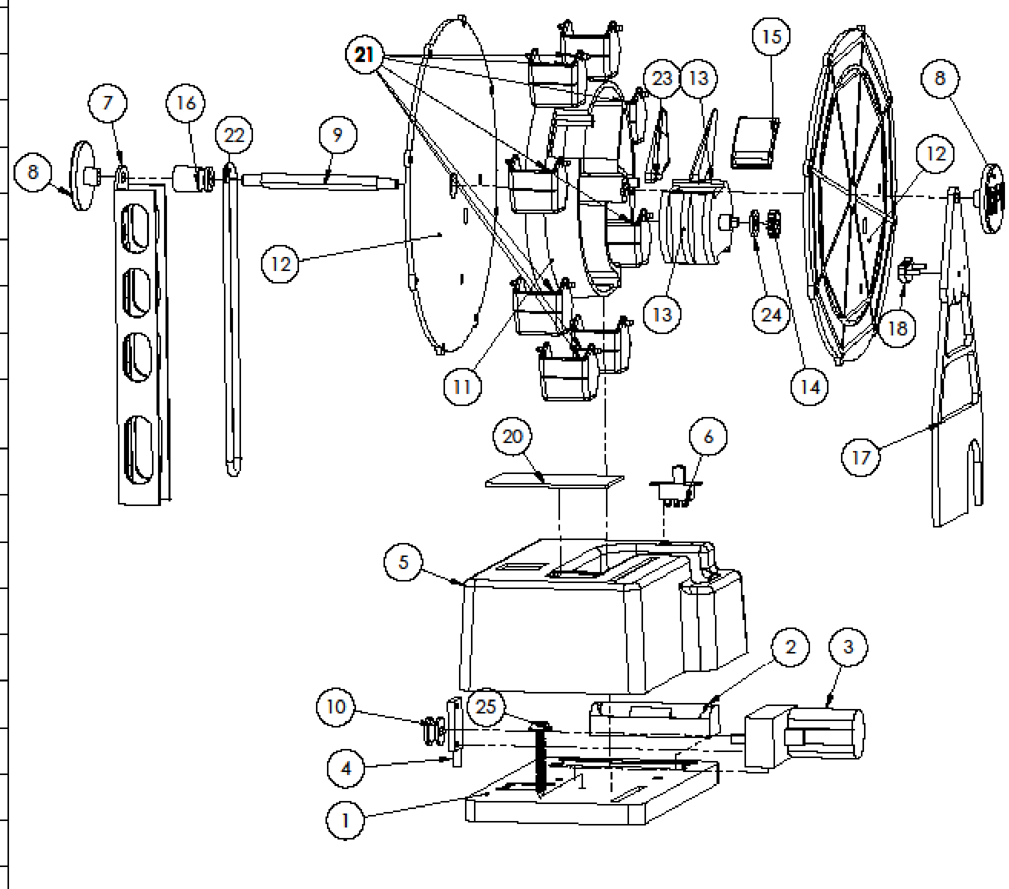
26	Component	12CandyA_BoxBuffer24_C_041203	12CandyA_BoxBuffer27_C_041204	Box Buffer	Polystyrene	Vacuum Forming	400
25.5	Tool	12CandyA_BoxBoffer24_T500_010307		Box Buffer Forming Fixture	RENShape	Machining/Sanding	1
27	Tool						
27.1a	Tool	12CandyA_MoldA100_T100_011206	12CandyA_MoldAMoving100_T100_011206	PIM mold A Moving	Aluminum	Machining	1
27.1b	Tool	12CandyA_MoldA101_T100_011206	12CandyA_MoldAStationary100_T100_011206	PIM mold A Stationary	Aluminum	Machining	1
27.1.1	Haas Mill CNC Code	12CandyA_MoldA_HM101_010222	-	CNC Code for Moving Side of A	-	MasterCAM	-
27.1.2	Haas Mill CNC Code	12CandyA_MoldA_HM102_010208	-	CNC Code for Jar Cavity	-	MasterCAM	-
27.1.3	Haas Mill CNC Code	12CandyA_MoldA_HM103_010213	-	CNC Code for Jar Insert	-	MasterCAM	-
27.1.3	Haas Mill CNC Code	12CandyA_MoldA_HM104_010208	-	CNC Code for Motor Strap	-	MasterCAM	-
27.2a	Tool	12CandyA_MoldB200_T200_011206	12CandyA_MoldBMoving200_T200_011206	PIM Mold B Moving	Aluminum	Machining	1
27.2b	Tool	12CandyA_MoldB201_T200_011206	12CandyA_MoldBStationary200_T200_011206	PIM Mold B Stationary	Aluminum	Machining	1
27.2.1	Haas Mill CNC Code	12CandyA_MoldB_HM201_010227	-	CNC Code for Moving Side of B	-	MasterCAM	-

27.2.2	Haas Mill CNC Code	12CandyA_MoldB_HM202_010223	-	CNC Code for Stationary Side of B	-	MasterCAM	-
27.2.3	Haas Mill CNC Code	12CandyA_MoldB_HM203_010225	-	CNC Code for Axle Pin Stationary Side	-	MasterCAM	-
27.2.4	Haas Mill CNC Code	12CandyA_MoldB_HM204_010228	-	CNC Code for Female Cart Insert	-	MasterCAM	-
27.2.5	Haas Mill CNC Code	12CandyA_MoldB_HM205_010301	-	CNC Code for Male Cart Insert	-	MasterCAM	-
27.2.6	Haas Mill CNC Code	12CandyA_MoldB_HM206_010226	-	CNC Code for Doser	-	MasterCAM	-
27.2.7	Haas Mill CNC Code	12CandyA_MoldB_HM207_010226	-	CNC Code for Jar Lid Moving Side	-	MasterCAM	-
27.2.8	Haas Mill CNC Code	12CandyA_MoldB_HM208_010225	-	CNC Code for Jar Lid Stationary Side	-	MasterCAM	-
27.3a	Tool	12CandyA_MiniMold700_T300_010415	12CandyA_MiniMold700_T700_010415	PIM MiniMold Moving	Aluminum	Machining	1
27.3b	Tool	12CandyA_MiniMold700_T301_010415	12CandyA_MiniMold700_T701_010415	PIM MiniMold Stationary	Aluminum	Machining	1
27.3.1	Haas Mill CNC Code	12CandyA_MiniMold_HM_010417	-	CNC Code for MiniMold	-	MasterCAM	-
27.4	Tool	12CandyA_UpperBase11_T400_041112	12CandyA_UpperBase11_T300_011206	Upper Base Forming Fixture	RENShape	Machining	1
27.5	Tool	12CandyA_BoxBoffer24_T500_010307	12CandyA_BoxBoffer27_T500_010307	Box Buffer Forming Fixture	RENShape	Machining	1
28	Process Fixture						
28.2	Process Fixture	12CandyA_PackagingLaserFixture200_PF200_011206	12CandyA_PackagingLaserFixture200_PF200_011206	Box Laser Cutting Fixture Assembly	-	-	1
	Process Fixture	12CandyA_PackagingLaserFixture201_PF201_011206	12CandyA_PackagingLaserFixture201_PF201_011206	Box Laser Cutting Fixture	ABS	Machining	1

	Process Fixture	12CandyA_PackagingLaserFixture202_PF202_011206	12CandyA_PackagingLaserFixture202_PF202_011206	Box Laser Cutting Fixture	ABS	Machining	1
28.3	Process Fixture	12CandyA_DriveBeltFixture300_PF300_011206	12CandyA_DriveBeltFixture300_PF300_011206	Drive Belt Fixture Assembly	-	-	1
	Process Fixture	12CandyA_DriveBeltFixtureBody301_PF301_011206	12CandyA_DriveBeltFixtureBody301_PF301_011206	Axle	Aluminum	Lathe	1
	Process Fixture	12CandyA_DriveBeltFixtureAxleCap302_PF302_011206	12CandyA_DriveBeltFixtureAxleCap302_PF302_011206	End Cap for Live Center	Aluminum	Lathe	1
	Process Fixture	12CandyA_DriveBeltFixtureThru303_PF303_011206	12CandyA_DriveBeltFixtureThru303_PF303_011207	Spacer at Collet End	Aluminum	Lathe	1
28.4	Process Fixture	12CandyA_UpperBaseLaserFixture400_PF400_011206	12CandyA_UpperBaseLaserFixture400_PF400_011206	Upper Base Laser Cutting Fixture Assembly	-	-	1
	Process Fixture	12CandyA_UpperBaseLaserFixture401_PF401_011206	12CandyA_UpperBaseLaserFixture401_PF401_011206	Upper Base Laser Cutting Fixture	ABS	Machining	1
28.5	Process Fixture	12CandyA_BackSupportFixture500_PF500_0102024	12CandyA_BackSupportFixture500_PF500_0102024	Back Support Assembly	-	-	1
	Process Fixture	12CandyA_BackSupportFixtureBase501_PF501_010224	12CandyA_BackSupportFixtureBase501_PF501_010224	Fixture Base	Aluminum	Machining	1
	Process Fixture	12CandyA_BackSupportFixtureBackPlate502_PF502_010224	12CandyA_BackSupportFixtureBackPlate502_PF502_010224	Back Support	Aluminum	Machining	4
	Process Fixture	12CandyA_BackSupportFixtureHoldDown503_PF503_010224	12CandyA_BackSupportFixtureHoldDown503_PF503_010224	Holddown	Aluminum	Machining	1
	Process Fixture	12CandyA_BackSupportFixtureTweenPlate504_PF504_010224	12CandyA_BackSupportFixtureTweenPlate504_PF504_010224	Tween Plate	Aluminum	Machining	3
	Process Fixture	12CandyA_BackSupportFixture WedgeLower505_PF505_010224	12CandyA_BackSupportFixtureWedgeLower505_PF505_010224	Lower Wedge	Aluminum	Machining	2
	Process Fixture	12CandyA_BackSupportFixture WedgeUpper506_PF506_010224	12CandyA_BackSupportFixtureWedgeUpper506_PF506_010224	Upper Wedge	Aluminum	Machining	2
28.6	Process Fixture	12CandyA_MotorDriveBeltFixture_PF600_011205	12CandyA_MotorDriveBeltFixture_PF600_011206	12CandyA_MotorDriveBeltFixture_PF601_011207	-	-	1

	Process Fixture	12CandyA_MotorDriveBeltFixtureBody601_PF601_010225	12CandyA_MotorDriveBeltFixtureBody601_PF601_010226	12CandyA_MotorDriveBeltFixtureBody601_PF601_010227	Aluminum	Lathe	1
	Process Fixture	12CandyA_MotorDriveBeltFixtureCap602_PF602_010225	12CandyA_MotorDriveBeltFixtureCap602_PF602_010226	12CandyA_MotorDriveBeltFixtureCap602_PF602_010227	Aluminum	Lathe	1
	Process Fixture	12CandyA_MotorDriveBeltFixtureThru603_PF603_010225	12CandyA_MotorDriveBeltFixtureThru603_PF603_010226	12CandyA_MotorDriveBeltFixtureThru603_PF603_010227	Aluminum	Lathe	1
29	Quality Control						
29.3	Quality Control	12CandyA_Struts03_QC303_011203	12CandyA_Struts03_QC303_041206	Quality Control Gauge	Aluminum	Lathe	1
29.7	Quality Control	12CandyA_Axle07_QC307_011203	12CandyA_Axle07_QC307_011206	Quality Control Gauge	Aluminum	Lathe	1
29.12.1	Quality Control	12CandyA_LowerBase12_QC3121_011203	12CandyA_LowerBase12_QC3121_011206	Quality Control Gauge	Aluminum	Machining	1
29.12.2	Quality Control	12CandyA_LowerBase12_QC3122_011203	12CandyA_LowerBase12_QC3122_011206	Quality Control Gauge	Aluminum	Machining	1
29.12.3	Quality Control	12CandyA_LowerBase12_QC3123_011203	12CandyA_LowerBase12_QC3123_011206	Quality Control Gauge	Aluminum	Machining	1
29.15	Quality Control	12CandyA_MainGear15_QC315_011203	12CandyA_MainGear15_QC315_011206	Quality Control Gauge	Aluminum	Machining	1
29.16	Quality Control	12CandyA_DriveBeltCarrier16_QC316_011203	12CandyA_DriveBeltCarrier16_QC316_011206	Quality Control Gauge	Aluminum	Lathe, Machining	1
29.20	Quality Control	12CandyA_MotorDriveBeltCarrier20_QC320_011203	12CandyA_MotorDriveBeltCarrier20_QC320_041206	Quality Control Gauge	Aluminum	Lathe, Machining	1

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	12CandyA_LowerBase12_C_041112	Lower Base	1
2	12CandyA_BatteryMount12_PC_021107	BATTERY HOLDER, SZ AA, ONE CELL	1
3	12CandyA_Motor09_PC_021108	Motor	1
4	12CandyA_MotorStrap19_C_021108	Motor Strap	1
5	12CandyA_UpperBase11_C_041112	Upper Base	1
6	12CandyA_OnSwitch18_PC_011107	On Switch	1
7	12CandyA_BackSupport06_C_071108	Back Support	1
8	12CandyA_AxlePin14_C_041206	Axle Pin	2
9	12CandyA_Axle07_C_051016	Axle	1
10	12CandyA_MotorDriveBeltCarrier20_C_051129	Motor Drive Belt Carrier	1
11	12CandyA_Jar04_C_021017	Jar	1
12	12CandyA_Struts03_C_061017	Struts	2
13	12CandyA_Doser10_C_061112	Doser	1
14	12CandyA_MainGear15_C_051017	Main Gear	1
15	12CandyA_JarLid02_C_031108	Jar Lid	1
16	12CandyA_DriveBeltCarrier16_C_061108	Drive Belt Carrier	1
17	12CandyA_FrontSupport05_C_031108	Front Support	1
18	12CandyA_OuterGear13_C_051108	Outer Gear	1
20	12CandyA_LogoPlate22_C_010502	Logo Plate	1
21	12CandyA_Cart01_C_010904	Cart	8
22	Drive belt for renders	Drive Belt	1
23	12CandyA_Funnel20_C_010409	Funnel	1
24	12CandyA_Washer21_C_01412	Washer	1
25	90930A201	Bracing Screw	1



DWG NOTES: (UNLESS OTHERWISE NOTED)
1) ALL UNITS: INCHES
2) < FILL IN NOTES HERE >

MATERIAL:
< INSERT MATERIAL HERE >

TOLERANCES (UNLESS NOTED)
DECIMAL: X.X : ±0.015
X.XX : ±0.01
X.XXX : ±0.005
FRACTIONAL: ±1/32
NO. PARTS REQ'D: < # >

RENSSELAER POLYTECHNIC INSTITUTE

EXPLODED VIEW

DRAWN BY: SETH WRAIGHT/DANIEL GOLDING
FACULTY ADVISOR: Samuel Chiappone
SIZE B
COURSE NAME/NUMBER: MPS Ferris Wheel Team
DATE: Friday, May 03, 2013
SCALE 1:2
SHEET 1 OF 1

3.2: Assembly BOM

Assembly	Category	Reference #	Part Description	Material	Qty
1020	Tool		Pneumatic Rotary EE	Misc.	1
1021		12CandyA_PneuRotaryPlate1021_AF1021_030220	Plate	Aluminum	1
1022		12CandyA_Pneu_Rotary_AF_030220	Pneumatic Rotary	Misc.	1
1030	Fixture	12CandyA_LowerBaseFD1030_AF1030_040223	Lower Base Feeder	Lexan, Stainless Steel	1
1031		12CandyA_LowerBaseFDBase1031_AF1031_040223	Base	Lexan	1
1032		12CandyA_LowerBaseFDConnector_AF1032_040223	Connector	Lexan	1
1033		026-D	Pneumatic Cylinder	Stainless Steel	1
1033.1		D-129	Large Bracket	Stainless Steel	1
1033.2		D-770	Small Bracket	Stainless Steel	1
1034		12CandyA_LowerBaseFDPusher1034_AF1034_040223	Pusher	Lexan	1
1035		12CandyA_LowerBaseFDTray1035_AF1035_040223	Tray	Lexan	2
1036		12CandyA_LowerBaseFDStandoff1036_AF1036_040223	Standoff	Lexan	1
1037		12CandyA_LowerBaseFDTower1037_AF1037_040223	Tower 1	Lexan	1
1038		12CandyA_LowerBaseFDTower1038_AF1038_040223	Tower 2	Lexan	2
1039		12CandyA_LowerBaseFDTower1039_AF1039_040223	Tower 3	Lexan	2
1040	Fixture		Electronics Pallet	ABS	1
1041		12CandyA_ElectronicPLTop1041_AF1041_040223	Top	ABS	1
1042		12CandyA_ElectronicPLBottom1042_AF1042_040223	Bottom	ABS	1
1050	Fixture	12CandyA_BackSupPress1050_AF1050_020401	Back Support Press Fixture	Aluminum, ABS	1
1051		12CandyA_BackSupPressPress1051_AF1051_020401	Press Plate	Aluminum	1
1052		12CandyA_BackSupPressBackTop1052_AF1052_020401	Top Back	Aluminum	1
1053		12CandyA_BackSupPressFrontTop1053_AF1053_020401	Top Front	Aluminum	1
1054		12CandyA_BackSupPressBaseHolder1054_AF1054_020401	Base Holder	ABS	1
1055		12CandyA_BackSupPressBaseLayer1055_AF1055_020401	Base Layer	ABS	1
1056		12CandyA_BackSupPressC1056_AF1056_020506	C-Channel	Aluminum	1
1060	Fixture	12CandyA_SlidingBaseFX1060_AF1060_030223	Sliding Base Fixture	Lexan, Stainless Steel	1
1061		12CandyA_SlidingBaseFXBottom1061_AF1061_030223	Bottom Plate	Lexan	1
1062		12CandyA_SlidingBaseFXGlide1062_AF1062_030223	Glide	Lexan	2
1063		12CandyA_SlidingBaseFXGuide1063_AF1063_030223	Guide 1	Lexan	1
1064		12CandyA_SlidingBaseFXGuide1064_AF1064_030223	Guide 2	Lexan	1
1065		12CandyA_SlidingBaseFXStand1065_AF1065_030223	Stand	Lexan	1
1066		12CandyA_SlidingBaseFXStand1066_AF1066_030223	Stand 2	Lexan	1
1067		12CandyA_SlidingBaseFXTop1067_AF1067_030223	Top	Lexan	1
1068		026-D	Pneumatic Cylinder	Stainless Steel	1
1068.1		D-129	Large Bracket	Stainless Steel	1
1068.2		D-770	Small Bracket	Stainless Steel	1
1070	Fixture	12CandyA_GlueFX1070_AF1070_020213	Glue Fixture	Aluminum	1
1071		12CandyA_GlueFXPlate1071_AF1071_020213	Plate	Aluminum	1
1072		12CandyA_GlueFXStand1072_AF1072_020213	Stand	Aluminum	2
1080	Tool	12CandyA_GripSuctionEE1080_RE1080_020214	Gripper/Suction EE	Aluminum	1
1081		12CandyA_GripSuctionEEBody1081_RE1081_020214	Body	Aluminum	1
1082		12CandyA_GripSuctionEEChannel1082_RE1082_020214	Channel	Aluminum	1
1083		12CandyA_GripSuctionEEPin1083_RE1083_020214	Pin	Aluminum	2
1084		12CandyA_GripSuctionEELongPin1084_RE1084_020214	Long Pin	Aluminum	1
1085		12CandyA_GripSuctionEEAttach1085_RE1085_020214	Attachment	Aluminum	1
1086		12CandyA_GripSuctionEEConvex1086_RE1086_020214	Convex Curve	Aluminum	1
1087		12CandyA_GripSuctionEEConcave1087_RE1087_020214	Concave Curve	Aluminum	1
1088		12CandyA_GripSuctionEEPlate1088_RE1088_020214	Plate	Aluminum	1
1090	Fixture	12CandyA_CartPL1090_AF1090_020326	Cart Pallet	ABS	1
1091		12CandyA_CartPLTop1091_AF1091_020326	Top	ABS	1
1092		12CandyA_CartPLBottom1092_AF1092_020326	Bottom	ABS	1
1100	Fixture	12CandyA_DoserPL1100_AF1100_020415	Doser Pallet	Polystyrene	1
1101		12CandyA_DoserPLPlate1101_AF1101_020415	Plate	Polystyrene	3
1102		12CandyA_DoserPLDivider1102_AF1102_020415	Divider	Polystyrene	3
1110	Fixture	12CandyA_JarPL1110_AF1110_020415	Jar Pallet	ABS	1
1111		12CandyA_JarPLTop1111_AF1111_020415	Top	ABS	1
1112		12CandyA_JarPLRisers1112_AF1112_020415	Risers	ABS	1
1140	Fixture	12CandyA_StrutStack1140_AF1140_010328	Strut Stack	ABS, Aluminum	2

1141		12CandyA_StrutStackBase1141_AF1141_010328	Base	ABS	2
1142		12CandyA_StrutStackPeg1142_AF1142_010328	Peg	Aluminum	10
1150	Fixture	12CandyA_SlidingWheelFX1150_AF1150_020428	Sliding Wheel Fixture	ABS, Aluminum	1
1151		12CandyA_SlidingWheelFXGearPlate1151_AF1151_020428	Locator Plate	Aluminum	1
1152		12CandyA_SlidingWheelFXLowerBrace1152_AF1152_020428	Lower Brace	ABS	1
1153		12CandyA_SlidingWheelFXUpperBrace1153_AF1153_020428	Upper Brace	ABS	1
1154		12CandyA_SlidingWheelFXSmallSpacer1154_AF1154_010428	Small Spacer	Steel	8
1155		12CandyA_SlidingWheelFXLargeSpacer1155_AF1155_010428	Large Spacer	Steel	4
1156		12CandyA_SlidingWheelFXLBracket1156_AF1156_020428	L-Bracket	Aluminum	2
1160	Fixture	12CandyA_AdapterPlate1160_AF1160_010430	Wheel Fixture Adapter Plate	Aluminum	1
1161		12CandyA_AdapterPlatePlate1161_AF1161_010430	Plate	Aluminum	1
1162		12CandyA_AdapterPlateL1162_AF1162_010430	L Bracket	Aluminum	1
1163		12CandyA_AdapterPlateSensorSpacer1163_AF1163_010430	Sensor Spacer	Aluminum	1
1164			Sensor	Misc.	1
1170	Fixture		Welding Horn	Steel	1
1180	Fixture	12CandyA_AcetoneWeldingFX1180_AF1180_050422	Acetone Welding Fixture	Polystyrene	3
1230	Fixture	12CandyA_HeatStakeFX1230_AF1230_020409	Heat Stake Fixture	ABS	1
1260	Component	Packaging Assembly	Box	Card board	400
1270	Code		Base & Back Program Code	NC Code	1
1280	Code		Wheel Program Code	NC Code	1
1290	Component		Motor Screw	Steel	800
1300	Component		Bracing Screw	Steel	400

4. Manufacturing

4.1: Manufacturing Introduction

This section of the Technical Data Package elaborates on the manufacturing processes used to produce components for the Ferris Wheel Candy Dispenser.

Manufacturing of components for the Ferris Wheel Candy Dispenser involves the use of six distinct manufacturing processes to create a complement of 24 distinct parts (33 total parts per product), including packaging.

Plastic Injection Molding

Twelve of these components are produced through plastic injection molding, split between two large mold plates & one mini-mold. The eight carts, two axle pins, doser, and jar lid are molded from red polypropylene in one shared mold (two separate injection groups). A second mold is used for the jar, two distinct drive belt carriers, main gear, outer gear, and motor strap (two separate injection groups). These parts are made out of black ABS plastic. A third mini-mold is used to inject the left and right side of the funnel and the washer. These parts will be made out of black ABS plastic.

CNC Turning

The two drive belt carriers go through a secondary process of CNC turning to add the required groove around the perimeter. This process utilizes a custom fixture to hold ten pulleys at a time in the lathe. Additionally, the axle is turned on the CNC lathe to add some round sections to 3/16" square steel stock. This process requires a 3/16" square collet with a custom-installed back stop to allow for quick filtering.

Abrasive Water-Jet Cutting

The front support and lower base are abrasive water-jet cut, allowing for rapid production of complex geometry. The front support is cut from 1/8" aluminum sheet stock, and the lower base from 3/8" polycarbonate.

CNC Mill

The lower base undergoes a secondary machining operation on the CNC Mill, being clamped in a vice and having several pocket features added. As common machining coolant is not compatible with polycarbonate, this process is cooled with compressed air during machining. Also, the back supports are machined on the CNC mill, having features added from two sides of aluminum C-channel stock. A custom fixture is used to clamp four parts in place simultaneously, two oriented for machining of the backs of the part, and the other two oriented for machining of the sides.

Vacuum Forming

The upper base and box standoff are both created using the vacuum forming process. Both are formed out of 0.060" polystyrene material, around custom-machined molds made out of medium-density Renshape polyurethane foam.

Laser Cutting

Both the upper base and box standoff are removed from the vacuum forming flashing and have additional features added through laser cutting. Custom fixtures are used to cut two parts simultaneously; one is mounted upside down to be removed from its flashing, and the other mounted right side up to have additional features added to its top surface. The laser cutter is also used to cut and etch the acrylic struts, adding aesthetic appeal to the product. Finally, the packaging box is cut and etched on the laser cutter, opening a window for viewing of the product and etching in the product name, sponsor logos, and team roster.

4.2: Carts (BOM #1) – General Information

Part Number	1
Drawing Number	12CandyA_Cart01_C_010904
Assembly Reference Drawing Number	1

Part Description	
Function: The cart is a small container used for carrying the dispensed candy a full revolution around the Ferris Wheel. It is connected via a clearance fit to the struts (12CandyA_Struts03_C_061017).	
Material: Polypropylene - Red	
Number Required: 2800	
Make or Buy Component: Make	
Associated Calculations:	Fit for cart shaft: RC 7 Nominal Size: 0.1180 in. Shrinkage of cart: 0.0024 in. Max Shaft: 0.1168 in. Min Shaft: 0.1161 in. Max Clearance: 0.0031 in. Min Clearance: 0.0012 in.
Notes: Though there are 8 carts, the only cart that will ever carry candy is the one positioned below the dosing device. The rest are present to ensure the product is recognized as a Ferris Wheel.	

Material consideration was of particular importance on the cart, as it could not be ultrasonically welded to the struts due to the fact that it needed to turn. Thus Polypropylene was chosen, considering that material does not weld to Acrylic. Source: Machinery's Handbook, 28 ed.
Major Design Changes: Cart direction was reversed upon discovery of jamming when gears mated and the carts make initial contact with the raised lip on the upper base. Pegs that hold the carts into the struts were extended in order to ensure the carts could not come lose during operation of the candy Ferris wheel. 1 in 8 of the carts injected will become part 24 (Candy Cart) that allows the candy to fall through a hole in the cart due to the removed bump on the upper base.

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for molding the carts.	
Primary Process: Plastic Injection Molding – Mold B2	
Justification: Repeatability for multiple copies of the same part	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 350°F Injection Molding Temperature: 120°F Specific Heat: 0.406-0.478 BTU Mass: 0.007 lb Density: 0.033 lb/in^3 Shrinkage: Range of 0.010 – 0.030 Average: 0.020 2.00% Shrinkage allowable Cycle Time: 70 seconds per injection of 8 (excludes post processing)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, Polypropylene.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the cart is attached to the struts. As dictated by the 2.00% shrinkage, the best tolerance can be ± 0.01 in.

Surface Finishing Requirements
Remove flashing if any.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldB200_T200_011206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: Caliper measurement of cart width at interface point with struts

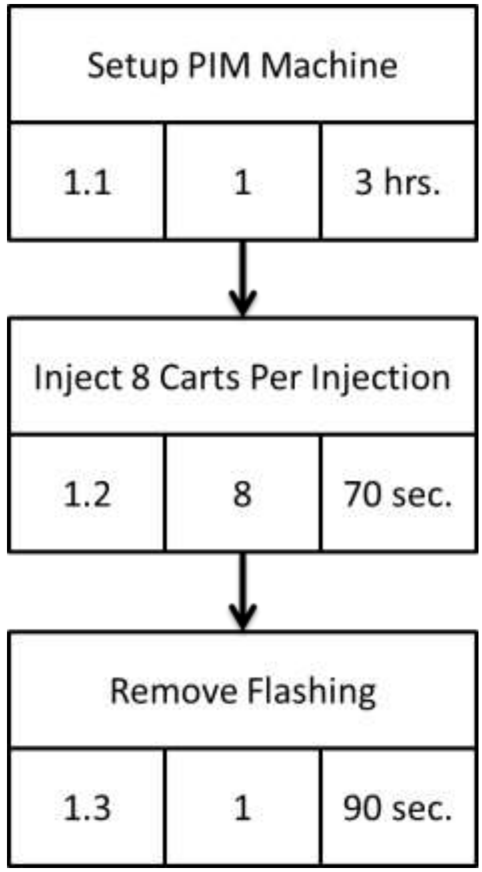
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Cart01_C_081126 CAM: N/A

Material Resource Planning
Volume of Part: 0.214 in^3
Density of Material: 0.033 lb/in^3
Weight of Material: 0.214 in^3 X 0.033 lb/in^3 X 3200 X 1.2 = 27.12 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Stacy, D., McDonald, R.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M., Terranova, V.	

4.2.1: Carts – Process Schematic



Step	Time Required	# Required	Total Time
1.1	3 hrs	1	3 hrs
1.2	70 sec	400	7 hrs 47 min
1.3	90 sec	2800	70 hrs
		Total Production Time	80 hrs 47 min

4.3: Jar Lid (BOM #2) – General Information

Part Number	2
Drawing Number	12CandyA_JarLid02_C_031108
Assembly Reference Drawing Number	2

Part Description	
Function: The jar lid will allow for a method to access the inside of the candy jar for purposes of refilling candy. It will be wedged between the candy jar (12CandyA_Jar04_C_021017) and the struts (12CandyA_Struts03_C_061017).	
Material: Polypropylene - Red	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for jar sliding: RC 7 Nominal Size: 3.6850 in. Shrinkage: 0.0737 in. Max Shaft: 3.6800 in. Min Shaft: 3.6778 in. Max Clearance: 0.0107 in. Min Clearance: 0.0050 in.
Notes: Material consideration was of particular importance on the jar lid, as it could not be ultrasonically welded to the struts due to the fact that it needed to turn. Thus Polypropylene was chosen, considering that material does not weld to Acrylic. Source: Machinery's Handbook, 28 ed.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for molding the lid.	
Primary Process: Plastic Injection Molding – Mold B1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 350°F Injection Molding Temperature: 120°F Specific Heat: 0.406-0.478 BTU Mass: 0.003 lb Density: 0.033 lb/in^3 Shrinkage: Range of 0.010 – 0.030 Average: 0.020 2.00% Shrinkage allowable Cycle Time: 55 sec per injection
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, Polypropylene	
Design Changes: Added raise nub to facilitate increased friction between Jar Lid & Jar to prevent jar lid opening during operation of product.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the lid slides between the jar and the struts. As dictated by 2.00% shrinkage, tolerance should be ± 0.005 in.

Surface Finishing Requirements
Remove flashing if any.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldB200_T200_011206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: Measure the thickness of the jar lid with a micrometer

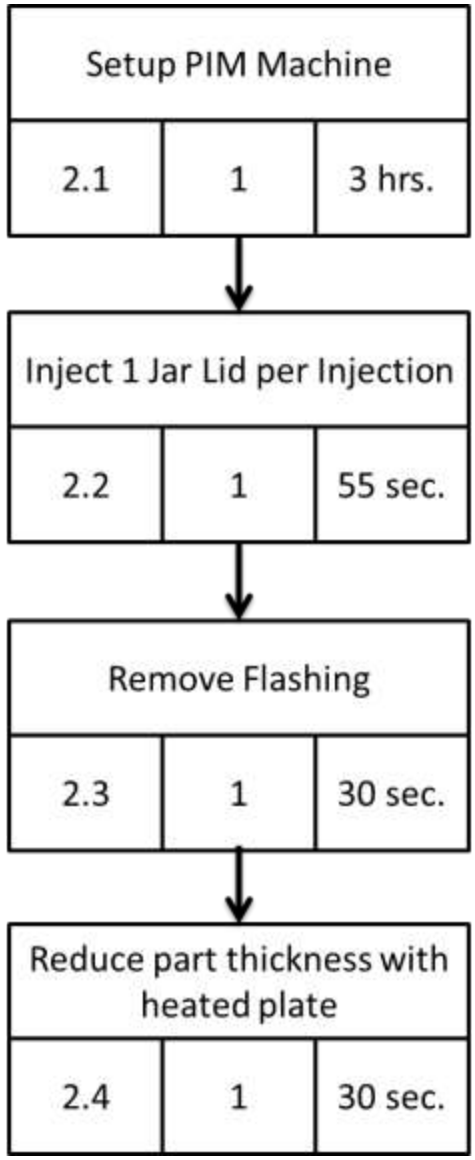
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_JarLid02_C_051126 CAM: N/A

Material Resource Planning
Volume of Part: 0.077 in^3
Density of Material: 0.033 lb/in^3
Weight of Material: 0.077 in^3 X 0.033 lb/in^3 X 400 X 1.2 = 1.220 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Wraight, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.3.1: Jar Lid – Process Schematic



Step	Time Required	# Required	Total Time
2.1	3 hrs	1	3 hrs
2.2	55 sec	400	6 hrs 7 min
2.3	30 sec	400	3 hrs 20 min
2.4	30 sec	400	3 hrs 20 min
		Total Production Time	15 hrs 47 min

4.4: Struts (BOM #3) – General Information

Part Number	3
Drawing Number	12CandyA_Struts03_C_061017
Assembly Reference Drawing Number	3

Part Description	
Function: The struts will serve as the face of the Ferris Wheel. They will be ultrasonically welded to the jar (12CandyA_Jar04_C_021017) and will contain the carts (12CandyA_Cart01_C_061206) via a clearance fit, as well as the jar lid (12CandyA_JarLid02_C_031206). The whole wheel assembly will be attached to the drive by the axle (12CandyA_Axle07_C_051016).	
Material: Polymethyl Methacrylate (Acrylic)	
Number Required: 800	
Make or Buy Component: Make	
Associated Calculations:	Fit for struts cart hole: RC 7 Nominal Size: 0.1180 in. Max Hole: 0.1192 in. Min Hole: 0.1180 in. Max Clearance: 0.0031 in. Min Clearance: 0.0012 in. Fit for struts doser hole: RC 7

	Nominal Size: 0.2780 in. Max Hole: 0.2794 in. Min Hole: 0.2780 in. Max Clearance: 0.0039 in. Min Clearance: 0.0016 in. Fit for struts small locator pin hole: LC 8 Nominal Size: 0.1650 in. Max Hole: 0.1668 in. Min Hole: 0.1650 in. Max Clearance: 0.0042 in. Min Clearance: 0.0012 in. Fit for struts large locator pin hole: LC 8 Nominal Size: 0.370 in. Max Hole: 0.3728 in. Min Hole: 0.3700 in. Max Clearance: 0.0064 in. Min Clearance: 0.0020 in.
Notes: Source: Machinery's Handbook, 28 ed.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for cutting the struts.	
Primary Process: Laser cutting and laser engraving	
Justification: Laser cutting provided a clean finish to cut surfaces, while laser engraving provides the aesthetic features required.	
Machine Tool: Hurricane Lasers, Charley Model	
Associated Calculations:	Laser Settings: Cut: Speed: 20% Power: 100%

	Engrave: Speed: 200% Power: 30% Note: Time per part: ~2’30”
Notes: Engraving is performed using LaserCut’s Cut option	
Design Changes: Changed from laser engraving whole pattern to engraving only lines to reduce cycle from 45 min per part to 2 minutes 30 sec per part.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerances exist where the locator pins of the jar interface with the struts and also where the doser interfaces with the struts. The tightest tolerance that can be held by the laser is ± 0.003. Source: Laser Study, Appendix A, B.

Surface Finishing Requirements
Etching

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_Struts03_QC303_041206 Measurements: Locator gaps in the struts will be measured with a caliper.

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Struts03_C_051108 CAM: N/A

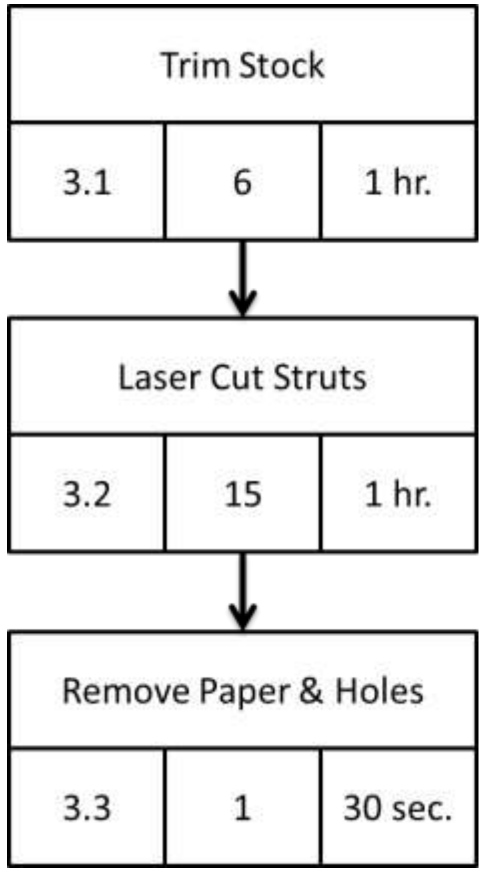
AWJ: N/A LASER: AML > 1213_Team_A > Shared Documents > Laser Code > Struts

Material Resource Planning
Area of Material: 30 in^2
Material Dimensions: 48 in. X 96 in. X 3/32 in.
Notes: N/A

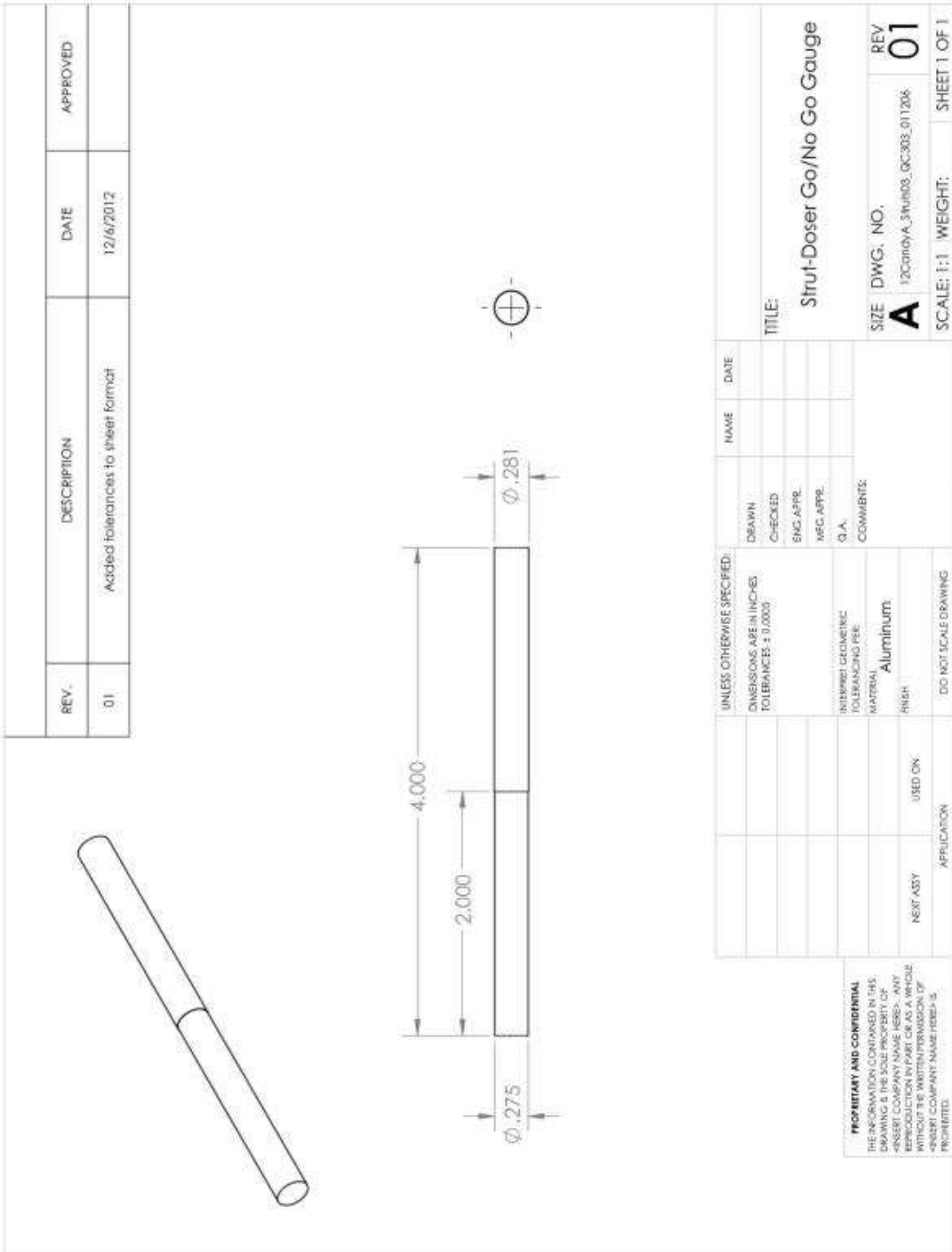
Budget Allocation
Material Cost per sheet: $67.40 * 4
Total Cost: $269.60
Notes: Will use stock in MILL and purchase additional stock as necessary.

Responsible Team Member (s)		**Date**
Research & Cost:	Koo., W., Browne, T.	
Design:	Stacy, D.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.4.1: Struts – Process Schematic



Step	Time Required	# Required	Total Time
3.1	6 hrs	6	6 hrs
3.2	1 hr (per 15)	400	26 hrs 40 min
3.3	30 sec (per)	400	3 hrs 20 min
		Total Production Time	36 hrs


REV.
DESCRIPTION
DATE
APPROVED
01
Added tolerances to sheet format
12/6/2012
4.000
2.000
Ø.275
Ø.281
PROPRIETARY AND CONFIDENTIAL
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
MATERIAL
Aluminum
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Strut-Doser Go/No Go Gauge
SIZE
A
DWG. NO.
REV
01
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1
1
2
3
4
5

4.5: Jar (BOM # 4) – General Information

Part Number	4
Drawing Number	12CandyA_Jar04_C_021017
Assembly Reference Drawing Number	4

Part Description	
Function: The jar will contain not only the gobstoppers but also house the dosing device (12CandyA_Doser10_C_061112) and the jar lid (12CandyA_JarLid02_C_031206). It will also be welded to the struts (12CandyA_Struts03_C_061017) ultrasonically and the axle (12CandyA_Axle07_C_051016).	
Material: ABS – Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for dosing device: RC 7 Nominal Size: 0.8268 in. Shrinkage: 0.0049 in. Max Hole: 0.8288 in Min Hole: 0.8268 in Max Clearance: 0.0057 in Min Clearance: 0.0025 in

	Fit for axle hole: LC 6 Nominal Size: 0.1875 in. Shrinkage: 0.0011 in. Max Hole: 0.1887 in. Min Hole: 0.1875 in. Max Clearance: 0.0027 in. Min Clearance: 0.0008 in. Fit for jar small locator pins: LC 8 Nominal Size: 0.1650 in. Shrinkage: 0.0010 in. Max Shaft: 0.1638 in. Min Shaft: 0.1626 in. Max Clearance: 0.0042 in. Min Clearance: 0.0012 in. Fit for jar large locator pins: LC 8 Nominal Size: 0.3700 in. Shrinkage: 0.0022 in. Max Shaft: 0.3680 in. Min Shaft: 0.3664 in. Max Clearance: 0.0064 in. Min Clearance: 0.0020 in.
Notes: Source: Machinery's Handbook, 28 ed.	
Design Changes: None	

Proposed Manufacturing Process Plan
Description: This section outlines the primary manufacturing process for molding the jar.
Primary Process: Plastic Injection Molding – Mold A2
Justification: Repeatability for multiple copies of the same part.
Machine Tool: Arburg PIM machine

Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.065 lb Density: 0.038 lb/in^3 Shrinkage: Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time: 45 sec (per)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerances exist where the dosing device comes into contact with the jar, where the axle passes through the jar, and where the struts snap into the locator pins on the jar. Tolerances are ± 0.02 in. for the doser and strut interface and ± 0.002 in. for the locator pin location.

Surface Finishing Requirements
Use as is

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldA100_T100_011206

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Jar04_C_031126

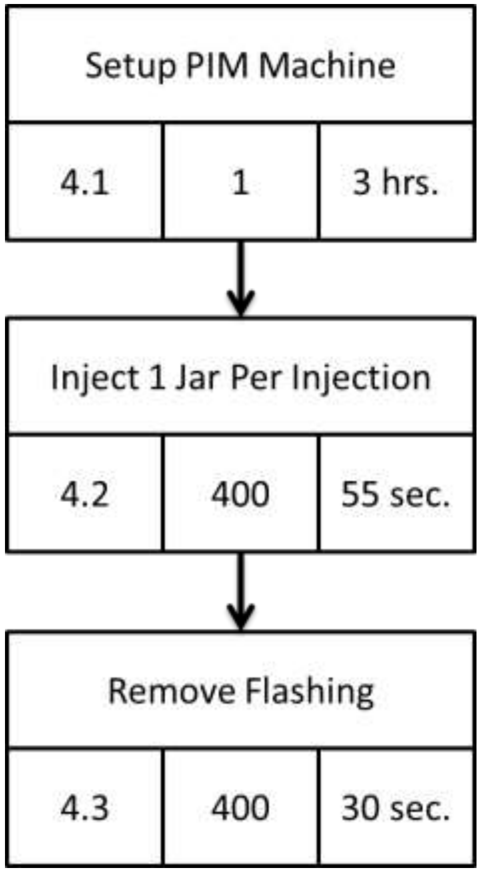
CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_Jar04_HM204f_011203 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_Jar04_HM204m_011207

Material Resource Planning
Volume of Part: 1.705 in^3
Density of Material: 0.038 lb/in^3
Weight of Material: 1.705 in^3 X 0.038 lb/in^3 X 400 X 1.2 = 31.10 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Stacy, D., Terranova, V., Wraight, S., Zavos, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M., Terranova, V.	

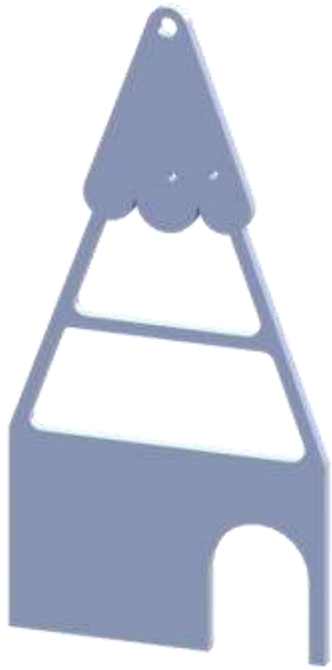
4.5.1: Jar – Process Schematic



Step	Time Required	# Required	Total Time
4.1	3 hrs	1	6 hrs.
4.2	55 sec (per)	400	6 hrs. 7min
4.3	30 sec (per)	400	3 hrs. 20 min
		Total Production Time	15 hrs. 27 min

4.6: Front Support (BOM # 5) – General Information

Part Number	5
Drawing Number	12CandyA_FrontSupport05_C_031108
Assembly Reference Drawing Number	5



Part Description	
Function: The front support will act as a support for the wheel itself (12CandyA_CandyWheel_MA_061203) and will interface directly with the axle (12CandyA_Axle07_C_051016) via a clearance fit. The front support will also slide into the lower base (12CandyA_LowerBase12_C_041112). A gear (12CandyA_MainGear15_C_051017) will snap into the back side of the front support.	
Material: T6061 Aluminum	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for axle hole: RC6 Nominal Size: 0.1875 in. Max Hole: 0.1887 in. Min Hole: 0.1875 in. Max Clearance: 0.0027 in. Min Clearance: 0.0008 in.

	Fit for lower base fit: FN1 Nominal Size: 0.0600 in. Max Shaft: 0.0605 in. Min Shaft: 0.0603 in. Max Interference: 0.0001in. Min Interference: 0.0005 in. Fit for outer gear hole: LC3 Nominal Size: 0.0800 in. Max Hole: 0.0806 in. Min Hole: 0.0800 in. Max Clearance: 0.0010 in. Min Clearance: 0.0000 in.
Notes: Source: Machinery's Handbook 28 ed.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for waterjet cutting the front support.	
Primary Process: Abrasive Waterjet Cutting	
Justification: Repeatability for multiple copies of the same part, variability in manufacturing processes.	
Machine Tool: Abrasive Water Jet	
Associated Calculations:	AWJ Settings: Material Setting: 8.62 – Aluminum(6061) Speed: 40% Time: 55 min (per 25)
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the axle fits into the front support and can only be held to a value of, ± 0.03 in., due to the accuracy of the Abrasive Waterjet Cutter.

Surface Finishing Requirements
Tumble to flat matte finish

Tools, Tooling, and Fixture Drawing Number(s)
N/A

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_Axle07_QC325_011206 Measurements: Measure the axle hole in the Front support with a caliper.

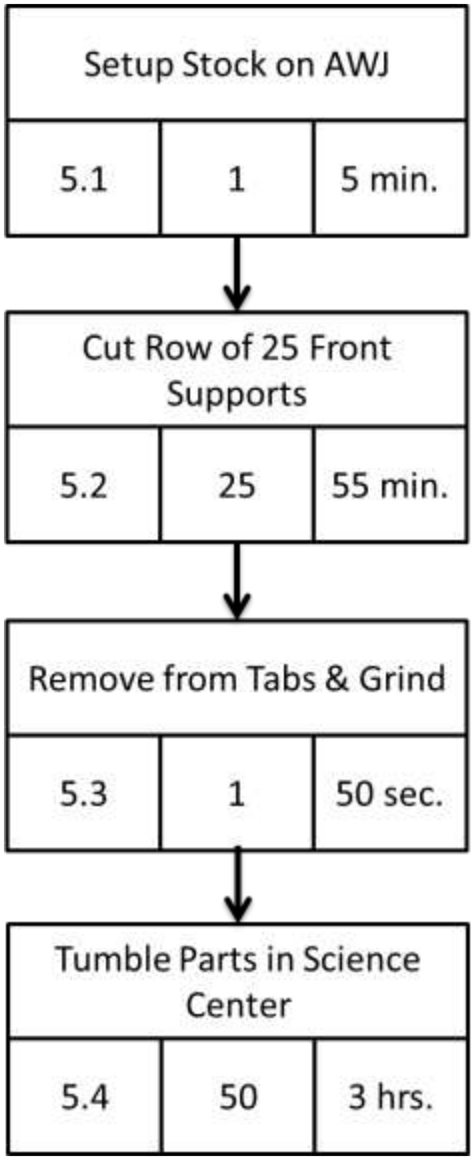
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_FrontSupport05_C_031108 AWJ: AML > 1213_Team_A > Shared Documents > AWJ Code > 12CandyA_FrontSupport05_WJ405_021126

Material Resource Planning
Area of Material: 3.48 in^2
Material Dimension: 48 in. X 96 in. X 0.08 in.
Notes: N/A

Budget Allocation
Cost per sheet: $147.35/sheet
Total Cost: 2 X $147.22/sheet = $294.70
AWJ Cost per cycle: $17.91 * 16 cycles
AWJ Total Cost: $286.67
Notes: Material will be obtained from Albany Steel http://albanysteel.efcpart.com:5080/Database/query.asp?Category=ALUMINUM&SubCategory=SHEET

Responsible Team Member (s)		Date
Research & Cost:	Browne, T., Koo, W., Pacifico, C.	
Design:	Stacy, D., Zavos, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.6.1: Front Support – Process Schematic



Step	Time Required	# Required	Total Time
5.1	5 min. (per)	16	1 hr. 20 min.
5.2	55 min. (per 25)	400	16 hrs. 40 min.
5.3	50 sec. (per)	400	5 hrs. 34 min
5.4	3 hrs. (per 50)	400	24 hrs.
		Total Production Time	47 hrs. 34 min.

4.7: Back Support (BOM #6) – General Information

Part Number	6
Drawing Number	12CandyA_BackSupport06_C_071108
Assembly Reference Drawing Number	6

Part Description	
Function: The back support will act as a support for the wheel itself (12CandyA_CandyWheel_MA_061203) and will interface directly with the axle (12CandyA_Axle07_C_051016) via a clearance fit. The back support will also slide into the lower base (12CandyA_LowerBase12_C_041112) via an interference fit.	
Material: T6061 Aluminum	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for axle hole: RC6 Nominal Size: 0.1875 in. Max Hole: 0.1887 in. Min Hole: 0.1875 in. Max Clearance: 0.0027 in. Min Clearance: 0.0008 in.

	Fit for lower base fit: FN1 Nominal Size: 0.0600 in. Max Shaft: 0.0605 in. Min Shaft: 0.0603 in. Max Interference: 0.0001in. Min Interference: 0.0005 in.
Notes: Source: Machinery's Handbook 28 ed.	
Design Changes: Wrong stock was purchased, requiring the team to perform slotting operations, which in turn led to excessive increases in cycle time. Surface finish changed to tumbling to ensure a constant even finish on the part. Fixture changed from a 4-Axis part to being a 3-Axis part in a transfer fixture that allows different sides of the part to be machined during the same cycle. Slot end of material (bottom ½") if necessary with a 5/8" end mill to ensure part fits into lower bases without buckling.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for milling the back support.	
Primary Process: CNC Milling	
Justification: Constraints from geometry of part	
Machine Tool: 3 Axis Mill – Transfer Fixture	
Associated Calculations:	Speed: RPM = 12 X Cutting Speed / π X Diameter Approximating 3 for π RPM = 4 X 300ft/min / 0.25 = 4800 RPM Feed: $F = S_z \times N_t \times N$ F = 0.003 X 2 X 4800 = 28.8 in/min
Notes: Slot end of material (bottom ½") if necessary with a 5/8" end mill to ensure part fits into lower bases without buckling.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the back support is attached to the axle and the lower base. Tolerances should be ± 0.005 in., or as tight as possible.

Surface Finishing Requirements
Tumble Part to even matte finish

Tools, Tooling, and Fixture Drawing Number(s)
N/A

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_Axle07_QC325_011206 Measurements: Measure the axle hole in the back support with a caliper

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupport06_C_061129 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_BackSupport06_HM_010326

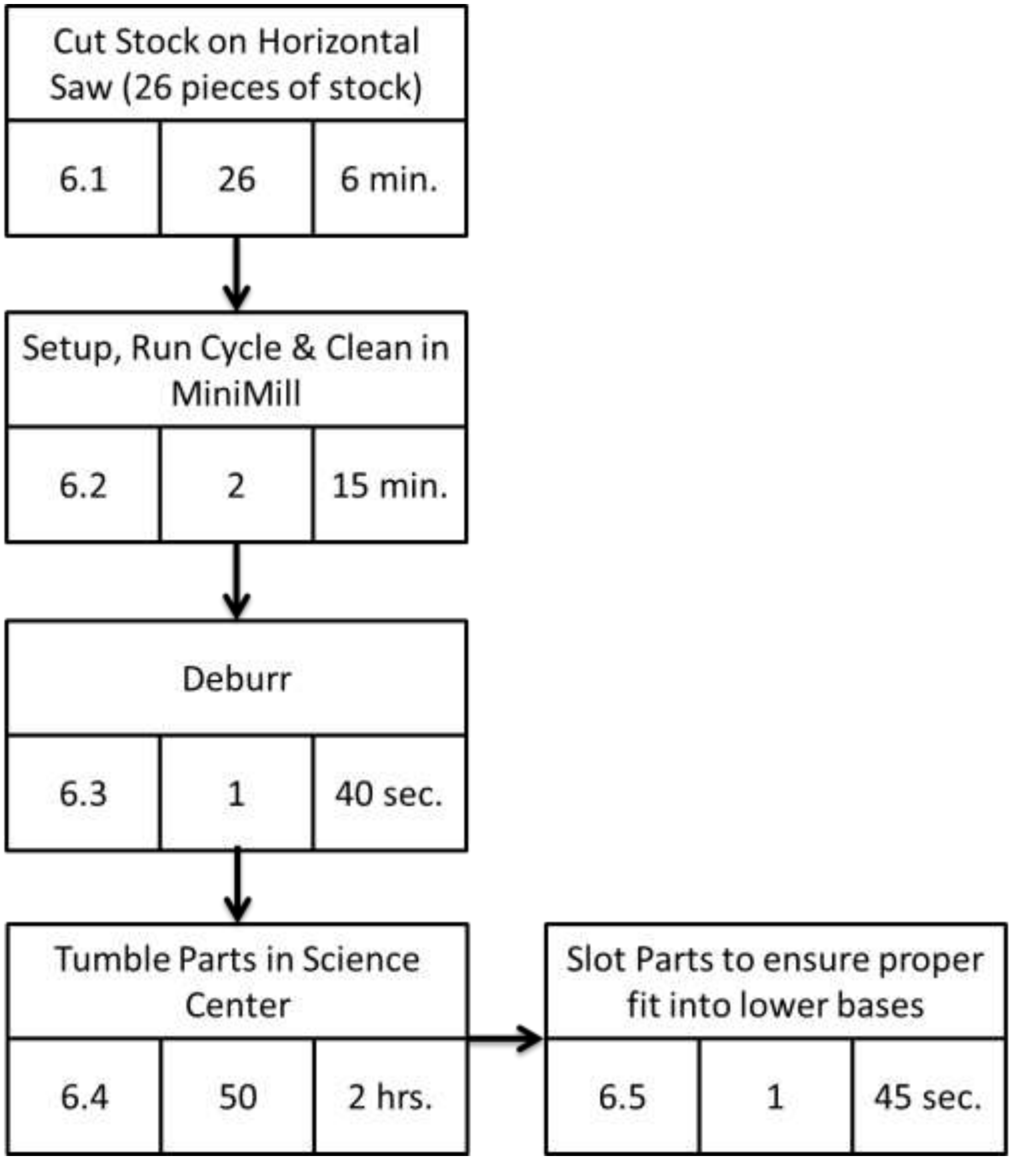
Material Resource Planning
Length of Part: 5.625 in
Total Length: 400 X 5.625in X 1ft/12in = 187.5 feet
Material Dimension: ¾ in X ¾ in X 1/8 in (USE 1/16" Stock for more efficient production)
Notes: Use 1/16" Stock, 1/8" that was used leads to many issues that cause over 300% increase in cycle time.

Budget Allocation
Cost per stock length (8 Feet): $9.35
Total Cost: 26 units * $9.35 = $243.10
Notes: Material will be obtained from Grainger http://www.grainger.com/Grainger/UChannel-6ALY7?Pid=search.

Responsible Team Member (s)		**Date**
Research & Cost:	Browne, T., Koo, W., Pacifico, C.	

Design:	Stacy, D., Terranova, V., Wraight, S., Zavos, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.7.1: Back Support – Process Schematic



Step	Time Required	# Required	Total Time
6.1	6 min.	26	2 hrs. 36 min.
6.2	15 min.	400	50 hrs.
6.3	40 sec.	400	4 hrs.27 min.
6.4	2 hrs.	400	16 hrs.
6.5	45 sec.	400	5 hrs.
		Total Production Time	78 hrs 3 min

4.8: Axle (BOM #7) – General Information

Part Number	7
Drawing Number	12CandyA_Axle07_C_051016
Assembly Reference Drawing Number	7

Part Description	
Function: The axle will be connected to both the front (12CandyA_FrontSupport05_C_031108) and back (12CandyA_BackSupport06_C_071108) supports. Attached between the two supports will be the candy wheel itself (12CandyA_CandyWheel_MA_061203) but specifically, the jar (12CandyA_Jar04_C_021017) will be the main interface. Two axle pins (12CandyA_AxlePin14_C_041206) will also act as caps to ensure the fixed position of the product. Finally, the axle will be attached to a pulley (12CandyA_DriveBeltCarrier16_C_061108).	
Material: 1018 Cold Rolled Steel	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for front supports, back supports, and pins: RC 6 Nominal Size: 0.1875 in. Max Shaft: 0.1867 in.

	Min Shaft: 0.1860 in. Max Clearance: 0.0027 in. Min Clearance: 0.0008 in. Fit for axle in jar: LC 6 Nominal Size: 0.1875 in. Max Shaft: 0.1871 in. Min Shaft: 0.1864 in. Max Clearance: 0.0027 in. Min Clearance: 0.0008 in.
Notes: The axle will be turned down from square steel stock, save for one section which will allow the wheel to be turned. Source: Machinery's Handbook 28 ed.	
Design Changes: Length modified to be shorter to accommodate new assembly & also reduced circular section to reduce cycle time.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for CNC machining the axle.	
Primary Process: CNC, Knurling	
Justification: Speed, cost, precision	
Machine Tool: Haas SL-10 CNC Lathe	
Associated Calculations:	Speed: RPM = 12 X Cutting Speed / π X Diameter Approximating 3 for π RPM = 4 X 100ft/min / 0.1875 = 2133.3 RPM Feed: $F = S_z \text{ X } N_t \text{ X } N$ F = 0.002 X 1 X 2133.3 = 4.2667
Notes: A knurling operation will also be performed on both ends of the axle to ensure the fit of the axle pins	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the axle fits into all holes, (those in the front support, back support, jar, pulley, and axle pins). All tolerances need to be ± 0.001 in. or as tight as possible.

Surface Finishing Requirements
Knurling

Tools, Tooling, and Fixture Drawing Number(s)
N/A

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_Axle07_QC307_011206 Measurements: Measure the dimensions of the axle with a micrometer.

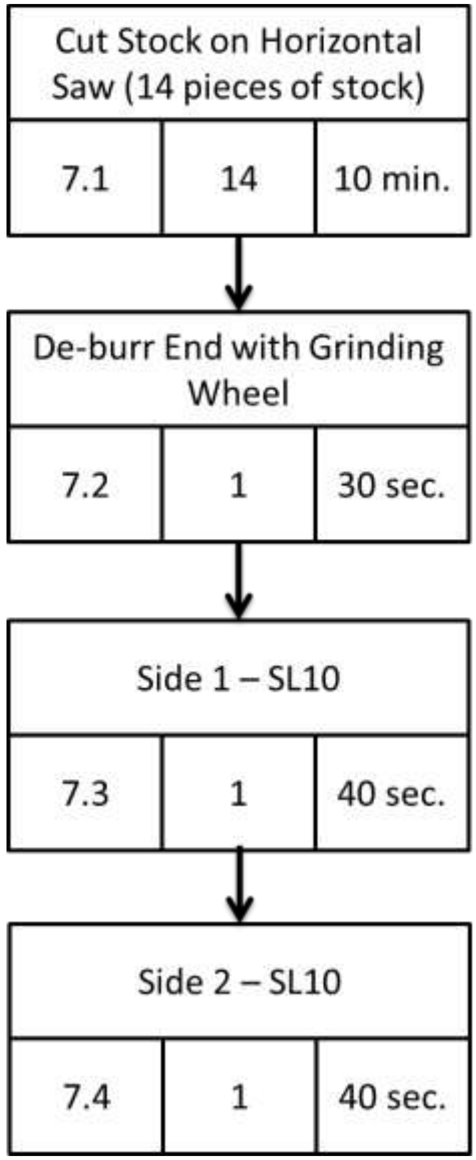
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Axle07_C_021016 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_Axle07_HL_010419

Material Resource Planning
Length of Part: 3 in
Total Length: 400 X (3 in + 0.1875) X 1ft/12in = 106.25 ft
Density of Material: 0.284 lb/in^3
Material Dimension: 3/16 in. X 3/16 in. X 8 in.
Notes: N/A

Budget Allocation
Cost per stock (8 feet): $6.71
Total Cost: 14 units * $6.71/units = $94.10
Notes: Material will be obtained from Stock Car Steel http://www.stockcarsteel.com/cold-rolled-steel-bar/cold-rolled-1018-steel-square-bar.

Responsible Team Member (s)		Date
Research & Cost:	Browne, T., Koo, W., Pacifico, C.	
Design:	Zavos, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.8.1: Axle – Process Schematic



Step	Time Required	# Required	Total Time
7.1	10 min.	14	2 hrs. 20 min.
7.2	30 sec.	400	3 hrs. 20 min.
7.3	40 sec.	400	4 hrs.27 min.
7.4	40 sec.	400	4 hrs.27 min.
		Total Production Time	14 hrs. 34 min

4.9: Drive Belt (BOM #8) – General Information

Part Number	8
Drawing Number	See attached specifications
Assembly Reference Drawing Number	8

Part Description	
Function: The drive belt will drive the pulleys (12CandyA_DriveBeltCarrier16_C_061108), (12CandyA_MotorDriveBeltCarrier20_C_051129) as they are powered by the DC Motor.	
Material: N/A	
Number Required: 400	
Make or Buy Component: Buy	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan
Description: This part is a purchased part that will be ready for assembly upon receipt.
Primary Process: N/A
Justification: Need for a belt to drive the Candy Wheel
Machine Tool: N/A

Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: Visual Inspection as necessary

CAD, CAM, AWJ, LASER File Names/Location
CAD: N/A CAM: N/A AWJ: N/A LASER: N/A

Material Resource Planning
Volume of Part: N/A
Density of Material: N/A
Weight of Material: N/A
Notes: N/A

Budget Allocation
Cost per unit: $0.26
Cost per bag: 50 X $0.26 = $13.00
Notes: Material will be obtained from Motion Industries (http://www.motionindustries.com/motion3/jsp/mii/parametricSearchSecondaryMI.jsp?AM_ACTION=ParametricSearchSecondaryAM&LANGUAGE=0&AM_FIRST=Y&LINE_NO=3&SR_LINE_NO=2&SEARCH_DESC=00614683&SEARCH_FIELD=M&MFR_PART_NO=042+BUNA-N+O-RING+%2850+PER+BAG%29&BUS_ACTION=details&display_option=N&CAT_GRP_CD=02030800&var1=3&var2=00614683&KeepThis=true&TB_iframe=true&height=500&width=600)

Responsible Team Member (s)		Date
Research & Cost:	Koo., W., Robinson, J., Wraight, S.	
Design:	N/A	
CAD:	N/A	
Documentation:	Snyder, M.	

4.9.1: Drive Belt – Purchase Information

O-RING

Print

Item Number	00614683
Description	042, 90 Durometer 50 Per Bag O-Ring
MFG. Part Number	042
Manufacturer	O-RING
Available Inventory	In Stock
Price	$0.26
Input QTY	add

PRIMARY PARAMETERS:

Description: O-Ring

Inside Diameter: 3-1/4"

Outside Diameter: 3-3/8"

Cross Section: 1/16"

Material: Buna-N

Standard Package Quantity: 50 Per Bag

SECONDARY PARAMETERS

TYPICAL APPLICATION: Use With Abrasive Or High Pressure Applications

TRADE/BRAND NAME: Chemigum, Nysyn, Krynac, Hycar, Paracril, Perbunan

TEMPERATURE RANGE: Minus 40° To 275°

ADDITIONAL DETAIL: Listed With Underwriter's Laboratories

INSIDE DIAMETER TOLERANCE: 3.239 Plus Or Minus .024

CROSS SECTION TOLERANCE: .070 Plus Or Minus .003

HARDNESS: 90 Durometer

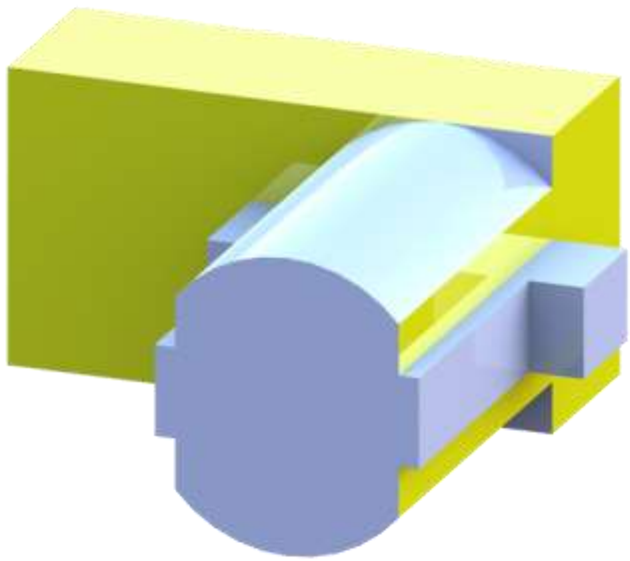
BACK UP ORING NUMBER: 8-042

METHOD SOLD: Priced Per Each

QUAD O-RING NUMBER: Qr-4042

4.10: Motor (BOM #9) – General Information

Part Number	9
Drawing Number	12CandyA_Motor09_PC_021108
Assembly Reference Drawing Number	9



Part Description	
Function: The motor will be secured to the lower base (12CandyA_LowerBase12_C_041112) and attached to the drive belt (12CandyA_MotorDriveBeltCarrier20_C_051129). It will be used to drive the Candy Wheel.	
Material: N/A	
Number Required: 400	
Make or Buy Component: Buy	
Associated Calculations:	Torque: Volume of Gobstopper: 0.065 in^3 Weight of Gobstopper: 0.0037 lbs Jar Holding volume: 7.5 in^3 X 50% Packing Factor Adjusted Jar Volume: 3.75 in^3 Gobstoppers in Jar: 3.75 in^3 / 0.065 in^3 = 57.69 Gobstoppers Actual Counted Gobstoppers in Jar: Estimated Weight: 57.69 X 0.0037 lbs = 0.213 lbs Actual Weight: 46 X 0.0037 lbs = 0.1702 lbs Weight of Carts: 0.21 in^3 X 0.034 lb/in^3 X 8 = 0.0571 lbs

	Weight of Lid: 0.065 in^3 X 0.034 lb/in^3 = 0.0022 lbs Weight of Struts: 2.61 in^3 X 0.0426 lb/in^3 X 2 = 0.2224 lbs Weight of Jar: 1.576 in^3 X 0.0379 lb/in^3 = 0.0597 lbs Weight of Doser: 0.77 in^3 X 0.034 lb/in^3 = 0.0262 lbs Total Weight: 0.5806 lbs Using CAD analyses, it was determined that the C.O.M. of the previous is approximately 0.5" from the center of the wheel. Frictional Forces: 0.47 X 0.5806 lbs = 0.2729 lbs Torque: (0.5806 lbs + 0.2729 lbs) X 0.5" = 0.4268 in-lbs
Notes: Purchased from TTMotors, model number TGP01S-A130 18100-220 or TGP02S-A130 18100-220. In the event that the motor cannot produce the necessary torque (as all calculations are sound, but also ideal, neglecting friction) or exceeds cost limits, the motor and all related components; drive belt, drive belt carriers (12CandyA_DriveBeltCarrier16_C_061108), (12CandyA_MotorDriveBeltCarrier20_C_051129) battery mount, on switch, and the motor fastener (12CandyA_MotorStrap19_C_021108) can be removed. Source for coefficient of friction: http://www.engineershandbook.com/Tables/frictioncoefficients.htm.	
Design Changes: Wrong motor was purchased leading to the need to purchase new screws to attach the motor to the motor strap, changing the motor strap to accommodate the new screw location, and modifying the location of the hole in the lower base for the motor.	

Proposed Manufacturing Process Plan	
Description: This part is a purchased part that will be ready for assembly upon receipt.	
Primary Process: N/A	
Justification: Need for a power source to drive the Candy Wheel	
Machine Tool: N/A	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

Quality Control Process
N/A

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Motor09_PC_021108

Material Resource Planning
Volume of Part: N/A
Density of Material: N/A
Weight of Material: N/A
Notes: N/A

Budget Allocation
Cost per unit: $0.80/Unit
Material Cost: $0.80 X 400 = $320.00
Notes: Material will be obtained from TTMotors http://www.ttmotor.com/.

Responsible Team Member (s)		**Date**
Research & Cost:	McDonald, R., Snyder, M.	
Design:	N/A	
CAD:	N/A	
Documentation:	Snyder, M.	

4.10.1: Motor – Purchase Information

TTMOTOR

Products Search:

All Size GO

Home
About Us
Company Profile Factory Site Equipment Quality Certification Contact Us
Products
DC Motor Gear Motor Stepping Motor Brushless Motor
Application
Automobiles Robot Medical System Home Appliances Electric Tools Security System Instruments and Meters
Technical Support
Structure
Contact

Model: TGP02S-A130

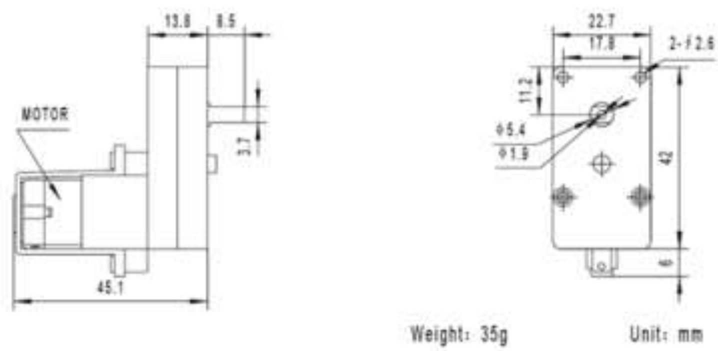
Gear Motor

Applications
Electric Tools Robot Medical System Home Appliances Automobiles

Description

Reduction Ratio:

1/48、1/120、1/180、1/220、1/288

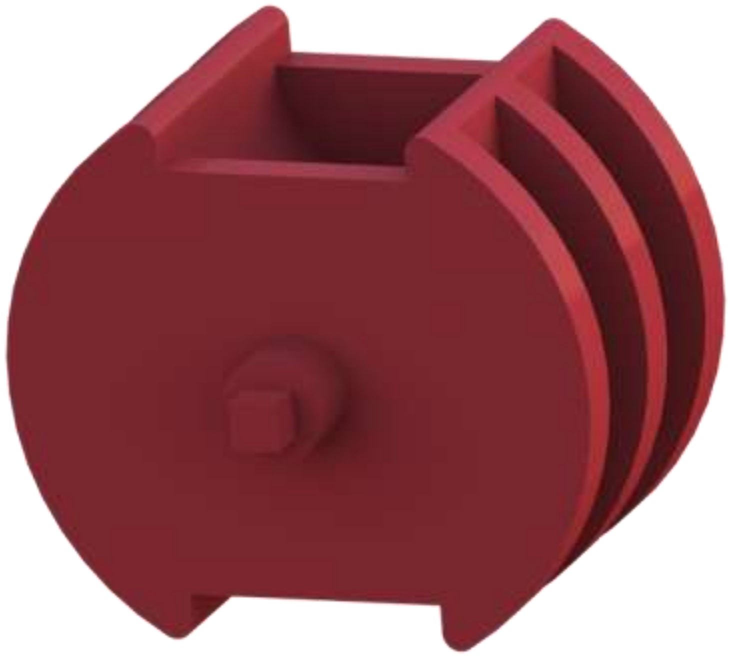


MODEL		VOLTAGE OPERATING RANGE	NOMINAL	NO LOAD SPEED	NO LOAD CURRENT	AT LOAD SPEED	AT LOAD CURRENT	AT LOAD TORQUE		AT LOAD OUTPUT	STALL TORQUE		STALL CURRENT
			V	rpm	A	rpm	A	N.m	Kg.cm	w	N.m	Kg.cm	A
TGP02S-A130	10300-288	3.0-12.0	6	21	0.10	19	0.17	0.05	0.47	0.18	0.18	1.8	0.6
	14175-120	3.0-6.0	4.5	90	0.20	72	0.50	0.03	0.3	0.38	0.14	1.4	1.25
	12215-48	3.0-9.0	3.0	110	0.12	85	0.20	0.01	0.11	0.13	0.027	0.27	0.45
	18100-220	3.0-6.0	3.0	50	0.25	34	0.45	0.07	0.71	0.52	0.24	2.4	1.1

BACK CLOSE

4.11: Doser (BOM #10) – General Information

Part Number	10
Drawing Number	12CandyA_Doser10_C_061112
Assembly Reference Drawing Number	10



Part Description	
Function: The doser is the means by which candy is transported into the carts. It sits in the jar (12CandyA_Jar04_C_021017) and is turned by a gear (12CandyA_MainGear15_C_051017) attached to the outside of it upon passing a smaller gear (12CandyA_OuterGear13_C_051108). It also shares a surface with the struts (12CandyA_Struts03_C_061017).	
Material: Polypropylene - Red	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for jar: RC 7 Nominal Size: 0.8268 in. Shrinkage: 0.0165 in. Max Shaft: 0.8243 in. Min Shaft: 0.8231 in. Max Clearance: 0.0057 in.

	Min Clearance: 0.0025 in. Fit for doser shaft in struts: RC 7 Nominal Size: 0.2780 in. Max Shaft: 0.2764 in. Min Shaft: 0.2755 in. Max Clearance: 0.0039 in. Min Clearance: 0.0016 in.
Notes: Material consideration was of particular importance on the doser, as it could not be ultrasonically welded to the struts due to the fact that it needed to turn. Thus Polypropylene was chosen, considering that material does not weld to Acrylic. Source: Machinery's Handbook 28 ed.	
Design Changes: None	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for molding the doser.	
Primary Process: Plastic Injection Molding – Mold B1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated **Calculations:**	Draft Angle: 2 degrees on all surfaces. Melting Temp: 350°F Injection Molding Temperature: 120°F Specific Heat: 0.406-0.478 BTU/lb°F Mass: 0.032 lbs Density: 0.033 lb/in^3 Shrinkage: Range of 0.010 – 0.030 Average: 0.020 Shrinkage allowable: 2.00% Cycle Time: 55 sec. (per injection)

Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, Polypropylene

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where a 0.28 in. diameter shaft of the doser fit through an opening in the struts. Tolerances should be ± 0.003 in. for this shaft. After 0.12 in., the larger shaft is stepped down to a small shaft, which should have a tolerance of ± 0.001 in. or as tight as possible.

Surface Finishing Requirements
Remove flashing if any.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: Measure the Doser gear shaft with a micrometer.

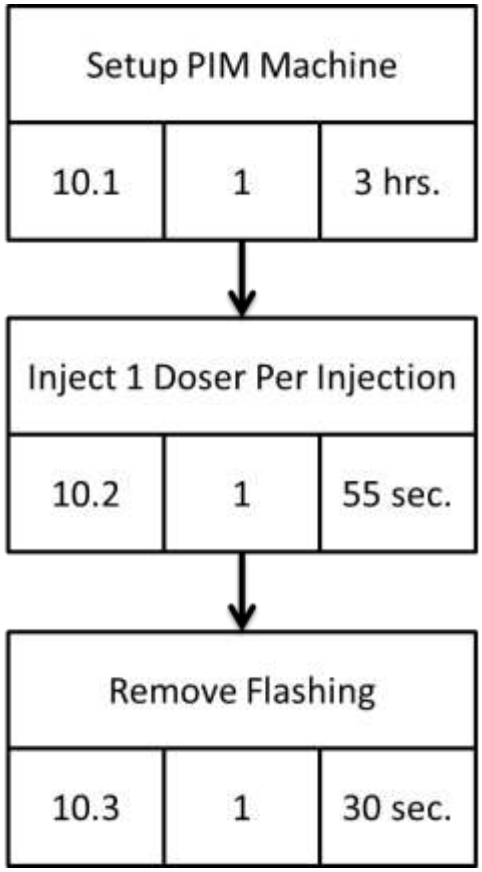
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Doser10_C_071126 CAM: N/A AWJ: N/A LASER: N/A

Material Resource Planning
Volume of Part: 0.982in^3
Density of Material: 0.033 lb/in^3
Weight of Material: 0.982 in^3 X 0.033 lb/in^3 X 400 X 1.2 = 15.55 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Stacy, D.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

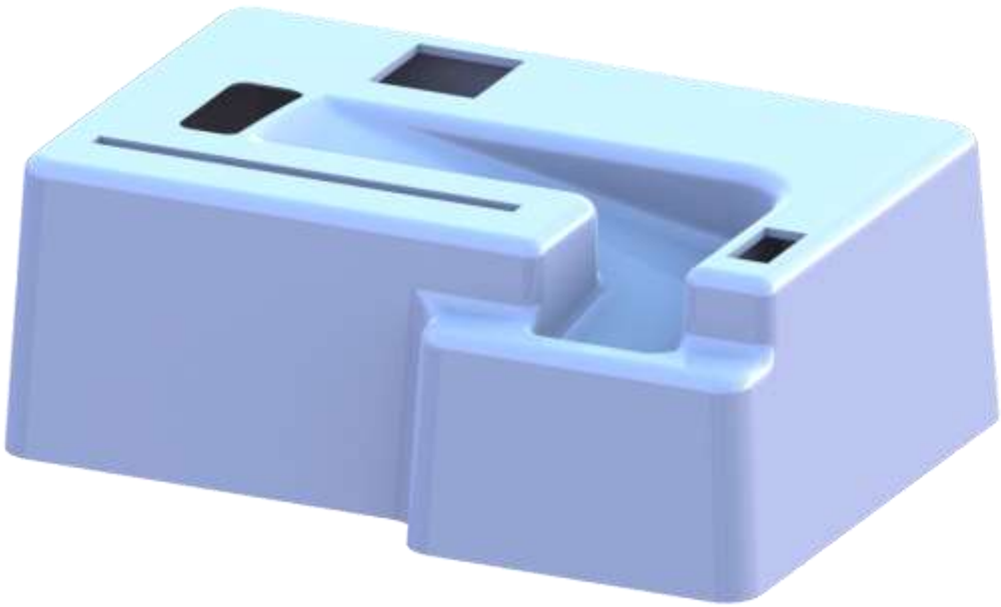
4.11.1: Doser – Process Schematic



Step	Time Required	# Required	Total Time
10.1	3 hrs.	1	3 hrs.
10.2	55 sec.	400	6 hrs. 7 min.
10.3	30 sec.	400	3 hrs. 20 min.
		Total Production Time	12 hrs. 27 min

4.12: Upper Base (BOM #11) – General Information

Part Number	11
Drawing Number	12CandyA_UpperBase11_C_041112
Assembly Reference Drawing Number	11



Part Description	
Function: The upper base provides a tray for candy delivery to the end-user. It is assembled through an interface with the front support (12CandyA_FrontSupport05_C_031108) and the rear support (12CandyA_BackSupport06_C_071108). It will fit via an interference fit with the lower base (12CandyA_LowerBase12_C_041112).	
Material: Polystyrene	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for lower base: FN1 Nominal Size: 5.5000 in. Max Hole: 5.5010 in. Min Hole: 5.5000 in. Max Interference: 0.0029 Min Interference: 0.0012
Notes: Source: Laser Study, Appendix A, B.	
Major Design Changes: The bump has been removed due to the issues it has created during	

operation of the final product.

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for vacuum forming the upper base.	
Primary Process: Vacuum Forming, Lasercutting	
Justification: Easy production method for mass production	
Machine Tool: Formech 660 Vacuum Former, Hurricane Lasers, Charlie Model	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the upper base fits over the lower base. The tolerance is ± 0.002 in. for the said interface. It should be noted that any features cut into the upper base with a laser cutting operation will most likely only be able to be held to a tolerance of ± 0.003 in., as specified by the Laser Study, Appendix A, B.

Surface Finishing Requirements
None.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_UpperBase11_T124_041206 FIXTURE: 12CandyA_UpperBaseLaserFixture400_PF400_011206

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Drawing(s) > 12CandyA_UpperBase11_C_051203 CAM: N/A AWJ: N/A

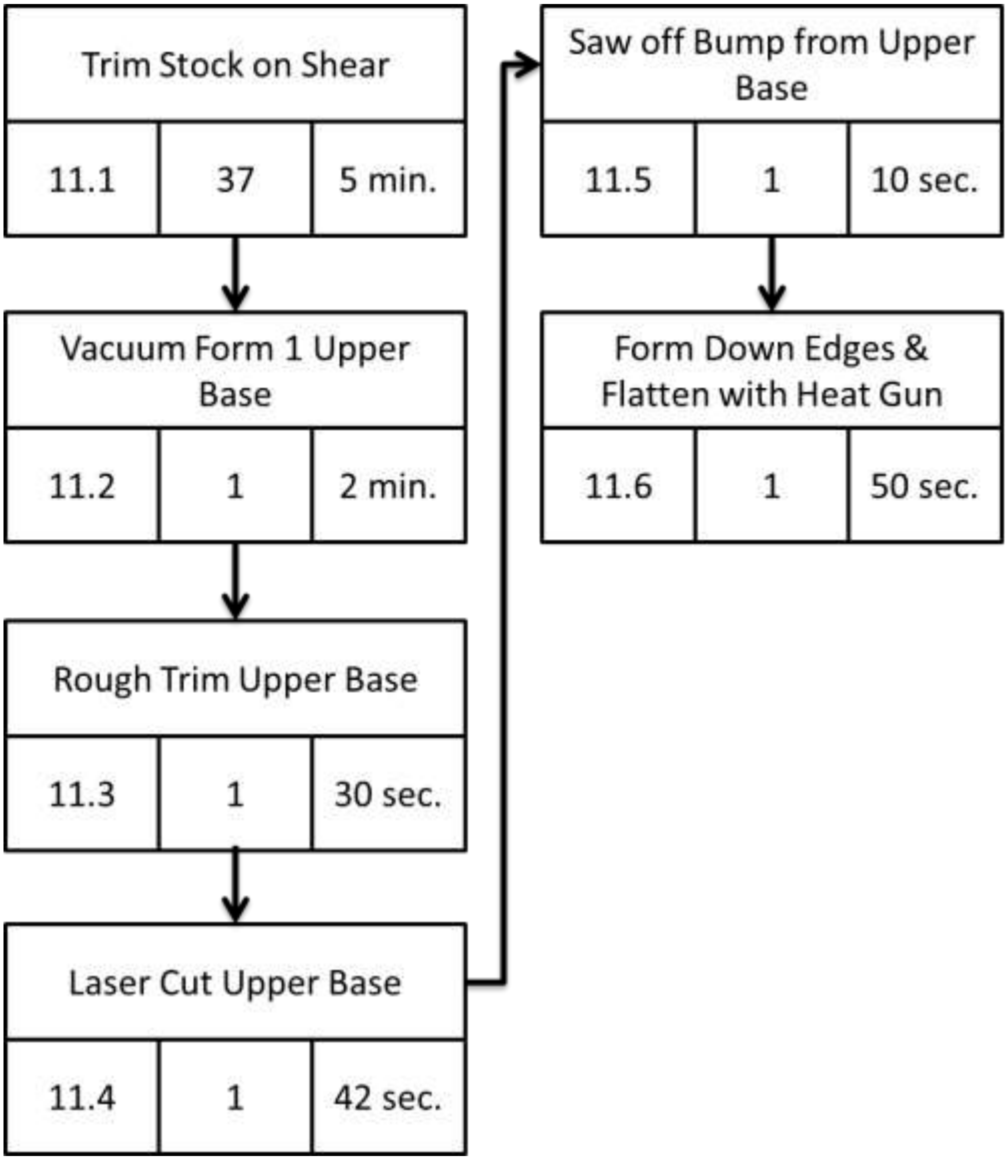
LASER: AML > 1213_Team_A > Shared Documents > Laser Code > Upper Base AML > 1213_Team_A > Shared Documents > Laser Code > Upper Base Perimeter

Material Resource Planning
Area of Part: N/A
Material Dimensions: 15 in. X 66 in. 0.08 in.
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	McDonald, R., Wraight, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

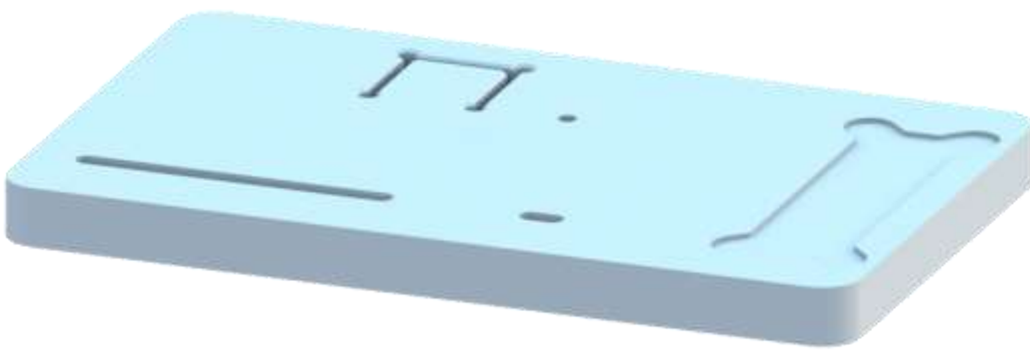
4.12.1: Upper Base – Process Schematic



Step	Time Required	# Required	Total Time
11.1	5 min.	37	3 hrs. 5 min.
11.2	2 min.	400	13 hrs. 20 min.
11.3	30 sec.	400	3 hrs. 20 min.
11.4	42 sec.	400	4 hrs. 20 min.
11.5	10 sec.	400	1 hr. 7 min.
11.6	50 sec.	400	5 hrs. 35 min.
		Total Production Time	29 hrs. 42 min.

4.13: Lower Base (BOM #12) – General Information

Part Number	12
Drawing Number	12CandyA_LowerBase12_C_041112
Assembly Reference Drawing Number	12



Part Description	
Function: The lower base supports the entire candy wheel (12CandyA_CandyWheel_MA_061203) through an interference fit with the front support (12CandyA_FrontSupport05_C_031108) and the rear support (12CandyA_BackSupport06_C_071108). It will fit via an interference fit with the upper base (12CandyA_UpperBase11_C_041112). In addition, it will house the electronic components used to power the wheel.	
Material: Polycarbonate (Lexan)	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for upper base: FN1 Nominal Size: 5.5000 in. Max Shaft: 5.5029 in. Min Shaft: 5.5022 in. Max Interference: 0.0029 in.

	Min Interference: 0.0012 in. Fit for front support: FN1 Nominal Size: 0.1400 in. Max Hole: 0.1403 in. Min Hole: 0.1400 in. Max Interference: 0.0006 in. Min Interference: 0.0001 in. Fit for rear support: FN1 Nominal Size: 0.0600 in. Max Hole: 0.0603 in. Min Hole: 0.0600 in. Max Interference: 0.0005 in. Min Interference: 0.0001 in.
Notes: N/A	
Design Changes: Modified location of motor strap hole to accommodate new motor design. Added a 2° taped to the front support channel & a 45° on the back support slots to better facilitate assembly.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for waterjet cutting and milling the lower base.	
Primary Process: Abrasive Waterjet, Milling	
Justification: Simple cuts made on plastic; Lexan cannot be cut with the laser cutter, required accuracy can't be attained with the Abrasive Waterjet, so Milling must be used.	
Machine Tool: Pinnacle M-40, 4 Axis Mill	
Associated Calculations:	AWJ Settings: Material Setting: 17.92 - Nylon Speed: 40%

	Time: 1’50” Milling Values: Speed: RPM = 12 X Cutting Speed / π X Diameter Approximating 3 for π RPM = 4 X 330ft/min / 0.25 = 5280 RPM Feed: $F = S_z$ X N_t X N F = 0.003 X 2 X 5280 = 31.7 in/min
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the upper base fits over the lower base, which can be held to ± 0.002 in. The tolerance for the back support can only be held to a value of ±0.03, due to the accuracy of the waterjet. The remaining tolerance for the front support should be held to ± 0.001 in. or as close as possible.

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
N/A

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_LowerBase12_QC3121_011206 AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_LowerBase12_QC3122_011206 AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_LowerBase12_QC3123_011206 Measurements: N/A

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_LowerBase12_C_041112

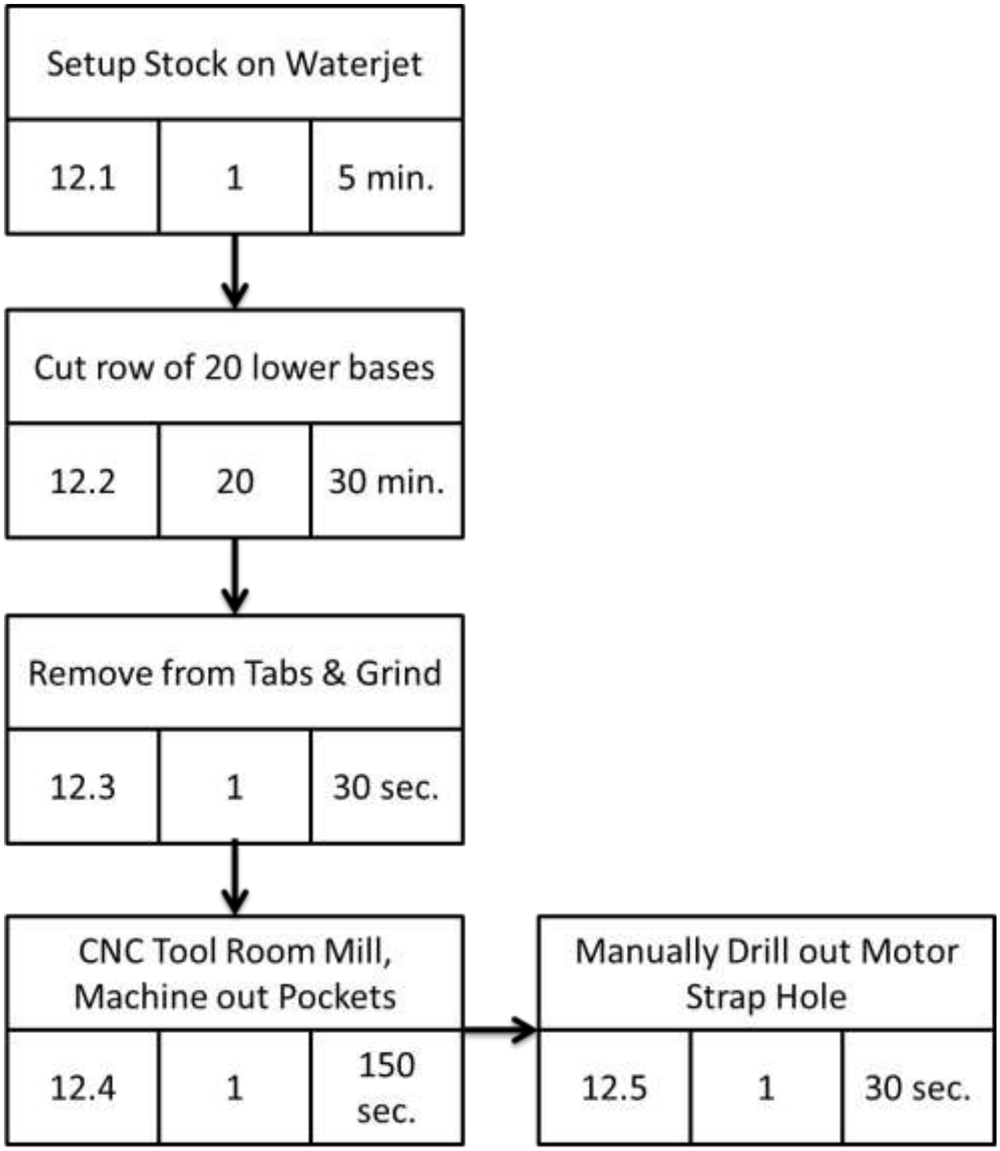
CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_LowerBase12_HM_010321 AWJ: AML > 1213_Team_A > Shared Documents > AWJ Code > 12CandyA_LowerBase12_WJ412_031129

Material Resource Planning
Material Dimensions: 41 in. X 58 in. X 0.35 in.
Notes: N/A

Budget Allocation
AWJ Cost per Part: $0.43
AWJ Total Cost: $170.00
Notes: Material will be obtained free of charge from the MILL, cost accrued from AWJ cutting.

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Wraight, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.13.1: Lower Base – Process Schematic



Step	Time Required	# Required	Total Time
12.1	5 min. (per 20)	20	1 hrs. 40 min.
12.2	30 min. (per 20)	20	10 hrs.
12.3	30 sec.	400	3 hrs. 20 min.
12.4	150 sec.	400	16 hrs. 40 min.
12.5	30 sec.	400	3 hrs. 20 min.
		Total Production Time	23 hrs.

4.14: Outer Gear (BOM #13) – General Information

Part Number	13
Drawing Number	12CandyA_OuterGear13_C_051108
Assembly Reference Drawing Number	13

Part Description	
Function: The outer gear is a stationary gear that snaps into the front support (12CandyA_FrontSupport05_C_031108). When the doser, which is connected to the main gear (12CandyA_MainGear15_C_051017) passes by the stationary, outer gear (12CandyA_OuterGear13_C_051108), it will turn the doser (12CandyA_Doser10_C_061112), causing a candy to fall into the cart (12CandyA_Cart01_C_061206).	
Material: ABS - Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for outer gear shafts: LC3 Nominal Size: 0.0800 in. Shrinkage: 0.0005 in. Max Shaft: 0.0800 in. Min Shaft: 0.0706 in.

	Max Clearance: 0.0010 in. Min Clearance: 0.0000 in. Fit for main gear: Setting at ± 0.001 in.
Notes: Due to tolerances of machine and tolerance table http://www.engineersedge.com/gears/gear_toleances_fine_pitch.htm we can use total tolerances ranging from 0.0010 to 0.0014 in.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for injection molding the outer gear.	
Primary Process: Plastic Injection Molding – Mold A1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.001 lbs Density: 0.038 lb/in^3 Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time: 45 sec (per injection)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
Remove flashing if any

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldA100_T100_011206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

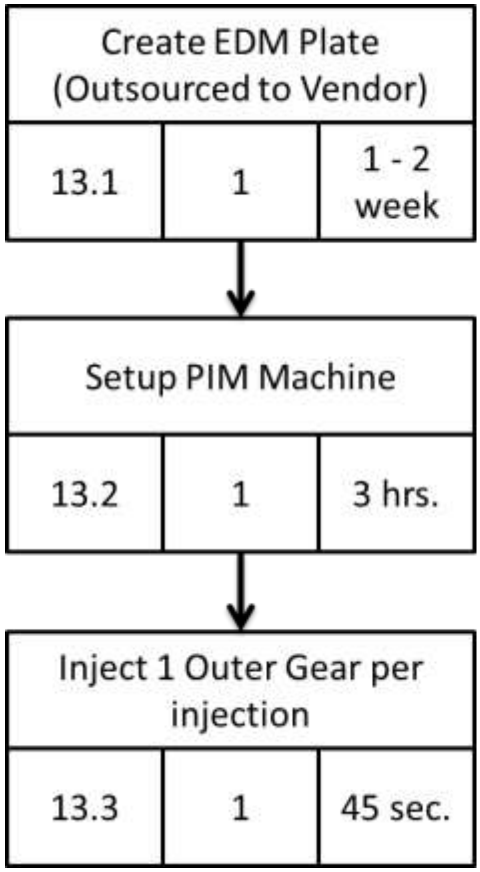
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_OuterGear13_C_081126 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_OuterGear13_HM213f_011207 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_OuterGear13_HM213m_011207 AWJ: N/A LASER: N/A

Material Resource Planning
Volume of Part: 0.024 in^3
Density of Material: 0.038 lb/in^3
Weight of Material: 0.024 in^3 X 0.038 lb/in^3 X 400 X 1.2 = 0.438 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Stacy, D., Robinson, J., Zavos, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	M. Snyder	

4.14.1: Outer Gear – Process Schematic



Step	Time Required	# Required	Total Time
13.1	1 -2 weeks lead time	1	--
13.2	3 hrs.	1	3 hrs.
13.3	45 sec.	400	5 hrs.
		Total Production Time	8 hrs.

4.15: Axle Pin (BOM #14) – General Information

Part Number	14
Drawing Number	12CandyA_AxlePin14_C_041206
Assembly Reference Drawing Number	14

Part Description	
Function: The axle pin is a simple piece to prevent sliding of the wheel off of the axle. It is connected to the axle (12CandyA_Axle07_C_051016) via a clearance fit.	
Material: Polypropylene - Red	
Number Required: 800	
Make or Buy Component: Make	
Associated Calculations:	Fit for axle pins: RC6 Nominal Size: 0.1875 in. Shrinkage: 0.0011 in. Max Hole: 0.1887 in. Min Hole: 0.1875 in. Max Clearance: 0.0027 in. Min Clearance: 0.0008 in.
Notes: Source: Machinery's Handbook 28 ed.	
Design Changes: Added RPI Text to pin for ascetics purposes.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for injection molding the axle pins.	
Primary Process: Plastic Injection Molding – Mold B1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 350°F Injection Molding Temperature: 120°F Specific Heat: 0.406-0.478 BTU/lb°F Mass: 0.005 lbs Density: 0.033 lb/in^3 Shrinkage: Range of 0.010 – 0.030 Average: 0.020 Shrinkage allowable: 2.00% Cycle Time: 55 sec. (per injection)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the axle pins fit over the axle. This tolerance will be ± 0.001 in., as dictated by 2.00% shrinkage.

Surface Finishing Requirements
Remove flashing if any

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldB200_T200_011206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

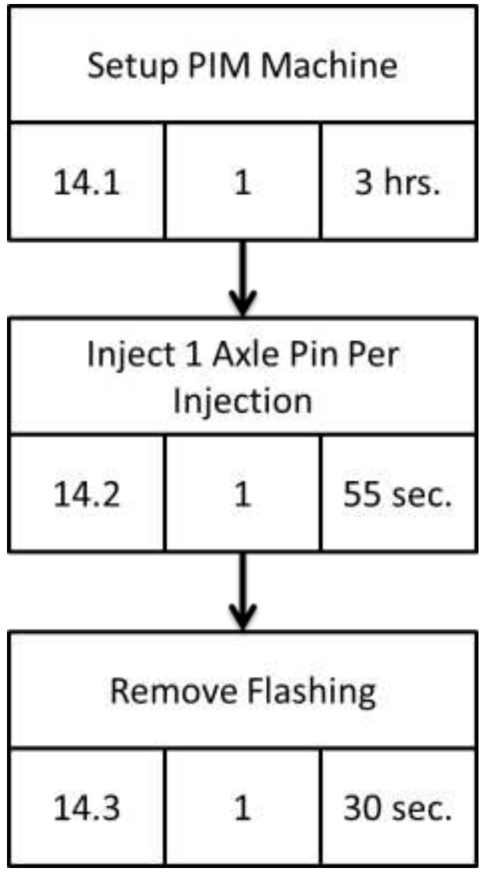
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing >12CandyA_AxlePin14_C_051126 CAM: N/A AWJ: N/A LASER: N/A

Material Resource Planning
Volume of Part: 0.163 in^3
Density of Material: 0.033 lb/in^3
Weight of Material: 0.163 in^3 X 0.033 lb/in^3 X 800 X 1.2 = 5.164 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	N/A	
Design:	Stacy, D., Zavos, S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

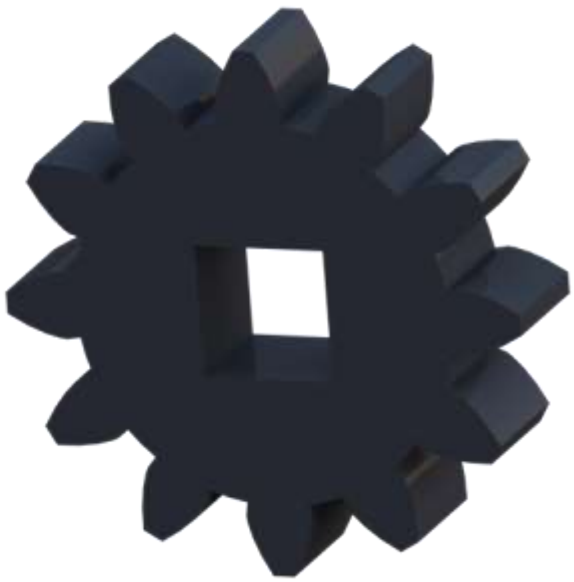
4.15.1: Axle Pin – Process Schematic



Step	Time Required	# Required	Total Time
14.1	3 hrs.	1	3 hrs.
14.2	55 sec.	400	6 hrs. 7 min.
14.3	30 sec.	400	3 hrs. 20 min.
		Total Production Time	12 hrs. 27 min.

4.16: Main Gear (BOM #15) – General Information

Part Number	15
Drawing Number	12CandyA_MainGear15_C_051017
Assembly Reference Drawing Number	15



Part Description	
Function: The main gear is attached to the doser (12CandyA_Doser10_C_061112). It turns the doser every time it passes by the fixed, outer gear (12CandyA_OuterGear13_C_051108).	
Material: ABS - Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for doser: FN 1 Nominal: 0.1250 in. Shrinkage: 0.0008 in. Max Hole: 0.1253 in. Min Hole: 0.1250 in. Max Clearance: 0.0006 in. Min Clearance: 0.0001 in. Fit for outer gear: Setting at ± 0.001 in.
Notes: Due to tolerances of machine and tolerance table	

http://www.engineersedge.com/gears/gear_toleances_fine_pitch.htm we can use total tolerances ranging from 0.0010 to 0.0014 in.

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for injection molding the main gear.	
Primary Process: Plastic Injection Molding – Mold A1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.001 lbs Density: 0.038 lb/in^3 Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time:
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the main gear snaps onto the doser. The tolerance is ± 0.001 in. or as close as possible.

Surface Finishing Requirements
Remove flashing if any

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldA100_T100_011206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_MainGear15_QC315_011206 Measurements: N/A

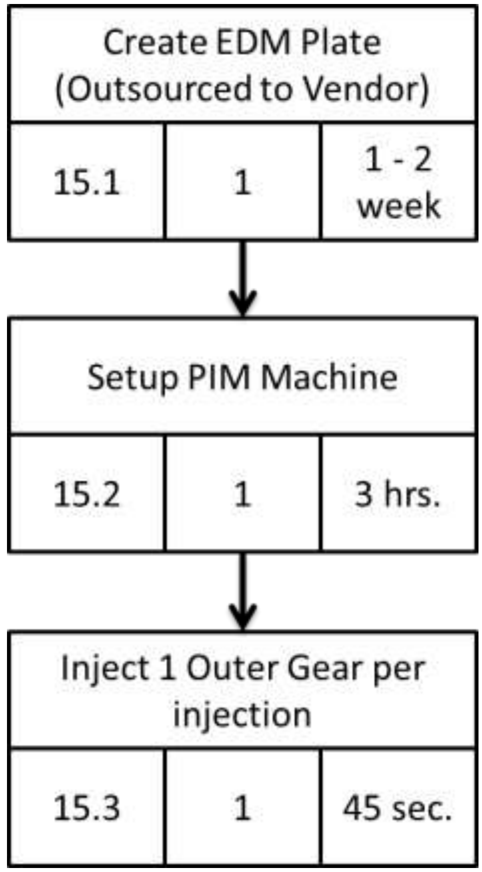
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_MainGear15_C_061126 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MainGear15_HM215f_011207 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MainGear15_HM215m_011207

Material Resource Planning
Volume of Part: 0.016in^3
Density of Material: 0.038 lb/in^3
Weight of Material: 0.016in^3 X 0.038 lb/in^3 X 400 X 1.2 = 0.295 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	N/A	
Design:	Stacy, D., Robinson, J.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

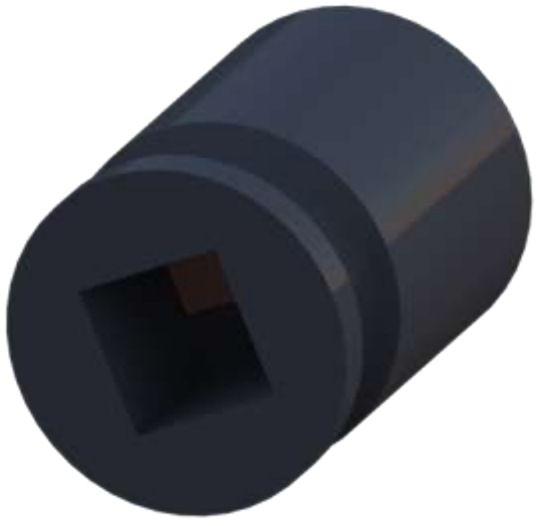
4.16.1: Main Gear – Process Schematic



Step	Time Required	# Required	Total Time
15.1	1 -2 weeks lead time	1	--
15.2	3 hrs.	1	3 hrs.
15.3	45 sec.	400	5 hrs.
		Total Production Time	8 hrs.

4.17: Drive Belt Carrier (BOM #16) – General Information

Part Number	16
Drawing Number	12CandyA_DriveBeltCarrier16_C_061108
Assembly Reference Drawing Number	16



Part Description	
Function: The drive belt carrier is a pulley that transfers power from the motor to the wheel via the drive belt. It is snap fit over the axle (12CandyA_Axle07_C_051016) to turn the candy wheel.	
Material: ABS - Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for Axle: FN 1 Nominal: 0.2000 in. Shrinkage: 0.0012 in. Max Hole: 0.2004 in. Min Hole: 0.2000 in. Max Clearance: 0.0008 in. Min Clearance: 0.0001 in.
Notes: Source: Machinery's Handbook 28 ed.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for injection molding the drive belt carrier.	
Primary Process: Plastic Injection Molding – Mold A1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.002 lbs Density: 0.038 lb/in^3 Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time: 45 sec. (per injection)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact Machine groove on manual lathe.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Tolerances, as specified by shrinkage, need to be ± 0.001 in. or as close as possible.

Surface Finishing Requirements
Remove flashing if any

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldA100_T100_011206 FIXTURE: 12CandyA_DriveBeltFixture300_T300_011206

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_DriveBeltCarrier16_QC316_011206 Measurements: N/A

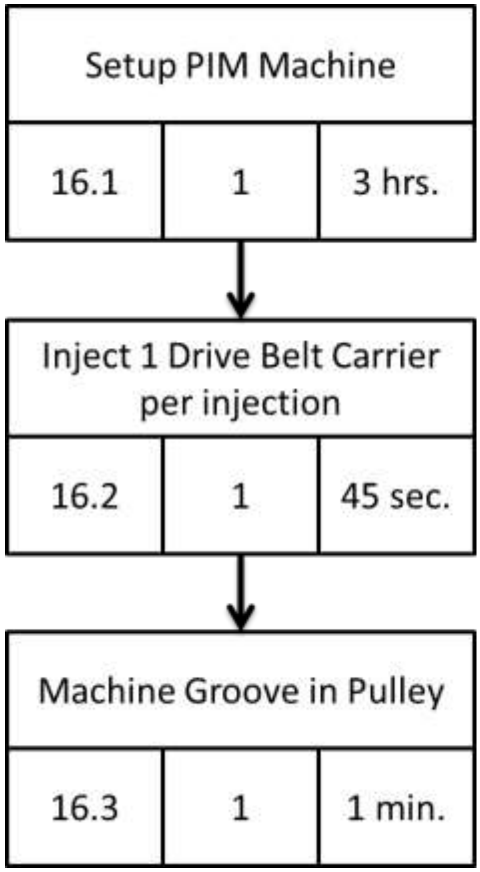
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_DriveBeltCarrier16_C_061126 CAM: N/A

Material Resource Planning
Volume of Part: 0.062 in^3
Density of Material: 0.038 lb/in^3
Weight of Material: 0.062 in^3 X 0.038 lb/in^3 X 400 X 1.2 = 1.131 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	N/A	
Design:	Stacy, D., Robinson, J.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

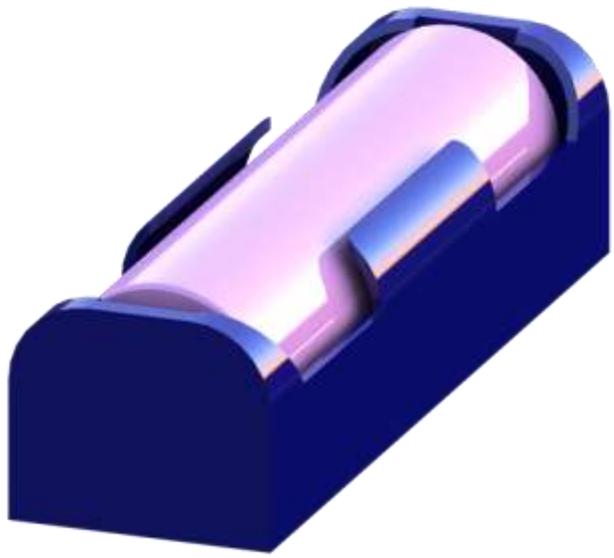
4.17.1: Drive Belt Carrier – Process Schematic



Step	Time Required	# Required	Total Time
16.1	3 hrs.	1	--
16.2	45 sec.	400	5 hrs.
16.3	1 min.	400	6 hrs. 40 min.
		Total Production Time	8 hrs.

4.18: Battery Mount (BOM #17) – General Information

Part Number	17
Drawing Number	12CandyA_BatteryMount12_PC_021107
Assembly Reference Drawing Number	17



Part Description	
Function: The battery mount will secure the batteries to the lower base (12CandyA_LowerBase12_C_041112).	
Material: N/A	
Number Required: 400	
Make or Buy Component: Buy	
Associated Calculations:	N/A
Notes: As described on the Mouser website, part number 12BH311A-GR, http://www.mouser.com/catalog/specsheets/EPD-200646.pdf	

Proposed Manufacturing Process Plan
Description: This part is a purchased part that will be ready for assembly upon receipt.
Primary Process: N/A
Justification: Need for a way to hold the batteries.

Machine Tool: N/A	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: Visual inspection as necessary

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BatteryMount17_PC_021107

Material Resource Planning
Volume of Part: N/A
Density of Material: N/A
Weight of Material: N/A
Notes: N/A

Budget Allocation
Cost per unit: $0.35
Total Cost: $156.15
Notes: N/A

Responsible Team Member (s)		Date
Research & Cost:	Gabai, J., Robinson, J.	
Design:	N/A	
CAD:	N/A	
Documentation:	Snyder, M.	

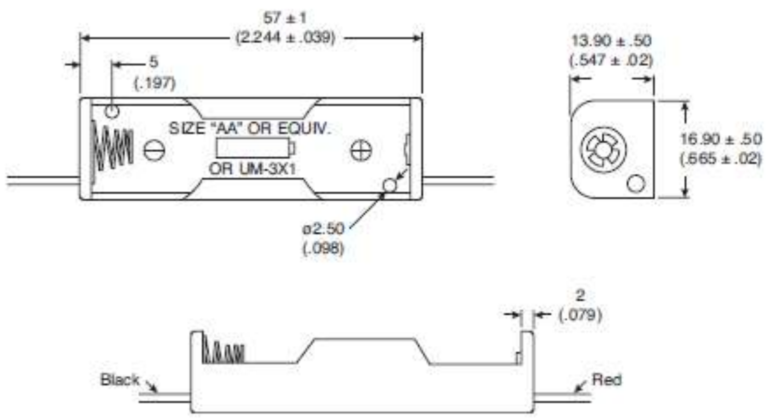
4.18.1: Battery Mount – Purchase Information

eagle plastic devices

1 "AA" Battery Holder with Leads

12BH311A-GR

Date Last Revised: 06-18-07



Dimensions: mm (in.)

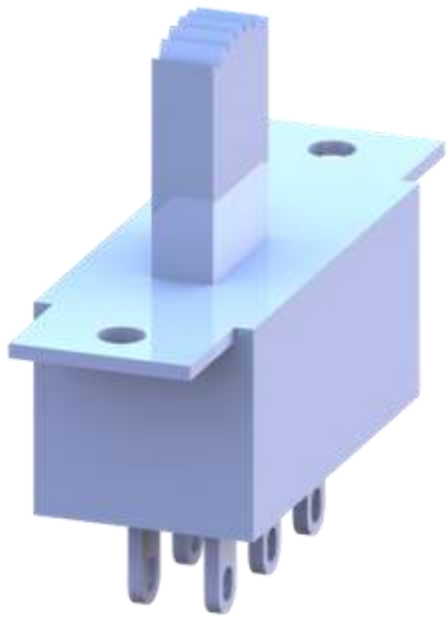
SPECIFICATIONS	
Wire:	AWG # 26 Black and red 150mm ± 5mm Strip and tin 5mm ± 1mm
Material:	PP Resin, black color
Spring:	0.6mm 65C spring wire
RoHS Compliant	

Available from Mouser Electronics
1-800-346-6873 / www.mouser.com

EPD-200646

4.19: On Switch (BOM #18) – General Information

Part Number	18
Drawing Number	12CandyA_OnSwitch18_PC_011107
Assembly Reference Drawing Number	18



Part Description	
Function: The on switch will activate the motor (12CandyA_Motor09_PC_021108).	
Material: N/A	
Number Required: 400	
Make or Buy Component: Buy	
Associated Calculations:	N/A
Notes: As specified by Digi-Key's website, part number CKN10381-ND, http://media.digikey.com/pdf/Data%20Sheets/C&K/SS-22F02-DG.pdf	

Proposed Manufacturing Process Plan
Description: This part is a purchased part that will be ready for assembly upon receipt.
Primary Process: N/A
Justification: Need for a way to activate the motor.
Machine Tool: N/A

Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

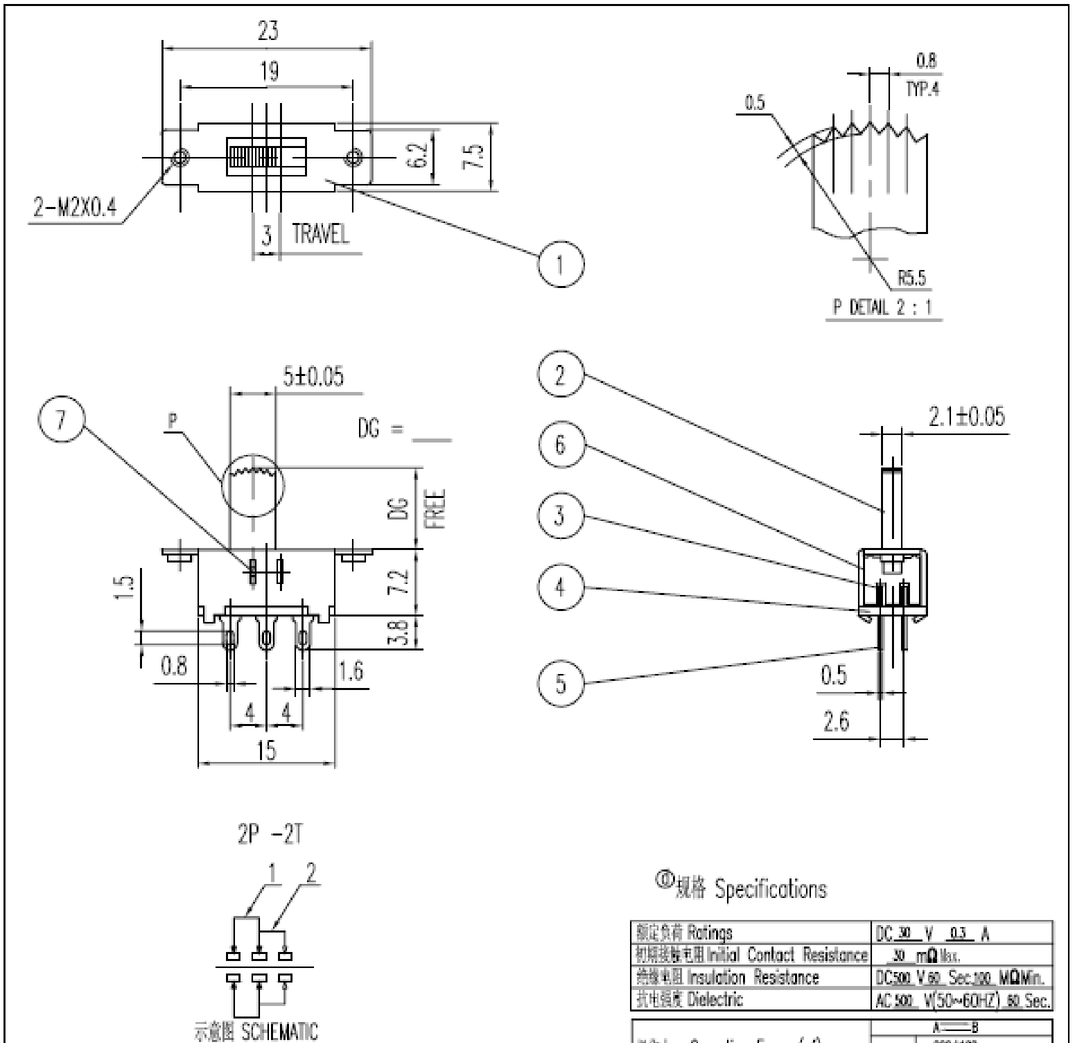
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_OnSwitch18_PC_011107 CAM: N/A AWJ: N/A LASER: N/A

Material Resource Planning
Volume of Part: N/A
Density of Material: N/A
Weight of Material: N/A
Notes: N/A

Budget Allocation
Cost per unit: $0.52
Total Cost: $208.00
Notes: N/A

Responsible Team Member (s)		**Date**
Research & Cost:	Terranova, V.	
Design:	N/A	
CAD:	N/A	
Documentation:	Snyder, M.	

4.19.1: On Switch – Purchase Information



ⓓ规格 Specifications

额定负荷 Ratings	DC 30 V 0.3 A
初期接触电阻 Initial Contact Resistance	30 mΩ Max.
绝缘电阻 Insulation Resistance	DC500 V 60 Sec.100 MΩMin.
抗电强度 Dielectric	AC 500 V(50~60HZ) 60 Sec.

操作力 Operating Force (gf)	A——B	200±100
	(L)	150±50
负载寿命 Operating Life With Load	10,000 次 Cycles	

序NO.	零件 PART	材料 MATERIAL	数量QTY	备注 REMARKS
7	钢珠 STEEL BALL	STEEL	2	NATURAL
6	弹簧 SPRING	STEEL	1	NATURAL
5	端子 TERMINAL	C2680R ⓔ	6	Ag PLATED
4	基板 TERMINAL BASE	PHENOL RESIN	1	BLACK
3	接触片 CONTACT	C5210R	2	Ag CLAD
2	胶柄 KNOB	P O M	1	DG 3, 6, 7
1	铁壳 FRAME	S P C C	1	BLACKENED Ni PLATED

标号 REV	内容 DESCRIPTION	签名 SIGN.	日期 DATE
A01	ADD: 规格 Specifications 见ⓓ C2680R-EH——C2680R 见ⓓ	王光云	06-04-12
03	见ⓒ	易金平	11 SEP 03

DWG NO. ITEM1672

TOLERANCES UNLESS OTHERWISE SPEC.	
UNDER 1	± 0.10
1 - 10	± 0.30
OVER 10	± 0.50

TITLE	SLIDE SWITCH		ITEM NO	SS-22F02-DG		
DRAWN	王光云	06-04-12	VERSION	A01	PAGE 1 OF 1	
REVIEWED	张念明	06-04-12	SCALE		UNIT	mm
APPROVED	林高全	06-04-12	PROJECTION			

COMAX ELECTRONICS (HUIZHOU) CO.,LTD.

ED37 版本:A01

4.20: Motor Strap (BOM #19) – General Information

Part Number	19
Drawing Number	12CandyA_MotorStrap19_C_021108
Assembly Reference Drawing Number	19

Part Description	
Function: The motor fastener will secure the motor to the lower base (12CandyA_LowerBase12_C_041112).	
Material: ABS - Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for Lower Base: FN1 Nominal Size: 0.12 in. Shrinkage: 0.0007 in. Max Shaft: 0.1206 in. Min Shaft: 0.1204 in. Max Interference: 0.0006 in. Min Interference: 0.0001 in.
Notes: Source: Machinery's Handbook 28 ed. In the event that glue can be used, this part will not be part of production.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for injection molding the motor fastener.	
Primary Process: Plastic Injection Molding – Mold A1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.001 lbs Density: 0.038 lb/in^3 Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time: 45 sec. (per injection)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldA100_T100_011206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

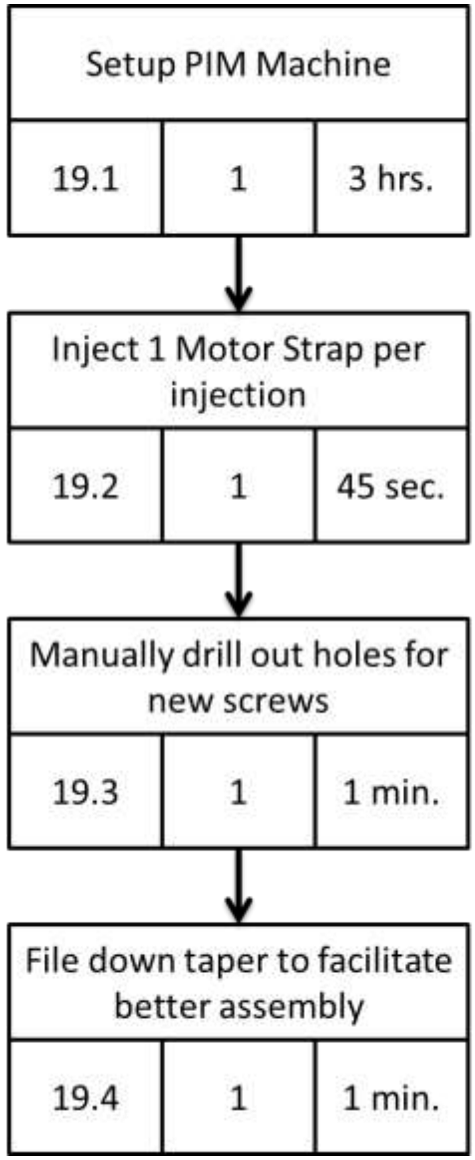
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_MotorStrap19_C_041126 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MotorStrap19_HM219f_011207 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MotorStrap19_HM219m_011207

Material Resource Planning
Volume of Part: 0.038 in^3
Density of Material: 0.038 lb/in^3
Weight of Material: $0.038 in^3 \times 0.038\ lb/in^3 \times 400 \times 1.2 = 0.693$ lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	Wraight, S., Zavos, S.	
Design:	Wraight, S., Zavos, S.	
CAD:	Wraight, S., Zavos, S.	
Documentation:	Snyder, M.	

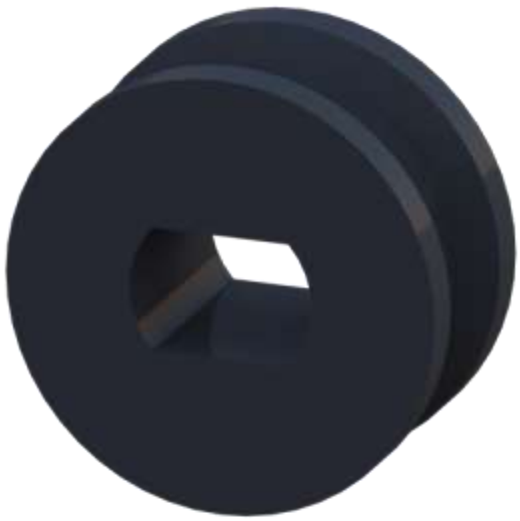
4.20.1: Motor Strap – Process Schematic



Step	Time Required	# Required	Total Time
19.1	3 hrs.	1	3 hrs.
19.2	45 sec.	400	5 hrs.
19.3	1 min.	400	6 hrs. 40 min.
19.4	1 min.		6 hrs. 40 min.
		Total Production Time	21 hrs. 20 min.

4.21: Motor Drive Belt Carrier (BOM #20) – General Information

Part Number	20
Drawing Number	12CandyA_MotorDriveBeltCarrier20_C_051129
Assembly Reference Drawing Number	20



Part Description	
Function: The lower drive belt carrier will be attached to the motor and used to transfer the torque to the drive belt, and drive belt carrier (12CandyA_DriveBeltCarrier16_C_061108).	
Material: ABS - Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	Fit for Motor Axle: FN1 Nominal Size: 0.1500 in. Shrinkage: 0.0009 in. Max Hole: 0.1503 in. Min Hole: 0.1500 in. Max Interference: 0.0006 in. Min Interference: 0.0001 in.
Source: Machinery's Handbook, 28 ed. NOTE: Hole has two different distances, smaller of the two was used in this calculation.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for injection molding the lower drive belt carrier.	
Primary Process: Plastic Injection Molding – Mold A1	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.001 lbs Density: 0.038 lb/in^3 Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time: 45 sec. (per injection)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact Machine groove on manual lathe.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the drive belt carrier is attached to the motor. This tolerance must be as close to ± 0.001 in. as possible.

Surface Finishing Requirements
Remove flashing if any

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldA100_T100_011206 FIXTURE: 12CandyA_DriveBeltFixture300_T300_011206

Quality Control Process
Go/No-Go Gauges: AML > 1213_Team_A > Shared Documents > QC Gauges > Drawing(s) > 12CandyA_MotorDriveBeltCarrier20_QC320_041206 Measurements: N/A

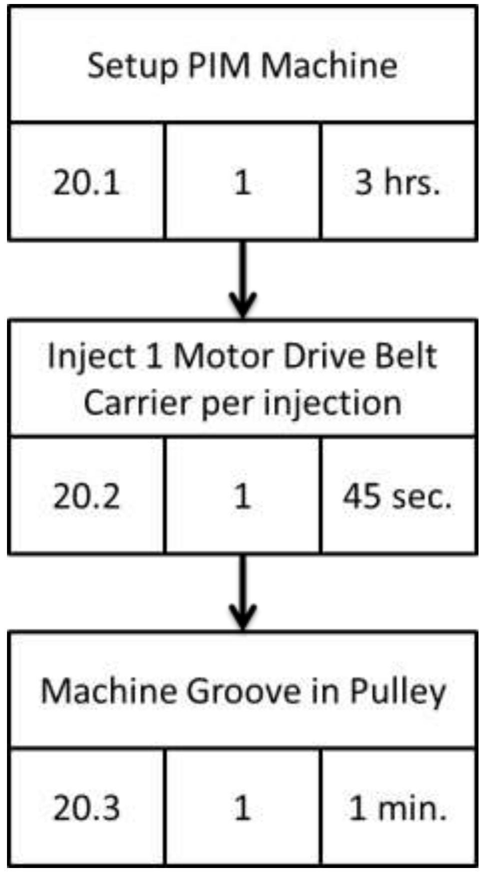
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_MotorDriveBeltCarrier20_C_051129 CAM: N/A

Material Resource Planning
Volume of Part: 0.036 in^3
Density of Material: 0.038 lb/in^3
Weight of Material: 0.036in^3 X 0.038 lb/in^3 X 400 X 1.2 = 0.657 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Zavos., S.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.21.1: Motor Drive Belt Carrier – Process Schematic



Step	Time Required	# Required	Total Time
20.1	3 hrs.	1	3 hrs.
20.2	55 sec.	400	6 hrs. 7 min.
20.3	30 sec.	400	3 hrs. 20 min.
		Total Production Time	12 hrs. 27 min.

4.22: Funnel (Left & Right) (BOM #21) – General Information

Part Number	21
Drawing Number	12CandyA_Funnel20_C_010409
Assembly Reference Drawing Number	21

Part Description	
Function: The funnel pieces function as a fix to the jamming of candy pieces when they enter into the doser. By narrowing the channel for the candy to enter, the candy pieces can no longer be side by side causing a jam.	
Material: ABS - Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	N/A
Source: Machinery's Handbook, 28 ed. NOTE: Hole has two different distances, smaller of the two was used in this calculation.	

Proposed Manufacturing Process Plan
Description: This section outlines the primary manufacturing process for injection molding the funnels (left & right)

Primary Process: Plastic Injection Molding – MiniMold
Justification: Repeatability for multiple copies of the same part.
Machine Tool: Battenfeld Plastic Injection Machine

Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.001 lbs Density: 0.038 lb/in^3 Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time: 35 sec.
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerances exist on the radius of where the funnels will be acetone welded to the jar, this radius should match within ±0.005”

Surface Finishing Requirements
Remove flashing if any

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MiniMold_T400_010415 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

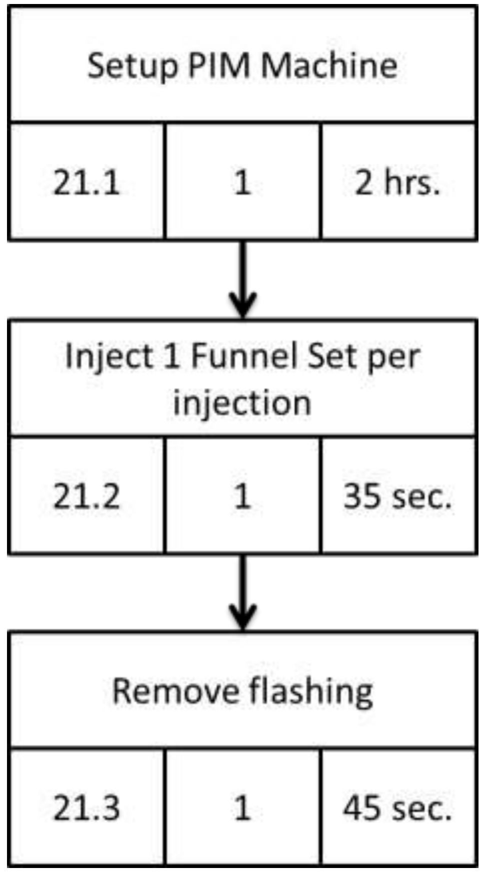
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Funnel20_C_010409 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > AML > 1213_Team_A > Shared Documents > CAM Files > AML > 1213_Team_A > Shared Documents > CAM Files >

Material Resource Planning
Volume of Part: 0.18 in^3
Density of Material: 0.038 lb/in^3
Weight of Material: 0.18in^3 X 0.038 lb/in^3 X 400 X 1.2 = 3.283 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	N/A	
Design:	Burtzos. T.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.22.1: Funnel (Left & Right) – Process Schematic



Step	Time Required	# Required	Total Time
21.1	2 hrs.	1	2 hrs.
21.2	35 sec.	400	3 hrs. 54 min.
21.3	30 sec.	400	3 hrs. 20 min.
		Total Production Time	9 hrs. 14 min.

4.23: Washer (BOM #22) – General Information

Part Number	22
Drawing Number	12CandyA_Washer21_C_010412
Assembly Reference Drawing Number	22

Part Description	
Function: The washer functions to ensure that the doser is spaced out forward enough to ensure that the main gear and the outer gear mate consistently as the production functions.	
Material: ABS - Black	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	N/A
Source: Machinery's Handbook, 28 ed. NOTE: Hole has two different distances, smaller of the two was used in this calculation.	

Proposed Manufacturing Process Plan
Description: This section outlines the primary manufacturing process for injection molding the washer.
Primary Process: Plastic Injection Molding – MiniMold

Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Battenfeld Plastic Injection Machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 221°F Injection Molding Temperature: 180°F Specific Heat: 0.351 BTU/lb°F Mass: 0.001 lbs Density: 0.038 lb/in^3 Shrinkage: Range of 0.004 – 0.008 Average: 0.006 Shrinkage allowable: 0.60% Cycle Time: 35 sec.
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, ABS – Medium Impact	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerances exist on the radius of where the funnels will be acetone welded to the jar, this radius should match within ±0.005”

Surface Finishing Requirements
Remove flashing if any

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MiniMold_T400_010415 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

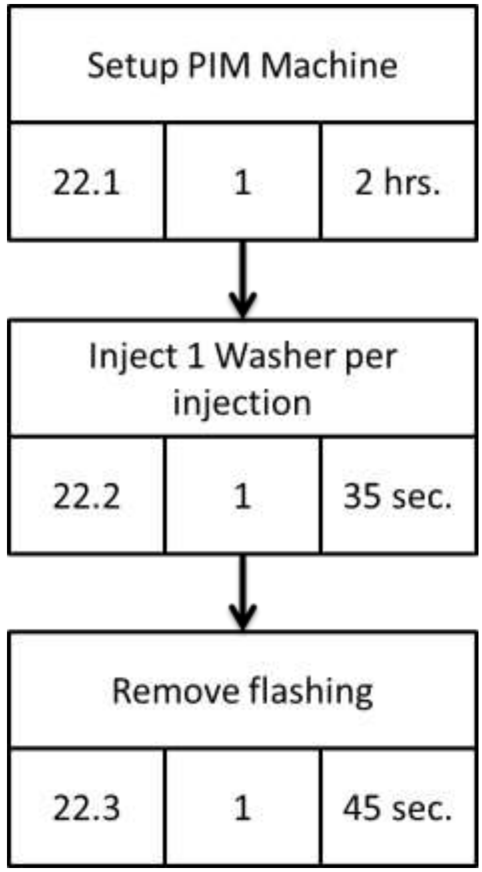
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Washer21_C_010409

Material Resource Planning
Volume of Part: 0.18 in^3
Density of Material: 0.038 lb/in^3
Weight of Material: 0.18in^3 X 0.038 lb/in^3 X 400 X 1.2 = 3.283 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	N/A	
Design:	Burtzos. T.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.23.1: Washer – Process Schematic



Step	Time Required	# Required	Total Time
22.1	2 hrs.	1	2 hrs.
22.2	35 sec.	400	3 hrs. 54 min.
22.3	30 sec.	400	3 hrs. 20 min.
		Total Production Time	9 hrs. 14 min.

4.24: Logo Plate (BOM #23) – General Information

Part Number	23
Drawing Number	12CandyA_LogoPlate22_C_010502
Assembly Reference Drawing Number	23

Part Description	
Function: The logo plate functions to highlight the MILL on our product in addition to covering over the hole that is created from the emergency fix of trimming the mound off of the upper base in order to have a functioning product.	
Material: Laserables II [Two-Layer Plastic] (Top Layer Red, Base Color White)	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	N/A
Source: Machinery's Handbook, 28 ed. NOTE: Hole has two different distances, smaller of the two was used in this calculation.	

Proposed Manufacturing Process Plan
Description: This section outlines the primary manufacturing process for laser cutting the logo plate.

Primary Process: Laser Engraving/Cutting	
Justification: Repeatability for multiple copies of the same part.	
Machine Tool: Hurricane Lasers, Charley Model	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
There are no critical sizes outside of fractional dimensions on this part, it must cover over the hole created in the upper base, no other factor is critical on this part.

Surface Finishing Requirements
Remove excess powder left from laser engraving.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_LogoPlate22_C_010502

Material Resource Planning
Volume of Part: N/A
Density of Material: N/A
Weight of Material: N/A
Notes: N/A

4.24.1: Logo Plate – Process Schematic

Cut out 90 Logo Plates per sheet (210 sec. per 1)		
23.1	90	5.25 hrs.

Step	Time Required	# Required	Total Time
23.1	5.25 hrs.	5	26 hrs. 15 min.
		Total Production Time	26 hrs. 15 min.

4.25: Candy Cart (BOM #24) – General Information

Part Number	24
Drawing Number	12CandyA_CandyCart23_C_010502
Assembly Reference Drawing Number	24

Part Description	
Function: The purpose of the candy cart is to allow that cart under the doser to have a hole in it so that candy will not become stuck and thus not drop into the upper base. As the upper base no longer has a bump on it to knock over the cart during the rotation of the wheel, this allows candy to fall into the upper base and allow the customer to get to the dispensed candy.	
Material: Polypropylene (Red)	
Number Required: 400	
Make or Buy Component: Make (Modify)	
Associated Calculations:	N/A
Source: Machinery's Handbook, 28 ed. NOTE: Hole has two different distances, smaller of the two was used in this calculation.	
Note: This part is the same as part 1; however, 1 in 8 of those parts will now have a hole drilled in the bottom in order to allow the candy to exit the cart and fall into the upper base with the now removed bump on the upper base.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for molding the carts.	
Primary Process: Plastic Injection Molding – Mold B2	
Justification: Repeatability for multiple copies of the same part	
Machine Tool: Arburg PIM machine	
Associated Calculations:	Draft Angle: 2 degrees on all surfaces. Melting Temp: 350°F Injection Molding Temperature: 120°F Specific Heat: 0.406-0.478 BTU Mass: 0.007 lb Density: 0.033 lb/in^3 Shrinkage: Range of 0.010 – 0.030 Average: 0.020 2.00% Shrinkage allowable Cycle Time: 70 seconds per injection of 8 (excludes post processing)
Notes: Shrinkage source: Injection Molding of Polymers Lab and Mold Design Exercise, http://mfg.eng.rpi.edu/aml/course/Shrinkage%20Rate%20Exercise.pdf, Table 1, Polypropylene.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Critical tolerance exists where the cart is attached to the struts. As dictated by the 2.00% shrinkage, the best tolerance can be ± 0.01 in.

Surface Finishing Requirements
Remove flashing if any.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_MoldB200_T200_011206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A

Measurements: Caliper measurement of cart width at interface point with struts

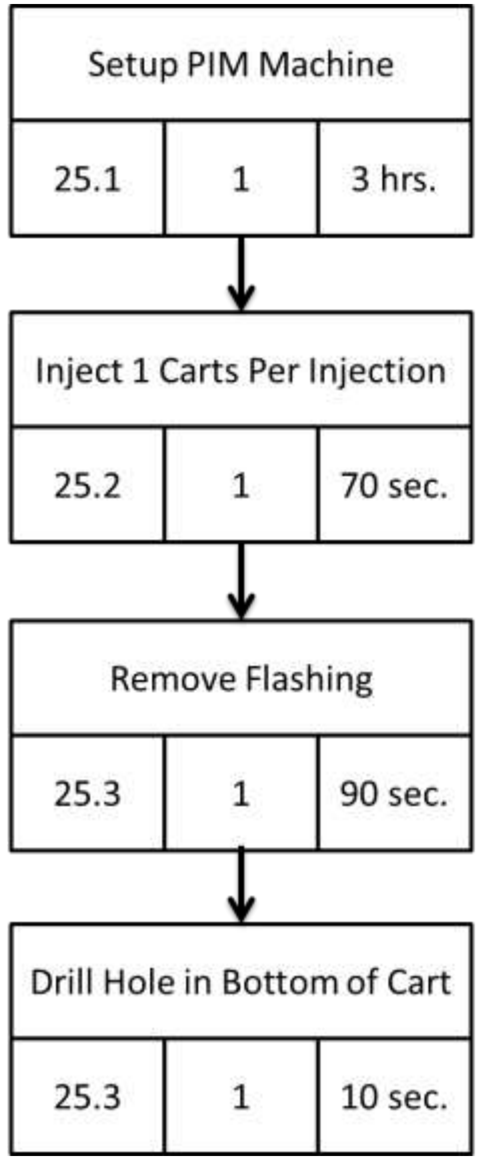
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_Cart01_C_081126 CAM: N/A

Material Resource Planning
Volume of Part: 0.214 in^3
Density of Material: 0.033 lb/in^3
Weight of Material: 0.214 in^3 X 0.033 lb/in^3 X 3200 X 1.2 = 27.12 lbs
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Stacy, D., McDonald, R.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M., Terranova, V.	

4.25.1: Candy Cart – Process Schematic



Step	Time Required	# Required	Total Time
25.1	3 hrs	1	3 hrs.
25.2	70 sec	400	7 hrs. 47 min
25.3	90 sec	400	10 hrs.
25.4	10 sec	400	1 hr.
		Total Production Time	21 hrs. 47 min.

4.26: Outer Box (BOM #25) – General Information

Part Number	25
Drawing Number	12CandyA_OuterBox23_C_010

Part Description	
Function: The outer box will serve as a method of packaging for the Candy Wheel (12CandyA_CandyWheel_MA_061203).	
Material: N/A	
Number Required: 400	
Make or Buy Component: Buy	
Associated Calculations:	N/A
Notes: Obtained from http://www.cardboardboxes4u.com/shop/cardboard-boxes/stock-boxes/4-to-8-length-box/8-3-4-x-4-3-8-x-9-1-2-corrugated-boxes.html	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for cutting the cardboard.	
Primary Process: Laser cutting and laser etching	
Justification: Laser cutting provided a cleaner finish and considering the part required etching, it would be more efficient to complete all steps on one machine.	
Machine Tool: Hurricane Lasers, Charley Model	
Associated Calculations:	Laser Settings: Cut: Speed: 90% Power: 80% Time: 2'07" (front) 10' 40" (back)
Notes: Current time is for full engraving of strut features. This can be improved by adjusting the path of the laser itself, and the style of engraving.	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: 12CandyA_PackagingLaserFixture200_PF200_011206

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

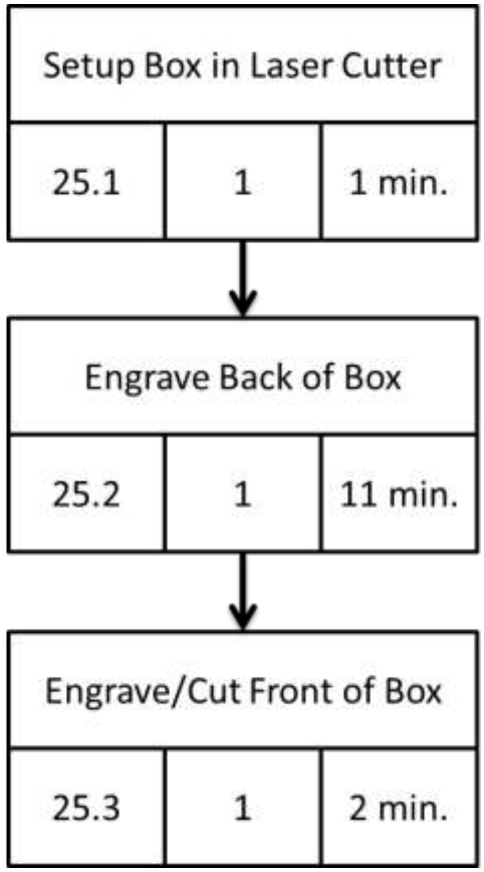
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Assembly > 12CandyA_OuterBox26_PC_031205 CAM: N/A AWJ: N/A LASER: AML > 1213_Team_A > Shared Documents > Laser Code > Packaging Cut

Material Resource Planning
Volume of Part: N/A
Density of Material: N/A
Weight of Material: N/A
Notes: N/A

Budget Allocation
Cost per unit: $0.37
Total Cost: $148.00
Notes: N/A

Responsible Team Member (s)		Date
Research & Cost:	Robinson, J.	
Design:	N/A	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Snyder, M.	

4.26.1: Outer Box – Process Schematic



Step	Time Required	# Required	Total Time
25.1	1 min.	400	6 hrs. 40 min.
25.2	11 min.	400	73 hrs. 20 min.
25.3	2 min.	400	13 hrs. 20 min.
		Total Production Time	93 hrs. 20 min.

4.27: Box Buffer (Riser) (BOM #26) – General Information

Part Number	26
Drawing Number	12CandyA_BoxBuffer24_C_011206

Part Description	
Function: The box buffer supports the entire candy wheel (12CandyA_CandyWheel_MA_061203) as it sits in the box (12CandyA_OuterBox26_PC_031205).	
Material: Polystyrene	
Number Required: 400	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for vacuum forming the box buffer.	
Primary Process: Vacuum Forming, Lasercutting	
Justification: Easy production method for mass production	
Machine Tool: Formech 660 Vacuum Former, Hurricane Lasers, Charlie Model	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
Trim off flashing

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: 12CandyA_BoxBuffer24_T500_041206 FIXTURE: N/A

Quality Control Process
Go/No-Go Gauges: N/A Measurements: N/A

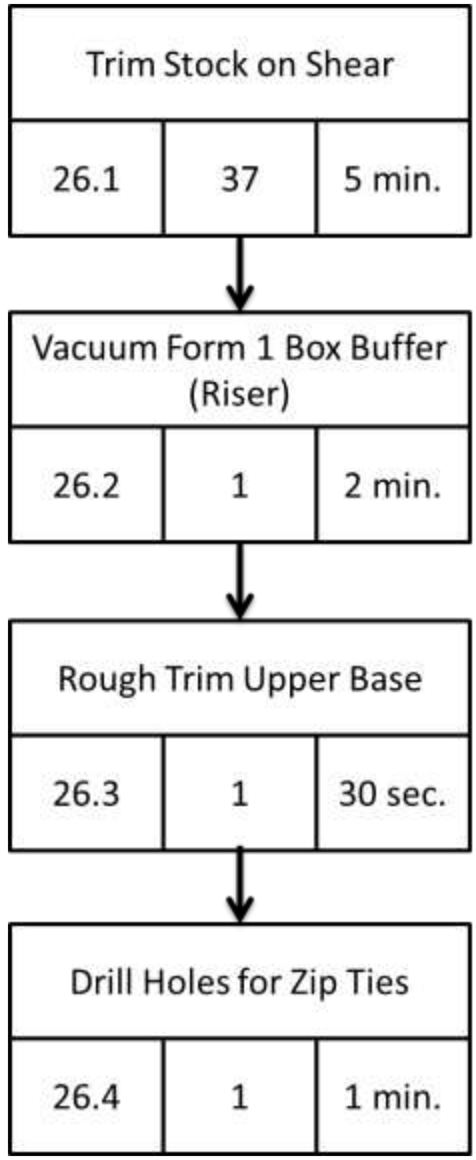
CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > 12CandyA_BoxBuffer24_C_041206 CAM: N/A AWJ: N/A LASER: N/A

Material Resource Planning
Area of Part: N/A
Material Dimensions: N/A
Notes: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	N/A	
Design:	Robinson, J.	
CAD:	Burtzos, T., Pacifico, C.	

4.27.1: Box Buffer (Riser) – Process Schematic



Step	Time Required	# Required	Total Time
26.1	5 min.	37	3 hrs. 5 min.
26.2	2 min.	400	13 hrs. 20 min.
26.3	30 sec.	400	3 hrs. 20 min.
26.4	1 min.	400	6 hrs. 40 min.
		Total Production Time	26 hrs. 20 min.

4.28: Mold A (BOM #27.1) – General Information

Part Number	27.1
Drawing Number	12CandyA_MoldAMoving100_T100_011206 12CandyA_MoldAStationary100_T100_011206

Part Description	
Function: Plastic injection mold for the ABS pieces of the product.	
Material: Aluminum	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: Will need to be injected in two separate injections (all parts except Jar will be group A1, Jar will be A2). This is due to shot volume and clamping force limits on the Plastic Injection Machine in the MILL.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this mold	
Primary Process: CNC Mill, Manual Mill	
Justification: Speed, cost, precision	
Machine Tool: Assorted end mills, reamers, drills, and taps	
Associated Calculations:	Speed: RPM = 12 X Cutting Speed / π X Diameter Approximating 3 for π RPM = 4 X 300ft/min / 0.25 = 4800 RPM Feed: $F = S_z \times N_t \times N$ F = 0.002 X 2 X 4800 = 28.8 in/min
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Machine to tolerances of drawing.

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
FIXTURE: N/A TOOL: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_MoldA100_T100_011206 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldA_HM101_010222 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldA_HM102_010208 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldA_HM103_010213 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldA_HM104_010208

Budget Allocation
Material Cost per lb: N/A
Material Cost: $500
Notes: $500 for whole mold assembly

Responsible Team Member (s)		Date
Research & Cost:	Burtzos, T., Pacifico, C.	
Design:	Burtzos, T., Pacifico, C.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Burtzos, T., Pacifico, C.	

4.29: Mold B (BOM #27.2) – General Information

Part Number	27.2
Drawing Number	12CandyA_MoldBMoving200_T200_011206 12CandyA_MoldBStationary200_T200_011206

Part Description	
Function: Plastic injection mold for the PP pieces of the product.	
Material: Aluminum	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: Will need to be injected in two separate injections (all parts except 8 Carts will be group B1, all Carts will be B2). This is due to shot volume and clamping force limits on the Plastic Injection Machine in the MILL.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this mold	
Primary Process: CNC Mill, Manual Mill	
Justification: Cost, Precision, Repeatability	
Machine Tool: Assorted end mills, drills, reamers, taps	
Associated Calculations:	Speed: RPM = 12 X Cutting Speed / π X Diameter Approximating 3 for π RPM = 4 X 300ft/min / 0.25 = 4800 RPM Feed: $F = S_z \times N_t \times N$ F = 0.002 X 2 X 4800 = 28.8 in/min
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Machine to drawing.

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_MoldB200_T200_011206 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM201_010227 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM202_010223 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM203_010225 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM204_010228 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM205_010301 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM206_010226 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM207_010226 AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MoldB_HM208_010225

Budget Allocation
Material Cost per lb: N/A
Material Cost: $500
Notes: $500 for whole mold assembly

Responsible Team Member (s)		Date
Research & Cost:	Burtzos, T., Pacifico, C.	
Design:	Burtzos, T., Pacifico, C.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Burtzos, T., Pacifico, C.	

4.30: Mini Mold (BOM #27.3) – General Information

Part Number	27.3
Drawing Number	12CandyA_MiniMold700_T700_0104015

Part Description	
Function: Plastic injection mold for small parts needed to increase functional reliability of the product.	
Material: Aluminum	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this mold	
Primary Process: CNC Mill, Manual Mill	
Justification: Cost, Precision, Repeatability	
Machine Tool: Assorted end mills, drills, reamers, taps	
Associated Calculations:	Speed: RPM = 12 X Cutting Speed / π X Diameter Approximating 3 for π RPM = 4 X 300ft/min / 0.25 = 4800 RPM Feed: $F = S_z \times N_t \times N$ F = 0.002 X 2 X 4800 = 28.8 in/min
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Machine to drawing.

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_MiniMold700_T700_010415 CAM: AML > 1213_Team_A > Shared Documents > CAM Files > 12CandyA_MiniMold_HM_010417

Budget Allocation
Material Cost per lb: N/A
Material Cost: $200
Notes: $200 for whole mold assembly

Responsible Team Member (s)		Date
Research & Cost:	Burtzos, T., Pacifico, C.	
Design:	Burtzos, T., Pacifico, C.	
CAD:	Burtzos, T., Pacifico, C.	
Documentation:	Burtzos, T., Pacifico, C.	

4.31: Upper Base Forming Fixture (BOM #27.4) – General Information

Part Number	27.4
Drawing Number	12CandyA_UpperBase11_T124_041206

Part Description	
Function: This piece is a fixture mold the upper base (12CandyA_UpperBase11_C_041112) on the vacuum forming machine.	
Material: RENShape	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this fixture	
Primary Process: CNC Router	
Justification: Preferred method to construct molds	
Machine Tool: CNC Router	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
Belt sanding as necessary

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A TOOL: As specified by the Rensselaer Architecture Woodshop

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_UpperBase11_T124_011112 IGES: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_UpperBase11_T111_041112

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Obtained free of charge from EMPAC

Responsible Team Member (s)		Date
Research & Cost:	Wraight., S.	
Design:	Wraight., S.	
CAD:	Wraight., S.	
Documentation:	Snyder, M.	

4.32: Box Buffer Forming Fixture (BOM #27.5) – General Information

Part Number	27.5
Drawing Number	12CandyA_BoxBuffer24_T500_041206

Part Description	
Function: This piece is a fixture mold the box buffer (12CandyA_BoxBuffer24_C_031206) on the vacuum forming machine.	
Material: RENShape	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this fixture	
Primary Process: Sander	
Justification: Simple shape of forming fixture, non-critical dimensions & no machining time	
Machine Tool: Sander	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
Belt sanding as necessary

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A TOOL: As specified by the Rensselaer Architecture Woodshop

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BoxBuffer24_T500_011112 IGES: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BoxBuffer24_T500_041112

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Obtained free of charge from EMPAC

Responsible Team Member (s)		**Date**
Research & Cost:	Wraight., S.	
Design:	Wraight., S.	
CAD:	Wraight., S.	
Documentation:	Snyder, M.	

4.33: Box Laser Cutting Fixture (BOM #28.2) – General Information

Part Number	28.2
Drawing Number	12CandyA_PackagingLaserFixture200_PF200_011206

Part Description	
Function: This piece is a fixture to assist in laser cutting labels in the box.	
Material: ABS	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this fixture	
Primary Process: Laser cutting	
Justification: ABS parts are easily and rapidly made on the laser cutter.	
Machine Tool: N/A	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_PackagingLaserFixture201_PF201_011206 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_PackagingLaserFixture202_PF202_011206 CAM: N/A AWJ: N/A LASER: AML > 1213_Team_A > Shared Documents > Laser Code > Packaging Fixture Foot AML > 1213_Team_A > Shared Documents > Laser Code > Packaging Fixture Plate

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Made from found stock.

Responsible Team Member (s)		**Date**
Research & Cost:	Wraight., S.	
Design:	Wraight., S.	
CAD:	Wraight., S.	
Documentation:	Snyder, M.	

4.34: Drive Belt Fixture (BOM #28.3) – General Information

Part Number	28.3
Assembly Number	12CandyA_DriveBeltFixture300_PF300_011206

Part Description	
Function: This piece is a fixture to assist in cutting a groove in the drive belt carrier (12CandyA_DriveBeltCarrier16_C_061108)	
Material: Steel	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: Component made with manual machining.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this fixture	
Primary Process: Manual machining	
Justification: Parts are sufficiently simple that CNC is not required.	
Machine Tool: Lathe and mill	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Protrusions on the body component (12CandyA_DriveBeltFixtureBody301_PF301_011206) should be held within tolerance of +0.000” -0.005”

Surface Finishing Requirements
Machined surface is sufficient.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A TOOL: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_DriveBeltFixtureBody301_PF301_011206 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_DriveBeltFixtureAxleCap302_PF302_011206 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_DriveBeltFixtureMotorCap303_PF303_011206 CAM: N/A AWJ: N/A LASER: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Made from found stock.

Responsible Team Member (s)		Date
Research & Cost:	Wraight., S.	
Design:	Wraight., S.	
CAD:	Wraight., S.	
Documentation:	Snyder, M.	

4.35: Upper Base Laser Cutting Fixture (BOM #28.4) – General Information

Part Number	28.4
Assembly Number	12CandyA_UpperBaseLaserFixture400_PF400_011206

Part Description	
Function: This piece is a fixture to assist in laser cutting excess material from the upper base (12CandyA_UpperBase11_C_041112)	
Material: ABS	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this fixture	
Primary Process: Manual machining	
Justification: Part is sufficiently simple that CNC is not required.	
Machine Tool: Mill	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Bolt locations are to be within ±0.005”

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A TOOL: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_UpperBaseLaserFixture401_PF401_011206 CAM: N/A AWJ: N/A LASER: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Made from found stock.

Responsible Team Member (s)		Date
Research & Cost:	N/A	
Design:	Wraight., S.	
CAD:	Wraight., S.	
Documentation:	Snyder, M.	

4.36: Back Support Fixture (BOM #28.5) – General Information

Part Number	28.5
Assembly Number	12CandyA_BackSupportFixture500_PF500_010224

Part Description	
Function: This piece is a fixture to assist in laser cutting labels in the box.	
Material: Aluminum	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this fixture	
Primary Process: Manual Machining	
Justification: CNC machine time limited and not complicated enough to justify CNC Time	
Machine Tool: As needed	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupportFixture500_PF500_010224 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupportFixtureBase501_PF501_010224 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupportFixtureBackPlate502_PF502_010224 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupportFixtureHoldDown503_PF503_010224 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupportFixtureTweenPlate504_PF504_010224 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupportFixtureWedgeLower505_PF505_010224 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_BackSupportFixtureWedgeUpper506_PF506_010224 CAM: N/A AWJ: N/A LASER: N/A

Budget Allocation
Material Cost per lb: N/A
Material Cost: N/A
Notes: Made from found stock.

Responsible Team Member (s)		**Date**
Research & Cost:	Wraight., S.	
Design:	Wraight., S.	
CAD:	Wraight., S.	
Documentation:	Snyder, M.	

4.37: Drive Belt Fixture (BOM #28.6) – General Information

Part Number	28.6
Assembly Number	12CandyA_MotorDriveBeltFixture600_PF600_011206

Part Description	
Function: This piece is a fixture to assist in cutting a groove in the motor drive belt carriers (12CandyA_MotorDriveBeltCarrier20_C_061206)	
Material: Steel	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: Component made with manual machining.	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making this fixture	
Primary Process: Manual machining	
Justification: Parts are sufficiently simple that CNC is not required.	
Machine Tool: Lathe and mill	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
Protrusions on the body component (12CandyA_DriveBeltFixtureBody601_PF601_011206) should be held within tolerance of +0.000” -0.005”

Surface Finishing Requirements
Machined surface is sufficient.

Tools, Tooling, and Fixture Drawing Number(s)
MOLD: N/A FIXTURE: N/A TOOL: N/A

CAD & CAM File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_DriveBeltFixtureBody601_PF601_011206 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_DriveBeltFixtureAxleCap602_PF602_011206 AML > 1213_Team_A > Shared Documents > CAD Files > Manufacturing > 12CandyA_DriveBeltFixtureMotorCap603_PF603_011206 CAM: N/A AWJ: N/A LASER: N/A

Budget Allocation
Material Cost: N/A
Notes: Made from found stock.

Responsible Team Member (s)		Date
Research & Cost:	Wraight., S.	
Design:	Wraight., S.	
CAD:	Wraight., S.	
Documentation:	Snyder, M.	

4.38: Axle Front Support/Back Support QC Gage (BOM #29.3) – General Information

Part Number	29.3
Drawing Number	12CandyA_Axle07_QC325_011206

Part Description	
Function: This piece will function as a quality control gauge for the front support (12CandyA_FrontSupport05_C_031108) and back support (12CandyA_BackSupport06_C_071108) with respect to the axle (12CandyA_Axle07_C_051016).	
Material: Aluminum	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making the QC Gauge for the axle, front, and back support.	
Primary Process: Lathing, Milling	
Justification: QC Gauges will be lathed as they are stepped cylinders. Some gauges and features will require milling.	
Machine Tool: CNC Lathe, Haas CNC Mill	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > QC Gauges > Parts > 12CandyA_Axle07_QC325_011203 CAM: N/A AWJ: N/A LASER: N/A

Material Resource Planning
N/A
Notes: Scrap and excess material from the MILL will be ideal for constructing QC Gauges.

Budget Allocation
Total Cost: $0.00
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	Wraight, S., Zavos, S.	
Design:	Wraight, S., Zavos, S.	
CAD:	mini	
Documentation:	Snyder, M.	

4.39: Strut QC Gage (BOM #29.3) – General Information

Part Number	29.3
Drawing Number	12CandyA_Struts03_QC303_041206

Part Description	
Function: This piece will function as a quality control gauge for the hole in the struts (12CandyA_Struts03_C_061017) at the interface with the doser (12CandyA_Doser10_C_061112).	
Material: Aluminum Stock	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	none
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process making the QC gauges for the struts.	
Primary Process: Lathing, Milling,	
Justification: QC Gauges will be lathed as they are stepped cylinders. Some gauges and features will require milling.	
Machine Tool: CNC Lathe, Haas CNC Mill	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
Use as is

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > QC Gauges > Parts > 12CandyA_Struts03_QC303_011203

Material Resource Planning
N/A
Notes: Scrap and excess material from the MILL will be ideal for constructing QC Gauges.

Budget Allocation
Total Cost: $0.00
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		Date
Research & Cost:	Wraight, S., Zavos, S.	
Design:	Wraight, S., Zavos, S.	
CAD:	Zavos, S.	
Documentation:	Snyder, M.	

4.40: Axle QC Gage (BOM #29.7) – General Information

Part Number	29.7
Drawing Number	12CandyA_Axle07_QC307_011206

Part Description	
Function: This piece will function as a quality control gauge for the axle (12CandyA_Axle07_C_051016) to measure each of its lengths.	
Material: Scrap Material (Steel or Aluminum or Plastic Stock Acceptable)	
Number Required: 1	
Make or Buy Component: Make	
Associated Calculations:	N/A
Notes: N/A	

Proposed Manufacturing Process Plan	
Description: This section outlines the primary manufacturing process for making a QC gauge for the axle.	
Primary Process: Lathing, Milling	
Justification: QC Gauges will be lathed as they are stepped cylinders. Some gauges and features will require milling.	
Machine Tool: CNC Lathe, Haas CNC Mill	
Associated Calculations:	N/A
Notes: N/A	

Critical Tolerance Issues and Drawing Reference Number(s) with Noted Tolerances
N/A

Surface Finishing Requirements
N/A

CAD, CAM, AWJ, LASER File Names/Location
CAD: AML > 1213_Team_A > Shared Documents > QC Gauges > Parts >12CandyA_Axle07_QC307_011203 CAM: N/A

AWJ: N/A LASER: N/A

Material Resource Planning
N/A
Notes: Scrap and excess material from the MILL will be ideal for constructing QC Gauges.

Budget Allocation
Total Cost: $0.00
Notes: Material will be obtained free of charge from the MILL

Responsible Team Member (s)		**Date**
Research & Cost:	Wraight, S., Zavos, S.	
Design:	Wraight, S., Zavos, S.	
CAD:	Zavos, S.	
Documentation:	Snyder, M.	

5. Assembly

5.1: Assembly Introduction

This section of the Technical Data Package presents and elaborates on the assembly systems suggested for the production of the Ferris Wheel Candy Dispenser.

The Ferris Wheel Candy Dispenser will be assembled in three subassemblies and one final assembly. The first subassembly of the product is the wheel assembly where the Staubli robot will be used as a manipulator to place components at the appropriate locations in a fixture and an ultrasonic welder will be used to secure the struts to the candy jar. The second subassembly is the base assembly. This sequence is made up of operations from both the Adept robot and a human hand to assemble the lower and upper bases, as well as the electronic components within them. The third subassembly is an A-frame consisting of the outer gear being heatstaked to the front support. The final assembly of the candy dispenser will consists of putting the three completed sub-assemblies together and attaching the axle & axle pins to create a finished product by hand.

<u>The Wheel Assembly</u>
The assembly of the wheel is accomplished using the fixture pictured below, the Staubli robot, and the ultrasonic welder. The Staubli places the first Strut on the wheel fixture. It places the 8 carts, jar subsubassembly, doser, and second strut on top. The entire subassembly is pneumatically shifted under a nearby welder and most of the struts are welded to the jar. It is shifted over even further so the welder can press down on the other half of the struts and the weld is completed. Then the assembly is removed and the washer and main gear are attached by a human operator.

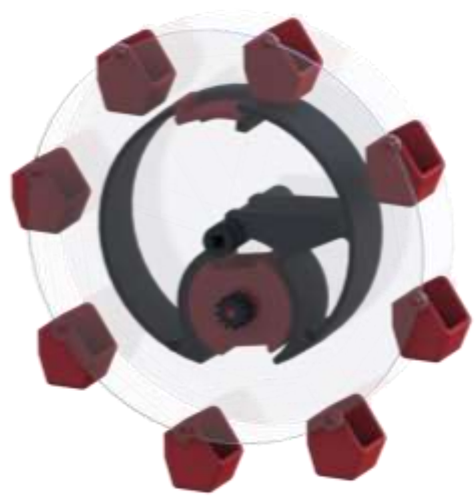


Figure 12 - Wheel Assembly

The Base Assembly

The Adept dispenses a lower base from a slide escapement fixture. Then the lower base is slid under a hot glue fixture and the robot puts the battery holder down on the glue. The lower base is shifted over and the process is repeated for the motor subsubassembly. Then the Adept passes the subassembly off to a human operator who secures a bracing screw to help hold the motor in place, presses in a back support on a manual press, and inserts the drive belt into the subassembly. Then the human operator solders the electronics together, including an additional piece of wire and a switch, puts a AA battery in the battery holder, places the upper base on the assembly, and hot-glues the switch and logo plate to the upper base.

Figure 13 - Base Assembly

The Final Assembly

The human operator will put the drive belt carrier in the drive belt and the axle through both the drive belt carrier and the back support of the base subassembly. The wheel subassembly then gets placed on the axle, and the A-frame subassembly is angled onto the axle and into the lower base. Axle pins are place on both ends of the axle. The Ferris Wheel Candy dispenser is now fully assembled.

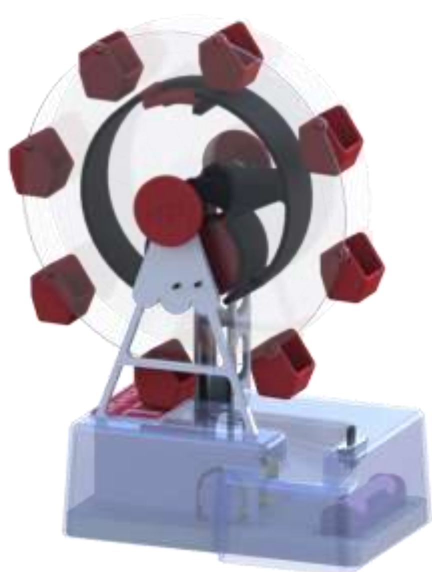


Figure 14 - Final Assembly

5.2: Assembly Flow Chart

Motor Subsubassembly
- Screws removed
  - Tote of Motors
  - Screwdriver
- Motor Strap on Motor
  - Tote of Motor Straps
- Screws replaced
  - Screwdriver
- Motor Drive Belt Carrier on Motor
  - Tote of Motor Drive Belt Carriers
- Motor QC check: Motor strap properly oriented, Motor turns with electricity
  - Motor Subsubassembly Gage

Wheel Subassembly
- Staubli
- Wheel Subassembly fixture
- Double Sided Clipper/Suction End Effector
- Back Strut on assembly
  - Strut stack
- Jar Subsubassembly on assembly
  - Jar Subsubassembly Pallet
- Doser on assembly
  - Doser feeder
- Carts on assembly
  - Cart feeder
- Front Strut on assembly
  - Strut stack
- Assembly slides under welder
  - Pneumatic wheel slider
- Struts welded to Jar
  - Welding Horn
- Assembly slides back
  - Pneumatic wheel slider
- Assembly removed from fixture
- Wheel QC check
  - -Wheel total thickness
  - -Doser and Carts spin
  - -Wheel doesn't fall apart
  - -Jar lid fits and slides properly
- Washer on assembly
  - Tote of Washers
- Main Gear on assembly
  - Tote of Main Gears

Base Subassembly
- Adept
- Base Subassembly fixture
- Two Suction Actuater End Effector
- Lower Base on assembly
  - Lower Base feeder
- Assembly slides under glue
  - Pneumatic base slider
- Glue for Motor applied
  - Glue fixture
- Assembly slides back
  - Pneumatic base slider
- Motor Subsubassembly on assembly
  - Motor Subsubassembly pallet
- Assembly shifted in base slider
- Assembly slides under glue
  - Pneumatic base slider
- Glue for Battery Pack applied
  - Glue fixture
- Assembly slides back
  - Pneumatic base slider
- Battery Holder on assembly
  - Battery Holder pallet
- Assembly put on train
- Back Support on assembly
  - Tote of Back Supports
- Back Support pressed in
  - Manual Press fixture
- Bracing Screw on assembly
  - Tote of Bracing Screws

Base Subassembly (cont.)
- Soldering Equipment
- Drive Belt on Motor Drive Belt Carrierx
  - Tote of Drive Belts
- Motor soldered to Battery Holder
- Battery Holder soldered to Switch
  - Tote of Switches
- Switch soldered to Copper Wire
  - Tote of Copper Wire
- Copper Wire soldered to Motor
- Battery in Battery Pack
  - Tote of Batteries
- Upper Base on assembly
  - Tote of Upper Bases
- Switch pushed through Upper Base
- Switch glued to Upper Base
  - Glueing equipment
- Logo Plate glued to Upper Base
  - Tote of Logo Plates
  - Glueing equipment
- Base QC check: Electronics functionality, Back support fully secured, Upper base fully attached

KEY
- Subassembly Heading
- Robot action
- Pneumatic slider action
- Other automated action
- Manual action
- Tool or construct required
- Quality Control

A-Frame Subassembly

Heatstaker

Outer Gear in Heatstake Fixture

Tote of Outer Gears

Heatstake fixture

Front Support in Heatstake Fixture

Tote of Front Supports

Outer Gear heatstaked

Jar Subsubassembly

Jar in fixture

Tote of Jars

Acetone Welding Fixture

Funnel in Jar

Tote of Funnels

Acetone weld Funnel to Jar

Acetone and cotton swab

Flip Jar and fixture and repeat for other funnel

Jar Lid in Jar

Tote of Jar Lids

Jar QC check

-Funnels secure and flush with Jar

Final Assembly

Drive Belt Carrier in Drive Belt

Tote of Drive Belt Carriers

Base Subassembly pallet

Axle through Drive Belt Carrier and Back Support

Tote of Axles

Wheel Subassembly on assembly

Tote of Wheel Subassemblies

A-frame Subassembly angled onto assembly

Tote of A-frame Subassemblies

Axle Pins on assembly

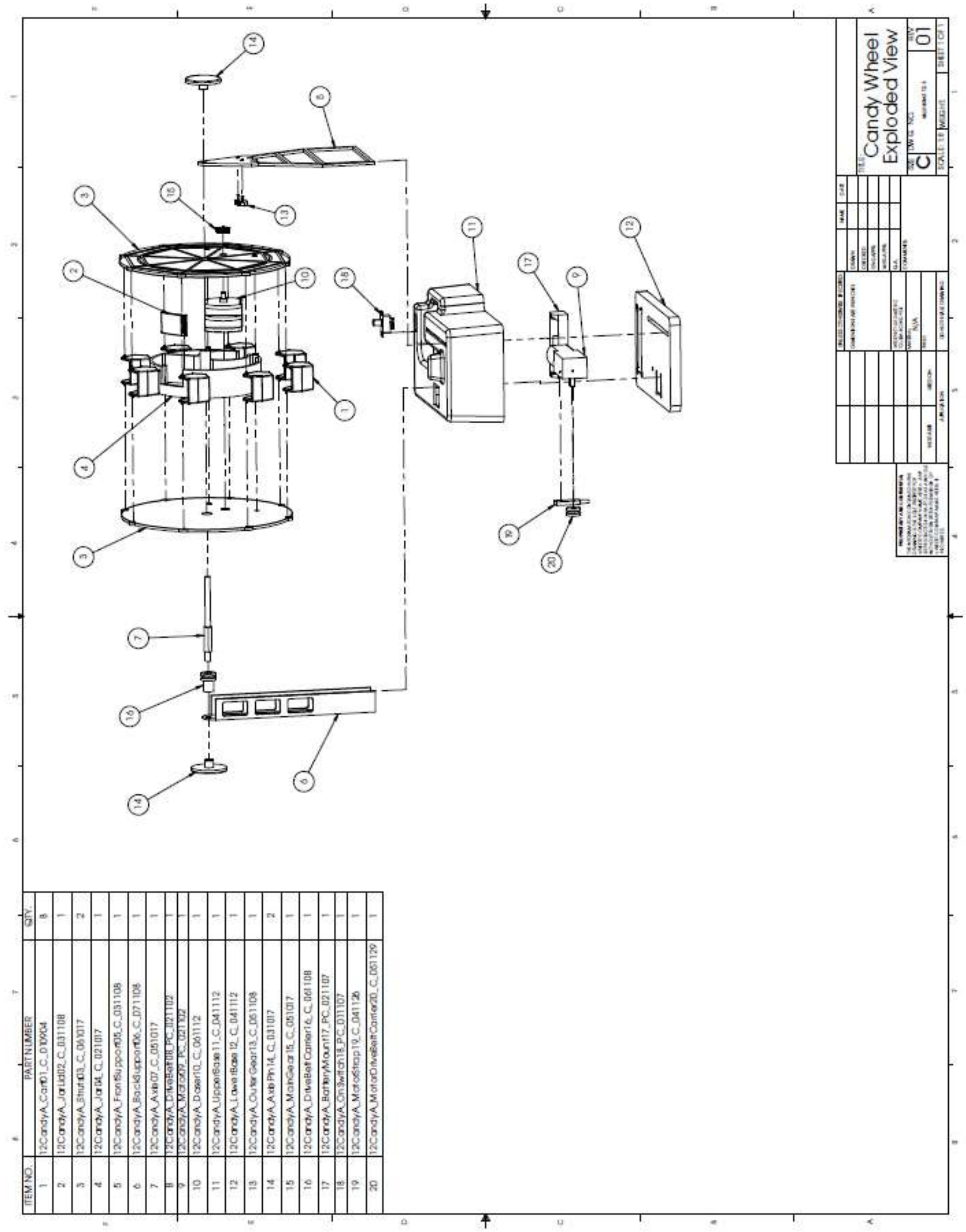
Tote of Axle Pins

Unit QC check

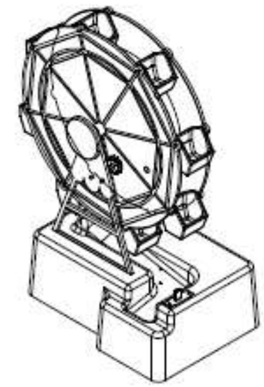
-Does it dispense candy?

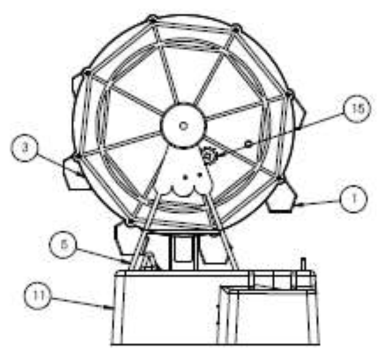
-Axle pins hold unit together

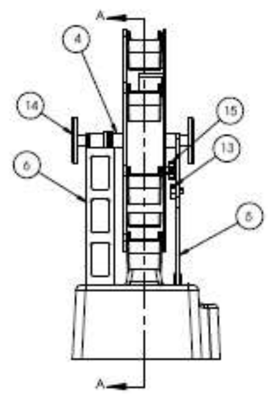
5.3: Exploded and Assembly CAD Views

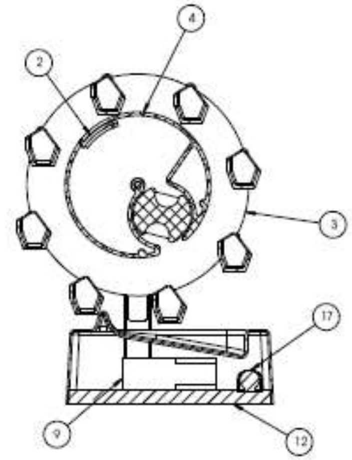


ITEM NO.	PART NUMBER	QTY.
1	12CandyA_Cart01_C_010904	8
2	12CandyA_JarLid02_C_031108	1
3	12CandyA_Struts03_C_061017	2
4	12CandyA_Jar04_C_021017	1
5	12CandyA_FrontSupport05_C_031108	1
6	12CandyA_BackSupport06_C_071108	1
7	12CandyA_Axle07_C_061017	1
8	12CandyA_DriveBelt08_PC_021102	1
9	12CandyA_Motor09_PC_021102	1
10	12CandyA_Doser10_C_061112	1
11	12CandyA_UpperBase11_C_041112	1
12	12CandyA_LowerBase12_C_041112	1
13	12CandyA_OuterGear13_C_061108	1
14	12CandyA_AxlePin14_C_031017	2
15	12CandyA_MainGear15_C_051017	1
16	12CandyA_DriveBeltCarrier16_C_061108	1
17	12CandyA_BatteryMount17_PC_021107	1
18	12CandyA_OnSwithch18_PC_011107	1
19	12CandyA_MotorStrap19_C_041126	1
20	12CandyA_MotorDriveBeltCarrier20_C_051129	1

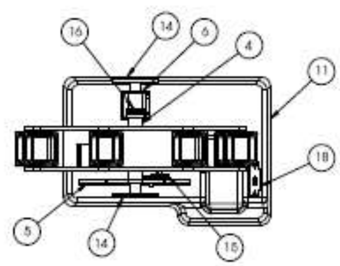








SECTION A-A



TITLE: Candy Wheel

SIZE C | DWG. NO. | REV 01

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 1

5.4: Overhead View

5.4.1: Base Assembly Robotic Envelope

Error! Reference source not found. The lower base automated assembly begins with a ew lower base being shifted out from the bottom of the Lower Base Feeder (the white fixture on the right side of Figure 15) and into the Lower Base Fixture (the blue fixture in the center of the figure). The robot (Adept) then rotates the lower base into the proper orientation in the Lower Base fixture, and then collects a motor from the Electronics Pallet (on the left edge of the figure). The Lower Base Fixture is then slowly shifted to under the Glue Gun Nozzle (the metal figure at the end of the thick black hose on the lower edge of the figure). The glue is dispensed, the Lower Base Fixture retracts, and the motor is placed. This process is repeated with the battery holder. Once both components have been glued down, the robot moves the finished lower base onto the conveyor cart (off the right edge of the figure).

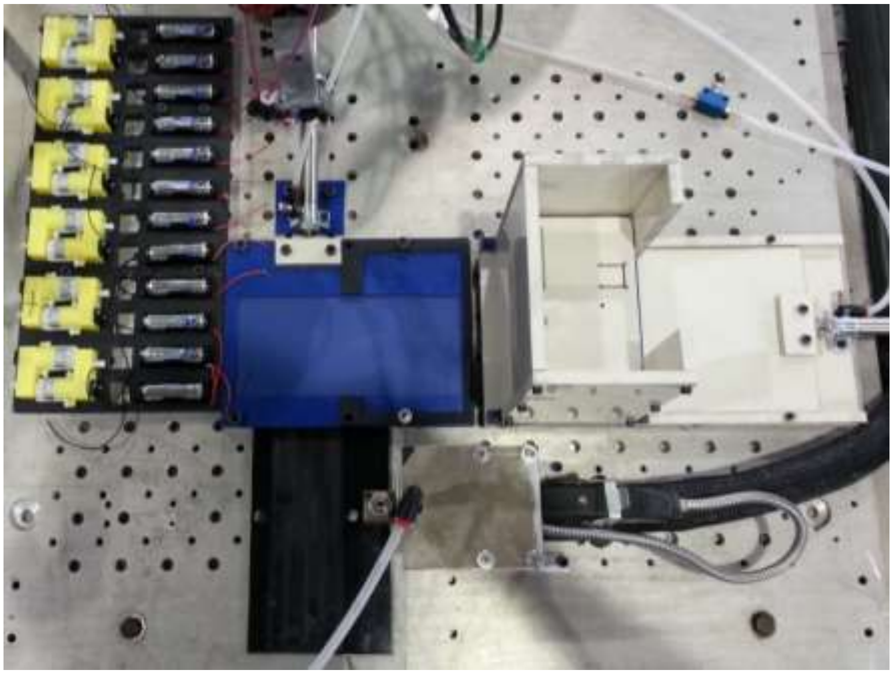


Figure 15 - Base Envelope

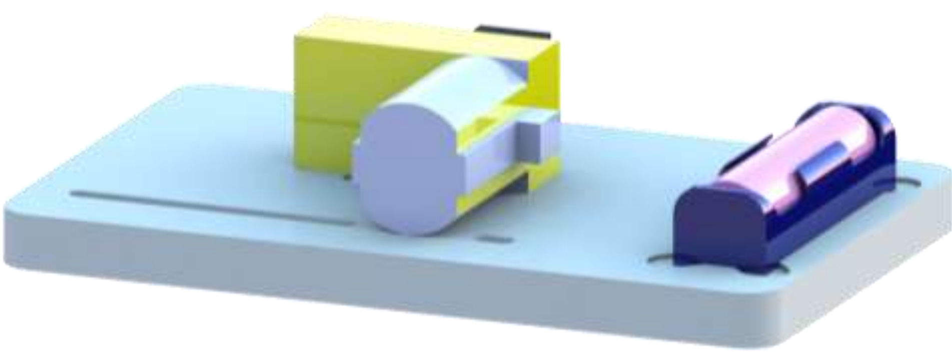


Figure 16: The base subassembly with the motor and battery cover glued in place

5.4.2: Wheel Assembly Robotic Envelope

The wheel assembly begins with the robot (Staubli) picking up a face-down strut from the stack in the upper right corner of and placing it into the wheel fixture on the left side of the figure. It then places into the wheel fixture a jar and lid combination, a doser, and eight carts. The doser pallet is on the bottom edge of the figure, the cart pallet in the center, and the doser pallet in the upper edge. Once all the parts have been pick-and-placed, the wheel fixture slides to two positions under the ultrasonic welder (off the left edge of the figure) and welded together. It then returns to its initial position, and the robot moves the completed wheel onto the conveyor cart (off the right edge of the figure).

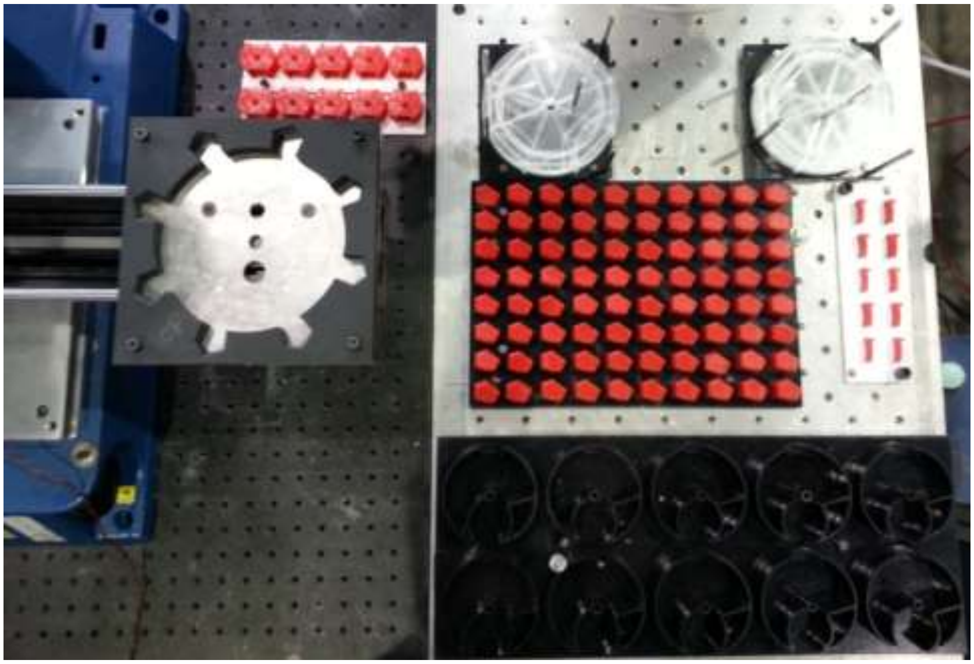


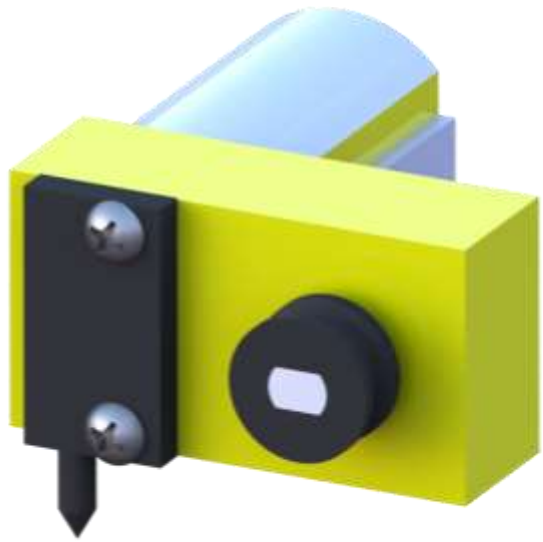
Figure 17 – Staubli Work Envelope

Figure 18 – The wheel assembly after finishing on the Staubli

5.5: Motor Subsubassembly

Assembly or Subassembly Name

Motor Subsubassembly



Assembly Description

The operator attaches replaces the screws in the Motors, attaching the Motor Strap. Then the operator presses the Motor Drive Belt Carrier on the Motor.

Assembly System Flow Chart Drawing Number 5.2

Proposed Assembly Process Plan

Part or Subassembly 1

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Motor	9	12CandyA_Motor09_PC_021108
Presentation Method	Bin		

Part or Subassembly 2

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Screw Removed		
Presentation Method	Screwdriver		

Part or Subassembly 3

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Motor Strap	19	12CandyA_MotorStrap19_C_011206
Presentation Method	Bin		

Part or Subassembly 4

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Motor Strap on Motor		
Presentation Method	By hand		

Part or Subassembly 5

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Screws	1290	
Presentation Method	Box		

Part or Subassembly 6

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Screws in Motor Strap		
Presentation Method	Screwdriver		

Part or Subassembly 7

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Motor Drive Belt Carrier	20	12CandyA_MotorDriveBeltCarrier20_C_051129
Presentation Method	Bin		

Part or Subassembly 8

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Motor Drive Belt Carrier on Motor		
Presentation Method	By hand		

Assembly

	Name	Item #	Drwg. Or Part #
Manipulator(s)	Operator		
End Effector(s)	Screwdriver		
Fixture(s)	N/A		
Fastening Method(s)	Screws Press Fit		
Inspection	Visual Electrical		

Critical Tolerances, Equipment, and Surface Finish Issues

Equipment Accuracy

Equipment Repeatability

Part Tolerance

Part Surface Variability

Assembly Force

Can be done easily by hand.

Part Finish Damage

Overturning the screws constricts gears inside and can render the motor not-operational.

Quality Control Process

Visual Inspection

Electronics functionality (apply voltage difference across motor leads)

CAD and CAM File Names/Locations

CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > Base Subassembly

Material Resource Planning

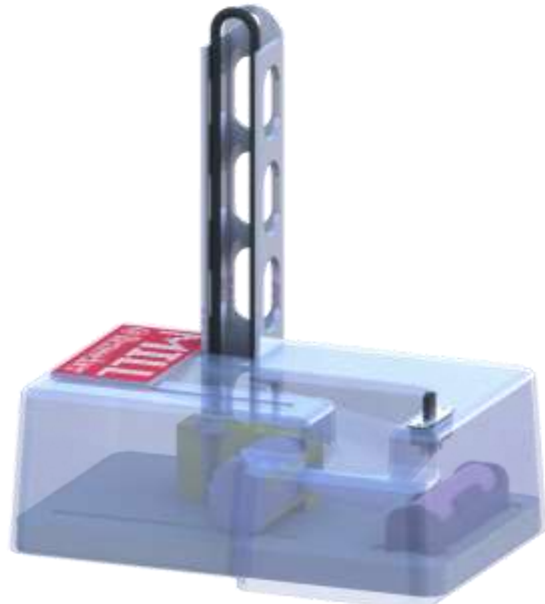
- N/A

Budget Allocation
• 400 Motors: \$0.80/motor, Total cost \$320 • 800 Screws: \$0.0457/screw, Total cost \$36.56

Responsible Team Member	Date
Conceptualization: Taylor Browne, Joshua Gabai, Wesley Koo, Robert McDonald, James Robinson-Liu, Michael Snyder, Devan Stacy Documentation: Joshua Gabai	

5.6: Base & Back Subassembly

Assembly or Subassembly Name
Base & Back Subassembly



Assembly Description
The Adept attaches the Motor Subsubassembly and Battery Holder to the Lower Base with hot glue. Then a human operator attaches the Back Support, Bracing Screw, and Drive Belt by hand. Then the human operator solders the electronics together, places the Upper Base on the assembly, and hot-glues the Switch and Logo Plate to the Upper Base.

Assembly System Flow Chart Drawing Number	5.2

Proposed Assembly Process Plan

Part or Subassembly 1

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Lower Base	12	12CandyA_LowerBase12_C_051204
Presentation Method	Feeder	1030	12CandyA_LowerBaseFD1030_AF1030_040223

Part or Subassembly 2

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Motor Subsubassembly		
Presentation Method	Pallet	1040	

Part or Subassembly 3

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Motor Subsubassembly on Lower Base		
Presentation Method	Adept (Hot Glue)	1070	12CandyA_GlueFX1070_AF1070_020213

Part or Subassembly 4

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Battery Holder	17	12CandyA_BatteryMount17_PC_021107
Presentation Method	Pallet	1040	

Part or Subassembly 5

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Battery Holder on Lower Base		
Presentation Method	Adept (Hot Glue)	1070	12CandyA_GlueFX1070_AF1070_020213

Part or Subassembly 6

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Back Support	6	12CandyA_BackSupport06_C_061129
Presentation Method	Bin		

Part or Subassembly 7

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Back Support on assembly		
Presentation Method	Manual Press	1050	

Part or Subassembly 8

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Bracing Screw on assembly	1300	
Presentation Method	Screw in by hand		

Part or Subassembly 9

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Electronics soldered		
Presentation Method	Soldered by hand		

Part or Subassembly 10

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Upper Base	11	12CandyA_UpperBase11_C_051203
Presentation Method	Bin		

Part or Subassembly 11

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Upper Base on assembly		
Presentation Method	By hand		

Part or Subassembly 12

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Switch	18	12CandyA_OnSwitch18_PC_011107
Presentation Method	Bin		

Part or Subassembly 13

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Switch on Upper Base		
Presentation Method	Hot glued by hand		

Part or Subassembly 14

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Logo Plate	23	12CandyA_LogoPlate21_C_010502
Presentation Method	Bin		

Part or Subassembly 14

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Logo Plate on Upper Base		
Presentation Method	Hot glued by hand		

Assembly

	Name	Item #	Drwg. Or Part #
Manipulator(s)	Adept Operator Manual Press		
End Effector(s)	Pneumatic Rotary EE	1020	
Fixture(s)	Sliding base fixture Lower Base feeder Electronics Pallet Glue Fixture Manual Press Fixture	1060 1030 1040 1070 1050	12CandyA_SlidingBaseFX1060_AF1060_030223 12CandyA_LowerBaseFD1030_AF1030_040223 12CandyA_GlueFX1070_AF1070_020213

Fastening Method(s)	Hot Glue Soldering Press Fit
Inspection	Visual Strength test Electronic

Critical Tolerances, Equipment, and Surface Finish Issues

Equipment Accuracy

Fastening electronics
Placing Motor strap

Equipment Repeatability

Staubli RX90, 0.0008 in. retrieved from http://mfg.eng.rpi.edu/aml/course/chap2.pdf

Part Tolerance

Back Support press fit
Motor Strap press fit
Upper Base press fit

Part Surface Variability

Back Support inside surface

Assembly Force

Back Support buckling

Part Finish Damage

Back support buckling

Quality Control Process

Visual Inspection

Electronics functionality

Back Support fully secured

Battery holder secured

Upper Base fully attached

CAD and CAM File Names/Locations

CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > Base Subassembly

Material Resource Planning

- Materials for fixtures, feeders, and pallets – aluminum or Polystyrene as necessary and available
- Real cost $250 - $300 each, MILL cost $0

Budget Allocation

- 450 Battery Mounts: $0.347, Total cost $156.15
- 450 O-rings (in packs of 50): $0.26/ring, Total cost $117
- 400 Switches: $0.52/switch, Total cost $208
- 400 AA-batteries: $0.18/battery, Total cost $72
- 400 Bracing Screws: $0.106/screw, Total cost $42.50
- 400 feet of wire: $0.1627/foot, Total cost $65.08
- Staubli use $60/hour real cost, $0/hour MILL cost, labor hours TBD

Responsible Team Member **Date**

Conceptualization: Taylor Browne, Joshua Gabai, Wesley Koo, Robert McDonald, James Robinson-Liu, Michael Snyder, Devan Stacy

Pseudo-code: Robert McDonald

Assembly Lay-out: Taylor Browne, Robert McDonald

Documentation: Joshua Gabai

Base Assembly Pseudocode (Staubli)

(Is assumed that motor, battery pack, and switch are in a gravity feeder)

(Lower base and components are done by hand by the time robot code starts)

```
Start cycle
    Tool is the suction cup
    Move to lid store location
    Grab lid
    Move to lid frame location
    Redefine lid store location (shift to next array location)
    Lower lid over base
    Release suction
    Move to back support store location
    Grab back support
    Move to back support frame location
    Insert back support
    Release suction
    Grab base by lid
    Move to base storage
End cycle
```

5.7: Jar Subsubassembly

Assembly or Subassembly Name
Jar Subsubassembly

Assembly Description
A human operator acetone welds the two Funnels to the Jar and press fits the Jar Lid in.

Assembly System Flow Chart Drawing Number	5.2

Proposed Assembly Process Plan

Part or Subassembly 1

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Jar	4	12CandyA_Jar04_C_031126
Presentation Method	Bin		

Part or Subassembly 2

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Funnels	21	12CandyA_Funnel21_C_010409
Presentation Method	Bin		

Part or Subassembly 3

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Funnel on Jar		
Presentation Method	By hand, Acetone Weld		

Part or Subassembly 4

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Flip Jar and fixture		
Presentation Method	By hand		

Part or Subassembly 5

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Funnel on Jar		
Presentation Method	By hand, Acetone Weld		

Part or Subassembly 6

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Jar Lid	2	12CandyA_JarLid02_C_051126
Presentation Method	Bin		

Part or Subassembly 7

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Jar Lid in Jar		
Presentation Method	By hand		

Assembly

	Name	Item #	Drwg. Or Part #
Manipulator(s)	Operator		
End Effector(s)	N/A		
Fixture(s)	Acetone Welding Fixture	1180	12CandyA_AcetoneWeldingFX1180_AF1180_050422
Fastening Method(s)	Welding Interference fit		
Inspection	Visual		

Critical Tolerances, Equipment, and Surface Finish Issues

Equipment Accuracy

Equipment Repeatability

Part Tolerance

Jar Lid interference fit in Jar

Part Surface Variability

Extra plastic on Funnels will prevent proper welding

Assembly Force

Light pressure for both Funnels and Jar Lid

Part Finish Damage

Acetone on undesired surfaces will mar finish

Quality Control Process

Visual Inspection

Funnels and Jar Lid flush with Jar sides

CAD and CAM File Names/Locations

CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > Wheel Subassembly

Material Resource Planning

- Materials for fixtures – aluminum or plastic as available

Budget Allocation

- Acetone $5
- Cotton Swabs <$1
- Welding Fixtures from scrap material

Responsible Team Member **Date**

Conceptualization: Joshua Gabai, Daniel Golding, Trevor Burtzos

Documentation: Joshua Gabai

5.8: Wheel Subassembly

Assembly or Subassembly Name
Wheel Subassembly

Assembly Description
The Staubli places the first Strut on the wheel frame. It places the 8 carts, Jar Subsubassembly, Doser, and second Strut on top. The entire subassembly is pneumatically shifted under a nearby welder and the Struts are welded to the Jar. The assembly is removed and the Washer and Main Gear are attached by a human operator.

Assembly System Flow Chart Drawing Number	5.2

Proposed Assembly Process Plan

Part or Subassembly 1

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Struts	3	12CandyA_Struts03_C_051108
Presentation Method	Stack	1140	12CandyA_StrutStack1140_AF1140_010328

Part or Subassembly 2

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Jar Subsubassembly		
Presentation Method	Pallet	1110	12CandyA_JarPL1110_AF1110_020415

Part or Subassembly 3

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Jar Subsubassembly on Strut		
Presentation Method	Staubli		

Part or Subassembly 4

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Doser	10	12CandyA_Doser10_C_071126
Presentation Method	Pallet	1100	12CandyA_DoserPL1100_AF1100_020415

Part or Subassembly 5

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Doser in Jar		
Presentation Method	Staubli		

Part or Subassembly 6

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Carts	1	12CandyA_Cart01_C_081126
Presentation Method	Pallet	1090	12CandyA_CartPL1090_AF1090_020326

Part or Subassembly 7

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Carts on Strut		
Presentation Method	Staubli		

Part or Subassembly 8

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Strut on assembly		
Presentation Method	Staubli		

Part or Subassembly 9

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Weld Jar to Struts		
Presentation Method	Ultrasonic Welder		

Part or Subassembly 10

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Washer	22	12CandyA_Washer21_C_010412
Presentation Method	Bin		

Part or Subassembly 11

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Washer on Doser		
Presentation Method	By hand		

Part or Subassembly 12

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Main Gear	15	12CandyA_MainGear15_C_061126
Presentation Method	Bin		

Part or Subassembly 13

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Main Gear on Doser		
Presentation Method	By hand		

Assembly

	Name	Item #	Drwg. Or Part #
Manipulator(s)	Staubli Operator		
End Effector(s)	Gripper/Suction EE	1080	
Fixture(s)	Sliding Wheel Fixture, Wheel Fixture Adapter Plate, Jar pallet, Strut stack,	1150 1160 1110 1140	12CandyA_SlidingWheelFX1150_AF1150_020428 12CandyA_AdapterPlate1160_AF1160_010430 12CandyA_JarPL1110_AF1110_020415 12CandyA_StrutStack1140_AF1140_010328 12CandyA_CartPL1090_AF1090_020326

	Cart pallet	1090
Fastening Method(s)	Welding Interference Fit Loose Fit	
Inspection	Visual	

Critical Tolerances, Equipment, and Surface Finish Issues

Equipment Accuracy

Staubli RX90, 0.02 mm (0.00787 in.) retrieved from http://www.machinery-export.com/de/roboter/staubli/staubli-RX-90-EN.html

Properly orienting the Struts and Jar

Equipment Repeatability

Adept Cobra 800, 0.0008 in. retrieved from http://mfg.eng.rpi.edu/aml/course/chap2.pdf

Lining up Jar center with Strut centers. Getting all the Carts lined up with the top Strut.

Part Tolerance

Cart nubs

Part Surface Variability

Main Gear flash

Assembly Force

Fitting the gear on

Part Finish Damage

Welding

Quality Control Process

Visual Inspection

Wheel total thickness

Doser and carts spin

Wheel doesn’t fall apart

Jar lid fits properly

CAD and CAM File Names/Locations

CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > Wheel Subassembly

Material Resource Planning

- Materials for fixtures, feeders, and pallets – aluminum or Polystyrene as necessary and available
- Real cost $250 - $300 each, MILL cost $0
- Welding Horn

Budget Allocation

- Adept use: $60/hour real cost, $0/hour MILL cost, labor hours TBD
- Plastic Joining: $30/hour real cost, $0/hour MILL cost, labor hours TBD

Responsible Team Member **Date**

Conceptualization: Joshua Gabai, Wesley Koo, Robert McDonald, James Robinson-Liu, Michael Snyder, Devan Stacy, Daniel Golding

Pseudo-code: Robert McDonald

Assembly Lay-out: Taylor Browne, Robert McDonald, Daniel Golding

Documentation: Joshua Gabai

Wheel Assembly Pseudocode (Adept)

(Is assumed that doser, door, and gear are in gravity feeders)

Start cycle
    Tool is suction cup
    Move to plate stack
    Grab plate
    Redefine plate stack location (shift down one plate thickness)
    Move to frame center
    Drop plate
    Start cart loop (loop 8x)
        Move to cart feeder
        Grab cart
        Move to cart position in frame (based on current loop number)
        Rotate cart to proper orientation (based on current loop number)
        Place cart
    End cart loop
    Change tool to clippers
    Move to jar stack
    Grab jar
    Redefine jar stack location (to next location in array)
    Move to frame center
    Drop jar
    Move to doser store location
    Grab doser
    Move to doser wheel location
    Drop doser
    Move to door store location
    Grab door
    Move to door wheel location
    Drop door
    Tool change to suction cup
    Move to plate stack
    Grab plate
    Redefine plate stack location (shift down one plate thickness)
    Move to frame center
    Drop frame
    Pneumatic actuator pushes frame under ultrasonic welder
    Welder attaches plates to reservoir
    Pneumatic actuator pulls frame to initial position
    Tool change to clippers
    Move to gear store location
    Grabs gear
    Move to gear wheel location
    Insert gear
    Release clamps
    Tool change to suction cup
    Move to frame center

Grabs wheel unit
Moves to wheel storage location
Drop wheel
End cycle

5.9: A-frame Subassembly

Assembly or Subassembly Name
A-frame Subassembly

Assembly Description
The operator puts the Outer Gear and Front Support in the Heatstaker and heatstakes them together.

Assembly System Flow Chart Drawing Number	5.2

Proposed Assembly Process Plan

Part or Subassembly 1

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Outer Gear	13	12CandyA_OuterGear13_C_081126
Presentation Method	Bin		

Part or Subassembly 2

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Front Support	5	12CandyA_FrontSupport05_C_081129
Presentation Method	Bin		

Part or Subassembly 3

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Outer Gear and Front Support in Heatstake Fixture		
Presentation Method	By hand		

Part or Subassembly 4

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Heat Stake Outer Gear		
Presentation Method	Heatstaker		

Assembly

	Name	Item #	Drwg. Or Part #
Manipulator(s)	Operator Heatstaker		
End Effector(s)	N/A		
Fixture(s)	Heat stake fixture	1230	12CandyA_HeatStakeFX1230_AF1230_020409
Fastening Method(s)	Heat Stake		
Inspection	Visual		

Critical Tolerances, Equipment, and Surface Finish Issues

Equipment Accuracy

Equipment Repeatability

Heatstaker fastening

Part Tolerance

Placing Front Support on Outer Gear

Part Surface Variability

Hard to fit Front Support in fixture

Assembly Force

Removing subassembly from fixture

Part Finish Damage

Scraping of Front support against shaft.

Quality Control Process

Visual Inspection

Does it hold?

CAD and CAM File Names/Locations

CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > Final Subassembly

Material Resource Planning

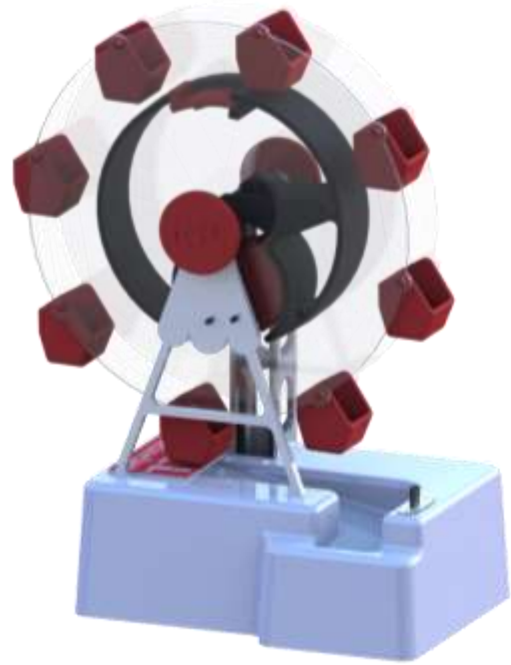
- Materials for fixture – aluminum
- Real cost $250 - $300, MILL cost $0

Budget Allocation
• Heat Staking cost TBD

Responsible Team Member	**Date**
<u>Conceptualization:</u> Taylor Browne, Joshua Gabai, Wesley Koo, Robert McDonald, James Robinson-Liu, Michael Snyder, Devan Stacy <u>Assembly Lay-out:</u> Daniel Golding <u>Documentation:</u> Joshua Gabai	

5.10: Final Assembly

Assembly or Subassembly Name
Final Assembly



Assembly Description
The human operator will put the drive belt carrier in the drive belt and the axle through both the drive belt carrier and the back support of the base subassembly. The wheel subassembly then gets placed on the axle, and the A-frame subassembly is angled onto the axle and into the lower base. Axle pins are place on both ends of the axle. The Ferris Wheel Candy dispenser is now fully assembled.

Assembly System Flow Chart Drawing Number	5.2

Proposed Assembly Process Plan

Part or Subassembly 1

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Base Subassembly		
Presentation Method	Bin		

Part or Subassembly 2

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Drive Belt Carrier	16	12CandyA_DriveBeltCarrier16_C_061126
Presentation Method	Bin		

Part or Subassembly 3

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Drive Belt Carrier on Base Subassembly		
Presentation Method	By hand		

Part or Subassembly 4

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Axle	7	12CandyA_Axle07_C_021016
Presentation Method	Bin		

Part or Subassembly 5

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Axle in assembly		
Presentation Method	By hand		

Part or Subassembly 6

	Name	Item #	Drwg. Or Part #
Part or Subassembly	A-frame Subassembly		
Presentation Method	Bin		

Part or Subassembly 7

	Name	Item #	Drwg. Or Part #
Part or Subassembly	A-frame on assembly		
Presentation Method	By hand		

Part or Subassembly 8

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Axle Pins	14	12CandyA_AxlePin14_C_051126
Presentation Method	Bin		

Part or Subassembly 9

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Axle Pins on assembly		
Presentation Method	By hand		

Assembly

		Name	Item #	Drwg. Or Part #
	Manipulator(s)	Operator		
	End Effector(s)	N/A		
	Fixture(s)	N/A		
	Fastening Method(s)	Interference Fit Loose Fit		
	Inspection	Visual Electronic		

Critical Tolerances, Equipment, and Surface Finish Issues

Equipment Accuracy

Equipment Repeatability

Part Tolerance

Fitting Wheel on shaft.

Fitting A-frame in Base

Part Surface Variability

Upper Base hole locations

Assembly Force

Axle Pins

Part Finish Damage

Scraping of Front support against shaft.

Quality Control Process

Visual Inspection

Do gears mesh?

Axle Pins holds unit together

CAD and CAM File Names/Locations

CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > Final Subassembly

Material Resource Planning

N/A

Budget Allocation

Manual Labor

Responsible Team Member	**Date**
Conceptualization: Taylor Browne, Joshua Gabai, Wesley Koo, Robert McDonald, James Robinson-Liu, Michael Snyder, Devan Stacy, Daniel Golding Documentation: Joshua Gabai	

5.11: Packaging Assembly

Brief Overview

The packaging of the Ferris wheel candy dispenser was designed to be appealing to the consumer, practical, and economical. Taking these factors in to consideration, the team decided to have the product showcased within the packaging regardless of the material. The packaging for the Ferris wheel consists of a cardboard box with a laser-cut window and a plastic riser. The assembly process for packaging begins with the Ferris wheel being zip-tied to the polystyrene plastic riser and then inserted into the modified cardboard box.

The cardboard box will have dimensions of 8 3/4" x 4 3/8" x 9 1/2" and was purchased from Cardboard Boxes 4 U. While the cardboard box is still in an unassembled state, the hole for viewing the product will be cut out on the laser cutter. The team name along with a brief description of the product will also be laser cut into the front of the cardboard box. The back of the box will feature a laser engraved team name, members' names, as well as our sponsors.

The riser to which the Ferris wheel will be zip-tied will be constructed out of polystyrene plastic. Polystyrene was chosen for this operation due to its strength and rigidity and its ability to be vacuum formed. By using this material, the weight of the Ferris wheel will not cause the plastic to bend out of shape or twist much as the riser is inserted into the cardboard box. The riser will be vacuum-formed over a MDF mold and the excess material cut off. Four holes will then be drilled into the plastic into which zip ties will be inserted. After all these parts are completed, the fully assembled Ferris wheel will be zip-tied onto the riser and the entire assembly inserted into the top of the box. Finally clear packing tape will be used to seal the box.

Figure 19: A front view of the laser cut packaging.

Assembly or Subassembly Name	**Drawing Number**
Ferris Wheel Packaging	Packaging Assembly

Assembly Description
Human interaction zip ties Ferris wheel assembly to Polystyrene riser and packages Ferris wheel.

Assembly System Flow Chart Drawing Number	5.2

Assembly System Plan View Drawing Number

Proposed Assembly Process Plan

Subassembly 1

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Ferris Wheel Assembly		
Presentation Method	Manual		

Part 2

	Name	Item #	Drwg. Or Part #
Part or Subassembly	KYDEX Riser		27
Presentation Method	Manual		

Subassembly 3

	Name	Item #	Drwg. Or Part #
Part or Subassembly	KYDEX Riser - Ferris Wheel Assembly		
Presentation Method	Manual		

Subassembly 4

	Name	Item #	Drwg. Or Part #
Part or Subassembly	Completed Packaging Assembly		Packaging Assembly
Presentation Method	Manual		

Assembly

	Name	Item #	Drwg. Or Part #
Manipulator(s)	Manual		
End Effector(s)	N/A		
Fixture(s)	Riser Drill fixture		
Fastening Method(s)	Zip ties / Packaging Tape		
Inspection	Manual		

Critical Tolerances, Equipment, and Surface Finish Issues

Equipment Accuracy

Tapered Riser ensures that riser Ferris wheel assembly fits every time.

Equipment Repeatability

Manual Attachment of zip ties may lead to different alignments of Ferris wheel on riser assembly.

Part Tolerance

Boxes are manufactured to specs. Riser designed to compress into box so a snug fit is maintained regardless of minor alignment issues.

Part Surface Variability

No Effect

Assembly Force

None

Part Finish Damage

All scuffing if it should occur will be on the inside of the box and invisible to the customer.

Quality Control Process

Visual Inspection to make sure product is seated against box bottom can be conducted quickly and accurately.

CAD and CAM File Names/Locations
CAD: AML > 1213_Team_A > Shared Documents > CAD Files > Subassembly > Packaging Subassembly

Material Resource Planning

- Unassembled boxes will be purchased from an outside vendor.
- Boxes will be 8 3/4"x 4 3/4 x 9 1/2" when constructed.

Budget Allocation

- Free of Charge or Cost per Part (with source):
- Packs of #: 1
- Total Dimensions: 8 3/4"x 4 3/4 x 9 1/2"
- Total Machine Time:

Responsible Team Member	**Date**
James Robinson-Liu	

Figure 20 - The finished product, ready for distribution

5.12: Assembly Fixtures, Feeders, and End Effectors

The following review briefly describes the many components required to properly execute the assembly of the Ferris Wheel Candy Dispenser. The order in which fixtures and feeder are presented below follows the order of the assembly process. However, the end effectors are left to be presented at the end as they may take part in multiple stages of the assembly.

Electronics Pallet

Figure 21 - Electronics Pallet

This pallet is an omni-pallet that holds the completed motors and battery holders. It is used in the assembly of the lower base. The pallet has two layers; the top and bottom layers will be cut from available 1/8” thick plastic on the waterjet and will be raised up using ¼-20 nuts. A quantity of twelve of each part is loaded into the pallet by the operator before the assembly of the lower base begins. The design of the pallet is based on the fact that the leads on the battery holder can easily interfere with the pick operation the end effector carries out on the motor. Thus the two components were spaced out by placing space between them.

Lower Base Slide Escapement Feeder

Figure 22 - Lower Base Escapement Feeder & Slider

This feeder is a slide escapement feeder powered by a pneumatic cylinder. Originally, considerations were being made to design this feeder as a stack instead. However, due to the limited vertical capabilities of the Adept Cobra 800, in addition to the height of the end effector, robot can only pick up a piece that is a maximum of approximately 6 inches off of the workspace. The part will be made from multiple pieces available 3/8” thick plastic, as well as some pieces of available 1/8” thick plastic. Considering twelve lower bases total a height of 4.5 inches (excluding the height of the pallets), the design shifted from a stack to a slide escapement feeder. This feeder must be loaded with sixteen lower bases by the operator before the assembly begins. The feeder feeds a blank lower base out from the bottom of the stack and into a slider.

Lower Base Slider

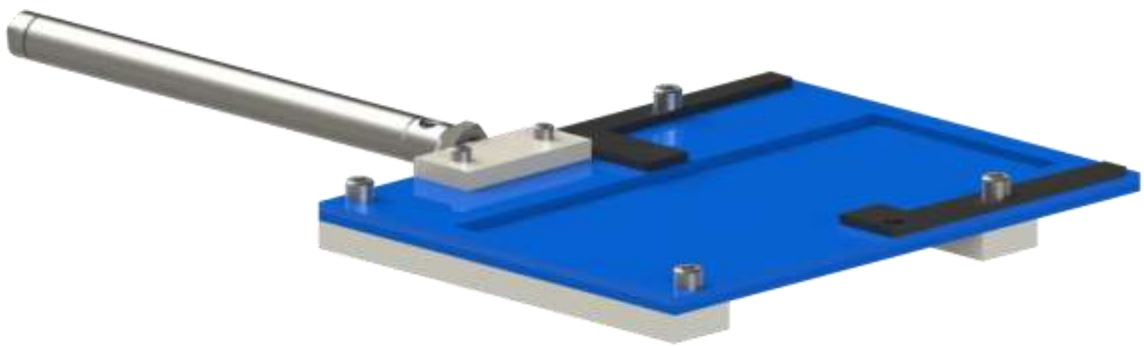


Figure 23 - Lower Base Slider

The Lower Base Slider transports the lower base to and from the initial position (upon exit from the slide escapement feeder) to the gluing position, beneath the Hot Glue Machine Head. It consists of multiple layers. A lower piece of plastic, milled and made of available material, exists to act as a guide for two tracks. The tracks will be made of 3/8" plastic and act as supports for the rest of the fixture. The next two layers up will be made of available 1/8" plastic. These two pieces act as trays for the dispensed part. Considering the part must be picked up and rotated to a different orientation, there are two layers to allow for two different depths. Both pieces can be waterjet cut. The final part acts as a tray to catch pieces that are dispensed from the slide escapement feeder. Much like the other pieces, it is made of available 1/8" plastic and waterjet cut. A final piece exists to connect to the piston to allow for sliding. This is made of available 3/8" plastic and due to size constraints, can be cut on a band saw and drilled using a press.

Glue Fixture

Figure 24 - Glue Fixture

The glue fixture is simply meant to hold the hot glue machine head in place. It consists of a stand and a plate. Both will be made of aluminum and can be waterjet cut. The stand is a ½” thick piece that will elevate the hot glue machine head to the proper head. The plate is a 1/8” thick piece of aluminum that will connect the stand and the hot glue machine head, securing the latter into place. The piece will be made of aluminum and not plastic because of aluminum’s heat dispersion capabilities.

Pneumatic Rotary End Effector

Figure 25 - Pneumatic Rotary End Effector

This end effector is a convenient and clever piece of equipment that uses pneumatics to adjust the position of the end effector suction cups. There is a separate signal to adjust the angle of the end effector over a range of 180°. This is especially useful on a machine such as the Adept Cobra 800 considering only has four axes. The pneumatic rotary actuator essentially adds half of an axis. This end effector will be used for picking up and placing parts that are originally on the workspace and standing up in the workspace. The end effector is approximately 7 inches long, but can be actuated from 90° to 0/180° to decrease its length to approximately 4 ½”. This end effector was already constructed.

Conveyor Fixture

The conveyor fixture will be used to transport the completed lower base from the workspace to the operator for QC purposes. It is a simple piece that will be made of any available material, roughly ½” thick and waterjet cut. It simply holds the completed lower base in the proper position, and needs not support any force.

Press Fixture

The manual press will be used to press the back support into the lower base. The completed lower base will be moved to the manual press and held in place by the operator. A two part fixture will be attached to the press. The first piece will support the inside of the back support channel while the other piece will support the outside to prevent buckling. This piece will be milled out of available aluminum.

Ultrasonic Welding Slider

Figure 26 - Ultrasonic Welding Slider

The ultrasonic welding slider is a simple slider that acts as a fixture as well. The first step of the wheel construction is completed here. The lower strut, carts, jar, jar lid, doser, and upper strut are assembled in this slider. After assembly, the slider function carries the part to the ultrasonic welder, where it is welded together. The slider will be made of available metal stock, no necessary thickness.

Limit Switch Fixture

The limit switch fixture is secured to the base of the ultrasonic welder and used to stop the sliding fixture at the right point under the welder. The fixture itself is a piece of angle iron with two channels to allow for adjustability of the position of the switch and two holes to secure it to the fixture.

Strut Stack

Figure 27 - Strut Stack

The strut stack is also a simple stack made from the negative of a strut, using pins. There are two strut stacks, one for the face down struts (which is the first part placed in the ultrasonic sliding fixture) and one for the face up struts (which is the last part placed in ultrasonic sliding fixture). Each is capable of holding ten struts. It consists of a baseplate with five posts. The central post will serve to fix the strut in the x and y dimensions, as it runs through the center of a strut. The outer posts serve to properly orient the strut and prevent it from rotating. It can be made of any available plastic, of varying thicknesses, per availability. The middle pin must be approximately 3/8” in diameter while the outer pins can be made of any diameter.

Jar Pallet

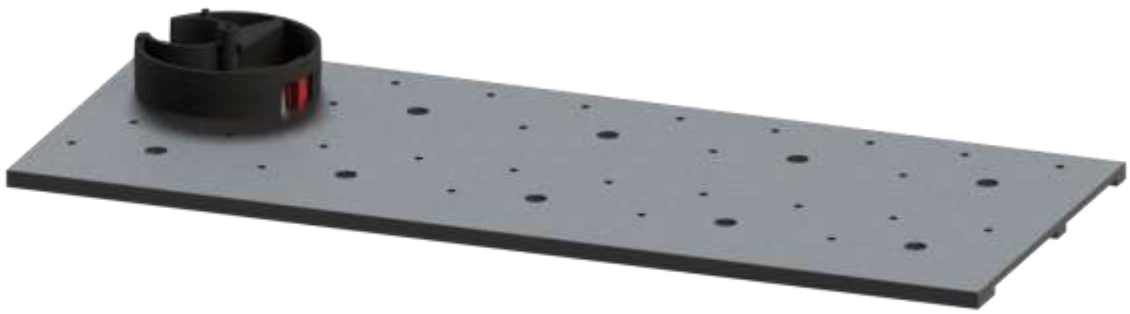


Figure 28 - Jar Pallet

The jar pallet is also a simple pallet made from available 1/8” plastic, cut on the waterjet. It is capable of holding ten jars. The top layer has 3 holes to mate with the 3 pegs of each jar. Jars will be loaded manually with jar lids in their slot and placed on the pallet. The lower layer is just used to support the pallet and boost it to the proper height.

Cart Pallet

Figure 29 - Cart Pallet

The cart pallet is a simple pallet with 8 columns by 10 columns of carts, to allow for the assembly of 10 Ferris Wheels. Each column holds a number of carts that can be removed by the Staubli for placement in the wheel assembly. The pallet must be loaded by hand. The cart pallet will be made of two available 1/8” thick stock. The top piece will be cut on the waterjet with 80 outlines for carts, while the bottom will have 80 accompanying holes for the pegs in the carts.

Doser Pallet

Figure 30 - Doser Pallet

The doser pallet is similar to the other pallets in that it was designed with little creativity and much utilitarianism in mind. It simply holds the dosers. It is made of 3 layers of polystyrene, cut on the lasercutting machine. 2 additional layers of polystyrene separate the 2 groups of 5 dosers, making for 10 in total.

Gripper/Suction End Effector

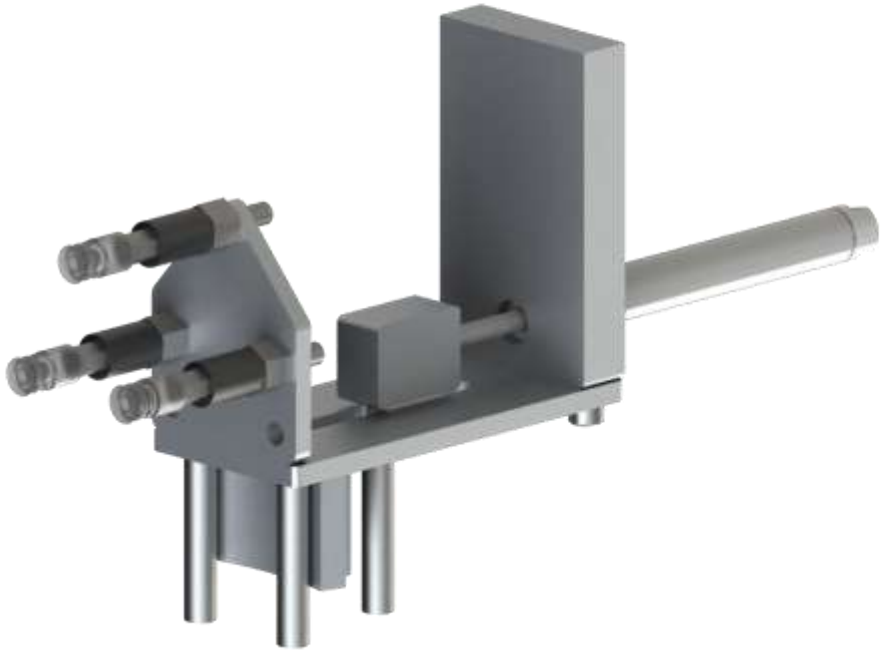


Figure 31 - Gripper/Suction End Effector

The Gripper/Suction End Effector is constructed to have a suction apparatus on one side and a clipper apparatus on the other side. The advantage of this is that no tool changes are required to complete the entire process. Much like with the Pneumatic Rotary End Effector, this is an innovative solution that provides multi-functionality. The clipper uses a Bimba 012-D pneumatic cylinder. There are three suction cups, two of which operate on one signal, and the third operates on a separate signal. This does come with a drawback however. To allow for rotation between the two functions (which are designed as 180° apart from one another) the 5th and 6th axes of the robot will be used for movement and "tool changes," potentially limiting the movement of the Staubli robot arm slightly. The end effector will be made from available aluminum stock with a ½" thickness, milled down to 7/16" thickness for geometrical constraint purposes.

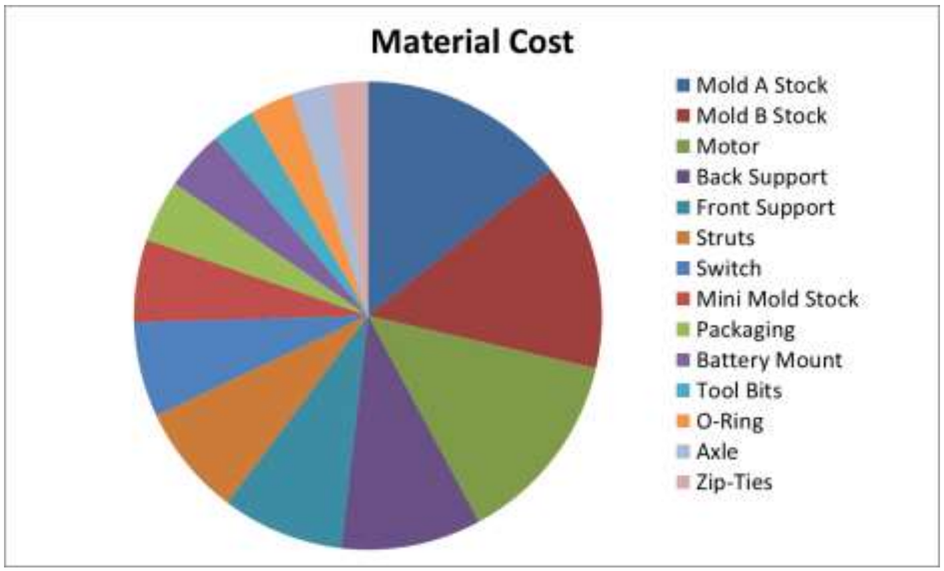
6. Cost Analysis

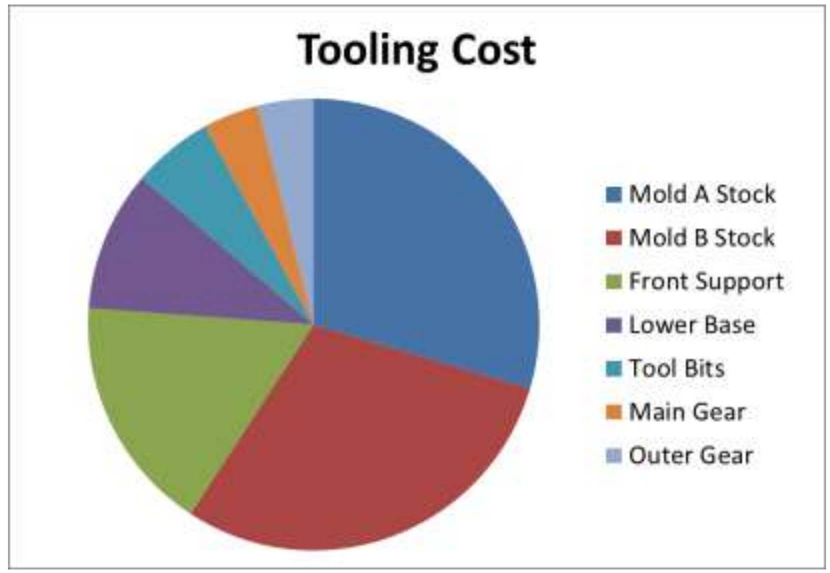
6.1: Capital Costs

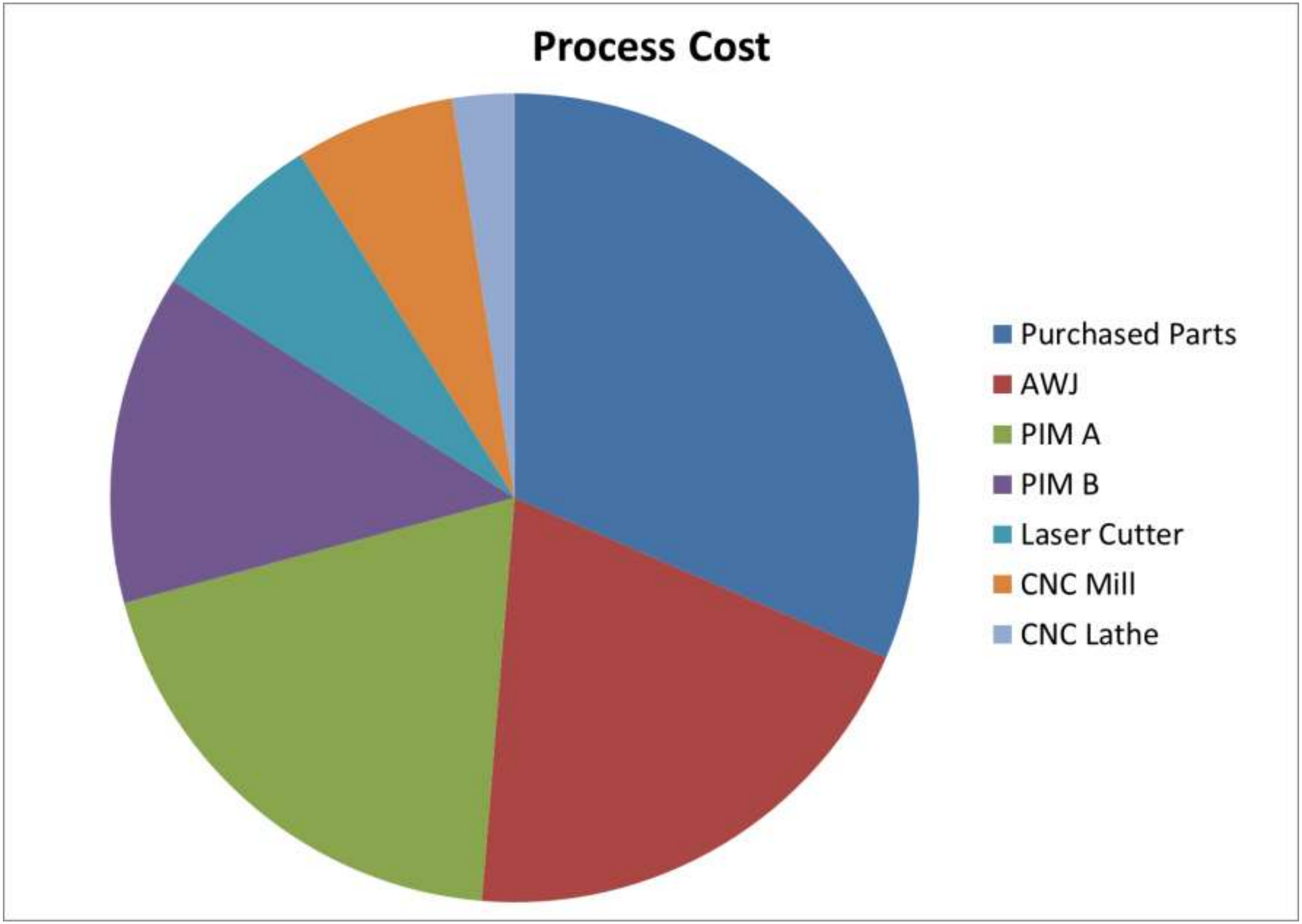
Name of Part	# Parts	Process	Material					Process Cost		
			Type	Stock	Unit Cost	Quant.	Total	Cycle Time (min)	Tooling Needed	
									Part/Insert	Cost
Jar	400	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mold A	$0.00
Motor Strap	400	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mold A	$0.00
Drive Belt Carrier	400	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mold A	$0.00
Motor Drive Belt Carrier	400	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mold A	$0.00
Main Gear	400	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mold A/ EDM	$67.50
Outer Gear	400	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mold A/ EDM	$67.50
Mold A Stock	N/A	N/A	N/A	Aluminum 6061	$500	1	$500.00	N/A	N/A	$0.00
Mold B Stock	N/A	N/A	N/A	Aluminum 6061	$500	1	$500.00	N/A	N/A	$0.00
Jar Lid	400	PIM	PP	N/A	N/A	N/A	N/A	N/A	Mold B	$0.00
Doser	400	PIM	PP	N/A	N/A	N/A	N/A	N/A	Mold B	$0.00
Axle Pin	800	PIM	PP	N/A	N/A	N/A	N/A	N/A	Mold B	$0.00
Cart	3200	PIM	PP	N/A	N/A	N/A	N/A	N/A	Mold B	$0.00
Mini Mold Stock	N/A	N/A	N/A	Aluminum 6061	$200.00	1	$200.00	N/A	N/A	$0.00
Washer	400	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mini Mold	$0.00
Funnels	800	PIM	ABS	N/A	N/A	N/A	N/A	N/A	Mini Mold	$0.00
Struts	800	Laser	Acrylic	0.093"x48"x96"	$67.40	4	$269.60	30:00:00	N/A	$0.00
Upper Base	400	Vac Form/laser	Polystyrene	0.06x11"x66"	$0.00	60	$0.00	N/A	Upper Base Mold	$0.00
Axle	400	CNC Lathe	1018 Cold Rolled Steel	3/16"x8'	$6.71	14	$94.00	N/A	N/A	$0.00
Back Support	400	CNC Mill	Al T6063	0.75x0.75x0.125	$9.35	26	$339.10	N/A	Fixture	$0.00
Front Support	400	AWJ	Al T6061	0.125"x4'x8'	$147.35	2	$294.70	N/A	N/A	$0.00
Lower Base	400	AWJ/CNC	Polycarbonate (Lexan)	56"x48"x0.375"	$0.00	5	$0.00	N/A	N/A	$0.00

Packaging	400	Purchase/laser	Cardboard	8.75"x4.75"x9.5"	$0.37	400	$148.96	N/A	N/A	$0.00
Motor	400	Purchase	N/A	N/A	$0.80	410	$473.00	N/A	N/A	$0.00
O-Ring	400	Purchase	Buna-N	Bag of 50	$0.26	8	$104.00	N/A	N/A	$0.00
Battery Mount	400	Purchase	N/A	1 Mount	$0.35	420	$145.74	N/A	N/A	$0.00
Switch	400	Purchase	N/A	N/A	$0.52	400	$229.32	N/A	N/A	$0.00
Zip-Ties	1000	Purchase	N/A	1 Zip-Tie	$0.09	1000	$92.25	N/A	N/A	$0.00
Batteries	400	donated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.00
Motor Screws	800	donated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.00
Lower Base Screws	400	donated	N/A	N/A	N/A	N/A	N/A	N/A	N/A	$0.00
Tool Bits	N/A	N/A	N/A	Miscellaneous	$104.94	1	$104.94	N/A	N/A	$0.00
AWJ Costs	N/A	N/A	N/A	Miscellaneous	$456.00	N/A	$456.00	N/A	N/A	$0.00

TOTAL	**$4,086.61**






Process Cost
Purchased Parts
AWJ
PIM A
PIM B
Laser Cutter
CNC Mill
CNC Lathe

6.2: Sustainability

Glossary of terms used in the charts:

Service – Parts that are difficult to separate but must be replaced to further their functional life.

REMAN – Remanufacture, parts that are difficult to reclaim, but are easy to access for replacement or upgrade.

RM – Redesign Material, parts that should use a different material if possible.

RDA – Redesign Architecture, parts/assemblies that should be re-thought to be easier to disassemble for reclaiming and/or reuse.

SHRED – parts of different materials tightly connected such that they require being broken down before they can be reclaimed

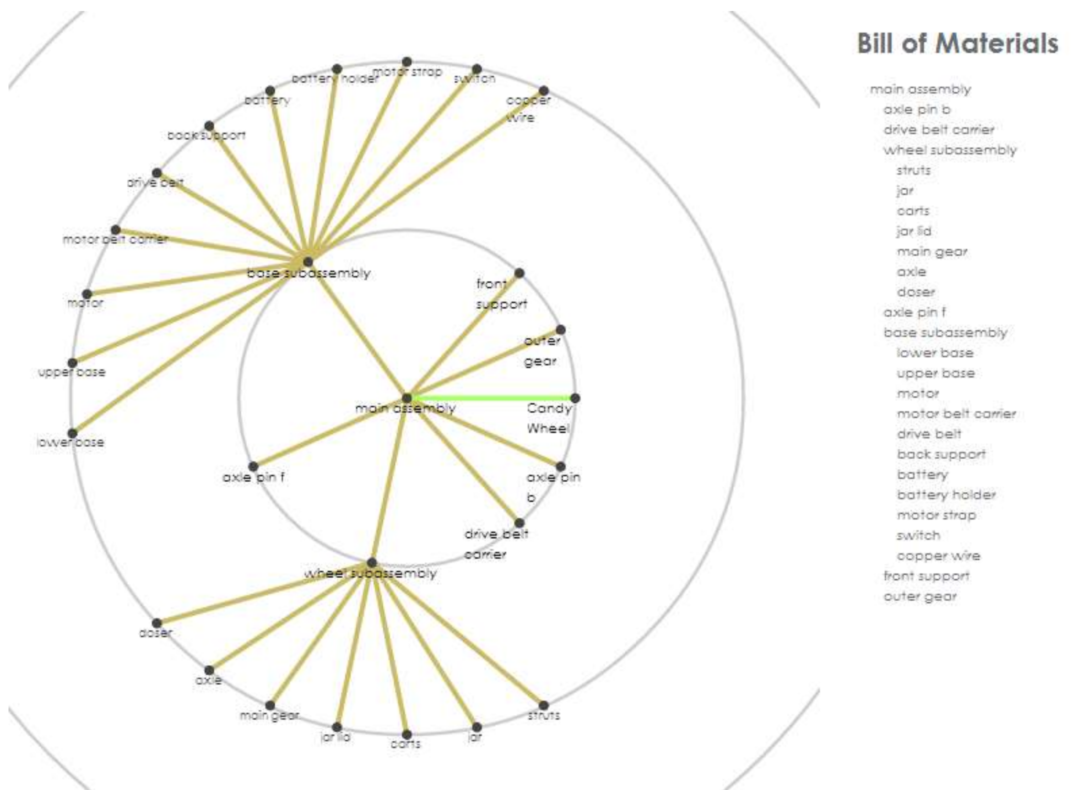


Figure 32 - Bill of Materials Map

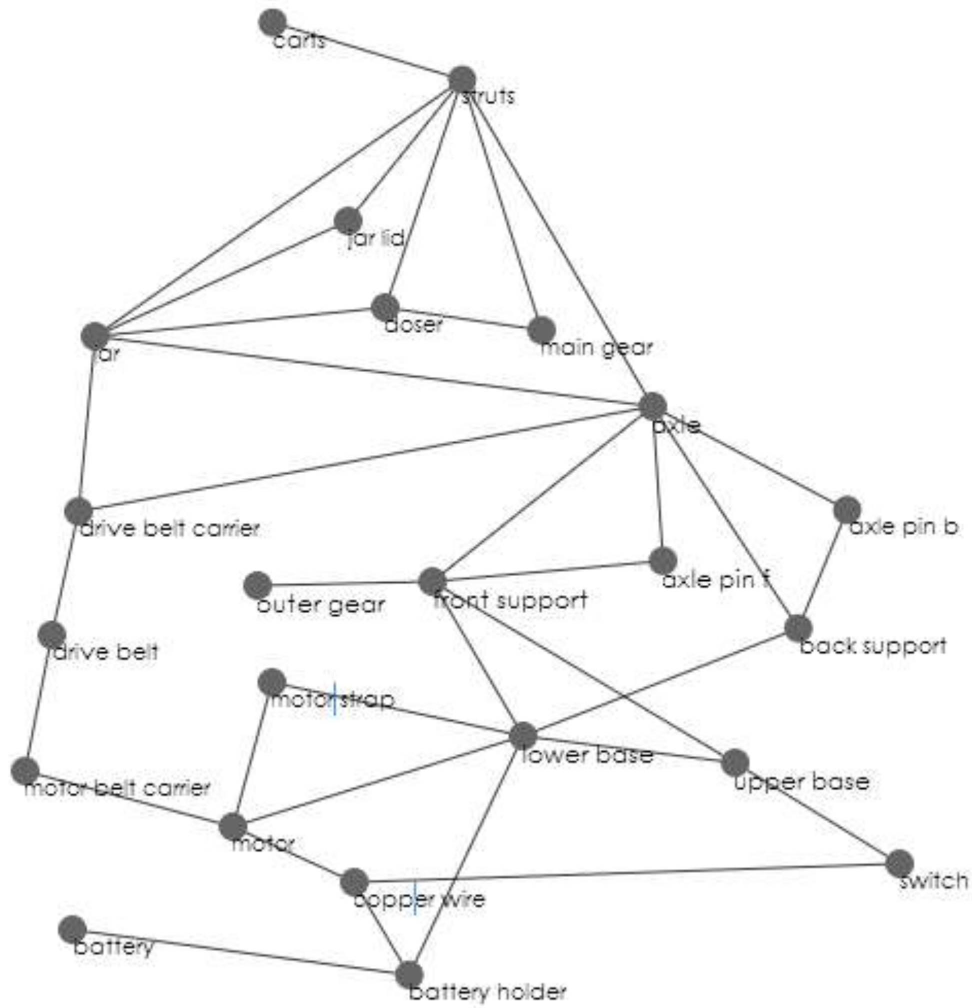


Figure 33 - Connections Map

Sustainability

The candy wheel is manufactured mostly out of plastic, with a large number of injection molded parts. As seen in Figure 34 - ***Sustainability by Percent Weight*** and Figure 35 - ***Sustainability by Percent Parts***, the majority of the product has to be shredded. This is because we have many parts that consist of multiple materials and are difficult to separate, and therefore cannot be reused until they are broken down.

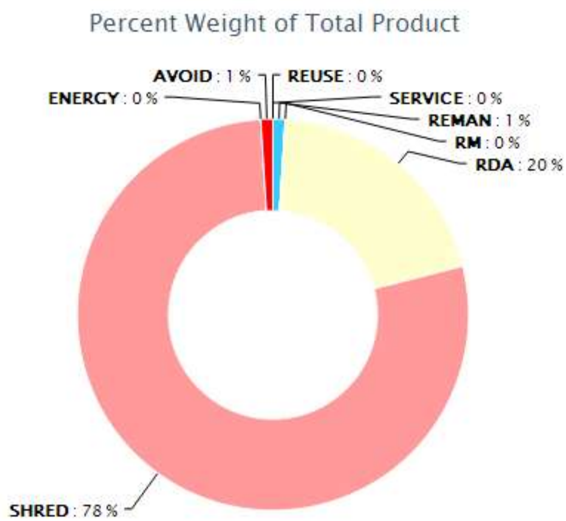


Figure 34 - Sustainability by Percent Weight

A major sustainability challenge for the team is the redesign architecture slice of the pie chart in Figure 35. This twenty-three percent slice signals that the current design has multiple parts that cannot be pulled apart easily at the recycling plant. Future iterations of the Ferris wheel candy dispenser should be designed with materials that can be broken down easily at end-of-life.

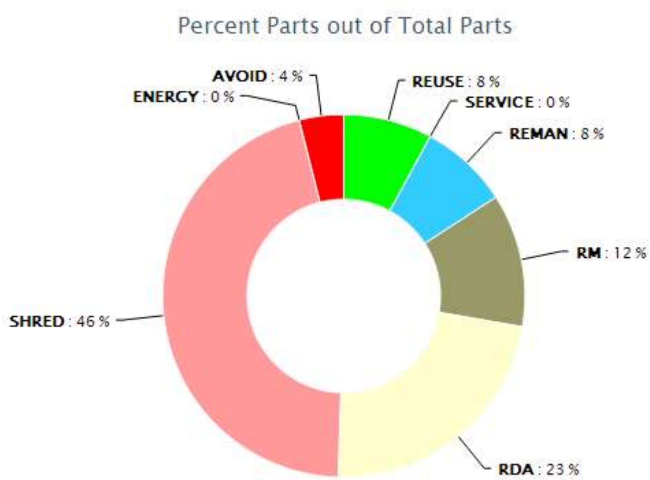


Figure 35 - Sustainability by Percent Parts

Figure 36 shows how many parts must be shredded instead of being reused, mostly due to the tight press-fits incorporated in the design. However, the pie chart also shows that several of the parts which show up under RDA are unavoidable because they are purchased components. This is also true for the part listed under REMAN, as it is another purchased component.

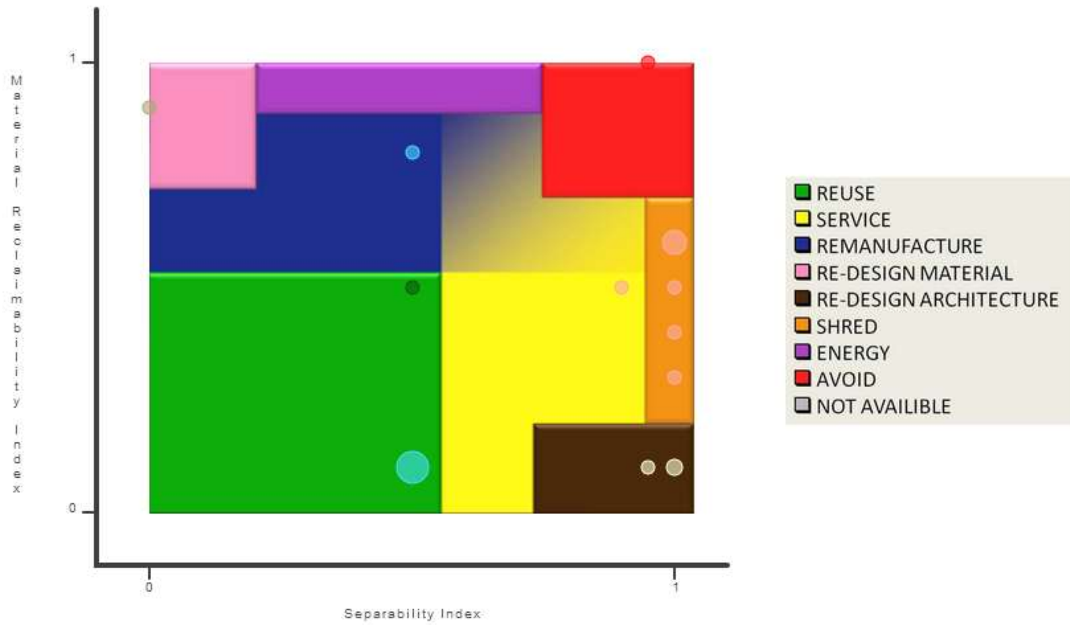


Figure 36 - End of Use Frequency by Percent Part

From the upper left, and moving counter-clockwise, the dot in the pink area is the main assembly and the wheel and base subassemblies. The light blue dot in the dark blue region is the drive belt. The red dot in the red area is the copper wire. The pink dot in the yellow region is the motor strap. The column of dots in the orange region, going down, are the struts, the axle pins, jar, main gear, lower base, outer gear, cart, jar lid, doser, and upper base. The right-most dot in the brown region in the lower right represents the motor, front support, back support, battery and battery holder. The dot to the left of it is the switch. The large dot in the lower right of the green region is the axle, and the dot in the upper right of the green region is the two drive belt carriers.

Appendices

Appendix A: Manufacturing Standard Operating Procedures

Included in this Appendix (alphabetical by part, then sequential by process for each part):

- Axle Rough Length Cut
- Axle Machining

- Back Support Rough Length Cut
- Back Support Slotting
- Back Support Machining

- Box Front & Back Laser Cutting

- Cart Flash Trimming
- Cart Drilling

- Drive Belt Carrier Grooving

- Front Support Sanding
-
- Jar Lid Thinning

- Logo Plate Laser Cutting

- Lower Base AWJ
- Lower Base Motor Strap Hole Drilling
- Lower Base Final Machining

- Motor Strap Filing

- Plastic Injection Molding

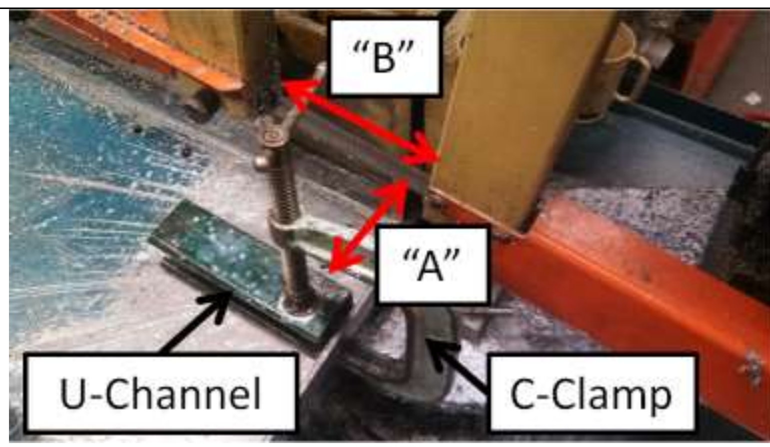
- Riser Vacuum Forming
- Riser Trimming
- Riser Hole Drilling

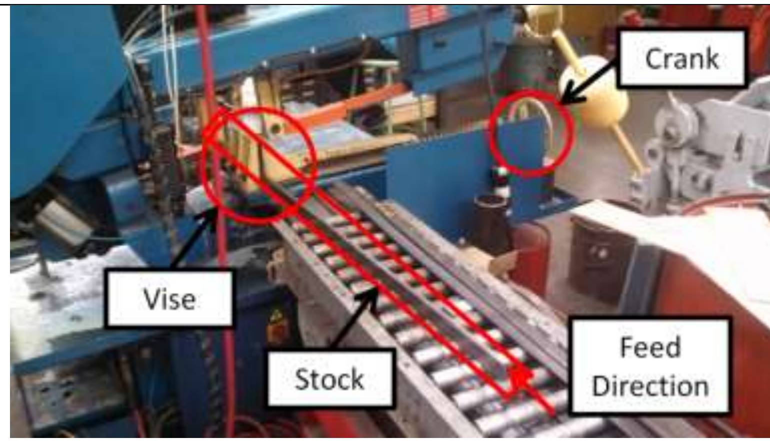
- Strut Laser Cutting

- Tumbling

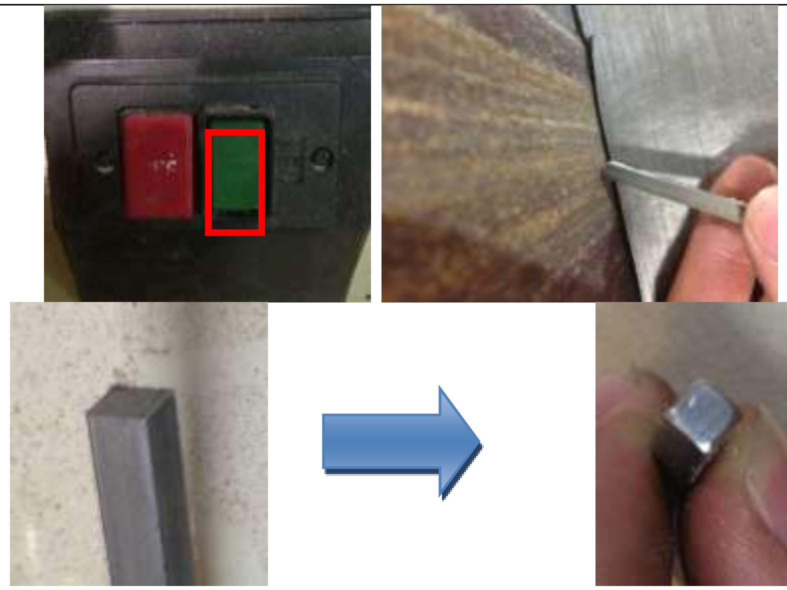
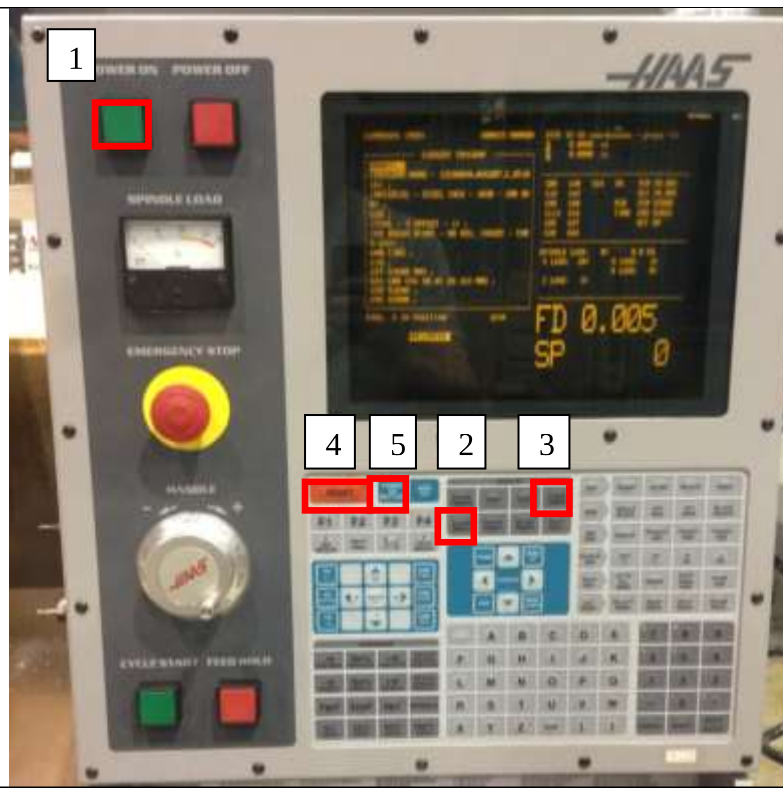
- Upper Base Vacuum Forming
- Upper Base Laser Cutting
- Upper Base Bump Removal
- Upper Base Bump Flattening

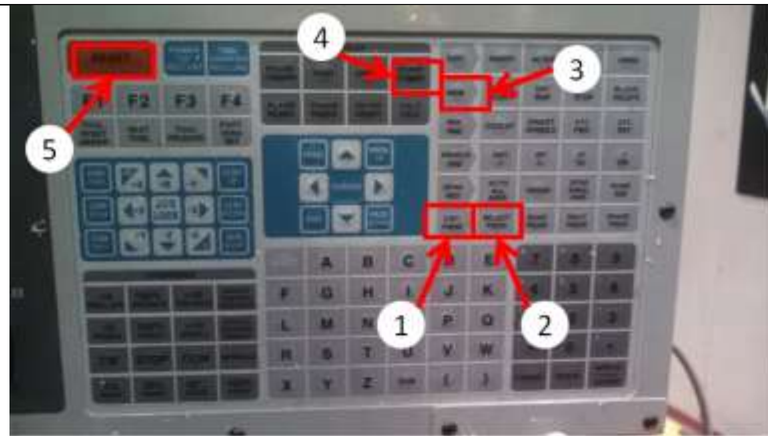
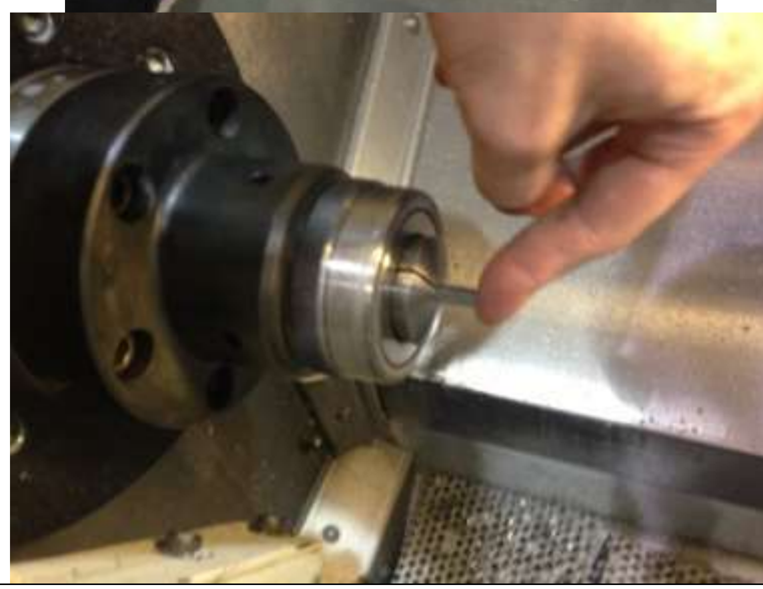
Process: Rough Length Cut of Axles
Machine: Horizontal Band Saw (Process Lab)
Stock: 8' Lengths of 3/16" Square Stock

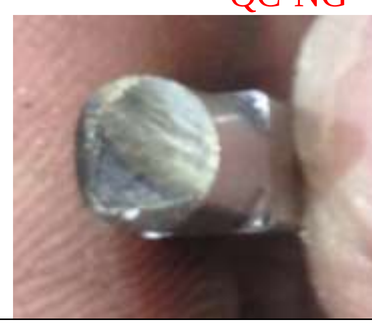
1	**General Machine Information** **(1) <u>On Button</u>** Press in to start machine. **(2) <u>Safety Key</u>** Turn to "On" to cut **(3) <u>Head Up Button</u>** Press to raise the head **(4) <u>E-Stop</u>** Press in to stop machine in case of emergency (to release turn CCW) **(5) <u>Feed Speed</u>** Turn CCW to increase, CW to decrease speed **(6) <u>Head Lock</u>** Turn horizontal to lock the head, turn vertical to allow head to drop	
2	**Setup Stop** Using a C-Clamp and U-Channel, measure the distance between the band saw blade and the stop to be between 3.125" and 3.25" ("A") Adjust the blade guard so that it is only wide enough for the required cutting width ("B") Raise the head with button (3)	

3	**Feeding Stock** Open the Vise by turning the crank. From the back of the machine, stack the stock 7 high and 2 wide. Lightly tap the stock pieces flush against the stop. Turn the crank to close the vise and securely hold all stock pieces.	
4	**Cutting Axle Stock** Press the On Button & Release the head lock (Button 1 & 6). The head will now drop. Apply coolant to the stock while cutting. Adjust the cutting speed (Button 5) as necessary. The machine will turn itself off. After cutting, press the Head Up Button (Button 3)	
5	**Cut Remaining Stock** Repeat Steps 3-4 until all stock has been cut.	
6	**Cleanup** Ensure that after cutting the area has been cleaned, vacuumed & wiped dry of coolant.	

Process: Machining of Axles
Machine: SL-10 CNC Lathe, Belt Sander
Stock: Axle Stock

1	**Required Pre-Processing: Remove burrs from one end of axle with belt sander** 1. Turn on sander 2. Sand all edges of the **Side without a burr**	
2	**Turning on Machine & Setup** 1. "Power On" 2. "ALARM MESGS" 3. "CURNT COMDS" 4. "RESET" 5. "Power Up/Restart"	

3	**Load Program (only if program is not #O00033)** 1. "LIST PROG" a. Scroll to "O000033" 2. "SELECT PROG" 3. "MEM" 4. "CURNT COMDS" 5. "RESET"	
4	**Load Stock** 1. Open collet (if necessary) by pressing left foot pedal 2. Press stock into collet 3. Press pedal to clamp stock	 

5	**Close door and Run Cycle** 1. Close door fully 2. Press cycle start to begin	
6	**Remove part** 1. Press left pedal to toggle collet **2. QC-Check the end of part was faced** if the part is not faced, put it aside for rework	 QC-OK QC-NG  
7	**Running Production Parts** Repeat steps 4-6 until your shift is over	
8	**Other side-** Before running other side, adjust collet stop and adjust machine zero accordingly. Use steps 4-6 with program **O00034** for second side	
9	**Cleanup (End of Day)** At the end of the day use the vacuum to clean up plastic chips on the floor and around the machine. Press the "POWER OFF" Button.	

Process: Rough Length Cut of Back Support
Machine: Horizontal Band Saw (M.I.L.L.)
Stock: 8' Lengths of ¾" by ¾" U-Channel

1	**General Machine Information** See image to right for names of parts.	
2	**Setting Up Stop** Measure the location of the back stop to be between 6.25" and 6.375" from the blade ("A")	
3	**Feeding Stock** Open the vise and slide the stock into the back stop. Turn the crank and lock the part in.	
4	**Cutting Back Support Stock** Turn the machine on with the On/Off Switch. Flip the coolant switch (or spray coolant with a spray bottle) while cutting. Turn the valve on the piston from horizontal CW and adjust as necessary during the cutting. When the cutting is done, the machine will turn itself off. Turn the valve completely vertical and raise the head of the cutter. Turn the valve horizontal now to lock in place.	
5	**Cut Remaining Stock** Repeat Steps 3-4 until all stock has been cut.	
6	**Cleanup** Ensure that after cutting the area has been cleaned, vacuumed & wiped dry of coolant.	

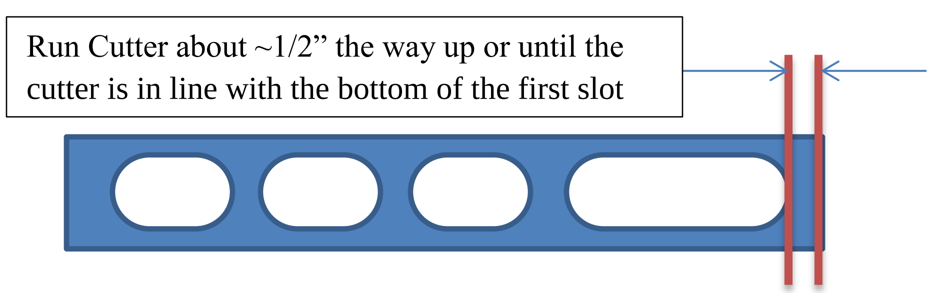
Back Support Slotting SOP

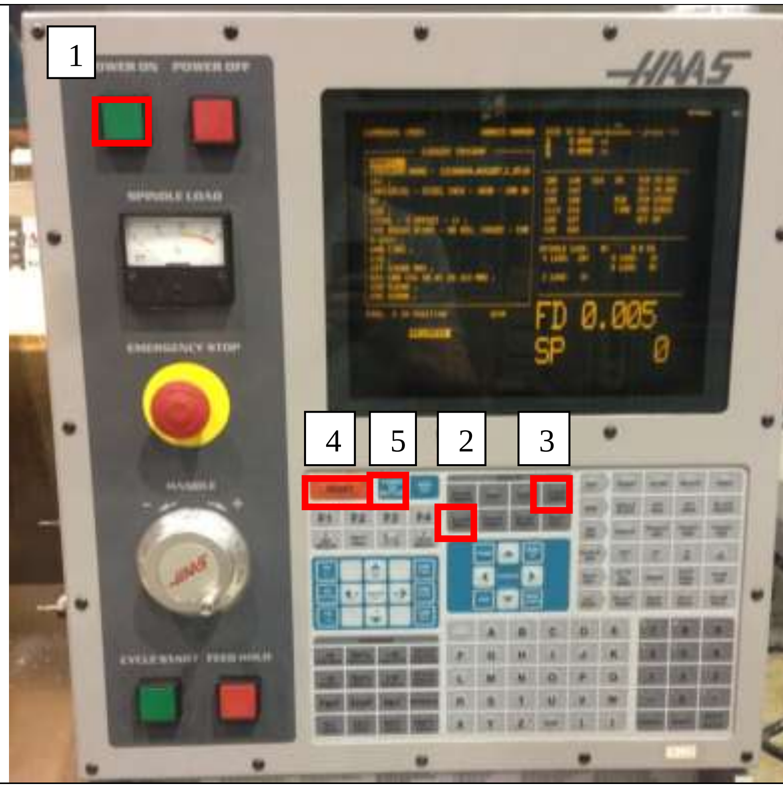
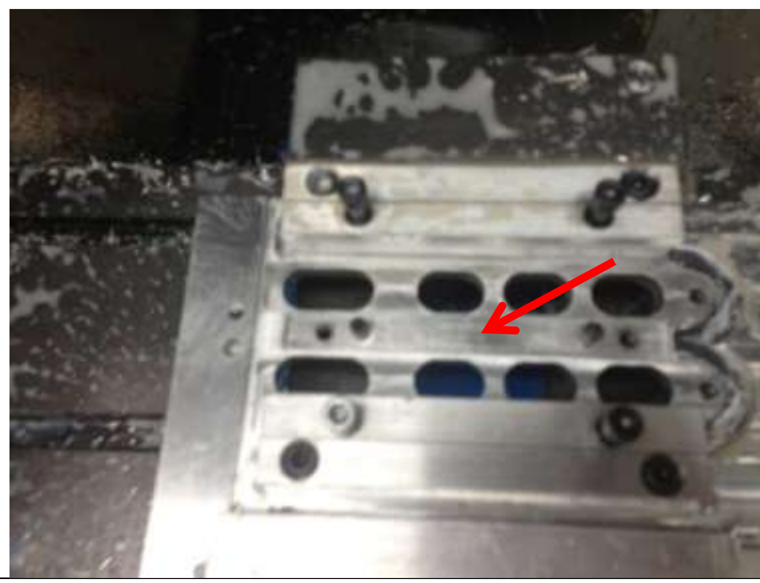
Required Tooling:

- Manual 3-Axis Mill (Use MSC)
- 2 Parallels
- Center Rigid Support (Should be by the press station setup)
- 5/8" End Mill
- Back Support Stock

Directions:

- **Zeroing Y Position**
    - Place Edge Finder in the Mill
    - Turn on the Mill
    - Zero the Mill on Y Off the back side of the Vice
        - IMPORTANT: Offset by edge finder diameter [0.100"]
    - Move Mill to Y = 0.375 (this will be the center of the slot)
    - Turn off Mill
    - Lock the Y-Axis Position
- **Zeroing Z Position**
    - Remove Edge Finder & Place 5/8" 4-Flute End Mill into Mill
    - Have Mill over the vice
    - Place parallel under the end mill, remove & raise table by 0.001"
        - IMPORTANT: Make sure the parallel is not under the cutter when raising the table
    - When parallel no longer slides on the end mill lower table by 0.001"
    - Lower table by 0.0625"
    - Lock the table lock (Z-Axis)
- **Slotting of Back Supports**
    - Place back support into vice with center rigid support (block of aluminum to prevent backs supports from buckling inwards)
    - Tighten the vise tight
    - Startup machine to ~1200 RPM
    - Run the cutter to the position specified in the diagram below



1	**Turning on Machine & Setup** 1. “Power On” 2. “ALARM MESGS” 3. “CURNT COMDS” 4. “RESET” 5. “Power Up/Restart”	
2	**Load Stock** 1. Unscrew the 4 raised bolts with a torque wrench until loose. 2. Remove the divider (shown by the red arrow) completely. 3. Remove the manufactured back supports and place two new pieces of aluminum stock. The stock should be oriented such that it makes a ‘U’ when looking from the side (both edges pointing vertically).	

3	**Secure Stock** 1. Tighten the four bolts highlighted in red with a tension wrench on the lowest setting. 2. Tighten the remaining two screws in the center until snug.	
4	**Second Stage** 1. Take the two back supports that were previously set aside and deburr them. Then align them in the front-half of the fixture, as shown. 2. Tighten the highlighted screws until tight.	
5	**Final Check** 1. Ensure that all four back supports being machined are aligned properly, as shown. **2.** Press cycle start. Wait 9 minutes for the cycle to complete, and then repeat.	
6	**Cleanup (End of Day)** At the end of the day use the air and broom to clean off the metal shavings and empty the Mini-Mill coolant bay. Press the "POWER OFF" Button.	

Standard Operation Procedure: Laser Cutting of Box, Front and Back

Safety Requirements:
Safety Glasses User has hand over E-Stop button at all times that Lasercutter is in operation.
Equipment Used:
Hurricane Lasers Charley Model
Technical Document List:
Struts: AML > 1213_Team_A > Shared Documents > Laser Code > Struts Upper Base: AML > 1213_Team_A > Shared Documents > Laser Code > Base

Procedure

1	Turn on the ventilation system by pushing the black "START" button on the other side of the support beam behind the Formech 660.	
2	Turn on the chiller next to the Hurricane Laser machine by pressing the toggle switch to "I."	

3	Turn the E-Stop button clockwise to release it, and then make sure the laser toggle switch is in the “ON” position. This will cause the machine to home.	
4	Push the “ESC” key.	

5	Orient the box to be cut as shown: with the bottom flap text visible and upright. This side will be the FRONT of the box.	
6	Insert the plastic fixture fully into the box, with the flat sheet closer to the back side of the box.	

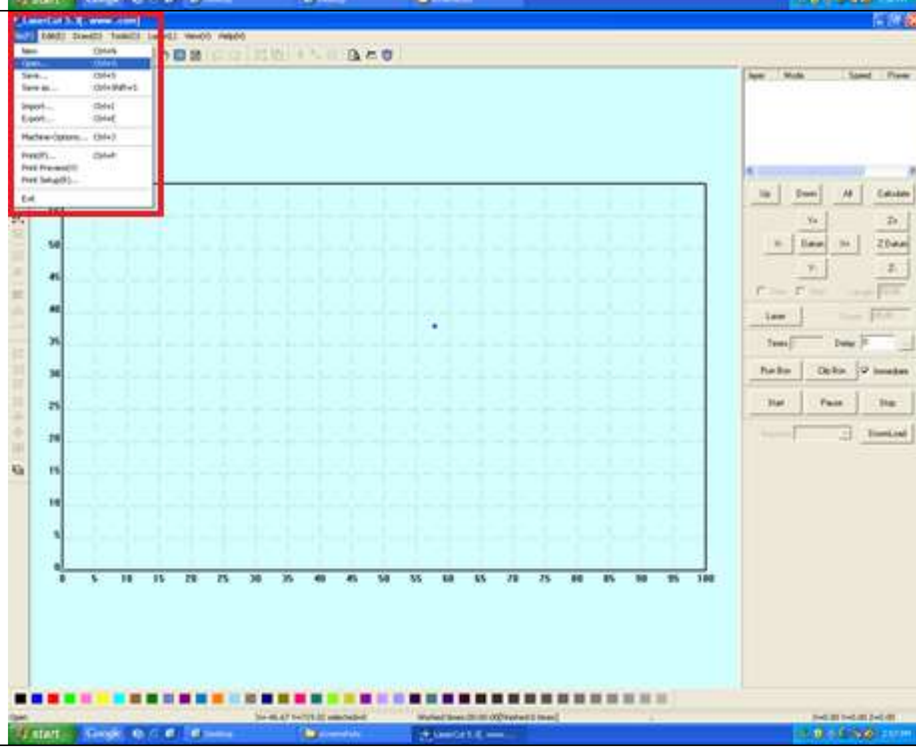
7	Open the hatch using the handle.	
8	Place the Z-axis fixture on the table beside the box. Use the arrow keys to position the focusing probe over this fixture as shown. Note: The table may have to be lowered – press the Z button to enter the z-adjustment mode, and then press the down arrow key to lower to table.	

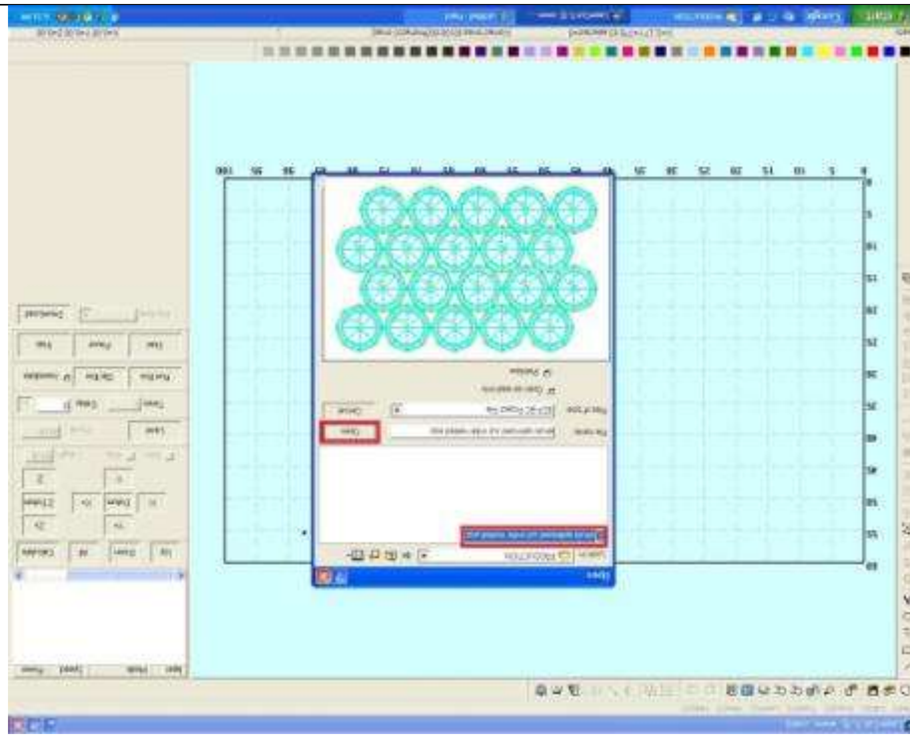
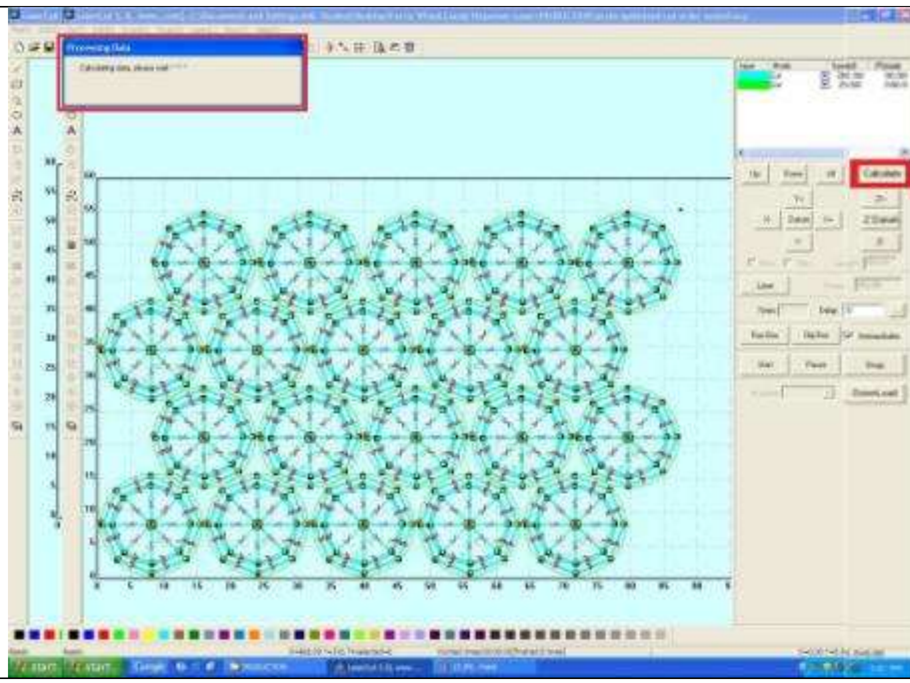
9	Push the “Z” button in the middle of the arrow keys and then the “RESET” button to focus and set the Z axis.	
10	Place the box in the machine, front-side up.	

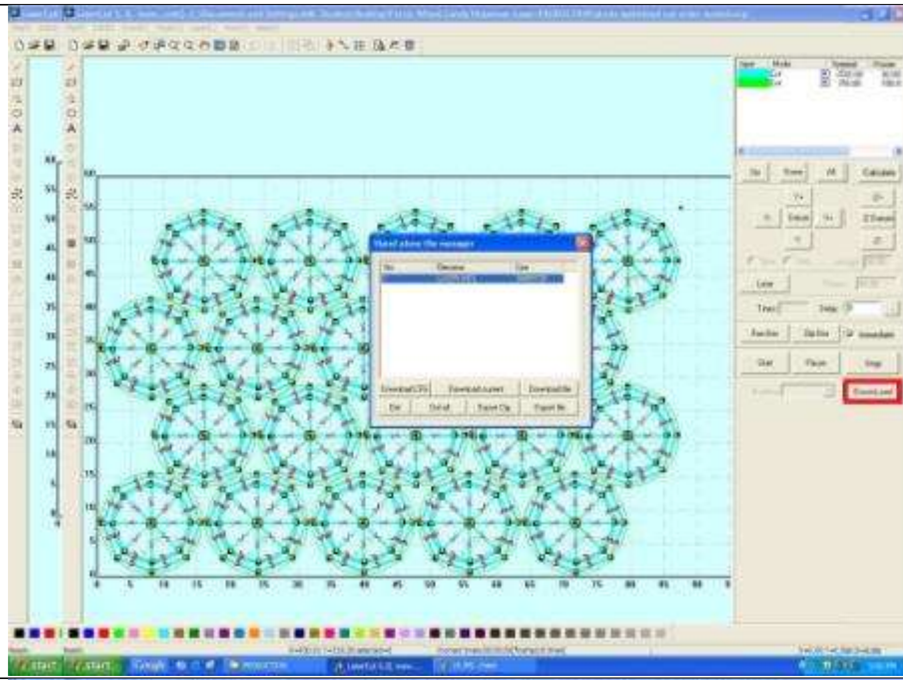
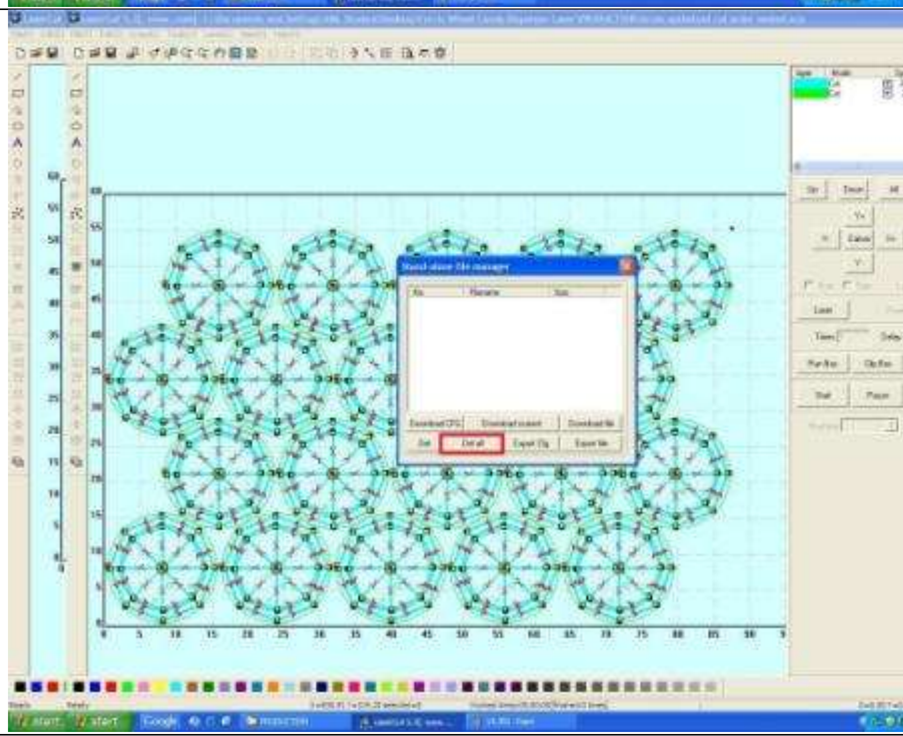
11	Use the horizontal laser gantry to visually square the box on the machine bed.	
12	Used the arrow keys to position the focusing probe over the material.	

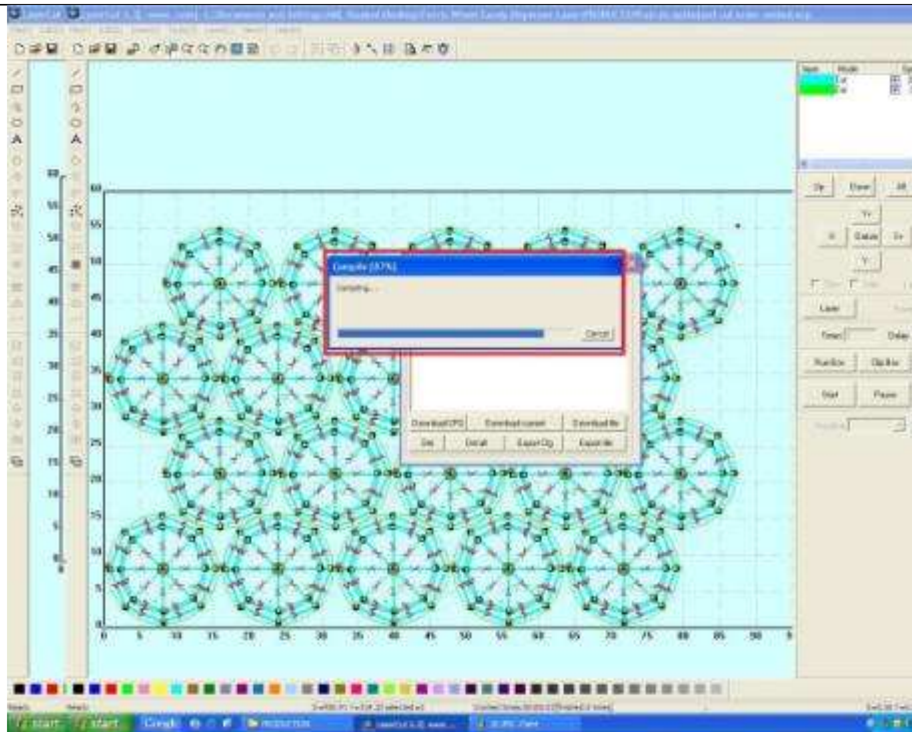
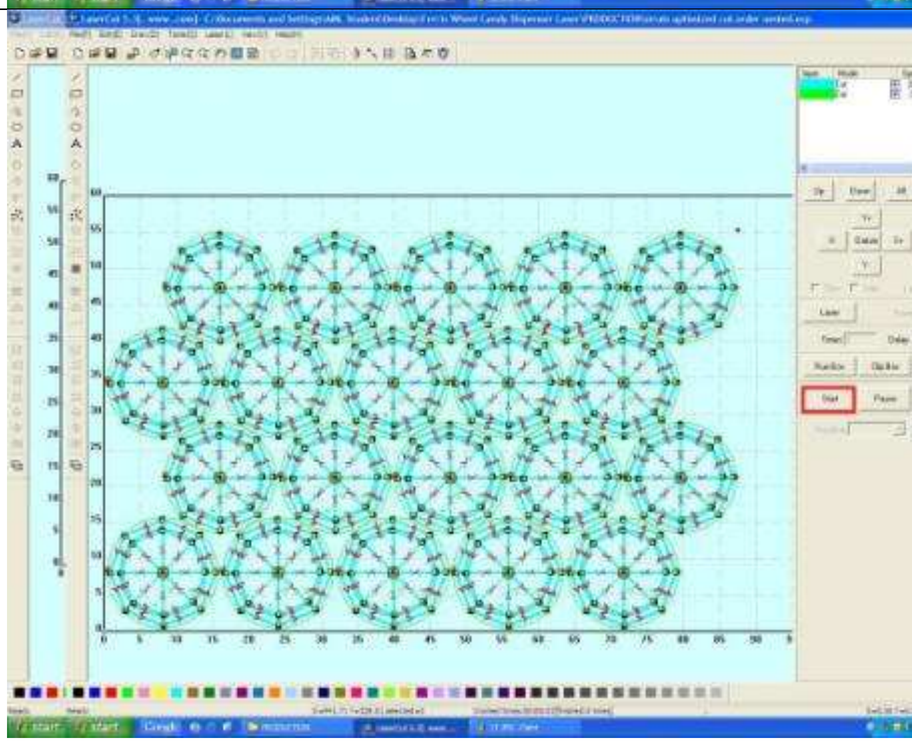
13	Define the origin to the upper right hand corner of the box body, not including the flaps.	
14	Push the "ENTER" button when the probe is positioned.	

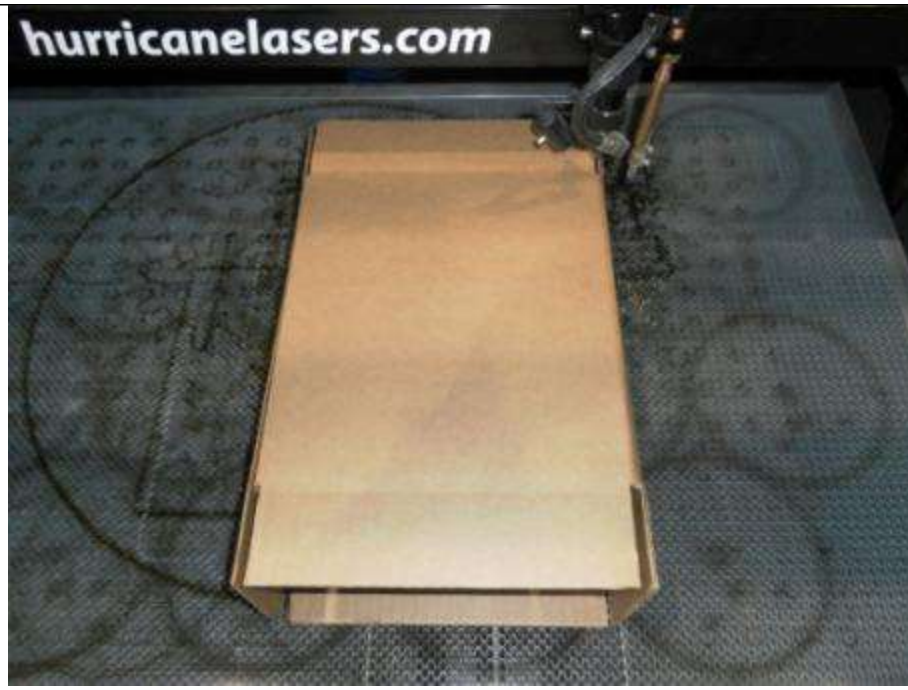
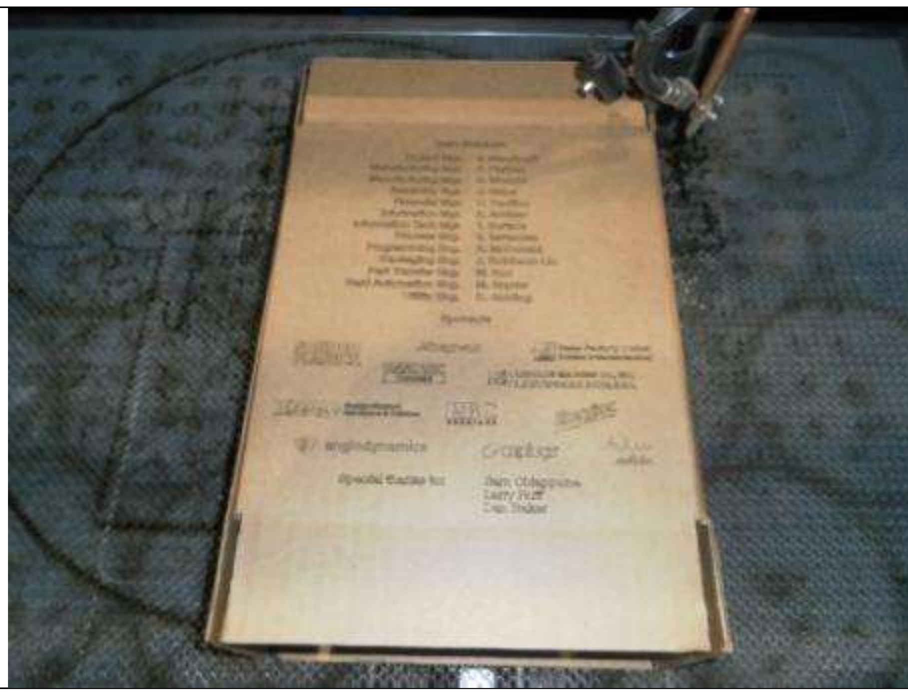
15	Push the "ENTER" button again to bring you into the "LOGIC ORG" screen. Push "ENTER" to set the "LOGIC ORG."	
16	Push the "ESC" button to exit the "LOGIC ORG" screen. The laser is now ready to run.	

17	Log into the adjacent computer workstation. Once the computer has booted, navigate to "Shortcut to Lasercut53.exe" on the desktop and launch the application.	
18	Once the application has been launched, navigate to "File > Open."	

19	Select Desktop > Ferris Wheel Candy Dispenser – Laser > PRODUCTION > “Box Front Optimized.ecp” and click “Open.” Note: The following screenshots are for a different file but the procedure is the same.	
20	Click the “Calculate” button. A window titled “Processing Data” will pop up. Wait until completion.	

21	Once the "Processing Data" window closes, click on the "Download" button. A window titled "Stand-alone File Manager" will pop up.	
22	In the "Stand-alone File Manager" window, select the file and then click the "Del all" button, then select the "Download Current" button.	

23	The “Download” window will open and show the progress of the file downloading to the laser. Wait until completion.	
24	Click the “Start” button and attend to the laser, keeping your hand on the “E-Stop” button. NOTE: To cut additional boxes, repeat steps 5 – 24. To engrave the back of the box, see step 25.	

25	Flip the box over and place it back on the table, this time with the BACK side upward. Realign the box with the current logical origin position and visually square it to the table as described in steps 11 and 13.	
26	Follow steps 17-24, this time opening the called “Box Back Optimized.ecp. Running this file will etch the back of the box as shown.	

27	To shut the machine off, push the "E-STOP" button and turn it counterclockwise.	
28	Turn off the chiller next to the Hurricane Laser machine by pressing the toggle switch to "O."	

29	Turn off the ventilation system by pushing the red “STOP” button on the other side of the support beam behind the Formech 660.	

Cleanup

When the part is finished cutting, remove the material and part and any weights or magnets that were used. Return the weights, magnets, and any excess material to their respective homes.

Standard Operation Procedure: Cart Flash Trimming

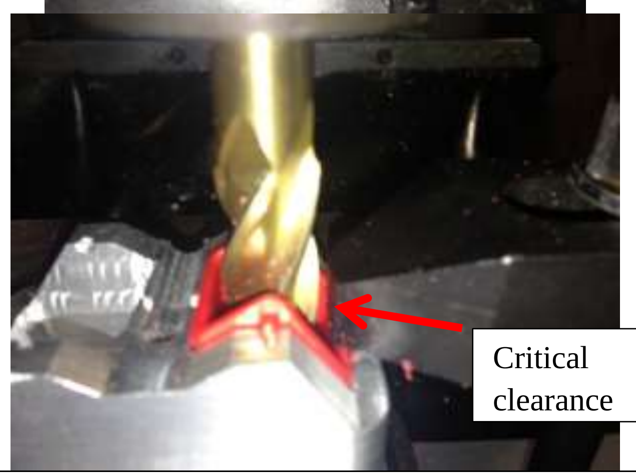
Safety Requirements:
Safety Glasses
Equipment Used:
Utility or X-Acto Knife
Technical Document List:
N/A

Procedure

1	Obtain an untrimmed cart from the box of carts.	
2	Inspect for areas of flash. Flash usually occurs on the front and back edges as well as the area around the pins.	
3	Trim all flash off until area is smooth. A finished cart is shown.	
4	Repeat from step 1 until all carts are trimmed.	

Cleanup
Collect and discard all red plastic shavings. Return tools to their proper storage locations.

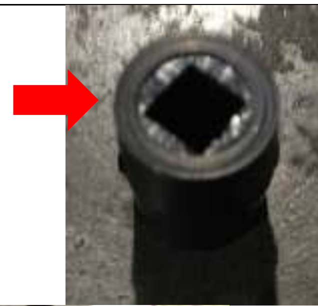
Process: Cart Drilling
Machine: Mill
Stock: Cart

1	**Machine setup** **3.** Setup mill with 9/16 center cutting end mill **4.** Put mold cavity in vise **5.** Center mill on cart bottom	
2	**Load Cart** 6. Put cart in cavity 7. use clamp to hold cart in place- **Do not overtighten, cart will shift in cavity** 8. **Make sure the mill will not hit the clamp**	 

3	**Running machine** 6. Use quill lever to drill part 7. Use stop to just make it through part 8. Make sure part did not move during process, if so, modify clamping pressure	 
4	**Cleanup** **1.** Remove clamp and mold cavity **2.** Clean up mill area	

Process: Drive Belt Carrier Grooving
Machine: Lathe
Stock: Drive Belt Carrier

1	**Machine setup** **6.** Set Speed to 250RPM **7.** Put Collet chuck on spindle **8.** Insert square collet **9.** Put live center on tailstock	
2	**Locate z-axis** 9. Lock turret in place and disengage autofeed with handle. Push or pull knob to ensure it is in the central position before rotating 10. Adjust turret using fine positioning crank to locate channel 0.125” from side	
3	**Zero x-axis** 9. Use axle to calibrate x 10. Zero x to 0.45” diameter-nominal surface of the part	

4	**Load Stock** 4. Slide stock onto axle with machined side facing the collet 5. Ensure the axle protrudes 3/8”-1/2” past part- shown between lines	  
5	**Loading stock-pt2** 3. Slide stop buffer onto axle, and slide live center to engage	
6	**Turn part** **3.** Lift indicated handle to start spindle **4.** Turn x axis crank to 0.125” after touching off on part to cut groove **5.** Press handle down to center position to stop spindle	 
7	**Running Production Parts** Repeat steps 4-6 until your shift is over	
8	**Cleanup** Clean machine and dispose of all chips	

Standard Operation Procedure: Front Support Sanding

Safety Requirements:
Safety Glasses
Equipment Used:
Belt sander
Technical Document List:

Procedure

1	Obtain parts to be sanded.	
2	Turn on belt sander using the toggle switch on top.	
3	Sand protruding tabs until flush with rest of part. Be careful, the part gets very hot.	
4	Repeat from step 1 for all remaining parts.	

Cleanup
Turn off belt sander, clean up work area, and return parts to the cabinet.

Standard Operation Procedure: Jar Lid Thinning

Safety Requirements:
Safety Glasses
Equipment Used:
Circular Grooved Heating Apparatus
Technical Document List:
N/A

Procedure

1	Turn on the Circular Grooved Heating Apparatus by pressing the "System On" button. Wait a few minutes for temperature shown on display to stabilize.	
2	Insert jar lid into Circular Grooved Heating Apparatus as shown, with the Run through the groove until the jar lid is thinned. **Be careful, the Circular Grooved Heating Apparatus is very hot.**	
3	Repeat from step 2 until all jar lids are thinned.	

Cleanup
Turn off the Circular Grooved Heating Apparatus by pressing the E-Stop button. Return jar lids to the cabinet.

Standard Operation Procedure: Laser Cutting of Logo Plate

Safety Requirements:
Safety Glasses User has hand over E-Stop button at all times that Lasercutter is in operation.
Equipment Used:
Hurricane Lasers Charley Model
Technical Document List:
Struts: AML > 1213_Team_A > Shared Documents > Laser Code > Struts Upper Base: AML > 1213_Team_A > Shared Documents > Laser Code > Base

Procedure

1	Turn on the ventilation system by pushing the black "START" button on the other side of the support beam behind the Formech 660.	
2	Turn on the chiller next to the Hurricane Laser machine by pressing the toggle switch to "I."	

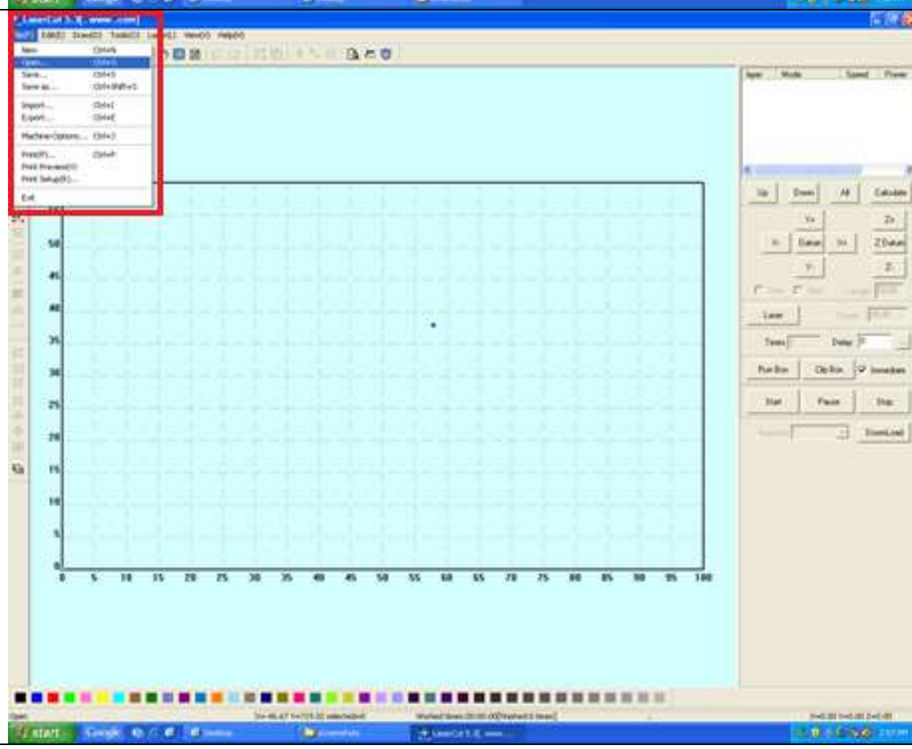
3	Turn the E-Stop button clockwise to release it, and then make sure the laser toggle switch is in the "ON" position. This will cause the machine to home.	
4	Push the "ESC" key.	

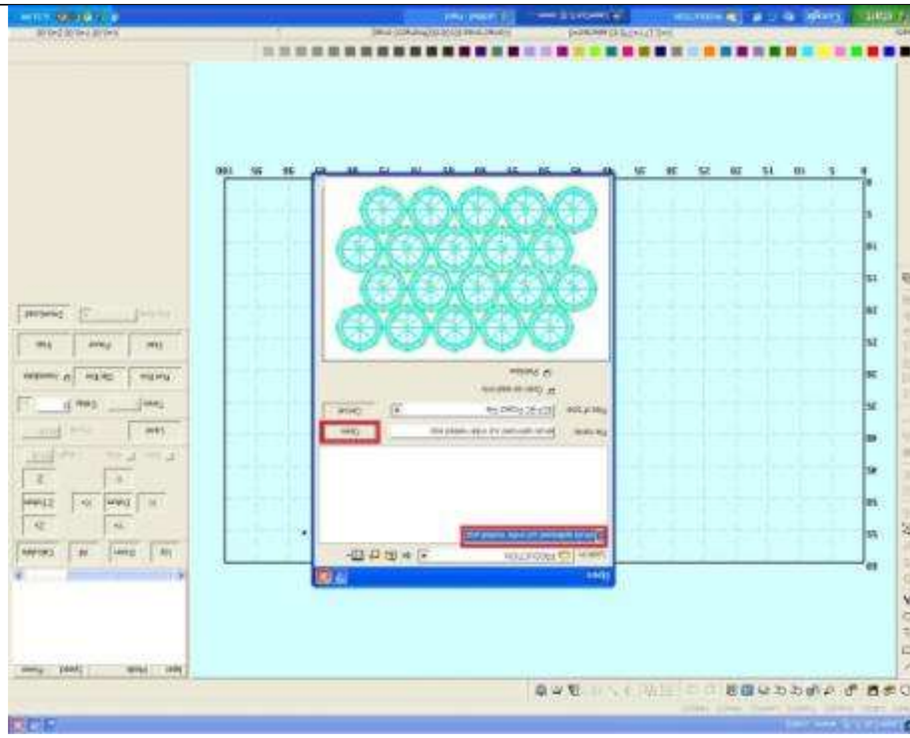
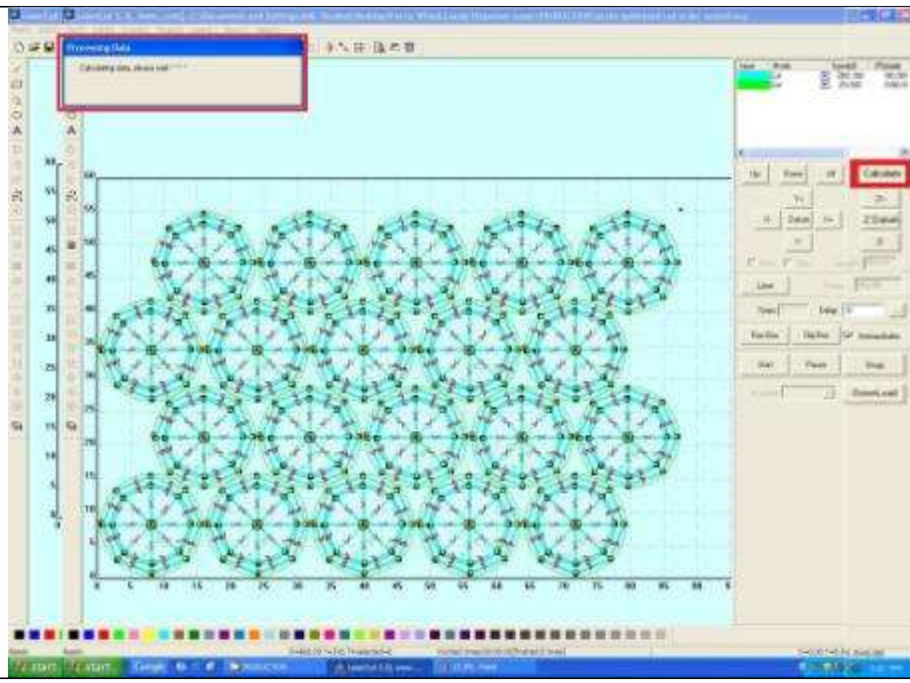
5	Peel the plastic coating from the colored side of the raw material.	
6	Open the hatch using the handle.	

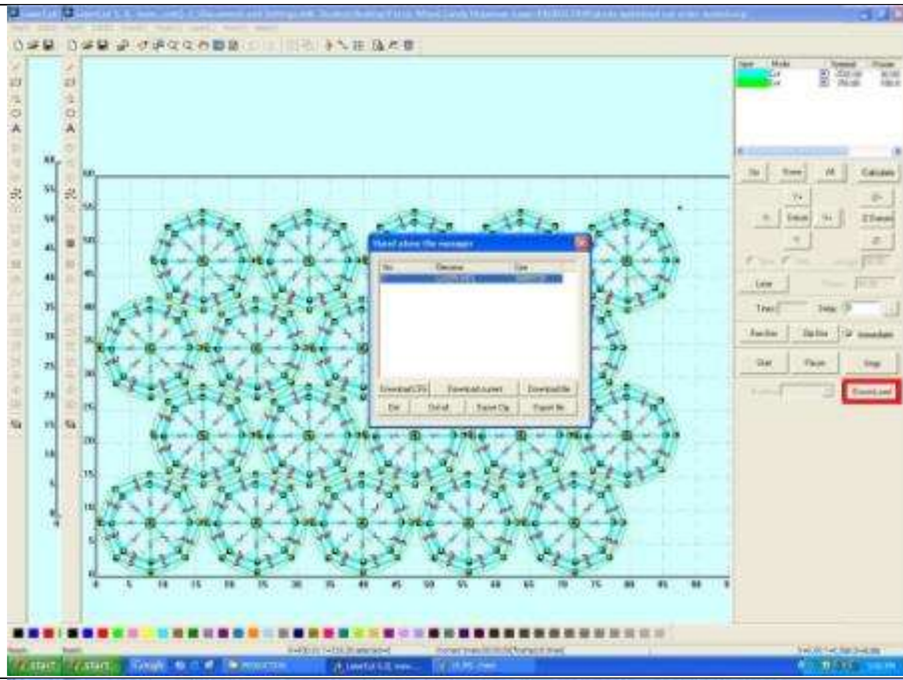
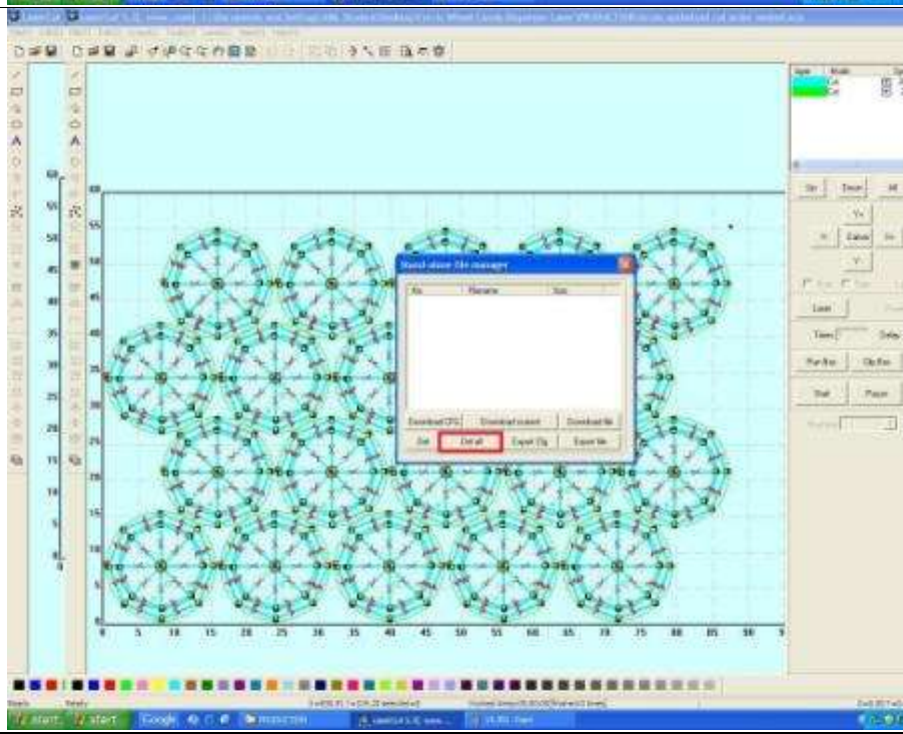
7	Place the raw material in the machine, colored side up.	
8	Used the arrow keys to position the focusing probe over the material. Define the origin to the upper right hand corner of the stock.	

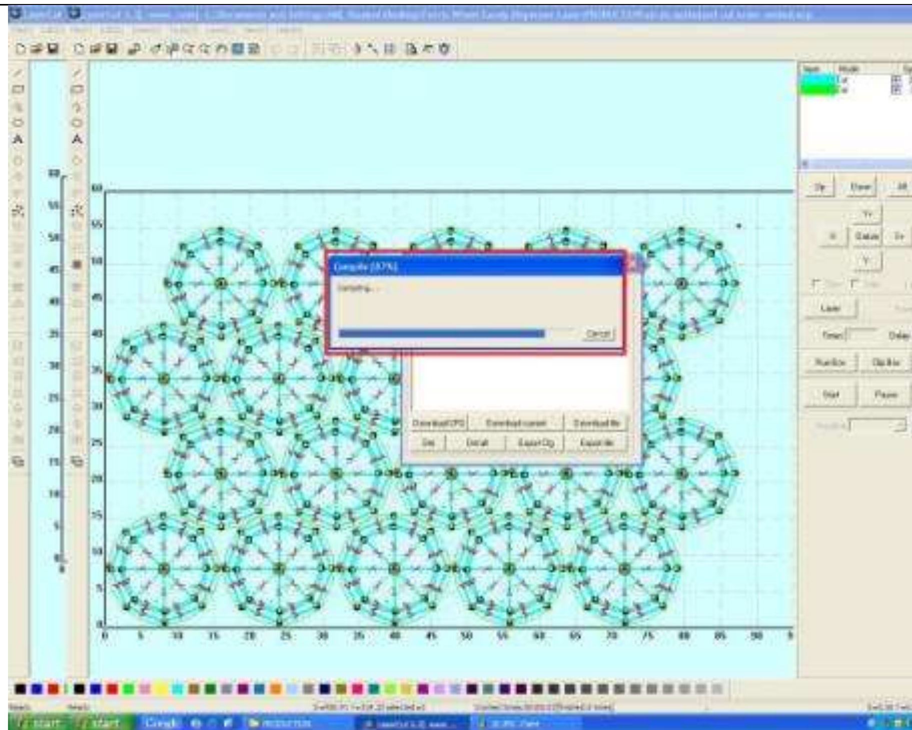
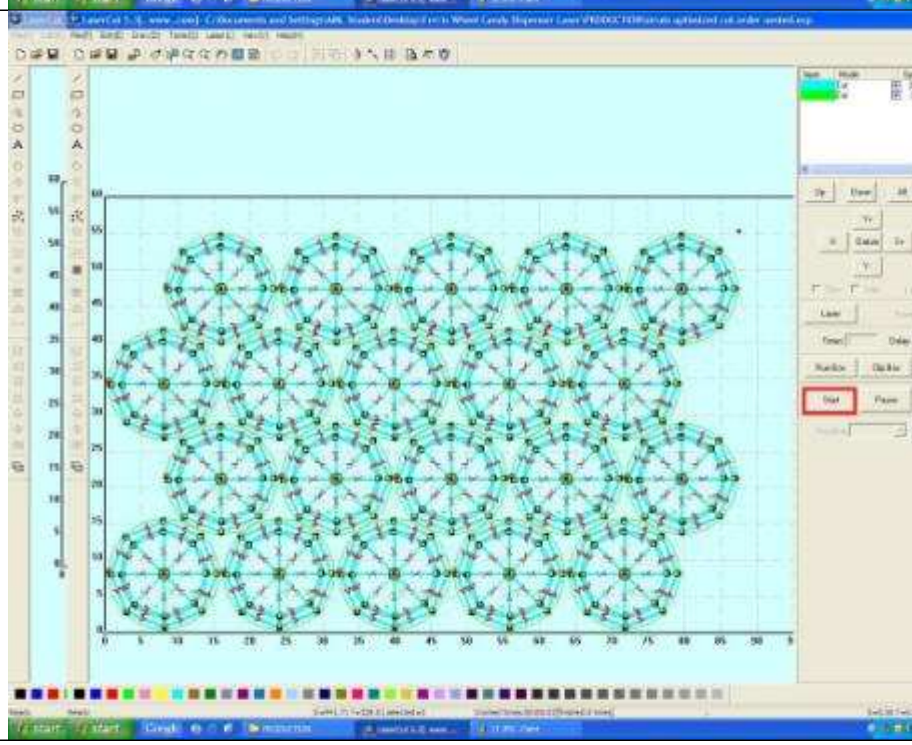
9	Push the “ENTER” button when the probe is positioned.	
10	Push the “ENTER” button again to bring you into the “LOGIC ORG” screen. Push “ENTER” to set the “LOGIC ORG.”	

11	Push the "ESC" button to exit the "LOGIC ORG" screen.	
12	Push the "Z" button in the middle of the arrow keys and then the "RESET" button to focus and set the Z axis. The laser is now ready to run. NOTE: Ensure that the focusing probe is over the material.	

13	Log into the adjacent computer workstation. Once the computer has booted, navigate to “Shortcut to Lasercut53.exe” on the desktop and launch the application.	
14	Once the application has been launched, navigate to “File > Open.”	

15	Select Desktop > Ferris Wheel Candy Dispenser – Laser > PRODUCTION > “Logo plate sheet.ecp” and click “Open.” NOTE: While the screenshots that follow represent a different file, the process is identical.	
16	Click the “Calculate” button. A window titled “Processing Data” will pop up. Wait until completion.	

17	Once the "Processing Data" window closes, click on the "Download" button. A window titled "Stand-alone File Manager" will pop up.	
18	In the "Stand-alone File Manager" window, select the file and then click the "Del all" button, then select the "Download Current" button.	

19	The "Download" window will open and show the progress of the file downloading to the laser. Wait until completion.	
20	Click the "Start" button and attend to the laser, keeping your hand on the "E-Stop" button. NOTE: To cut additional parts, repeat steps 15 – 18.	

21	To shut the machine off, push the "E-STOP" button and turn it counterclockwise.	
22	Turn off the chiller next to the Hurricane Laser machine by pressing the toggle switch to "O."	

23	Turn off the ventilation system by pushing the red “STOP” button on the other side of the support beam behind the Formech 660.	

Cleanup

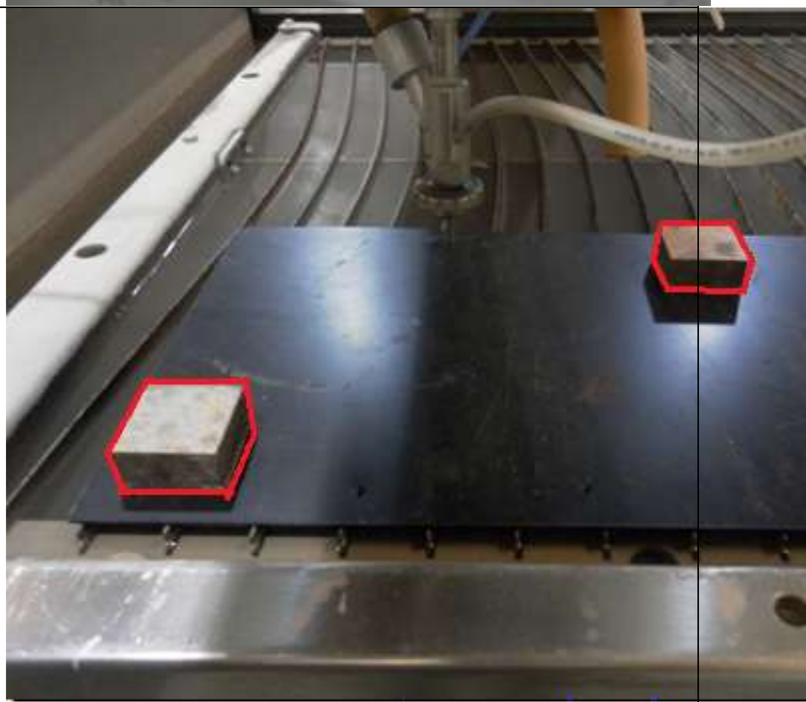
When the part is finished cutting, remove the material and part and any weights or magnets that were used. Return the weights, magnets, and any excess material to their respective homes.

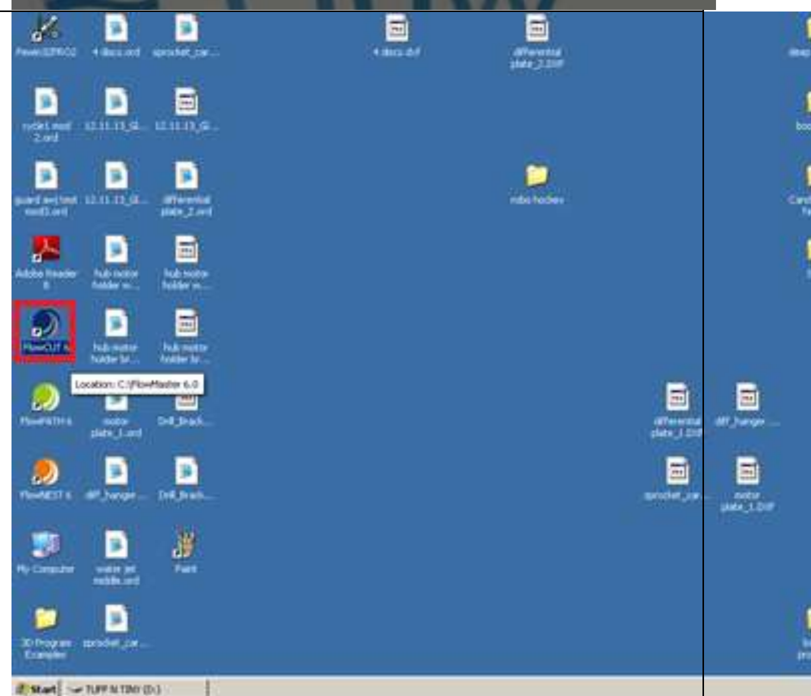
Standard Operation Procedure: Lower Base Abrasive Water Jet

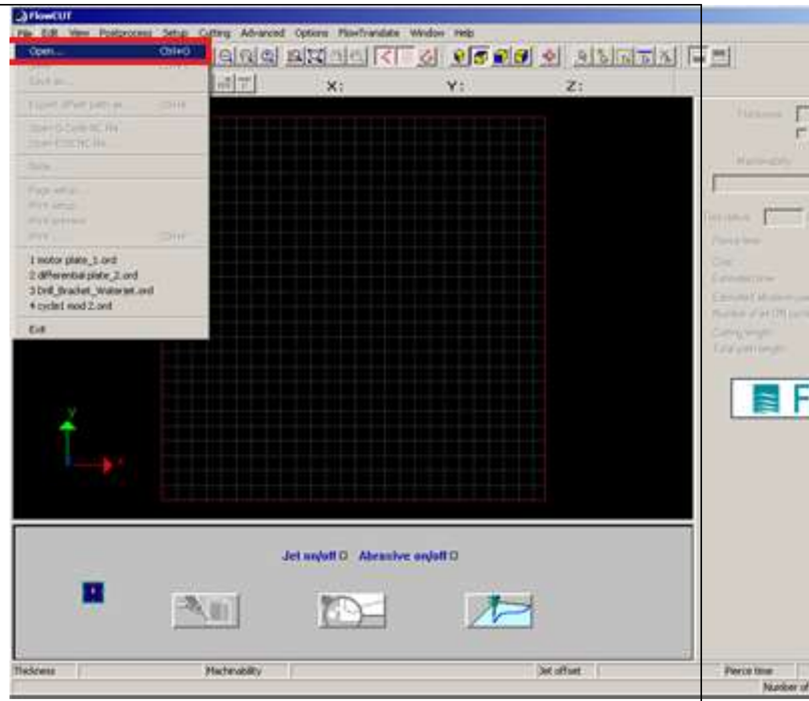
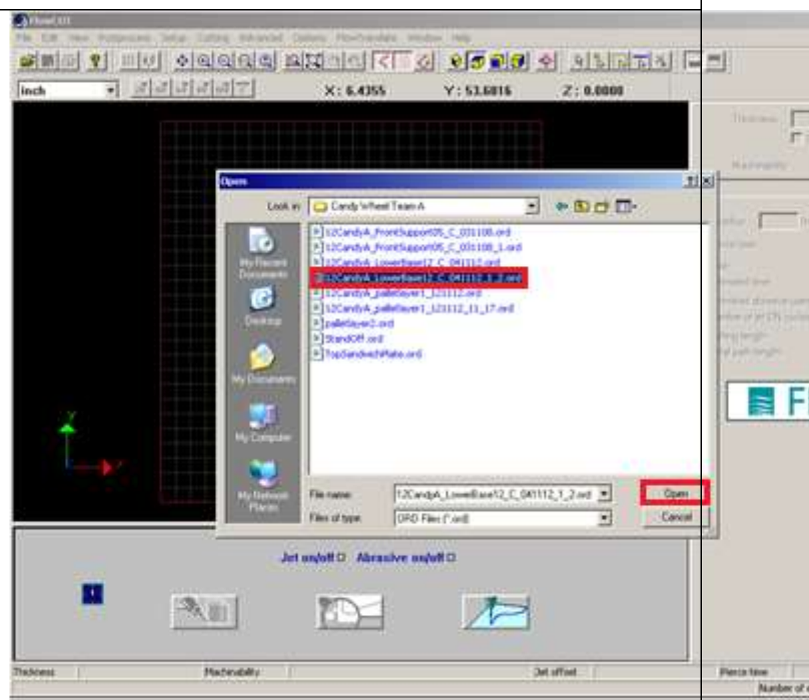
Safety Requirements:
• Safety Glasses • Hearing Protection (recommended) • User must be attentive to the Waterjet during operation. It is not necessary to have a hand on the E-STOP at all time.
Equipment Used:
Flow Waterjet Mach2 1313b
Technical Document List:
Lower Base: AML > 1213_Team_A > Shared Documents > AWJ Code > 12CandyA_LowerBase12_C_041112_1_2 (Dropbox\MPS\Manufacturing\CAM\AWJ\AWJ - LowerBase12_41x29_DXF.dxf) A-Frame: AML > 1213_Team_A > Shared Documents > AWJ Code > 12CandyA_FrontSupport05_C_031108_1

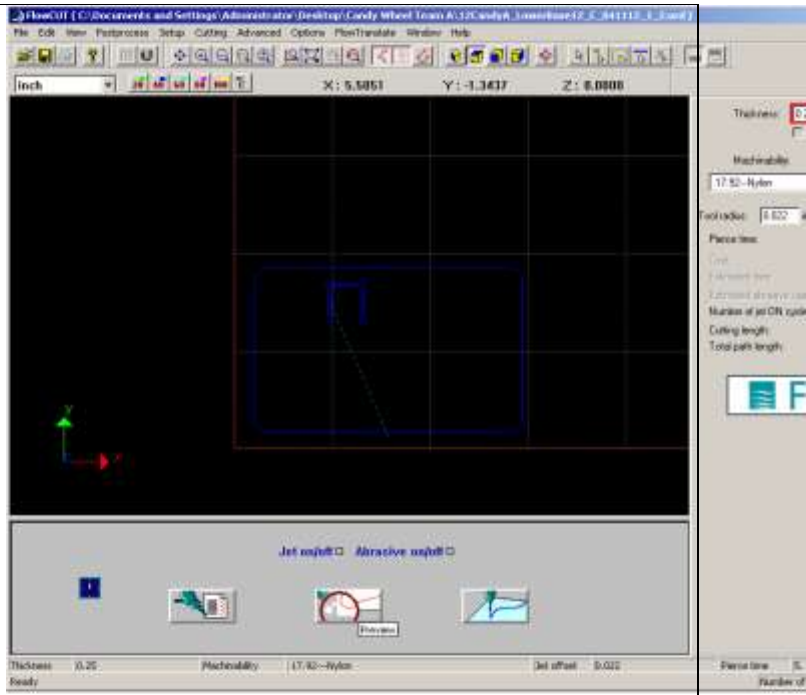
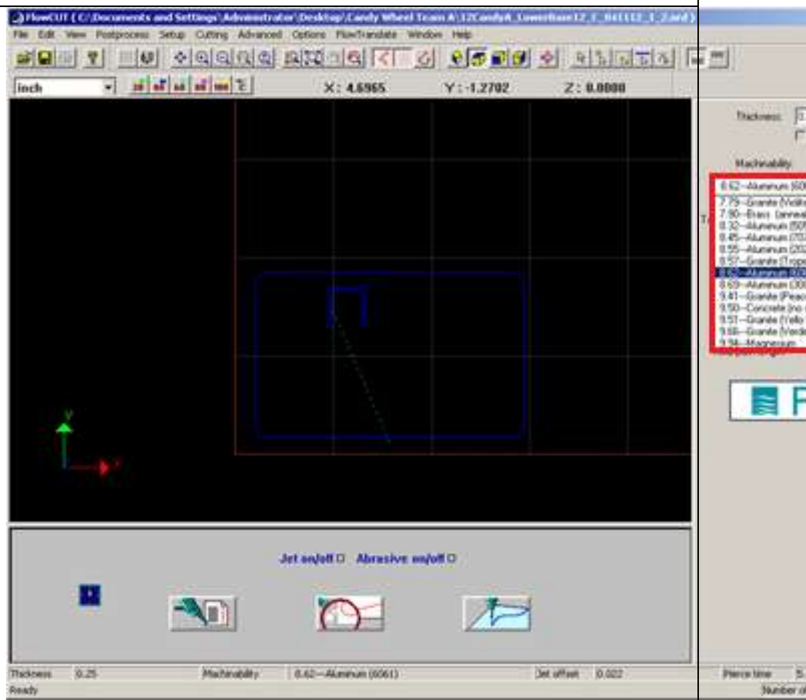
Procedure

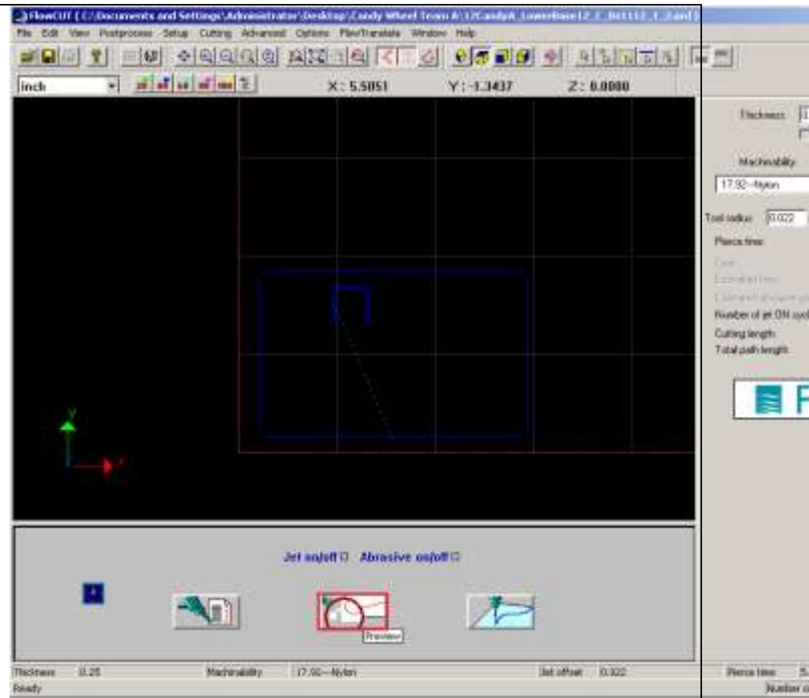
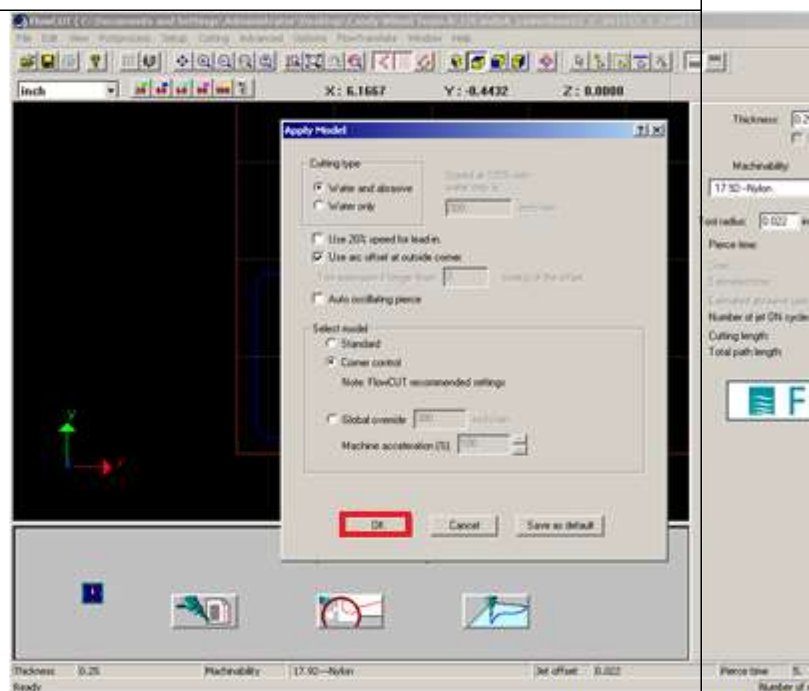
1	Throw both of the switches on the wall to the right of the water to the position shown in the image. This will turn on the computer.	
2	Pre-Cut Sheets	**For Lower Base:** With the saw, cut the stock into two equal sized sheets: • 29” by 41” in size **For Front Support:** With the saw, cut the stock into two equal sized sheets: • 48” by 48” in size

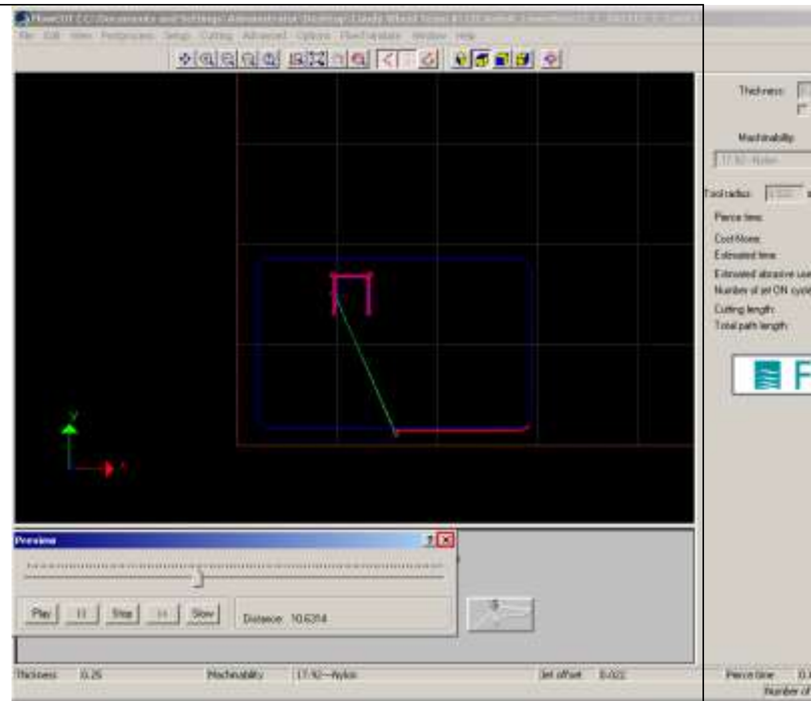
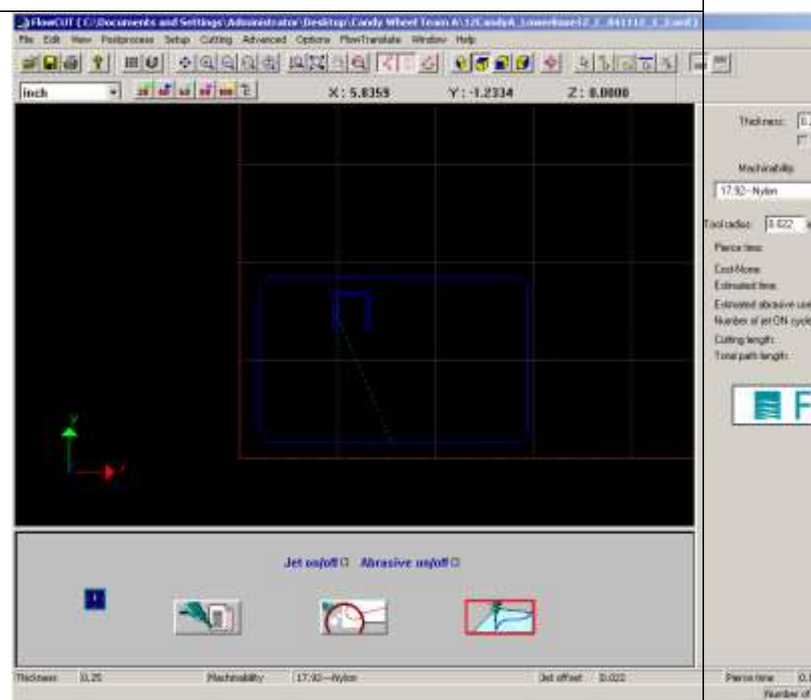
3	Place the material in the waterjet cutting bed.	
4	Secure the material with weights.	

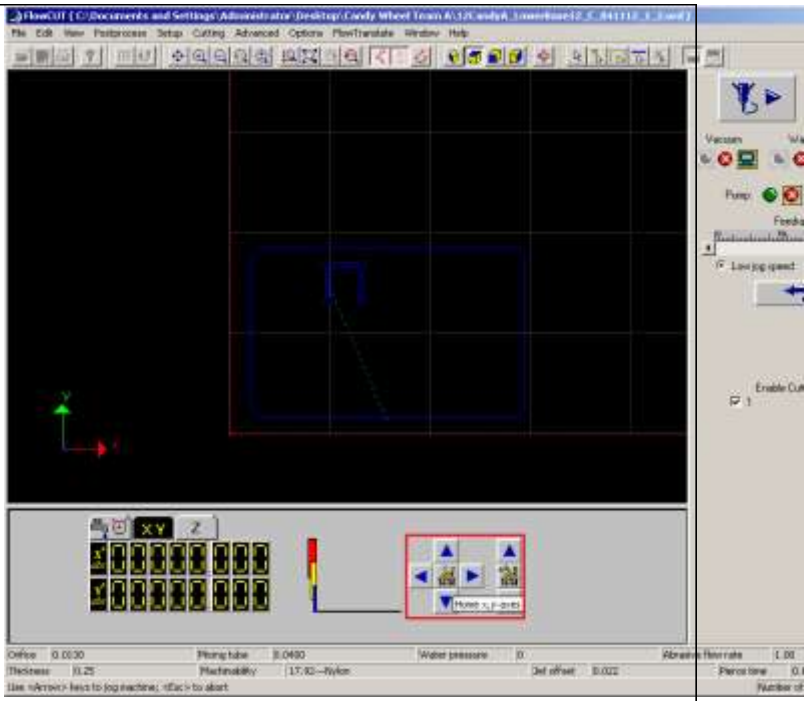
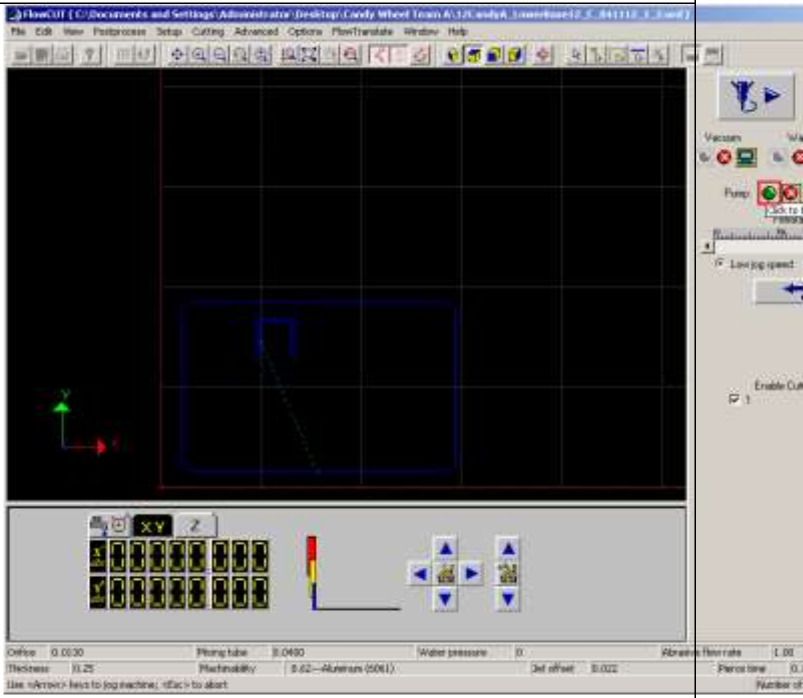
5	Set up the splashguard.	
6	Once the computer has booted, navigate to “FlowCUT 6” on the desktop and launch the application.	

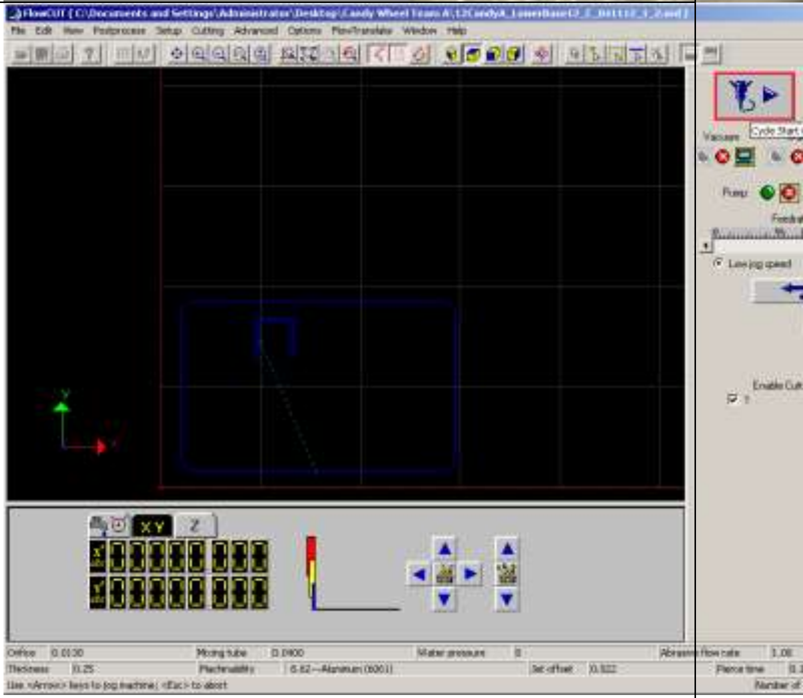
7	Once the application has been launched, navigate to "File > Open."	
8	Select the proper file from the folder, click "Open." File Name: AWJ - LowerBase12_41x29.ord Location (or from Flash Drive) \Dropbox\MPS\Manufacturing\CAM\AWJ	

9	Set the thickness to the material. Lower Base: 0.375” Front Support: 0.125”	
10	Select the proper material from the pulldown menu on the right (8.62—Aluminum (6061) for aluminum parts Nylon for plastic).	

11	Next, select the “Preview” button.	
12	A popup menu will appear, simply click “OK.”	

13	The preview will begin, tracing the path of the cut. When the preview is completed, click the small "x" in the "Preview" window to close it.	
14	Click the "Run Machine" button.	

15	Click on Z home button, say ok to home z. When done, click on X-Y home. Select go to machine home. This is only done when first setting up machine. Then set the home value for the x, y, and z planes using the jog buttons. – do this each cycle.	
16	Once the cutter has been homed, click the small green button resembling a traffic light to turn the pump on.	

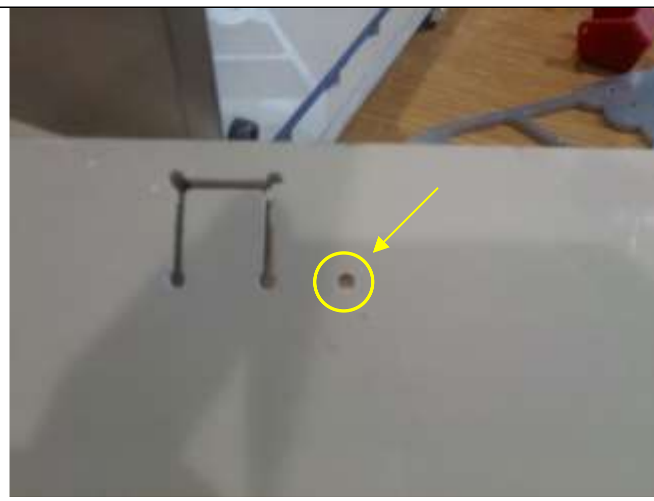
17	Before proceeding to the next step, make sure the E-Stop button on the computer is within reach.	
18	When the pump has fully been initiated, click the “Cycle Start” button to begin cutting.	

Cleanup

When the part is finished cutting, remove the splashguards and the weights from the part, and wash thoroughly. Return the splashguards, weights, and any excess material to their respective homes.

Safety Requirements:
Safety Glasses
Equipment Used:
Drill 0.128" drill bit
Technical Document List:
N/A

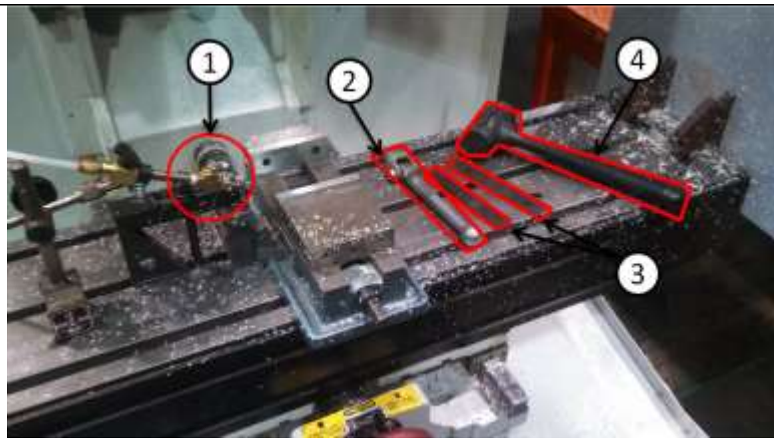
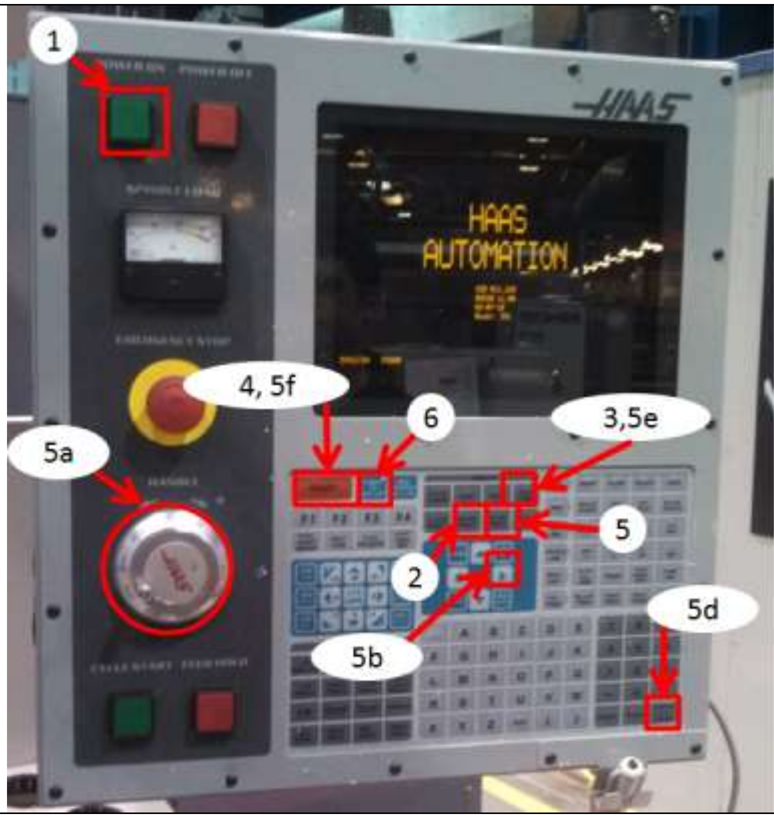
Procedure

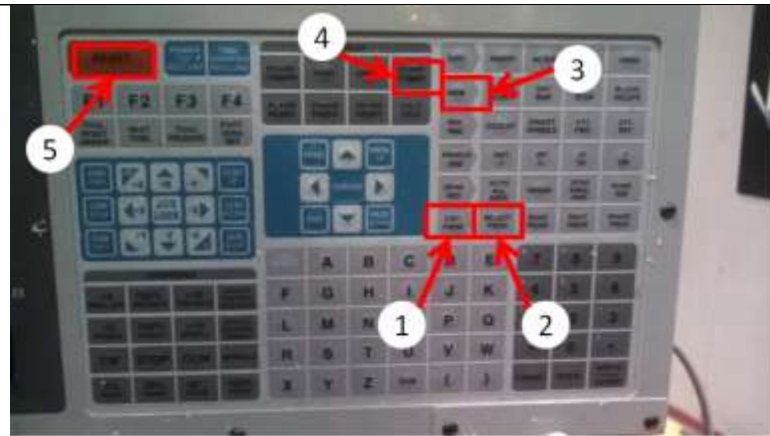
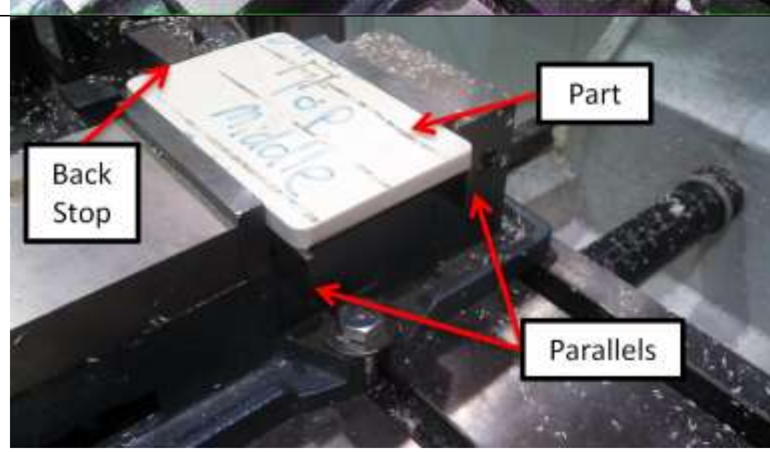
1	Obtain a non-drilled lower base from the box in the A-Team cabinet.	
2	Clamp part to edge of a sturdy table in the MILL machine shop area.	
3	Drill out indicated hole, one pass (in and out) with the 0.128" drill. Be careful not to drill into the table.	
4	Repeat from step 1 until all lower bases are drilled.	

Cleanup
Collect and discard all red plastic shavings. Return tools to their proper storage locations.

Process: Final Machining of Lower Bases

Machine: Tool Room Mill
Stock: AWJ Rough Cut Lower Bases

1	**Required Tooling** **(7) <u>Air Nozzle</u>** Used to keep the bit cool when slotting **(8) <u>Vise Wrench</u>** Used to tighten the vise **(9) <u>Parallels (x2)</u>** Used to ensure part is flat **(10) <u>Rubber Mallet</u>** Used to hit part flat to vise/parallels	
2	**Turning on Machine & Setup** 11. "Power On" 12. "ALARM MESGS" 13. "CURNT COMDS" 14. "RESET" 15. "SETNG GRAPH" a. Scroll to Program 1 b. Select Safety Switch Override (51) c. Use Right Arrow to be "ON" d. Press "WRITE/ENTER" e. "CURNT COMDS" f. "RESET" 16. "Power Up/Restart"	

3	**Load Program (only if program is not #O89898)** 11. "LIST PROG" a. Scroll to "O89898" 12. "SELECT PROG" 13. "MEM" 14. "CURNT COMDS" 15. "RESET"	
4	**Turning on the Air Coolant** Turn the nozzle from closed (perpendicular to the nozzle) to be ~50-75% open (CCW) (Green Zone). Ensure that the nozzle points to the front support slot during cutting to avoid melting the polycarbonate.	
5	**Setting Up Vise** Place the parallels on both side of the vise and flush against the wall.	
6	**Setting Up Part** Place a lower base into the vise as shown. Push the Base into the back stop to ensure consistent parts are made. Close the vise loosing & use the rubber mallet on the four corners of the part to ensure it is seated on the parallels. Check the parallels will not fall over	

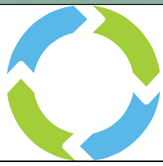
7	**Running Program** Press “Cycle Start” [1] (green button on lower left of panel) If any point an end mill snaps or an issue arises, press the E-STOP [2] to minimize damage to the part or machine.	

8	**Tool Changes** A tool change will be called in this order: • Tool 6: 1/8" End Mill • Tool 7: 5/16" End Mill • Tool 8: 45° Chamfer Mill Firmly hold onto the tool & press "TOOL RELEASE" (right below "F3" and "RESET"). The end mill will drop; place it into the tool rack. Grab the next tool. Place the tool into the spindle aligning the keyways. Press upwards on the tool & press "TOOL RELEASE" again. When the keyways are aligned release the end mill. Press "CYCLE START" again, the machine will now machine until the next tool change. **DO NOT DROP END MILLS, they will shatter.** *Remember, the machine will stop partway and turn the spindle on, wait for the screen to call for a tool change before placing hands near the tool!*	
9	**Running Production Parts** Repeat steps 6-8 until your shift is over	
10	**Cleanup (End of Day)** At the end of the day use the vacuum to clean up plastic chips on the floor and around the machine. Press the "POWER OFF" Button. Remove the last tool in the spindle after cleanup is complete.	

Standard Operation Procedure: Motor Strap Filing

Safety Requirements:
Safety Glasses
Equipment Used:
File
Technical Document List:
N/A

Procedure

1	Obtain a motor strap from the box in the A-Team cabinet.	
2	File the end of the motor strap so that it is cone-shaped on the end, all the way around as shown in red.	
3	Repeat from step 2 until all motor straps are filed.	

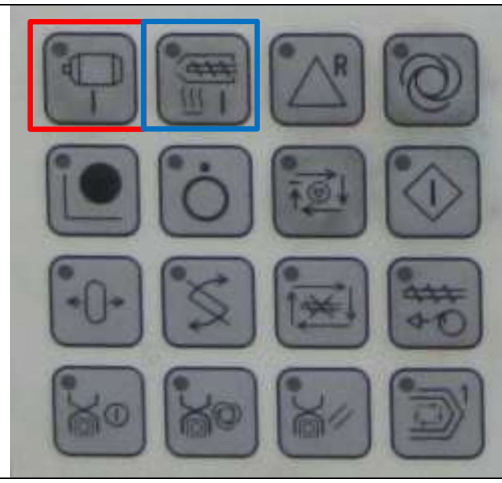
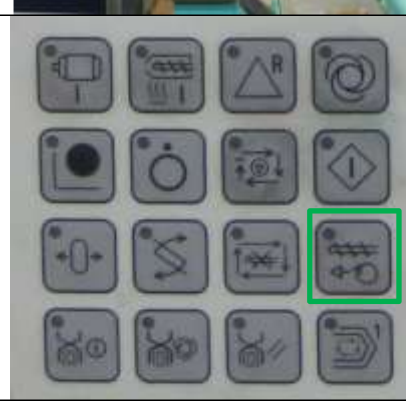
Cleanup
Put away the file and clean up all plastic shavings.

Standard Operating Procedure: Plastic Injection Molding (PIM)

Safety Requirements:
Wear Safety Glasses at all times. Remain in the Injection Molding Area of the MILL while the machine is in use.
Equipment Used:
• Arburg Allrounder 221K 38-ton Plastic Injection Molder with Candy PIM mold A or B installed • Utility knife • Clearing rod • Plastic pellets (ABS or Polypropylene)
Technical Document List:
Refer to Technical Data Package for mold drawings.

Procedure

1	Turn on wall vent switch (left) and cooling valve (right)	 
2	Turn on main power switch to molder (front of unit)	
3	Make sure both main door and screw door (shown) are closed	

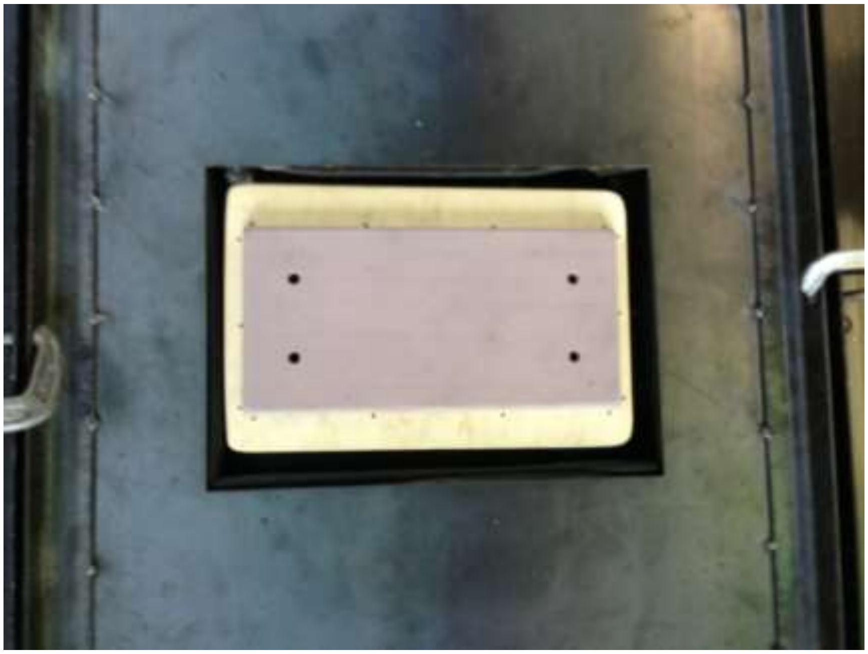
4	Turn on machine and heater (red then blue)	
5	Select the correct program (Candy PIM mold A or B) from the list on the control panel	
6	Wait for T801-T805 on the control window reach the correct temperatures	T801: T802: T803: T804: T805:
7	Fill hopper with plastic pellets (either Polypropylene or ABS) such that window is covered.	
8	Press Purge button (green)	

9	Open screw shield using handle (shown) and use clearing bar to scrape out purged plastic. Replace shield.	
10	Run the machine in full-automatic mode by pressing Cycle (red), Auto (blue), and then the Run button (yellow).	
11	Watch for parts to fall into USPS bin below machine. Production will continue until machine is stopped or runs out of plastic pellets.	

Cleanup:
Auto-purge machine as above and remove purged plastic
Turn off heaters and power to machine
Turn off vent fan
Shut cooling valve

Standard Operating Procedure: Risers

1. Turn on machine and turn on both center heating consoles to 6(Full)
2. Allow machine to heat up
3. Place mold in machine and then lower platform using orange lever.



4. Place .06" inch thick polystyrene sheet on top of rubber siding and clamp down using the 2 orange vices. Make sure rubber moulding doesn't get in the way.

5. Set timer to 80 seconds and turn on
.

6. Pull back heating element and wait until timer beeps.
7. Push back heating slider element
8. Press and hold vacuum for ~10s.
9. Press release for 3s
10. Lower mold lever
11. Release vice grips and remove riser from machine.

Standard Operation Procedures: Riser Trimming

Safety Requirements:
Safety Glasses
Equipment Used:
Circular Grooved Heating Apparatus
Technical Document List:
N/A

Procedure

1	Place riser on shear, aligning the edge of the riser with the shear blade.	
2	Shear all four sides in this manner.	
3	Repeat from step 1 until all risers are trimmed.	

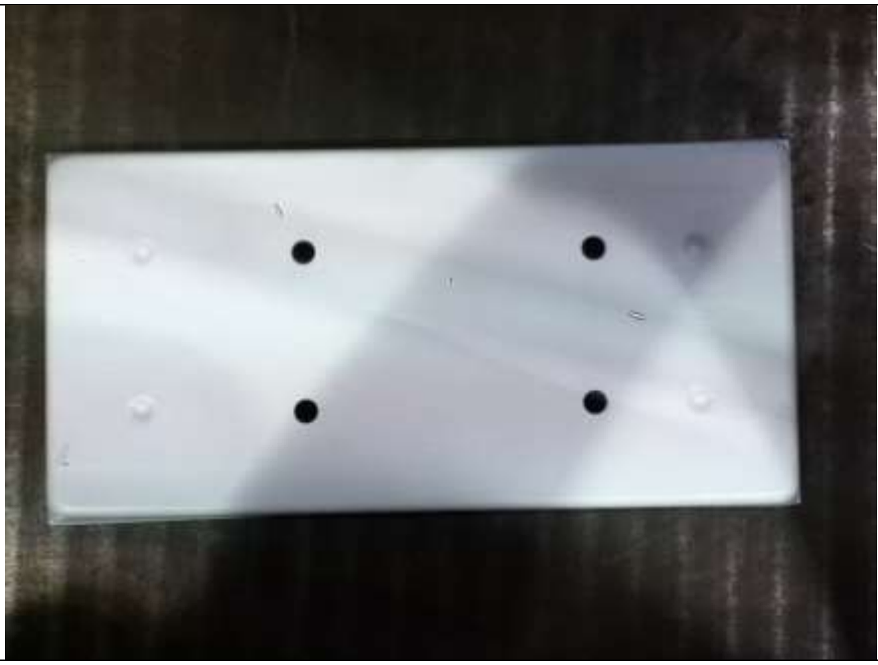
Cleanup
Turn off the Circular Grooved Heating Apparatus by pressing the E-Stop button. Return jar lids to the cabinet.

Standard Operation Procedure: Riser Hole Drilling

Safety Requirements:
Safety Glasses
Equipment Used:
Drill 0.128" drill bit
Technical Document List:
N/A

Procedure

1	Chuck a ¼" drill bit in the drill press.	
2	Place part face up on drill press table	
3	Drill out four center holes, locating the drill bit in the molded indentations.	

4	Repeat from step 2 until all lower bases are drilled.	

Cleanup
Collect and discard all red plastic shavings. Return tools to their proper storage locations.

Standard Operation Procedure: Laser Cutting of Struts

Safety Requirements:
Safety Glasses User has hand over E-Stop button at all times that Lasercutter is in operation.
Equipment Used:
Hurricane Lasers Charley Model
Technical Document List:
Struts: AML > 1213_Team_A > Shared Documents > Laser Code > Struts Upper Base: AML > 1213_Team_A > Shared Documents > Laser Code > Base

Procedure

1	Turn on the ventilation system by pushing the black "START" button on the other side of the support beam behind the Formech 660.	
2	Turn on the chiller next to the Hurricane Laser machine by pressing the toggle switch to "I."	

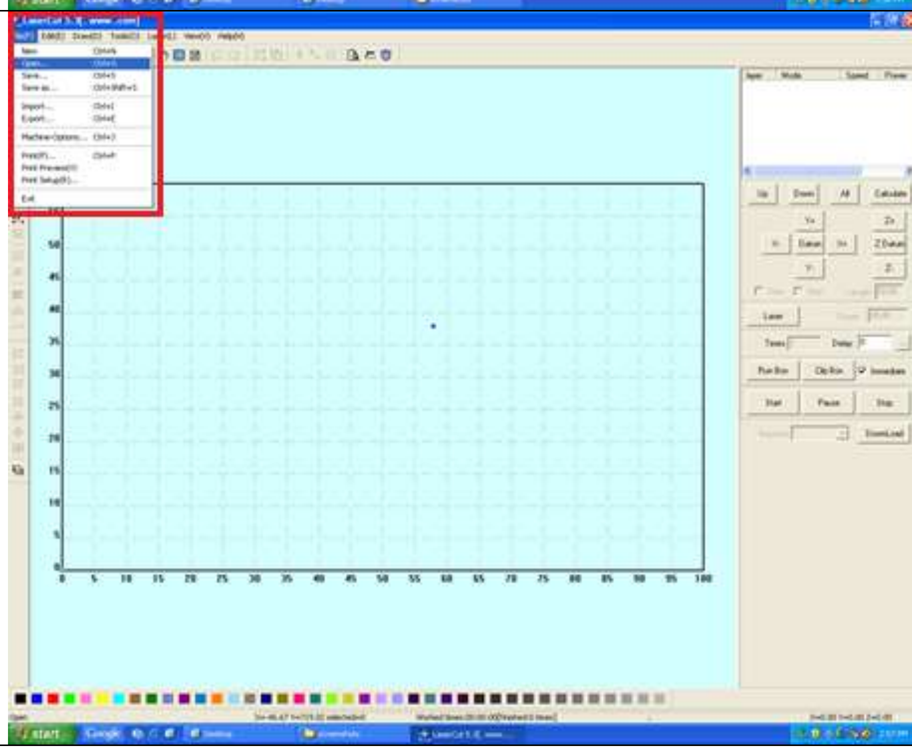
3	Turn the E-Stop button clockwise to release it, and then make sure the laser toggle switch is in the "ON" position. This will cause the machine to home.	
4	Push the "ESC" key.	

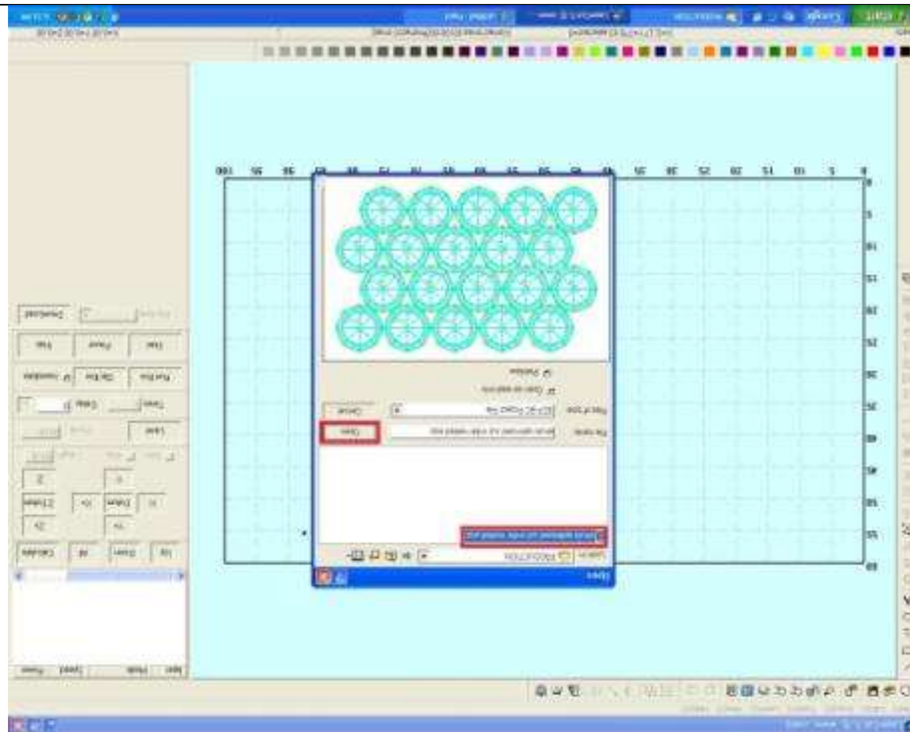
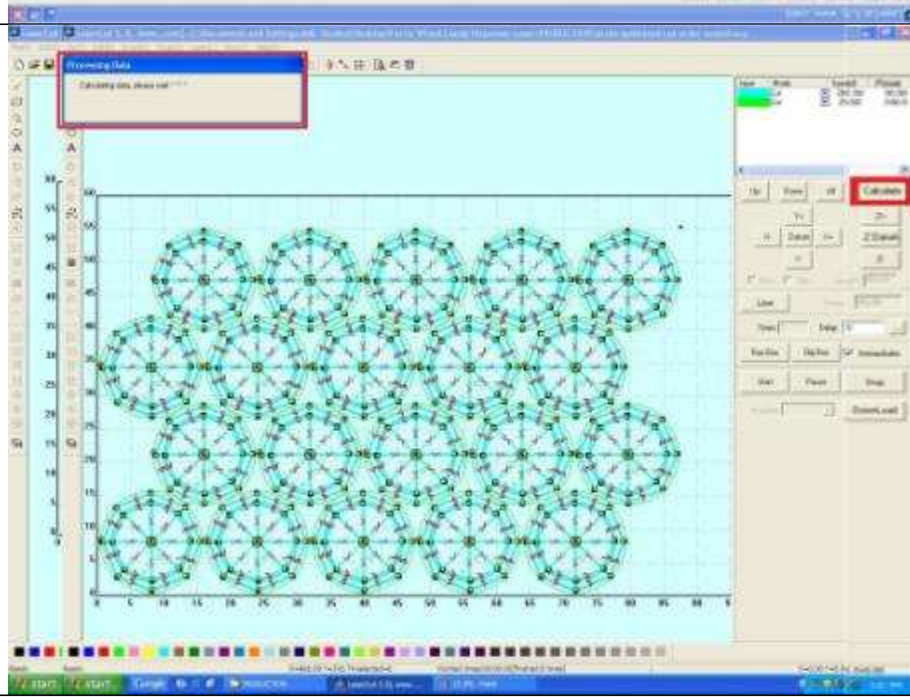
5	Peel the paper coating from one side of the raw material. The material will now have a plastic side and a paper side.	
6	Open the hatch using the handle.	

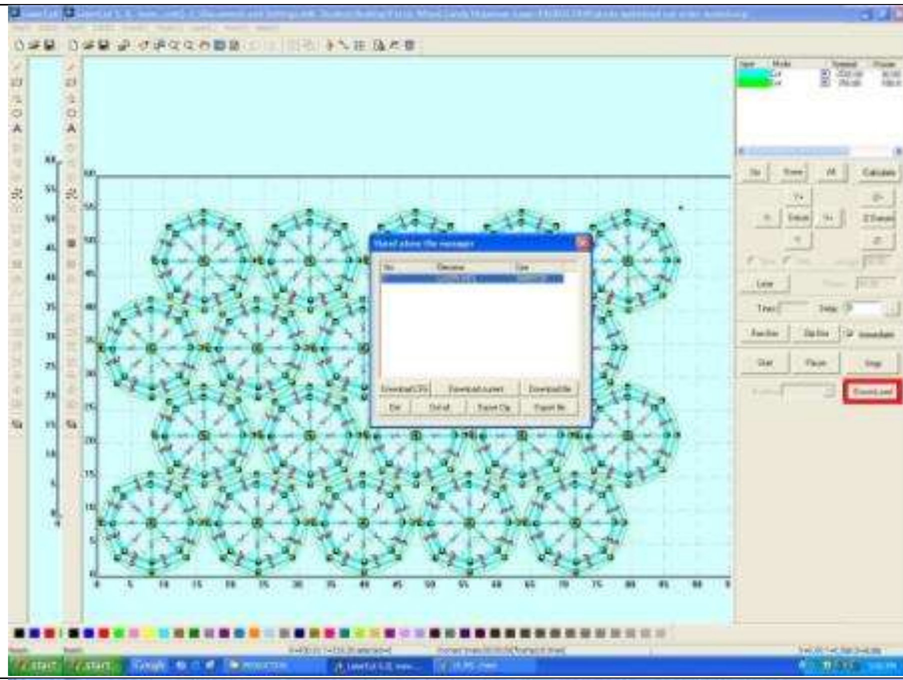
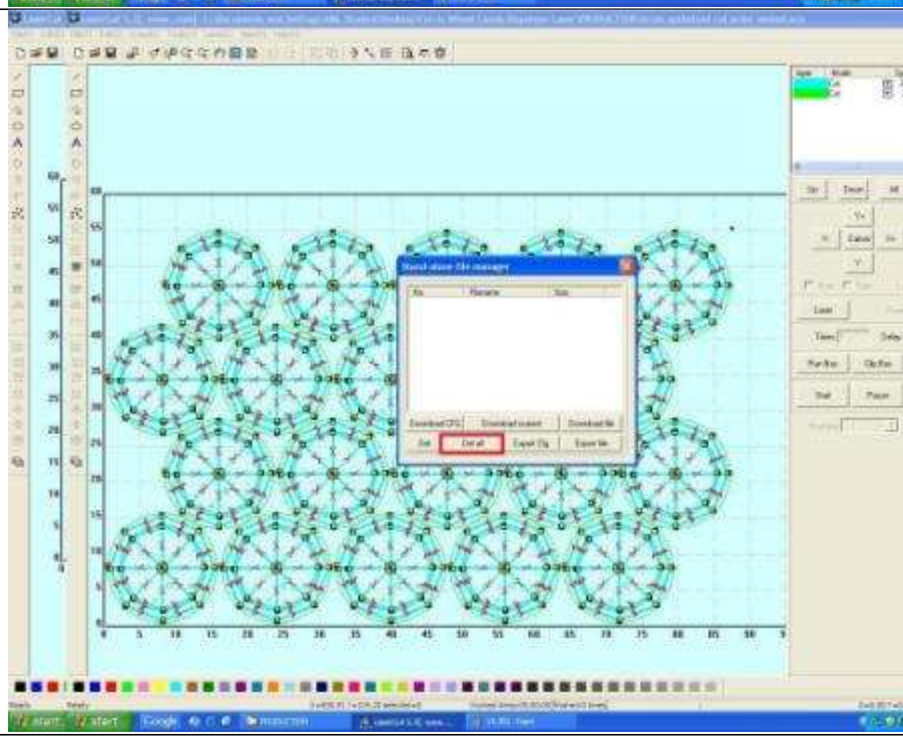
7	Place the raw material in the machine, paper-side down and plastic-side up.	 	
8	Used the arrow keys to position the focusing probe over the material. Define the origin to the upper right hand corner of the stock.	 	

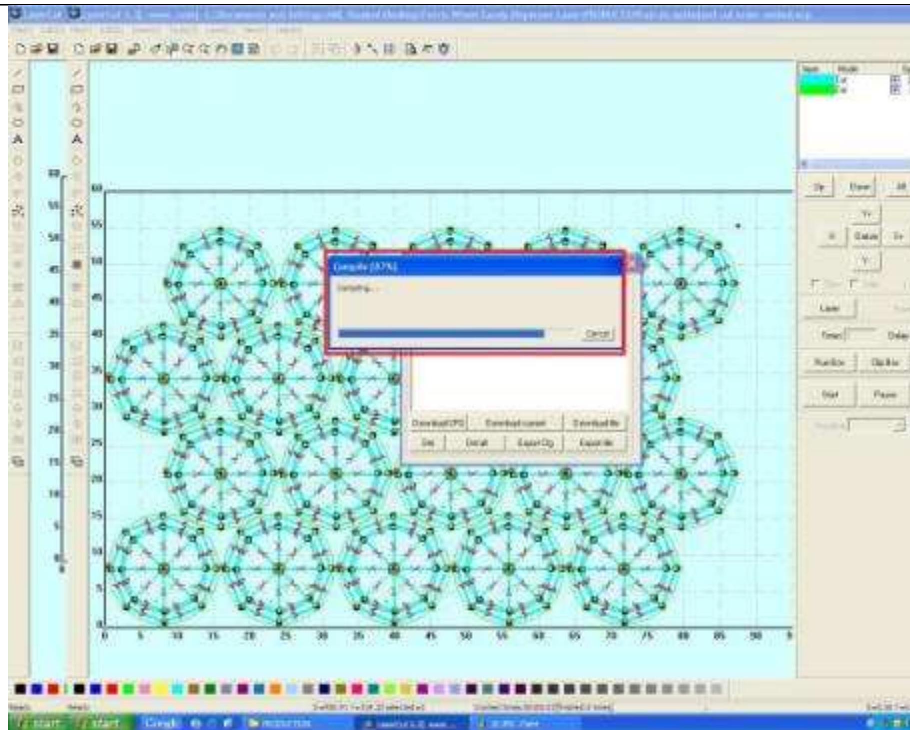
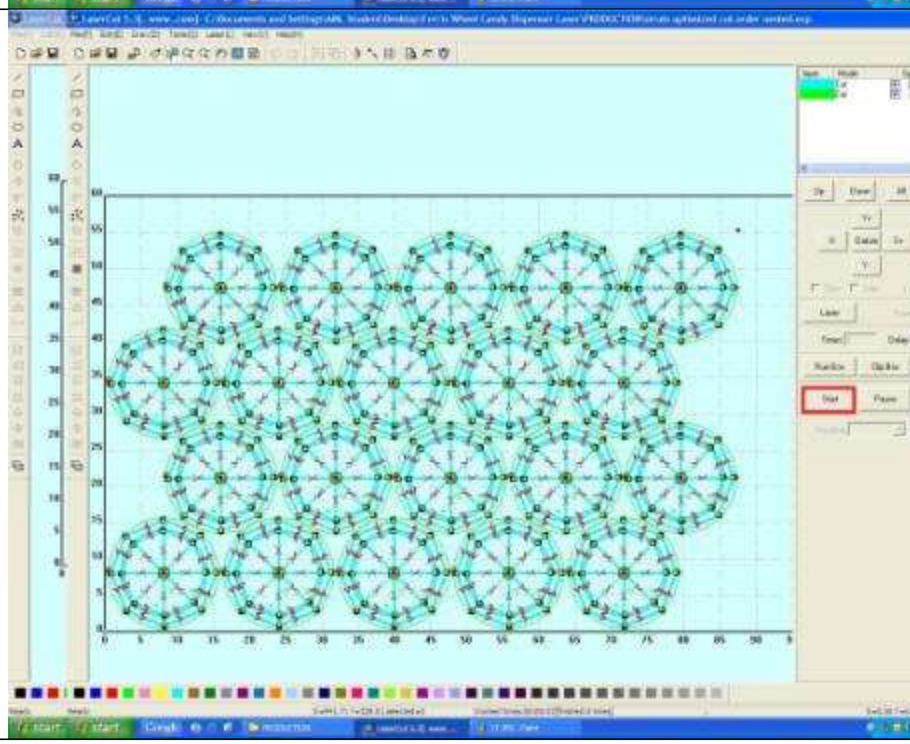
9	Push the “ENTER” button when the probe is positioned.	
10	Push the “ENTER” button again to bring you into the “LOGIC ORG” screen. Push “ENTER” to set the “LOGIC ORG.”	

11	Push the "ESC" button to exit the "LOGIC ORG" screen.	
12	Push the "Z" button in the middle of the arrow keys and then the "RESET" button to focus and set the Z axis. The laser is now ready to run. NOTE: Ensure that the focusing probe is over the material.	

13	Log into the adjacent computer workstation. Once the computer has booted, navigate to “Shortcut to Lasercut53.exe” on the desktop and launch the application.	
14	Once the application has been launched, navigate to “File > Open.”	

15	Select Desktop > Ferris Wheel Candy Dispenser – Laser > PRODUCTION > “Struts optimized cut order nested.ecp” and click “Open.”	
16	Click the “Calculate” button. A window titled “Processing Data” will pop up. Wait until completion.	

17	Once the "Processing Data" window closes, click on the "Download" button. A window titled "Stand-alone File Manager" will pop up.	
18	In the "Stand-alone File Manager" window, select the file and then click the "Del all" button, then select the "Download Current" button.	

19	The “Download” window will open and show the progress of the file downloading to the laser. Wait until completion.	
20	Click the “Start” button and attend to the laser, keeping your hand on the “E-Stop” button. NOTE: To cut additional parts, repeat steps 15 – 18.	

21	The paper must be peeled off of the back of each individual part.	
22	The blanks must be popped from each hole around the edge of the strut (8 blanks) and also from the interior holes of the strut (4 blanks).	

23	To shut the machine off, push the "E-STOP" button and turn it counterclockwise.	
24	Turn off the chiller next to the Hurricane Laser machine by pressing the toggle switch to "O."	

25	Turn off the ventilation system by pushing the red “STOP” button on the other side of the support beam behind the Formech 660.	

Cleanup

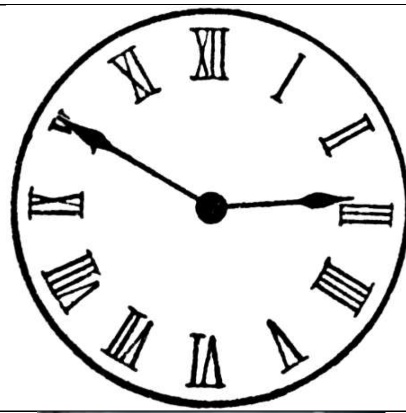
When the part is finished cutting, remove the material and part and any weights or magnets that were used. Return the weights, magnets, and any excess material to their respective homes.

Standard Operation Procedures: Tumbling

Safety Requirements:
Safety Glasses
Equipment Used:
Tumbler
Technical Document List:

Procedure

1	Obtain parts that need to be tumbled.	
2	Turn on tumbler using switch on front.	
3	Insert up to 75 parts into tumbler.	

4	Wait about 2 hours.	
5	Return to the tumbler and remove all parts.	

Cleanup

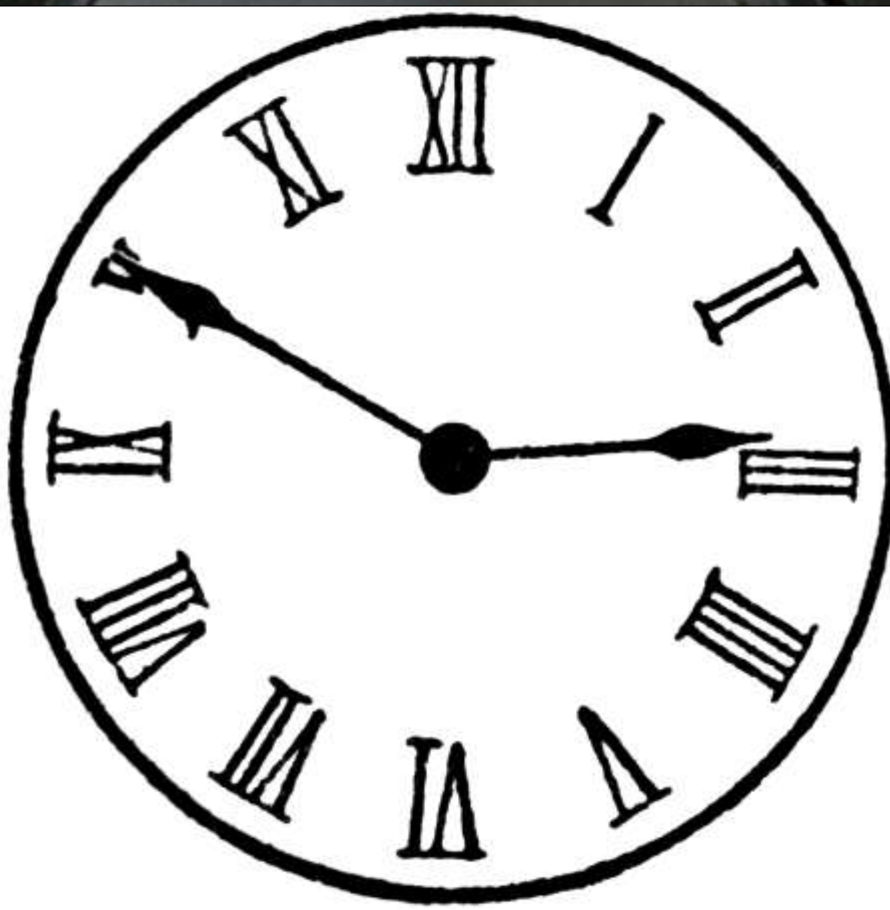
Turn off tumbler and return parts to the cabinet.

Standard Operation Procedure: Formech 660 Vacuum Former

Safety Requirements:
Safety Glasses User is attending to machine during operation.
Equipment Used:
Formech 660 Vacuum Forming Machine
Technical Document List:

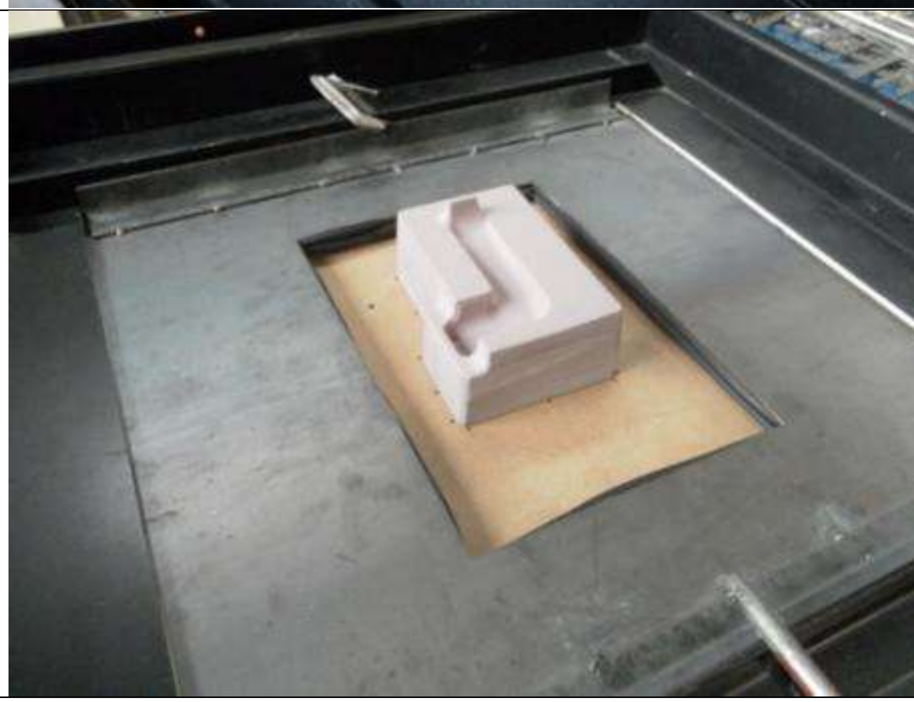
Procedure

<table>
<tr><td>1</td><td>Turn on the ventilation system by pushing the black “START” button on the other side of the support beam behind the Formech 660.</td><td></td></tr>
<tr><td>2</td><td>Turn the Formech 660 on by toggling the red switch on the back of the machine.</td><td></td></tr>
</table>

3	Turn on the appropriate heating knobs. NOTE: This may take trial and error.	
4	The Formech 660 requires approximately 30 minutes to heat up.	

5	On the control panel, set the "TIME" to 105 seconds. The rightmost readout is for the ones column, the middle readout is for the tens column, and the leftmost readout is for the hundreds column. NOTE: The design of the interface is very counterintuitive. The toggles on the bottom of the readout increase the "TIME" while the toggles on the top decrease the "TIME."	
6	Ensure that the "TIMER" is toggled in the "DOWN" position, NOT as shown here.	

7	Pull the lever toward you, as shown in the picture.	
8	The mold plate should be raised up.	

9	If it is necessary to change the metal flange plate to allow for a bigger mold, loosen the c-clamps and switch the flange out.	
10	Place the mold on the plate.	

11	Pull the lever back upward. This will cause the mold plate and mold to descend into the belly of the machine.	
12	Lift the holding fixture using the orange handles.	

<table>
<tr><td>13</td><td>Place the raw material over the opening.</td><td></td></tr>
<tr><td>14</td><td>Lower the holding fixture and lock it into a closed position using the two clamps beneath the handles.</td><td></td></tr>
</table>

15	Pull the heater toward the front of the machine. This will start the timer.	
16	When the TIMER beeps after the set period of TIME, push the heater back.	

17	As fast as possible, pull the handle toward you and downward to raise the mold up to the material.	
18	Push and hold the “MOULD” button for 7 to 10 seconds. Afterward, release the “MOULD” button.	

19	Push the “STOP” button.	
20	Push and hold the “RELEASE” button.	

21	Pull the lever back upward. This will cause the mold plate and mold to descend into the belly of the machine.	
22	If the “RELEASE” button does not free the mold, return the lever to the down position. This will cause the mold plate and mold to rise.	

23	Lift the holding fixture using the orange handles.	
24	Pry the piece from the mold.	

25	To produce more parts, repeat steps 6 through 24.	

Cleanup

When the part is finished molding, remove the material and mold. Return any excess materials to their respective homes.

Standard Operation Procedure: Laser Cutting of Upper Base

Safety Requirements:
Safety Glasses
Equipment Used:
Hurricane Lasers Charley Model
Technical Document List:
Struts: AML > 1213_Team_A > Shared Documents > Laser Code > Struts Upper Base: AML > 1213_Team_A > Shared Documents > Laser Code > Base

Procedure

1	Turn on the ventilation system by pushing the black “START” button on the other side of the support beam behind the Formech 660.	
2	Turn on the chiller next to the Hurricane Laser machine by pressing the toggle switch to “I.”	

3	Turn the E-Stop button clockwise to release it, and then make sure the laser toggle switch is in the "ON" position. This will cause the machine to home.	
4	Push the "ESC" key.	

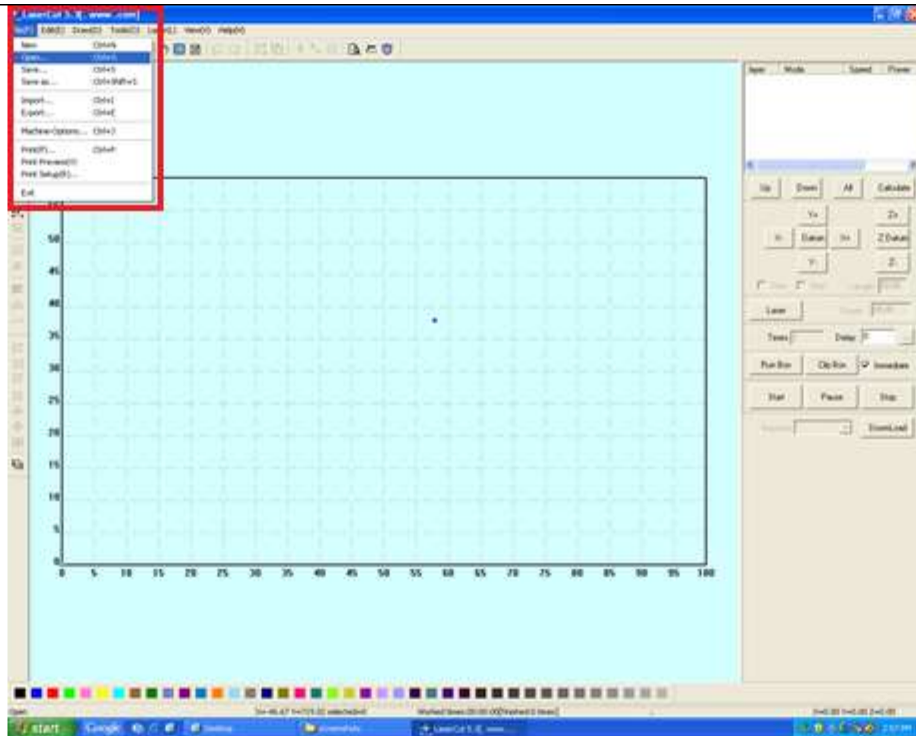
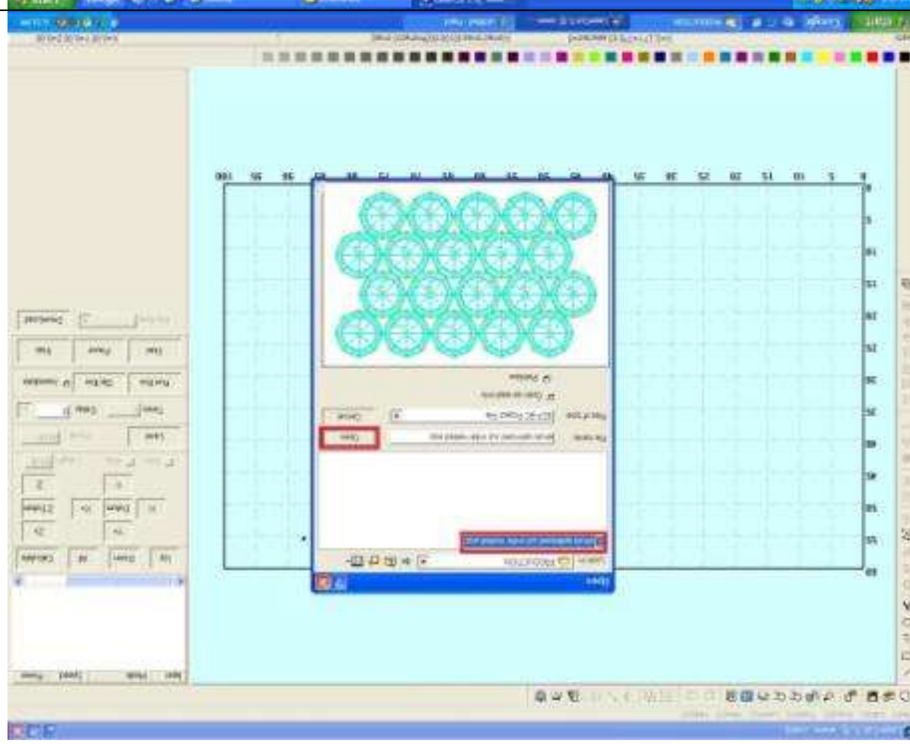
5	Open the hatch using the handle.	
6	Place the Upper Base fixture on the table as shown. Ensure that the table is low enough that the laser can pass over all bolts of the fixture. To lower the table, press the Z button to enter the z-adjustment mode, and then press the down arrow key to lower to table.	

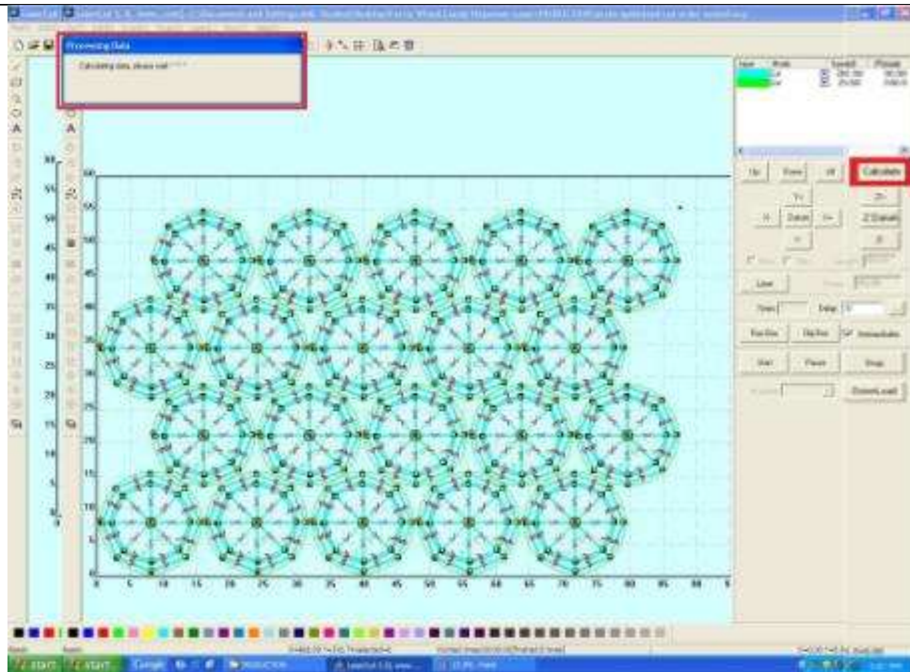
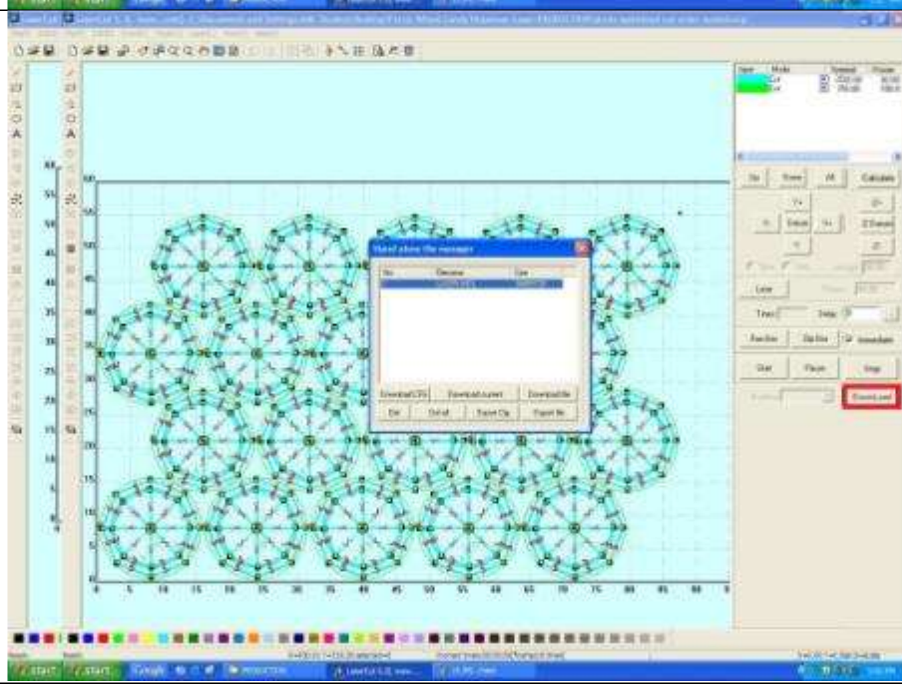
7	Use the horizontal laser gantry to visually square the fixture on the machine bed.	
8	Use the arrow keys to position the focusing probe over the top-right bolt, as shown.	

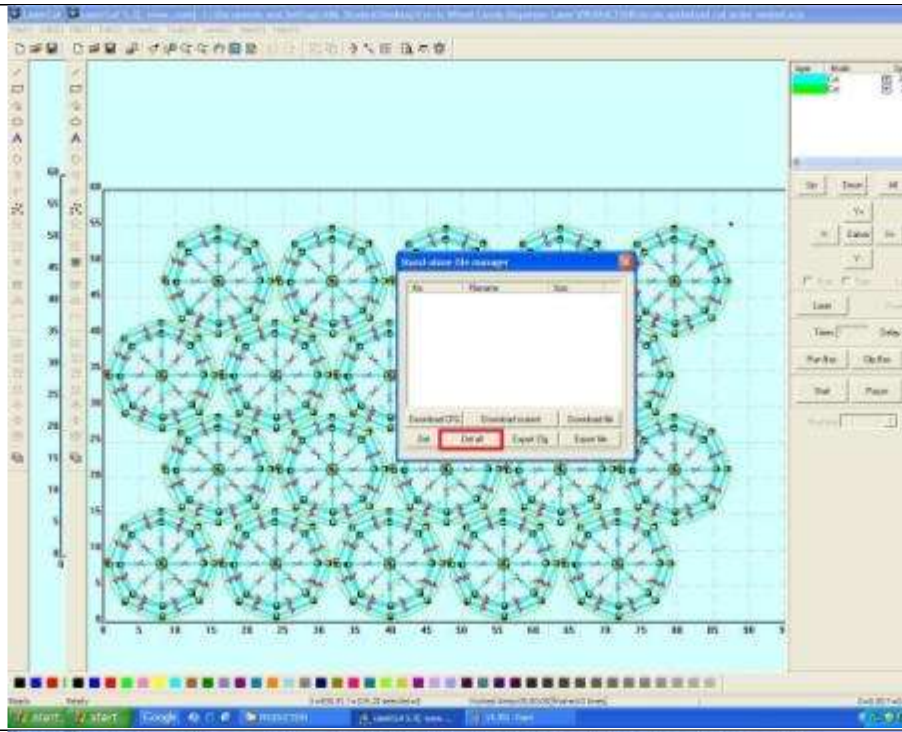
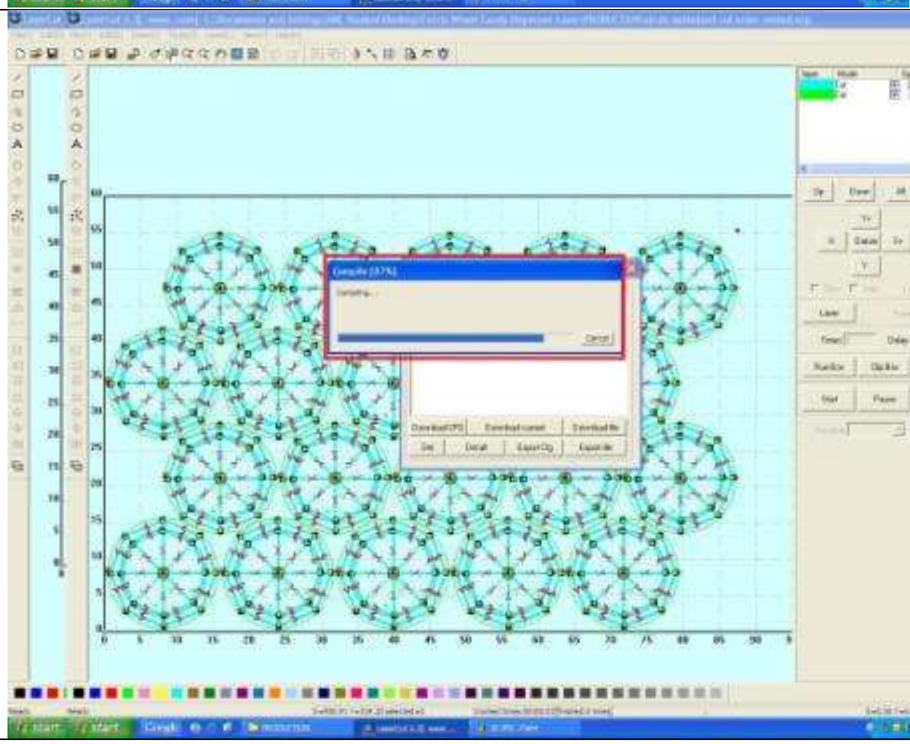
9	Push the "Z" button in the middle of the arrow keys and then the "RESET" button to focus and set the Z axis.		
12	Used the arrow keys to position the laser origin directly in the center of the top-right bolt, as shown. A black dot indicates the center of the bolt head.		

13	Push the "ENTER" button when the probe is positioned.	
14	Push the "ENTER" button again to bring you into the "LOGIC ORG" screen. Push "ENTER" to set the "LOGIC ORG."	

15	Push the "ESC" button to exit the "LOGIC ORG" screen. The laser is now ready to run.	
16	Log into the adjacent computer workstation. Once the computer has booted, navigate to "Shortcut to Lasercut53.exe" on the desktop and launch the application.	

17	Once the application has been launched, navigate to “File > Open.”	
18	Select Desktop > Ferris Wheel Candy Dispenser – Laser > PRODUCTION > “Box Front Optimized.ecp” and click “Open.” Note: The following screenshots are for a different file but the procedure is the same.	

19	Click the "Calculate" button. A window titled "Processing Data" will pop up. Wait until completion.	
20	Once the "Processing Data" window closes, click on the "Download" button. A window titled "Stand-alone File Manager" will pop up.	

21	In the “Stand-alone File Manager” window, select the file and then click the “Del all” button, then select the “Download Current” button.	
22	The “Download” window will open and show the progress of the file downloading to the laser. Wait until completion.	

23	Place a formed upper base in the left side of the fixture, oriented as shown. Lightly press it against the bolt heads to ensure it is seated with a three-point contact in the bottom-left corner (indicated by an arrow on the base of the fixture).	
24	Press "enter" on the machine several times to fully load the new program. Then press “Start Pause” to begin running the program. The program will cut the base out of its flashing; as soon as it is done press “stop” on the machine, while it is moving toward the right side of the fixture as shown.	

<table>
<tr><td>25</td><td>Remove the trimmed part from the left side of the fixture, and place it on the right side in the orientation shown, ensuring 3-point contact on the upper left corner (indicated by an arrow on the base of the fixture). Place a new part on the left side ensuring 3-point contact as before.</td><td>
</td></tr>
<tr><td>26</td><td>Press “Start Run” on the machine, this time allowing it to run to completion. Allow several seconds for smoke to clear before opening the machine.

NOTE: Repeat steps 25-26 to cut additional parts. At the end of your shift, leave the half-completed part on the fixture and return both to the cabinet.</td><td>
</td></tr>
</table>

27	To shut the machine off, push the “E-STOP” button and turn it counterclock-wise.	
28	Turn off the chiller next to the Hurricane Laser machine by pressing the toggle switch to “O.”	

29	Turn off the ventilation system by pushing the red “STOP” button on the other side of the support beam behind the Formech 660.	

Cleanup

When the part is finished cutting, remove the material and part and any weights or magnets that were used. Return the weights, magnets, and any excess material to their respective homes.

Process: Upper Base Bump Removal
Machine: Band saw
Stock: Base Assembly

1	**Machine setup** **10.** Setup Guide as shown in picture to remove the whole bump	 
2	**Remove bump** 17. Start saw 18. Using wooden block, feed into blade, ensuring that the rest of the upper base is not cut 19. Feed until bump is removed, **without cutting the back support**	   
3	**Running production** 16. Repeat step 2 until done 17. Cleanup the band saw area	

Process: Upper base bump flattening
Machine: Heat gun
Stock: Upper Base

1	**Setup** **11.** Place upper base with sawed-off bump on vacuum form mold. **12.** Plug in heat gun and set heat level to 7.	 
2	**Remove bump** 20. Use heat gun to warm area around sawed-off bump. 21. Use flat plate to press down area until flat.	 
3	**Running production** 18. Repeat step 2 until done. 19. Unplug heat gun and clean up area.	

Appendix B: Assembly Standard Operating Procedures

Included in this Appendix (alphabetical by assembly):

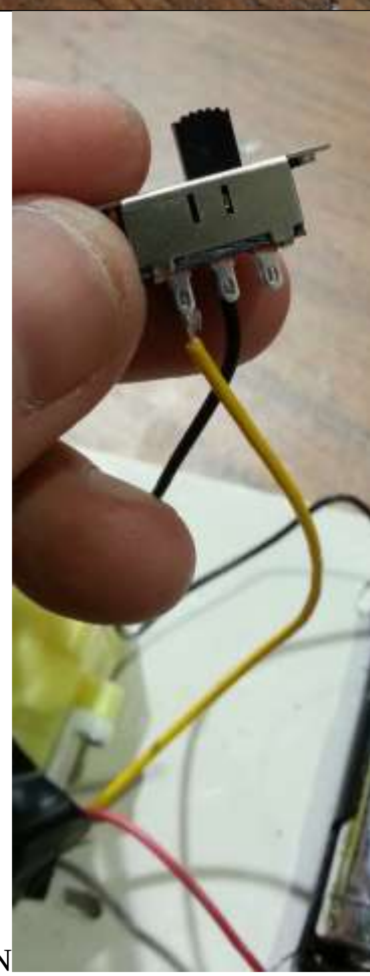
- Attaching Upper Base
- Bracing Screw
- Final Assembly
- Gluing Nameplate to Upper Base
- Heat Staking Outer Gear to Front Support
- Jar Sub-subassembly
- Motor Sub-Subassembly
- Packaging
- Pressing Back Support
- Robotic Base Assembly
- Robotic Wheel Assembly
- Soldering Lower Base
- Wheel Assembly Quality Control

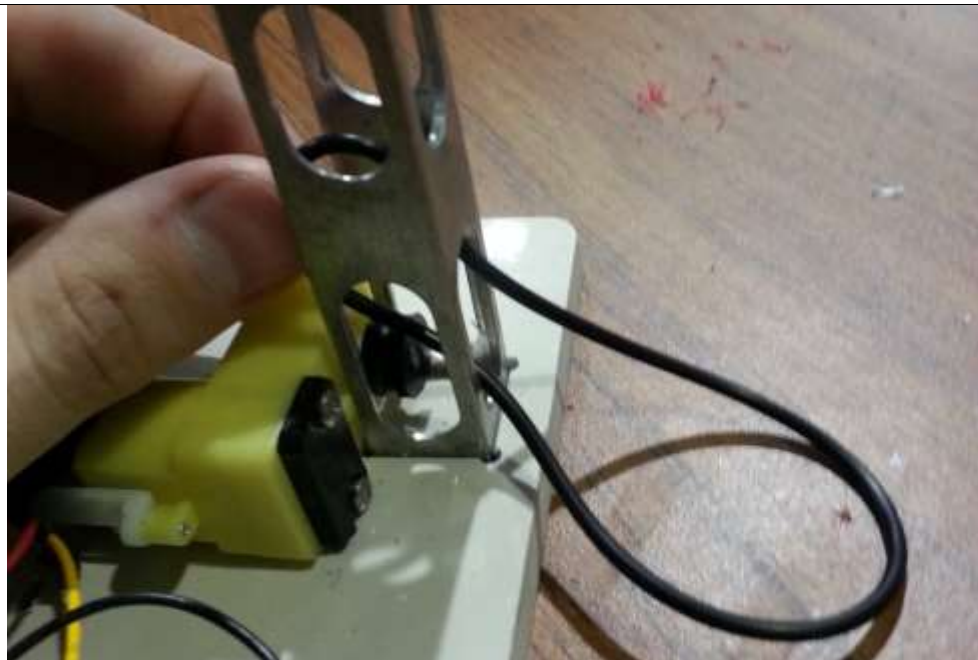
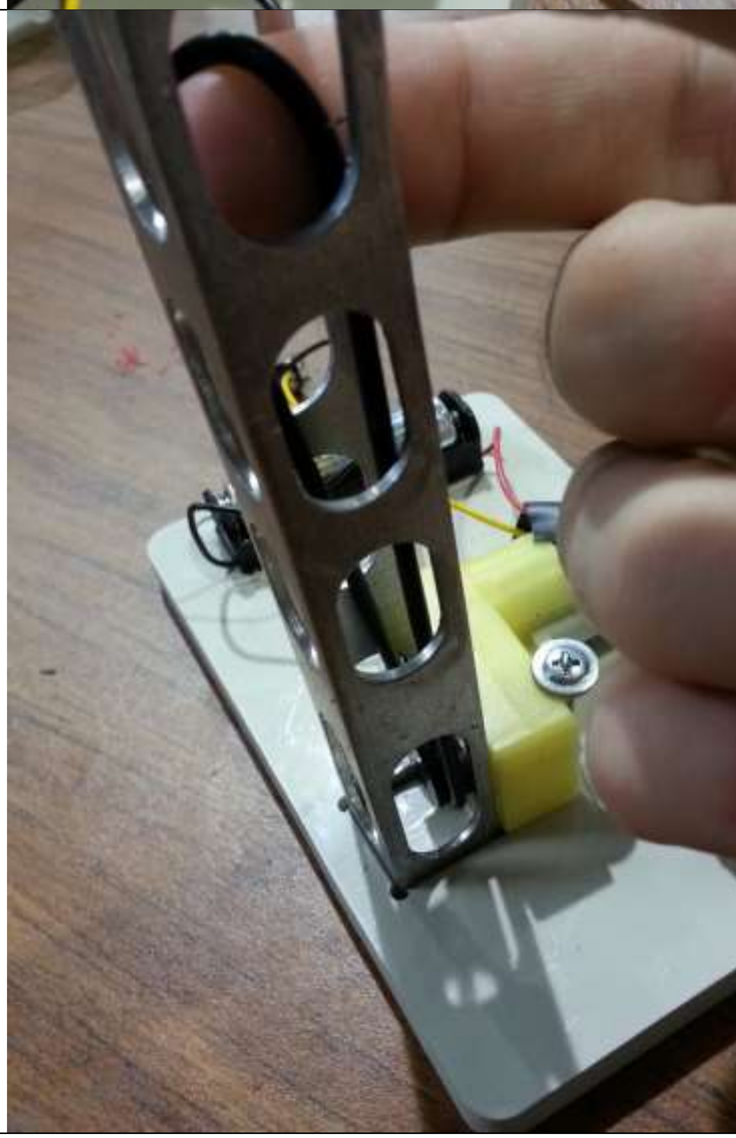
Standard Operation Procedure: Attaching the Upper Base

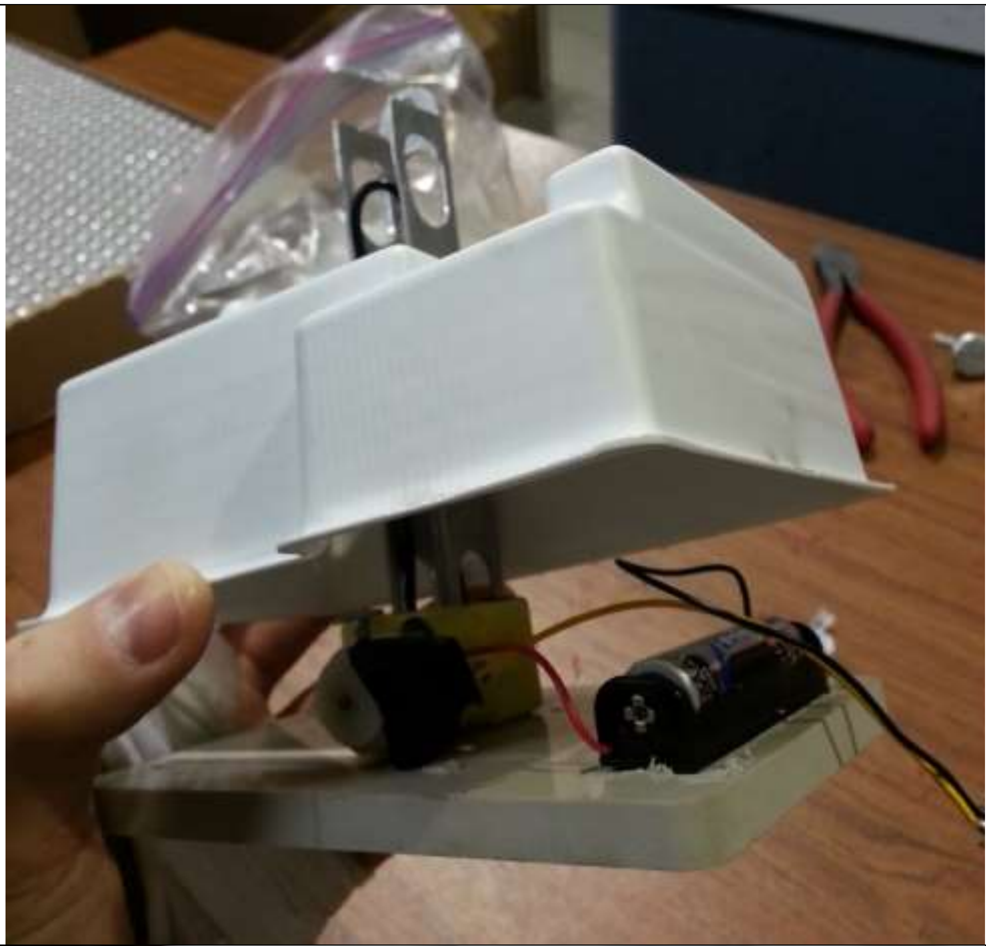
Safety Requirements:
N/A (Safety glasses if in the MILL)
Equipment Used:
Hot glue gun
Technical Document List:

Procedure

1	Begin by collecting all the required items to finish the base subassembly: a lower base, an upper base, a battery, an o-ring, and a glue gun	
2	Check to make sure that the battery holder is properly secured; if it is not, use hot glue to reattach it.	

3	Place a battery into the battery holder	
4	Flip the switch between the two positions, and ensure that the motor spins in one position and not the other. Also try to make sure that the motor spins in the correct direction; the motor shout spin counter-clockwise when viewed from the front of the base.	 ON  OFF

5	Take the o-ring and slide it through the lowest the hole in the back support…	
6	…then slide it through and loop it around the drive-belt carrier. Pull it straight upright and then leave it in the back support; it should stay upright.	

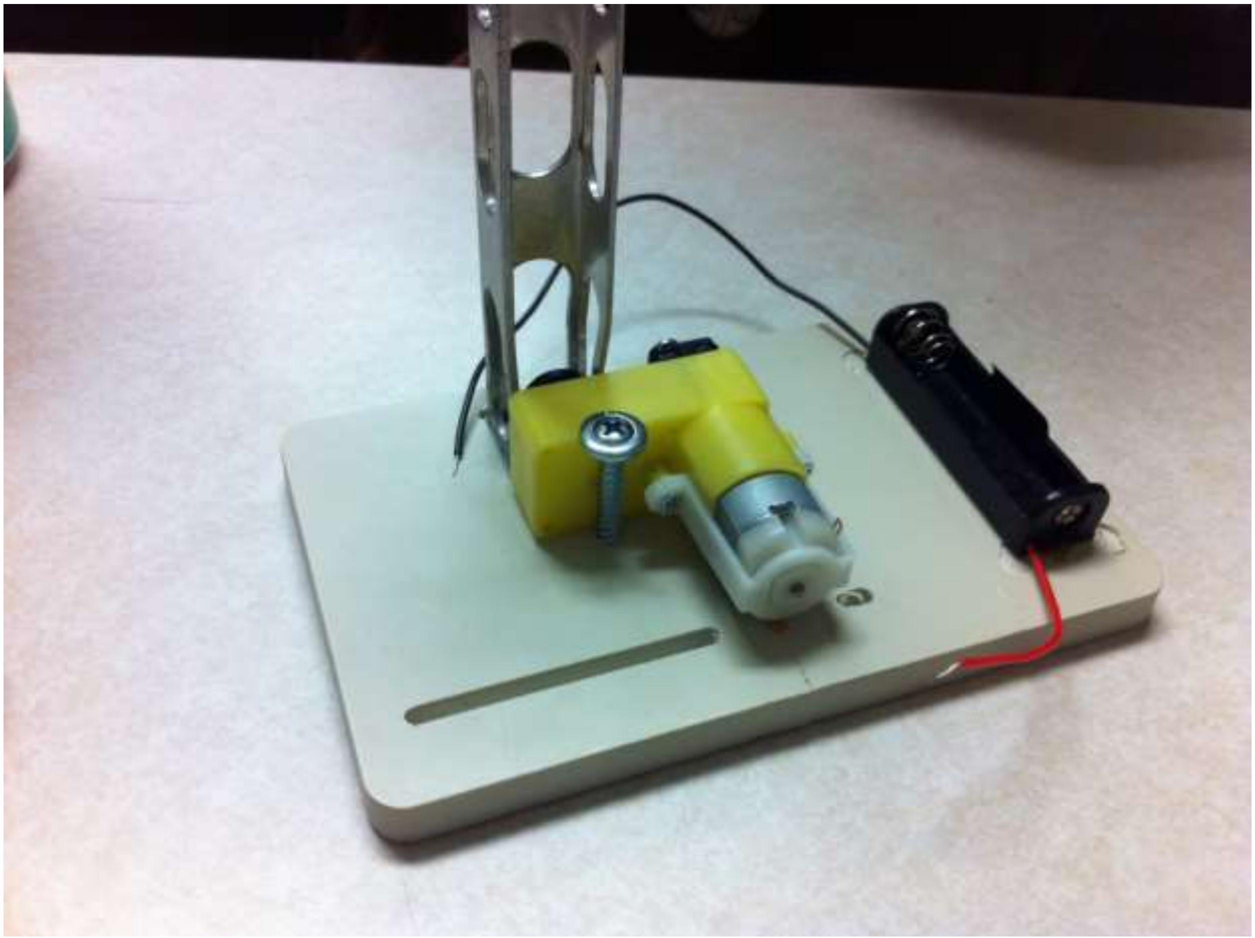
7	Slide the upper base over the back support and carefully slide the switch through its slot. It's often easiest to slide it through sideways, such that the smallest cross sectional area it passing through the slot.	
8	Orient the switch in the switch slot such that the motor turns on when the switch is pulled forwards, towards the front of the base, and is turned off when pushed towards the rear.	

9	Place a dab of hot glue underneath both of the screw holes on the switch, and then press the switch down onto them. Hold for 10 seconds or until glue is set, and then pull off any strands of glue left by the glue gun	
10	Place the finished Base Subassembly into a storage location, and then repeat until all bases are complete.	

Cleanup

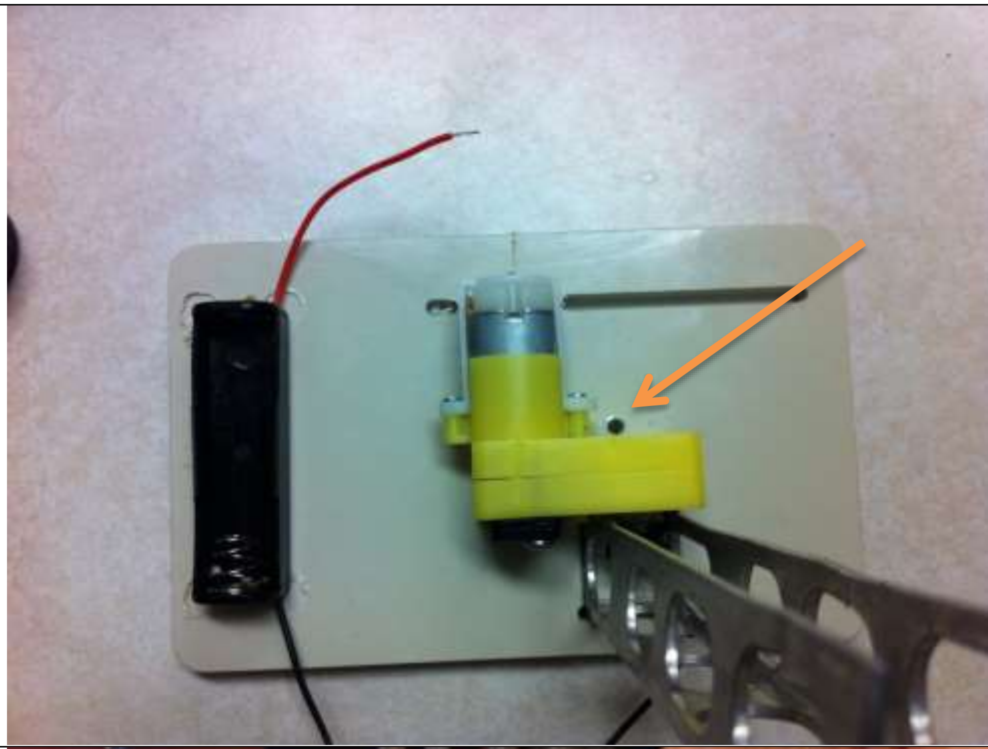
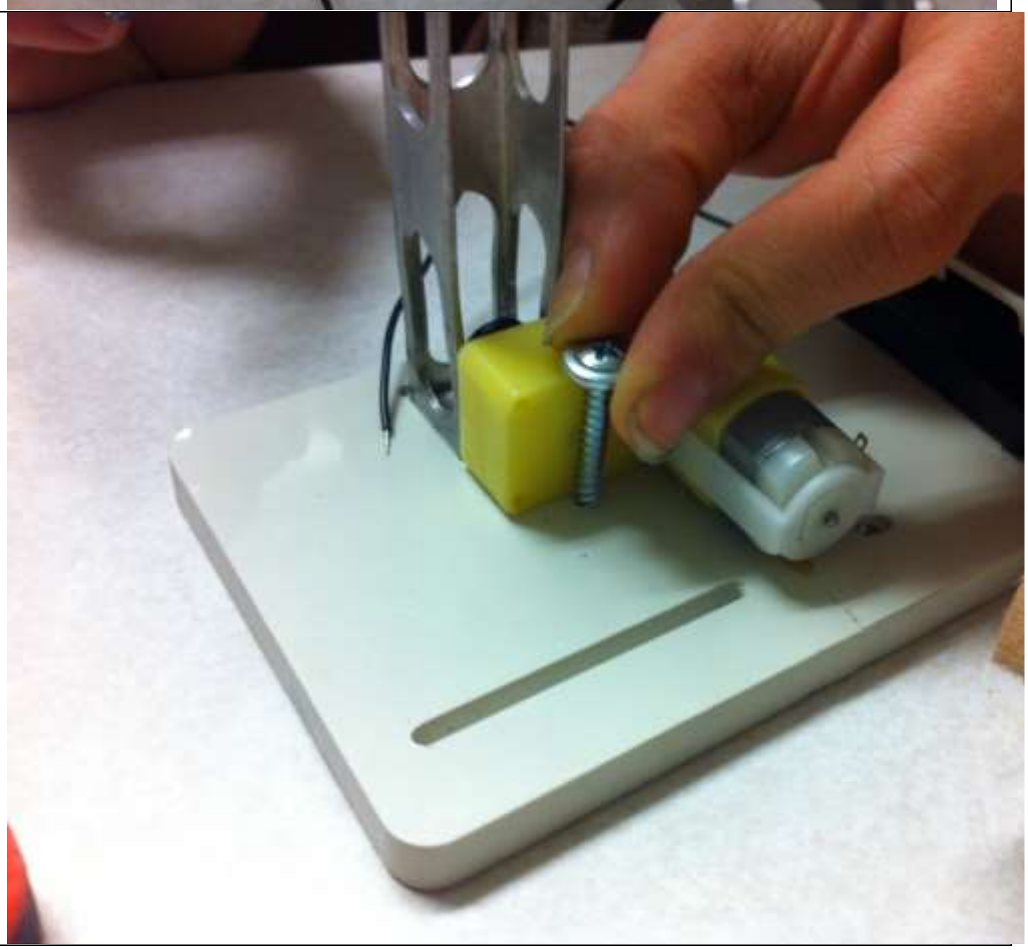
Unplug the glue gun and let it cool. Throw away any empty o-ring bags and glue particles that have accumulated during the process. Unfinished components should be returned to their respective storage locations.

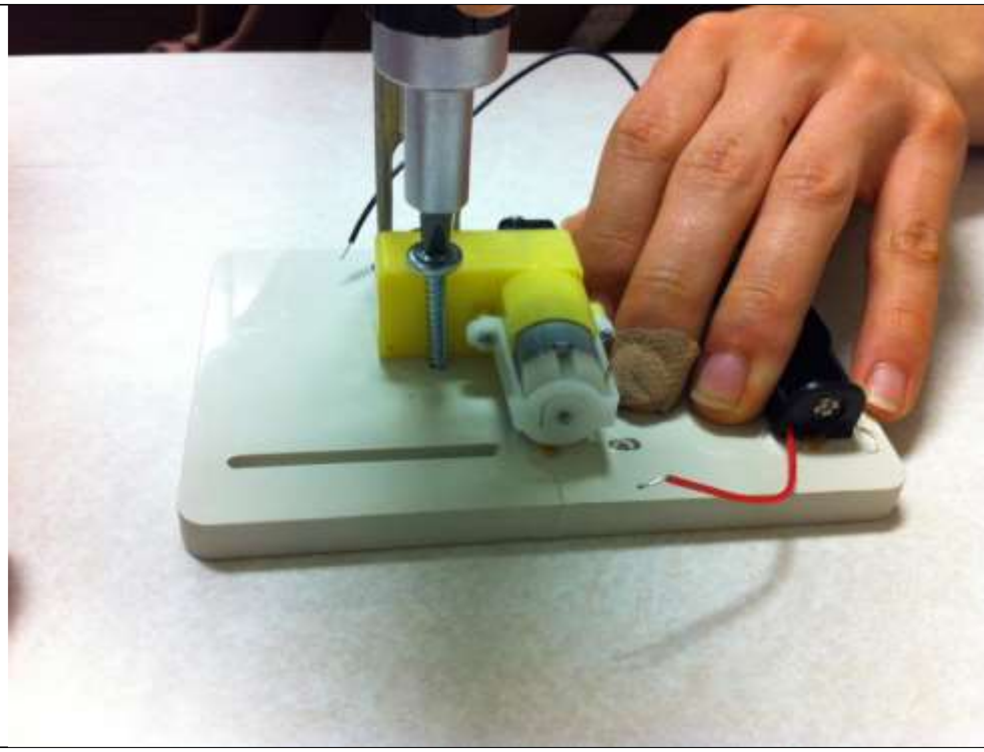
Standard Operating Procedure: Bracing Screw



Safety Requirements:
Safety Glasses
Equipment Used:
Drill Press Screwdriver
Technical Document List:
N/A

Procedure

1	Drill a 1/8th inch diameter hole out as shown. The exact location is lenient as long as it is close enough to the motor.	
2	Put the Bracing Screw in the hole flush with the motor. *The Bracing Screws are: Sheet Metal Screws – Truss Washer Needle Point, #8 x 1-1/4"*	

3	Screw the Bracing Screw in until it is holding the motor down securely. Be careful not to over-tighten it.	

Cleanup

When you are done, put the screw driver away and clean off the drill press.

Standard Operating Procedure: Final Assembly Process

Procedure

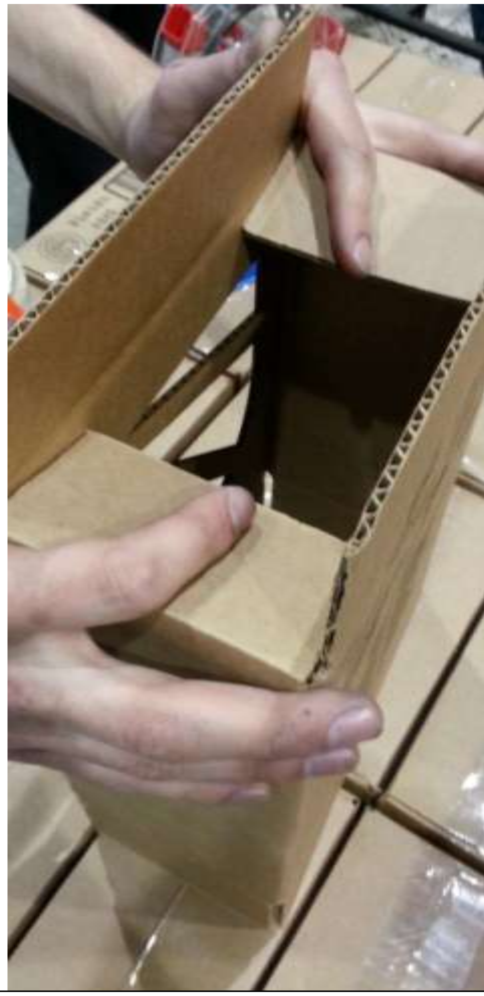
1	Slide an axle drive belt carrier onto the axle.	
2	Stretch the o-ring of the base out and loop it into the groove on the axle drive belt carrier, such that the long end of the axle drive belt carrier is pointed towards the base support.	

3	Slide the round section of the axle into the hole in the back support until the axle won’t move further, then release. The axle should stay in the back support by itself.		

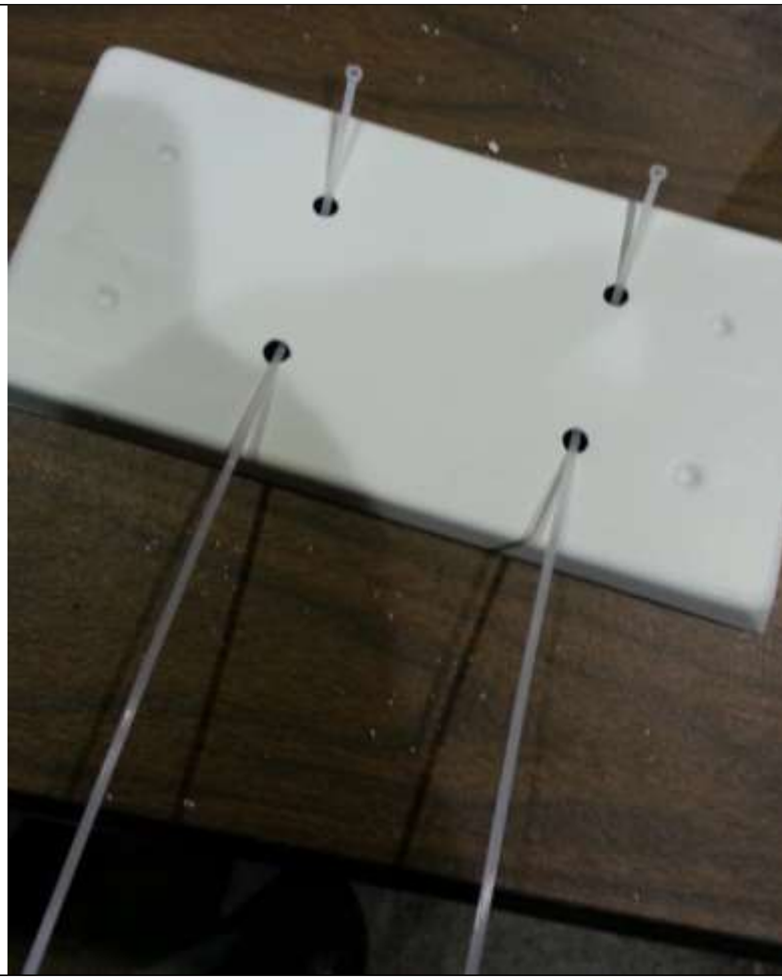
4	Slide the wheel onto the axle, making sure that the doser gear faces away from the back support.	

5	Then, insert the A-frame so that it sits in its groove in the lower base, and the axle slides through it. It is often easiest to slide it in at an angle, and then straighten it after it's in its groove.		

6	Press an axle pin onto each end of the axle, and gently press inwards. Don't press in too hard; there needs to be a little wiggle room on the axle to allow for imperfections in the product.	
7	Test the product to be sure that it works. As a general rule of thumb, if it can spin five consecutive times without needing assistance, it is an acceptable part.	

8	Take an engraved box and fold the bottom flaps in. Apply tape to hold them in place.	 

9	Slide zip ties into the risers by threading the thick end down through one hole and up again out the opposite hole. The thick end of the zip tie should be close to the riser, and the long thin end should extend out into the distance		

10	Place a finished wheel onto the riser, and loop the long end of the zip ties over the top of the wheel and into the opposite end of the zip tie. Secure gently; too tight damages the product.	

11	Bend the long ends of the zip ties under the riser, where they will be out of sight.	

12	Gently slide the product into the open box, making sure that the zip ties stay out of sight, and the A-frame is facing the display front of the box.		

13	Seal the box with tape. The product and packaging are now complete; place part into a storage location.	

Standard Operating Procedure: Gluing Nameplate to Upper Base

Safety Requirements:	
None (Safety Glasses if in MILL)	
Equipment Used:	
Hot Glue Gun	
Technical Document List:	
N/A	

Procedure

1	Gather your parts; an upper base and a "MILL @ Rensselaer" plate and a hot glue gun.	
2	Plug in the hot glue gun and wait 3-4 minutes until it heats up.	

3	Place the nameplate onto the upper base to see where you will need to glue.	
4	Start placing glue onto the upper base.	

5	The glue should form a pattern similar to this.	
6	Place the nameplate onto the glue quickly and press down for several seconds while the glue cools.	

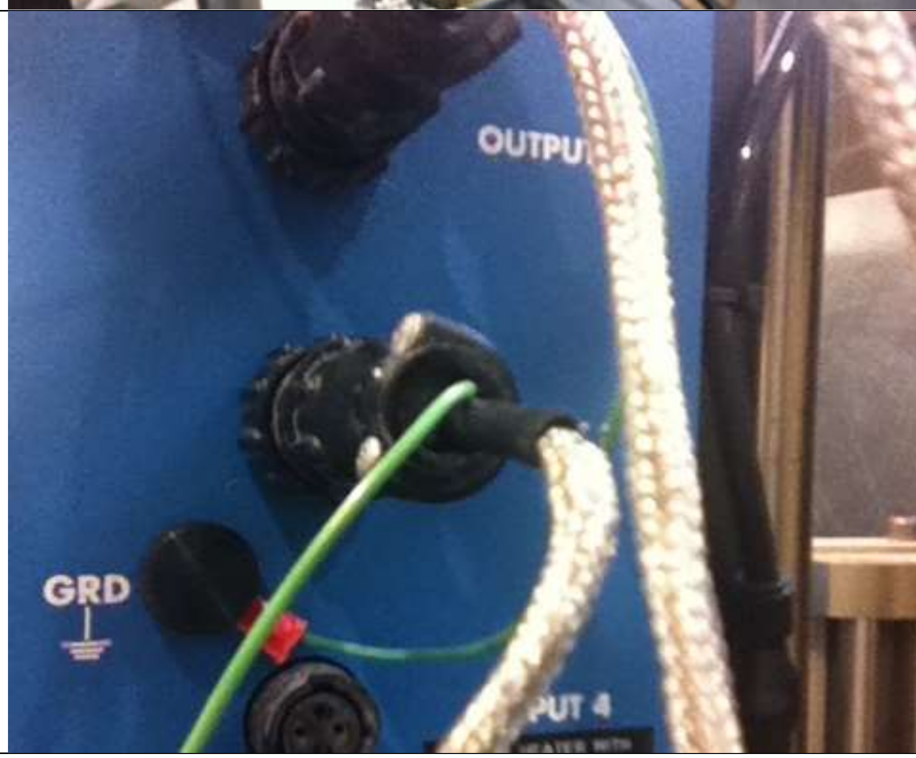
Cleanup

Unplug the hot glue gun and put it away.

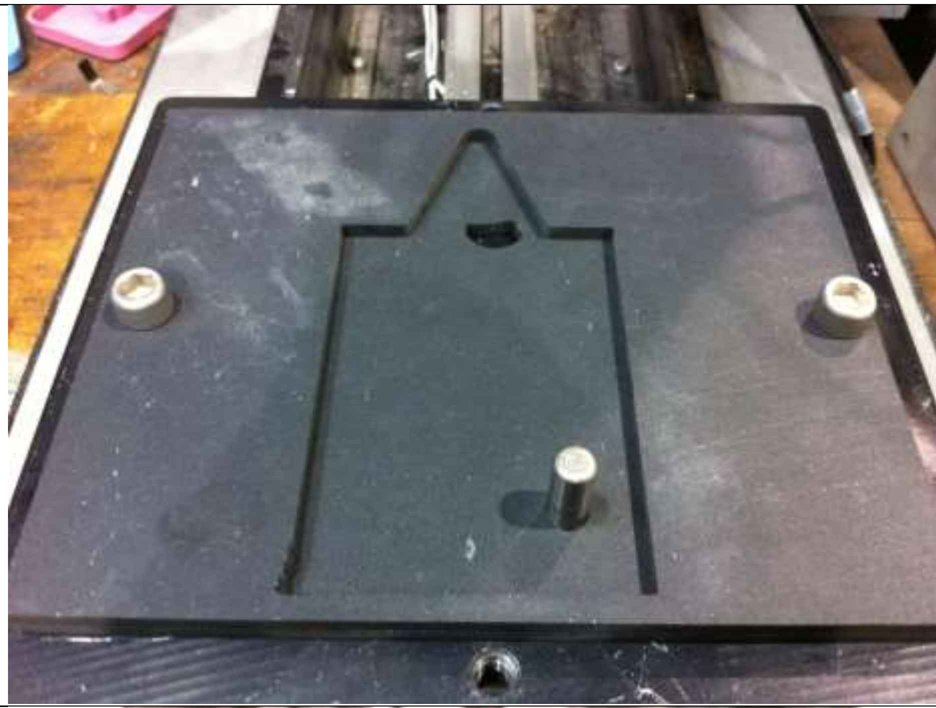
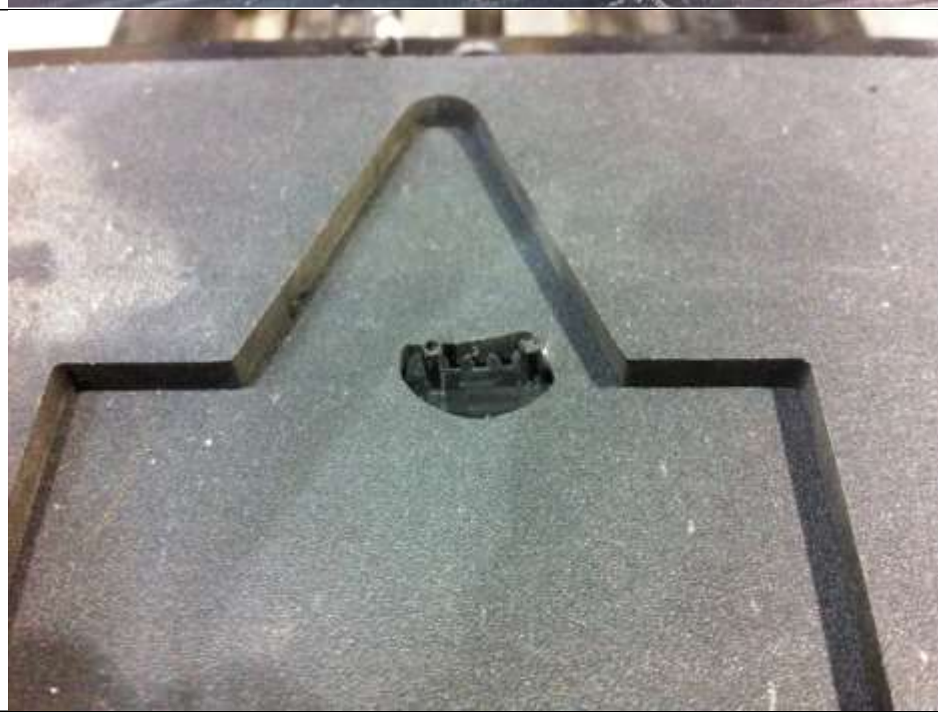
Standard Operating Procedure: Heat Staking of Outer Gear to Front Support

Safety Requirements:
Safety Glasses User is with machine while it is operating.
Equipment Used:
Sonitek TS500 Model Thermal Press
Technical Document List:
N/A

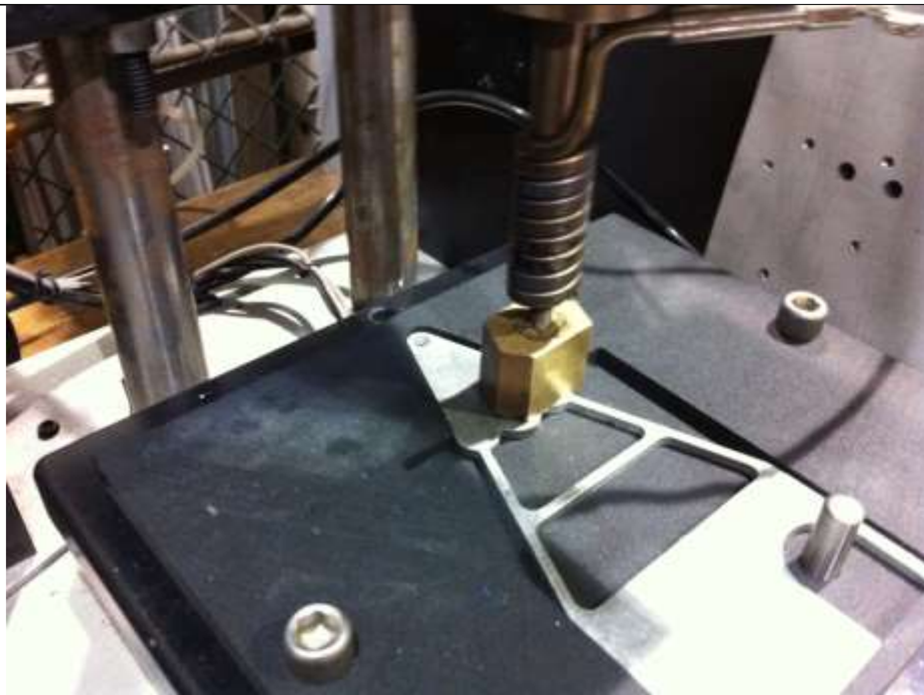
Procedure

1	Attach the heating element to the machine; tighten using the black knob on the left side.  *(Close-up of head)*	
2	Attach the single braided cord from the heating element to the back as shown. Also connect the green wire to the GRD port. The port pictured here is for "Zone 3".	

3	Turn on the machine by pressing the red toggle switch to “ON”. The button will light up. If the temperature displays below do not light up, press the reset switch	
4	The displays will flash between numbers and "-AL-" at first. This is OK. Wait until the temperature for the port you plugged into reaches 500. This will take 4-5 minutes.	

5	Set up the fixture on the table as shown by screwing in the two bolts until they are secure on the right and left sides.	
6	Place the outer gear into the slot with the two prongs facing upwards. (This picture is inaccurate; the gear will be flush with the surface.)	

7	Place the front support on top. First locate it with the two holes for the outer gear prongs, and then push it into the fixture. It will be a tight fit.	
8	Press and hold the two black buttons on the sides of the machine, until the fixture moves forwards and the heating head moves down.	 

9	The heating element will come down until it is flush with the outer gear and hold for several seconds, and then release. *IMPORTANT!* *If it does not move down far enough, see step 10.*	
10	If the head does not go down far enough, adjust the screw by lowering the height. The screw is located towards the back of the machine.	

11	Turn off the machine by switching the ON/OFF toggle switch to the off position.	

Cleanup

When you are done heat staking, remove the fixture and return it to its home on the assembly shelf. Also return any unused parts to their respective homes. If another team needs the thermal press, remove the heating element.

Standard Operating Procedures: Jar Subsubassembly

Safety Requirements:
Safety Glasses Latex Gloves Lab Coat
Equipment Used:
Acetone, Cotton Swabs, Welding Fixture
Technical Document List:
N/A

Procedure

1	Put the Jar on the Welding Fixture as shown.		
2	Put the Funnel flat side down as show		
3	Pour a small amount of acetone in a container and soak a cotton swab in it. *Note: It may be helpful to tear off half of the cotton on the end to reduce the amount of acetone absorbed in the swab.*		
4	With the funnel gently against the jar, run the cotton swab along the contact edges, letting		

	acetone seep into the gap. **IF ACETONE RUNS DOWN THE FACE OF THE FUNNEL OR TOUCHES THE FIXTURE, REMOVE PARTS IMMEDIATELY AND WAIT FOR FIXTURE TO DRY!!!**	
5	Press and hold the Funnel down and against the Jar for 45 seconds.	

6	Remove the Jar and flip the fixture. The funnel should be flush with the edge of the Jar.	
7	Flip the Jar and put it back in the fixture. Repeat steps 2 through 5 for the other Funnel.	

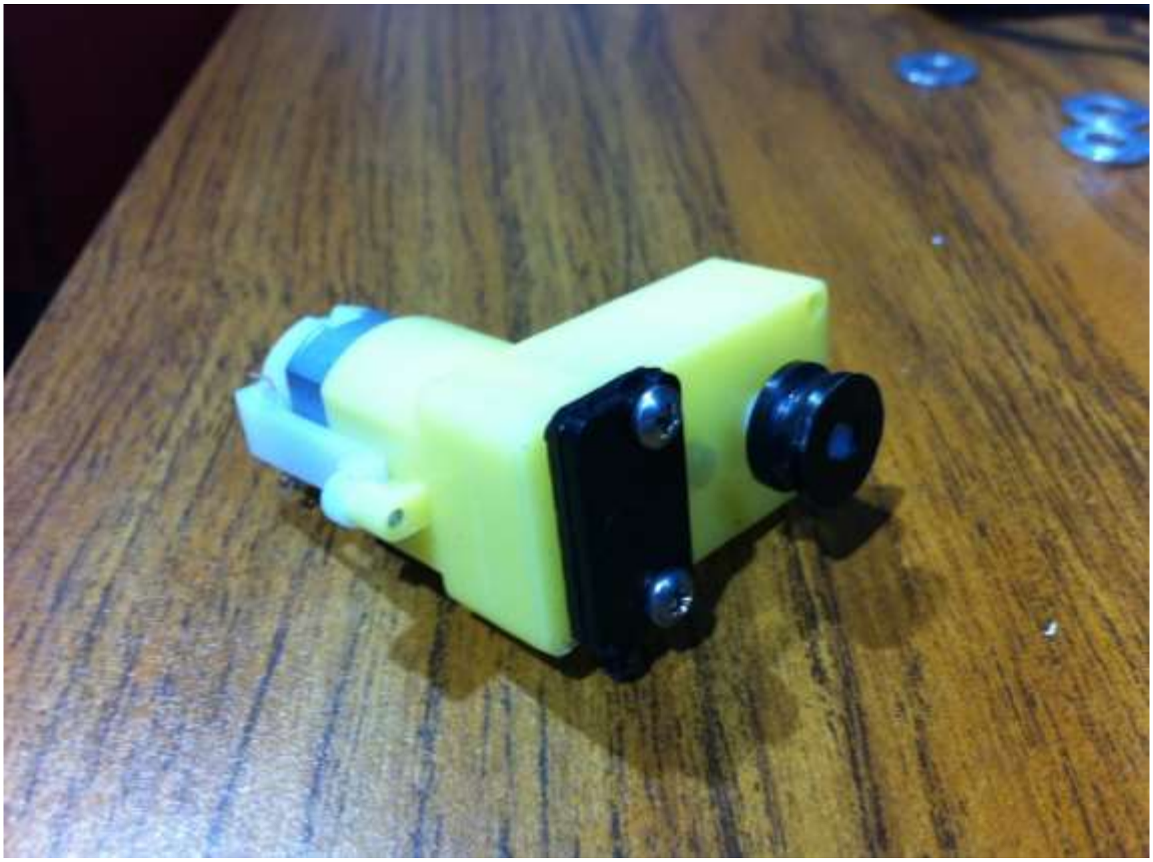
7	Take your completed Jar and get a Jar Lid	
8	Place the Jar Lid into the slot on the Jar in the "open" position.	

9	Press the Jar Lid into place.	

Cleanup

When you are done welding, return the fixture to its home on the assembly shelf. Also return any unused parts to their respective homes. Throw out cotton swabs. Let remaining acetone evaporate.

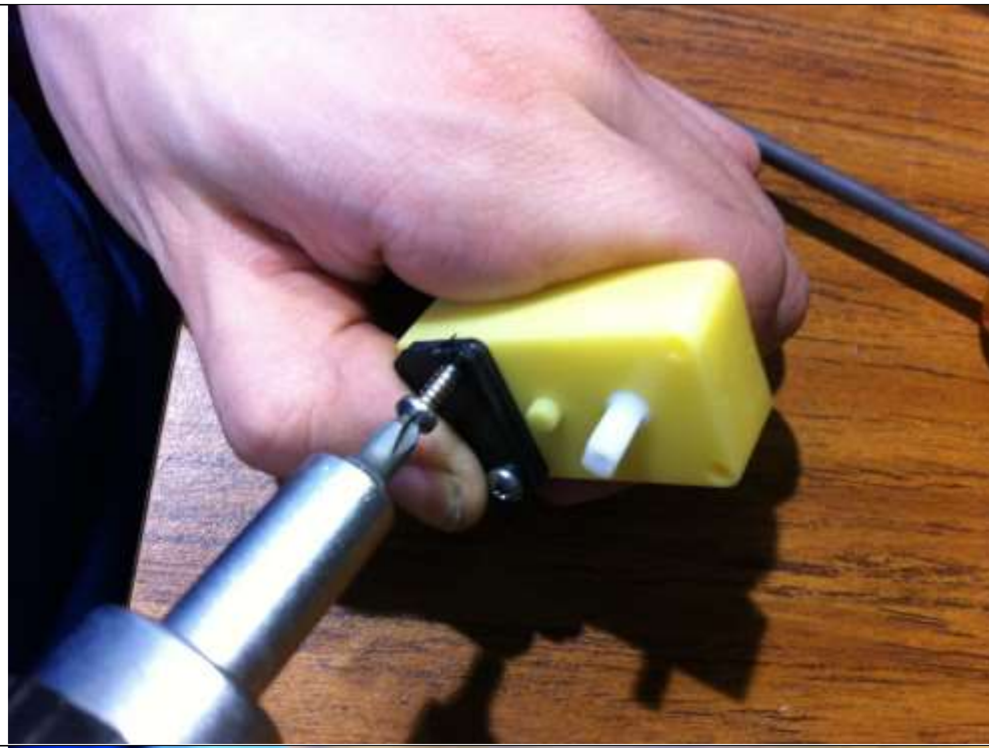
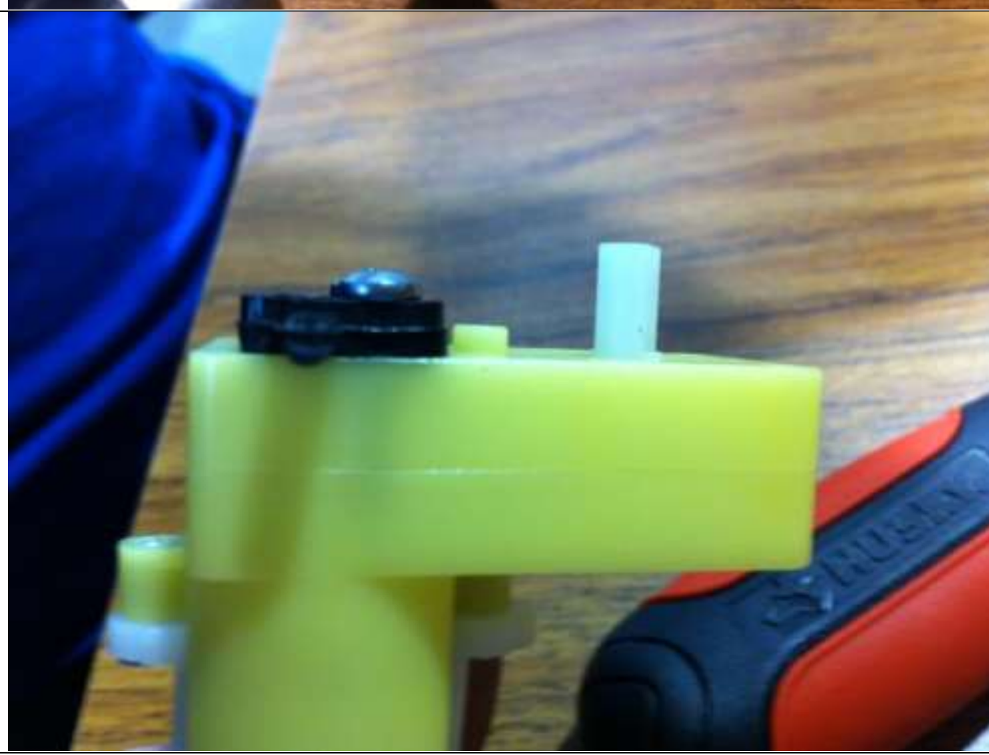
Standard Operating Procedure: Motor Sub-subassembly

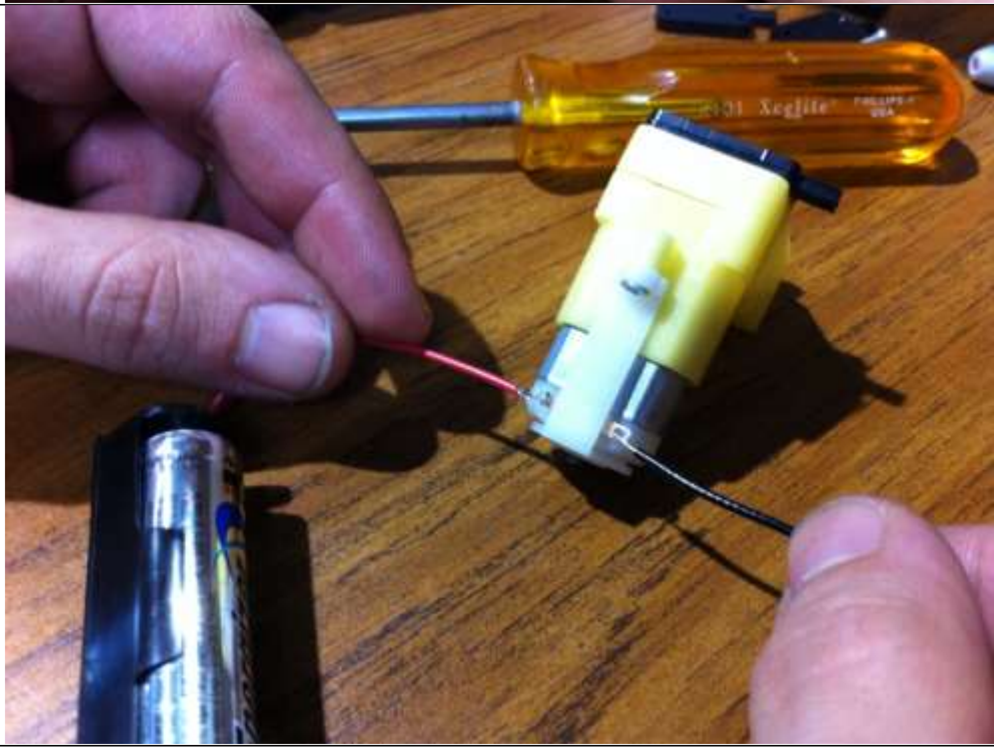


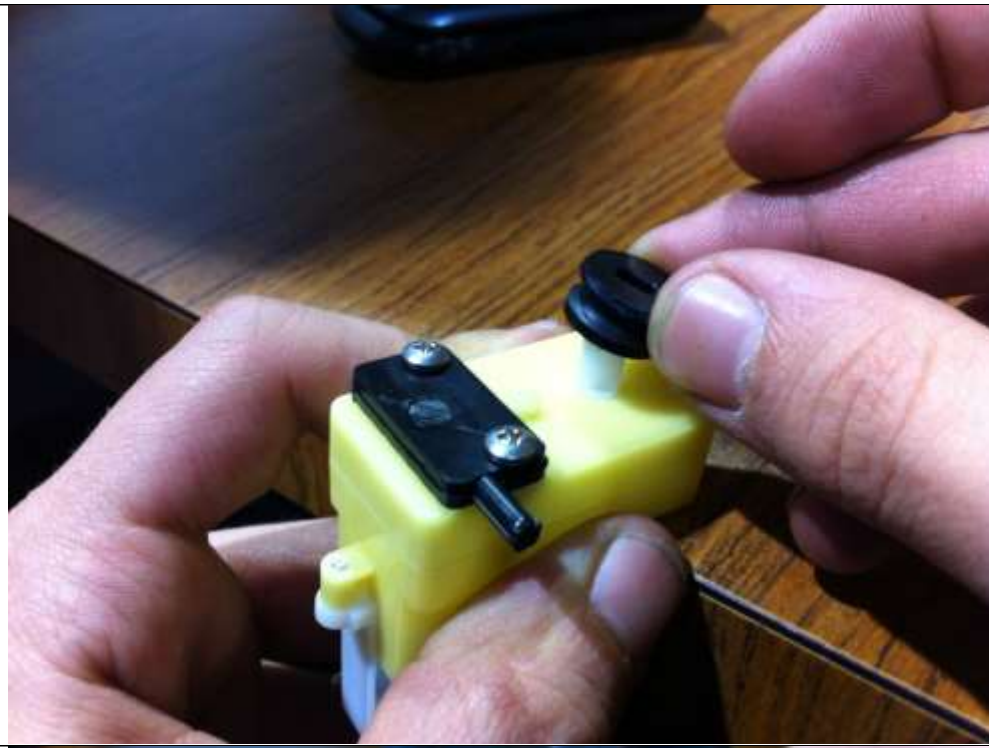
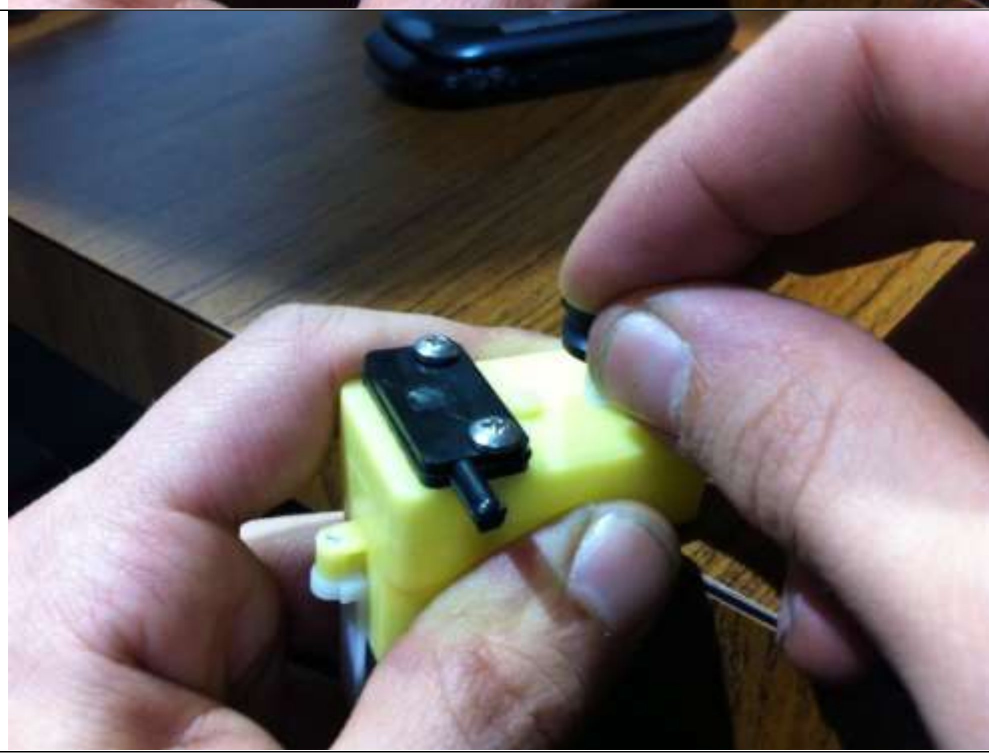
Safety Requirements:
None
Equipment Used:
Screwdriver
Technical Document List:
N/A

Procedure

1	Remove the two screws on the axle side of the motor as pictured.	
2	Place the motor strap on the motor, with the peg pointing in the direction shown. Place the two new screws in place to line up the strap with the previous holes.	

3	Fasten the screws, while holding the two sections of the motor together to prevent the screw from separating the two halves. *Do not over tighten.*	
4	Tighten the screws until the motor strap is flush with the motor casing. Also check to make sure the motor casing halves are not splitting. If they are, back out and screw in again.	

5	Test the motor strap for secureness by wiggling the peg back and forth. If it wiggles, tighten the strap down. *Again, do not overtighten.*	
6	Test if the motor spins with a battery in battery case by placing the two wire leads onto the motor leads. If it does not spin, loosen the two screws by a half-turn.	

7	Now place the motor drive belt carrier onto the motor's axle, as shown. The side of the part with the dimples should be facing the motor.	
8	Press the motor drive belt carrier onto the motor axle. Use the edge of a table as support if there are difficulties in pressing the part.	

Standard Operating Procedure: Final Packaging

Safety Requirements:

- Safety Glasses Required

Equipment Used:

- Zip-Ties
- Plastic Packing Tape

Procedure:

1. Center the completed Ferris wheel on top of the riser.

2. Using two zip-ties, attach the riser to the Ferris wheel, making sure it is tight but does not bend the riser.

3. Place the riser candy wheel assembly inside the assembled packaging box.

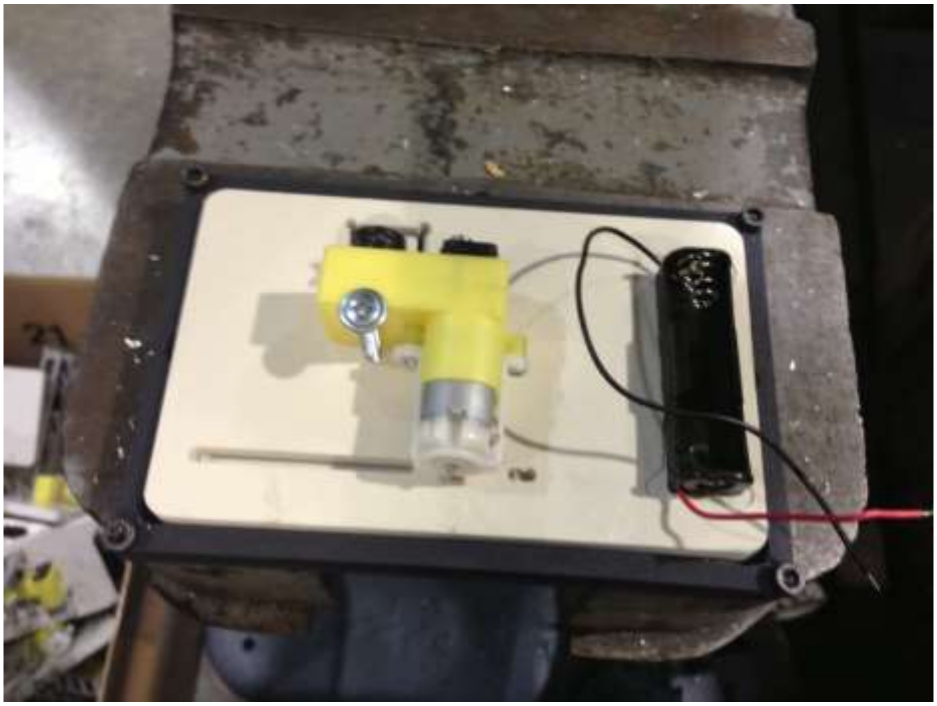
4. Close the top.

5. Use clear packing tape to seal the top of the box.

Standard Operating Procedure: Pressing Back Support

1. Place lower base in plastic mold with the C channel opening in the top left corner.

2. Make sure the base is fully inserted into Lower Press fixture and not sticking up.
3. Remove battery. If battery holder pops off, remove base from fixture and set aside for repair.

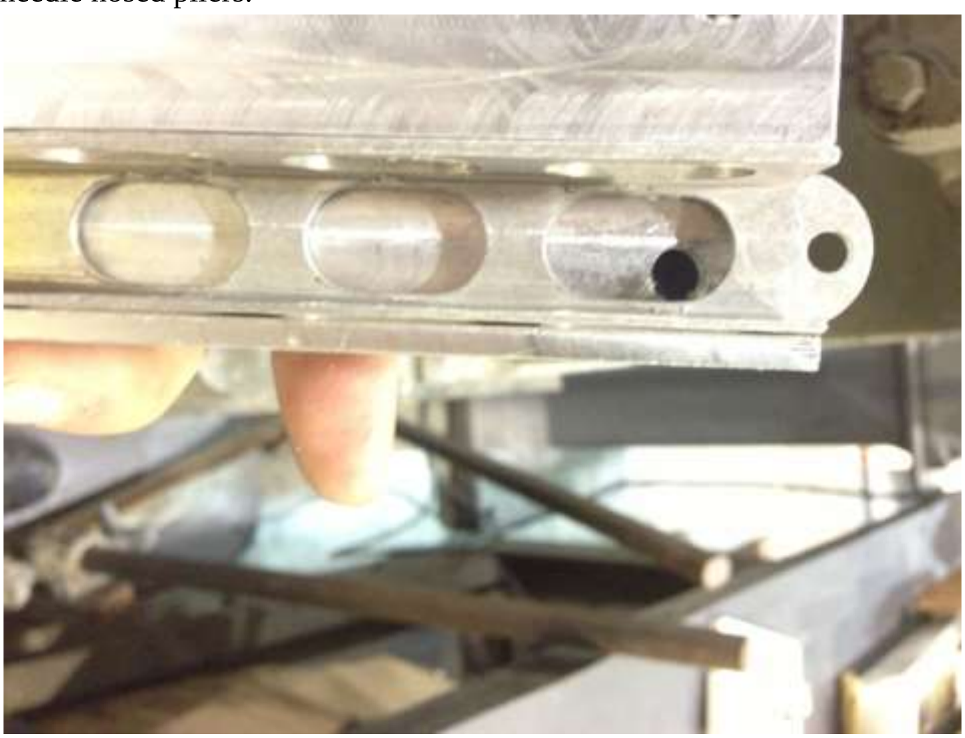


4. Insert Back support into outer holder as shown in picture below.

5. Place C channel over slot and hold in place by hand.

6. Slowly lower the press fixture looking through the slot on top to make sure the Arc of the top of the channel is aligned. The arc should be aligned to the top left of the slot.

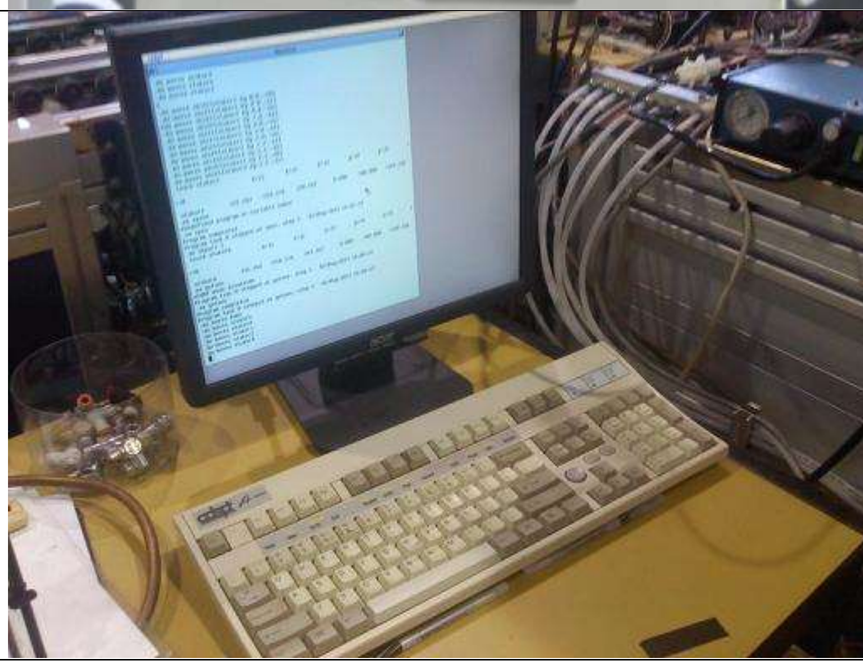
7. SLOWLY press down on the C channel with the press.
8. If there is too much resistance, STOP
9. Check if C channel is set, if not, realign and repeat.
10. Check for bending after piece is finished. If there is minor bending, fix with a pair of needle nosed pliers.

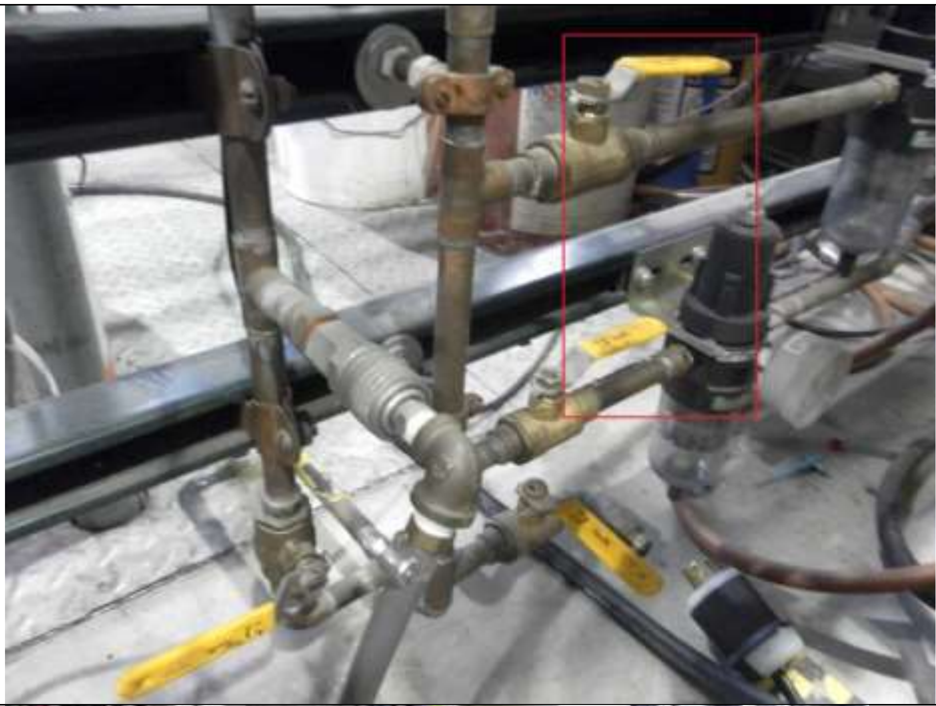
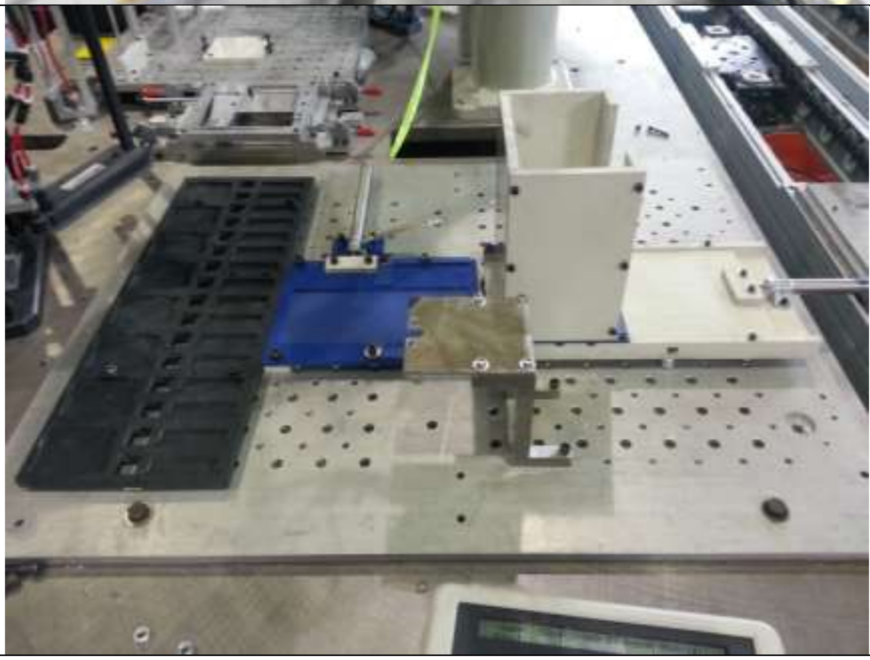


Standard Operating Procedure: Base Assembly

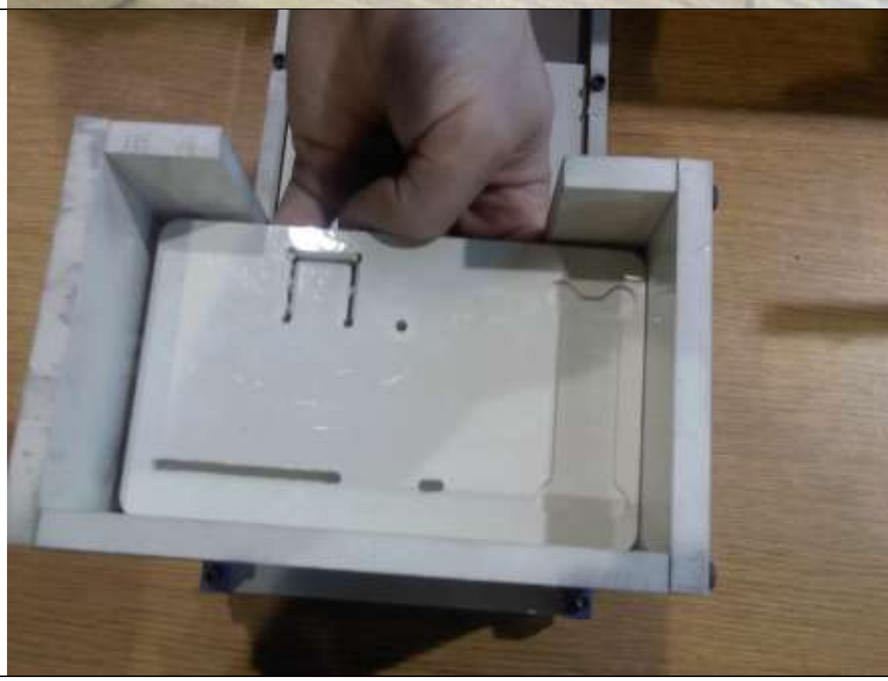
Safety Requirements:
• Safety Glasses • Hearing Protection (recommended) • At least two operators should be present at all times; one to perform any and all necessary manipulations of machinery, and the other to be ready with the emergency STOP button in case of emergencies • One operator must be attentive to the robot during operation. It is necessary to have a hand on the E-STOP at all time.
Equipment Used:
Adept Cobra 800
Technical Document List:
See Appendix E

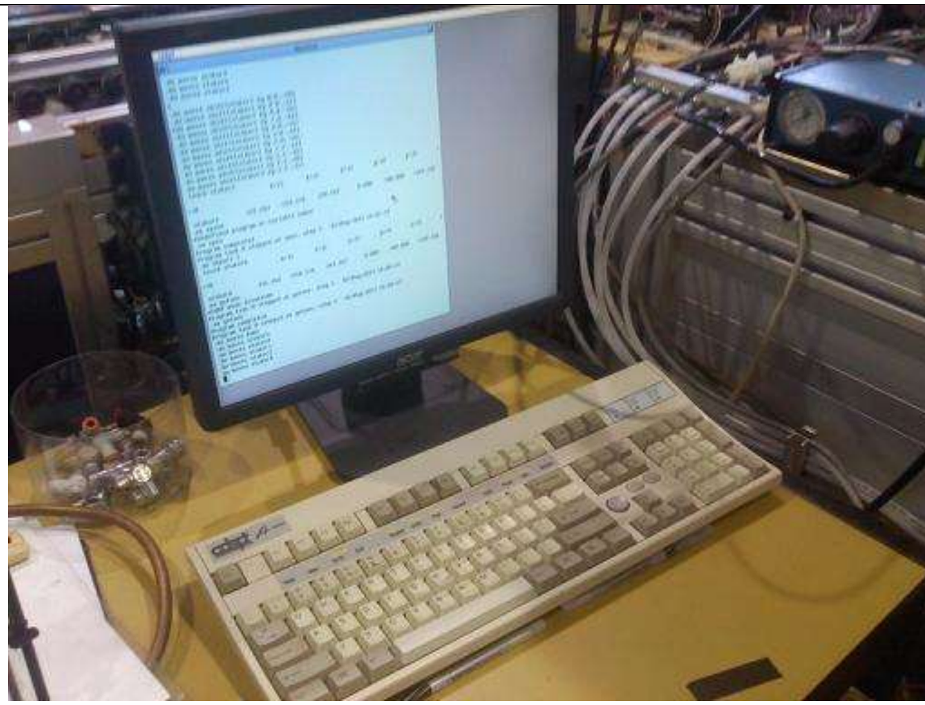
1	Turn on the heating elements for the tank on the hot glue machine to 300. When the LED above the dial flashes orange, it has reached temperature. This will take approximately 20 minutes.		
2	Once the tank has been heated, turn on the heating elements for Hose 1 on the hot glue machine to 300. When the LED above the dial flashes orange, it has reached temperature.		

3	Press the “Power On” button on the side of the Adept workspace.	
4	Turn on the monitor of the computer. Press “Enter” on the keyboard when the display reads “Load from Disk (D).”	

5	Enable pneumatics by engaging the two valves behind the machine.	
6	While the computer boots, place the pallets, feeders, and fixtures onto the workspace, as shown.	

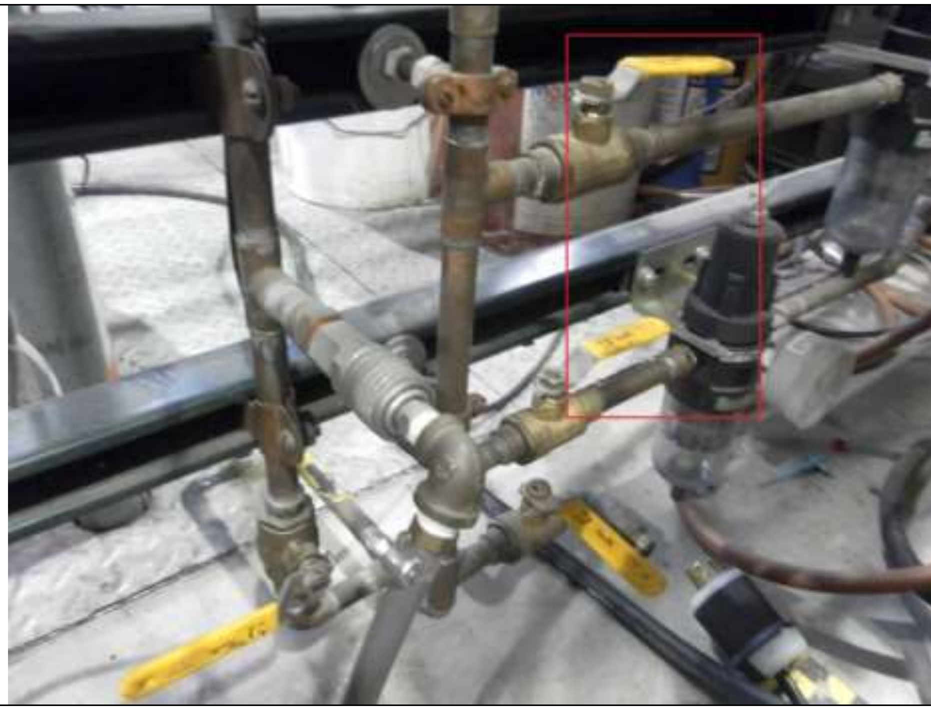
7	Ensure pneumatic signals are attached, as specified.	Ultrasonic Welding: SIGNAL 43 Tool Change: SIGNAL 8 Single Suction: SIGNAL 42 Double Suction: SIGNAL 37 Clipper: SIGNAL 7 Wait SIGNAL (-1034) Limit Switch (-1041) SIGNAL 48: Train Station #1 (on Adept pneumatics) SIGNAL 47: Train Station #3 (on Adept pneumatics)
8	When loading the motor pallet, motors must be oriented alternating and 180° apart, with the motor straps fitting down into the pallet, as shown. Place 12 motors in the pallet.	

9	Place 12 battery holders into the pallet in their respective places, with the red wire facing out, as shown.	
10	Load 12 lower bases into the lower base feeder, with the channel for the front support facing the front of the feeder, as shown.	

11	When the monitor is done loading the software, type "Load FWheelXX" where XX is a two digit number. Consult Robert McDonald or Michael Snyder for the latest revision (currently 16). Once the code has been loaded, type "ex basecode" to begin the program.	
12	The robot will run its cycle. If at any point the robot should collide with a fixture, be sure to press the E-Stop button on the pendant. To re-engage the robot after the E-Stop button on the pendant has been pressed, see the following instructions. Otherwise, continue to step 15.	

13	To re-engage the robot, turn the E-Stop button on the pendant clockwise until it clicks, then push the "COMP/PWR" button on the pendant.	
14	Push the flashing high power button on the control panel on the side of the base of the Adept workspace.	

15	Once completed, the robot will pick and place the part on the conveyor. Remove the finished product and place it in the finished product receptacle. To end the cycle and shut off the machine, push the E-Stop button on the pendant.	
16	Press the "Power Off" button on the side of the Adept workspace.	

17	Disable pneumatics by disengaging the two valves behind the machine.	

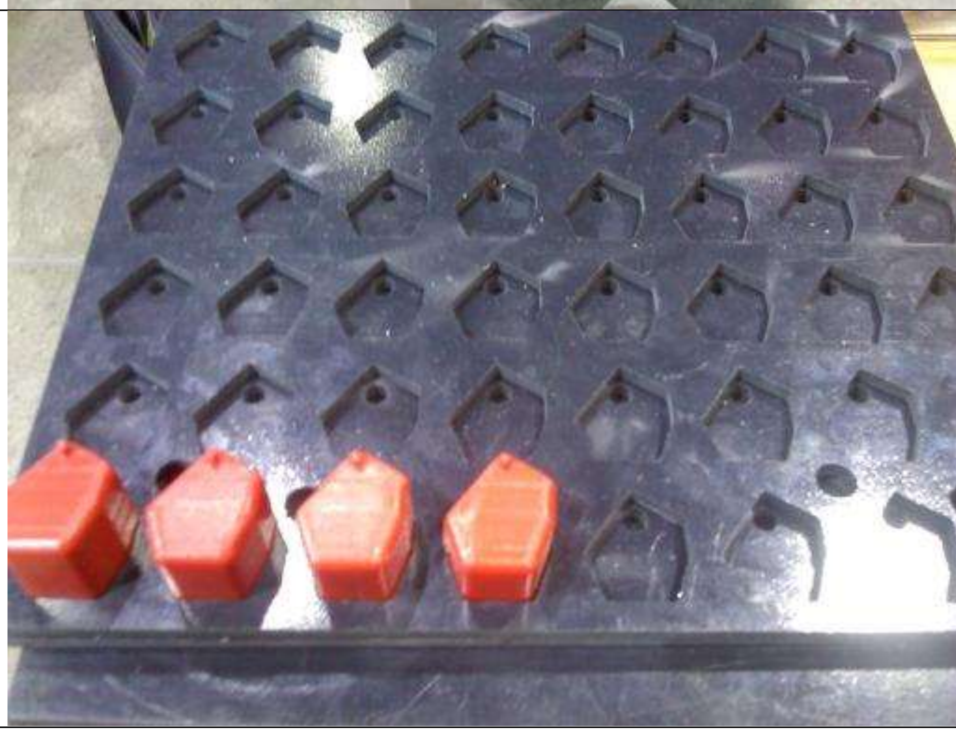
Standard Operating Procedure: Wheel Assembly

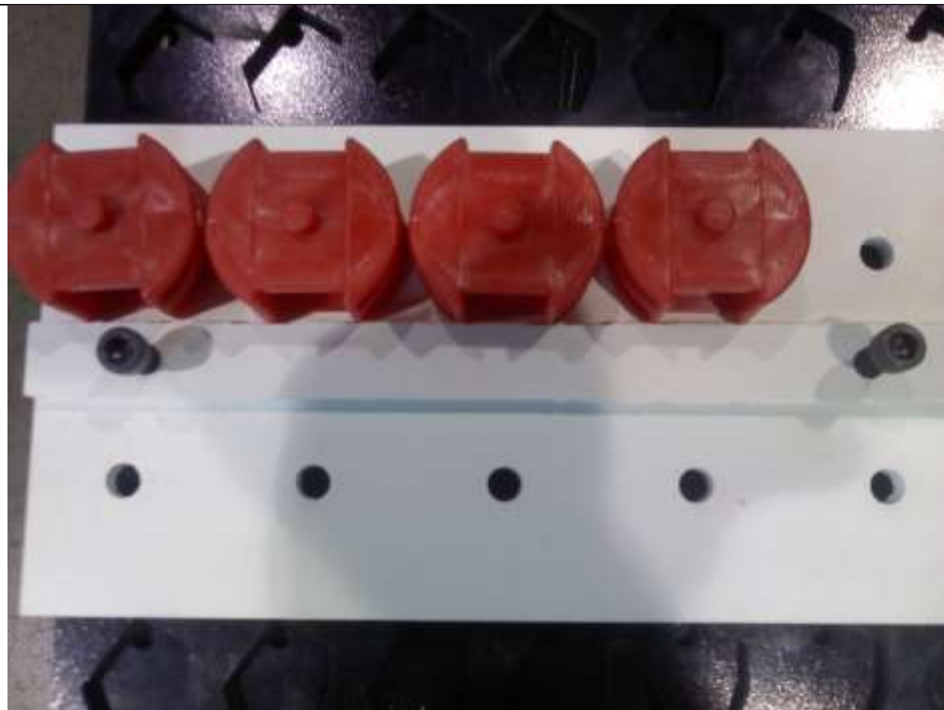
Safety Requirements:
• Safety glasses must be worn at all times. • Hearing Protection must be worn at all times. • At least two operators should be present at all times; one to perform any and all necessary manipulations of machinery, and the other to be ready with the emergency STOP button in case of emergencies. • One operator must be attentive to the robot during operation. It is necessary to have a hand on the E-STOP at all time.
Equipment Used:
Staubli Rx90 Robotic Arm
Technical Document List:
See Appendix F

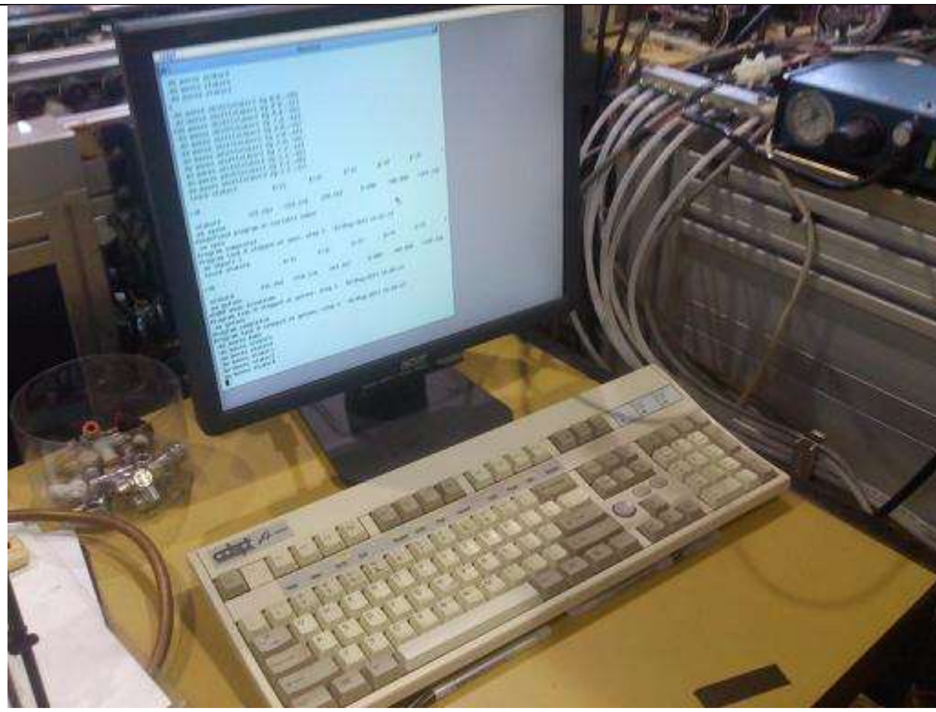
Procedure

1	Turn the I/O toggle switch attached to the plywood on the front of the Staubli to the "I" position.		
2	Turn the red and yellow switch from "Off" to "On" (so it is in the up position, as shown).		

3	Enable pneumatics by engaging the lone valve behind the machine.	
4	While the computer boots, place the pallets in the workspace.	
5	Ensure pneumatic signals are attached, as specified.	Tool Change: SIGNAL 51 Double Suction: SIGNAL 52 Single Suction: SIGNAL 39 Pneumatic Rotary: SIGNAL 49 Adept Station: SIGNAL 1 Press Station: SIGNAL 2 Lower Base Feeder: SIGNAL 54 Lower Base Sliding Fixture: SIGNAL 53 Glue: SIGNAL 34

6	When loading the jar pallet, jar lids must be inserted into the jars first. It is important that the lids be inserted and then moved to an "open" position, as shown. Place 10 jars onto the jar pallet with the lids facing down and in the orientation as shown.	
7	Ensue the tedium of loading 80 carts into their respective pallet, as shown.	

8	Load 10 dosers into their pallet, as shown.	
9	Load the struts into their respective pallets. Note: There are two stacks of struts: the rightmost one is for "face down" struts while the leftmost is for "face up" struts. Load 10 struts into each stack.	

10	When the monitor is done loading the software, type "Load FWheelXX" where XX is a two digit number. Consult Robert McDonald or Michael Snyder for the latest revision (currently 34). Once the code has been loaded, type "ex wheelcode" to begin the program.	
11	The robot will run its cycle. If at any point the robot should collide with a fixture, be sure to press the E-Stop button on the pendant. To re-engage the robot after the E-Stop button on the pendant has been pressed, see the following instructions. Otherwise, continue to step 18.	

12	To re-engage the robot, turn the E-Stop button on the pendant clockwise until it clicks. Push the "COMP/PWR" button on the pendant.	
13	Push the green, flashing high power button on the control panel on the base of the Staubli.	

14	Once the various parts have been placed into the fixture on the ultrasonic welder, the sliding fixture will slide beneath the welder. KEEP YOUR HANDS AND FACE CLEAR OF THE SLIDING FIXTURE. At this point, perform a QC check on the part.	
15	Push (and hold) the two black buttons on the base of the ultrasonic welder to bring the horn down and weld the parts together.	

16	Press the foot pedal to slide the ultrasonic welding fixture, and the product along with it, underneath the other side of the welding horn. KEEP YOUR HANDS AND FACE CLEAR OF THE SLIDING FIXTURE.	
17	Push (and hold) the two black buttons on the base of the ultrasonic welder to bring the horn down and weld the parts together.	

18	Press the foot pedal to slide the ultrasonic welding fixture, and the product along with it, toward the center of the workspace. KEEP YOUR HANDS AND FACE CLEAR OF THE SLIDING FIXTURE. Remove the finished product and press the foot pedal to begin the cycle again.	
19	To end the cycle and shut off the machine, push the E-Stop button on the pendant.	

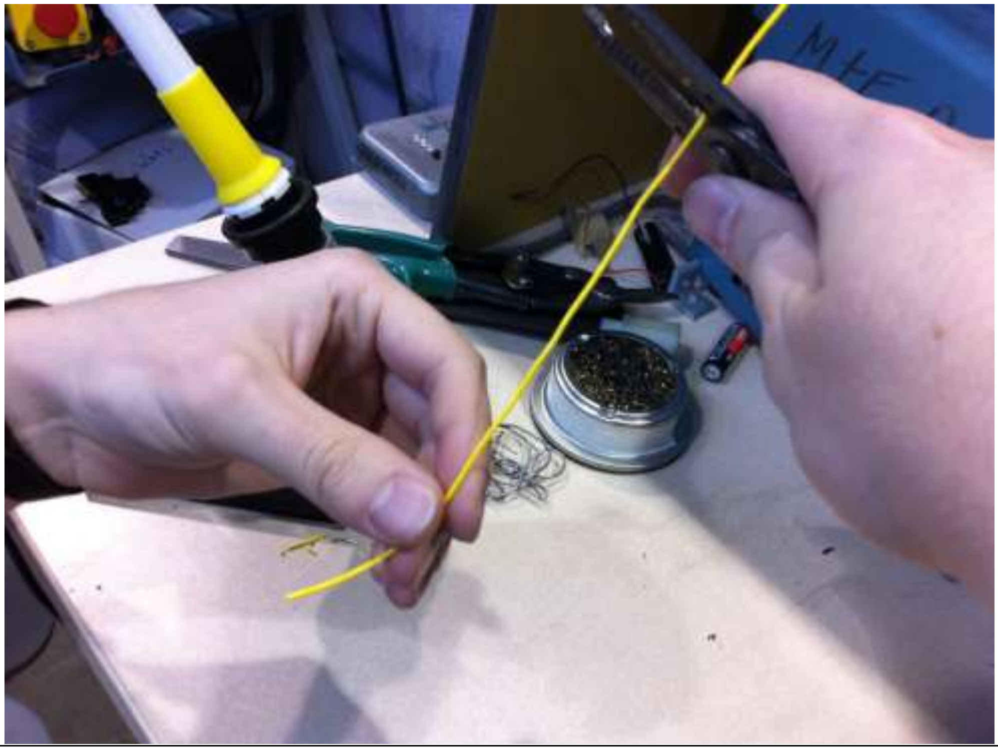
20	Turn the I/O toggle switch attached to the plywood on the front of the Staubli to the "O" position.	
21	Turn the red and yellow switch from "On" to "Off."	

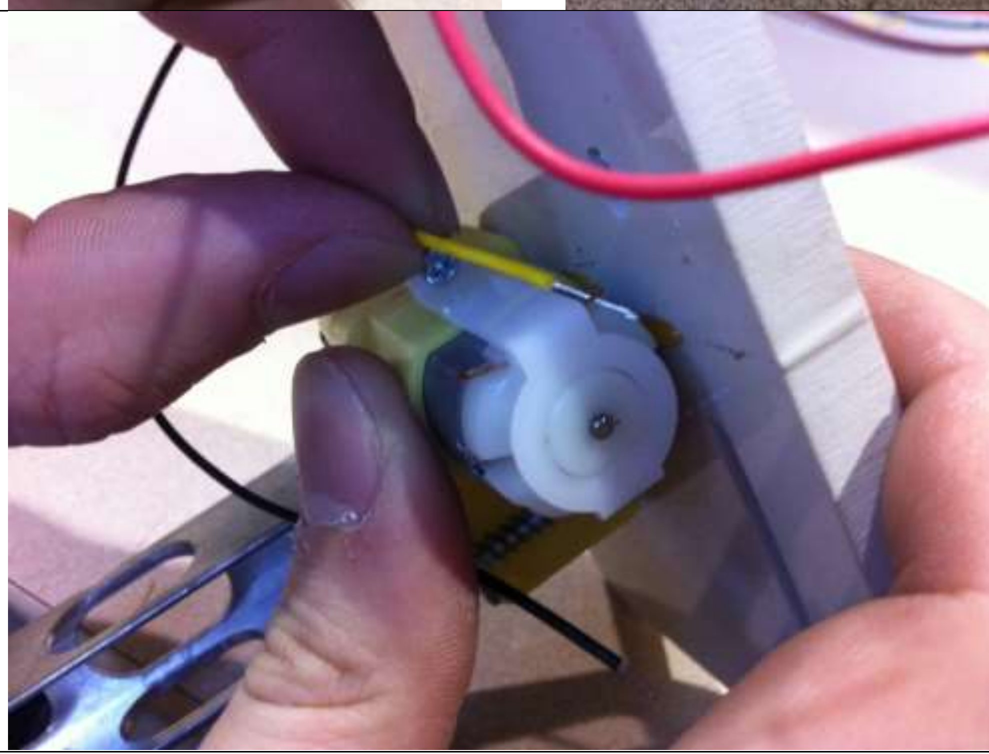
22	Disable pneumatics by disengaging the lone valve behind the machine.	

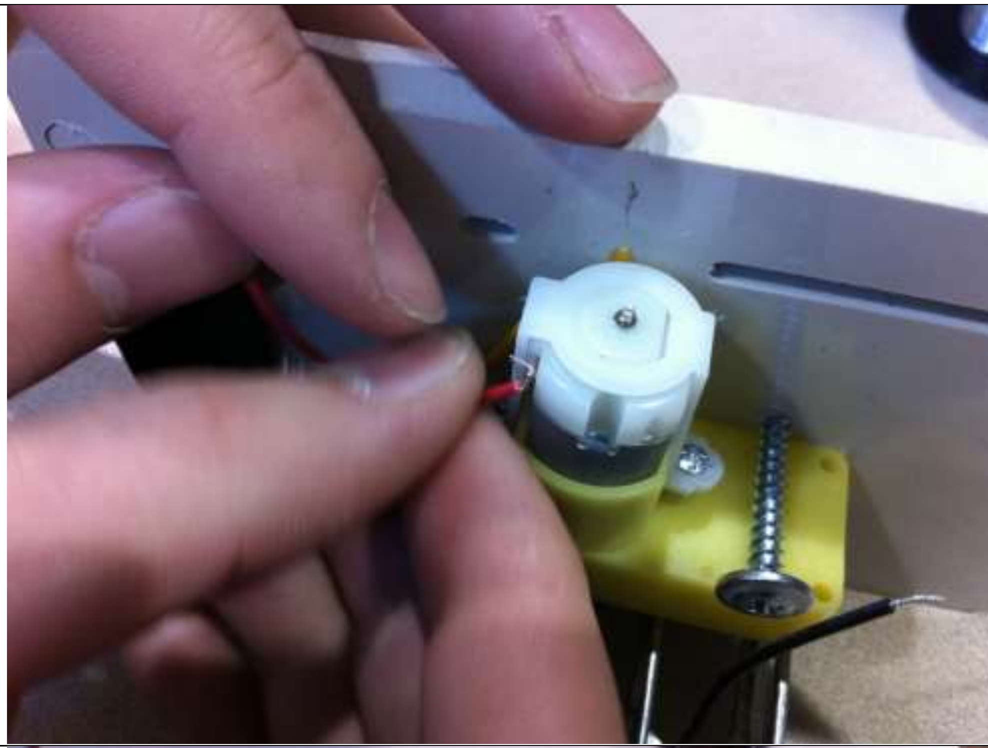
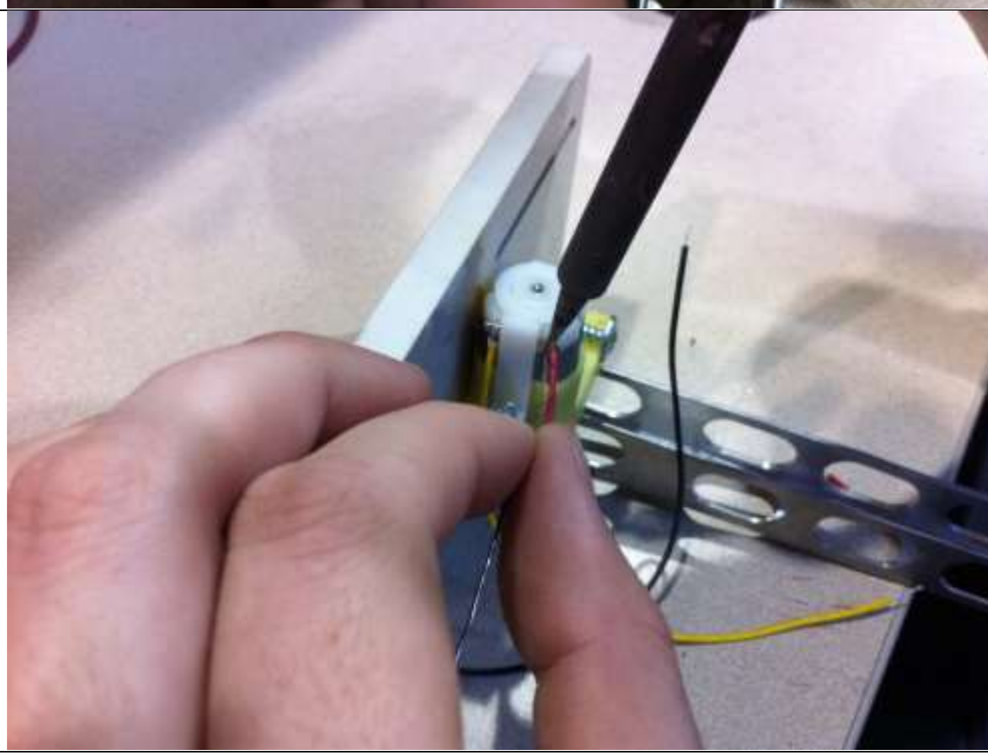
Standard Operating Procedure: Lower Base Soldering

Safety Requirements:
Safety Glasses
Equipment Used:
Wire Stripper, Soldering Iron
Technical Document List:
N/A

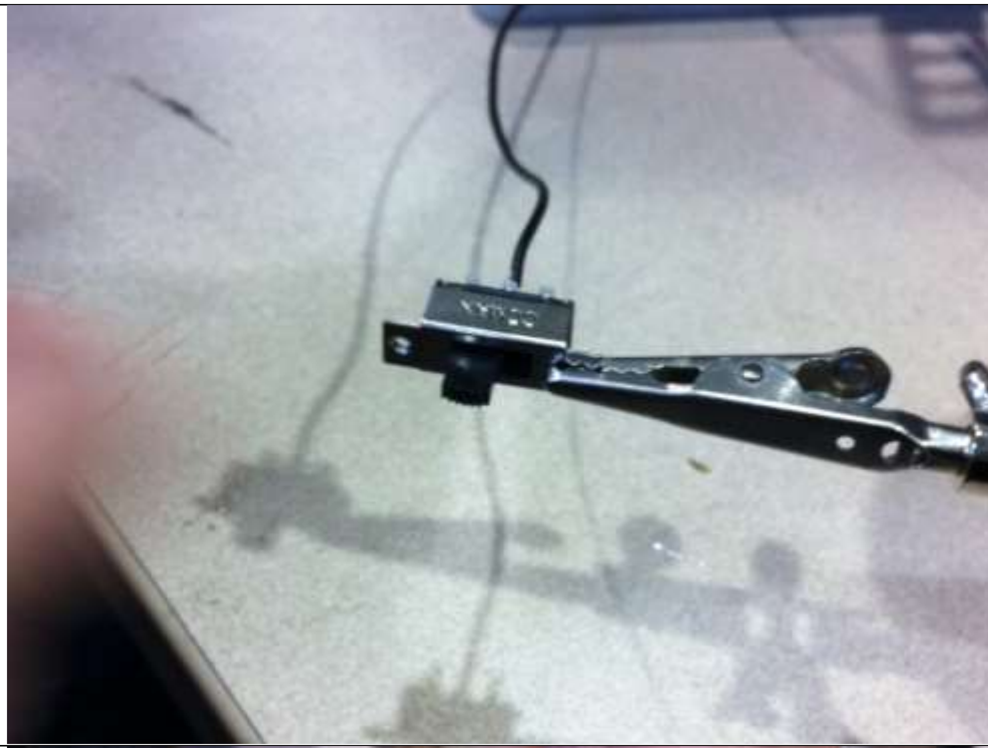
Procedure

1	Obtain a lower base assembly and a switch.	
2	Take 5 inches of wire from the spool.	

3	Strip both ends as shown.		
4	Turn the lower base on its side and connect the wire you cut (yellow) to the lower (side closest to the surface) lead of the motor.		

5	Connect the red wire from the battery holder to the upper motor lead.	
6	Solder both connections.	

7	Place a 1 inch strip of electrical tape over the leads. This prevents electrical contact with the front support.	
8	Take your helping third hand tool and position similar to image.	

9	Place the switch in the alligator clips and connect the black wire from the battery holder to the middle connection.	
10	Solder the black wire to its connection.	

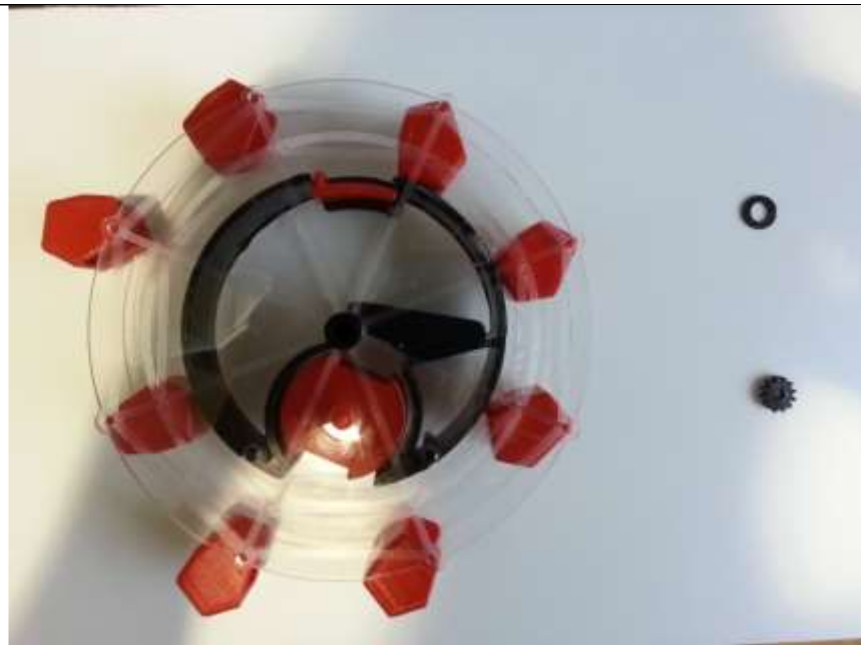
11	Connect the other end of the yellow wire to the left of the black connection.	
12	Solder the yellow wire to its connection.	

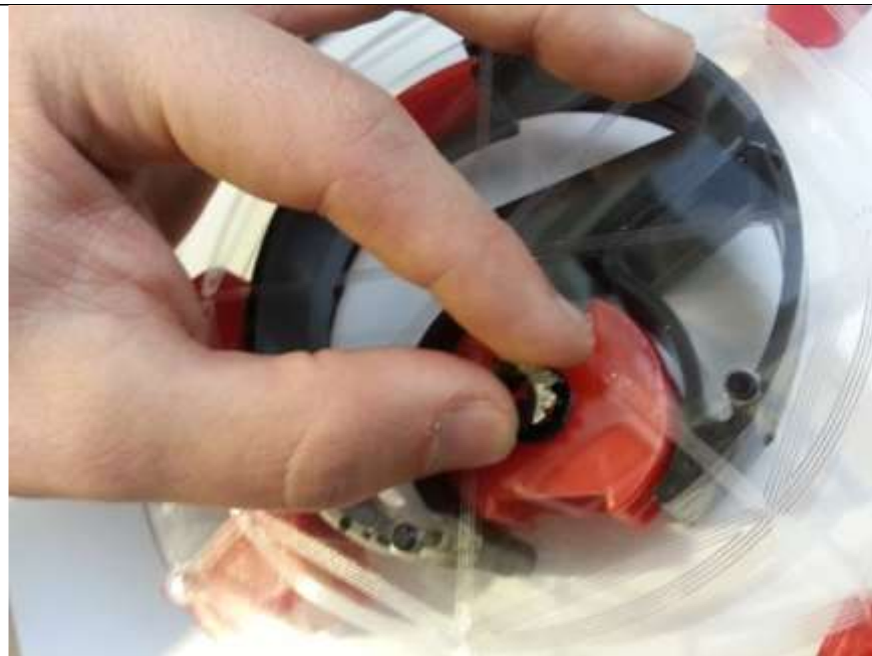
Cleanup

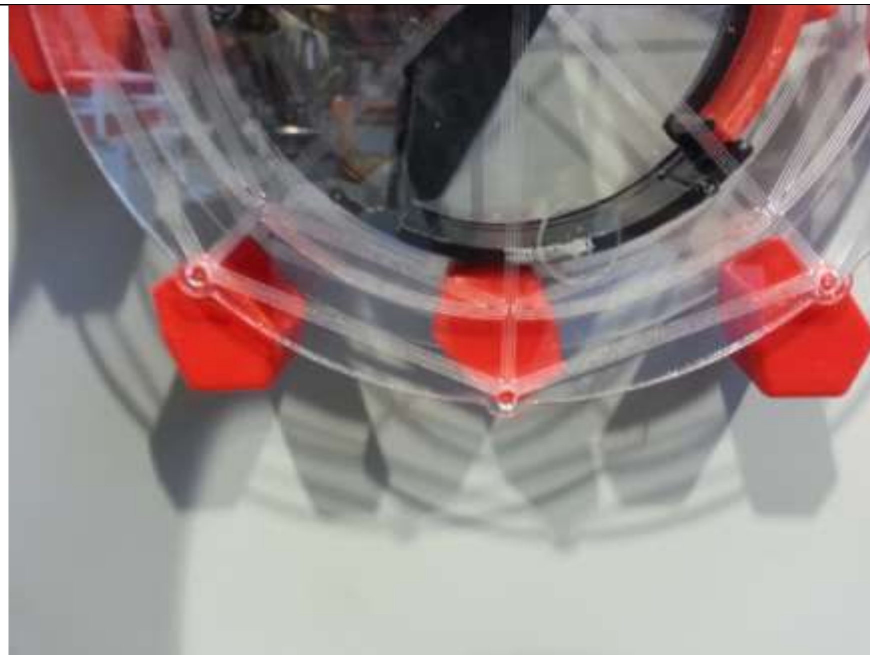
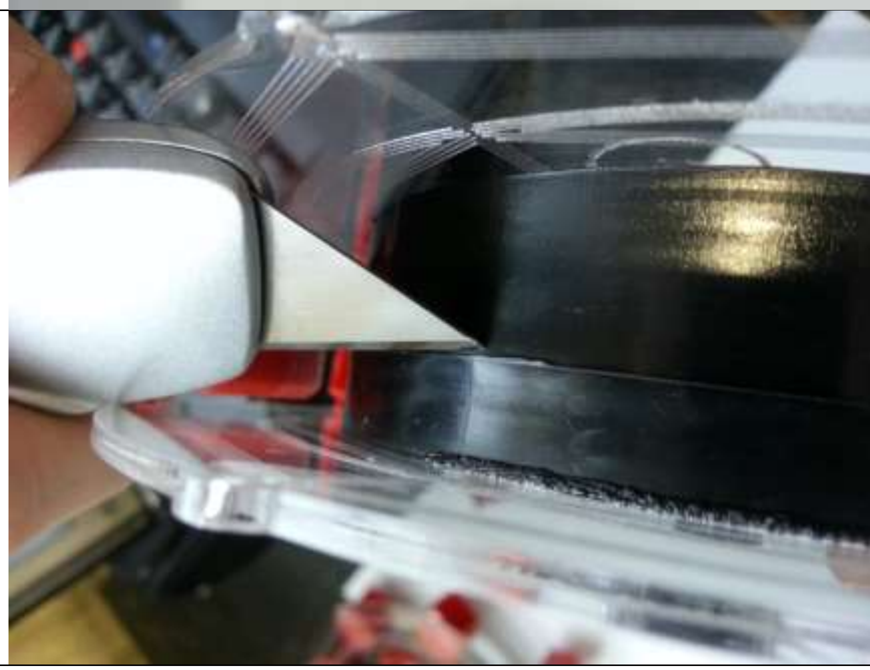
When you are done, unplug the soldering iron and let it cool. Clean up any wire trimmings from you workspace.

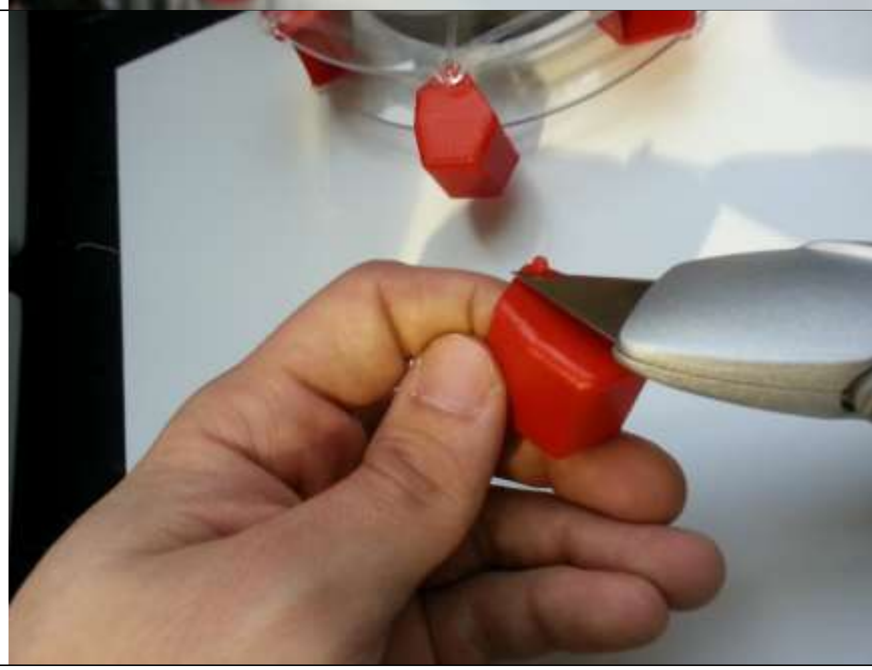
Standard Operating Procedure: Wheel Assembly Quality Control

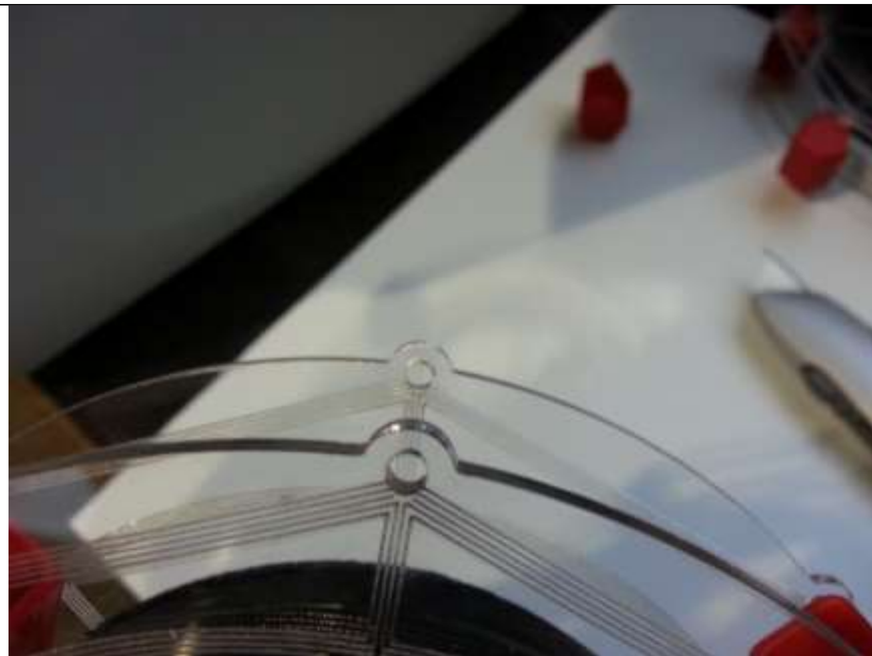
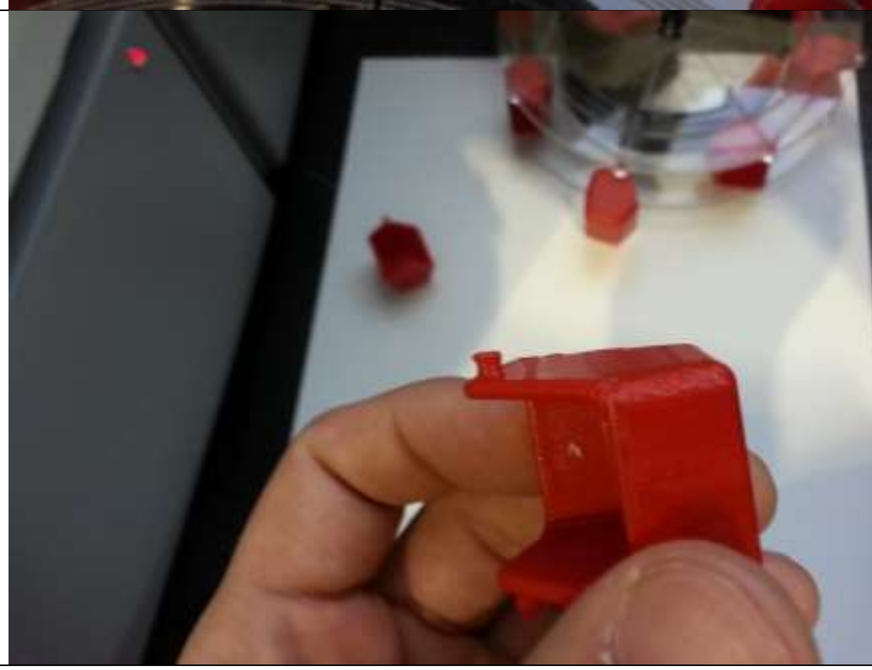
Process: Quality Control
Tool: Knife
Stock: Wheel Assembly

1	Acquire Candy Wheel, Washer, and Main Gear.	
2	With the Candy Wheel face up on a surface, place the washer over the doser shaft.	

3	Press the Main Gear onto the shaft, over the washer.	
4	Hold the Candy Wheel by the jar center shafts and rotate it to ensure that the cars all move.	

5	If a cart gets stuck against the jar, see step 6. If not continue to step 11.	
6	Trim any flashing that exists on the jar.	

7	If a cart continues to get stuck, trim the bottom face of the cart where it interfaces with the jar.	
8	If the cart gets stuck in any other position, remove the cart and trim the flashing on the side of the cart and on the pin.	

9	It may also be necessary to inspect the hole in the strut that mates with the pin. If a snag from lead-in exists, trim that as well.	
10	If any of the carts have pins that have been deformed, remove the cart, throw it away, and insert a new, trimmed cart.	

11	Check that the jar lid opens and closes smoothly.	
12	If the jar lid does not open or close smoothly, slide a razor between the jar lid and the struts to trim the lid. DO NOT deface the strut.	

13	Check that the doser turns smoothly.	
14	If the doser does not turn smoothly, ***.	
15	When the QC check has been completed, place the Candy Wheel in the proper storage unit.	

Appendix C: Laser Study

To ascertain the tolerance of the Hurricane Laser cutting machine, Team Member Seth Wraight performed a study of 60 different laser cut holes and their blanks. Measuring each hole and blank, he was able to ascertain a tolerance for the machine of 0.0030. It should be noted that the nominal hole size (the value as specified by the CAD drawing) was 0.2784, which is greater than most, but not all of the measured holes. The maximum difference from the nominal (largest value greater than the nominal value) was 0.0018. The absolute value of the minimum difference from the nominal (smallest value less than the nominal value) was 0.0022. Tolerances, however, were determined using the 3σ rule. Considering the maximum and minimum values of 0.0018 and 0.0022 are within the determined tolerance of 0.0030, the accuracy is sufficient. To the right is a listing of the values that were measured. For complete laser data, see Appendix B.

Part	Nominal Size	Average Hole Diameter	Difference from Nom.
1	0.2784	0.2778	-0.0006
2		0.2762	-0.0022
3		0.2778	-0.0006
4		0.2771	-0.0013
5		0.2782	-0.0002
6		0.2802	0.0018
7		0.2773	-0.0011
8		0.2773	-0.0011
9		0.2797	0.0013
10		0.2781	-0.0003
11		0.2780	-0.0004
12		0.2793	0.0009
13		0.2782	-0.0002
14		0.2770	-0.0014
15		0.2787	0.0002
16		0.2783	-0.0001
17		0.2766	-0.0018
18		0.2768	-0.0016
19		0.2771	-0.0013
20		0.2764	-0.0021
21		0.2784	0.0000
22		0.2766	-0.0018
23		0.2771	-0.0013
24		0.2779	-0.0005
25		0.2773	-0.0011
26		0.2772	-0.0012
27		0.2765	-0.0019
28		0.2767	-0.0017
29		0.2769	-0.0015
30		0.2767	-0.0017
Minimum Difference			-0.0022
Maximum Difference			0.0018
Average		0.2776	
Standard Dev.		0.0010	
3Sigma Tolerance		0.0030	

Appendix D: Complete Laser Data

Part	Hole 1	Hole 2	Hole difference	OD 1	OD 2	OD Difference
1	0.27685	0.2787	0.00185	0.2698	0.2697	1E-04
2	0.2757	0.2767	0.001	0.2694	0.26955	0.00015
3	0.27615	0.2795	0.00335	0.26955	0.2694	0.00015
4	0.2772	0.277	0.0002	0.26885	0.26975	0.0009
5	0.2774	0.2789	0.0015	0.2695	0.26965	0.00015
6	0.2802	0.2802	0	0.26975	0.2698	5E-05
7	0.2786	0.276	0.0026	0.2704	0.2709	0.0005
8	0.276	0.27855	0.00255	0.26965	0.27025	0.0006
9	0.27825	0.2811	0.00285	0.27155	0.2705	0.00105
10	0.27935	0.2768	0.00255	0.27005	0.2688	0.00125
11	0.27715	0.27875	0.0016	0.2699	0.2695	0.0004
12	0.28075	0.2778	0.00295	0.2705	0.27155	0.00105
13	0.2771	0.2793	0.0022	0.26965	0.2711	0.00145
14	0.27735	0.2766	0.00075	0.26945	0.2703	0.00085
15	0.2789	0.2784	0.0005	0.271	0.27025	0.00075
16	0.27835	0.2783	5E-05	0.26875	0.27005	0.0013
17	0.2769	0.2763	0.0006	0.26905	0.26925	0.0002
18	0.27695	0.2767	0.00025	0.26955	0.2716	0.00205
19	0.27765	0.2766	0.00105	0.26885	0.2704	0.00155
20	0.27525	0.27745	0.0022	0.26925	0.2694	0.00015
21	0.2767	0.2801	0.0034	0.27045	0.26985	0.0006
22	0.2765	0.2766	1E-04	0.2688	0.27015	0.00135
23	0.277	0.2772	0.0002	0.27005	0.2694	0.00065
24	0.27625	0.2796	0.00335	0.2708	0.27005	0.00075
25	0.27655	0.278	0.00145	0.2707	0.2697	0.001
26	0.27785	0.27645	0.0014	0.27085	0.27025	0.0006
27	0.2755	0.2775	0.002	0.26995	0.2713	0.00135

28	0.2761	0.27725	0.00115	0.26905	0.27055	0.0015
29	0.2756	0.27825	0.00265	0.2709	0.26985	0.00105
30	0.2758	0.27765	0.00185	0.2702	0.27055	0.00035
Average	0.277196667	0.277941667	0.001605	0.269873333	0.270111667	0.000795
Standard Dev	0.00136198	0.001321512	0.001090504	0.00074124	0.000684897	0.000526431
Max	0.28075	0.2811	0.0034	0.27155	0.2716	0.00205
Min	0.27525	0.276	0	0.26875	0.2688	5E-05
Range	0.0055	0.0051	0.0034	0.0028	0.0028	0.002

Appendix E: Base Assembly Code (Adept)

(Assumes all fixtures and components are in proper locations in robotic envelope)

```
.PROGRAM basecode()
        MOVES safe
        BREAK

        SIGNAL -49
        DELAY 1 ;robot arm needs to start cycle at safe, and proper orientation

        SET motor_store = motor_store_i
        SET battery_store = battery_store_i ;SETs ensure first loop picks up from first pallet locations

        FOR t = 1 TO 12 STEP 1 ;open loop to 12 lower bases w/o stopping
        SIGNAL 1
        DELAY 1

        SIGNAL -1 ;sends cart away from Adept Station, brings in empty cart

        SIGNAL -3 ;stops train in Pickup Station

        SIGNAL -54
        DELAY 1

        SIGNAL 54
        DELAY 1 ;shifts a lower base from the stack to the fixture

        APPROS base_temp, 50
        BREAK

        MOVES base_temp
        BREAK

        SIGNAL 52
        SIGNAL 39
        DELAY 1

        DEPART 50
        BREAK

        MOVES safe
        BREAK

        APPROS base_first, 50
        BREAK

        MOVES base_first
        BREAK

        SIGNAL -52
        SIGNAL -39
        DELAY 1

        DEPART 120
        BREAK ;rotates lower base to proper orientation in fixture
```

```
IF t < 8 THEN
        IF t > 6 THEN
                SET motor_store = motor_store_i2
        END
END ;shifts motor pickup to second row after the first 6

APPROS motor_store, 120
BREAK

MOVES motor_store
BREAK

SIGNAL 52
DELAY 1

DEPART 120
BREAK ;pick up motor

APPROS motor_local, 120
BREAK

SET motor_store = SHIFT(motor_store BY -61,0,0) ;SET to pick up next motor on subsequent loop
TIMER 1 = 0

SIGNAL -53
WAIT TIMER(1) > 4.3

SIGNAL -56
WAIT TIMER(1) >         5.7

SIGNAL 56
SIGNAL 53
WAIT TIMER(1) > 6.9 ;applies glue to lower base

MOVES motor_local
BREAK

SIGNAL -52
DELAY 1

DEPART 50
BREAK ;places motor into glue

APPROS base_first, 50
BREAK

MOVES base_first
BREAK

SIGNAL 52
DELAY 1

MOVES base_second
BREAK

SIGNAL -52
DELAY 1
```

```
DEPART 120
BREAK ;robotic arm grabs and shifts the fixture to secondary position

APPROS battery_store, 120
BREAK

MOVES battery_store
BREAK

SIGNAL 39
DELAY 1

DEPART 120
BREAK ;pick up battery holders

APPROS battery_local, 120
BREAK

SET battery_store = SHIFT(battery_store BY -30.5,0,0) ;SET to pick up next battery holder on subsequent loop
TIMER 2 = 0

SIGNAL -53
WAIT TIMER(2) > 4.3

SIGNAL -56
WAIT TIMER(2) > 5.7

SIGNAL 56
SIGNAL 53
WAIT TIMER(2) > 6.9 ;apply glue to lower base

MOVES battery_local
BREAK

SIGNAL -39
DELAY 1

DEPART 50
BREAK ;place battery holder onto lower base

SIGNAL 3
DELAY 1

SIGNAL -3 ;lets train leave Pickup Station, stops next train to arrive

APPROS base_second, 50
BREAK

MOVES base_second
BREAK

SIGNAL 52
SIGNAL 39
DELAY 1

DEPART 50
BREAK ;picks up entire lower base subassembly
```

```
    MOVES safe
    BREAK

    MOVES train_path
    BREAK

    APPROS base_train, 50
    BREAK

    MOVES base_train
    BREAK

    SIGNAL -52
    SIGNAL -39
    DELAY 1

    DEPART 50
    BREAK ;places entire lower base subassembly onto train

    MOVES train_path
    BREAK

    MOVES safe
    BREAK
END
```

Appendix F: Wheel Assembly Code (Staubli)

(Assumes all fixtures and components are in proper locations in robotic envelope)

Stored on Staubli as WheelCode under FWheel34

```
SET strut_store_2fd = strut_store_2di
SET strut_store_2fu = strut_store_2ui
SET cart_store_2 = cart_store_2_i
SET cart_store_1 = cart_store_1_i
SET jar_store_2 = jar_store_2_i
SET jar_store_1 = jar_store_1_i
SET doser_store_2 = doser_store_2_i
SET doser_store_1 = doser_store_1_i :SETs allow for all pallets pickup location to be reset to their initial
values

MOVES safe_suck
BREAK ;starts at safe and in suction orientation

FOR t = 1 TO 10 STEP 1 ;open loop for 10 subassembly productions

    MOVES strut_store_1fd
    BREAK

    MOVES strut_store_2fd
    BREAK

    SIG 42, 37
    DELAY 0.5

    MOVES strut_store_1fd
    BREAK

    MOVES safe_suck
    BREAK ;pick up struts using 3-point suction

    MOVES strut_local_1
    BREAK

    SET strut_store_2fd = SHIFT(strut_store_2fd BY 0,0,-2.39)

    MOVES strut_local_2
    BREAK

    MOVES strut_local_3
    BREAK

    SIG -42, -37
    DELAY 0.5

    MOVES strut_local_1
    BREAK ;places struts

    MOVES safe_suck
    BREAK
```

```
MOVES safe_clip
BREAK ;switches to clippers

IF t > 5 THEN
        IF t < 7 THEN
                SET jar_store_2 = SHIFT(jar_store_2_i BY 107.8,0,0)
                SET jar_store_1 = SHIFT(jar_store_1_i BY 107.8,0,0)
                SET doser_store_2 = SHIFT(doser_store_2_i BY 51,0,0)
                SET doser_store_1 = SHIFT(doser_store_2 BY 0,0,100)
        END
END ;SETs allow for pickup of second row on all two-row pallets

MOVES jar_store_1
BREAK

MOVES jar_store_2
BREAK

SIG 7
DELAY 0.5

MOVES jar_store_1
BREAK ;picks up jar

MOVES safe_clip
BREAK

MOVES jar_local_1
BREAK

SET jar_store_1 = SHIFT(jar_store_1 BY 0,-107.8,0)
SET jar_store_2 = SHIFT(jar_store_2 BY 0,-107.8,0)

MOVES jar_local_2
BREAK

SIG -7
DELAY 0.5

MOVES jar_local_1
BREAK ;places jar into fixture

MOVES safe_clip
BREAK

MOVES safe_suck
BREAK ;switches to suction

MOVES safe_doser
BREAK

MOVES doser_store_1
BREAK

MOVES doser_store_2
BREAK
```

```
SIG 37
DELAY 0.5

MOVES doser_store_1
BREAK

MOVES safe_doser
BREAK ;picks up doser using 2-point suction

MOVES doser_local_1
BREAK

MOVES doser_local_2
BREAK

SIG -37
DELAY 0.5

MOVES doser_local_1
BREAK

MOVES safe_cart
BREAK ;places doser

MOVES cart_store_1
BREAK

SET doser_store_2 = SHIFT(doser_store_2 BY 0,-40.68,0)
SET doser_store_1 = SHIFT(doser_store_2 BY 0,0,100)

MOVES cart_store_2
BREAK

SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart
BREAK ;picks up cart using 1-pont suction

SET cart_store_2 = (SHIFT cart_store_2 BY 30.48, 0, 0)
SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;SETs allow for pickup of next cart in row

MOVES cart_local_a1
BREAK

MOVES cart_local_a2
BREAK

SIG -42
DELAY 1

MOVES cart_local_a1
BREAK
```

```
MOVES safe_cart
BREAK ;place cart into wheel fixture (slot a)

MOVES cart_store_1
BREAK

MOVES cart_store_2
BREAK

SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart
BREAK ;picks up cart

SET cart_store_2 = (SHIFT cart_store_2 BY 30.48, 0, 0)
SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;SETs allow for pickup of next cart

MOVES cart_local_b1
BREAK

MOVES cart_local_b2
BREAK

SIG -42
DELAY 1

MOVES cart_local_b1
BREAK

MOVES safe_cart
BREAK ;place cart into wheel fixture (slot b)

MOVES cart_store_1
BREAK

MOVES cart_store_2
BREAK

SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart
BREAK ;picks up cart

SET cart_store_2 = (SHIFT cart_store_2 BY 30.48, 0, 0)
SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;SETs allow for pickup of next cart

MOVES cart_local_c1
BREAK
```

```
MOVES cart_local_c2
BREAK

SIG -42
DELAY 1

MOVES cart_local_c1
BREAK

MOVES safe_cart
BREAK ;place cart in wheel fixture (slot c)

MOVES cart_store_1
BREAK

MOVES cart_store_2
BREAK

SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart ;picks up cart

SET cart_store_2 = (SHIFT cart_store_2 BY 30.48, 0, 0)
SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;SETs allow for pickup of next cart

MOVES cart_local_d1
BREAK

MOVES cart_local_d2
BREAK

SIG -42
DELAY 1

MOVES cart_local_d1
BREAK

MOVES safe_cart
BREAK ;place cart in wheel fixture (slot d)

MOVES cart_store_1
BREAK

MOVES cart_store_2
BREAK

SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart
BREAK ;picks up cart
```

```
SET cart_store_2 = (SHIFT cart_store_2 BY 30.48, 0, 0)
SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;SETs allow for pickup of next cart

MOVES cart_local_e1
BREAK

MOVES cart_local_e2
BREAK

SIG -42
DELAY 1

MOVES cart_local_e1
BREAK

MOVES safe_cart
BREAK ;place cart in wheel fixture (slot e)

MOVES cart_store_1
BREAK

MOVES cart_store_2
BREAK

SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart
BREAK ;picks up cart

SET cart_store_2 = (SHIFT cart_store_2 BY 30.48, 0, 0)
SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;SETs allow for pickup of next cart

MOVES cart_local_f1
BREAK

MOVES cart_local_f2
BREAK

SIG -42
DELAY 1

MOVES cart_local_f1
BREAK

MOVES safe_cart
BREAK ;place cart in wheel fixture (slot f)

MOVES cart_store_1
BREAK

MOVES cart_store_2
BREAK
```

```
SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart
BREAK ;picks up cart

SET cart_store_2 = (SHIFT cart_store_2 BY 30.48, 0, 0)
SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;SETs allow for pickup of next cart

MOVES cart_local_g1
BREAK

MOVES cart_local_g2
BREAK

SIG -42
DELAY 1

MOVES cart_local_g1
BREAK

MOVES safe_cart
BREAK ;place cart in wheel fixture (slot g)

MOVES cart_store_1
BREAK

MOVES cart_store_2
BREAK

SIG 42
DELAY 0.5

MOVES cart_store_1
BREAK

MOVES safe_cart
BREAK ;picks up cart

MOVES cart_local_h1
BREAK

MOVES cart_local_h2
BREAK

SIG -42
DELAY 1

MOVES cart_local_h1
BREAK

MOVES safe_cart
BREAK ;place cart in wheel fixture (slot h)
```

```
    SET cart_store_2 = (SHIFT cart_store_2 BY -213.36, 35.56, 0) ;SETs allow for pickup of next…
    SET cart_store_1 = (SHIFT cart_store_2 BY 0, 0, 50) ;…row of carts on subsequent loop


    MOVES strut_store_1fu
    BREAK

    MOVES strut_store_2fu
    BREAK

    SIG 42, 37
    DELAY 0.5

    MOVES strut_store_1fu
    BREAK

    MOVES safe_suck
    BREAK ;pick up struts

    MOVES strut_local_1
    BREAK

    SET strut_store_2fu = SHIFT(strut_store_2fu BY 0,0,-2.36)

    MOVES strut_local_4
    BREAK

    SIG -42, -37
    DELAY 0.5

    MOVES strut_local_1
    BREAK ;place struts

    MOVES safe_suck
    BREAK

    SIG 43

    WAIT SIG(-1041)

    SIG -43 ;shift under welder, position 1

    WAIT SIG(-1034) ;wait for signal from operator that weld is complete

    TIMER 1 = 0
    SIG 43
    WAIT TIMER(1) > 1
    SIG -43 ;shift under welder, position 2

    WAIT SIG(-1034) ;wait for signal from operator that weld is complete

    TIMER 2 = 0
    SIG 39
    WAIT TIMER(2) > 2.2
    SIG -39 ;shift out from under welder

    WAIT SIG(-1034) ;wait for signal from operator that finished wheel is removed from fixture

END ;end assembly loop
```

Appendix G: Air Cylinder Force Calculations

As each air cylinder expands and contracts, a certain force is applied based on total air pressure and the cross sectional area of the cylinder itself. In order to make sure each cylinder won't fail under pressure, the maximum force that each cylinder can sustain must be calculated. Equation 1 shows the equation necessary to find these values.

$$P(psi) * A(in^2) = F(lbf)$$

where $A = \frac{\pi d^2(in)}{4}$

Equation 1: Air Cylinder Force Calculations

Each of the Bimba Original-Line Cylinders has the following profile and the following values were calculated from the properties given.

Cylinder Designator	Diameter(inches)	Stroke Length(in)	Area(in^2)	Pressure(psi)	Force(lbf)
BIMBA012D	7/16	2	.15	90	13.5
BIMBA176DXNR	1.5	6	1.767	90	159.04

Table 1: Properties of Original-Line Air Cylinders

Appendix H: Naming Conventions and Key

Considering that there are approximately 100 discrete units (CAD files, Drawing files, CAM files, etc.), it is imperative that a naming convention be developed to keep different parts in order.

YY PPPPP T __ CCCCC __ XXXX __ RR MM DD

Above is a conceptual example of a hypothetical part. In this case…

YY is the two digit year of the project, i.e., "12"

PPPPP is the name of the project, i.e., "Candy"

T is a single letter which denotes the team, i.e., "A"

CCCCC is a word which informs of the particular component, i.e., "Cart"

XXXX is a tag attached to the component consisting of letters and numbers which will denote the type of component.

--	C, PC
1, 2	T
2	HM, HL
3	QC
4	AWJ
5	LC

C is a component which is created by the team

PC is a purchased component

T is a tool such as a mold or a mill used in the creation of a product

HM is Haas Mill CNC Code

HL is Haas Lathe CNC Code

QC is a quality control gauge

AWJ is abrasive waterjet code (.ord file extension)

LC is lasercut code (.ecp, .g00, .ini file)

AF is an assembly fixture

RE is a robotic extension

RR is the revision number, i.e., “01”

MM is the month of the last update, i.e., “12” for December

DD is the day of the last update, i.e., “07” for the 7th

Appendix I: Manufacturing CAD Drawings

Appendix J: Assembly CAD Drawings

References

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