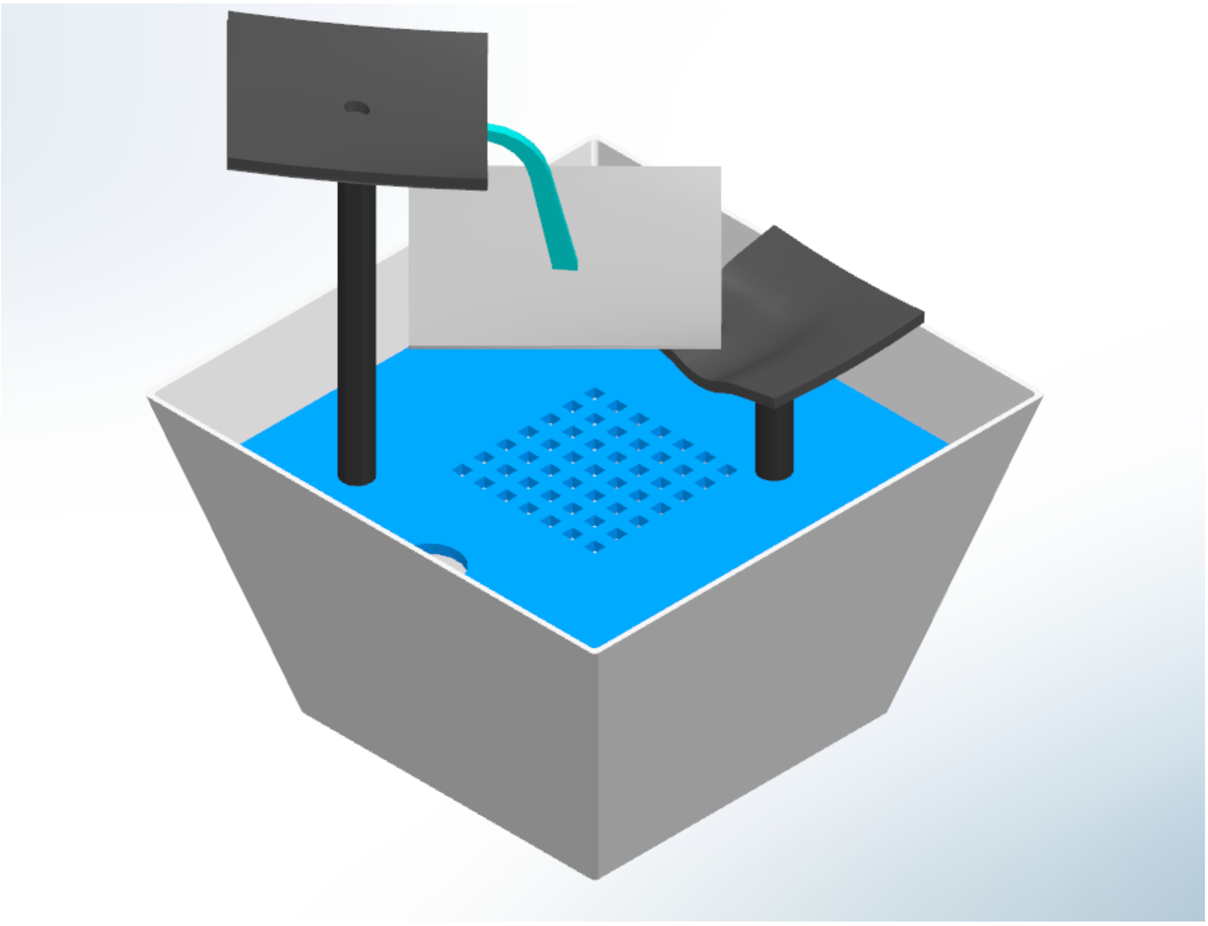
Rensselaer Polytechnic Institute Department of Mechanical, Aerospace, and Nuclear Engineering
Manufacturing Processes & Systems Laboratory
Spring 2023 Team C

Technical Data Package

The Magic Fountain

April 26, 2023



Team Members

Fall 2022 Team Members

Nick Porter - Project Manager
Abdullah Abid - Packaging Engineer
Katie Cornell - Assembly Manager
James Johnson - Hard Automation Engineer
Kenen Otake - Programming Engineer
Rees Kelley - Financial/Procurement Manager
Anthony Mazzella - Process Engineer
Dan Myers - Part Transfer Engineer
Nico Nigohosian - Manufacturing Manager
Kate O’Reilly - Information Manager
Nate Spina - Plastics Engineer

Spring 2023 Team Members

Nick Porter - Project Manager
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Rees Kelley - Financial/Procurement Manager
Anthony Mazzella - Process Engineer
Dan Myers - InformationTechnology Manager and Part Transfer Engineer
Nico Nigohosian - Manufacturing Manager
Kate O’Reilly - Technical Data Package Manager
Nate Spina - Plastics Engineer

Revision History

Revision	Date	Author	Reason
1.0	9-9-2022	Kate O'Reilly	Initial documentation with basic organization, Table of Contents, Executive Summary placement
1.1	9-11-2022	Nick Porter	Full implementation of Executive Summary
1.2	9-11-2022	Nick Porter	Added Sponsor and Teaching Team Acknowledgements
1.3	9-12-2022	Daniel Myers Abdullah Abid	Added content into the Benchmarking section, along with a comparison table.
1.4	9-13-2022	Anthony Mazzella	Added to manufacturing methods section up to 2.4.5
1.5	9-14-2022	Rees Kelley	Added Budget
1.6	9-14-2022	Nicolas Nigohosian	Added engineer drafts to section 3.2, and included assembly picture to title page.
1.7	9-14-2022	Katie Cornell	Added Product Description section 2.3
1.8	9-14-2022	James Johnson	Added sections 2.4.5 and 2.4.6 in Proposed Manufacturing Methods. Minor edits for grammar/clarity in sections 2.3 and 2.4
1.9	9-14-2022	Kenen Otake	Added section 2.1.1 Product Selection
1.10	9-15-2022	Nicolas Nigohosian	Added wire frame models to section 2.3
1.11	9-19-2022	Nicolas Nigohosian	Added colors to engineer drafts, as well as organized models and made lines bolder in section 2.3
1.12	9-20-2022	Daniel Myers	Added labels and arrows to deconstructed fountain and added name of fountain
1.13	9-20-2022	James Johnson	Added *Table 2.4: Manufacturing Overview* to the Proposed Manufacturing section. Edited section 2.3.7 to mention the possibility of LEDs depending on remaining budget. Rearranged the part order in section 2.4 to match 2.3
1.14	9-21-2022	Kate O'Reilly	Final edits for Milestone 1

		Nick Porter	
1.15	10-2-2022	Nicolas Nigohosian	Began Section 4 - Manufacturing and adding table to exploded view
1.16	10-3-22	Anthony Mazzella	Amended section 2.4 to meet milestone 1 feedback
1.17	10-5-22	James Johnson	Edited sections 2.3 and 2.4 based on milestone 1 feedback
2.0	10-11-22	Nick Porter	Editing Milestone 1 based on given feedback, finalizing processes, full readthrough
2.1	10-12-22	Kate O'Reilly	Began Section 5 - Assembly; final edits to Milestone 1 sections
2.2	10-12-22	Kenen Otake	Edited Section 2.4.1 Grate Material
2.3	10-12-22	Daniel Myers Nick Porter	Added sections 4.2 and 4.4 Top and End Bowl manufacturing templates, Plastic Injection mold tooling template
2.4	10-14-22	Kenen Otake	Added Section 4.6 Grate manufacturing template
2.5	10-14-22	Katie Cornell	Added Section 2.5 Assembly overview and flow chart
2.6	10-14-22	James Johnson	Added sleeve manufacturing template to section 4 Updated sleeve material and cost in section 6.1 Minor revisions to sleeve descriptions in section 2.3.5
2.7	10-14-22	Abdullah Abid	Added Section 2.6 Packaging
2.8	10-18-22	Kate O'Reilly	Final edits for Milestone 2
2.9	10-18-22	Anthony Mazzella	Added Section 4.3 Middle Bowl Manufacturing Template and Tooling
2.10	10-18-22	Rees Kelley	Added Pipe manufacturing Template
2.11	10-19-22	Nick Porter	Added Top and End Bowl MoldFlow Simulations
3.0	11-30-22	Kate O'Reilly	Editing based on Milestone 2 feedback. Removed sleeves; added pump connector.
3.1	12-3-22	Nick Porter	Added Standard Operating Procedures Section
3.2	12-4-22	Nicolas Nigohosian	Updating pictures of newer models and including engineering drawings for each component
3.3	12-4-22	Daniel Myers	Updated pictured with newer models and changed up

			bridge manufacturing sheet
3.4	12-4-22	Nick Porter	Added Technical Challenges Encountered and Solutions
3.5	12-4-22	Daniel Myers	Updated MoldFlow Simulations based off of the new designs, added description for simulations shown
3.6	12-4-22	Abdullah Abid	Updated Packaging Section, Adding label to the cardboard box.
3.7	12-5-22	James Johnson	Minor Corrections and Revisions to Section 2.4
3.8	12-5-22	Nick Porter	Added Prototype Testing Section
3.9	12-5-22	Rees Kelley	Updated Budget
3.10	12-5-22	Nick Porter	Added Ramping Up Section
3.11	12-5-22	Rees Kelley	Updated BOM
3.12	12-6-22	James Johnson	Added Sheet 7.2. Edited Sheet 6.2.
3.13	12-6-22	Katie Cornell	Imported Assembly Sheets and Drawings
3.14	12-6-22	Katie Cornell	Updated Assembly Flowchart and Assembly Overview
3.15	12-6-22	Anthony Mazzella	Added Middle Bowl Assembly Sheet and Drawings
3.16	12-6-22	Anthony Mazzella	Updated Middle Bowl Manufacturing Sheet
3.17	12-6-22	Anthony Mazzella	Added Middle Bowl Die and Punch Drawings
3.18	12-10-22	Nick Porter Rees Kelley	Implemented Prototype Testing Procedure and Results
3.19	12-10-22	Nate Spina	Added Multiple Drawing Sheets
3.20	12-10-22	James Johnson	Added manufacturing sheets 7.2.1, 7.2.2, and 7.3.3
3.21	12-10-22	Nicolas Nigohosian	Added drawing of press end fixture
3.22	12-10-22	James Johnson	Added updated assembly flow chart to 2.5
3.23	12-10-22	James Johnson	Fixed outdated BOM numbers/names in all manufacturing/assembly sheets. 11/26 were accurate. 15/26 were fixed.

3.24	12-10-22	Kenen Otake	Updated Sections 6.1 and 7.1 Assembly and Manufacturing sheets and Drawings
3.25	12-10-22	James Johnson	Updated BOM names/numbers on sheets to reflect newest version of BOM
3.26	12-10-22	Kenen Otake	Added Pump to Connection Assembly Drawings and Fixture Drawings to Section 3.2
3.27	12-10-22	Kenen Otake	Edited Section 9.2.1 Pump Assembly Standard Operating Procedure
4.0	2-21-23	Kate O'Reilly	Updated SOPs for manufacturing processes
4.1	2-22-23	Nicolas Nigohosian	Updated Component drawings
4.2	2-22-23	Nick Porter	Updated New Challenges Encountered and Solutions for Manufacturing
4.3	2-22-23	Katie Cornell	Updated New Challenges Encountered and Solutions for Assembly
4.4	2-22-23	Katie Cornell	Updated Exploded View Assembly Drawings
4.5	2-22-23	Abdullah Abid	Updated Assembly Fixture Drawings
4.6	2-23-23	Rees Kelley	Updated Budget and BOM
4.7	2-23-23	Nick Porter	Updated Future Work
4.8	4-5-23	Kate O'Reilly	Formatting changes. Updated SOP sections
4.9	4-10-23	Kate O'Reilly	Updated SOPs. Edited manufacturing sheets
4.10	4-20-23	Nick Porter	Updated Middle Bowl Manufacturing Sheet, Technical Challenge 10.1.3, Standard Operating Procedures
4.11	4-24-23	Nicolas Nigohosian	Added Assembly 4 Challenges 10.2.5, Basin Mold tooling sheet update, Basin Manufacturing Sheet
4.12	4-24-23	James Johnson	Updated drawings, assembly sheets, and manufacturing sheets for assemblies 2 and 3
4.13	4-25-23	Anthony Mazzella	Update Compound Die Drawings and Assembly 4 fixture
4.14	4-25-23	James Johnson	Added 10.2.4 Assembly 3 Alignment and press end fixture
4.15	4-25-23	Rees Kelley	Updated Budget, BOM, Added Pump Supply Chain Issue

4.16	4-26-23	Kate O’Reilly, Nick Porter	Final Review

Table of Contents

Section 1: Executive Summary

1.1 Executive Summary

The following Technical Data Package (TDP) contains the design, manufacturing, and assembly process of the *Magic Fountain* product. This TDP was created as a part of Rensselaer Polytechnic Institute's Manufacturing Processes and Systems Laboratory course (MPS), which gives students hands-on manufacturing engineering experience in a real-world setting.

This course allows students to work as a team to design a manufacturing product concept. The team will apply a variety of manufacturing and assembly processes to complete this goal over the course of a semester. Given a budget of $3,250 and all the tooling available in the Manufacturing Innovation Learning Laboratory (MILL), the team was tasked to make 300 copies of their product.

MPS Team C is the group of 10 students overseeing the *Magic Fountain's* development and production. They consist of mechanical, industrial and electrical engineers, both undergraduate and graduate students, with a wide variety of manufacturing experiences and leadership skills.

The *Magic Fountain* is a decorative desktop fountain with three bowls that allow water to cascade down. The product features a "floating bowl" concept that will grab the customer's attention. A clear bridge piece hangs from the top water bowl, supporting the middle bowl. When the fountain is powered, the bridge is surrounded by flowing water, giving the impression that the bowl is floating. The fountain is powered by a 5V submersible water pump with a USB connection. Each fountain should cost around $10.11 to make, for a total of $3,033.89 for all 300 copies.

The *Magic Fountain* has both manufactured and purchased parts. Manufactured parts include the basin, the water collection bowls, the pipes, the pump connector, the grate, and the bridge. The basin is vacuum-formed out of ABS plastic. The top bowl and end bowl that will be assembled onto the pipes are made out of injection-molded plastic. The bridge and grate are made out of laser-cut acrylic plastic. The middle bowl is made out of stainless steel. The pipes are made out of acrylic tubing. The pump connector is 3D printed out of ABS plastic via fused deposition modeling. Purchased parts include the USB connector, water pump, and decorative rocks.

1.2 Sponsor and Teaching Team Acknowledgement

MPS Team C would like to thank the sponsors shown below for their support throughout this project and semester. Our sponsors include Allendale Machinery – Haas Factory Outlet, Boeing, Capital District Chief Executive Network (CEN), LoDolce Machine Co. Inc., Hanwha Aerospace USA, Lutron, Mastercam, Putnam Precision, RBC Bearings Inc., Sandvik, NSH USA Corporation (Simmons), Snap-on, Sonoco, Specialty Silicone Products (SSP), Visual Knowledge Share Ltd. (VKS), Sikorsky, Becton, Dickinson and Company (BD) and Re:Build DAPR Engineering.

The team would also like to thank the course instructors – Professor Sam Chiappone, our project advisor Professor Johnson Samuel, and Professor Larry Oligny – along with the TAs for their unwavering support, interest, and devotion to their students's learning.

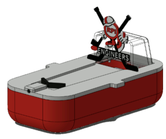
Section 2: Product Engineering

2.1 Product Selection and Background

2.1.1 Product Selection

Out of many products proposed, MPS Team C voted on three in particular: the Hockey Coin Bank, the Desktop Fountain (which would later become the *Magic Fountain*), and the Jaw Harp & Case. The team used the Product Selection Matrix shown below (Table 2.1.1) to guide their discussion. To ensure that all the course learning objectives are met, the team's product selection matrix included the diversity of manufacturing methods as a key criterion. For each proposed idea, the manufacturing processes were assigned either a 1, meaning the process can be applied to the product, or a 0, meaning the process cannot be applied to the product. The team also included a section on the matrix for other key design factors, and gave them a numerical value ranging from 1 to 5. For the assembly, quality control, and design criteria, a rating of 1 meant the factor would be simple and easier to achieve and a rating of 5 meant higher complexity and more challenging.

Table 2.1.1 Product Selection Matrix

Concept Name		**Hockey Coin Bank**	**Desktop Fountain**	**Jaw Harp**
Concept Image				
Criterion 1: Manufacturing Methods	Injection Molding	1	1	1
	Punching	0	0	1
	Machining	1	1	1
	Waterjet	1	1	1
	Metal Forming	0	1	1
	Vacuum Forming	1	1	0
	Electronics	1	1	0
Criterion 2: Key Design Factors	Assembly (1-5)	4	3	2
	Quality Control (1-5)	2	3	4
	Design (1-5)	4	3	2
	Budget (1-5)	3	3	3
	Interest (1-5)	5	4	3

The team used the results from the Product Selection Matrix to support the final selection voting process, the results of which are presented in Figure 2.1.1 below.

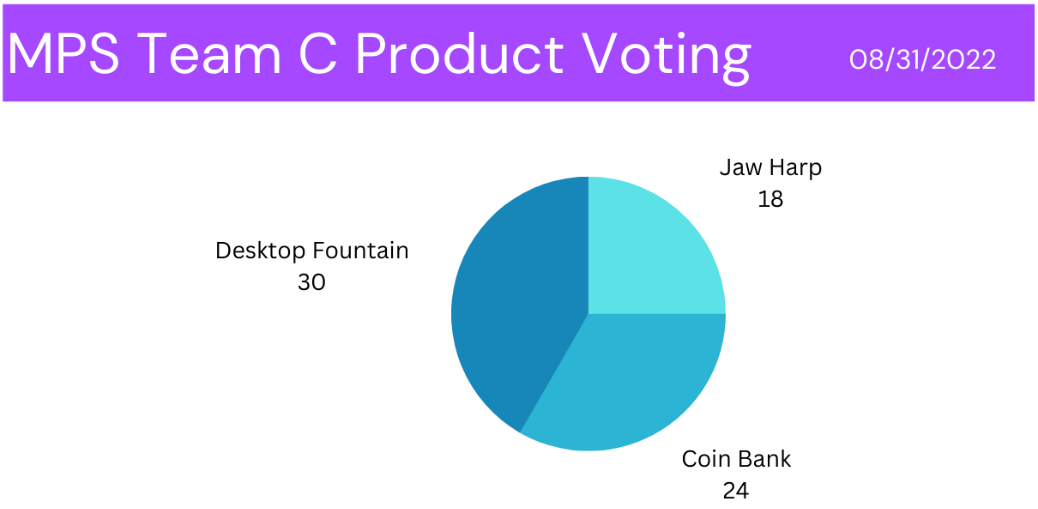


Figure 2.1.1 Product Voting Results

Each team member gave their favorite idea 3 votes, their second favorite idea 2 votes, and their least favorite idea 1 vote. As seen in Figure 2.1.1, the final concept choice was the Desktop Fountain with 30 total votes.

2.1.2 Product Background

A desktop fountain provides calming white noise and an appealing sight in what might otherwise be a dreary workspace. MPS Team C based their product design around aesthetics, functionality, cost, and ease of manufacture.

2.2 Benchmarking

Desktop or tabletop water fountains exist in many different variations. They are widespread and readily available via both online and physical retailers. Amazon alone pulls over 500 results when searching ‘desktop water fountain’ on their online market. Retailers such as Walmart and Target also stock similar products. Retail prices of desktop fountains range from $30 to over $300. The price point affects the materials used and the complexity of the features.

Figures 2.2.1 to 2.2.3 show some of the team's benchmarking efforts. The team tried to identify key features of existing products that could be implemented into their final design.

Many of the lower price fountains contained a three tier or three bowl design which the team liked for its symmetry. All the basins were similar, having either a square or round bowl shape. The bowls were most commonly supported by either sticks or posts (see Figure 2.2.1). In other designs, they were connected to pillars or ledges (see Figure 2.2.2). The team also had interest in an arch with a waterfall design (see Figure 2.2.3) and a staircase design around a post or up a wall.

Figure 2.2.1 HoMedics Indoor Tabletop Water Fountain

Figure 2.2.2 Durmmur 4-Tier Tabletop Small Water Fountain

Figure 2.2.3 Nature's Mark 10" H Mirrored Waterfall Light Show Tabletop Water Fountain

To better align their benchmarking efforts with the planned product and budget, the team kept the benchmarking products in the $30 to $40 range. The fountain shown in Figure 2.2.1 was available on Amazon. The team bought it to deconstruct and to better understand the internal mechanisms. All of the fountain parts are made entirely out of plastic, most likely via multiple plastic injection molds. Figure 2.2.4 shows the disassembled fountain.

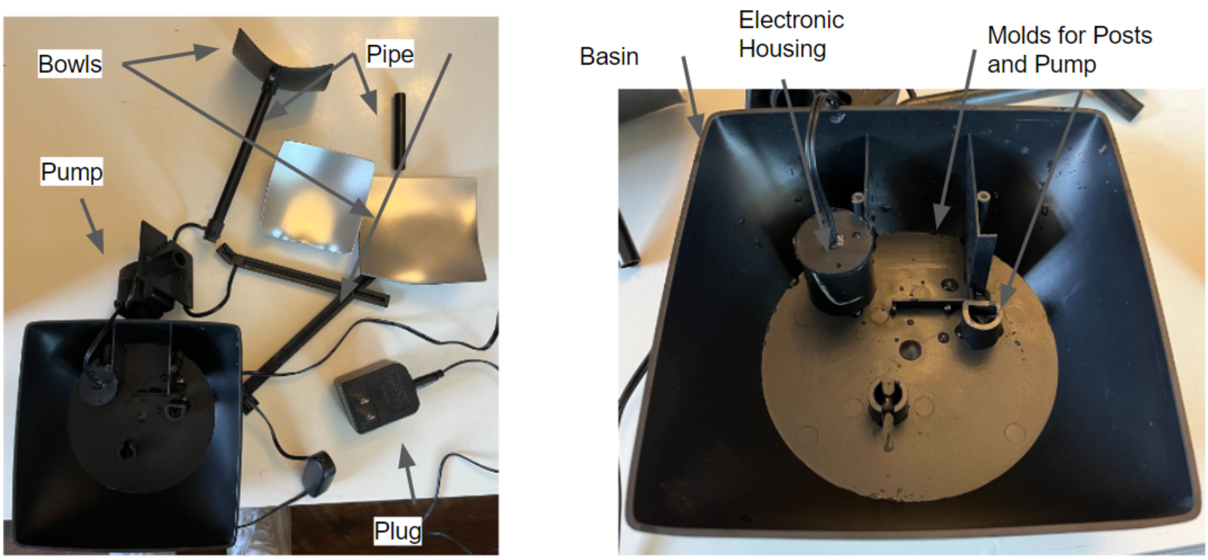


Figure 2.2.4 Disassembled HoMedics Indoor Tabletop Water Fountain (Figure 2.2.1)

Multiple pieces fit together via press fit. Molds in the bottom of the basin fit the pipes and house the pump. The team liked the idea of implementing press fit and molded fittings in their basin. Table 2.2 breaks down a few of the metrics of the benchmarked fountains.

Table 2.2: Benchmarking Features of *Magic Fountain*

	RPI *Magic Fountain*	**HoMedics Indoor Tabletop Water Fountain**	**Durmmur 4-Tier Tabletop Small Water Fountain**	**Nature's Mark 10" H Mirrored Waterfall Light Show Tabletop Water Fountain**
Features	Floating bowl design, metal plate, rocks	3 curved plates, 2 LEDs, and rocks	4 bowls, LEDs, rocks, adjustable flow rate	Mirror with water flowing down it, LEDs with changing colors
Price	$34.99	$34.99	$27.99	$39.99
Assembled Product Dimensions	6 x 6 x 8 inches	8.1 x 7.25 x 8.25 inches	6 x 5 x 8 inches	6 x 4 x 10.1 inches
Prominent Materials Used	Plastic, metal, Stones	Plastic	EPMC, plastic	Plastic
Power Source	USB power supply	Power cord	USB power supply	Power cord

2.3. Design and Features

2.3.1 Overview

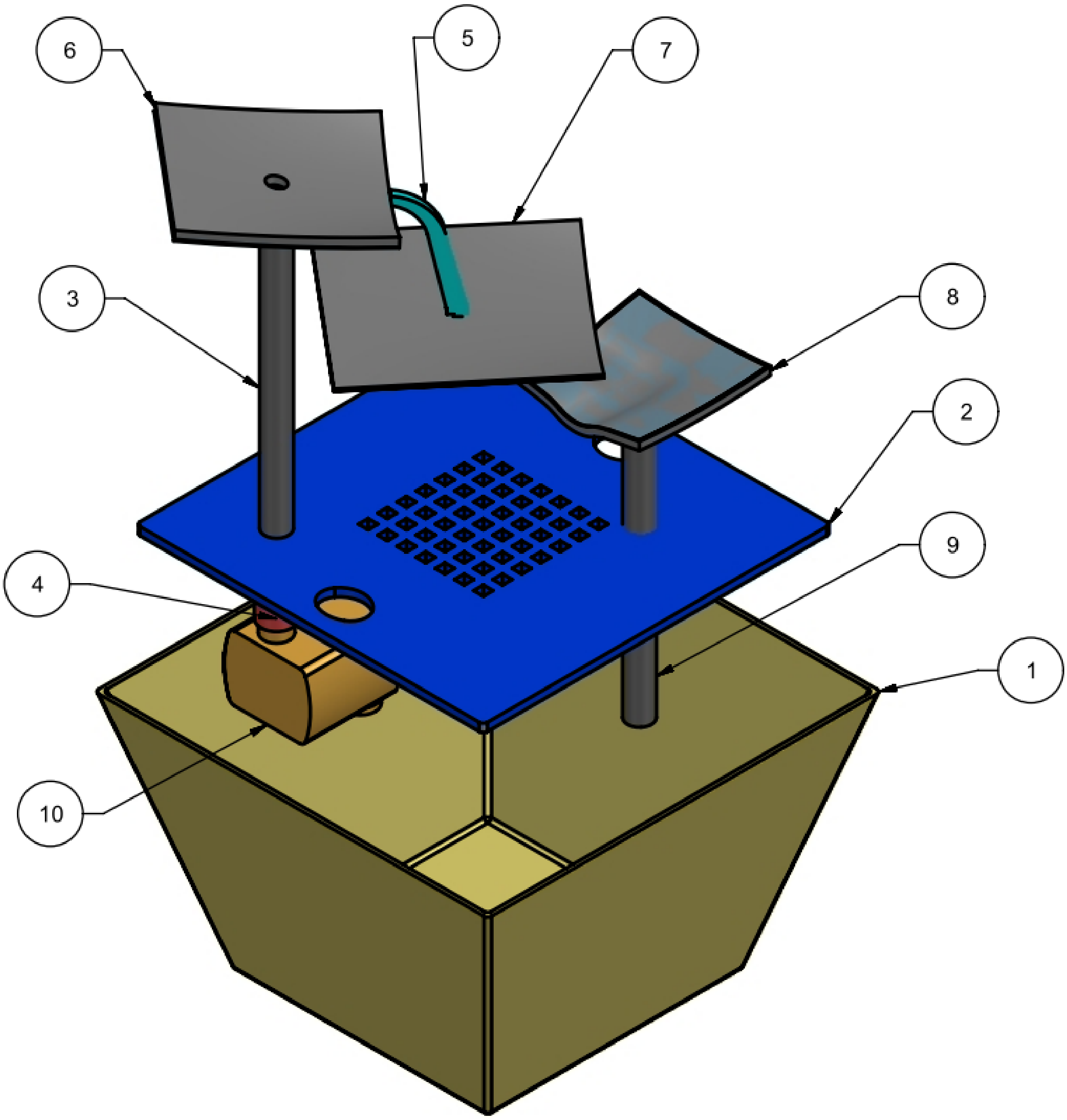


Figure 2.3.1 Exploded View of *Magic Fountain*

Table 2.3.1 Guide to Exploded View of *Magic Fountain*

Part			
1	**Basin**	**6**	**Top Bowl**
2	**Grate**	**7**	**Middle Bowl**
3	**Tall Pipe**	**8**	**End Bowl**
4	**Pump Connector**	**9**	**Short Pipe**
5	**Bridge**	**10**	**Pump**

The *Magic Fountain* is a desktop-sized water fountain, roughly 6 x 6 x 8 inches in size. The fountain consists of a basin, a grate, two pipes, a bridge, three bowls, a pump, and a pump connector. The basin of the fountain is watertight and holds all the other components. A grate rests inside the basin, which secures two pipes and the pump in place. Three bowls cascade the water down. The top and end bowls are attached to the two pipes, which in turn are held in place by the holes in the grate and a dimple in the basin. The middle bowl is attached to the top bowl via a clear plastic bridge. The pump draws water from the basin through the pump connector, which has a hole to bleed off excess water pressure. The water travels up the taller of the pipes and expels it into the top bowl. The water then cascades through the three bowls, returning to the basin. Aesthetic features of this product include a plaque displaying product sponsors and rocks that sit on top of the grate.

2.3.2 Basin

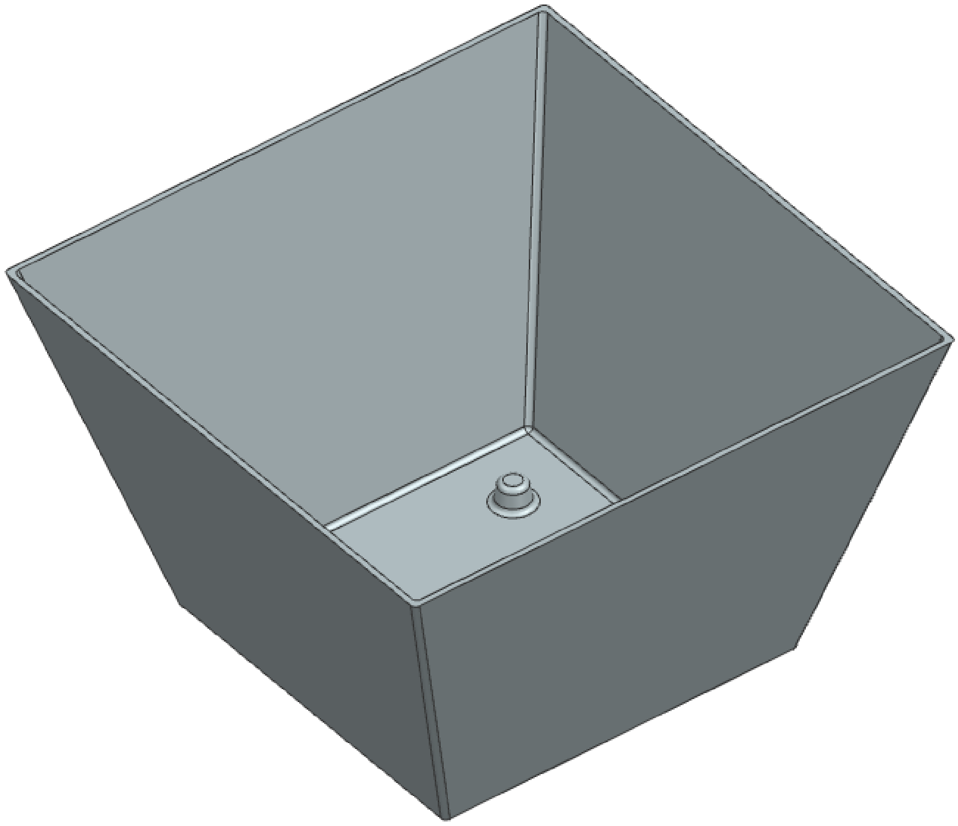


Figure 2.3.2 Basin

The basin holds all the components, along with the water. It is a tapered square bowl made from textured black ABS plastic with a side length of 6 inches at the top and 4 inches at the bottom and a height of 3.5 inches. A dimple in one corner of the basin supports the short pipe.

2.3.3 Grate

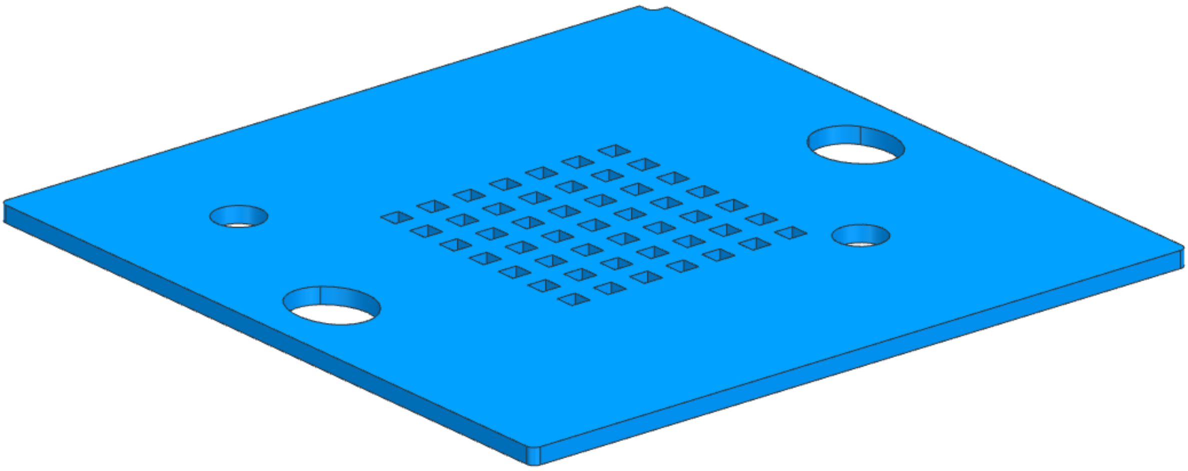


Figure 2.3.3 Grate

The grate holds the pipes and the pump in place. It is made of clear acrylic plastic with a side length of 5 inches. It sits halfway down in the basin. Water passes through the grate holes into the bottom of the basin where the pump rests. The pipes fit through two holes in the grate and are stabilized by the grate, the pump, and a dimple in the bottom of the basin. Two large finger holes are used to lift out the grate for cleaning purposes.

2.3.4 Pipes

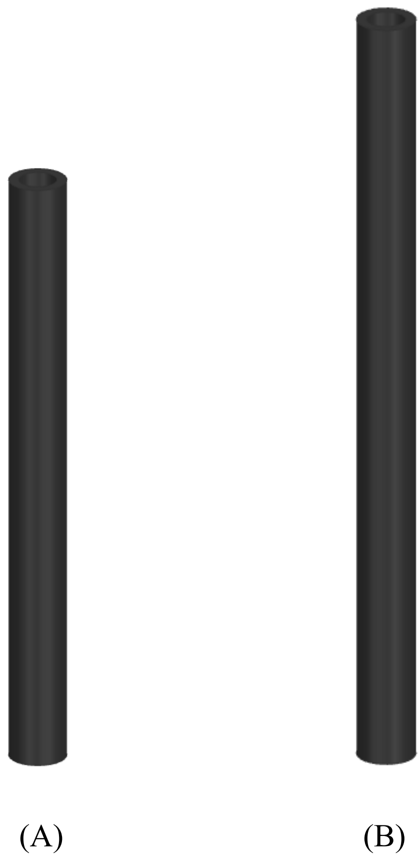


Figure 2.3.4 Short Pipe (A), Tall Pipe (B)

The pipes are made of black acrylic pipe that is cut to length and chamfered. Tall Pipe (B) has a height of 5.5 inches, and Short Pipe (A) has a height of 3.9875 inches. Tall Pipe (B) is attached to the pump via the pump connector, and water is pumped up through it. Stainless steel pipes were also a considered option, but plastic pipes are lighter and cheaper while also avoiding corrosion issues.

2.3.5 Pump Connector

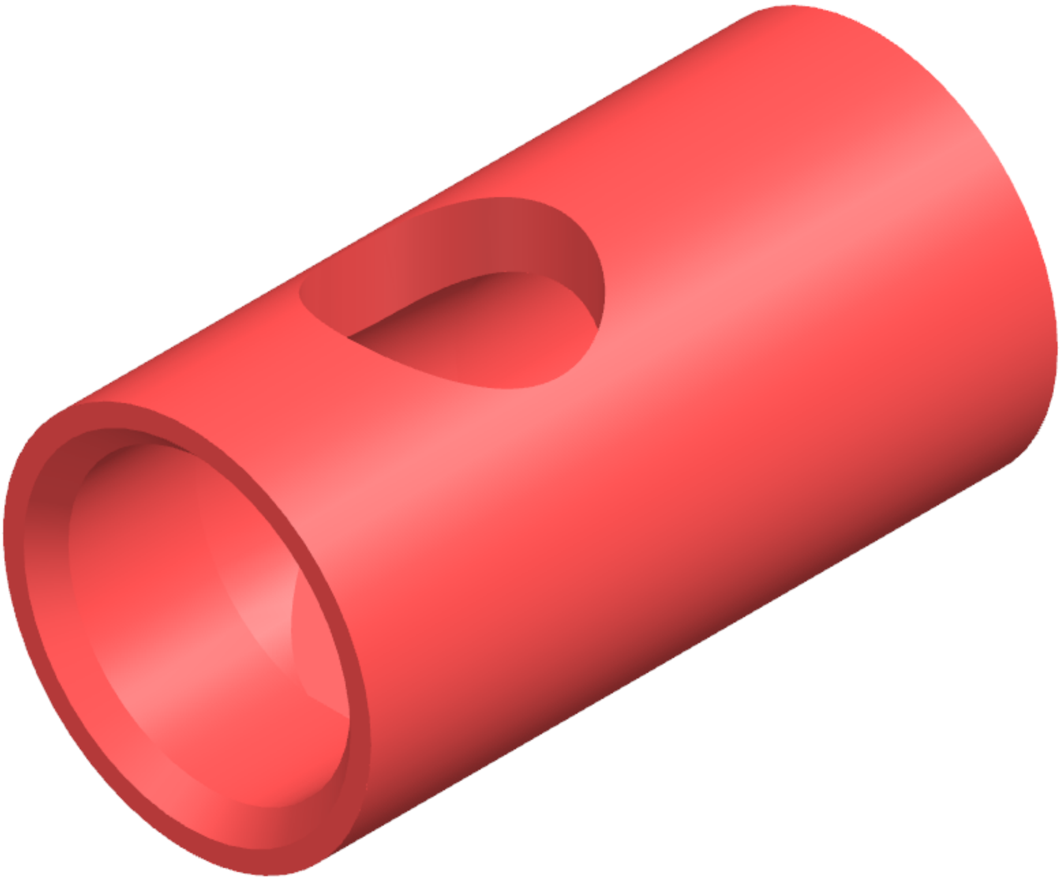


Figure 2.3.5: Pump Connector

The pump connector connects the pump to the tall pipe. It has a bleed-off hole through which excess water pressure is relieved such that water reaching the top of the fountain does not shoot out forcefully. It is composed of fused deposition modeling 3D printed black ABS plastic.

2.3.6 Bridge

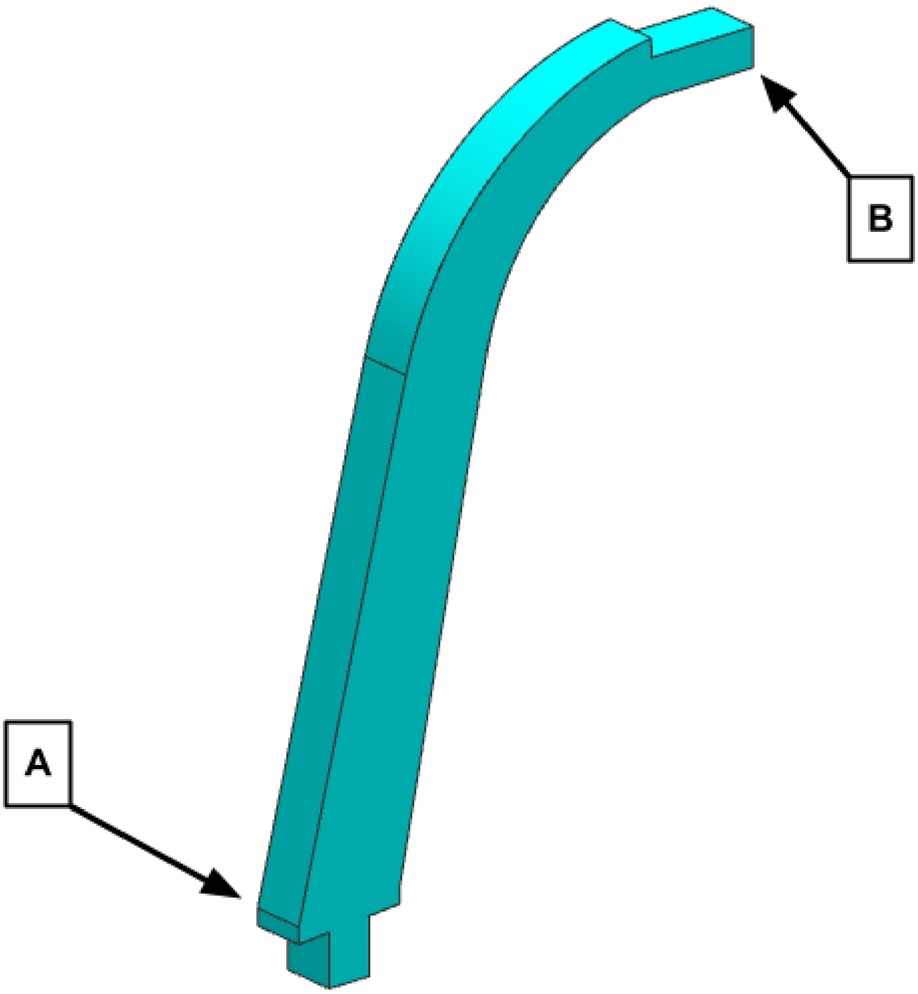
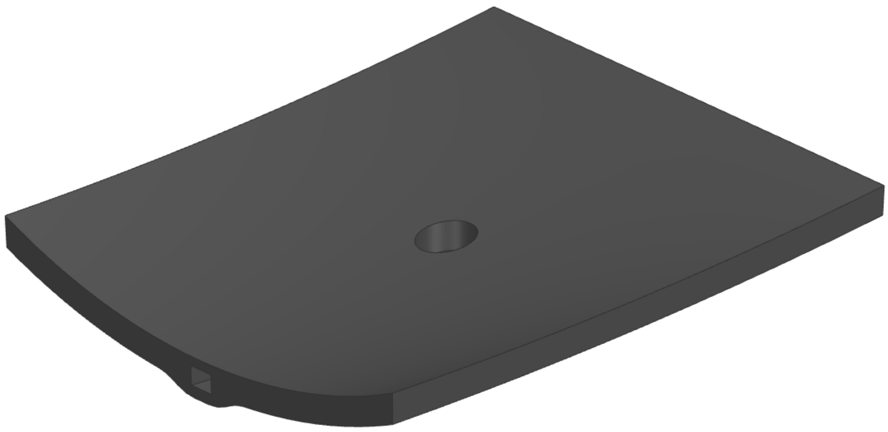


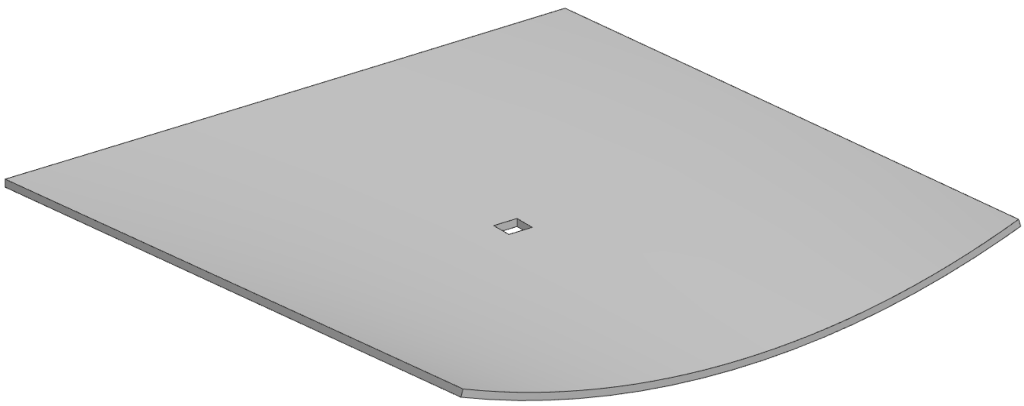
Figure 2.3.6 Bridge

The bridge is a piece of clear acrylic plastic with a peg at each end to attach it to the top and middle bowls. Water runs around the bridge and obscures it from view, making it appear as though the middle bowl is floating. Bridge end B attaches to the top bowl (bowl A, see Figure 2.3.7) via overmolding of the top bowl around the pre-existing bridge. Bridge end A fits into a slot in the middle bowl (bowl B, see Figure 2.3.7) that is then heat-staked to attach it to the middle bowl. The bridge is laser cut from clear acrylic plastic.

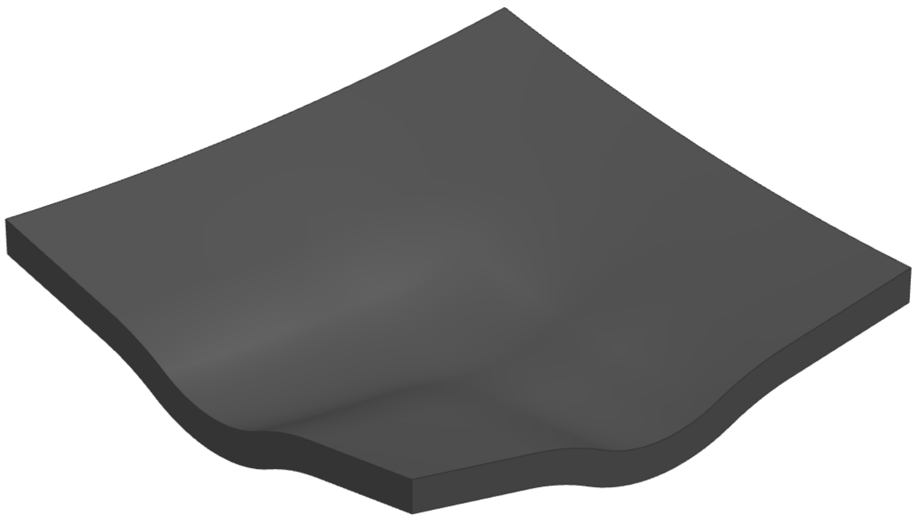
2.3.7 Bowls



(A)



(B)



(C)

Figure 2.3.7 Top Bowl (A), Middle Bowl (B), End Bowl (C)

The three bowls carry the water down the fountain. The middle (Figure 2.3.7 B) bowl is made of stainless steel, whereas the top (Figure 2.3.7 A) and end (Figure 2.3.7 C) bowls are made of silver plastic. The top bowl has a hole through which water is pumped. Water cascades over the edges of the bowls.

2.3.8 Electronics

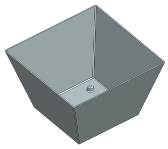
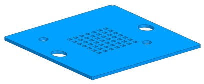
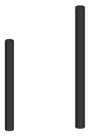
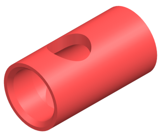
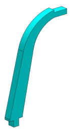
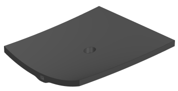
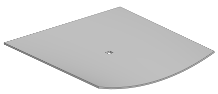
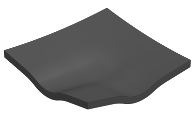
The electronics package for the *Magic Fountain* consists of a purchased submersible water pump powered by a USB cord. The pump draws water directly up the tallest pipe and out of a hole in the center of the topmost bowl.

2.4. Proposed Manufacturing Methods

2.4.1 Overview

The *Magic Fountain* consists of multiple parts. In the proposed design, both sheet metal and plastics are manufactured by a variety of different methods to meet the course requirements.

Table 2.4: Manufacturing Overview

Part			Material	Proposed Manufacturing Method
1	**Basin**		ABS Plastic	Vacuum Forming
2	**Grate**		Acrylic Sheet	Laser Cutting
3, 9	**Pipes**		Acrylic Tube	Cutting with Bandsaw
4	**Pump Connector**		ABS Plastic	3D Printing
5	**Bridge**		Acrylic Sheet	Laser Cutting
6	**Top Bowl**		ABS Plastic	Plastic Injection Molding
7	**Middle Bowl**		20-Gauge 304 Stainless Steel	Sheet Metal Forming
8	**End Bowl**		ABS Plastic	Plastic Injection Molding

2.4.2 Basin

The basin is an integral piece of the design. It is the structural foundation of the fountain and houses the pump and reserve water. Multiple manufacturing methods were discussed, such as plastic injection-molding, sheet metal forming, milling, and vacuum formed ABS plastic. Plastic injection-molding was rejected due to the size of the potential mold as well as the need of more than a single mold which would jeopardize budget. Milling was rejected due to wasted material and high cost. Sheet metal forming was a close second but was ultimately found to be too expensive. Therefore the proposed manufacturing method for this part is vacuum formed sheets of ABS plastic. Vacuum forming was selected due to its cheap implementation and low material cost.

2.4.3 Grate

The grate holds the two pipes in place. It is a flat plate with holes for the pipes and water to pass through. Since the grate is thin and flat, it is composed of laser-cut acrylic. Laser cutting allows for fast and accurate cuts in thin material and will allow many components to be made in quick succession.

2.4.4 Pipes

The pipes are cut from acrylic tubing. A hydraulic band saw is used to quickly cut the pipe to length, and a jig quickly positions the stock at the proper length between cuts. Initially, sleeves were part of the design to help support the pipes, but they were deemed unnecessary and removed.

2.4.5 Pump Connector

The pump connector is 3D printed out of ABS plastic using fused deposition modeling. The shape of the connector, particularly the notch inside of it, could not be easily machined from preexisting tubing. 3D printing allows for internal features to be added easily, and the part is small enough for many to be printed simultaneously.

2.4.6 Bridge

The bridge secures the middle water bowl to the top bowl. The manufacturing methods proposed for this part were plastic injection molding and laser cutting. Laser cutting would allow many parts to be made quickly, but would lack the ability to add nuanced features. Plastic injection molding could create parts with curved 3D geometry. Ultimately, laser cutting clear acrylic plastic was chosen as the part is not overly complex and can be represented by an extrusion of a 2D geometry. Acrylic plastic was chosen because it can be laser cut without issue and is easy to heat-stake.

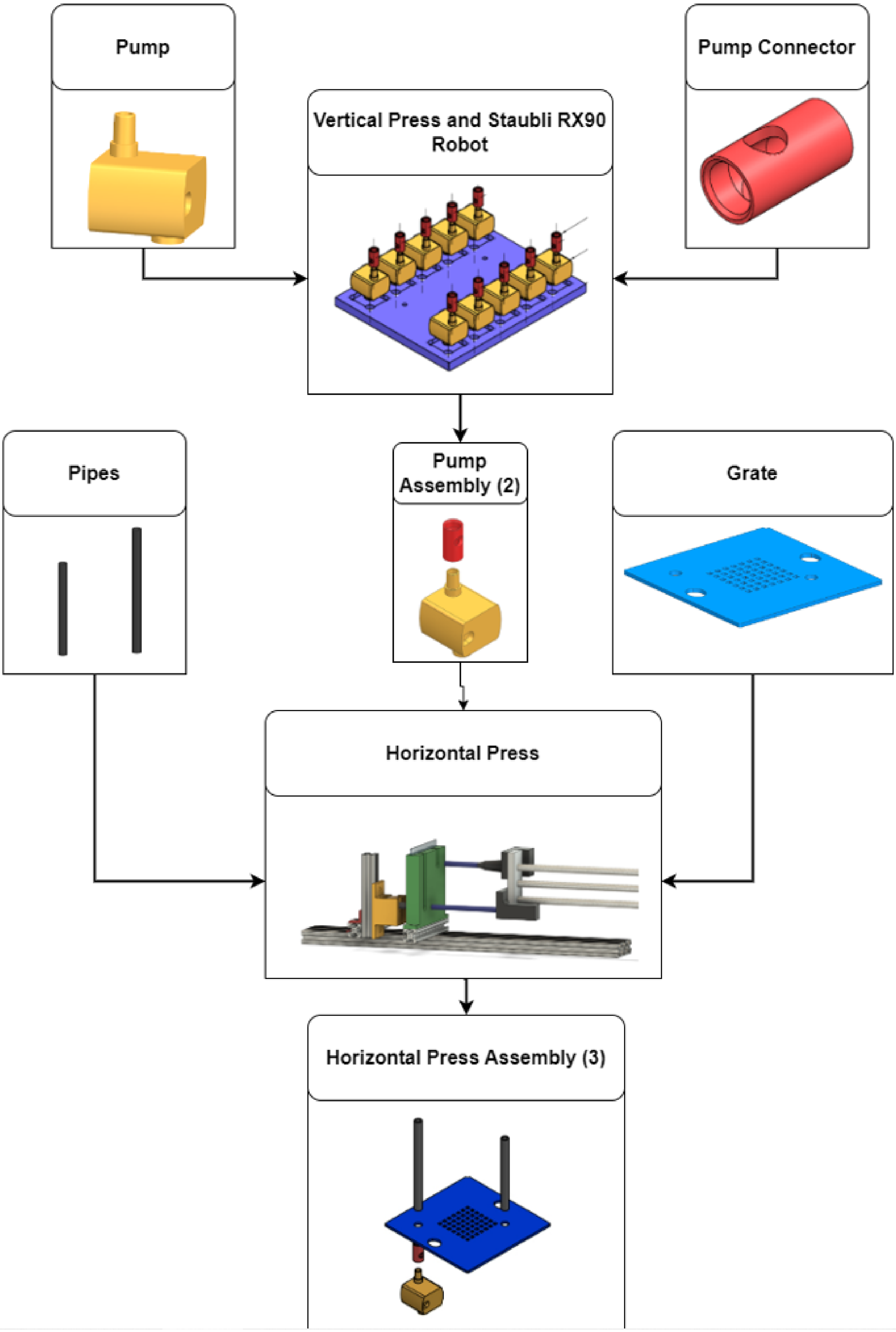
2.4.7 Top and End Bowls

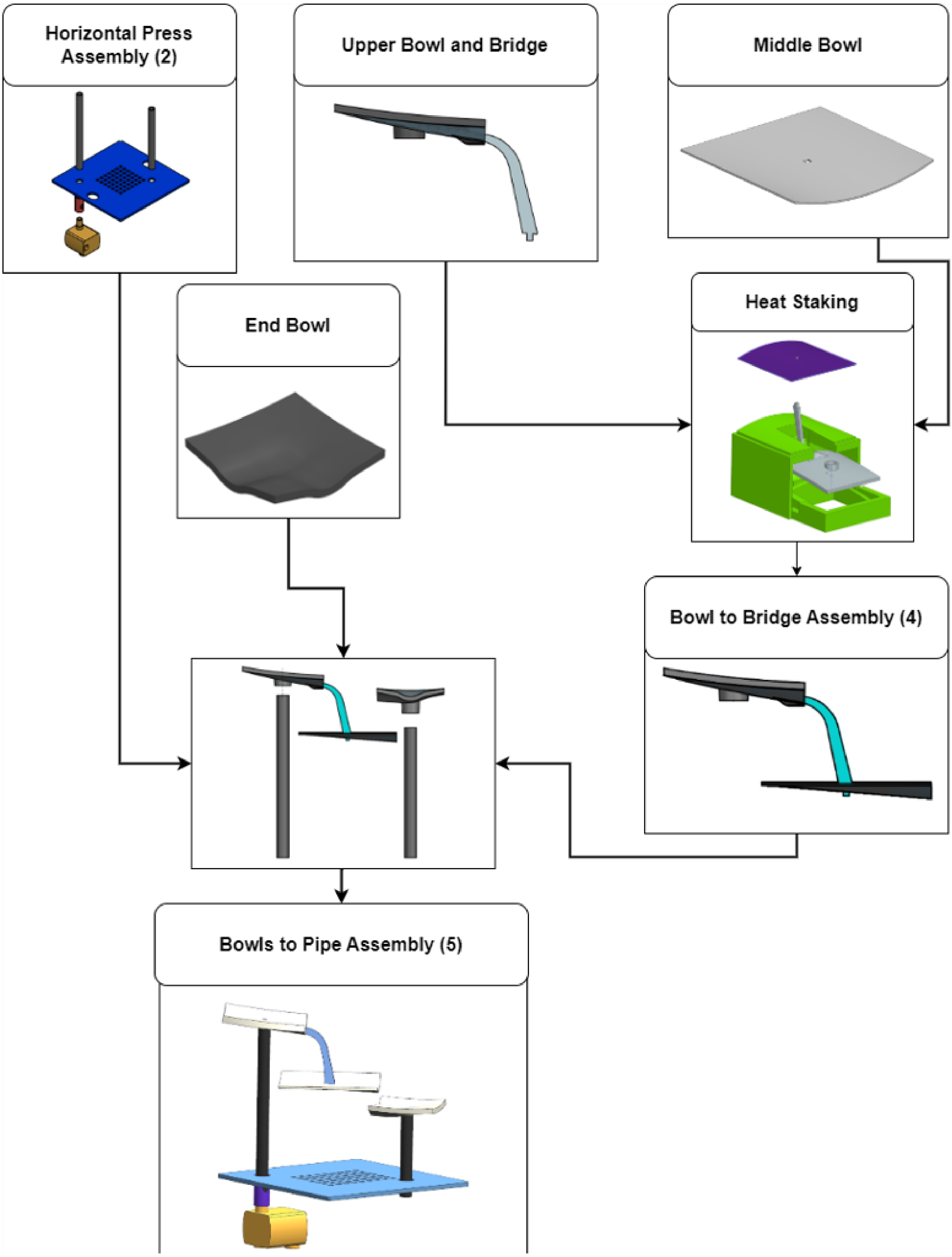
The manufacturing methods proposed for these parts were sheet metal stamping and plastic injection molding. Sheet metal stamping initially seemed like a great idea as the team loved the aesthetic of metal bowls. The inability to easily attach the sheet metal to the plastic piping and lack of budget for more metal ultimately led to the method being rejected. Therefore, plastic injection molding will be employed to manufacture these parts. Plastic injection molding with ABS plastic allows for an intricate design at a low cost, and the bowls will be press fit to the support columns. The team switched from using a metallic-colored plastic to a variety of red, brown and a mixture of pellets that produces a rust color. This matches the color of the rocks and adds to the product's aesthetics.

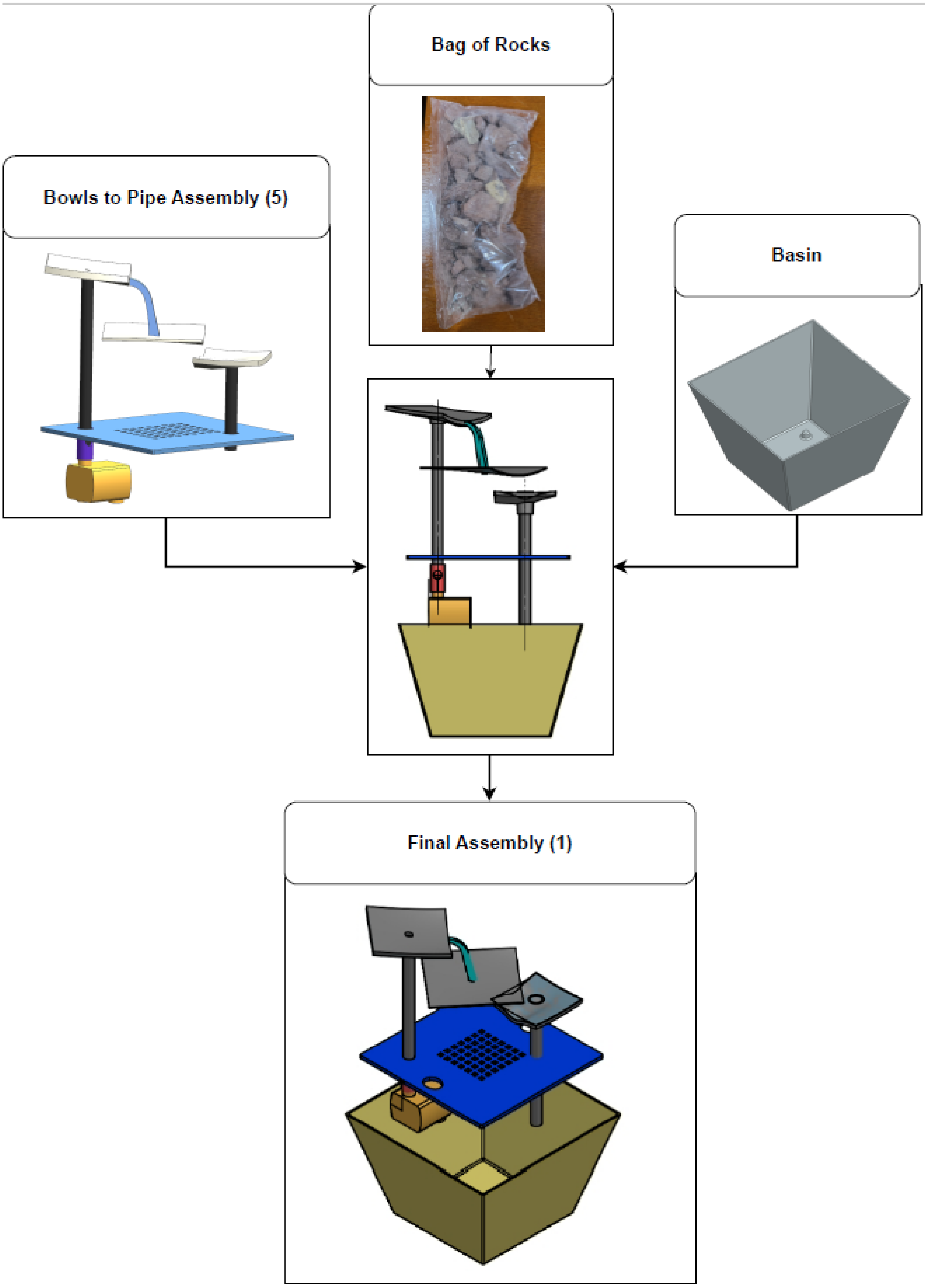
2.4.8 Middle Bowl

As was mentioned in section 2.4.2, sheet metal forming was a potential manufacturing process for both the basin and bowls. Hence, it could be used on the middle bowl. This bowl was the perfect candidate for sheet metal forming due to its small size and its being the focal point of the fountain. The bowl is supported by the bridge, so connecting it to a pipe is not an issue. The team wanted to diversify manufacturing processes, so plastic injection molding was rejected. A metal bowl in the middle will indicate that the fountain is well-crafted and will add an aesthetic focal point to the design. Hence, the middle bowl is formed from 20-gauge 304 stainless steel. Manual kick-shearing cuts the stock metal roll into blanks that are later formed in the compound die.

2.5 Assembly Overview and Flow Chart




Horizontal Press Assembly (2)
Upper Bowl and Bridge
Middle Bowl
End Bowl
Heat Staking
Bowl to Bridge Assembly (4)
Bowls to Pipe Assembly (5)


Bag of Rocks
Bowls to Pipe Assembly (5)
Basin
Final Assembly (1)

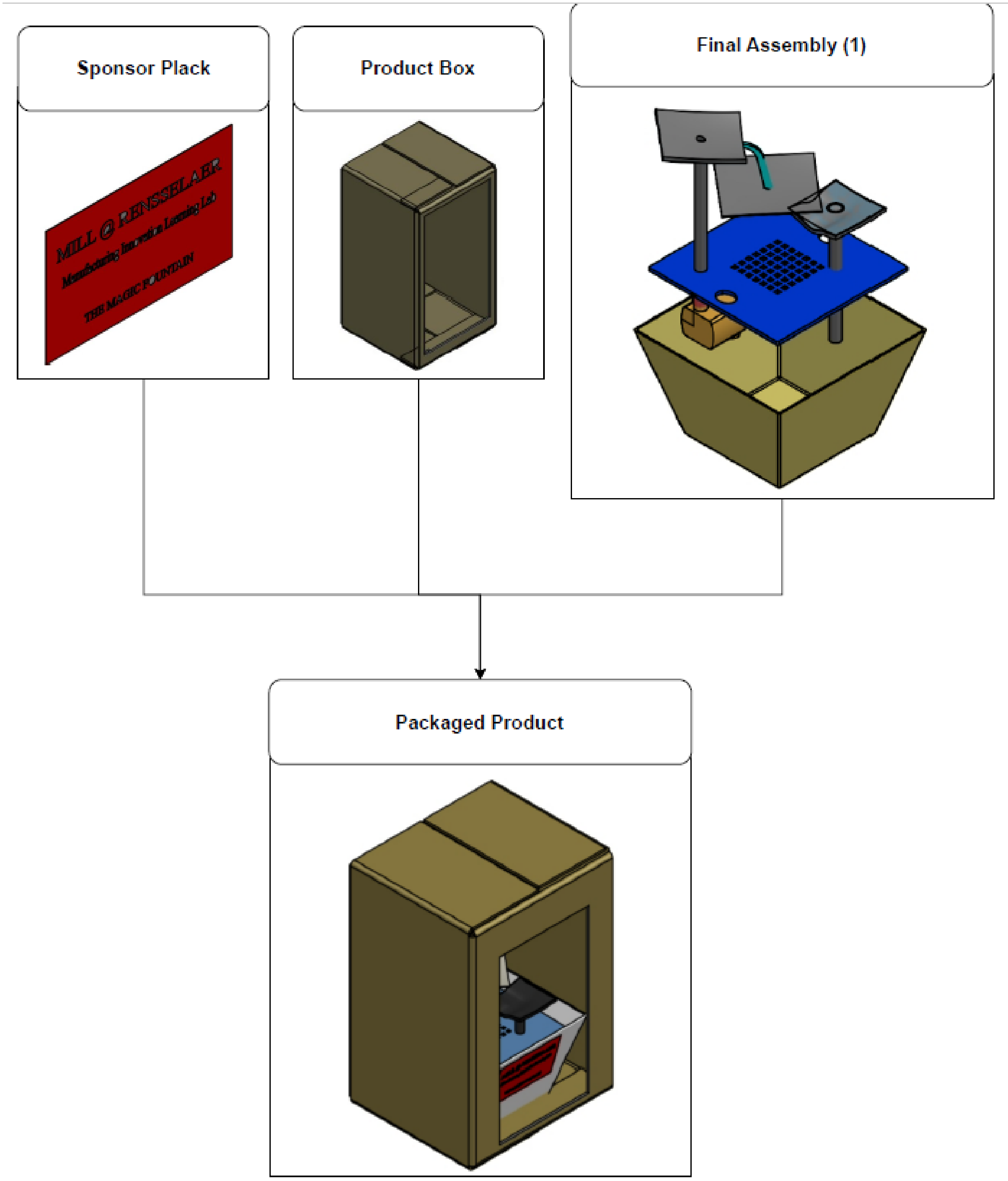


Figure 2.5.1 Assembly Flow Chart

The *Magic Fountain* is separated into 5 main assemblies. These assemblies include pressing the pump connector onto the pump, pressing the pipes through the grate, pressing the tall pipe onto the pump connector, pressing the bowls onto the pipes, and heat staking the bridge onto the middle bowl. The final assembly includes placing all previously mentioned parts into the basin along with a bag of rocks as an aesthetic piece for the end user. Pressing the pump connector onto the pump is performed automatically using the Staubli RX90 robot and the attached vertical press. Slide fitting the pipes through the grate and into the pump connector uses a custom horizontal press.

The first step is Pump Assembly (2). First the operator loads the pump connectors into the vertical gravity feeder and the pumps onto the connector fixture, making sure to keep the wires on top of the fixture. The Staubli robot then uses a custom gripper end effector to move the pump connectors from the feeder onto the pumps which are loaded on the connector fixture. The fixture then moves via conveyor to the vertical press where the two pieces are pressed together. This operation can be done with 5 pumps and pump connectors at once. Before the Pump Assembly takes place, every 10 pumps are tested to ensure that water passes through them properly and that they are not deformed.

For Horizontal Press Assembly (3), a press horizontally slides the two pipes through the grate. The tall pipe slides into the Pump Assembly (2). The parts must be manually loaded onto the machine.

The Bowl to Bridge Assembly (4) entails heat staking the bridge to the middle bowl. The top bowl has already been overmolded onto the bridge. The middle bowl is manually placed onto the bridge, and all three parts are loaded manually onto the heat staking fixture. The heat staking device then automatically heats the bridge such that it forms a secure connection with the middle bowl. The components will not fit in the heat staking fixture if they are not oriented correctly.

For the Bowls to Pipe Assembly (5), the Bowl to Bridge Assembly(4) and the end bowl are pressed manually onto the pipes. A visual aid shown below in Figure 2.5.2 ensures that the bowls are oriented correctly, as proper orientation is very important.

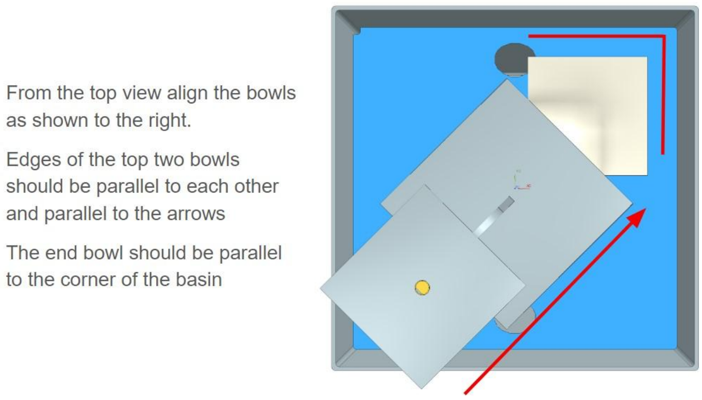


Figure 2.5.2 Visual Aid for Bowls to Pipe Assembly

Finally, the Final Assembly (1) takes place. This step consists of manually placing a bag of rocks and all previously mentioned and assembled parts into the basin. The pump and pipes automatically align themselves in the basin thanks to the dimple in the bottom of the basin.

2.6 Packaging

The packaging for the *Magic Fountain* consists of a cardboard box with a window on the front panel of the box to allow customers to view the product without disrupting the packaging. The *Magic Fountain* is fully supported inside the box with bubble wrap and packing paper. The box is provided by the MILL and has dimensions of 6" by 6" by 10". The thickness of the box is 1/16" or 1.0-1.8 mm. The front panel has a cutout made via laser cutting to create a viewing window for visibility of the product. This packaging method balances the need to be able to safely transport the *Magic Fountain* with the aesthetic value of being able to see the product clearly and allowing the design to grab the consumer's attention without needing to open a box.

Figure 2.6.1 Packaging Concept

The design of the package is shown in Figure 2.6.1 above. The cutout is a rectangle with dimensions of 5" x 9" (127 mm x 228.6 mm). The assembly of the box is simple: laser cutting the cutout, assembling the box, and placing the fountain within the box with the rocks under the grate, resting in the basin. A small plastic bag holds the assorted rocks that are to be added to the bowl for decoration. The plastic bag is a perforated plastic bag sourced from the MILL.

The sponsors are represented by a plastic sticker bearing all of the sponsor logos added to the right side of the packaging. The sticker design is shown in Figure 2.6.2.

There is also an individualized plaque for each sponsor's *Magic Fountain* onto which the sponsor name is engraved. This plaque is located on the front of the basin and is a piece of anodized aluminum with dimensions of approximately 3.14” by 2.13” and a thickness of 0.02”. These are custom-made for the *Magic Fountains* sent to the sponsors and are not present on most of the *Magic Fountains* produced.

Figure 2.6.2 Sticker Design (3” x 4”) to be placed on right side of the box

In each package with a fountain, we also included an “Instruction Manual” for the end-user. This includes any information needed for the user to set up their fountain including washing the rocks and putting them over the grate, how much water to put in the basin, the proper alignment for bowls and the pump, and how to keep your fountain running smoothly. There is also a note about how to clean your fountain. The instruction manual is displayed below in Figure 2.6.3.

Enjoy your new Fountain! Here are a few things that you should know:

- We washed the rocks, but before you take them out of the bag and pour them over the grate, it would be good to give them another good wash!
- Please fill the basin of your fountain with water up to grate- level
- To clean your fountain, take rocks off the grate and use finger holes in the grate to remove from the basin. You can now dump the water and wipe the basin clean
- To improve the water flow, run your finger over the clear bridge piece
- Circled below is a cutout for the pump cord to run through
- Here is a picture of our "ideal" bowl alignment, but feel free to make your fountain unique!

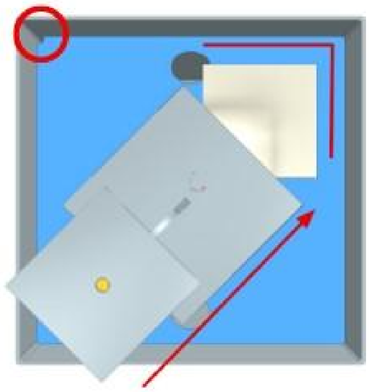
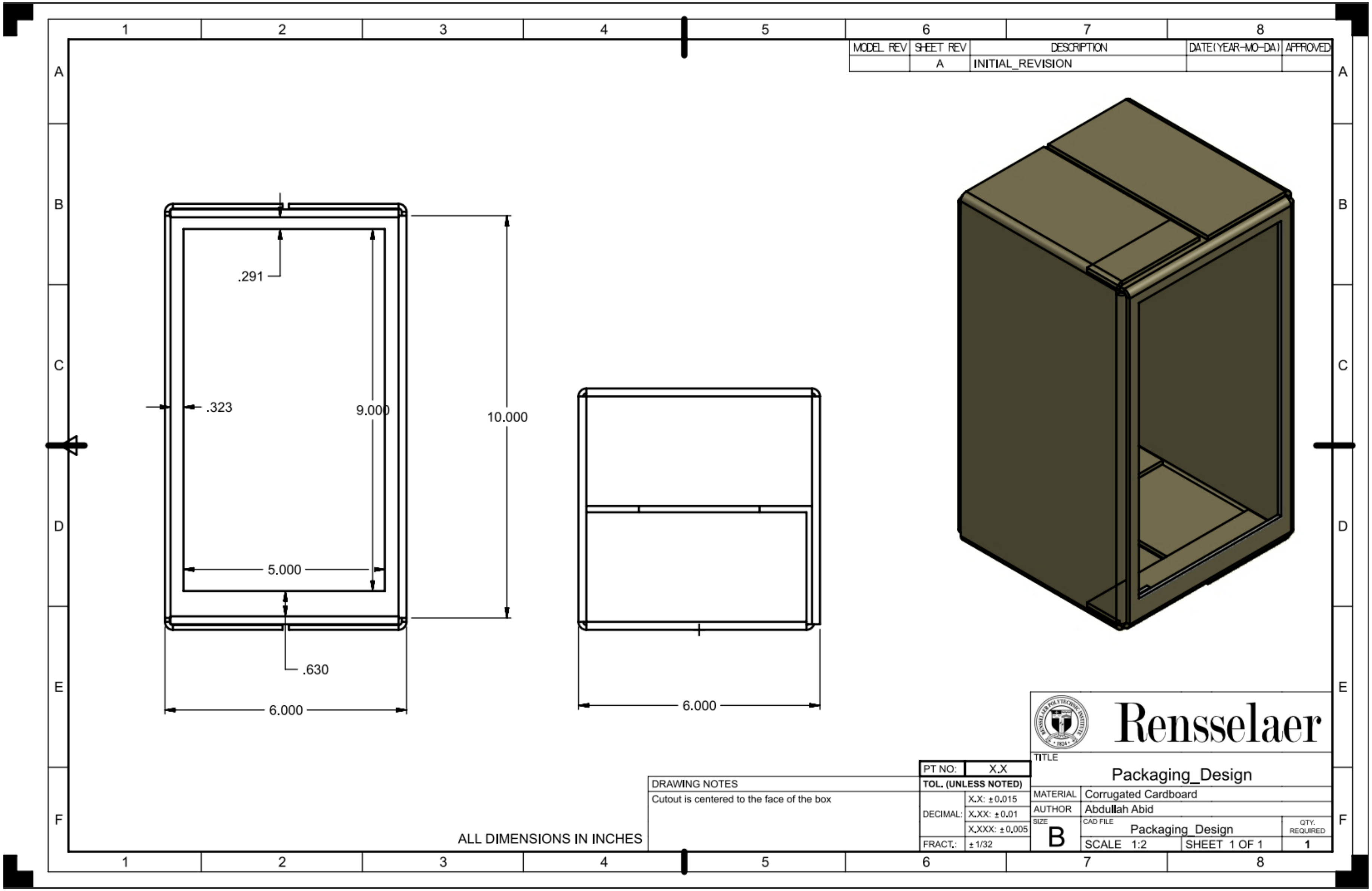


Figure 2.6.3 Instruction Manual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ALL DIMENSIONS IN INCHES
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FRACT.:
±1/32
Rensselaer
TITLE
Packaging_Design
MATERIAL
Corrugated Cardboard
AUTHOR
Abdullah Abid
SIZE
B
CAD FILE
Packaging_Design
QTY. REQUIRED
1
SCALE 1:2
SHEET 1 OF 1

2.7 Budget

Table 2.7 Budget

Part Description	Material	Supplier	Quantity Per Unit	Cost Per Unit	Total Cost
Basin	1/16" Black ABS Sheet	Home Depot	1	$1.92	$577.10
Pump	5V USB submersible pump (Jovtop JT-1020)	Ali Baba	1	$3.83	$1,150.00
Grate	1/8" acrylic sheet	Piedmont	1	$0.58	$174.00
Pipes	3/8"x3' acrylic pipe x82	Canal Plastics	1x5", 1x4"	$1.48	$443.33
Middle Bowl	0.036" T-410 coiled stainless steel	Mill	1	$0.00	$0.00
Bridge	1/8" acrylic sheet	MILL	1	$0.00	$0.00
Top and End Bowl	Supplied colored plastic (Mold cost)	MILL	2	$0.00	$0.00
Plastic Injection Mold	6061 Aluminum	MILL	0	$1.67	$500.00
Forming Die	Composite 3D Print	MILL	0	$0.00	$0.00
Rocks	Autumn Red Stone	Lowe's	1 lb	$0.17	$51.10
Pump Connector	ABS filament	Marlin	2.55 g	$0.09	$27.00
Packaging for Rocks	Plastic bags (heat sealed tube roll)	MILL	1	$0.00	$0.00
Packaging Sticker	Sticker paper (6 per page)	Uline	1	$0.12	$36.00
Package Box	6x6x12 cardboard box	MILL	1	$0.00	$0.00
Plaque	Anodized aluminum sheet and double sided tape	Donated	60 total	$0.00	$0.00
Water Jetting	Aggregate	MILL	0	$0.01	$2.50
			Total	$10.11	$3,033.89

The current project total is $3,033.89, $216.11 below the $3,250.00 budget given for production. The pump chosen, although significantly more expensive than the other pump options considered, allows for a higher quality end product due to lower operating noise. The cost of pumps increased due to overseas shipping fees of $370. In the real world, production costs would be significantly greater when manufacturing labor costs are included. Certain materials are provided by the MILL. These materials include injection molding pellets, stainless steel for the middle bowl, packaging boxes, and material for the forming die. This allowed for significant cost savings. Using an excess 20 ga steel roll from a previous project in the MILL, the group was able to save on a major cost associated with the middle bowl material.

Section 3: BOM and Drawings

3.1. Bill of Materials

Product Main Assembly (Parts, Subassemblies, Main Assembly)			
Number	BOM/3D Model Name	Drawing Title	Quantity per Unit
1A	Full Fountain Assembly Labeled	Final_Assembly_1A	1
1A	Final Assembly Pressfit	Final_Assembly_1A_Pressfit_Exploded	
1.1A	Final Assembly	Final_Assembly_1.1A	1
2A	Pump to Connection Assembly	Pump_2A	1
2A	Pump to Connection Assembly Press Fit	Pump_2A_Press_Fit	
3A	Horizontal Press Assembly	Horizontal_Press_Assembly_3A	1
3A	Press Assembly Exploded	Horizontal_Press_Assembly_3A_PressFit_Exploded	
3A	Horizontal Press Assembly Detailed Dimensions	Horizontal_Press_Assembly_3A_Dims.	
4A	Bowl to Bridge Assembly	Bowl_to_Bridge_Assembly_4A	1
4A	Bowl to Bridge Exploded	Bowl_to_Bridge_Assembly_Heat_Staking_Exploded_4A	
5A	Bowls to Pipe Assembly	Bowls_Pipe_Assembly_5A	1
5A	Bowls to Pipe Exploded	Bowls_Pipe_Assembly_5A_Pressfit_Exploded	1
1C	Basin	Basin_1C	1
2C	Bridge	Bridge_2C	1
3C	End Bowl	EndBowl_3C	1

4C	Middle Bowl	MiddleBowl_4C	1
4.1C	Middle Bowl Blank	MiddleBowl_Blank_4.1C	1
5C	Top Bowl	TopBowl_5C	1
6C	Grate	Grate_6C	1
7C	Pump Connector	PumpConnection_7C	1
8PC	Tall Pipe	TallPipe_8PC	1
9PC	Short Pipe	ShortPipe_9PC	1
10PC	Pump	Pump_10PC	1
11PC	Rocks	Autumn_Red_Stone_11PC	1
Manufacturing Process Tooling			
100T	PIM Mold Half Stationary	PIMMoldHalfStationary_100T	1
100.1T	PIM Mold Half Moving	PIMMoldHalfMoving_100.1T	1
200T	Middle Bowl Punch and Die	MiddleBowlPunchandDie_200T	1
200.1T	Middle Bowl Die	MiddleBowlDie_200.1T	1
200.2T	Middle Bowl Punch	MiddleBowlPunch_200.2T	1
200.3T	Middle Bowl Punch Guide Plate	MiddleBowlPunchandDieGuidePlate__200.3T	1
200.4T	Shearing Pin	ShearPin_200.4T	1
300T	Vacuum Forming Mold	BasinMold_300T	1
300.1	Laser Cutting Fixture	BasinFixture_300.1T	1
Assembly Fixtures, End Effectors, Pallets, Feeders			
1000F	Middle Bowl Fixture	MiddleBowlFixtureAssembly_1000F	1

	Assembly		
1000.1F	Heat Staking Fixture	MiddleBowlFixturing_1000.1F	1
2000F	Pump Fixture Assembly	PumpFixtureAssembly_2000F	1
2000.1F	Connector Fixture	ConnectorFixture_2000.1F	1
2000.2FE	Connector Feeder	Connector_Feeder_2000.2FE	1
2000.4E	Gripper	Gripper_2000.4E	1
3000F	Horizontal Press Fixture	Horizontal_Press_Fixture_3000F	1
3000.1F	Grate Fixture	Grate_Fixture_3000.1F	1
3000.2F	Press End Fixture	Press_End_Fixture_3000.2F	1
3000.3F	Press Pump Fixture	PressPump_Fixture_3000.3F	1
Packaging			
1PD	Package Box	Packaging_Design	1
2PD	Plastic Rock Bag	Rock_Bag	1

Table 3.1.1 Legend

Abbreviation	Category
C	**Component**
PC	**Purchased Component**
A	**Assembly**
T	**Tooling**
F	**Fixturing**
P	**Pallet**
E	**End Effector**
PD	**Packaging**

3.2. Drawings

Assembly Drawings

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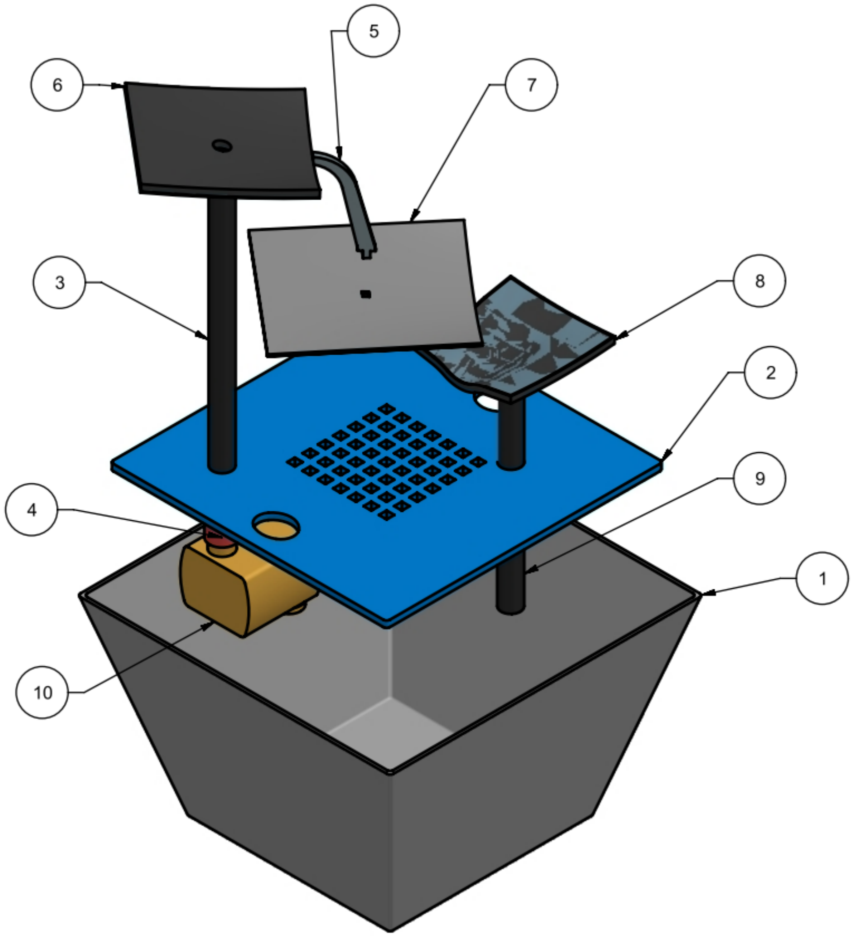
	A	INITIAL_REVISION		



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1	BASIN	1
2	GRATE	1
3	TALL PIPE	1
4	PUMP CONNECTOR	1
5	BRIDGE	1
6	TOP BOWL	1
7	MIDDLE BOWL	1
8	END BOWL	1
9	SHORT PIPE	1
10	PUMP	1

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO: 1A

TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015; X.XX: ±0.01; X.XXX: ±0.005
FRACT.: ±1/32

Rensselaer

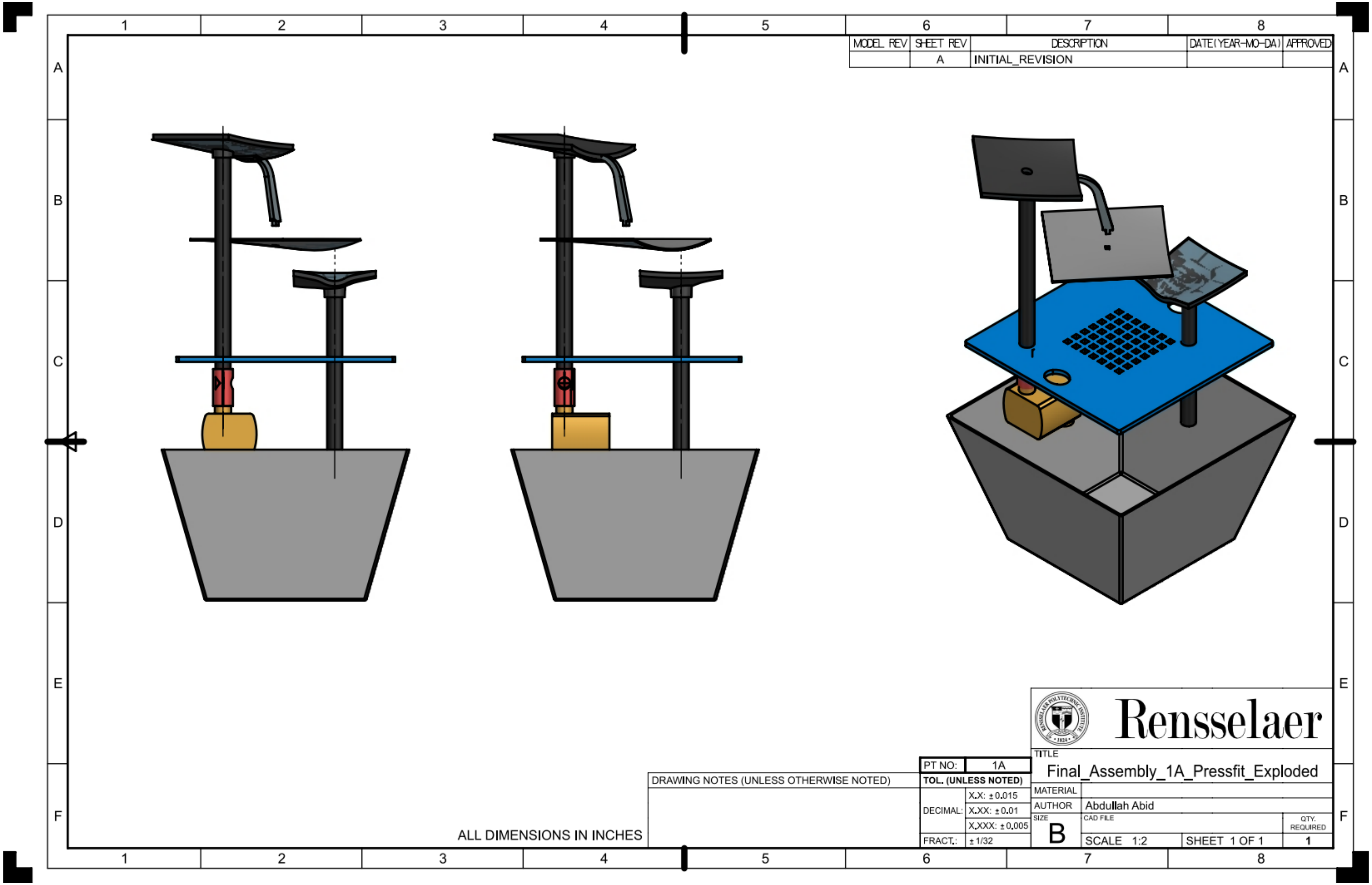
TITLE: Final_Assembly_1A

MATERIAL:

AUTHOR: Abdullah Abid

SIZE: B | CAD FILE: | QTY. REQUIRED:

SCALE 2:3 | SHEET 1 OF 1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APPROVED
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INITIAL_REVISION
Rensselaer
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ALL DIMENSIONS IN INCHES
MATERIAL
AUTHOR Abdullah Abid
SIZE B
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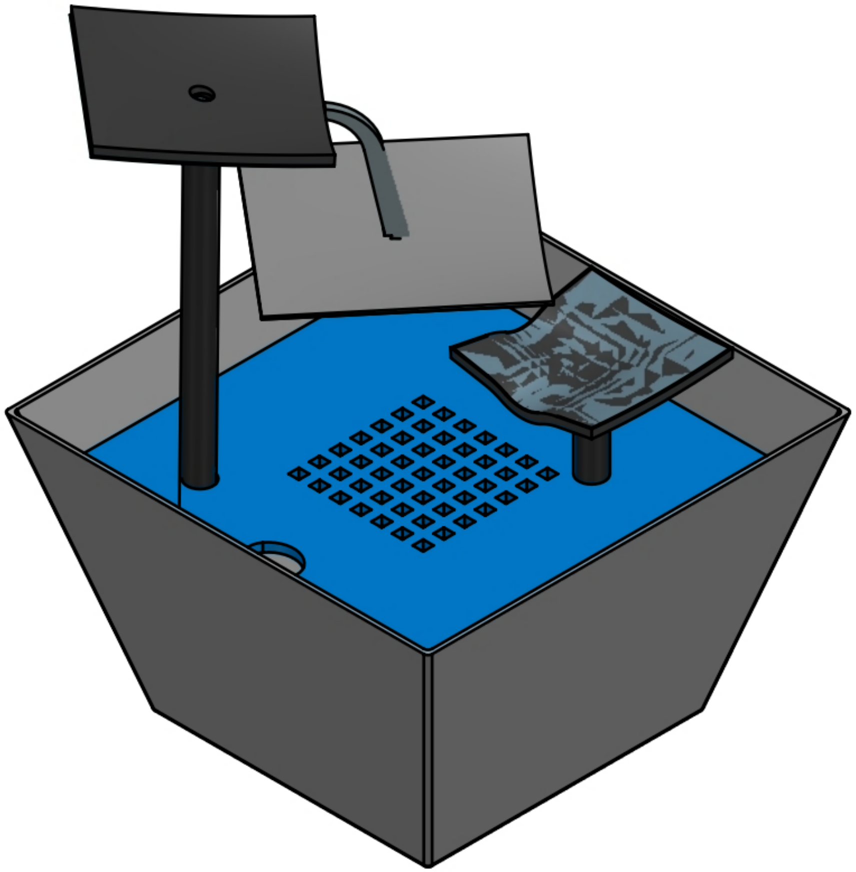

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Rensselaer

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AUTHOR	Abdullah Abid
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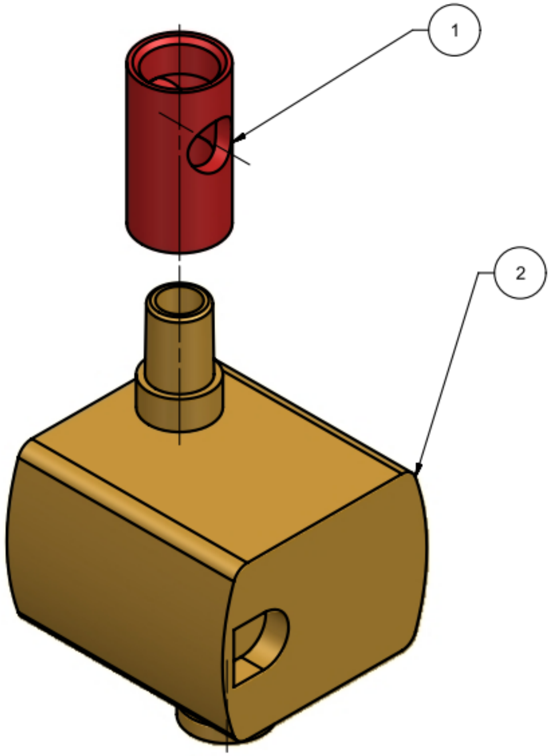

PC NO	PART NAME	QTY
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2	PUMP	1

Rensselaer

TITLE: Pump_2A

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AUTHOR	Kenen Otake
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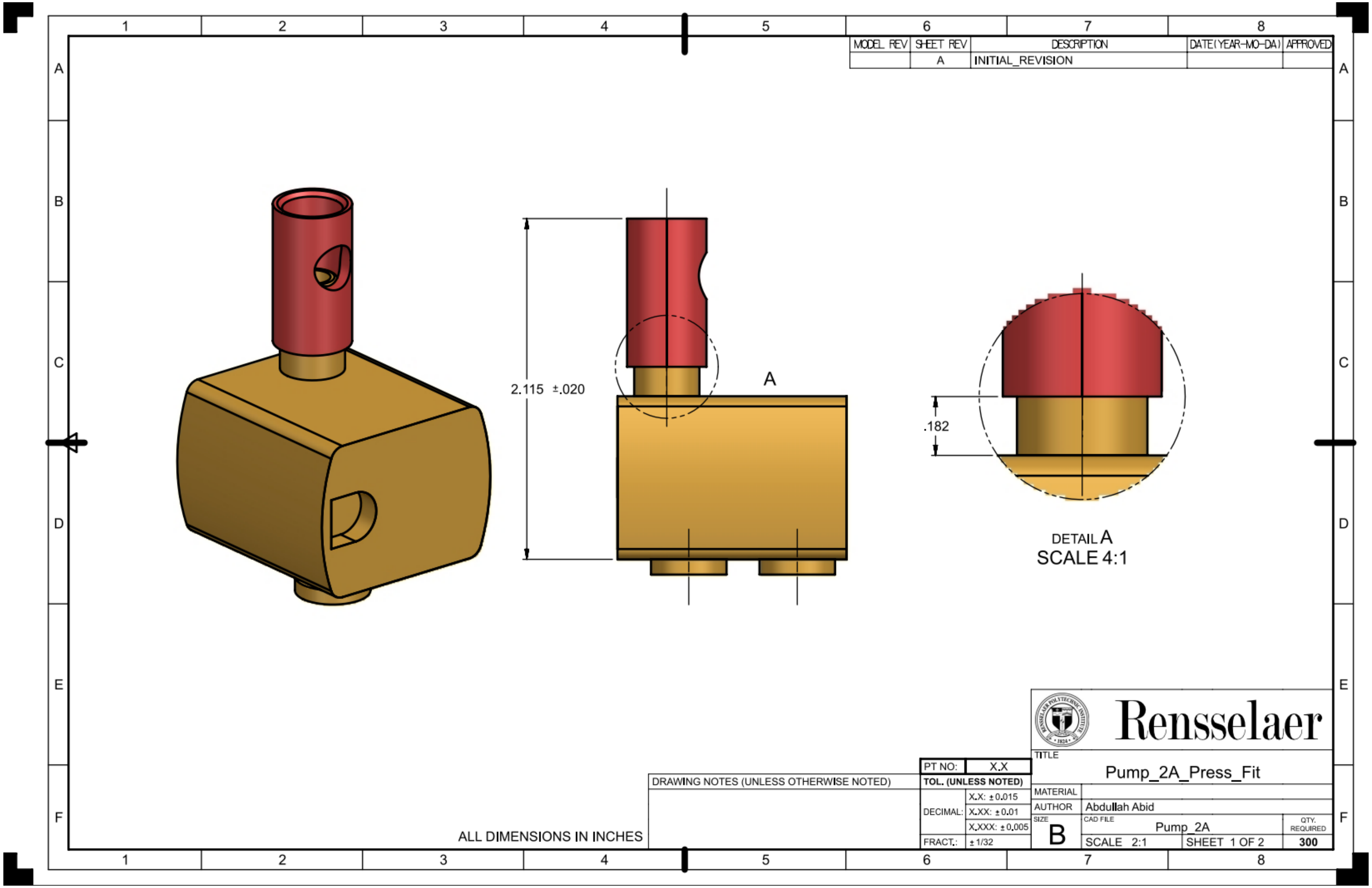
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FRACT.:
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Rensselaer
TITLE
Pump_2A_Press_Fit
MATERIAL
AUTHOR
Abdullah Abid
SIZE
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CAD FILE
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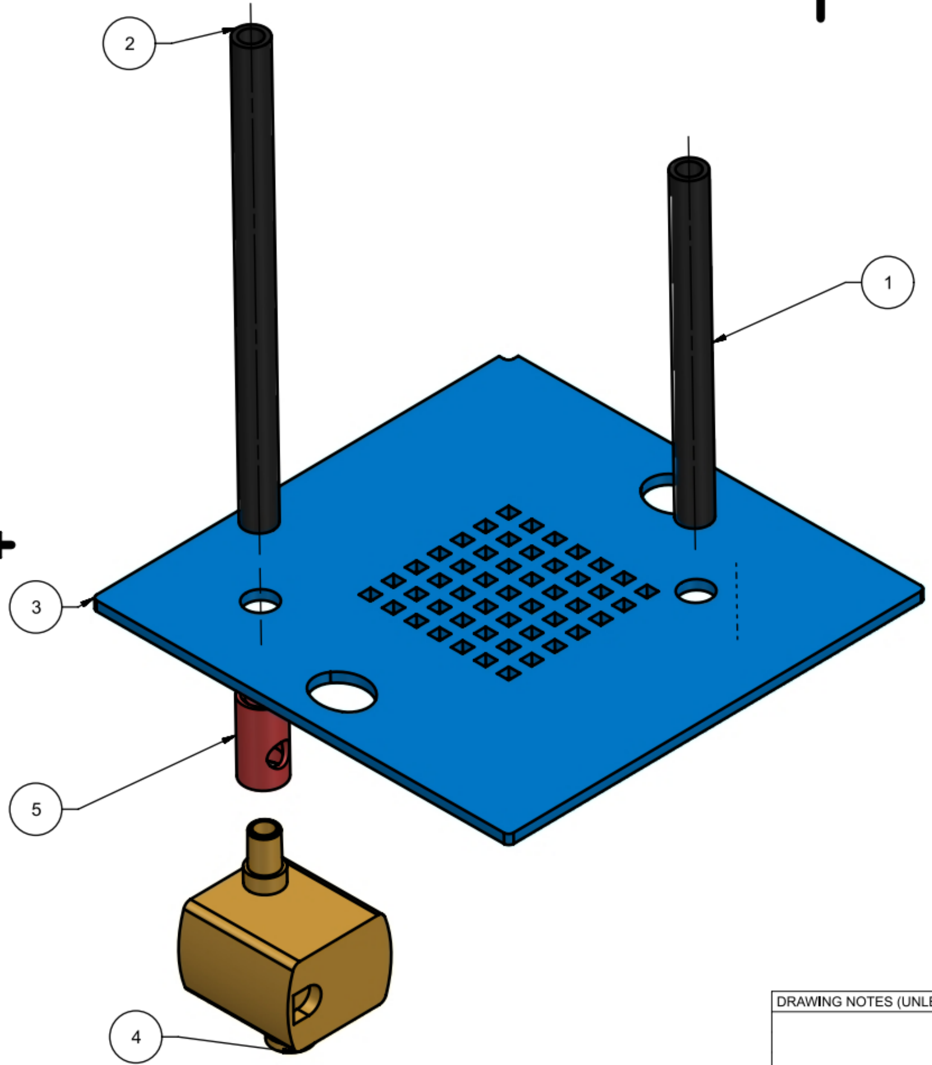

PART NO	PART NAME	QTY
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2	TALL PIPE	1
3	GRATE	1
4	PUMP	1
5	PUMP CONNECTOR	1

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

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Rensselaer

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MATERIAL	
AUTHOR	Abdullah Abid
SIZE	B
CAD FILE	
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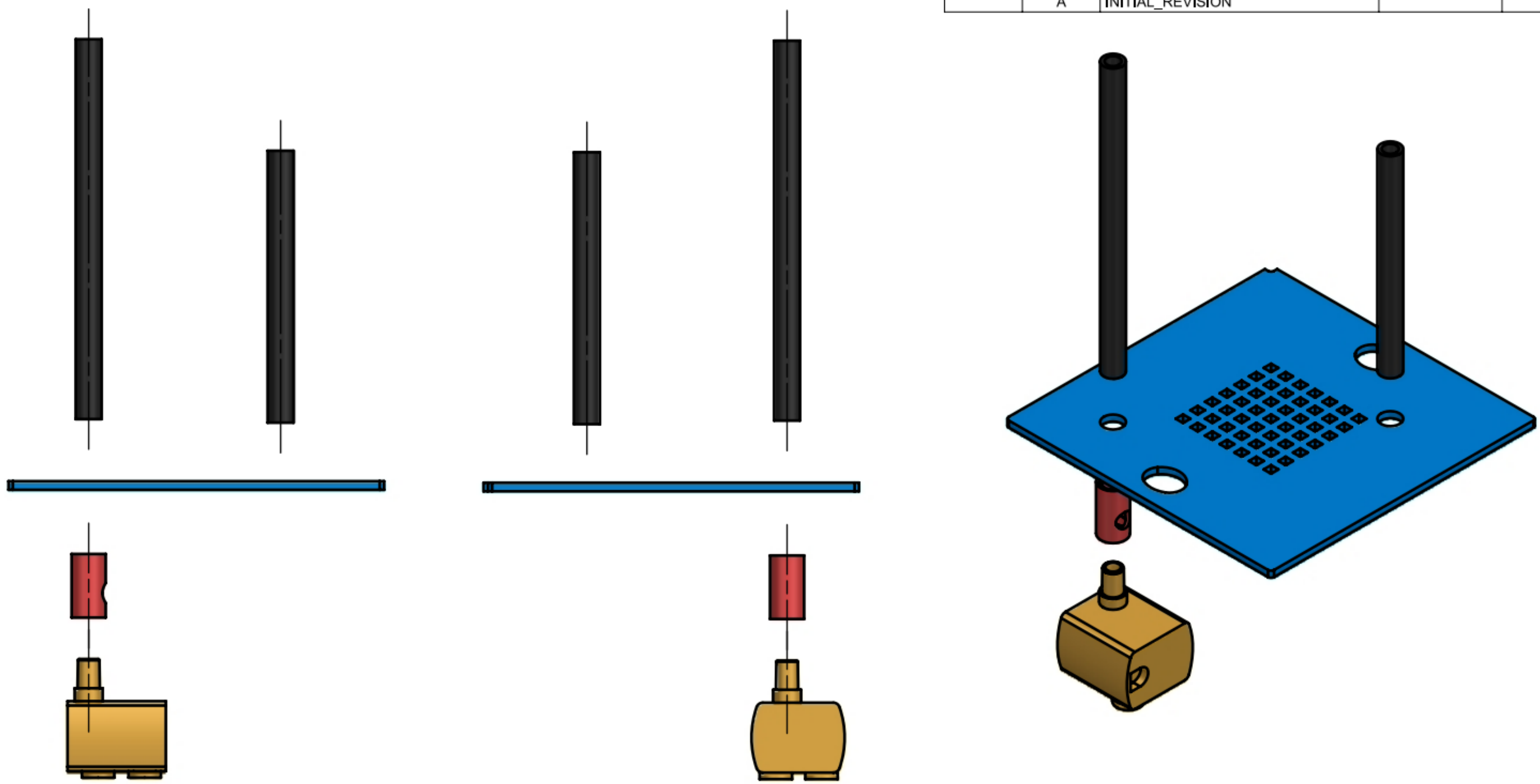

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Rensselaer

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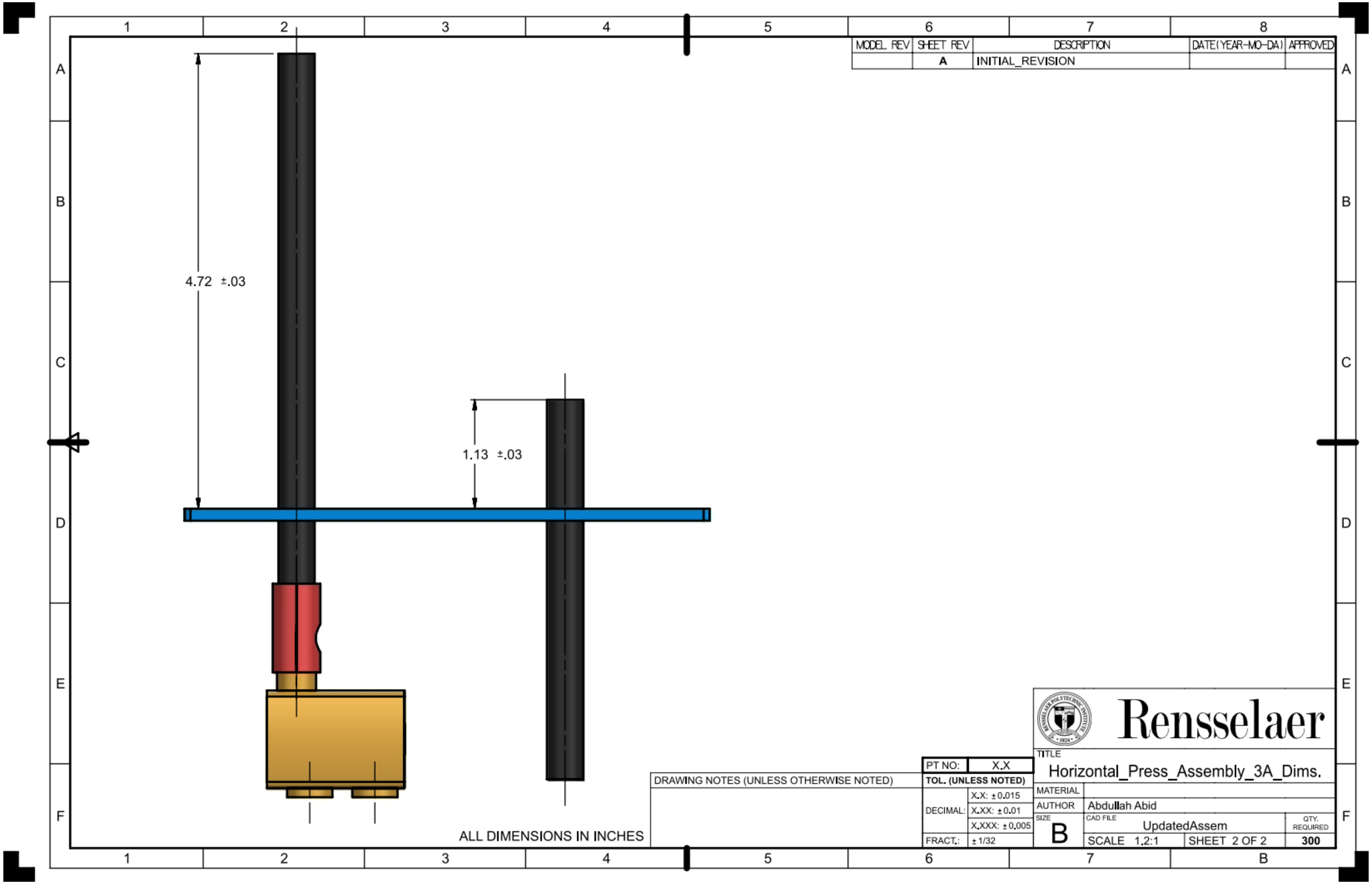
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AUTHOR
Abdullah Abid
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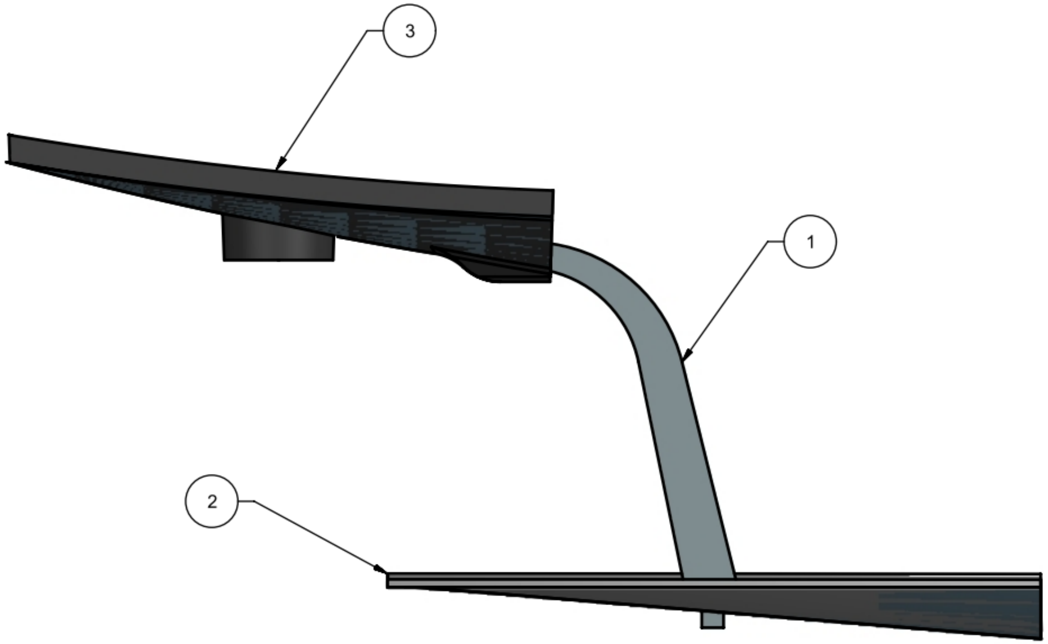

PART NO	PART NAME	QTY
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3	TOP BOWL	1

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

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FRACT.: ±1/32

Rensselaer

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MATERIAL

AUTHOR: Abdullah Abid

SIZE: B

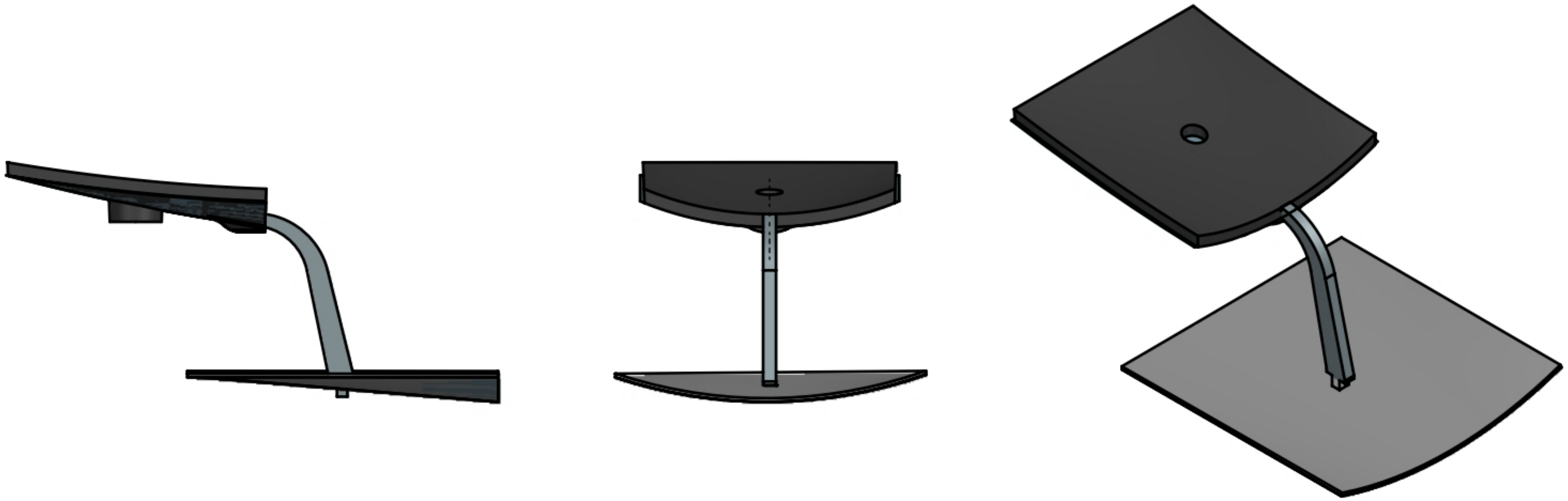
CAD FILE: Bowl_to_Bridge_Assembly_4A

SCALE 2:1

SHEET 1 OF 1

QTY. REQUIRED: 1

MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO:	4A
TOL. (UNLESS NOTED)	
DECIMAL:	X.X: ±0.015
	X.XX: ±0.01
	X.XXX: ±0.005
FRACT.:	±1/32

Rensselaer

TITLE	Bowl_to_Bridge_Assembly_Heat_Staking_Exploded_4A	
MATERIAL		
AUTHOR	Abdullah Abid	
SIZE B	CAD FILE Bowl_to_Bridge_Assembly_4A	QTY. REQUIRED 1
	SCALE 1:1	SHEET 1 OF 1

MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		

PART NO	PART NAME	QTY
1	TALL PIPE	1
2	SHORT PIPE	1
3	TOP BOWL	1
4	BRIDGE	1
5	MIDDLE BOWL	1
6	END BOWL	1

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO: 5.A

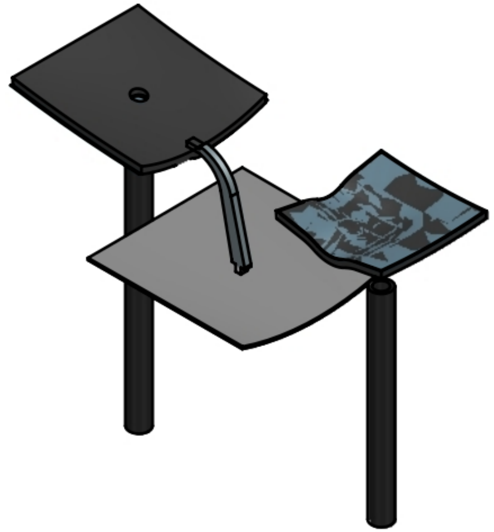
TOL. (UNLESS NOTED)

DECIMAL:	X.X: ±0.015	
	X.XX: ±0.01	
	X.XXX: ±0.005	
FRACT.:	±1/32	

Rensselaer

TITLE	Bowls_Pipe_Assembly_5A		
MATERIAL			
AUTHOR	Abdullah Abid		
SIZE B	CAD FILE		QTY. REQUIRED
	SCALE 1:1	SHEET 1 OF 1	1

MODEL REV	SHEET REV	DESCRIPTION	DATE(YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



SCALE 2:3

ALL DIMENSIONS IN INCHES

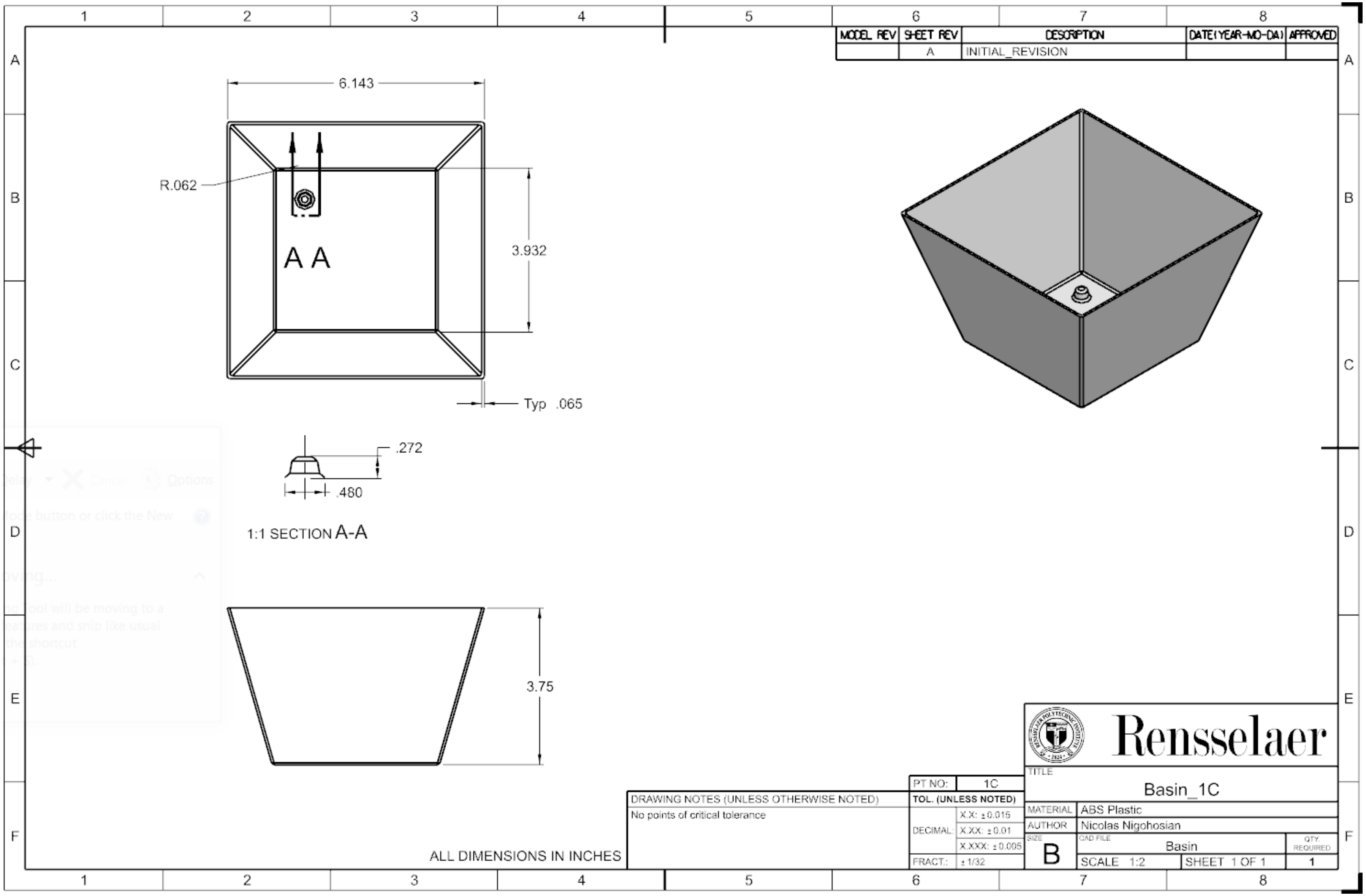
DRAWING NOTES (UNLESS OTHERWISE NOTED)

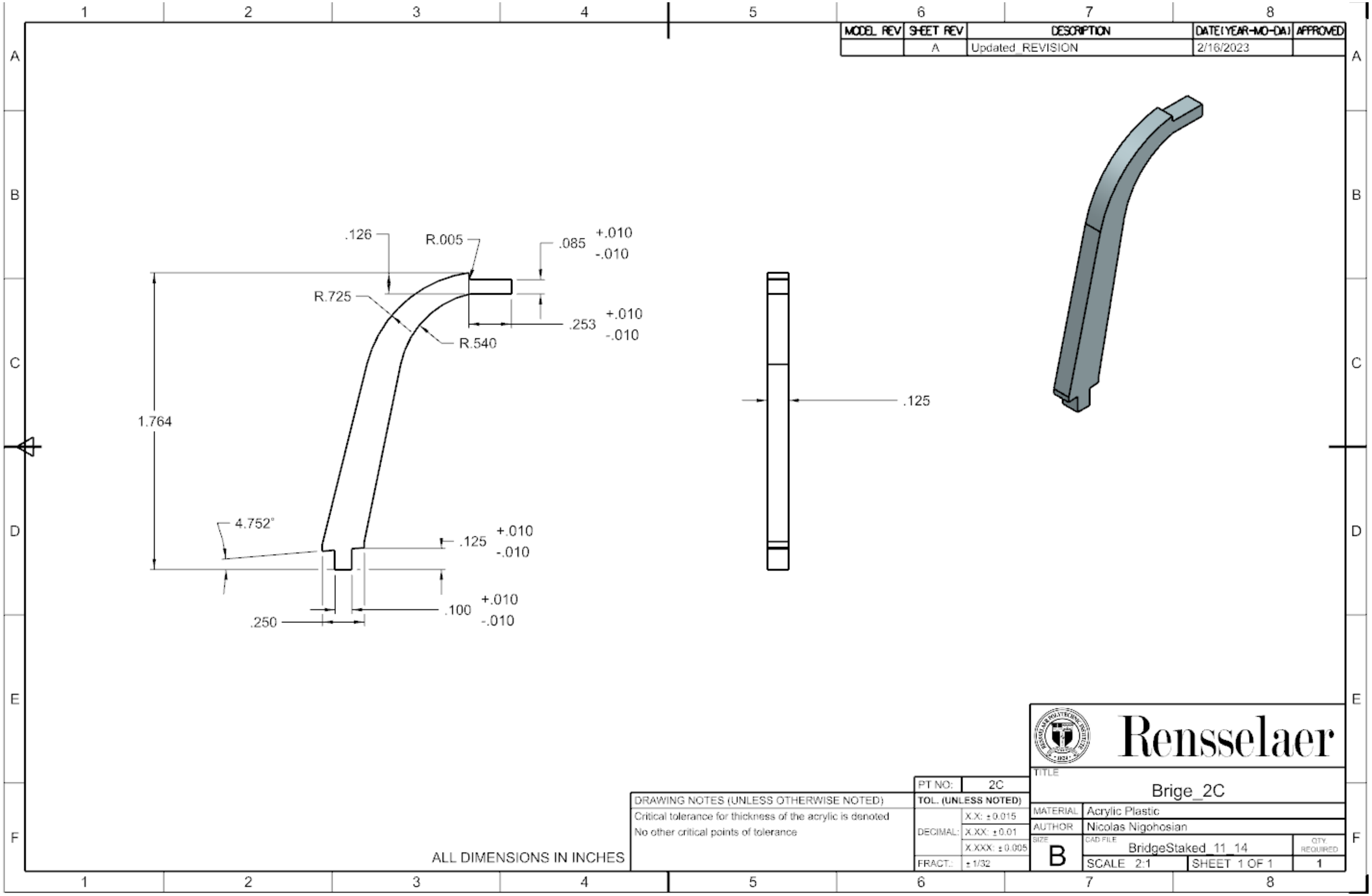
PT NO:	5A	
TOL. (UNLESS NOTED)		
DECIMAL:	X.X: ±0.015	
	X.XX: ±0.01	
	X.XXX: ±0.005	
FRACT.:	±1/32	

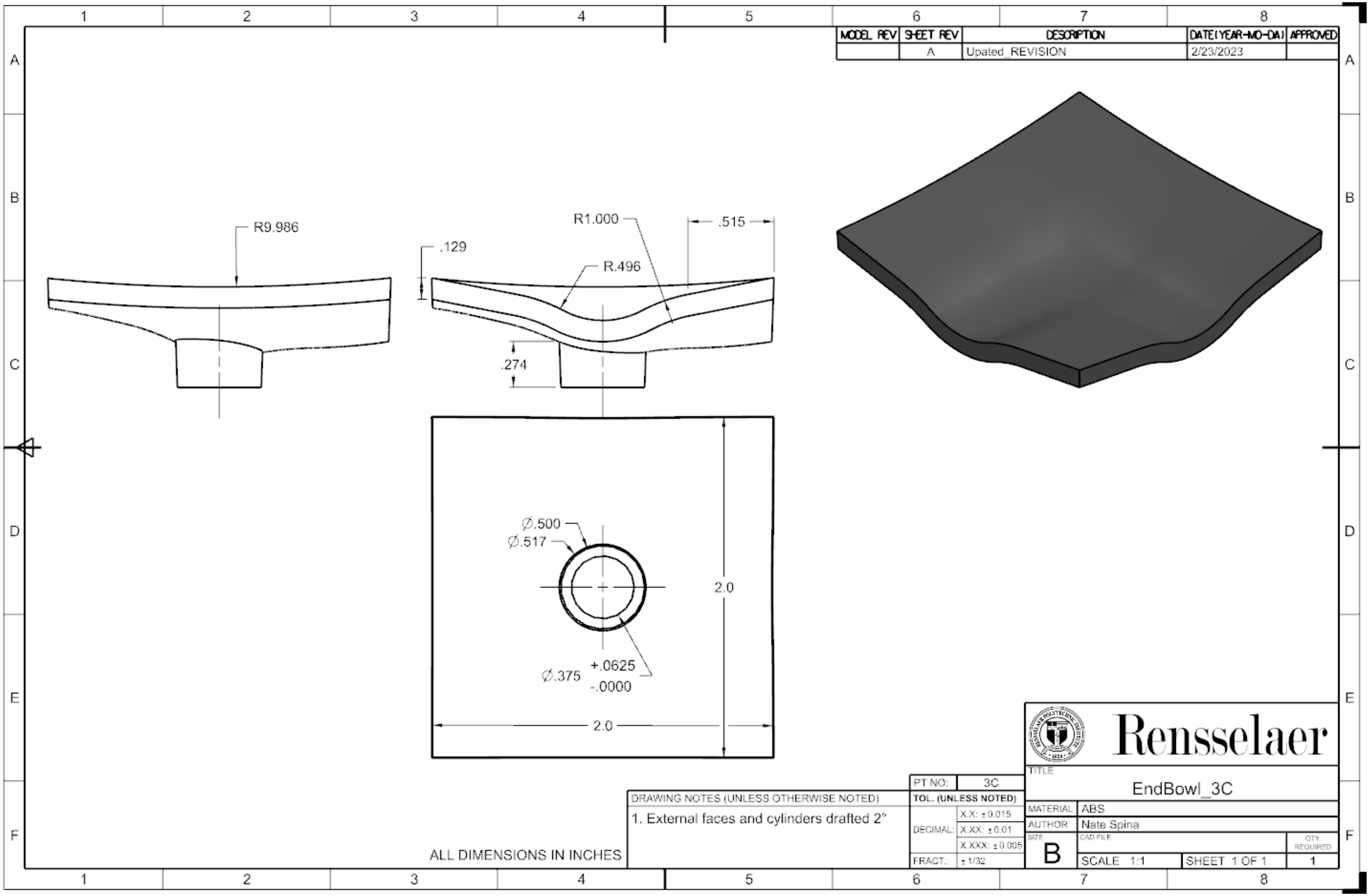
Rensselaer

TITLE	Bowls_Pipe_Assembly_5A_Pressfit_Exploded		
MATERIAL			
AUTHOR	Abdullah Abid		
SIZE B	CAD FILE Bowls_Pipe_Assembly_5A		QTY. REQUIRED 1
	SCALE 1:1	SHEET 1 OF 1	

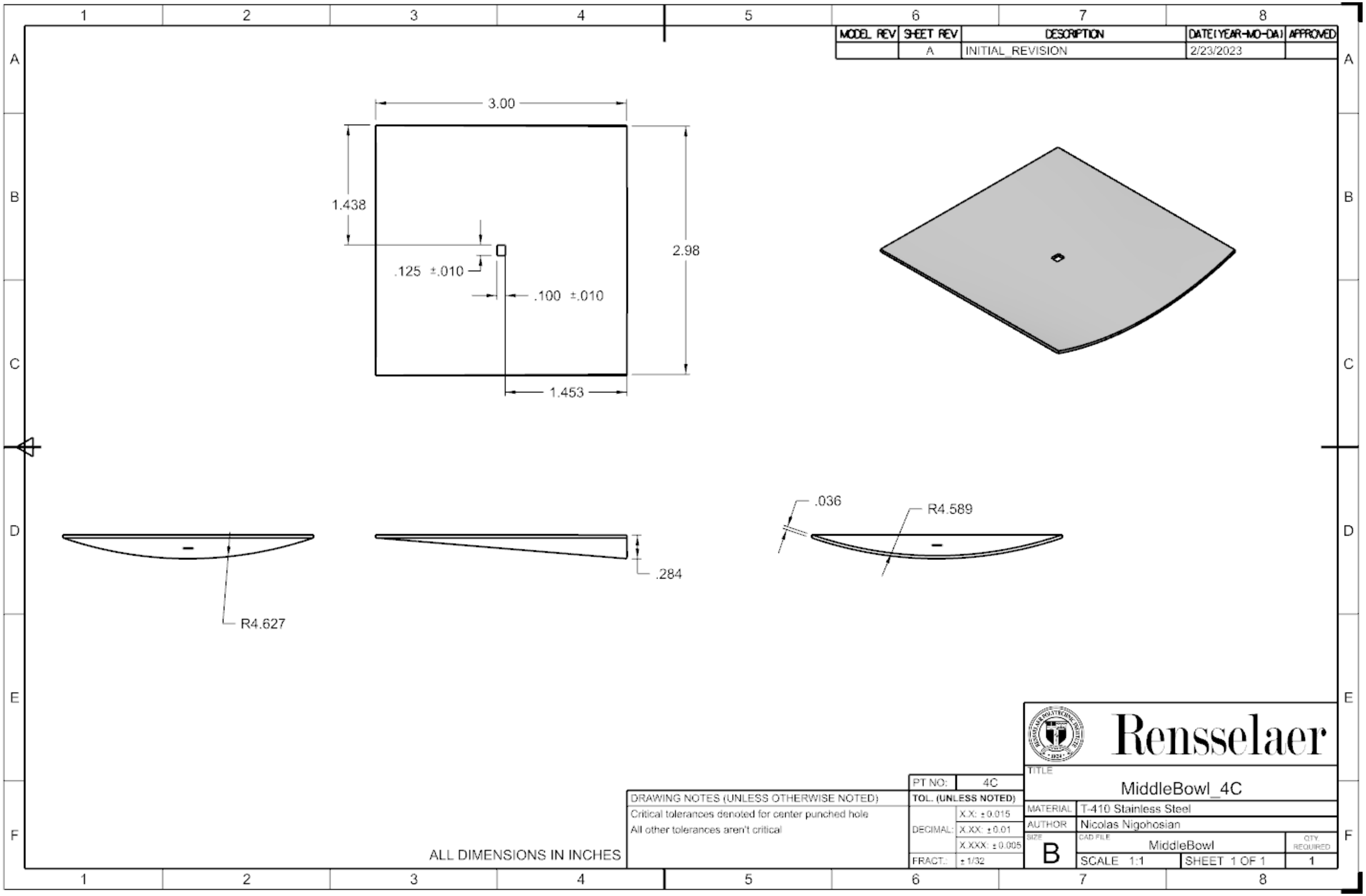
Component Drawings


MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
6.143
R.062
A A
3.932
Typ .065
.272
.480
1:1 SECTION A-A
3.75
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
No points of critical tolerance
PT NO: 1C
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Basin_1C
MATERIAL ABS Plastic
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE Basin
QTY. REQUIRED 1
SCALE 1:2
SHEET 1 OF 1

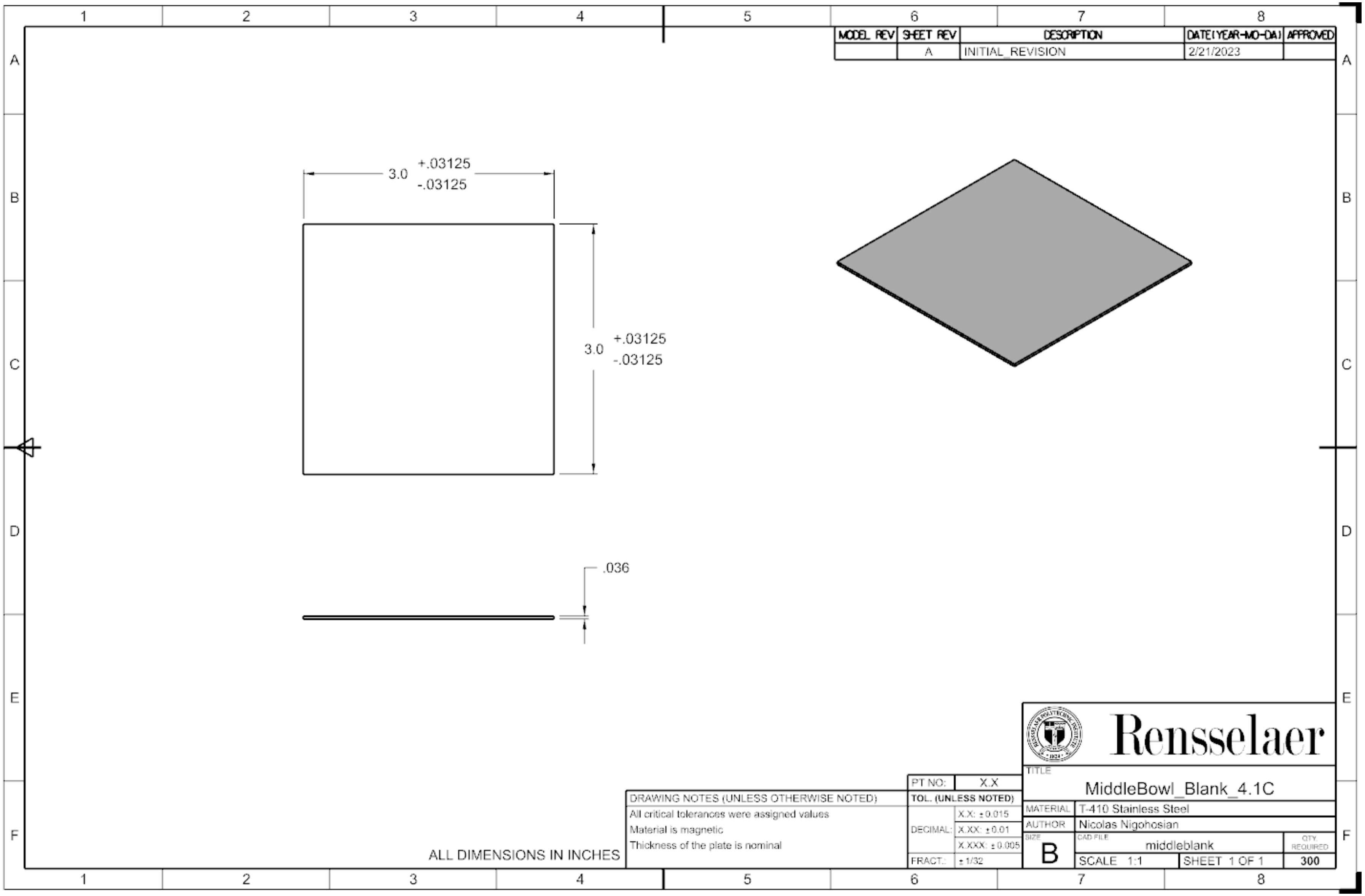

MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
Updated REVISION
2/16/2023
.126
R.005
.085 +.010 -.010
R.725
R.540
.253 +.010 -.010
1.764
4.752°
.125 +.010 -.010
.250
.100 +.010 -.010
.125
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Critical tolerance for thickness of the acrylic is denoted
No other critical points of tolerance
PT NO: 2C
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Brige_2C
MATERIAL Acrylic Plastic
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE BridgeStaked_11_14
QTY. REQUIRED 1
SCALE 2:1
SHEET 1 OF 1

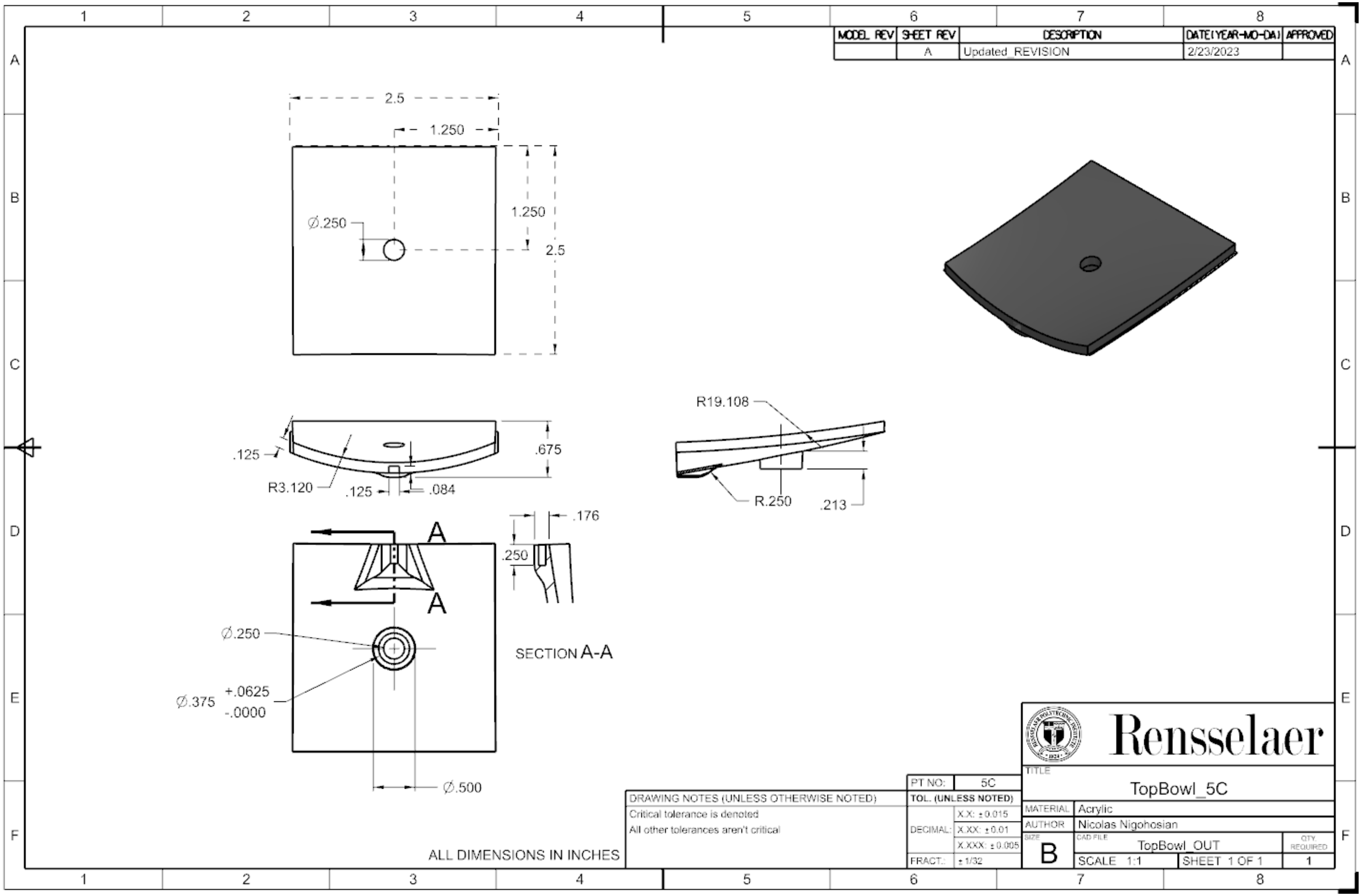


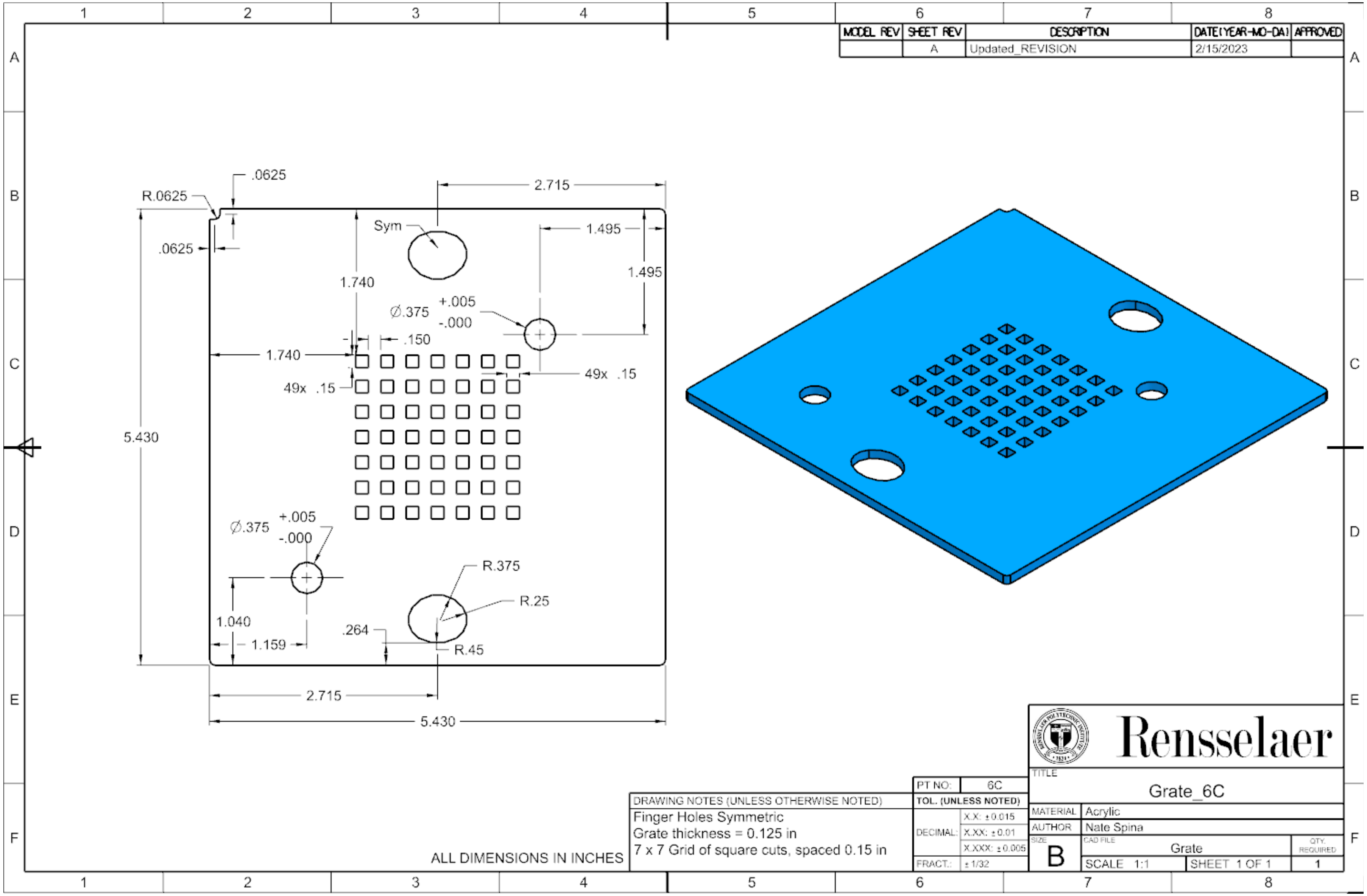
MODEL REV | SHEET REV | DESCRIPTION | DATE (YEAR-MO-DA) | APPROVED
A | Upated_REVISION | 2/23/2023
R9.986
.129
R1.000
.515
R.496
.274
Ø.500
Ø.517
Ø.375 +.0625 -.0000
2.0
2.0
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. External faces and cylinders drafted 2°
PT NO: 3C
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015 X.XX: ±0.01 X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE EndBowl_3C
MATERIAL ABS
AUTHOR Nate Spina
SIZE B
SCALE 1:1
SHEET 1 OF 1
QTY. REQUIRED 1

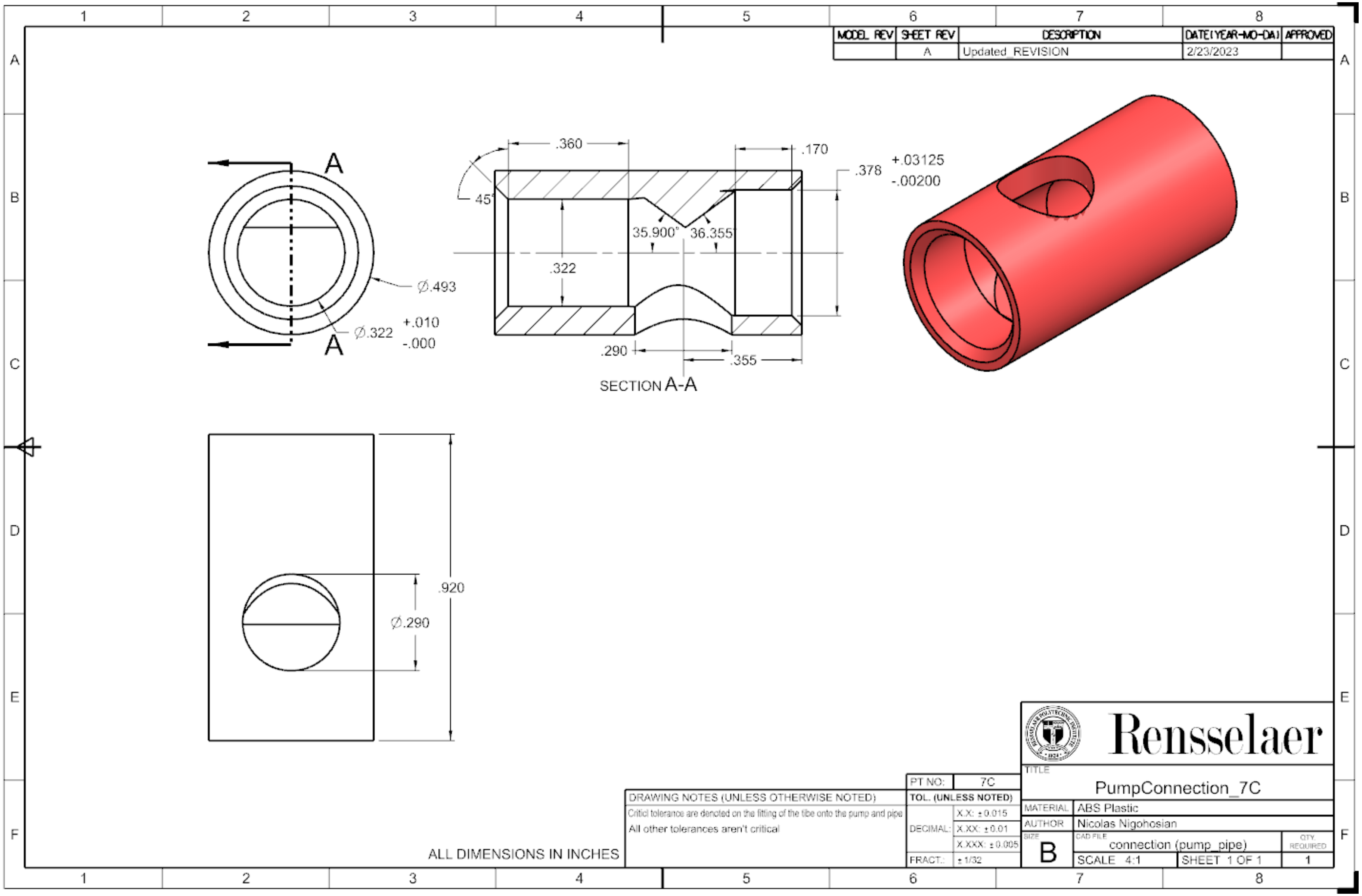


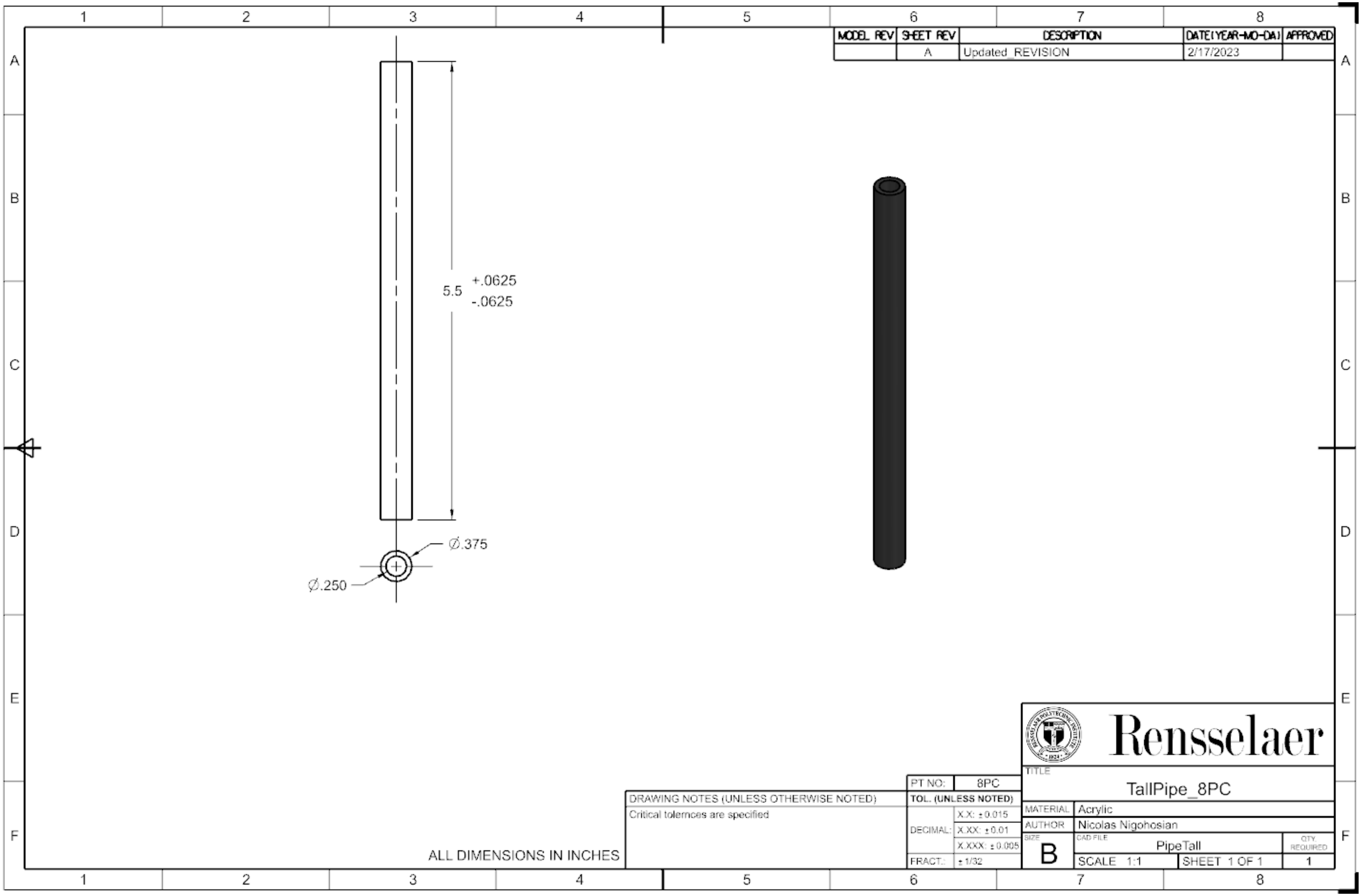
MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
2/23/2023
3.00
1.438
2.98
.125 ±.010
.100 ±.010
1.453
.036
R4.589
.284
R4.627
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Critical tolerances denoted for center punched hole
All other tolerances aren't critical
PT NO: 4C
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
MiddleBowl_4C
MATERIAL T-410 Stainless Steel
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE MiddleBowl
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

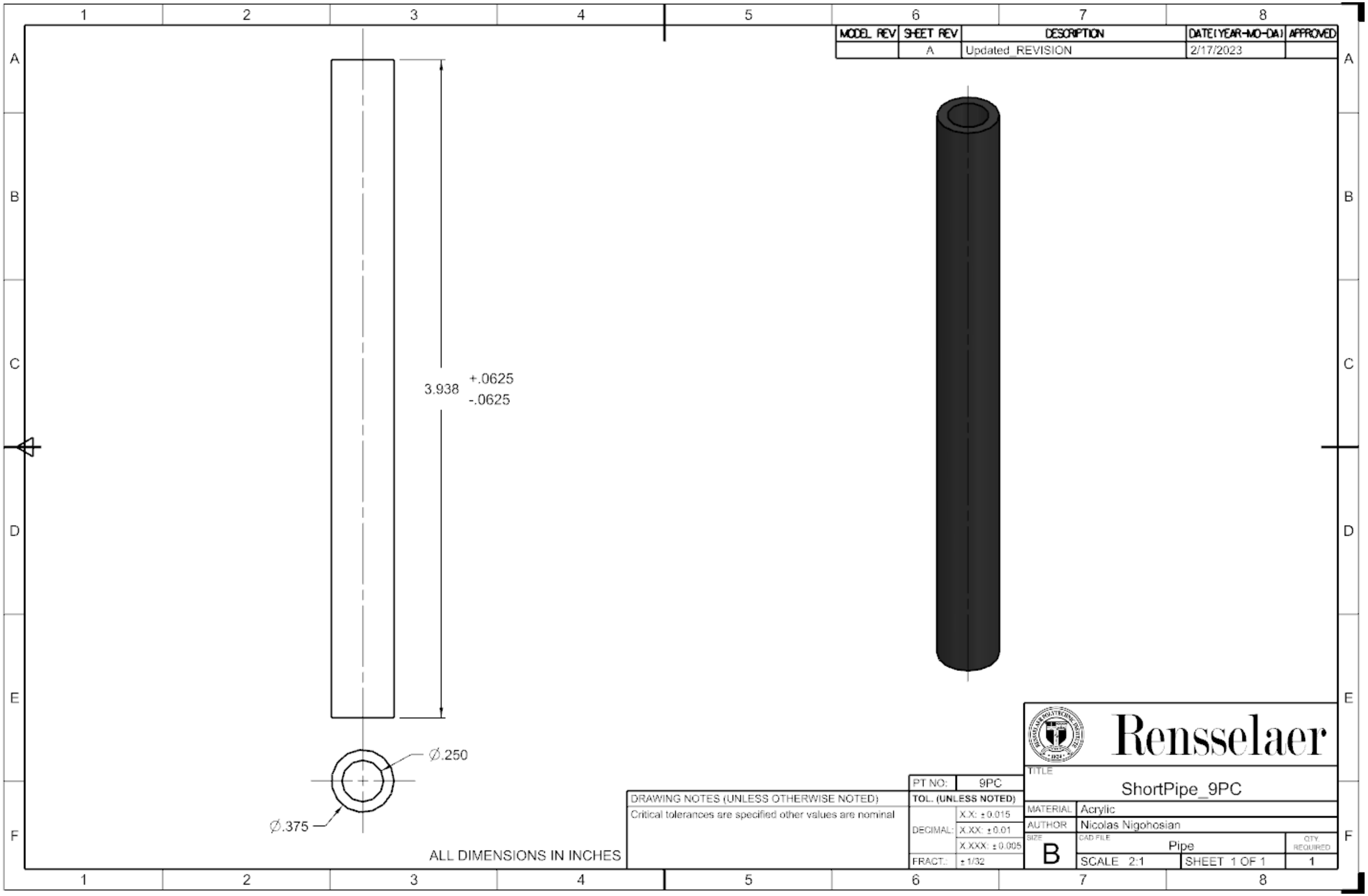

MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
2/21/2023
3.0 +.03125 -.03125
3.0 +.03125 -.03125
.036
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
All critical tolerances were assigned values
Material is magnetic
Thickness of the plate is nominal
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
MiddleBowl_Blank_4.1C
MATERIAL T-410 Stainless Steel
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE middleblank
QTY. REQUIRED 300
SCALE 1:1
SHEET 1 OF 1

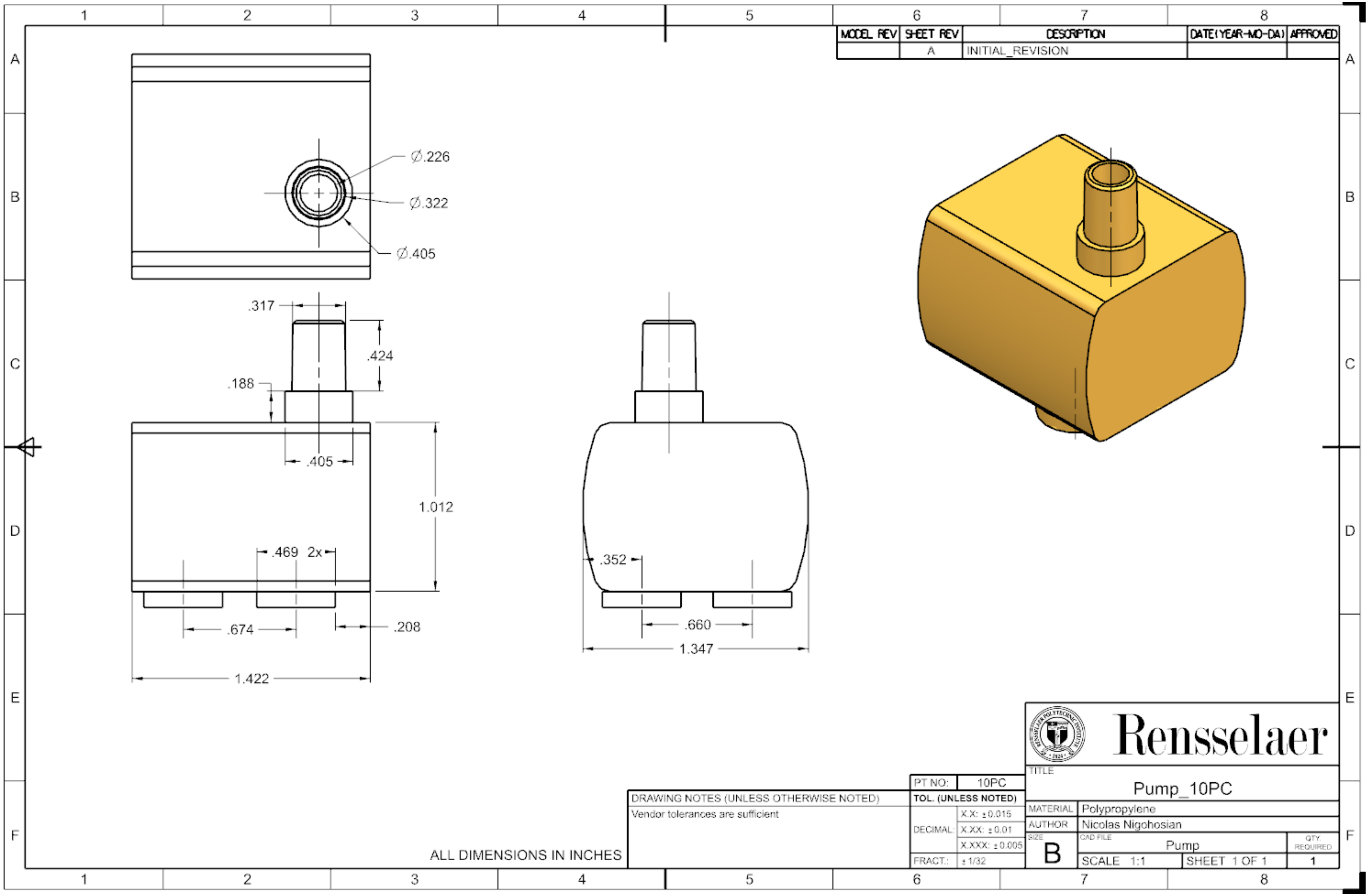

MODEL REV | SHEET REV | DESCRIPTION | DATE (YEAR-MO-DA) | APPROVED
A | Updated_REVISION | 2/23/2023
2.5
1.250
∅.250
1.250
2.5
R19.108
.125
.675
R3.120
.125
.084
R.250
.213
.176
A
.250
A
∅.250
SECTION A-A
∅.375 +.0625 -.0000
∅.500
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Critical tolerance is denoted
All other tolerances aren't critical
PT NO: 5C
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015 X.XX: ±0.01 X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE TopBowl_5C
MATERIAL Acrylic
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE TopBowl_OUT
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1


MODEL REV | SHEET REV | DESCRIPTION | DATE (YEAR-MO-DA) | APPROVED
A | Updated_REVISION | 2/15/2023
.0625
R.0625
.0625
2.715
1.495
1.495
Sym
1.740
∅.375 +.005 -.000
.150
1.740
49x .15
49x .15
5.430
∅.375 +.005 -.000
R.375
R.25
1.040
.264
1.159
R.45
2.715
5.430
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Finger Holes Symmetric
Grate thickness = 0.125 in
7 x 7 Grid of square cuts, spaced 0.15 in
PT NO: 6C
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015 X.XX: ±0.01 X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE Grate_6C
MATERIAL Acrylic
AUTHOR Nate Spina
SIZE B
CAD FILE Grate
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
Updated_REVISION
2/23/2023
A
A
Ø.493
Ø.322
+.010
-.000
.360
.170
.378
+.03125
-.00200
45°
35.900°
36.355°
.322
.290
.355
SECTION A-A
.920
Ø.290
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Critical tolerance are denoted on the fitting of the tibe onto the pump and pipe
All other tolerances aren't critical
PT NO: 7C
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
PumpConnection_7C
MATERIAL ABS Plastic
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE connection (pump_pipe)
QTY. REQUIRED 1
SCALE 4:1
SHEET 1 OF 1

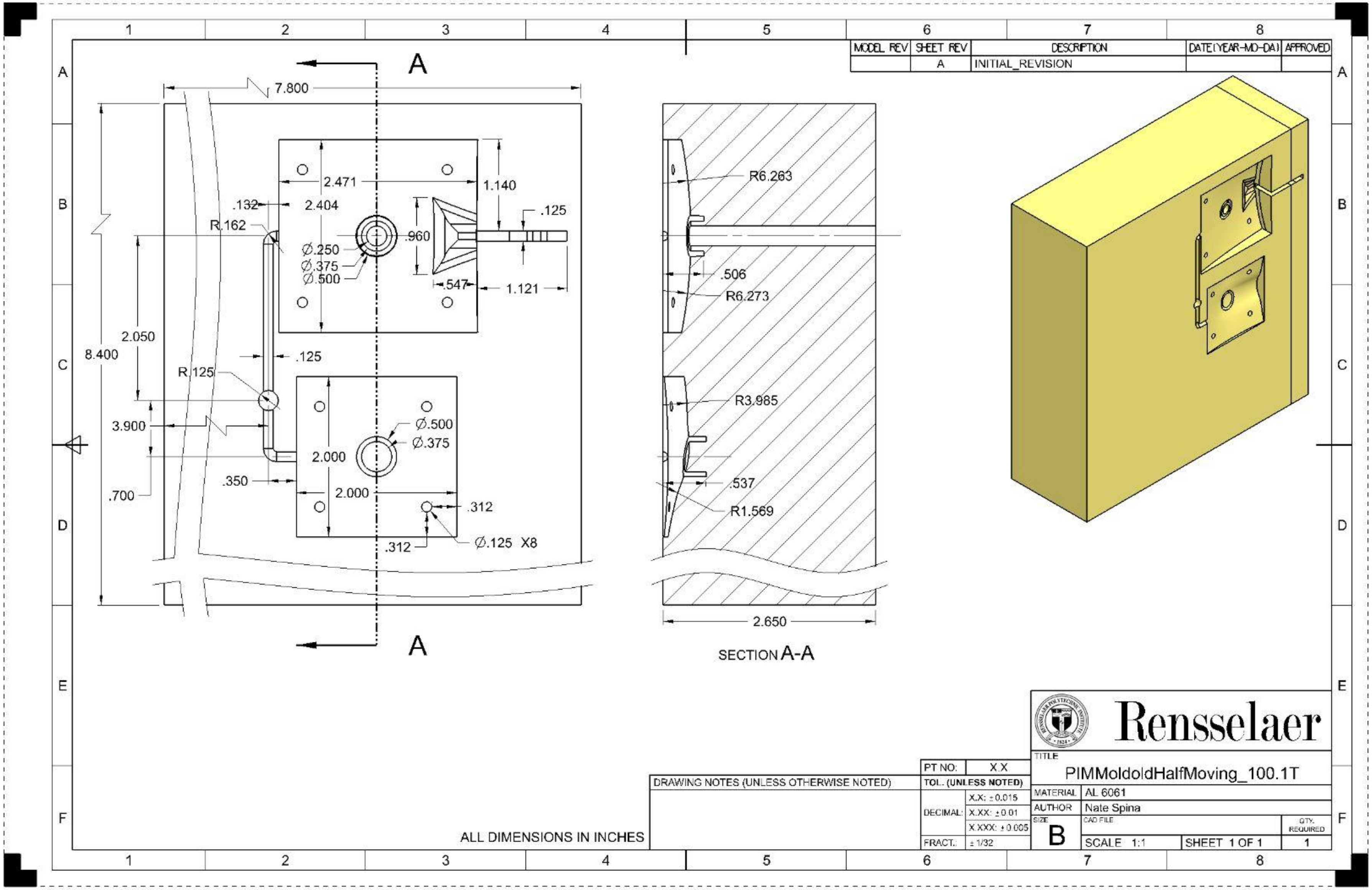

MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
Updated_REVISION
2/17/2023
5.5 +.0625 -.0625
∅.375
∅.250
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Critical tolernces are specified
PT NO: 8PC
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
TallPipe_8PC
MATERIAL Acrylic
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE PipeTall
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

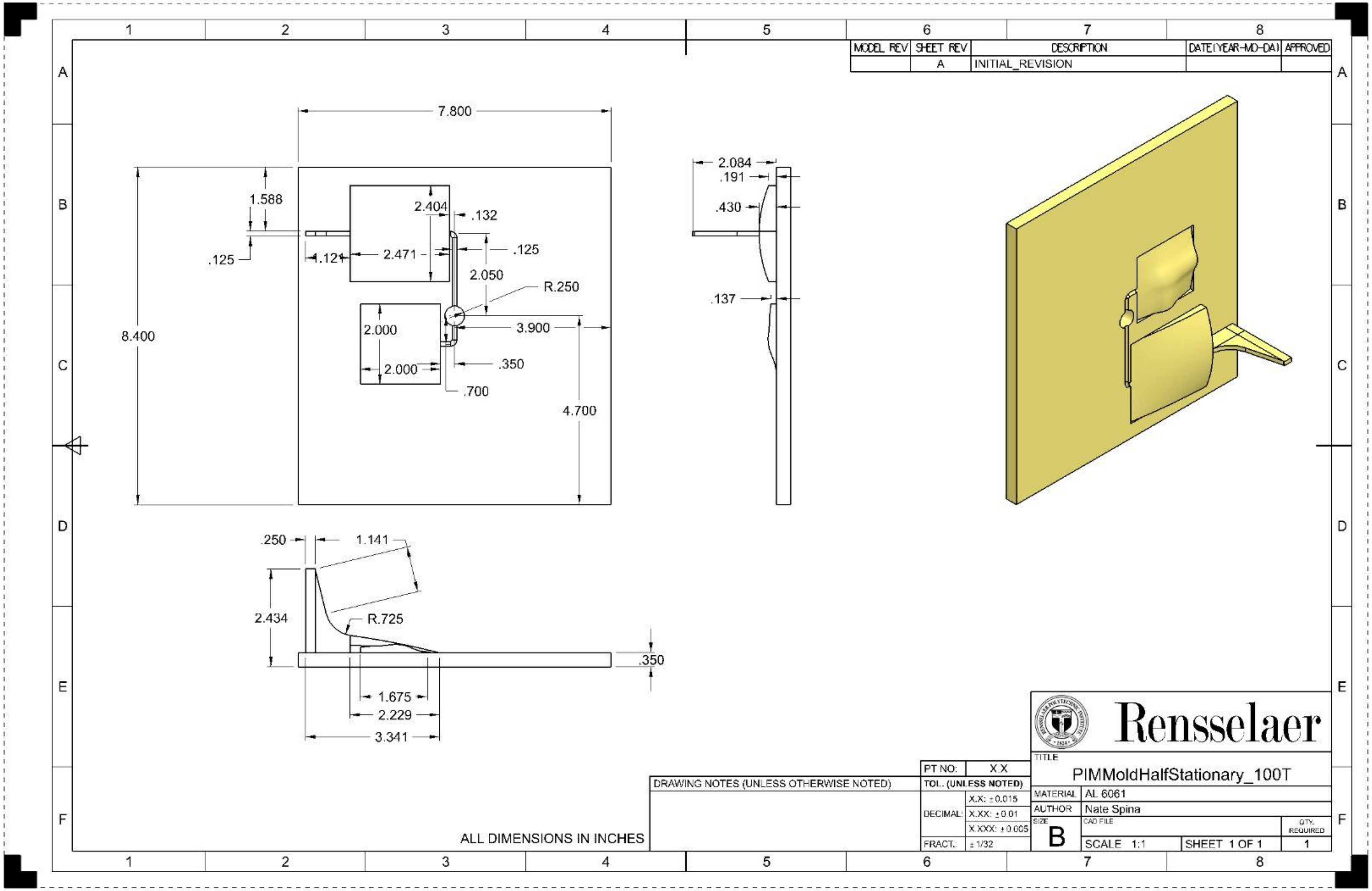

MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
Updated_REVISION
2/17/2023
3.938
+.0625
-.0625
Ø.250
Ø.375
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Critical tolerances are specified other values are nominal
PT NO:
9PC
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.:
±1/32
Rensselaer
TITLE
ShortPipe_9PC
MATERIAL
Acrylic
AUTHOR
Nicolas Nigohosian
SIZE
B
CAD FILE
Pipe
QTY. REQUIRED
1
SCALE 2:1
SHEET 1 OF 1



MODEL REV | SHEET REV | DESCRIPTION | DATE (YEAR-MO-DA) | APPROVED
A | INITIAL_REVISION
Ø.226
Ø.322
Ø.405
.317
.424
.188
.405
1.012
.469 2x
.674
.208
1.422
.352
.660
1.347
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
Vendor tolerances are sufficient
PT NO: 10PC
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Pump_10PC
MATERIAL Polypropylene
AUTHOR Nicolas Nigohosian
SIZE B
CAD FILE Pump
QTY REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

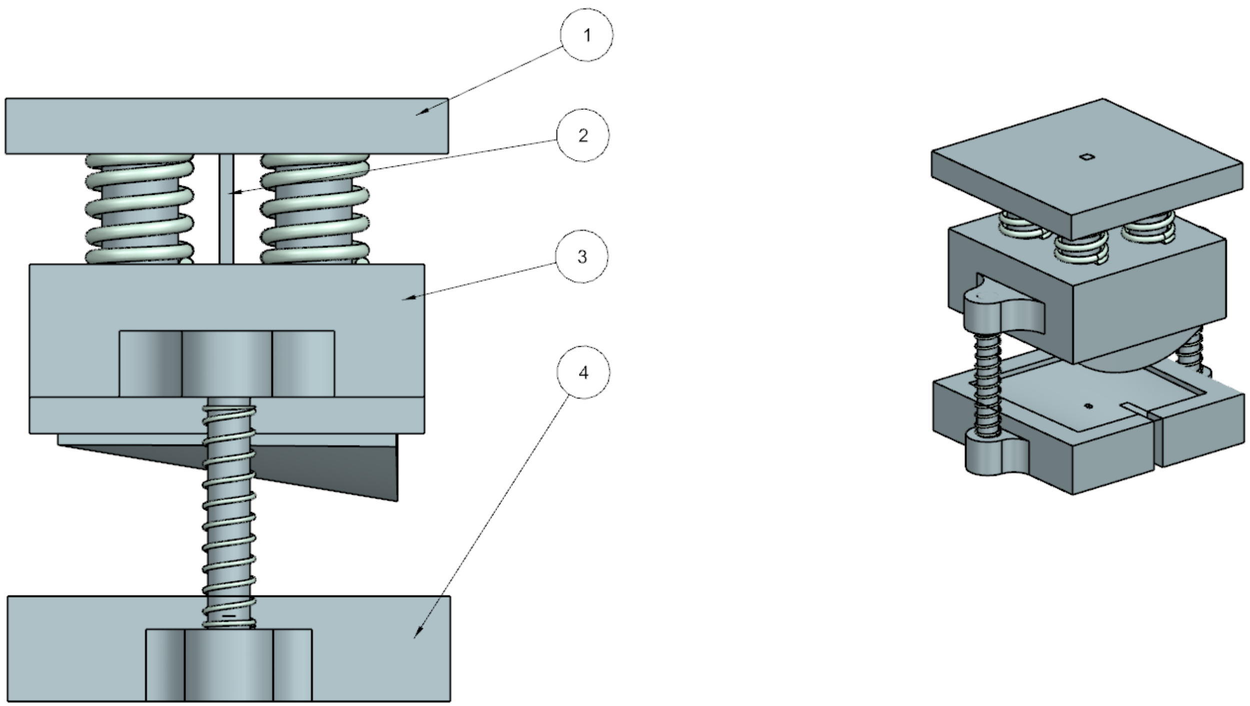
Process Tooling


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
A
7.800
8.400
2.471
2.404
1.140
.125
.132
R.162
.960
Ø.250
Ø.375
Ø.500
.547
1.121
2.050
.125
R.125
3.900
Ø.500
Ø.375
2.000
.350
2.000
.700
.312
.312
Ø.125 X8
A
R6.263
.506
R6.273
R3.985
.537
R1.569
2.650
SECTION A-A
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
PIMMoldoldHalfMoving_100.1T
MATERIAL AL 6061
AUTHOR Nate Spina
SIZE B
CAD FILE
SCALE 1:1
SHEET 1 OF 1
QTY. REQUIRED 1



MODEL REV | SHEET REV | DESCRIPTION | DATE(YEAR-MO-DA) | APPROVED
A | INITIAL_REVISION
7.800
8.400
1.588
2.404
.132
.125
.121
2.471
.125
2.050
R.250
2.000
3.900
2.000
.350
.700
4.700
2.084
.191
.430
.137
.250
1.141
2.434
R.725
.350
1.675
2.229
3.341
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
PIMMoldHalfStationary_100T
MATERIAL AL 6061
AUTHOR Nate Spina
SIZE B
CAD FILE
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

MODEL REV	SHEET REV	DESCRIPTION	DATE(YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



1	MiddleBowlPunchandDieGuidePlate_200.3T
2	ShearingPin_200.4T
3	MiddleBowlPunch.200.2T
4	MiddleBowlDie_200.1T

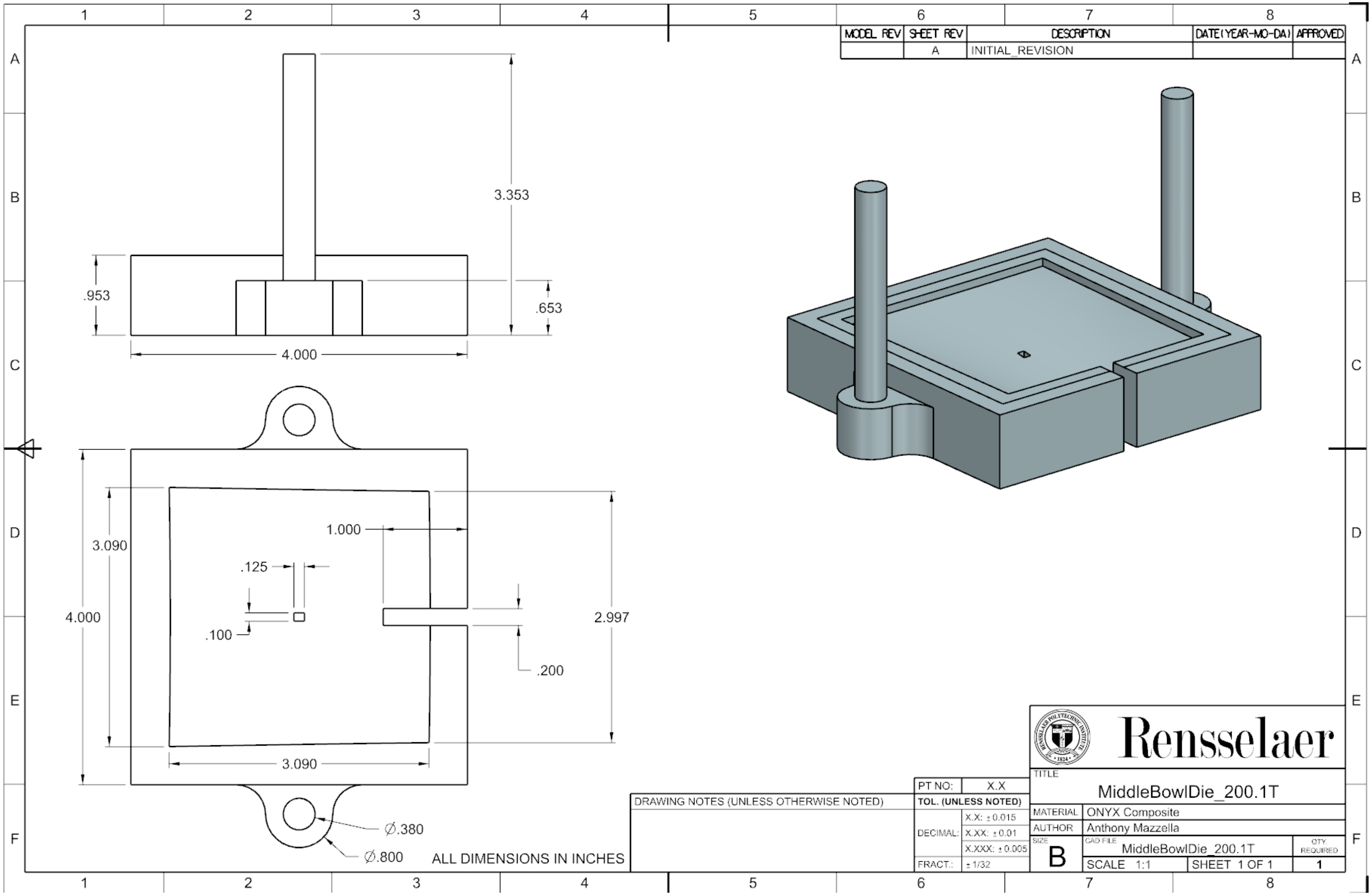
ALL DIMENSIONS IN INCHES

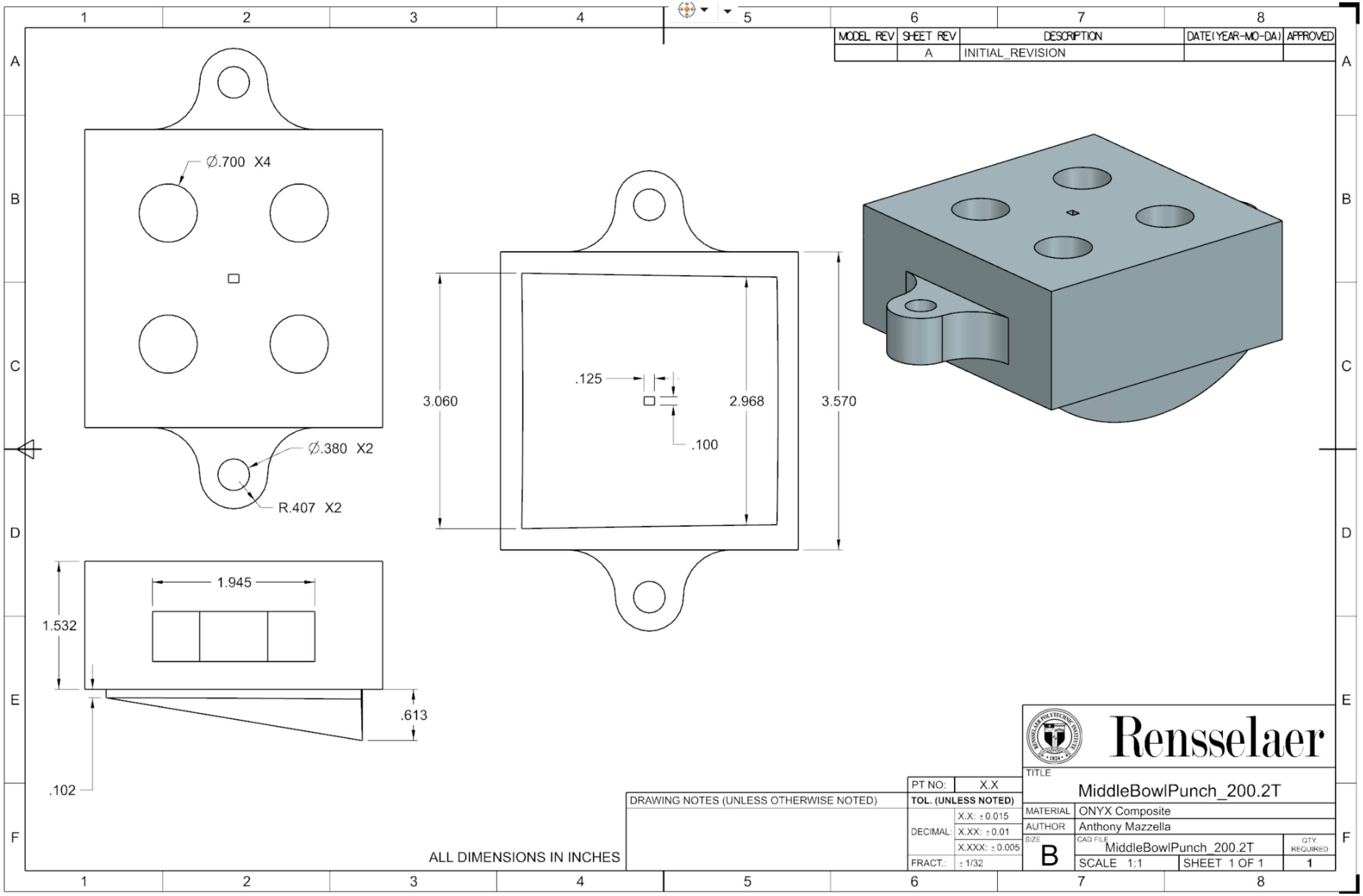
DRAWING NOTES (UNLESS OTHERWISE NOTED)

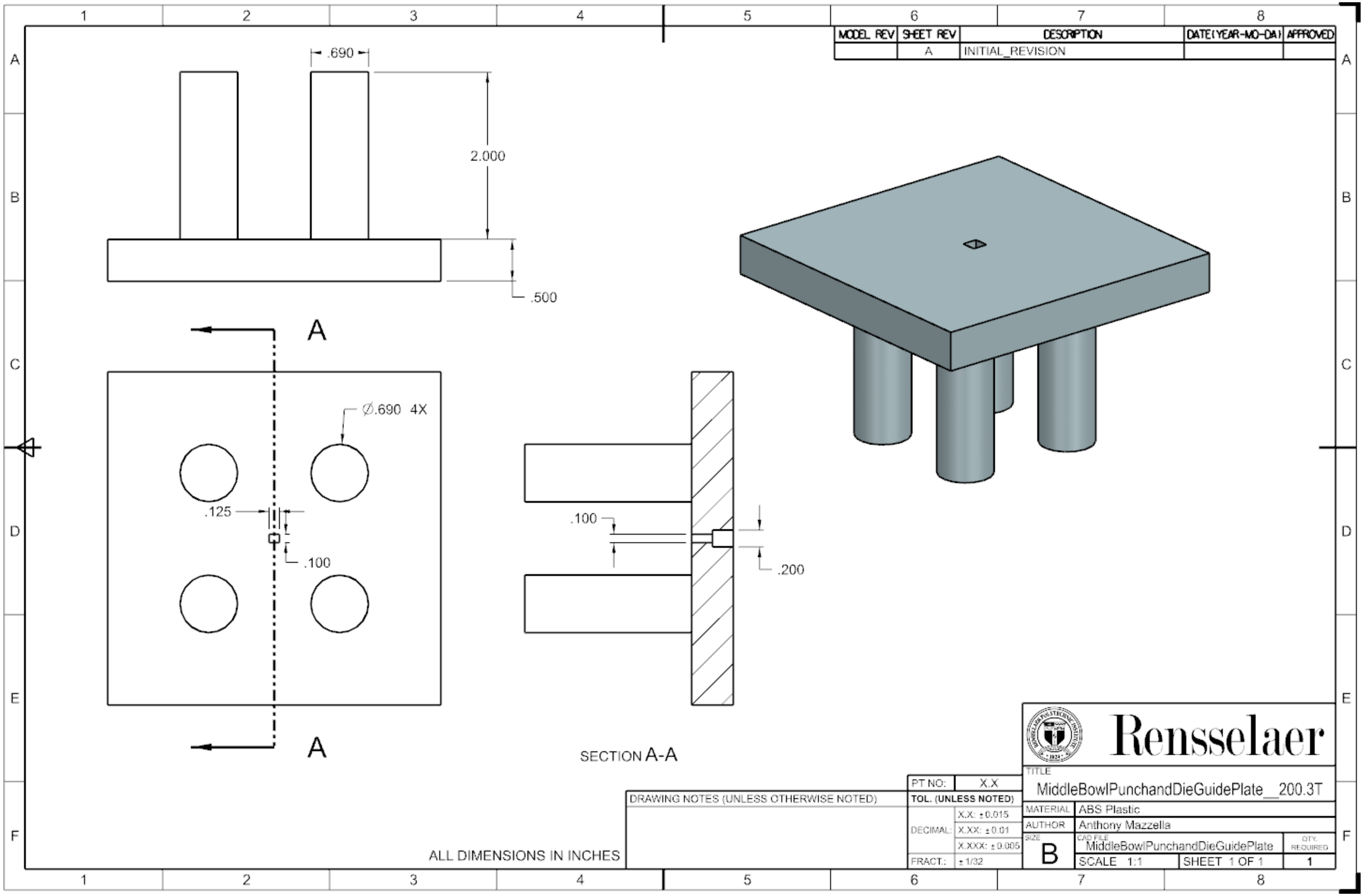
PT NO:	X.X
TOL. (UNLESS NOTED)	
DECIMAL:	X.X: ±0.015
	X.XX: ±0.01
	X.XXX: ±0.005
FRACT.:	±1/32

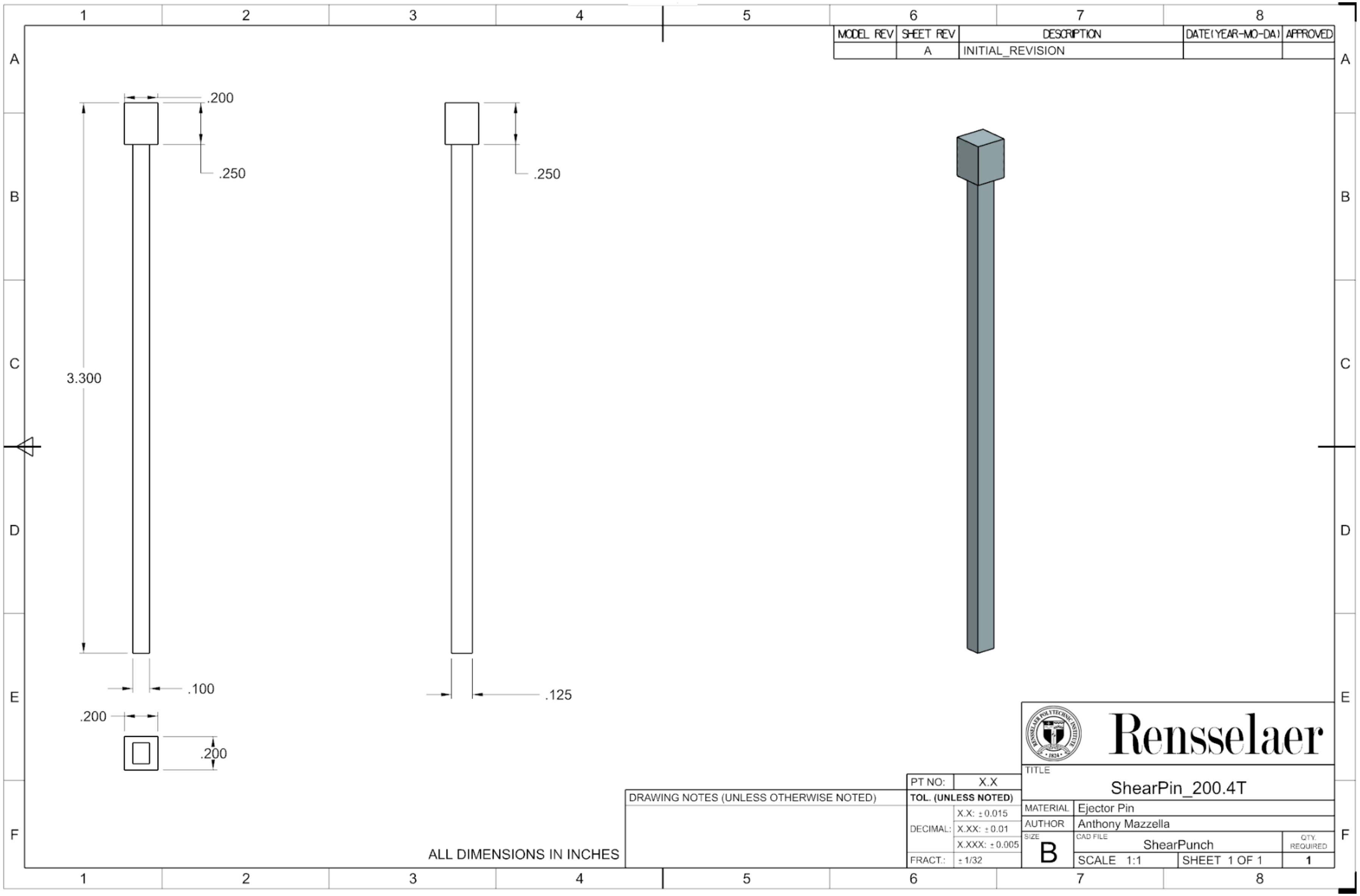
Rensselaer

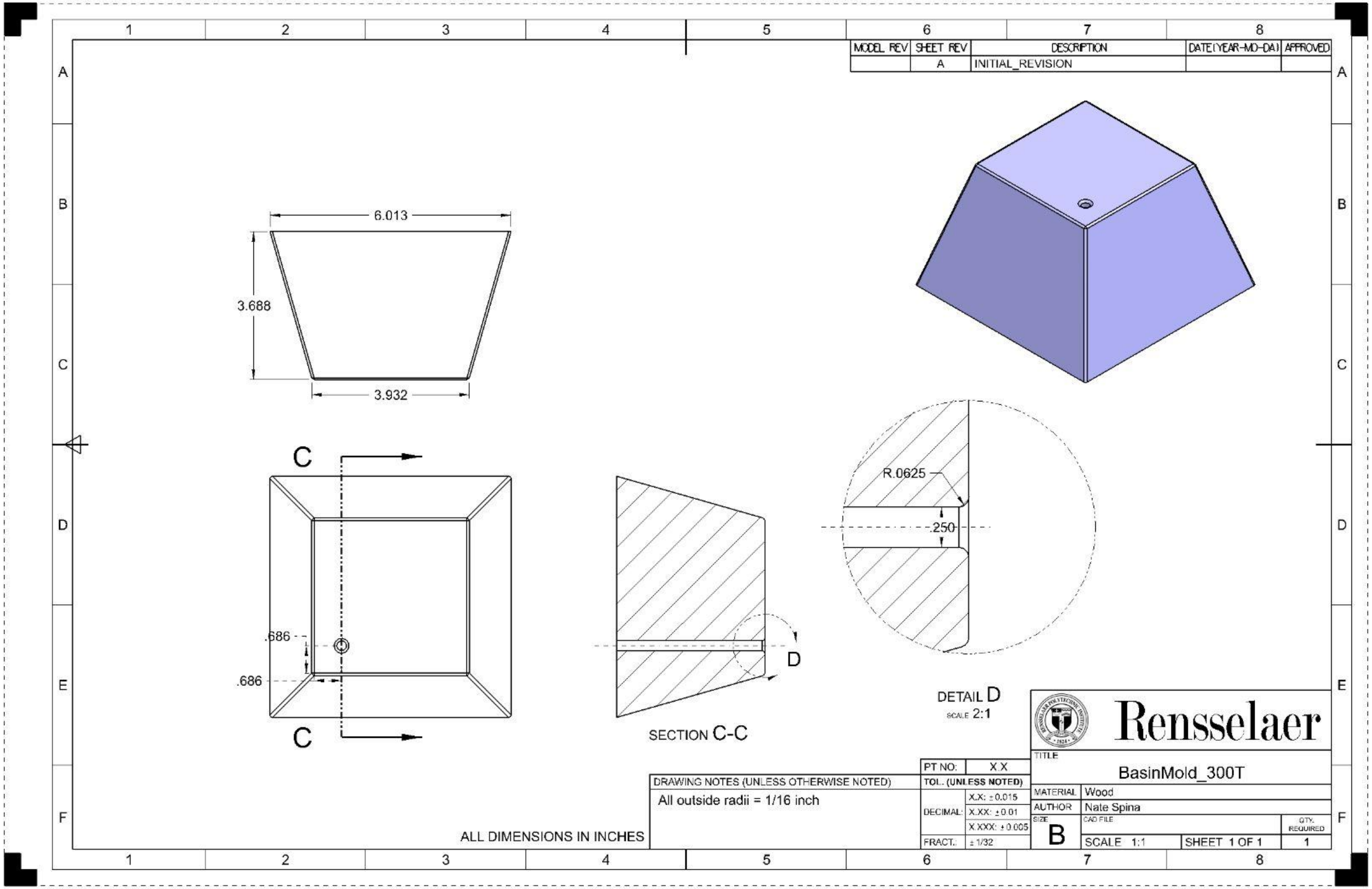
TITLE	MiddleBowlPunchandDie_200.T		
MATERIAL	Misc		
AUTHOR	Anthony Mazzell		
SIZE B	CAD FILE MiddleBowlPunchandDie_200T		QTY. REQUIRED 1
	SCALE 1:1	SHEET 1 OF 1	


MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
3.353
.953
.653
4.000
1.000
3.090
.125
4.000
.100
2.997
.200
3.090
∅.380
∅.800
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
MiddleBowlDie_200.1T
MATERIAL ONYX Composite
AUTHOR Anthony Mazzella
SIZE B
CAD FILE MiddleBowlDie_200.1T
QTY REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

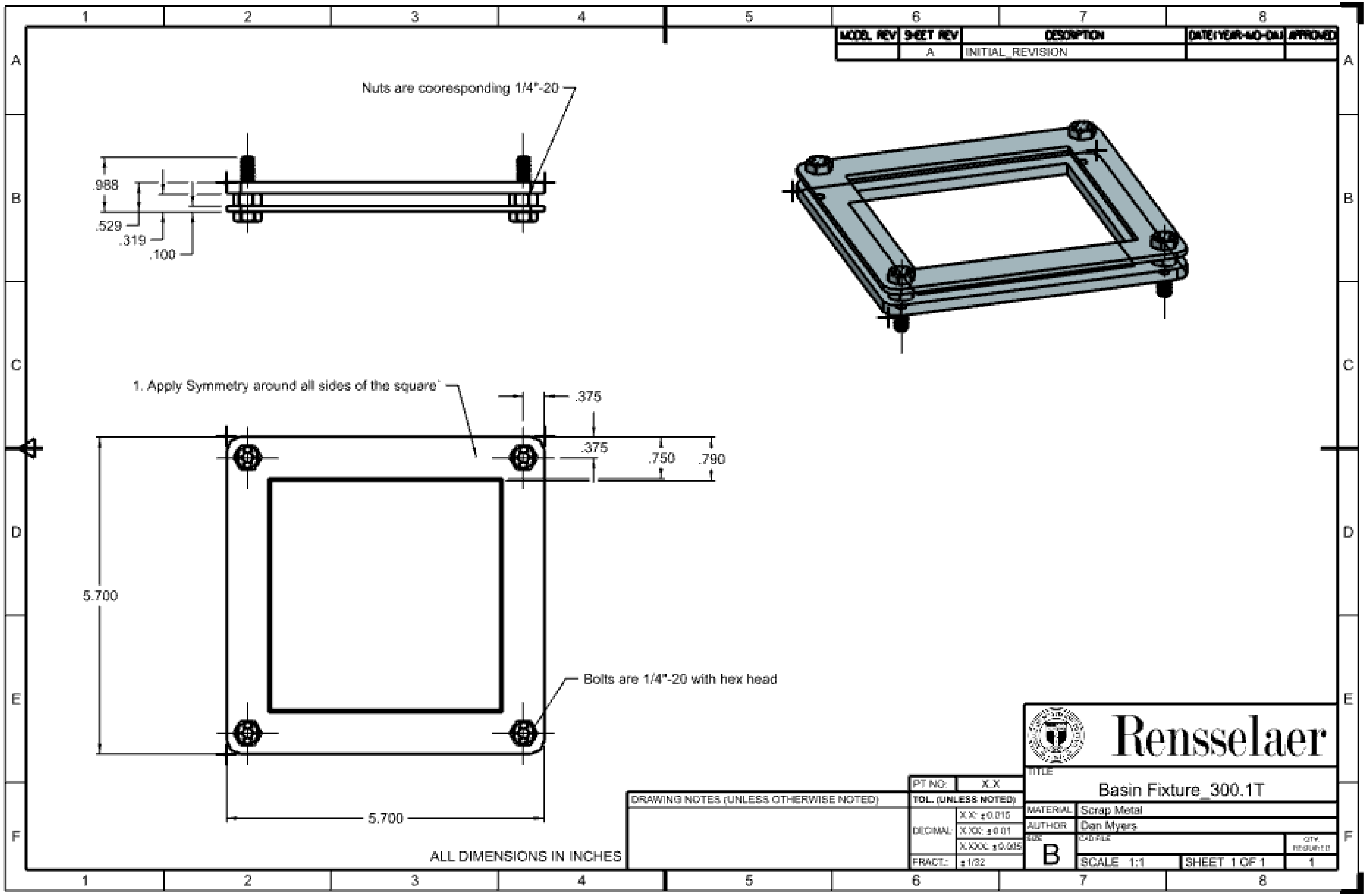

MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
∅.700 X4
∅.380 X2
R.407 X2
.125
.100
3.060
2.968
3.570
1.945
1.532
.613
.102
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
MiddleBowlPunch_200.2T
MATERIAL ONYX Composite
AUTHOR Anthony Mazzella
SIZE B
CAD FILE MiddleBowlPunch_200.2T
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1


MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
.690
2.000
.500
A
A
∅.690 4X
.125
.100
.100
.200
SECTION A-A
Rensselaer
PT NO:
X.X
TITLE
MiddleBowlPunchandDieGuidePlate__200.3T
DRAWING NOTES (UNLESS OTHERWISE NOTED)
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.:
±1/32
MATERIAL
ABS Plastic
AUTHOR
Anthony Mazzella
SIZE
B
CAD FILE
MiddleBowlPunchandDieGuidePlate
QTY. REQUIRED
1
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES


MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
.200
.250
3.300
.100
.200
.200
.250
.125
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
PT NO:
X.X
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.:
±1/32
Rensselaer
TITLE
ShearPin_200.4T
MATERIAL
Ejector Pin
AUTHOR
Anthony Mazzella
SIZE
B
CAD FILE
ShearPunch
QTY. REQUIRED
1
SCALE 1:1
SHEET 1 OF 1

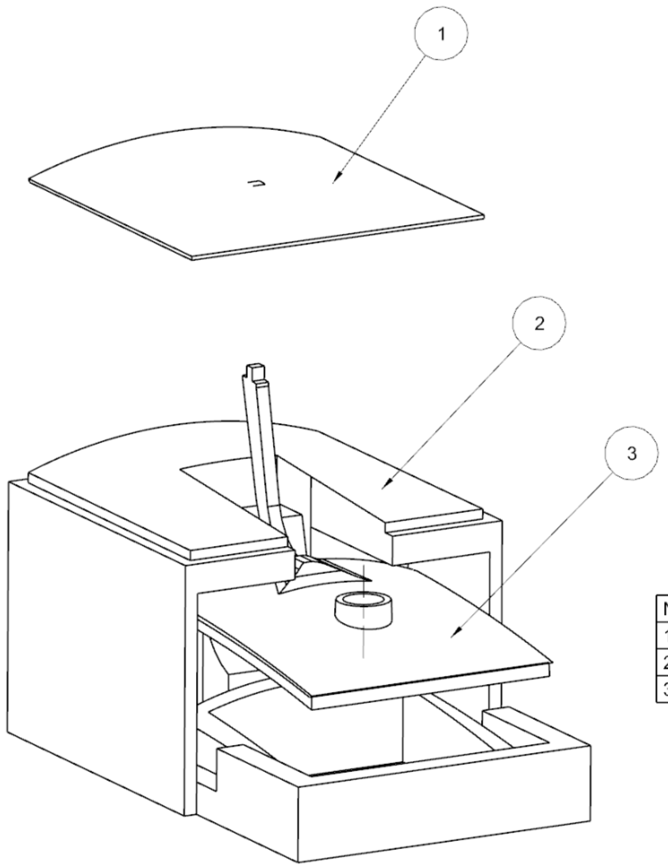


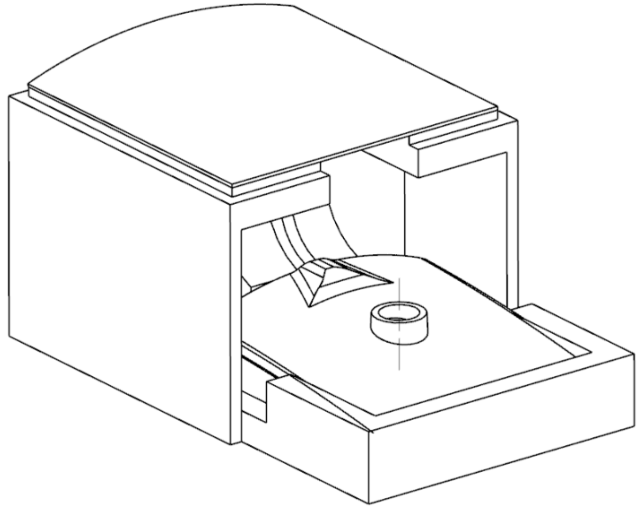
MODEL REV | SHEET REV | DESCRIPTION | DATE (YEAR-MO-DA) | APPROVED
A | INITIAL_REVISION
6.013
3.688
3.932
C
C
.686
.686
SECTION C-C
D
R.0625
.250
DETAIL D
SCALE 2:1
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
All outside radii = 1/16 inch
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
BasinMold_300T
MATERIAL Wood
AUTHOR Nate Spina
SIZE B
CAD FILE
SCALE 1:1
SHEET 1 OF 1
QTY. REQUIRED 1


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
Nuts are cooresponding 1/4"-20
.988
.529
.319
.100
1. Apply Symmetry around all sides of the square`
.375
.375
.750
.790
5.700
5.700
Bolts are 1/4"-20 with hex head
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Basin Fixture_300.1T
MATERIAL Scrap Metal
AUTHOR Dan Myers
SIZE B
CAD FILE
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

Assembly Fixtures, End Effectors, Pallets, Feeders, and QC Gauges

MODEL REV	SHEET REV	DESCRIPTION	DATE(YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		





Number	Part
1	Middle Bowl
2	Middle Bowl Fixture
3	Top Bowl + Bridge

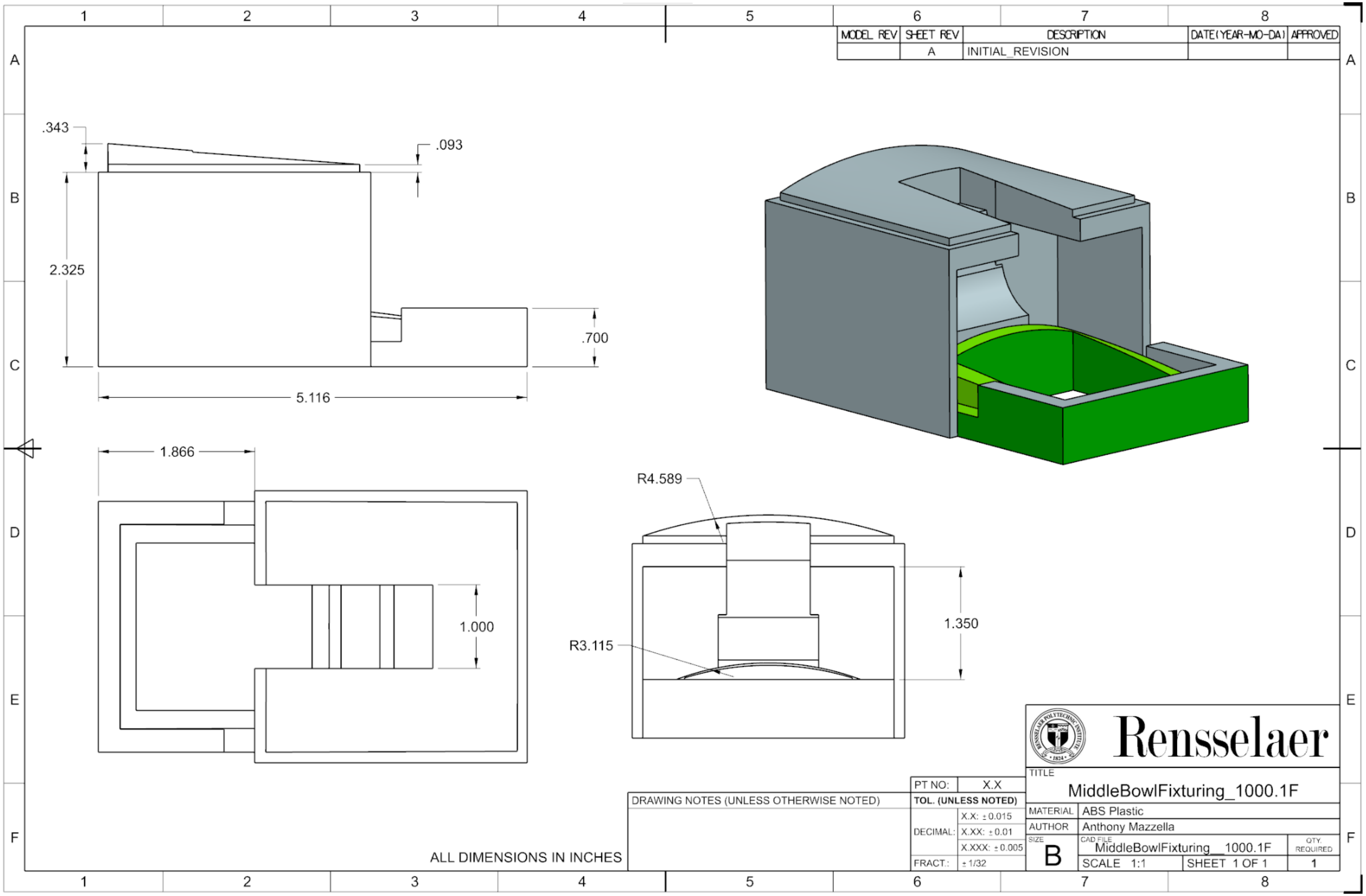
ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO:	X.X
TOL. (UNLESS NOTED)	
DECIMAL:	X.X: ±0.015
	X.XX: ±0.01
	X.XXX: ±0.005
FRACT.:	±1/32

Rensselaer

TITLE	MiddleBowlFixtureAssembly_1000F
MATERIAL	Misc
AUTHOR	Anthony Mazzella
SIZE	B
CAD FILE	MIddle Bowl Fixed Fix
QTY. REQUIRED	1
SCALE	1:1
SHEET	1 OF 1



MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
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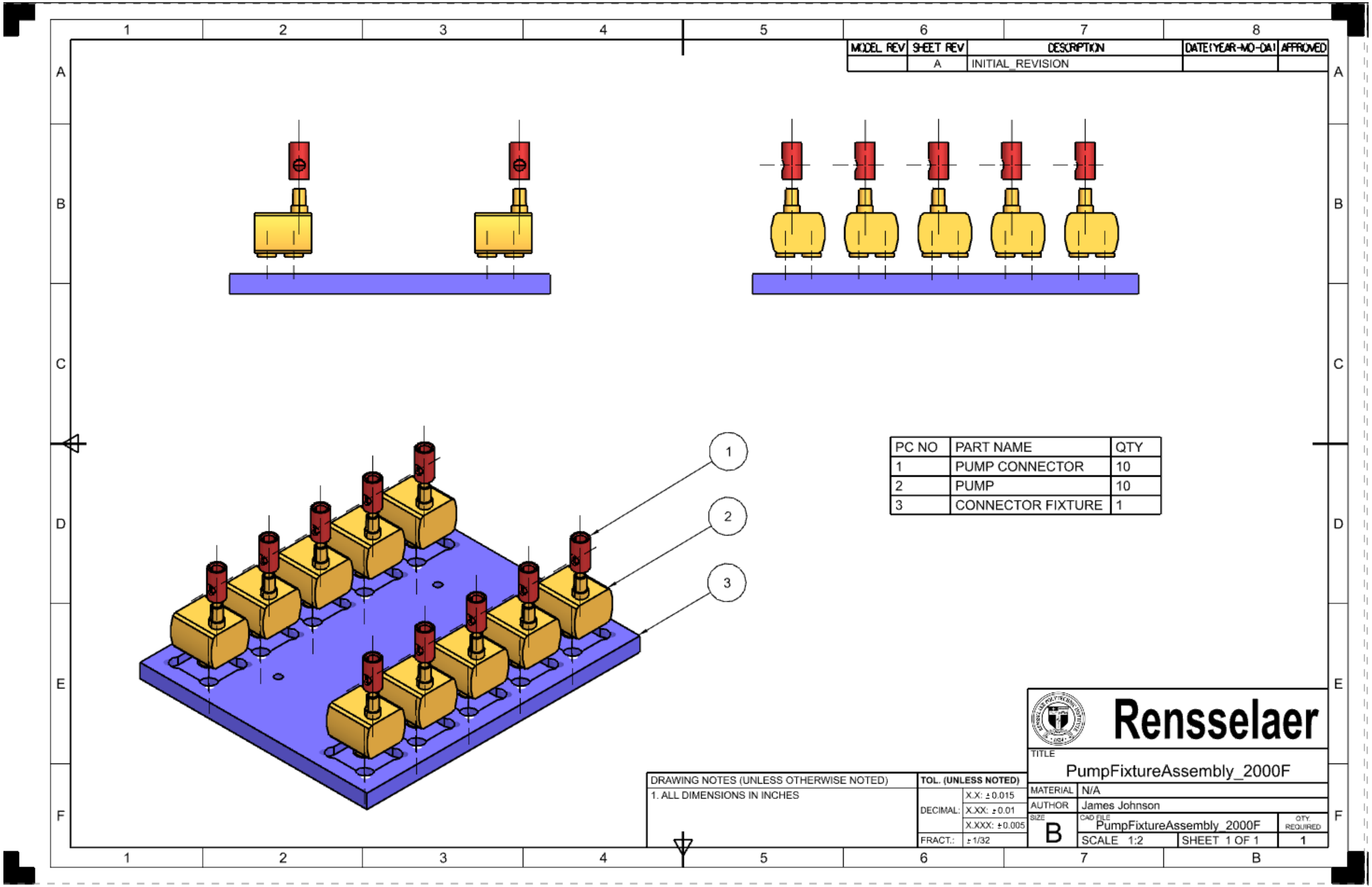
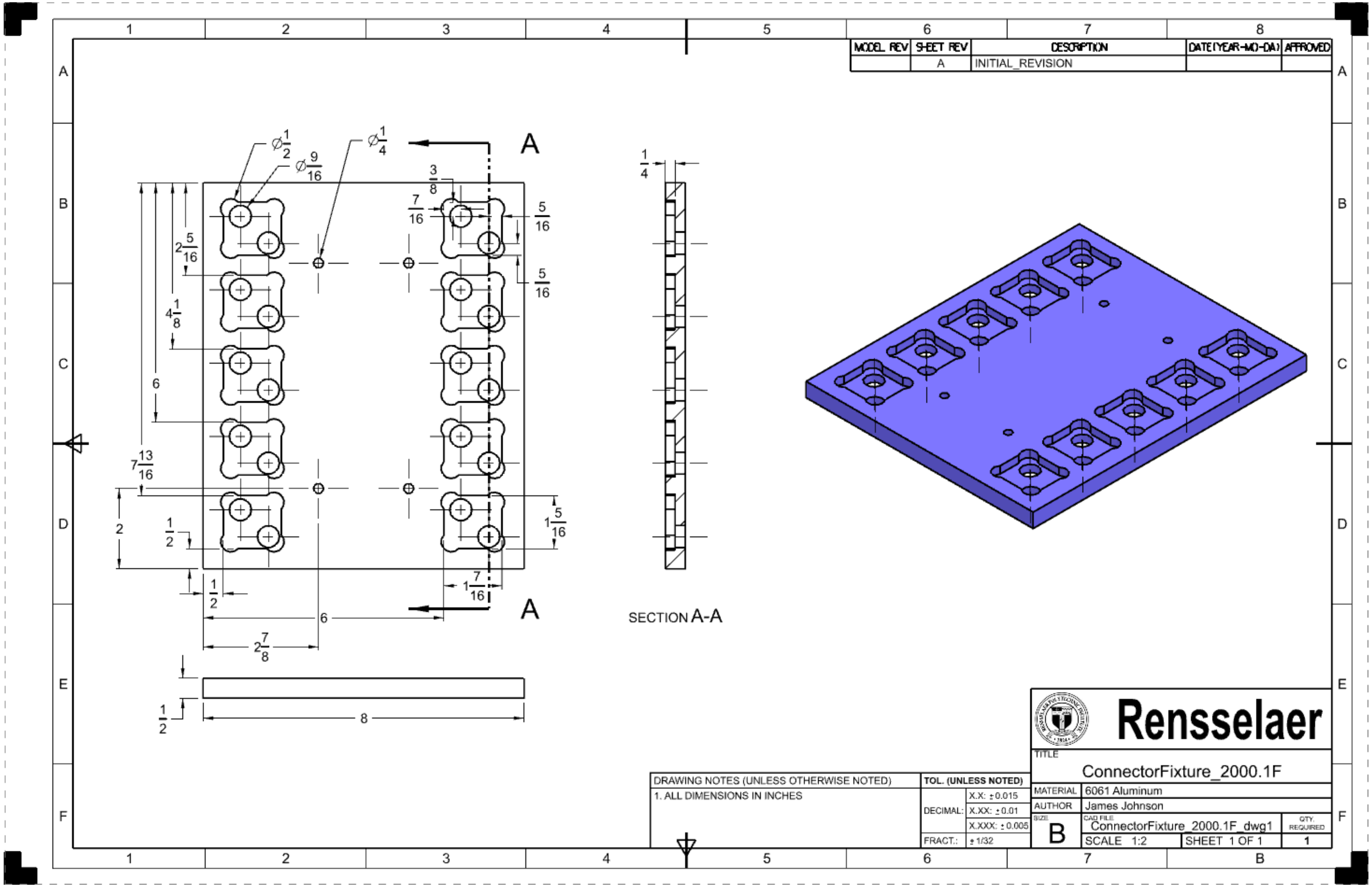
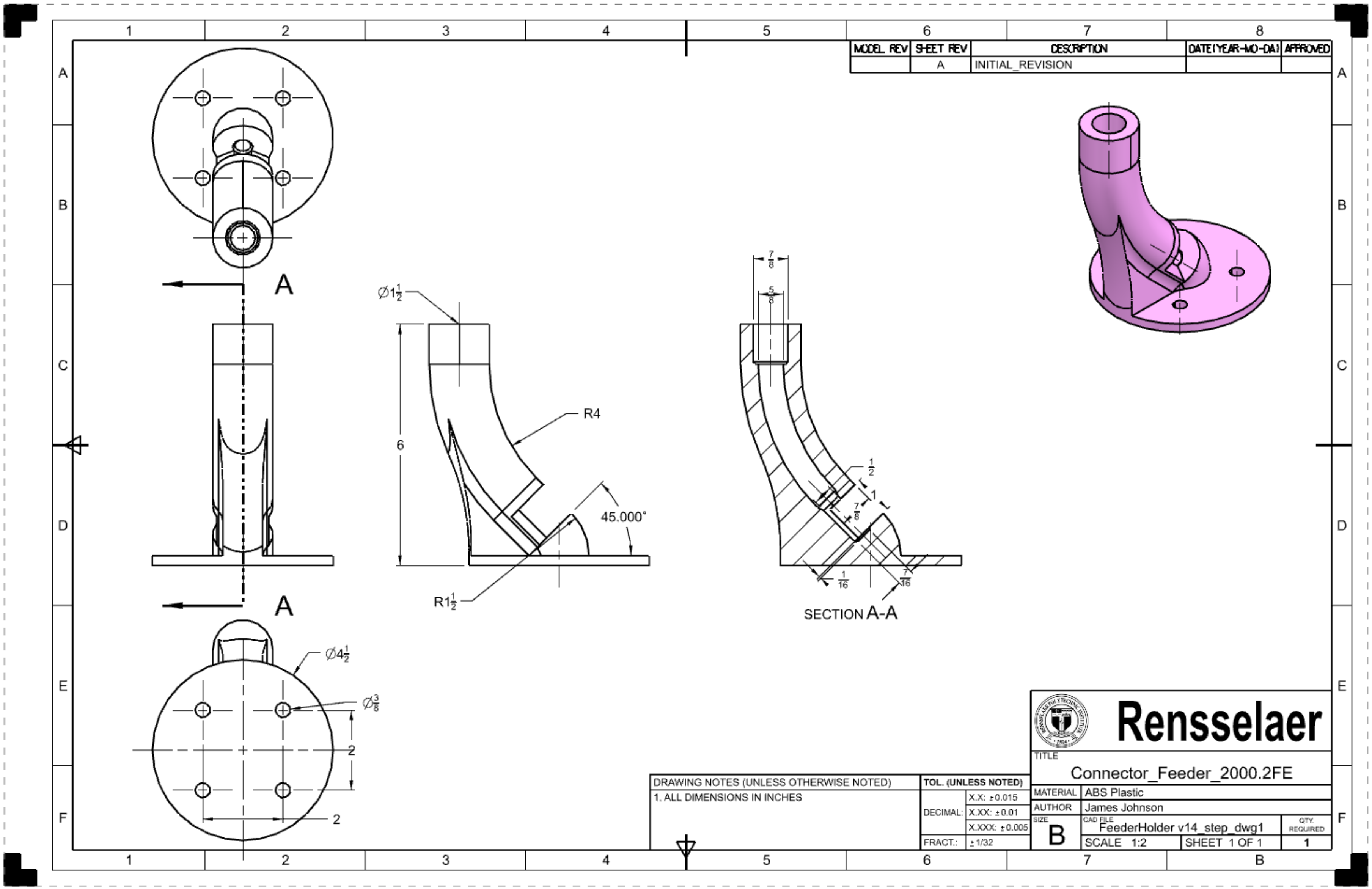
.093
2.325
.700
5.116
1.866
1.000
R4.589
R3.115
1.350
Rensselaer
TITLE
MiddleBowlFixturing_1000.1F
PT NO:
X.X
DRAWING NOTES (UNLESS OTHERWISE NOTED)
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.:
±1/32
MATERIAL
ABS Plastic
AUTHOR
Anthony Mazzella
SIZE
B
CAD FILE
MiddleBowlFixturing__1000.1F
QTY. REQUIRED
1
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES



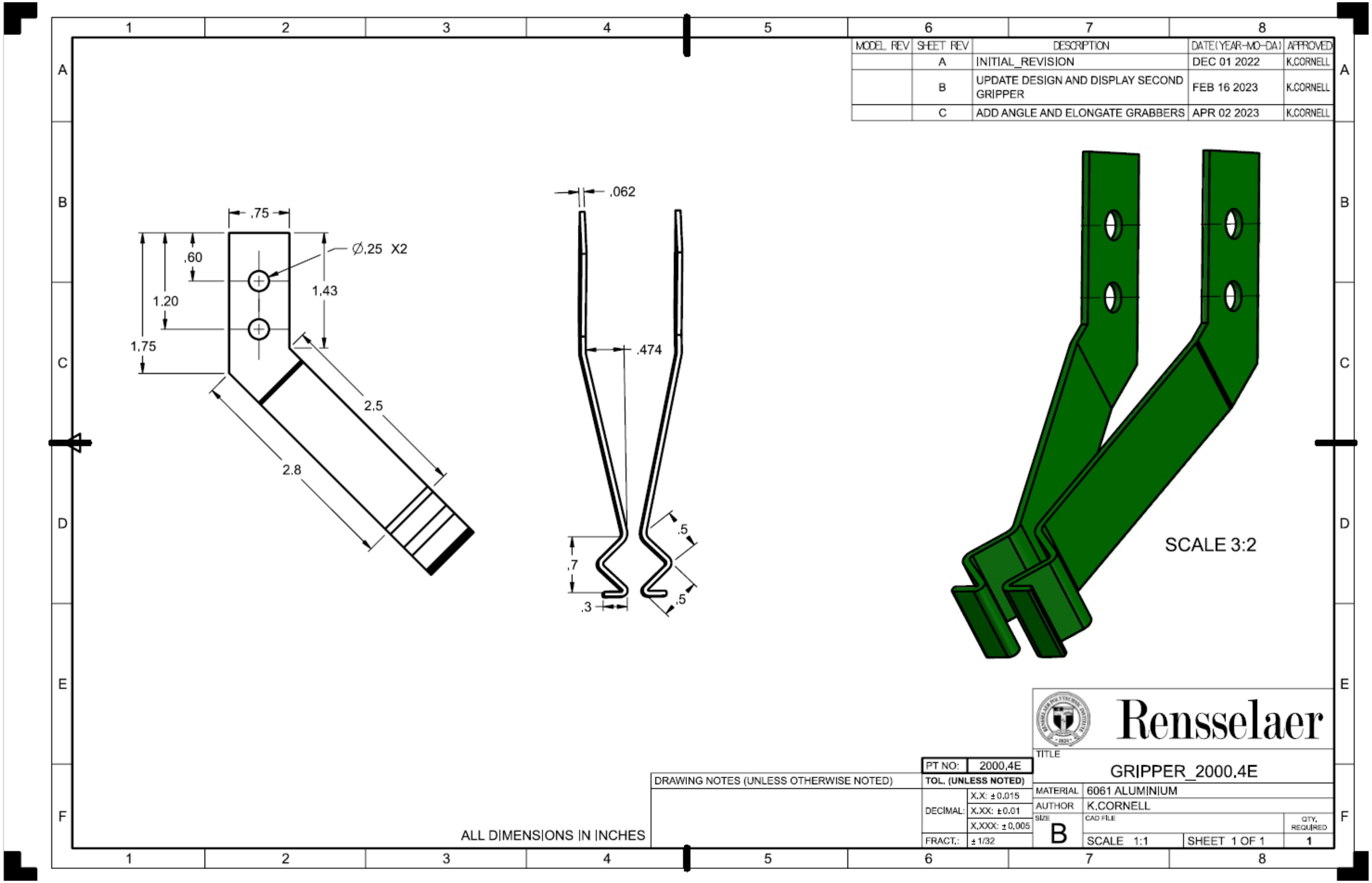
MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
1
2
3
PC NO
PART NAME
QTY
1
PUMP CONNECTOR
10
2
PUMP
10
3
CONNECTOR FIXTURE
1
Rensselaer
TITLE
PumpFixtureAssembly_2000F
MATERIAL
N/A
AUTHOR
James Johnson
SIZE
B
CAD FILE
PumpFixtureAssembly_2000F
QTY. REQUIRED
1
SCALE 1:2
SHEET 1 OF 1
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32



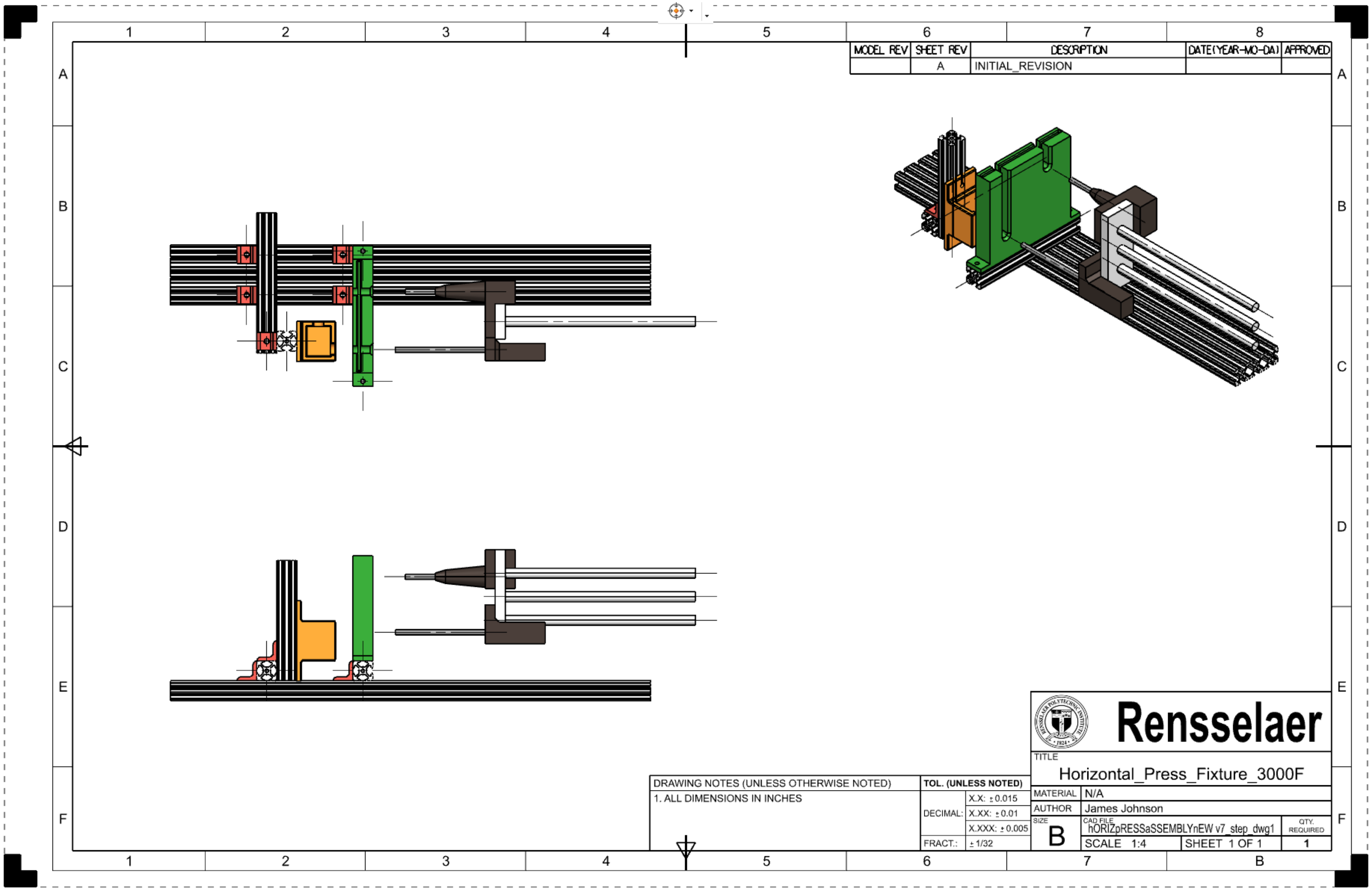
MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
A
SECTION A-A
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
ConnectorFixture_2000.1F
MATERIAL
6061 Aluminum
AUTHOR
James Johnson
SIZE
B
CAD FILE
ConnectorFixture_2000.1F_dwg1
QTY. REQUIRED
1
SCALE 1:2
SHEET 1 OF 1

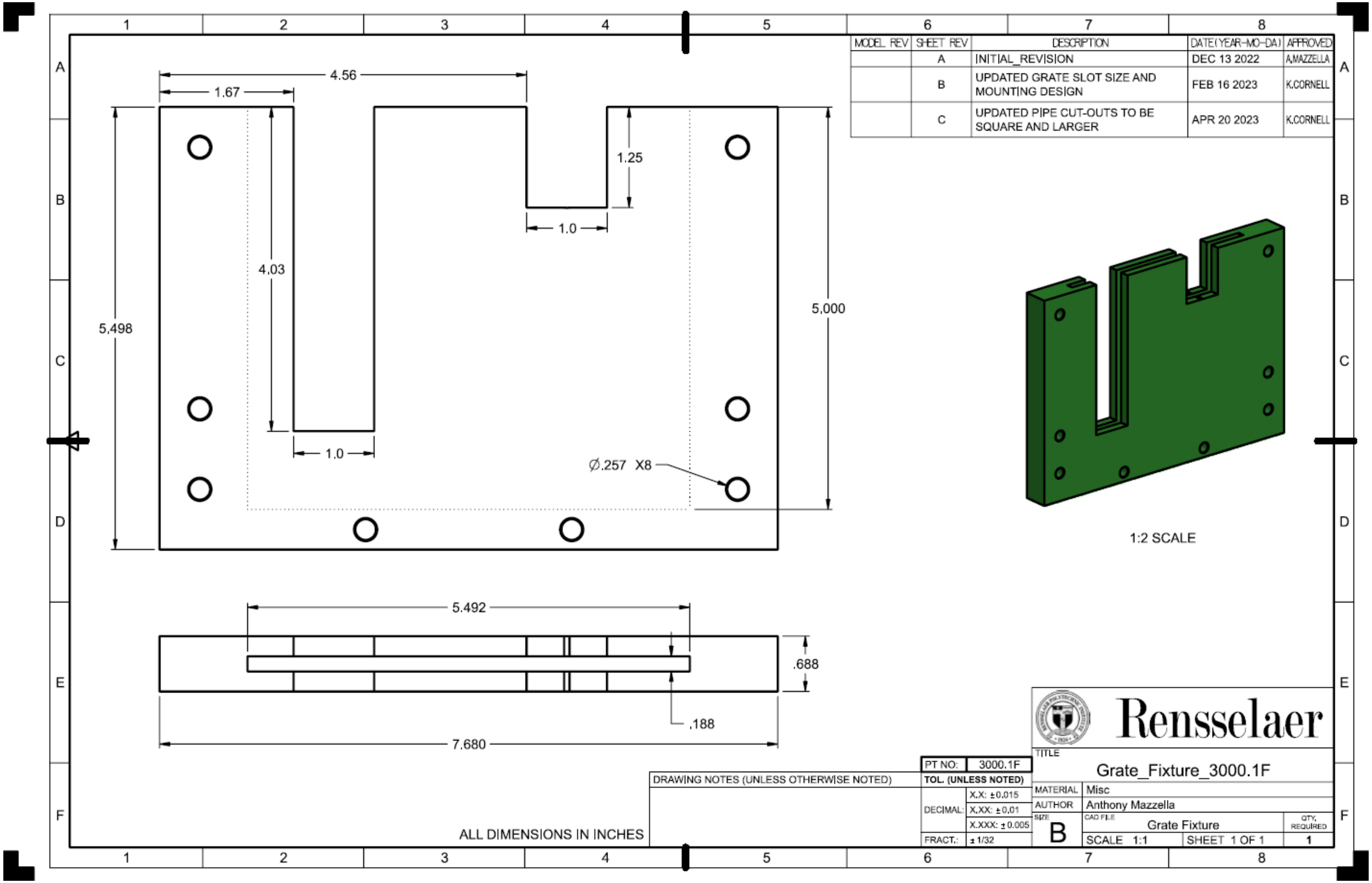


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
A
A
$\varnothing 1\frac{1}{2}$
R4
6
45.000°
$R1\frac{1}{2}$
$\frac{7}{8}$
$\frac{5}{8}$
$\frac{1}{2}$
1
$\frac{7}{8}$
$\frac{1}{16}$
$\frac{7}{16}$
SECTION A-A
$\varnothing 4\frac{1}{2}$
$\varnothing \frac{3}{8}$
2
2
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Connector_Feeder_2000.2FE
MATERIAL ABS Plastic
AUTHOR James Johnson
SIZE B
CAD FILE FeederHolder v14_step_dwg1
QTY. REQUIRED 1
SCALE 1:2
SHEET 1 OF 1

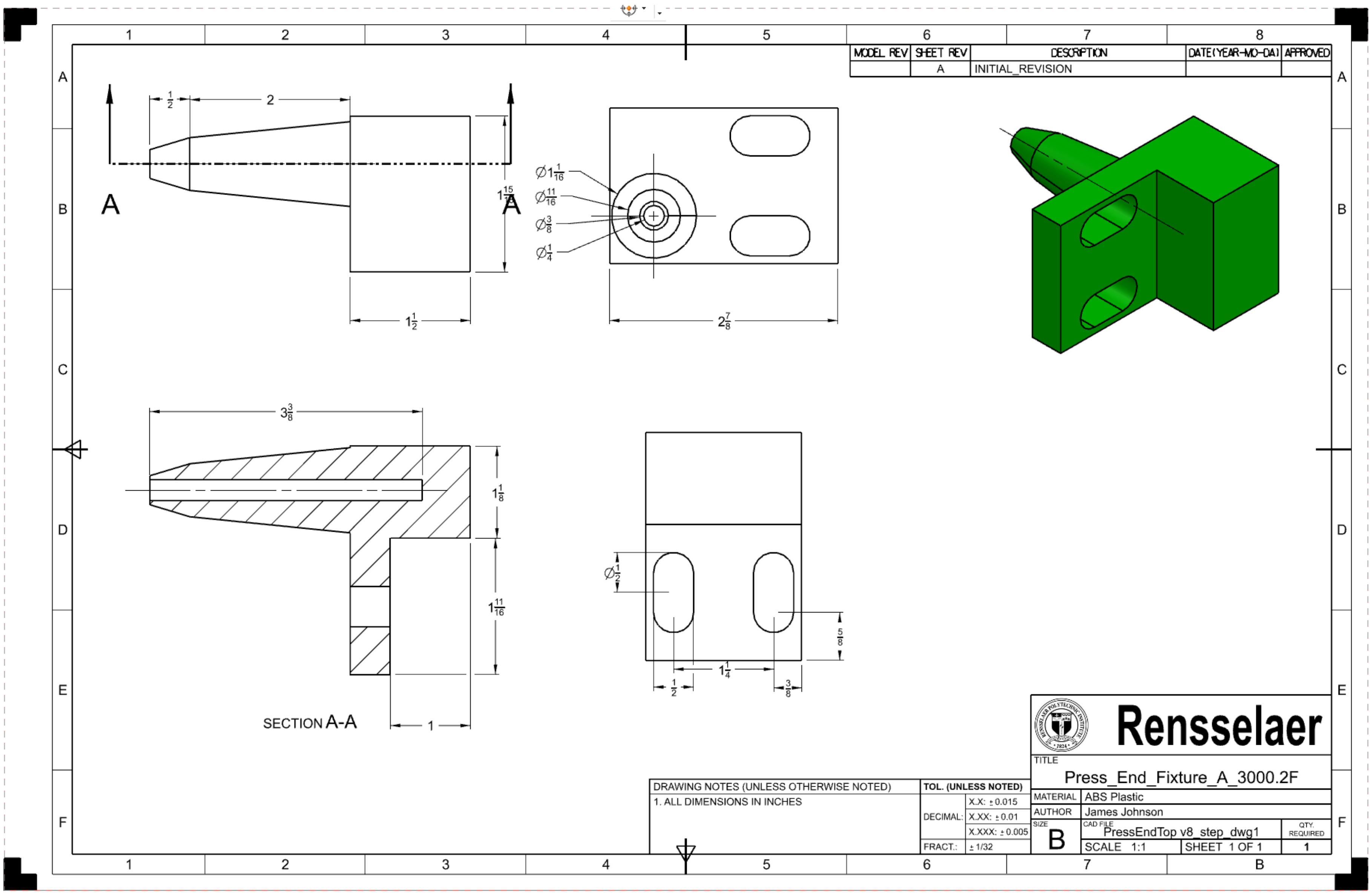


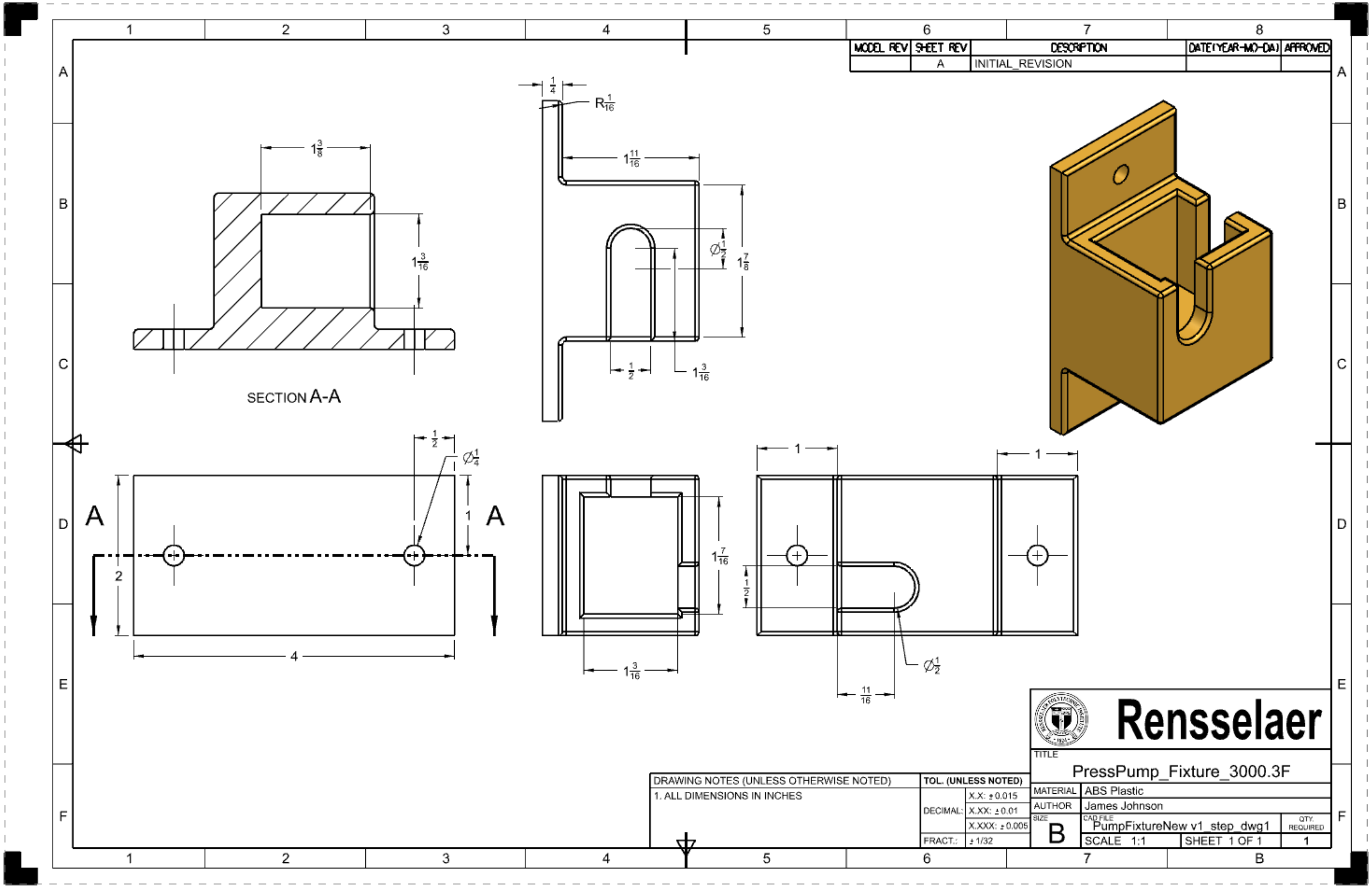
MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
DEC 01 2022
K.CORNELL
B
UPDATE DESIGN AND DISPLAY SECOND GRIPPER
FEB 16 2023
K.CORNELL
C
ADD ANGLE AND ELONGATE GRABBERS
APR 02 2023
K.CORNELL
.75
.60
Ø.25 X2
1.20
1.43
1.75
2.5
2.8
.062
.474
.5
.7
.5
.3
SCALE 3:2
Rensselaer
TITLE
GRIPPER_2000.4E
PT NO: 2000.4E
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
DRAWING NOTES (UNLESS OTHERWISE NOTED)
MATERIAL 6061 ALUMINIUM
AUTHOR K.CORNELL
SIZE B
CAD FILE
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES

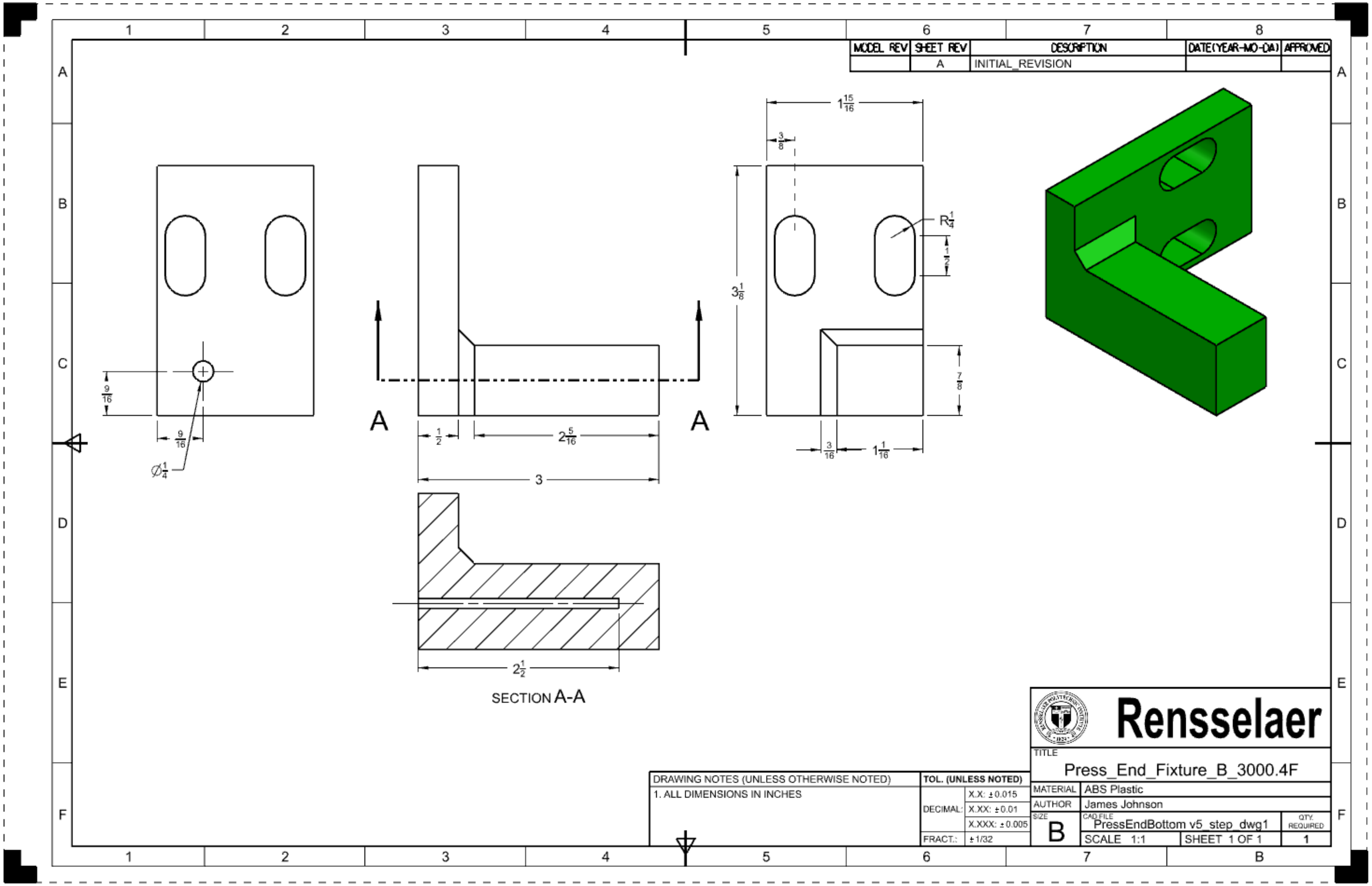

MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Horizontal_Press_Fixture_3000F
MATERIAL N/A
AUTHOR James Johnson
SIZE B
CAD FILE hORIZpRESSaSSEMBLYnEW v7_step_dwg1
QTY. REQUIRED 1
SCALE 1:4
SHEET 1 OF 1



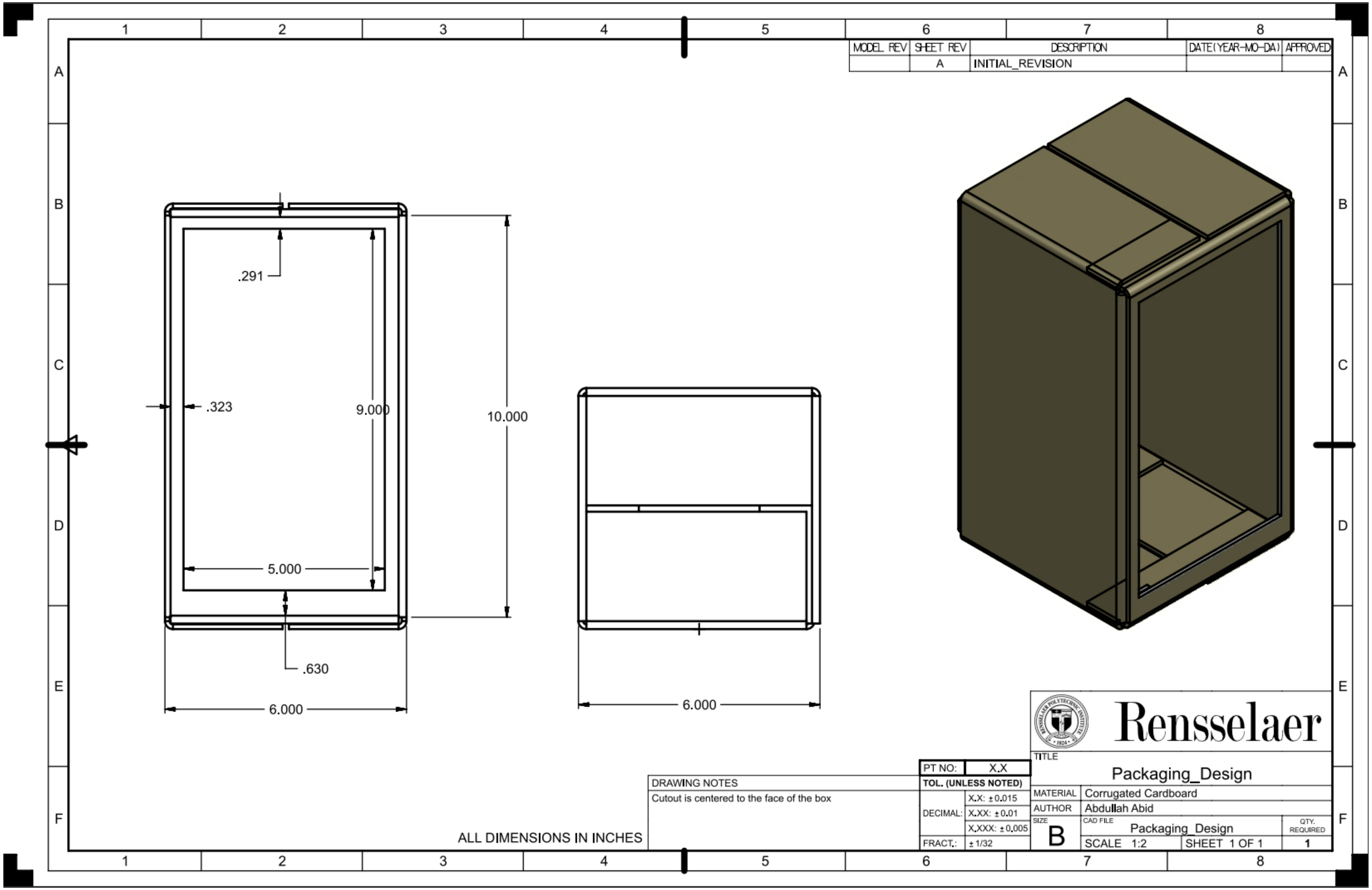
MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION	DEC 13 2022	A.MAZZELLA
	B	UPDATED GRATE SLOT SIZE AND MOUNTING DESIGN	FEB 16 2023	K.CORNELL
	C	UPDATED PIPE CUT-OUTS TO BE SQUARE AND LARGER	APR 20 2023	K.CORNELL


MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
A
A
SECTION A-A
Rensselaer
TITLE
Press_End_Fixture_A_3000.2F
MATERIAL
ABS Plastic
AUTHOR
James Johnson
SIZE
B
CAD FILE
PressEndTop v8_step_dwg1
QTY. REQUIRED
1
SCALE 1:1
SHEET 1 OF 1
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
SECTION A-A
A
A
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
PressPump_Fixture_3000.3F
MATERIAL
ABS Plastic
AUTHOR
James Johnson
SIZE
B
CAD FILE
PumpFixtureNew v1_step_dwg1
QTY. REQUIRED
1
SCALE 1:1
SHEET 1 OF 1

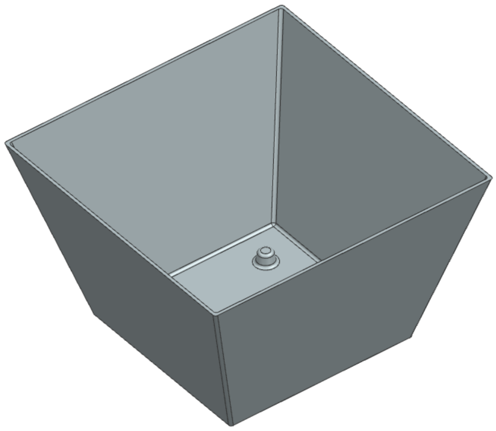

MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
A
A
SECTION A-A
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.:
±1/32
Rensselaer
TITLE
Press_End_Fixture_B_3000.4F
MATERIAL
ABS Plastic
AUTHOR
James Johnson
SIZE
B
CAD FILE
PressEndBottom v5_step_dwg1
QTY. REQUIRED
1
SCALE 1:1
SHEET 1 OF 1

Packaging Drawings


MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
.291
.323
9.000
10.000
5.000
.630
6.000
6.000
Rensselaer
TITLE
Packaging_Design
PT NO:
X.X
DRAWING NOTES
Cutout is centered to the face of the box
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.:
± 1/32
MATERIAL
Corrugated Cardboard
AUTHOR
Abdullah Abid
SIZE
B
CAD FILE
Packaging_Design
QTY. REQUIRED
1
SCALE 1:2
SHEET 1 OF 1
ALL DIMENSIONS IN INCHES

Section 4: Product Component Manufacturing Sheets

4.1 Basin Manufacturing Sheet

BOM #	Isometric View
1C	
BOM/3D Model Name	
Basin	
Drawing Title	
Basin_1C	

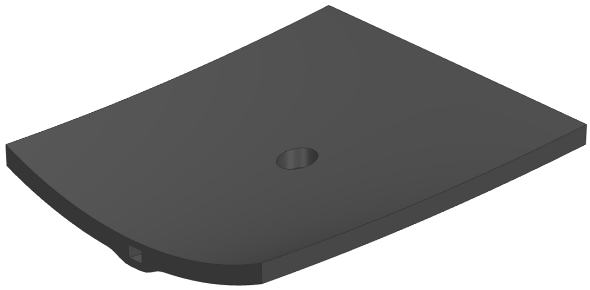
Part Information	
Material Type	**Black ABS Plastic Sheet**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**300**

Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	Vacuum Forming		
Machine Tool	Formech Vacuum Former		
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**
	300T	Vacuum Forming Mold	BasinMold_300T
Associated Manufacturing Parameters	Timer: 60 seconds Mold travel speed: Moderate Heat settings: All zones at 100%		
Quality Control	Make sure there isn't any wrinkling or defects in the basin prior to laser cutting. These defects can be resolved by more rounded edges or adjustment of temperature during the molding process. Put water into every 30th basin to ensure it doesn't leak.		
Associated Manufacturing Process Calculations	N/A		
Notes	Mold was originally created through the rapid prototyping of a FDM print with ABS. Mold was recreated out of a block of MDF material due to printed mold melting and deforming.		
Secondary Manufacturing Process/Post-Processing			
Process	Laser Cutting		
Machine Tool	Thunder Laser Nova 35		
Tooling Needed	**Name**	**BOM #**	**Drawing #**
	1C	Basin Fixture	Basin Fixture_300.1T

Associated Manufacturing Parameters	Cutting settings of 5 mm/s speed and 80% intensity
Quality Control	Visual inspection of any defective parts and sanding edge
Associated Manufacturing Process Calculations	N/A
Notes	N/A

Responsible Team Member(s)	**Name**	**Date**
	Nicolas Nigohosian	10/12/2022

4.2 Top Bowl Manufacturing Sheet

BOM #	Isometric View
5C	
BOM/3D Model Name	
Top Bowl	
Drawing Title	
TopBowl_5C	

Part Information	
Material Type	**ABS Plastic Pellets**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**300**

Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	Plastic Injection Molding		
Machine Tool	Arburg Allrounder 221K		
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**
	100T	PIM Mold Half Stationary	PIMMoldHalfStationary_100T
	100.1T	PIM Mold Half Moving	PIMMoldHalfMoving_100.1T
Associated Manufacturing Parameters	Melt Temp: 220℃ Mold Temp: 50℃ Screw Speed: 10-15 meters/min Back Pressure: 60-90 Bar Injection Pressure: 2.56 ksi Pack/Hold Pressure: 500-1100 bar 0.25 inch ejector pins Shrinkage Allowances: ABS shrink factor S = 0.006 inches/inch Draft Angles: part designed with 2° draft angles on all hard corners. Thickness: part designed with uniform 0.1” wall thicknesses. Part will be overmolded onto the preexisting bridge.		
Quality Control	The part should pass visual inspection upon assembly for any cracks or major defects that could affect water flow. Part should fit snugly on the pipe so that part does not move freely or fall off if turned upside down. Reject part if it does not meet criteria. The first molded part should go through a full inspection. Every 10 parts after should go through inspection for the fit between the pipe and bowl. Tolerancing for Bowl to Pipe Connection:		

	Diameter: 0.500 ± 0.015 Height: 0.250 ± 0.01 Critical tolerancing press fit. Must be able to withstand upward force of water.
Associated Manufacturing Process Calculations	Shot Size = Cavity Volume + Runner Volume = in^3 Cavity Volume: 0.7928 in^3
Notes	Surface Finishing Requirements 1. Remove any flashing and sharp edges 2. Remove sprue, runners, and gate from the finished part

Responsible Team Member(s)	**Name**	**Date**
	Daniel Myers	10/4/2022
	Nick Porter	10/4/2022

4.2.1 Top Bowl MoldFlow Simulations

Table 4.2.1 Top Bowl MoldFlow Summary

Cycle Time (s)	30.8122
Time to Fill (s)	0.8122

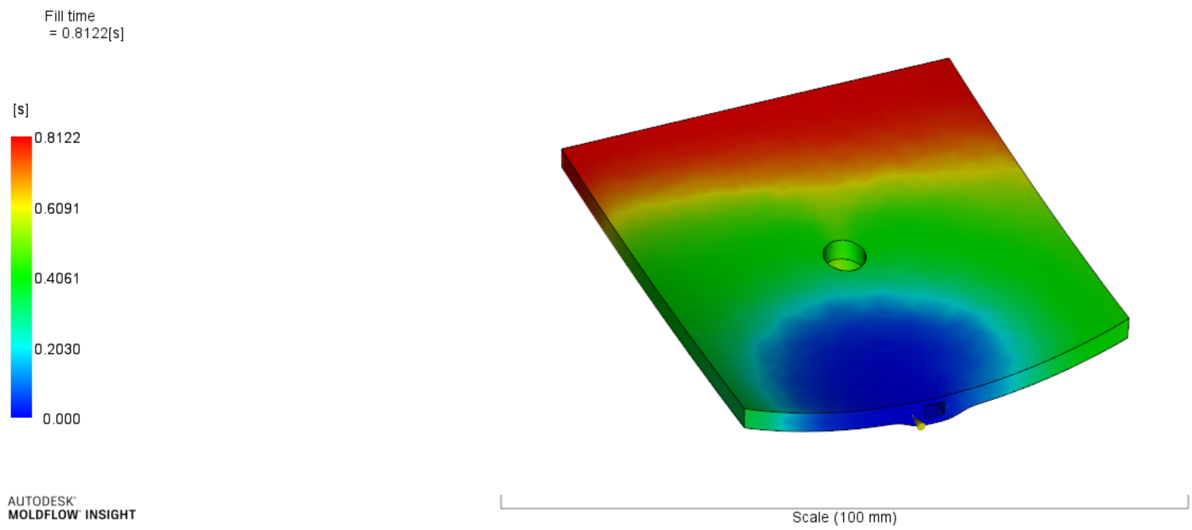


Figure 4.2.1 Top Bowl Fill Time

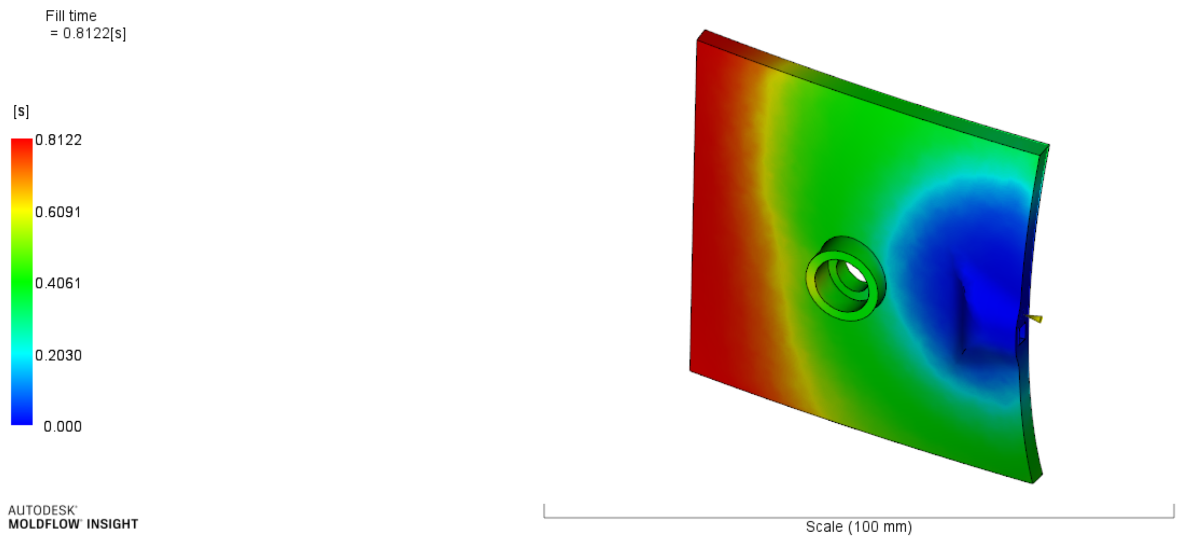


Figure 4.2.2 Top Bowl Fill Time

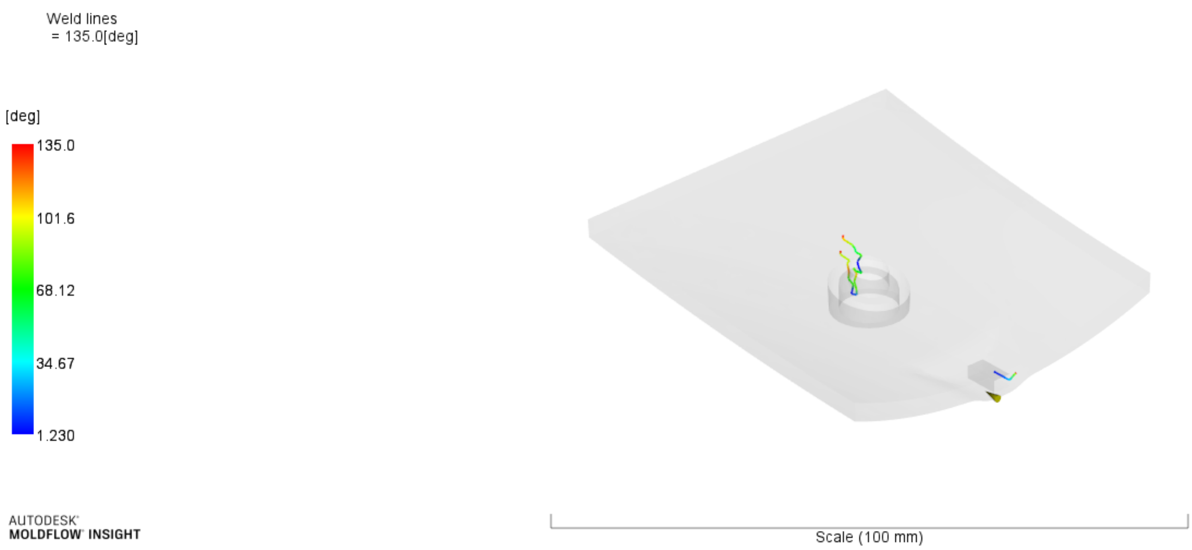


Figure 4.2.3 Top Bowl Weld Lines

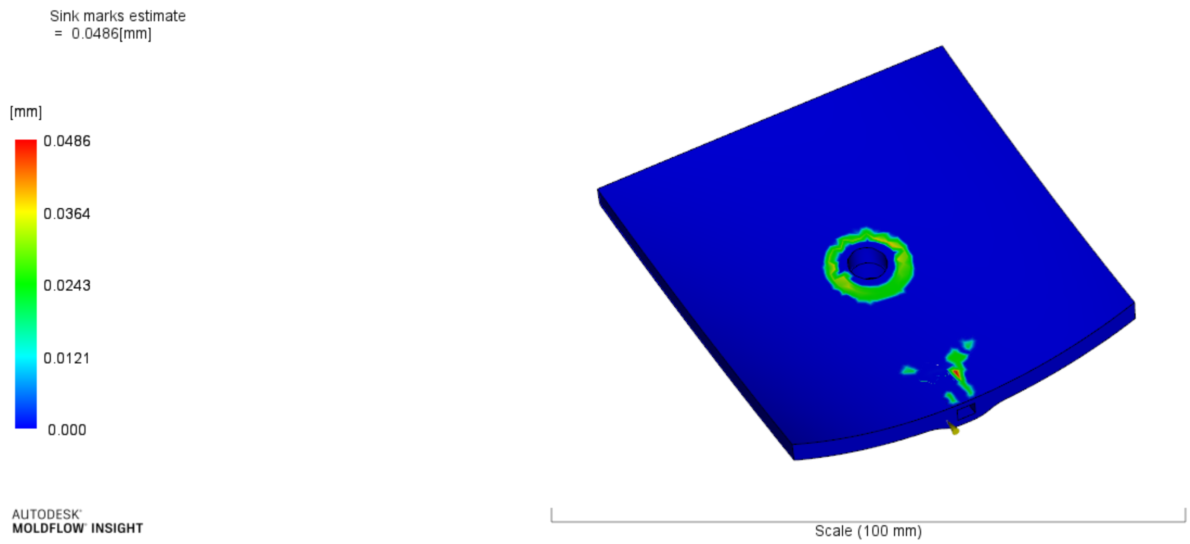
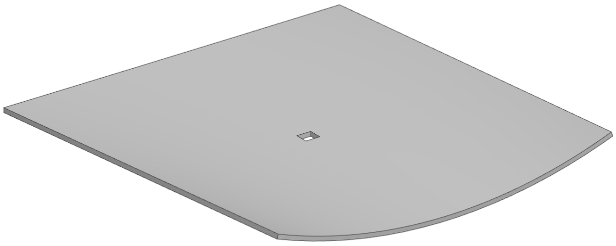


Figure 4.2.4 Top Bowl Sink Marks

Figure 4.2.1 and 4.2.2 show the plastic injection molding fill time for the top bowl. It is valuable to run a simulation on the fill time to make sure that the whole part can be molded from that injection point. It takes 0.8122 seconds to fill the entire part. Figures 4.2.3 and 4.2.4 show potential defects and defect locations within the molding of the top bowl. After the first few parts are created, these locations should be most closely monitored to see if PIM settings should be adjusted. The weld lines shown in Figure 4.2.3 show up mainly on the underside of the part, which is minimally visible to the user and so is a good place for a defect to be. The sink marks shown in Figure 4.2.4 predominantly show up in the middle of the piece, which is also permissible because water will pool in these locations anyway.

4.3 Middle Bowl Manufacturing Sheet

<table>
<tr><th>BOM #</th><th>Isometric View</th></tr>
<tr><td>4C</td><td rowspan="5"></td></tr>
<tr><td>BOM/3D Model Name</td></tr>
<tr><td>Middle Bowl</td></tr>
<tr><td>Drawing Title</td></tr>
<tr><td>MiddleBowl_4C</td></tr>
</table>

<table>
<tr><th colspan="2">Part Information</th></tr>
<tr><td>Material Type</td><td>Stainless Steel</td></tr>
<tr><td>Material Resource Planning (Raw Material Needed)</td><td>T-410 Stainless Steel Sheet (From MILL)</td></tr>
<tr><td>Part Count Required</td><td>300</td></tr>
</table>

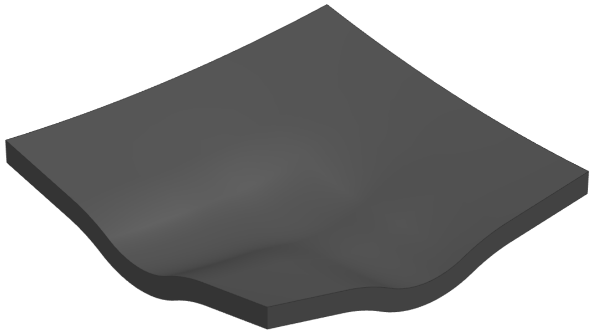
<table>
<tr><th colspan="4">Proposed Manufacturing Process Plan</th></tr>
<tr><th colspan="4">Primary Manufacturing Process</th></tr>
<tr><td>Process</td><td colspan="3">Shearing</td></tr>
<tr><td>Machine Tool</td><td colspan="3">Pexto Manual Kick Shear</td></tr>
<tr><td>Associated Manufacturing Parameters</td><td colspan="3">Square cuts of size 3.000”x3.000”

Tolerancing:
±0.03125” L and W</td></tr>
<tr><td>Quality Control</td><td colspan="3">Every 10th blank will be inspected with calipers to ensure they fall within tolerance.</td></tr>
<tr><td>Notes</td><td colspan="3">Scrap material to be discarded.</td></tr>
<tr><th colspan="4">Secondary Manufacturing Process</th></tr>
<tr><td>Process</td><td colspan="3">Sheet Metal Drawing</td></tr>
<tr><td>Machine Tool</td><td colspan="3">Drake Hydraulic Press</td></tr>
<tr><td rowspan="3">Tooling Needed</td><td>BOM #</td><td>BOM/3D Model Name</td><td>Drawing Title</td></tr>
<tr><td>200.1T</td><td>Middle Bowl Die</td><td>MiddleBowlDie_200.1T</td></tr>
<tr><td>200.2T</td><td>Middle Bowl Punch</td><td>MiddleBowlPunch_200.2T</td></tr>
<tr><td>Description</td><td colspan="3">Draw blanks into a bowl shape using the Drake Hydraulic Press. The same machinery will punch away excess brim material and form a square hole in the middle.</td></tr>
<tr><td>Associated Manufacturing Parameters</td><td colspan="3">N/A</td></tr>
<tr><td>Associated Manufacturing Process Calculations</td><td colspan="3">N/A</td></tr>
<tr><td>Quality Control</td><td colspan="3">Visually inspect parts for defects such as wrinkling and rough edges. The part should be inspected for cracks and proper shape to ensure proper water flow. The part should be able to fit over the bridge easily. The part must be able to withstand the force of flowing water without rotating or</td></tr>
</table>

	rattling. Every 30 parts will be tested using a sample bridge part to ensure a proper and snug fit. If the part does not pass any of these inspections it must be rejected.
Notes	The parts will stay in the press after completion of deep drawing.
Tertiary Manufacturing Process	
Process	Brim Trimming and Hole Punching
Machine Tool	Drake Hydraulic press
Associated Manufacturing Parameters	F_{max} = Punch Force UTS = 90,000psi S_0 = Sheet Thickness = 0.036" L = Total length Sheared = 0.45"
Associated Manufacturing Process Calculations	$F_{max} = 0.7 * (UTS) * S_o * L$ = 1,020.6lb
Quality Control	Parts will be visually inspected to ensure no cracking or rippling happened as a result of the Brim Trimming and Hole Punching. In addition, parts will be compared to before Brim Trimming and Hole Punching to ensure no change in dimensions.
Notes	This is the final process in the Middle Bowl Manufacturing. The bowls will be sanded once more before product assembly.
Quaternary Manufacturing Process	
Process	Sanding
Machine Tool	Husky ¼ in. Angle Die Grinder
Associated Manufacturing Parameters	150 Grit Sandpaper
Quality Control	Bottom protrusion should be now flat. Team members will manually assess each part after sanding.
Notes	Sand the bottom protrusion caused by the punch at the bottom of the bowl.
Quaternary Manufacturing Process	
Process	Tumbling
Machine Tool	Tumbler
Associated Manufacturing Parameters	N/A
Quality Control	Edges should be free of burrs and have a smooth finish to the touch. There should be a shined finish on the parts. Team members will manually assess each part after tumbling.
Notes	Only tumble 50 parts at once. Make sure to keep water level above the pump

Responsible Team Member(s)	**Name**	**Date**
	Anthony Mazzella	10/11/2022
	Nick Porter	10/11/2022

4.4 End Bowl Manufacturing Sheet

BOM #	Isometric View
3C	
BOM/3D Model Name	
End Bowl	
Drawing Title	
EndBowl_3C	

Part Information	
Material Type	ABS Plastic Pellets
Material Resource Planning (Raw Material Needed)	Provided by MILL
Part Count Required	300

Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	Plastic Injection Molding		
Machine Tool	Arburg Allrounder 221K		
Tooling Needed	BOM #	BOM/3D Model Name	Drawing Title
	100T	PIM Mold Half Stationary	PIMMoldHalfStationary_100T
	100.1T	PIM Mold Half Moving	PIMMoldHalfMoving_100.1T
Associated Manufacturing Parameters	Melt Temp: 220℃ Mold Temp: 50℃ Screw Speed: 10-15 meters/min Back Pressure: 60-90 Bar Injection Pressure: 2.56 ksi Pack/Hold Pressure: 500-1100 bar 0.25 inch ejector pins Shrinkage Allowances: ABS shrink factor S = 0.006 inches/inch Draft Angles: part designed with 2° draft angles on all hard corners. Thickness: part designed with uniform 0.1” wall thicknesses.		
Quality Control	The part should pass visual inspection upon assembly for any cracks or major defects that could affect water flow. Part should fit snugly within the pipe so that part does not move freely or fall off if turned upside down and under gravity forces. A part should be rejected if it does not meet criteria. The first molded part should go through a full inspection. Every 10 parts after should go through inspection for the fit between the pipe and bowl. Tolerancing for Bowl to Pipe Connection: Diameter: 0.500 ± 0.015		

	Height: 0.150 ± 0.01 Critical tolerancing press fit. These dimensions will be measured with a caliper, must be able to withstand upward force of water.
Associated Manufacturing Process Calculations	Shot Size = Cavity Volume + Runner Volume = in^3 Cavity Volume: 0.5736 in^3
Notes	Surface Finishing Requirements 1. Remove any flashing and sharp edges 2. Remove sprue, runners, and gate from the finished part

Responsible Team Member(s)	**Name**	**Date**
	Daniel Myers	10/4/2022
	Nick Porter	10/4/2022

4.4.1 End Bowl MoldFlow Simulations

Table 4.4.1 End Bowl MoldFlow Summary

Cycle Time (s)	30.7095
Time to Fill (s)	0.7095

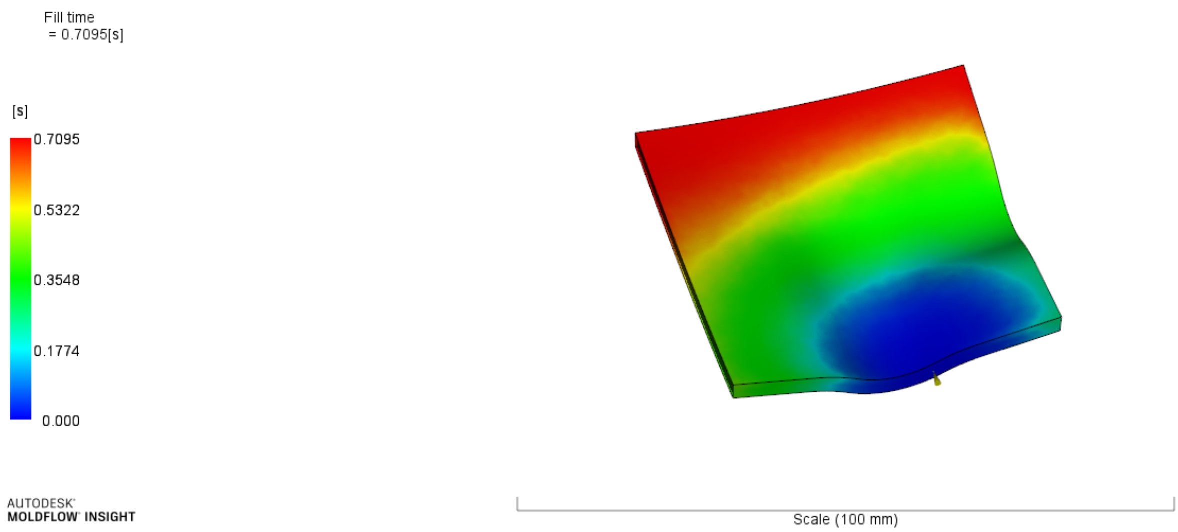


Figure 4.4.1 End Bowl Fill Time

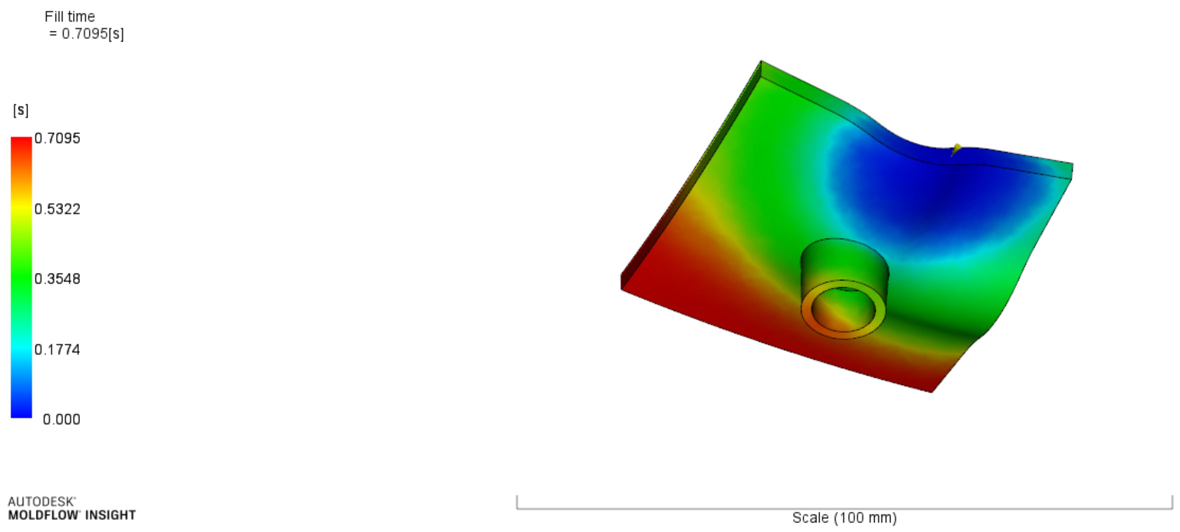


Figure 4.4.2 End Bowl Fill Time

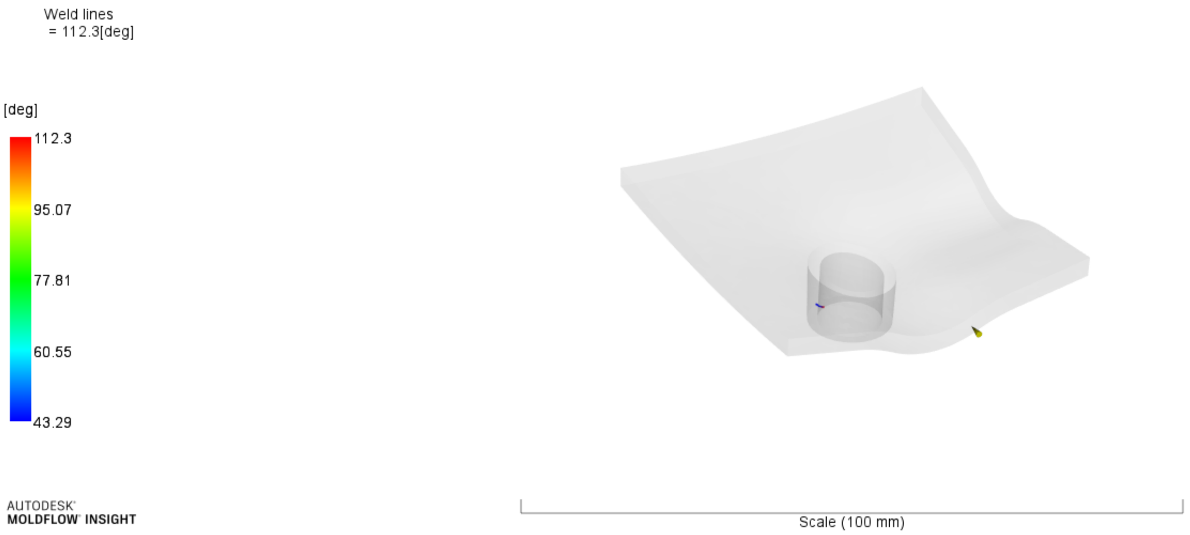


Figure 4.4.3 End Bowl Weld Lines

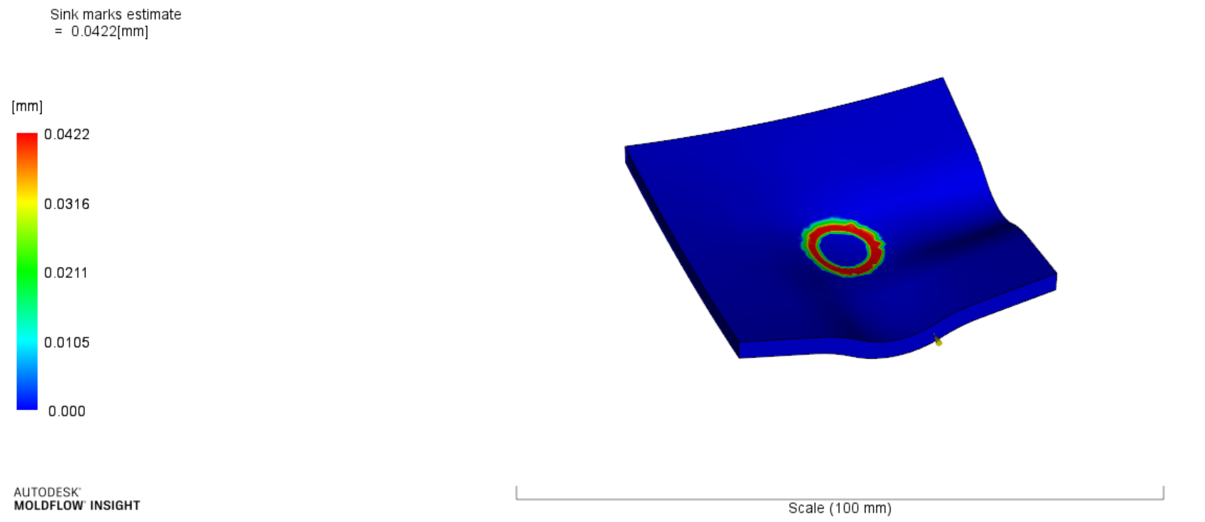
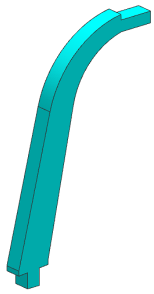


Figure 4.4.4 End Bowl Sink Traps

Similar to the simulations for the Top Bowl mold, Figures 4.4.1 and 4.4.2 show the fill time for the End Bowl, which is 0.7095 seconds. Potential defects are shown in Figures 4.4.3 and 4.4.4. In Figure 4.4.3, there is only one small point that could have a weld line, which will not be easily seen by the user. Figure 4.4.4 shows the sink marks, which are at the lowest point of the bowl where the most water will be pooled.

4.5 Bridge Manufacturing Sheet

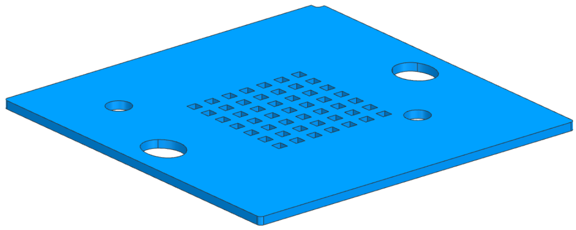
BOM #	Isometric View
2C	
BOM/3D Model Name	
Bridge	
Drawing Title	
Bridge_2C	

Part Information	
Material Type	**Clear Acrylic Plastic**
Material Resource Planning (Raw Material Needed)	**1/ 4" Acrylic Sheet supplied by McMaster Carr**
Part Count Required	**300**

Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	Laser Cutting		
Machine Tool	Thunder Laser System		
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**
	N/A	N/A	N/A
Associated Manufacturing Parameters	Pass Count: 1 Speed (mm/s): 20 Power (Max): 80%		
Quality Control	The part should pass visual inspection upon assembly for any cracks or major defects that could affect structural stability. The part should fit snugly through the middle bowl. A part should be rejected if it does not meet this criteria. The first part should go through a full inspection, as should every tenth part after. Tolerancing for bowl connections: Thickness 0.140 ± 0.001 Depth 0.2900 ± 0.001 Slot 0.510 ± 0.001		
Associated Manufacturing Process Calculations	N/A		
Notes	N/A		

Responsible Team Member(s)	Name	Date
	Daniel Myers	10/4/2022
	Nick Porter	10/4/2022

4.6 Grate Manufacturing Sheet

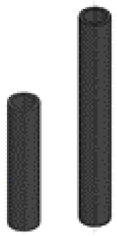
BOM #	Isometric View
6C	
BOM/3D Model Name	
Grate	
Drawing Title	
Grate_6C	

Part Information	
Material Type	**Clear Acrylic Plastic**
Material Resource Planning (Raw Material Needed)	**1/ 4" Acrylic Sheet supplied by McMaster Carr**
Part Count Required	**300**

Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	Laser Cutting		
Machine Tool	Thunder Laser System		
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**
	N/A	N/A	N/A
Associated Manufacturing Parameters	Pass Count:1 Speed (mm/s): 40 Power (Max): 80%		
Quality Control	Proper fitting of the grate and basin will determine quality control. Inspect flatness of part with a straightedge. Visual inspection for any defects along the edges of the part to ensure clean cuts.		
Associated Manufacturing Process Calculations	N/A		
Notes	N/A		

Responsible Team Member(s)	Name	Date
	Kenen Otake	10/11/2022

4.7 Pipes Manufacturing Sheet

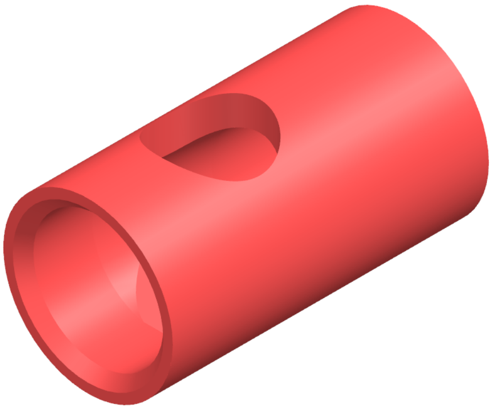
BOM #	Isometric View
8PC, 9PC	
BOM/3D Model Name	
Tall Pipe, Short Pipe	
Drawing Title	
TallPipe_8PC, ShortPipe_9PC	

Part Information	
Material Type	**Black Acrylic Tube**
Material Resource Planning (Raw Material Needed)	**300 ft of tubing in 40x6ft sections from Mcmaster Carr**
Part Count Required	**300x5.5”, 300x3.9875”**

Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	Cutting		
Machine Tool	Jet Horizontal Bandsaw		
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**
	N/A	N/A	N/A
Associated Manufacturing Parameters	Cutting speed of approx. 2,500 feet per minute Feed at approx. 1 inch per minute		
Quality Control	Inspect for cracks on each cut segment		
Associated Manufacturing Process Calculations	N/A		
Notes	N/A		
Secondary Manufacturing Process/Post-Processing			
Process	Chamfering and Deburring Ends		
Machine Tool	Pipe hand chamfer tool, material scraper		
Tooling Needed	**Name**	**BOM #**	**Drawing #**
	N/A	N/A	N/A
Associated Manufacturing Parameters	Scrape off excess material from ends before chamfering.		
Quality Control	N/A		
Associated Manufacturing Process Calculations	N/A		
Notes	N/A		

Responsible Team Member(s)	Name	Date
	Rees Kelley	10/14/2022

4.8 Pump Connector Manufacturing Sheet

BOM #	Isometric View
7C	
BOM/3D Model Name	
Pump Connector	
Drawing Title	
PumpConnection_7C	

Part Information	
Material Type	**Black ABS Plastic Filament**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**300**

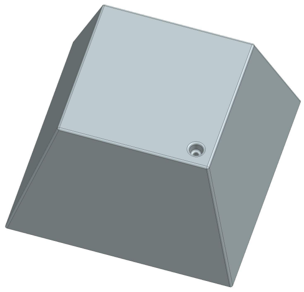
Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	FDM 3D Printing		
Machine Tool	Stratasys F170		
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**
	N/A	N/A	N/A
Associated Manufacturing Parameters	N/A		
Quality Control	Inspect for defects. Every 10th part, ensure that pipe and pump fit in their respective ends.		
Associated Manufacturing Process Calculations	N/A		
Notes	N/A		
Secondary Manufacturing Process/Post-Processing			
Process	Support Material Removal		
Machine Tool	Parts Cleaner		
Tooling Needed	**Name**	**BOM #**	**Drawing #**
	N/A	N/A	N/A
Associated Manufacturing Parameters	6 hrs in parts wash bin to dissolve support material		
Quality Control	N/A		

Associated Manufacturing Process Calculations	N/A
Notes	N/A

Responsible Team Member(s)	**Name**	**Date**
	Kate O’Reilly	12/1/2022

Section 5: Manufacturing Tooling Manufacturing Sheets

5.1 Basin Mold Manufacturing Tooling Sheet

BOM #	Isometric View
300T	
BOM/3D Model Name	
Vacuum Forming Mold	
Drawing Title	
BasinMold_300T	

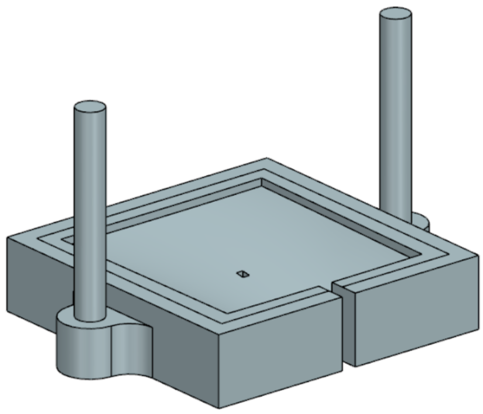
Part Information	
Material Type	**MDF Wood and Epoxy**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**1**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	Milled, sanded, and clamped
Machine Tool	Bandsaw and Beltsander
Associated Manufacturing Parameters	Refer to specifications and tolerances of drawing BasinMold_300T
Quality Control	Make sure the mold has a clean finish such that nothing will puncture the ABS sheet during the vacuum forming process or leave unwanted lines/marks.
Associated Manufacturing Process Calculations	N/A
Notes	N/A

Responsible Team Member(s)	Name	Date
	Nicolas Nigohosian	10/13/2022
	Nate Spina	10/13/2022

5.2 Middle Bowl Punch and Die

5.2.1 Middle Bowl Die Manufacturing Sheet

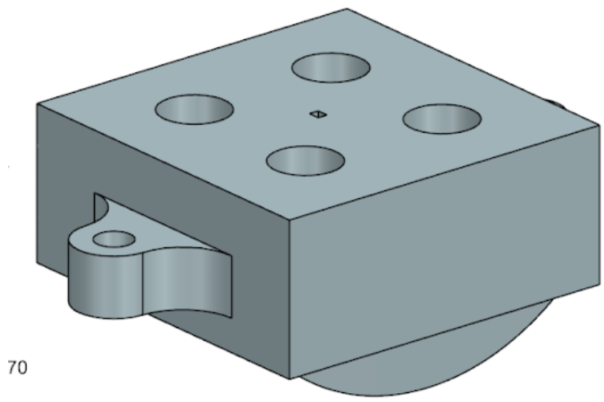
BOM #	Isometric View
200.1T	
BOM/3D Model Name	
Middle Bowl Die	
Drawing Title	
MiddleBowlDie_200.1T	

Part Information	
Material Type	**ONYX Composite**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**1**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	Composite 3D Printing
Machine Tool	MarkForged Printer
Associated Manufacturing Parameters	N/A
Quality Control	Parts must be inspected to ensure a clean surface finish. Parts should have critical dimensions measured with a caliper to ensure tolerancing is met.
Associated Manufacturing Process Calculations	N/A
Notes	The die will be fitted to a die set used on the press.

Responsible Team Member(s)	Name	Date
	Anthony Mazzella	04/26/2022

5.2.2 Middle Bowl Punch Manufacturing Sheet

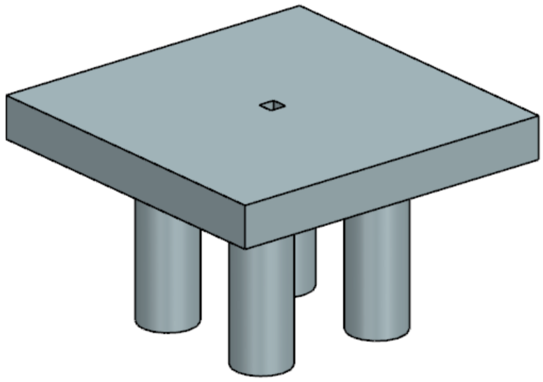
BOM #	Isometric View
200.2T	
BOM/3D Model Name	
Middle Bowl Punch	
Drawing Title	
MiddleBowlPunch_200.2T	

Part Information	
Material Type	**ONYX Composite**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**1**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	Composite 3D Printing
Machine Tool	Markforged Printer
Associated Manufacturing Parameters	N/A
Quality Control	Parts must be inspected to ensure a clean surface finish. Parts should have critical dimensions measured with a caliper to ensure tolerancing is met.
Associated Manufacturing Process Calculations	N/A
Notes	This piece will float between springs to allow easy insertion and removal of blanks.

Responsible Team Member(s)	Name	Date
	Anthony Mazzella	10/14/2022

5.2.3 Middle Bowl Punch and Die Guide Plate Manufacturing Sheet

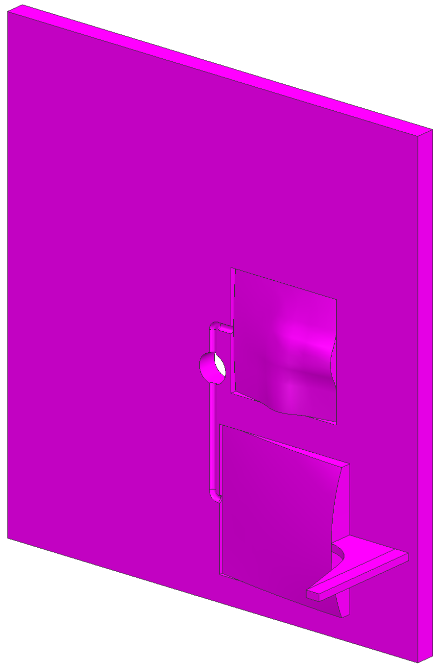
BOM #	Isometric View
200.3T	
BOM/3D Model Name	
Middle Bowl Punch and Die Guide Plate	
Drawing Title	
MiddleBowlPunchandDieGuidePlate_200.3T	

Part Information	
Material Type	**ABS Plastic**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**1**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	FDM 3D Printing
Machine Tool	Stratasys F170
Associated Manufacturing Parameters	N/A
Quality Control	Parts must be inspected to ensure a clean surface finish. Parts should have critical dimensions measured with a caliper to ensure tolerancing is met.
Associated Manufacturing Process Calculations	
Notes	Will be fitted to the top half of the die set to be used with the press.

Responsible Team Member(s)	Name	Date
	Anthony Mazzella	10/14/2022

5.3 Injection Mold Manufacturing Sheet

BOM #	Isometric View
100T	
BOM/3D Model Name	
PIM Mold Half Stationary	
Drawing Title	
PIMMoldHalfStationary_100T	

Part Information	
Material Type	**Aluminum 6061 Block [3x9x9in]**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	CNC Milling
Machine Tool	Haas Mill
Associated Manufacturing Parameters	Secure bridge into mold before closing and running the system to create the overmolded part. RPM = Spindle Speed CS = Cutting Speed in Surface Feet per Minute D = Cutter Diameter in Inches F= Feed Rate per Tooth in Inches F_{pt} = Feed per Tooth in Inches N_t = Number of teeth/Flutes on Cutter
Quality Control	Inspect mold for any visible defects, cracks, and burrs. Critical dimensions to check are holes for pipes to insert. Use calipers and measure dimensions to make sure they are consistent with drawing sheet dimensions. Other critical dimensions are where the bridge will be inserted into the mold for overmolding. Bridge should fit securely in place. Check dimensions with drawing sheet for this section as well.

Associated Manufacturing Process Calculations	$RPM = \frac{4(CS)}{D}$ $F = F_{pt}(RPM)(N_t)$
Notes	N/A

Responsible Team Member(s)	**Name**	**Date**
	Daniel Myers	10/13/2022
	Nate Spina	10/13/2022

5.3.1 Injection Mold Tool Path

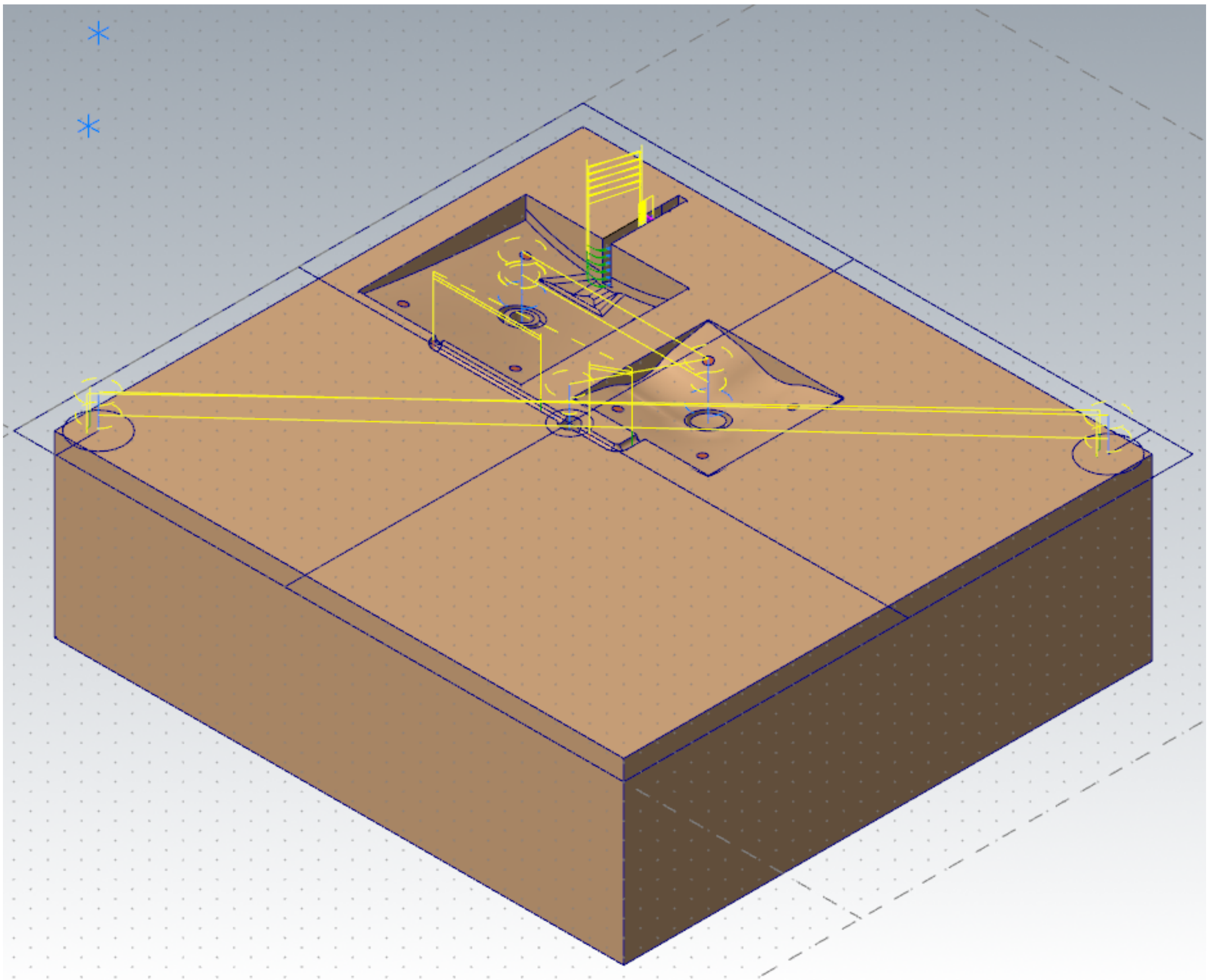


Figure 5.3.1 Injection Mold Moving Half Tool Path

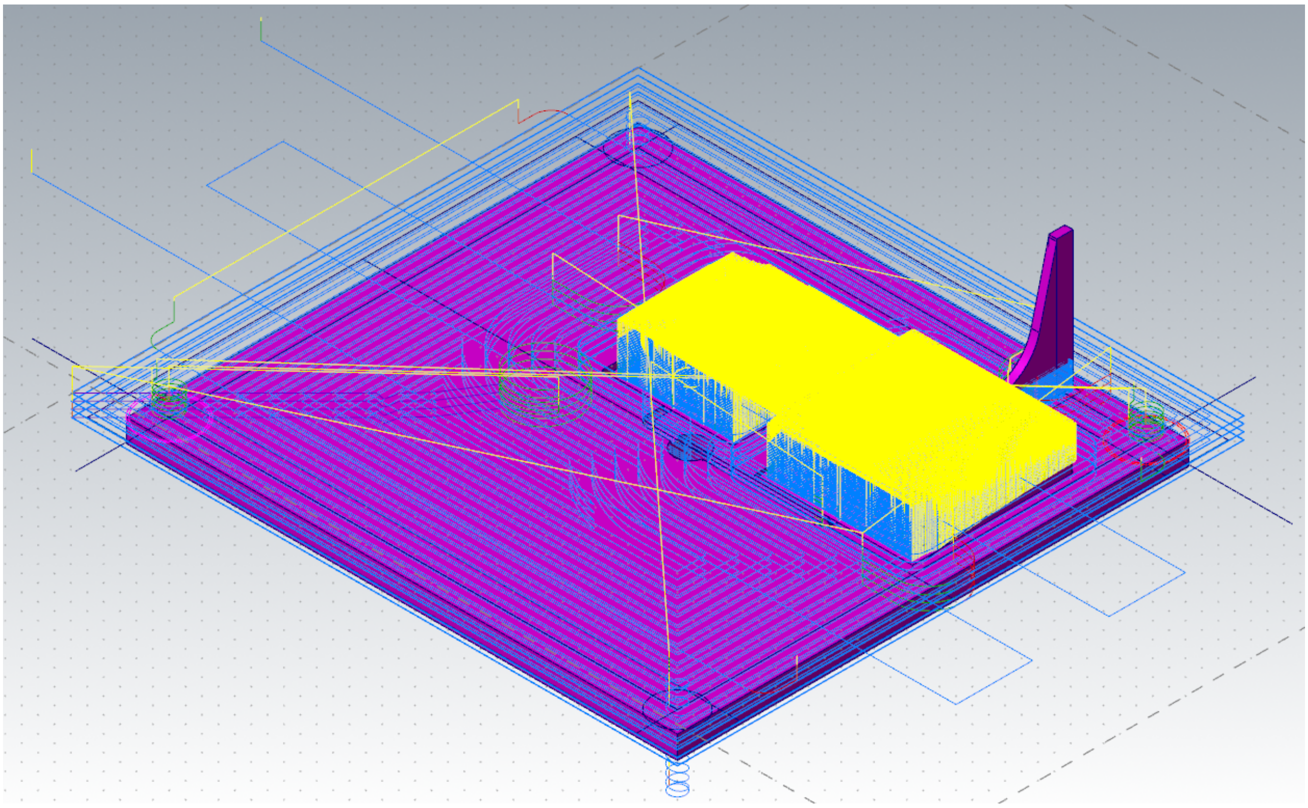


Figure 5.3.2 Injection Mold Stationary Half Tool Path

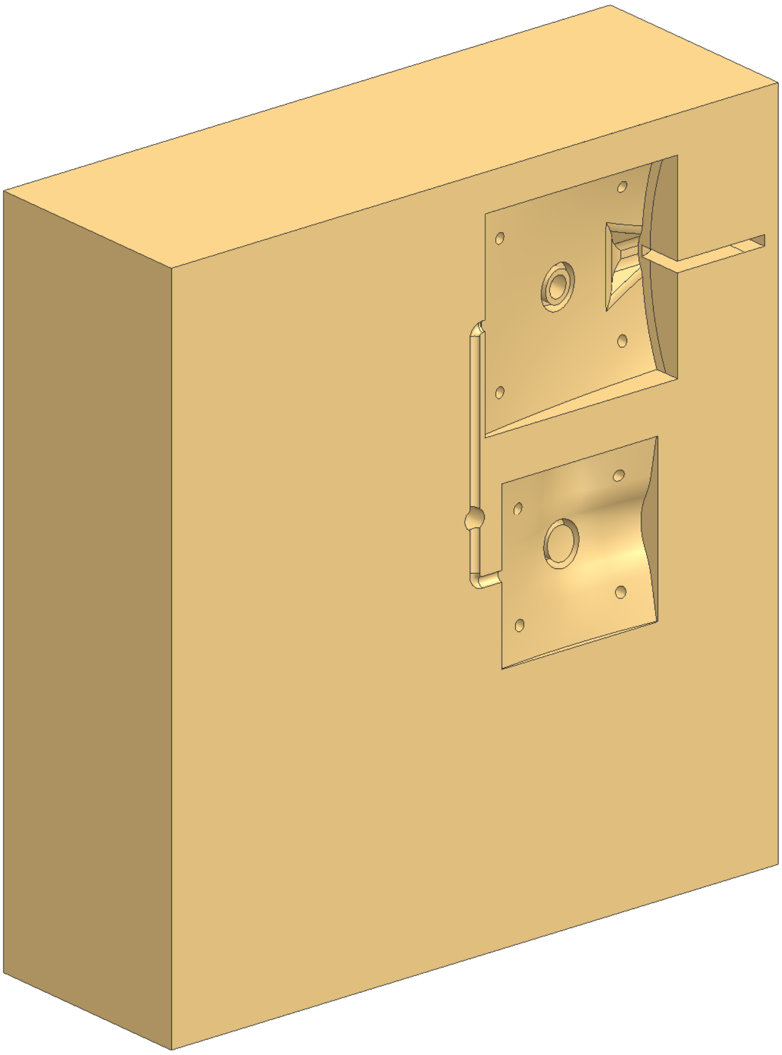


Figure 5.3.3 Injection Mold Moving Half

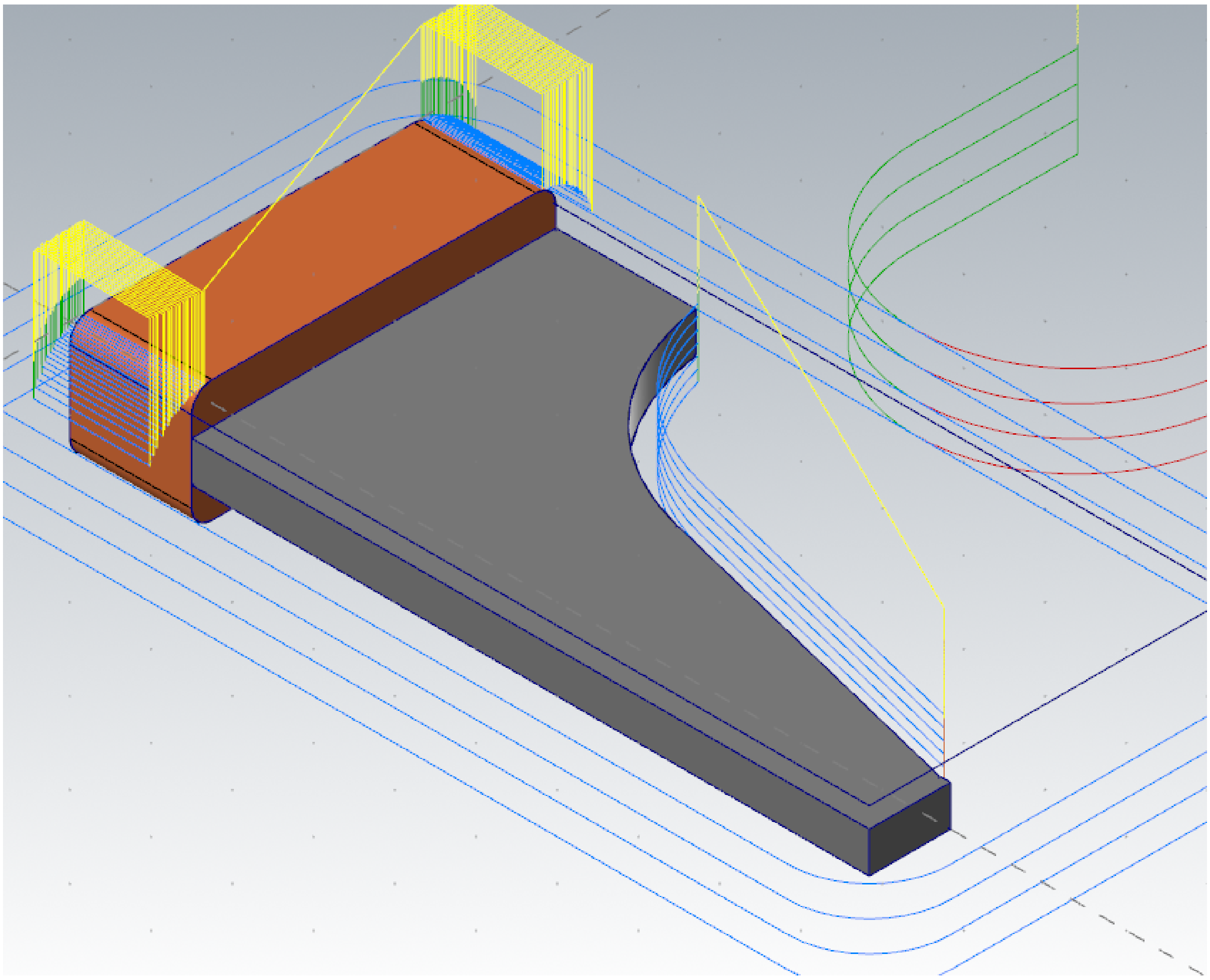
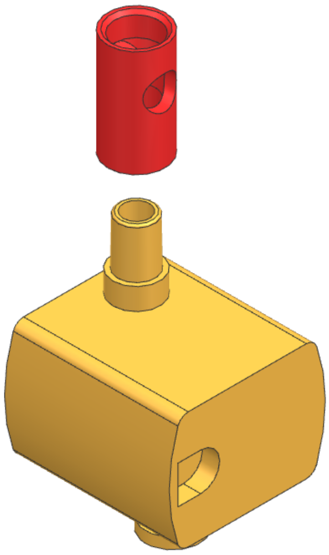


Figure 5.3.4 Bridge Setting Tool

Figures 5.3.1 and 5.3.2 show tool paths for machining the moving and stationary halves of the plastic injection mold, respectively. The finished renderings of the mold can be seen in Figure 5.3.3 and in the manufacturing sheet. Due to the complex geometries, the creation of the physical mold presented many challenges. One of these challenges was the long protrusion on the stationary half of the mold. This protrusion was meant to hold the bridge inside the mold. Due to its length, creating the stationary half as one piece would have wasted a lot of material. To counter this, the protrusion was created from a separate block and bolted onto the stationary half after machining. Another challenge was the creation of the slot meant to hold the bridge in the moving half. Machining this recess alone was challenging in itself due to its depth and the length of available tools. After the fact, because of the tight clearances, fitting in the acrylic bridge resulted in frequent breakages. To solve this issue, a tool which matched the geometry of the stationary half protrusion was made to properly seat the bridge inside the mold. The tool can be seen in Figure 5.3.4 and was able to greatly reduce breakages.

Section 6: Assembly Sheets

6.1 Pump Assembly

BOM #	Assembly or Subassembly Isometric View
2A	
BOM/3D Model Name	
Pump to Connection Assembly	
Drawing Title	
Pump_2A	

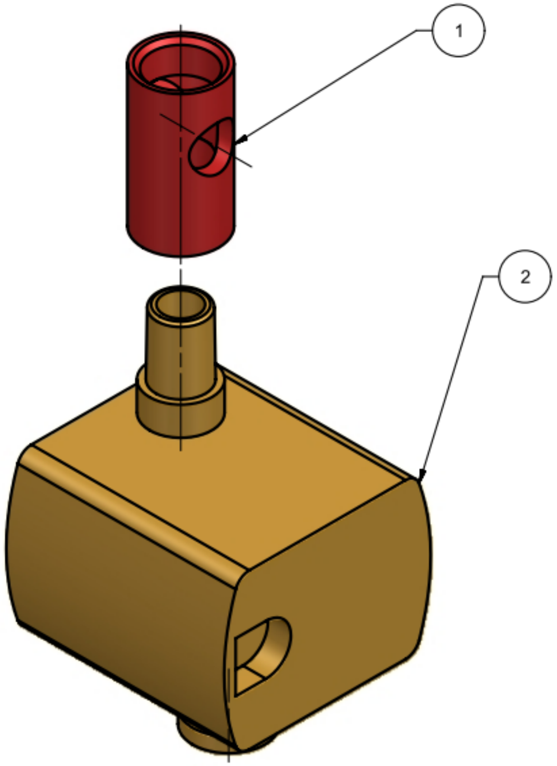
Proposed Assembly Process Plan				
Process	Vertical Press Fit			
Equipment	Custom Press Machine, Staubli Robot			
Parts/Subassemblies Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**	**Quantity**
	7C	Pump Connector	PumpConnection_7C	5
	10PC	Pump	Pump_10PC	5
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**	
	N/A	Vertical Press Machine	N/A	
	N/A	Staubli Robot	N/A	
	2000.1F	Connector Fixture	ConnectorFixture_2000.1F	
	2000.2FE	Connector Feeder	Connector_Feeder_2000.2FE	
	2000.4E	Gripper	Gripper_2000.4E	
Associated Assembly Parameters	Pumps are loaded onto connector fixture and connectors are loaded into connector feeder. The Staubli robot uses the custom effector to pick and place the connectors onto the pumps. The vertical press machine then joins the two components. After parts are pressed together, pump and pump connector should not have any deformation or cracking. Pump and pump connector should be fully pressed together.			
Quality Control	BEFORE ASSEMBLY: Plug in one in every 10 pumps to check that water passes through the pump properly and that there are no visual deformities or abnormal sounds from the pump. AFTER ASSEMBLY: Visual inspection to check for cracking. Check if the connector is fully pressed onto the pump using dimensions from drawing Pump_2A_Press_Fit.			

Associated Assembly Process Calculations	Pump Connector inner diameter = 0.322±0.010 in. Pump outer diameter = .405±0.010 in. Pump with Connector Pressed Distance: 2.115±0.2 in.
Notes	N/A

Responsible Team Members	**Name**	**Date**
	Katherine Cornell	04/23/23

Assembly/Subassembly Workstation Overhead View

MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



PC NO	PART NAME	QTY
1	PUMPCONNECTOR	1
2	PUMP	1

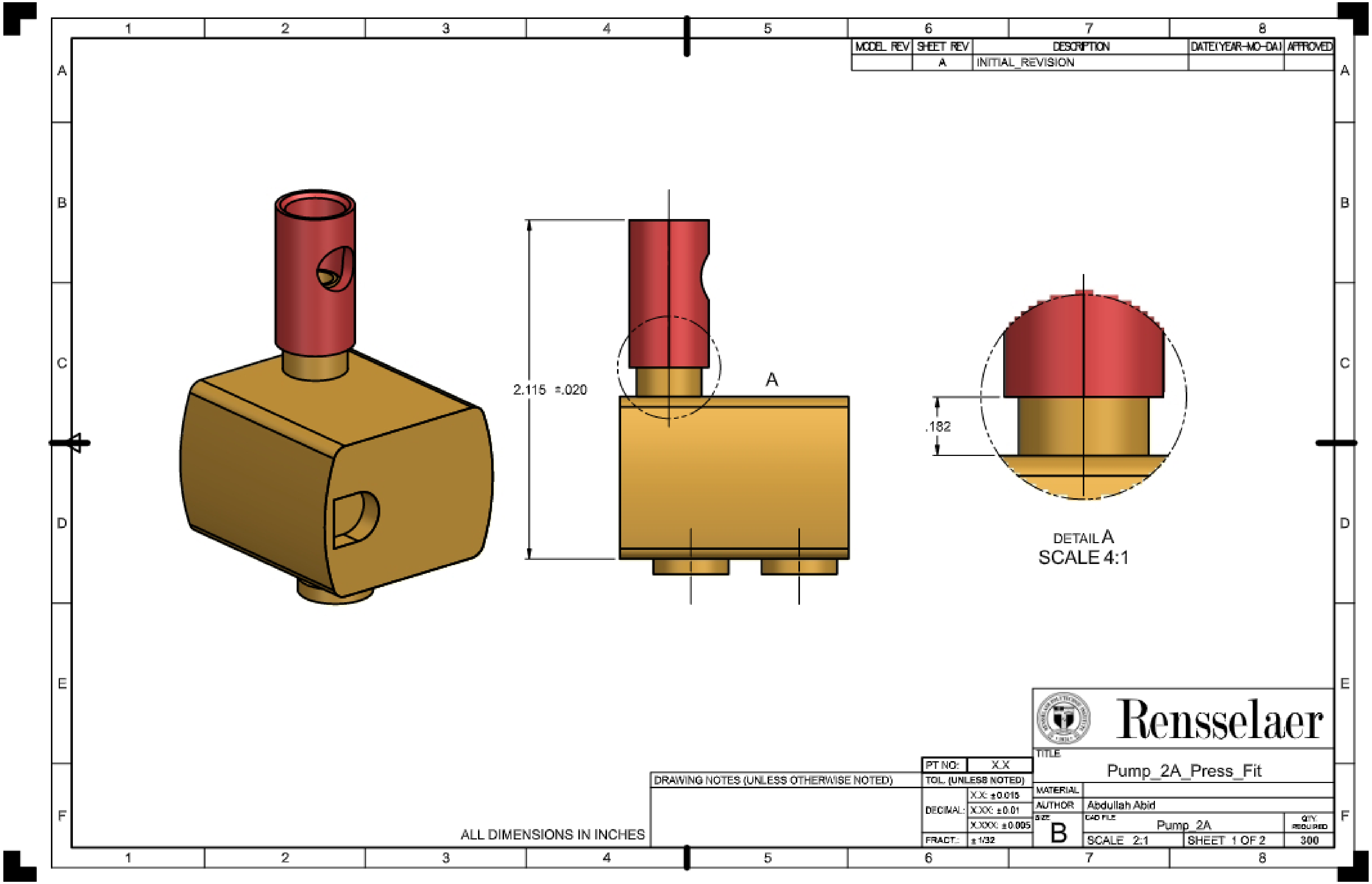
ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO:	2A
TOL. (UNLESS NOTED)	
DECIMAL:	X.X: ±0.015
	X.XX: ±0.01
	X.XXX: ±0.005
FRACT.:	±1/32

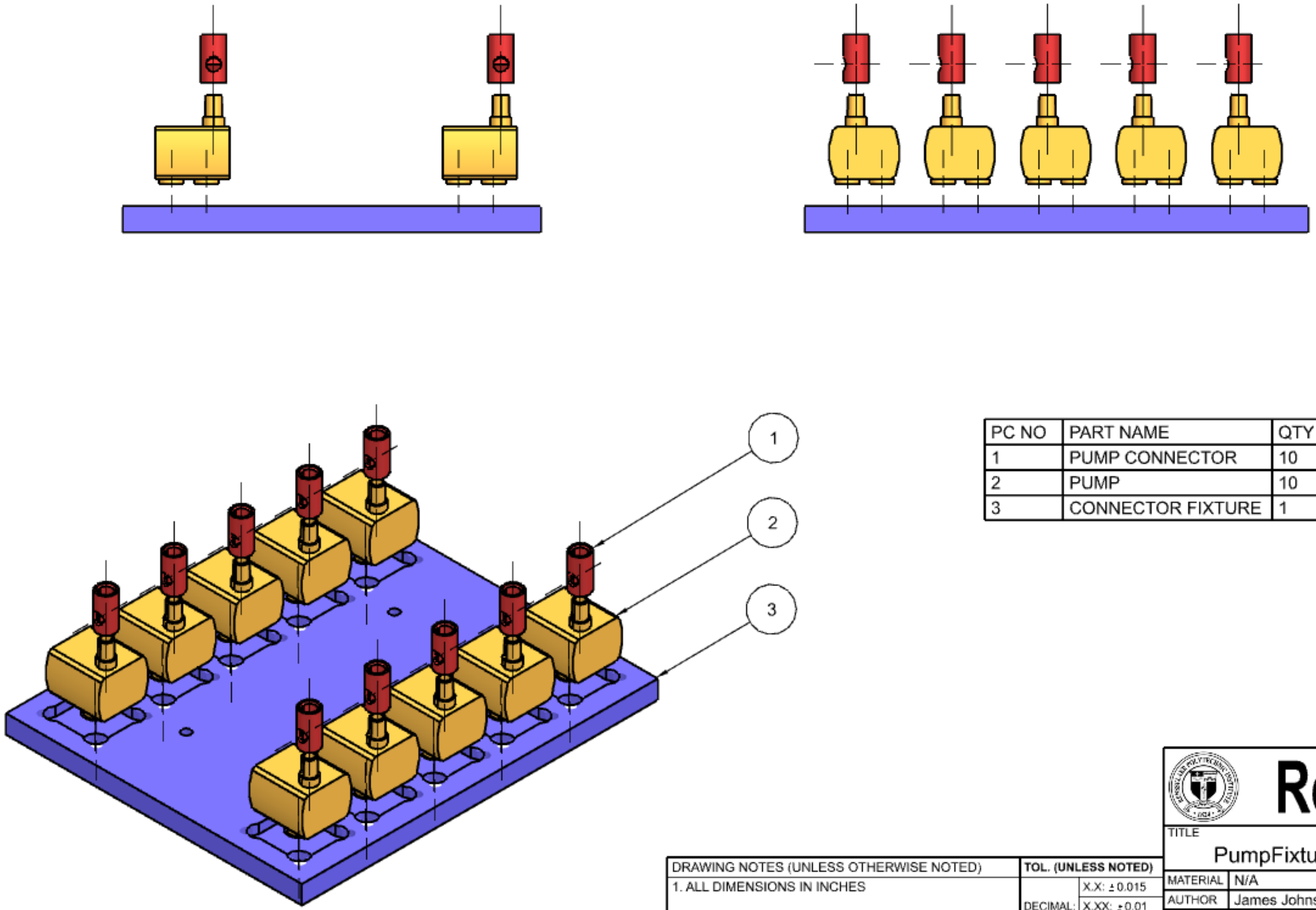
Rensselaer

TITLE	Pump_2A
MATERIAL	
AUTHOR	Kenen Otake
SIZE	B
CAD FILE	
SCALE	1:1
SHEET	1 OF 1
QTY. REQUIRED	1



MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
2.115 ±.020
A
.182
DETAIL A
SCALE 4:1
Rensselaer
TITLE
Pump_2A_Press_Fit
PT NO: X.X
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
DRAWING NOTES (UNLESS OTHERWISE NOTED)
ALL DIMENSIONS IN INCHES
MATERIAL
AUTHOR Abdullah Abid
SIZE B
CAD FILE Pump_2A
SCALE 2:1
SHEET 1 OF 2
QTY REQUIRED 300

MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



PC NO	PART NAME	QTY
1	PUMP CONNECTOR	10
2	PUMP	10
3	CONNECTOR FIXTURE	1

DRAWING NOTES (UNLESS OTHERWISE NOTED)

1. ALL DIMENSIONS IN INCHES

TOL. (UNLESS NOTED)

DECIMAL: X.X: ±0.015, X.XX: ±0.01, X.XXX: ±0.005

FRACT.: ±1/32

Rensselaer

TITLE: PumpFixtureAssembly_2000F

MATERIAL: N/A

AUTHOR: James Johnson

SIZE: B

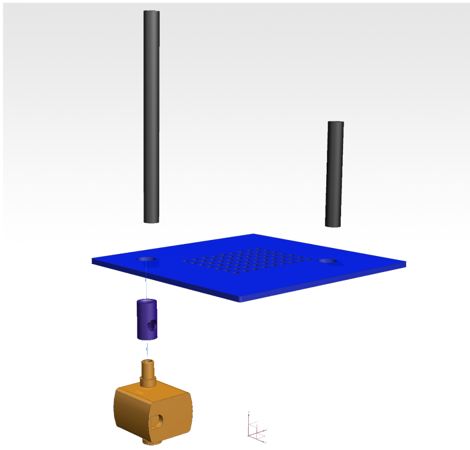
CAD FILE: PumpFixtureAssembly_2000F

QTY. REQUIRED: 1

SCALE 1:2

SHEET 1 OF 1

6.2 Horizontal Press Assembly

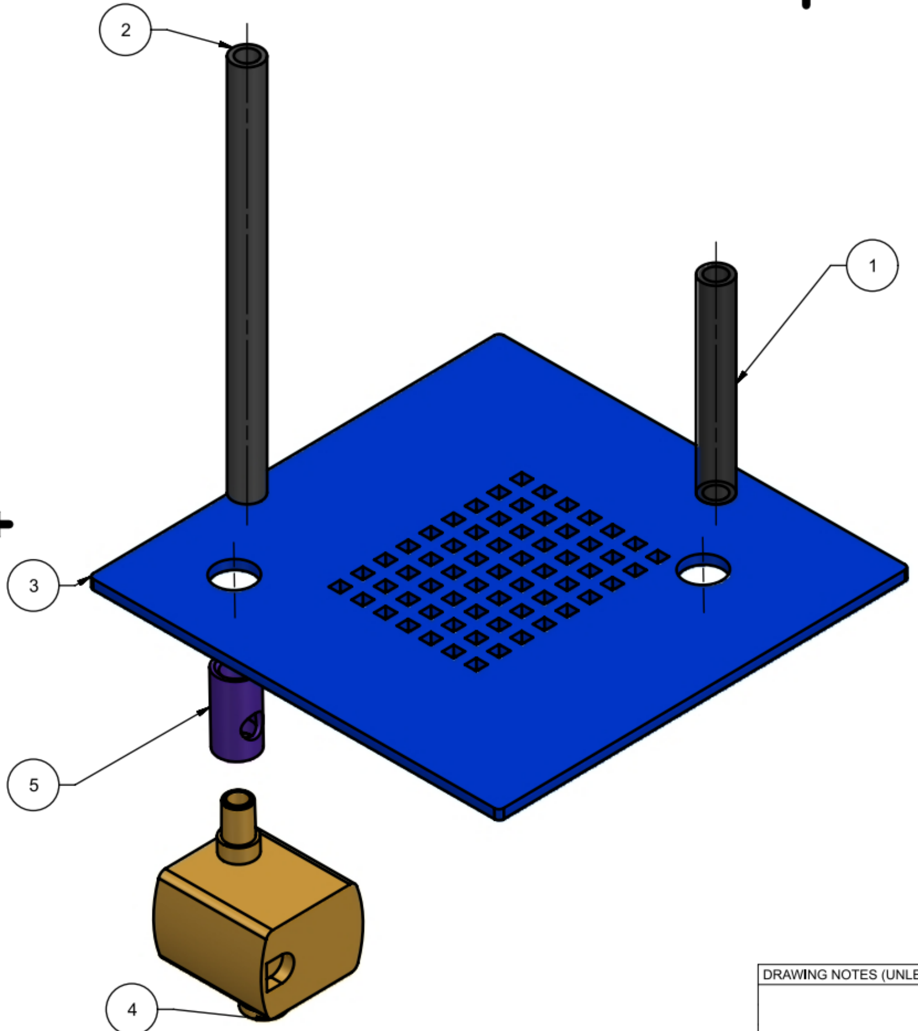
<table>
<tr><th>BOM #</th><th>Assembly or Subassembly Isometric View</th></tr>
<tr><td>3A</td><td rowspan="6"></td></tr>
<tr><th>BOM/3D Model Name</th></tr>
<tr><td>Horizontal Press Assembly</td></tr>
<tr><th>Drawing Title</th></tr>
<tr><td>Horizontal_Press_Assembly_3A</td></tr>
<tr><td></td></tr>
</table>

<table>
<tr><th colspan="5">Proposed Assembly Process Plan</th></tr>
<tr><th>Process</th><td colspan="4">Tight Slide Fit</td></tr>
<tr><th>Equipment</th><td colspan="4">Custom Press Machine</td></tr>
<tr><th rowspan="5">Parts/Subassemblies Needed</th><th>BOM #</th><th>BOM/3D Model Name</th><th>Drawing Title</th><th>Quantity</th></tr>
<tr><td>2A</td><td>Pump to Connection Assembly</td><td>Pump_2A</td><td>1</td></tr>
<tr><td>6C</td><td>Grate</td><td>Grate_6C</td><td>1</td></tr>
<tr><td>8PC</td><td>Tall Pipe</td><td>TallPipe_8PC</td><td>1</td></tr>
<tr><td>9PC</td><td>Short Pipe</td><td>ShortPipe_9PC</td><td>1</td></tr>
<tr><th rowspan="2">Tooling Needed</th><th>BOM #</th><th>BOM/3D Model Name</th><th colspan="2">Drawing Title</th></tr>
<tr><td>3000F</td><td>Horizontal Press Fixture</td><td colspan="2">Horizontal_Press_Fixture_3000F</td></tr>
<tr><th>Associated Assembly Parameters</th><td colspan="4">Pipes, grate and assembly 2A are loaded into a custom press machine. Check to make sure the correct pipes are loaded onto poles and grate is in the correct orientation. After parts are pressed together, pipes should be fully pressed through the grate with no cracking. Pipes should be perpendicular to grate.</td></tr>
<tr><th>Quality Control</th><td colspan="4">Visual inspection for cracking. Visually check if pump connector, pump, and pipe are fully pressed together. Check if pipes are fully pressed through grate using dimensions from Horizontal_Press_Assembly_3A</td></tr>
<tr><th>Associated Assembly Process Calculations</th><td colspan="4">N/A</td></tr>
<tr><th>Notes</th><td colspan="4">N/A</td></tr>
</table>

<table>
<tr><th rowspan="3">Responsible Team Members</th><th>Name</th><th>Date</th></tr>
<tr><td>Kenen Otake</td><td>11/15/2022</td></tr>
<tr><td>James Johnson</td><td>12/10/2022</td></tr>
</table>

Assembly/Subassembly Workstation Overhead View

MODEL REV	SHEET REV	DESCRIPTION	DATE(YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



PC NO	PART NAME	QTY
1	PIPE	1
2	PIPETALL	1
3	GRATEV2	1
4	PUMP	1
5	CONNECTION (PUMP_PIPE)	1

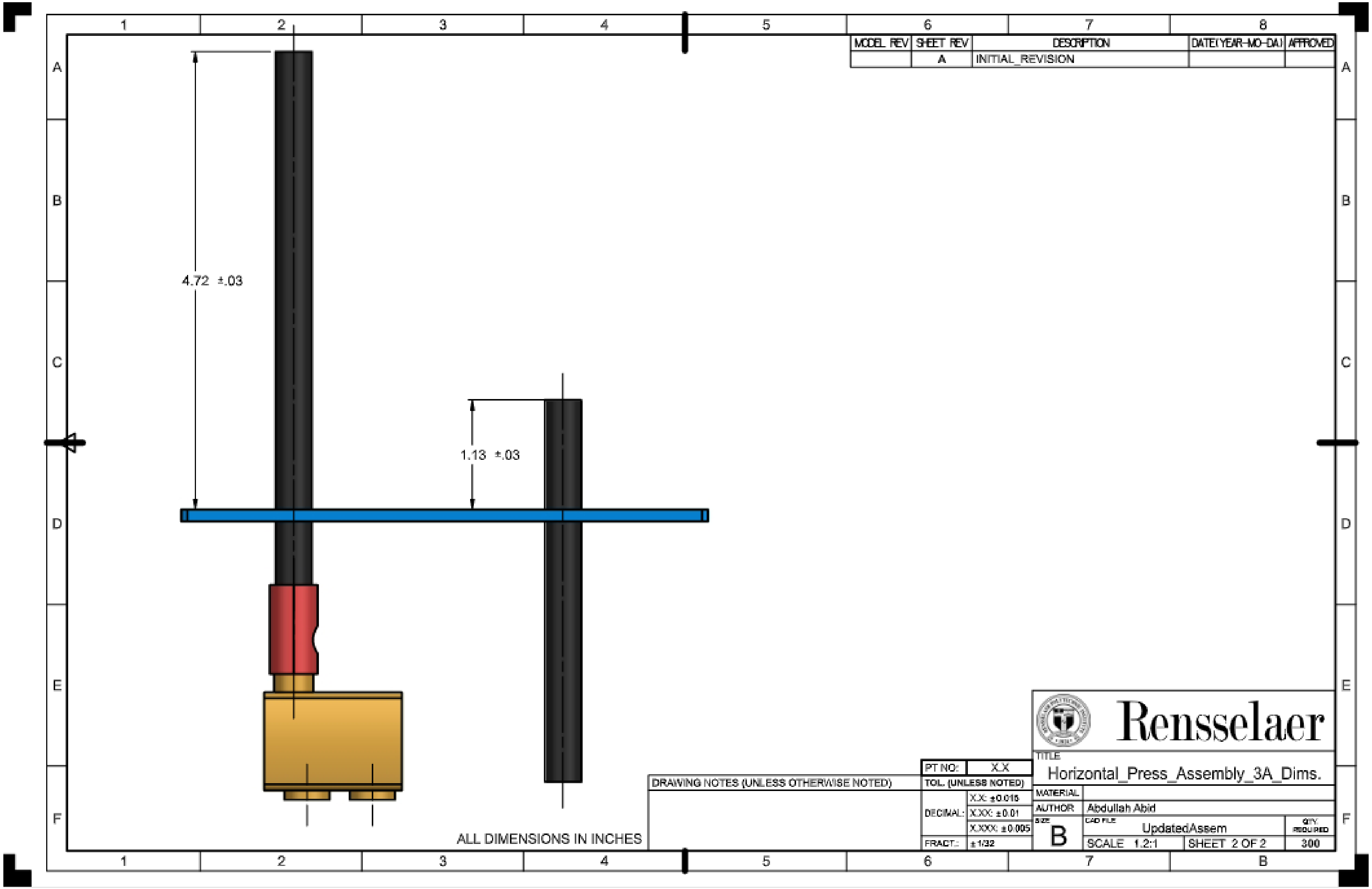
ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

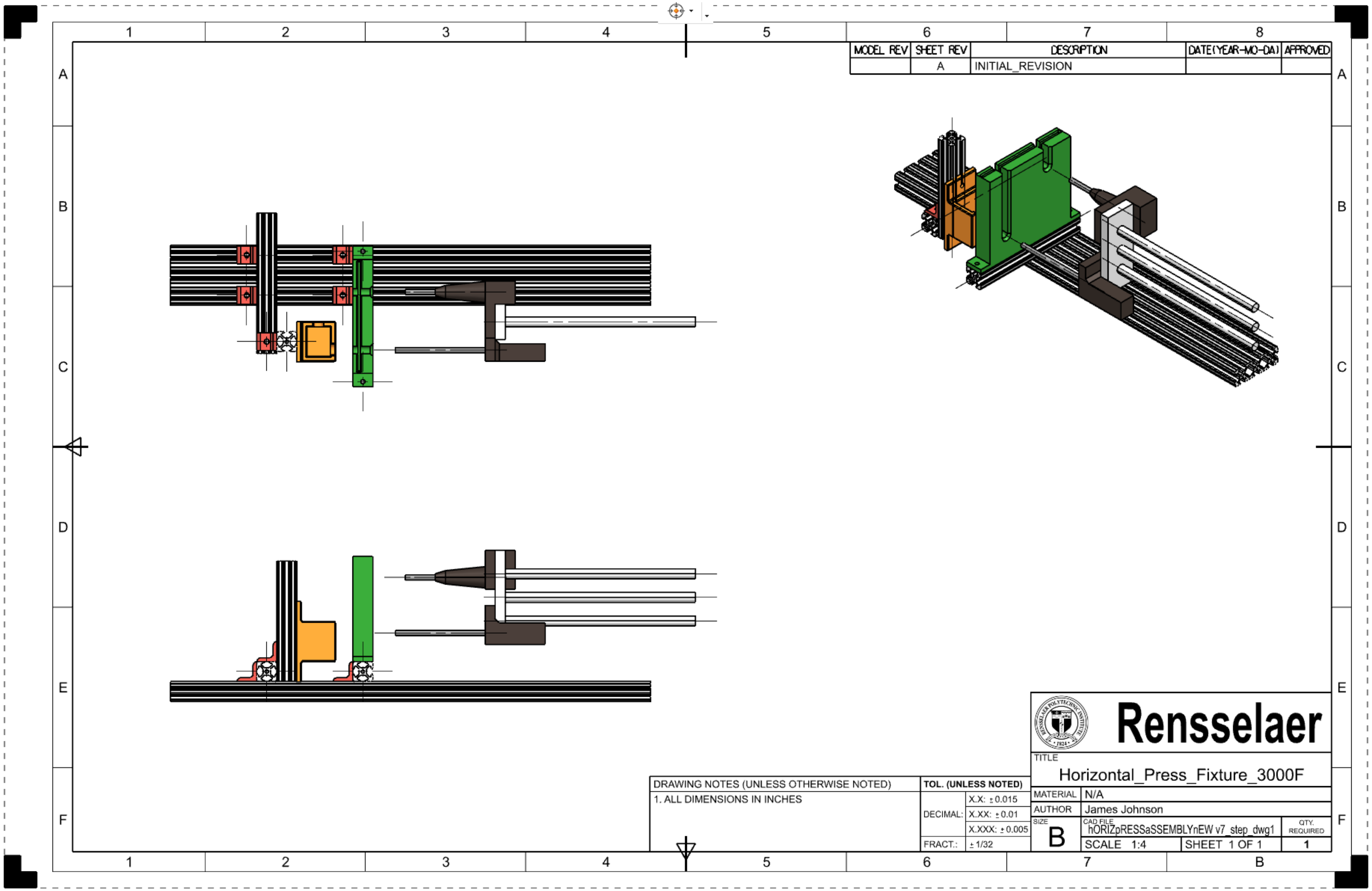
PT NO:	3A
TOL. (UNLESS NOTED)	
DECIMAL:	X.X: ±0.015
	X.XX: ±0.01
	X.XXX: ±0.005
FRACT.:	±1/32

Rensselaer

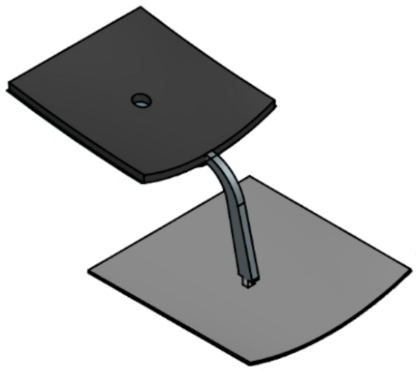
TITLE	Horizontal_Press_Assembly_3A
MATERIAL	
AUTHOR	Abdullah Abid
SIZE	B
CAD FILE	
SCALE	1:1
SHEET	1 OF 1
QTY. REQUIRED	1



4.72 ±.03
1.13 ±.03
ALL DIMENSIONS IN INCHES
MODEL REV
SHEET REV
DESCRIPTION
DATE(YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
Rensselaer
TITLE
Horizontal_Press_Assembly_3A_Dims.
PT NO: X.X
TOL. (UNLESS NOTED)
DRAWING NOTES (UNLESS OTHERWISE NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
MATERIAL
AUTHOR Abdullah Abid
SIZE B
CAD FILE UpdatedAssem
QTY REQUIRED 300
SCALE 1.2:1
SHEET 2 OF 2


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
Rensselaer
TITLE
Horizontal_Press_Fixture_3000F
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
MATERIAL N/A
AUTHOR James Johnson
SIZE B
CAD FILE hORIZpRESSaSSEMBLYnEW v7_step_dwg1
QTY. REQUIRED 1
SCALE 1:4
SHEET 1 OF 1

6.3 Bowl to Bridge Assembly

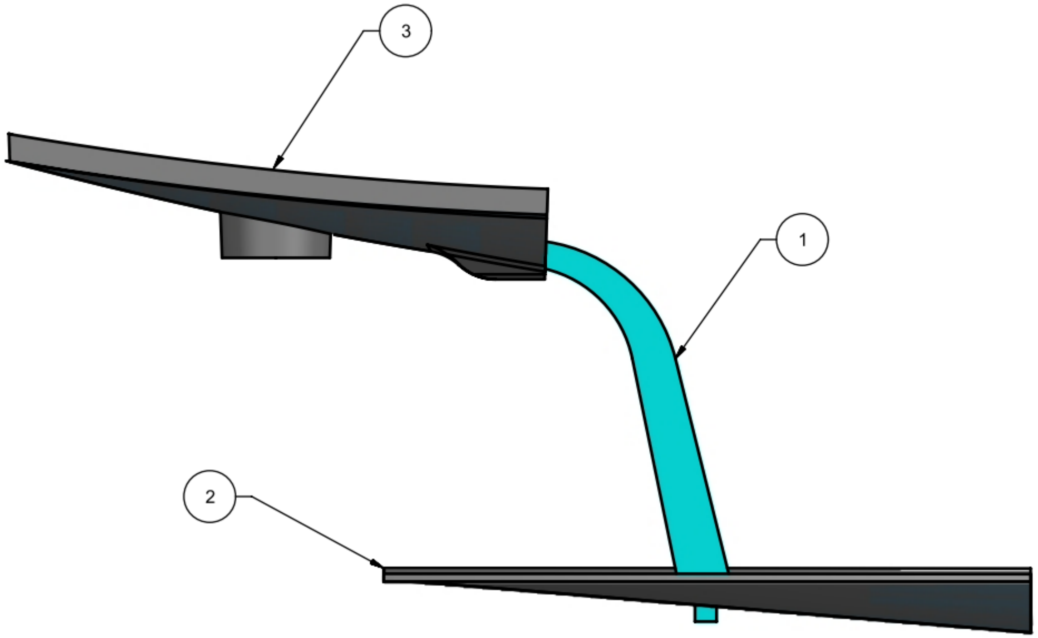
BOM #	Assembly or Subassembly Isometric View
4A	
BOM/3D Model Name	
Bowl to Bridge Assembly	
Drawing Title	
Bowl_to_Bridge_Assembly_4A	

Proposed Assembly Process Plan				
Process	Heat staking			
Equipment	Heat Staking Machine, Custom Heat Staking Fixture			
Parts/Subassemblies Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**	**Quantity**
	5C	Top Bowl	TopBowl_5C	1
	2C	Bridge	Bridge_2C	1
	4C	Middle Bowl	MiddleBowl_4C	1
Tooling Needed	**BOM #**	**BOM/3D Model Name**	**Drawing Title**	
	N/A	Heat Staking Machine	N/A	
	1000F	Middle Bowl Fixture	MiddleBowlFixtureAssembly_1000F	
Associated Assembly Parameters	Bolt fixture to heat staking machine. Place combined top bowl and bridge into fixture. Place middle bowl on top of fixture, over the bridge. Use machine to touch heated pin to the tab on the bridge, melting it over. Remove parts from machine. After heat staking, bridge and middle bowl should be firmly connected without any wobbling. There should be no deformation or cracking in either part.			
Quality Control	Visually inspect part for defects after heat staking.			
Associated Assembly Process Calculations	N/A			
Notes	N/A			

Responsible Team Members	**Name**	**Date**
	Kate O’Reilly	12/1/2022

Assembly/Subassembly Workstation Overhead View

MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



PC NO	PART NAME	QTY
1	BRIDGESTAKED_11_14	1
2	MIDDLEBOWL	1
3	TOPBOWL_OUT	1

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO: 4A

TOL. (UNLESS NOTED)

DECIMAL: X.X: ±0.015 X.XX: ±0.01 X.XXX: ±0.005

FRACT.: ±1/32

Rensselaer

TITLE Bowl_to_Bridge_Assembly_4A

MATERIAL

AUTHOR Abdullah Abid

SIZE B

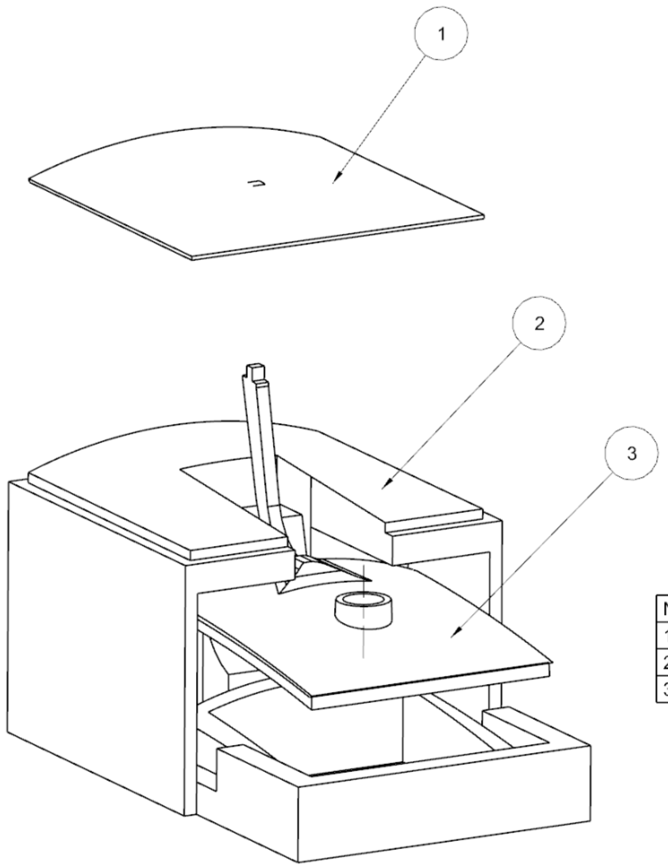
CAD FILE

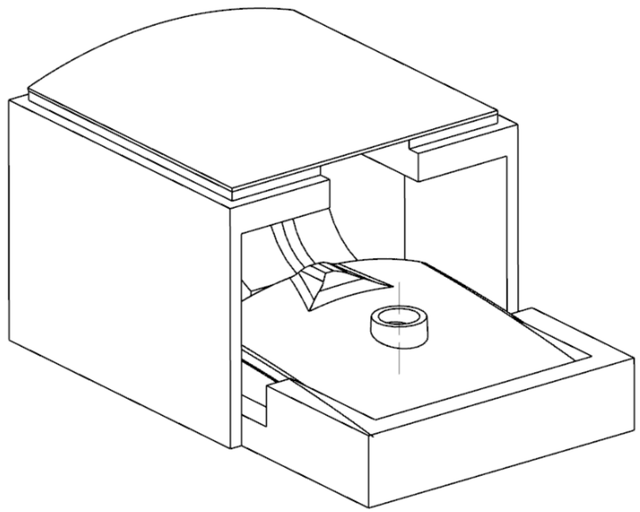
SCALE 2:1

SHEET 1 OF 1

QTY. REQUIRED 1

MODEL REV	SHEET REV	DESCRIPTION	DATE(YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		





Number	Part
1	Middle Bowl
2	Middle Bowl Fixture
3	Top Bowl + Bridge

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

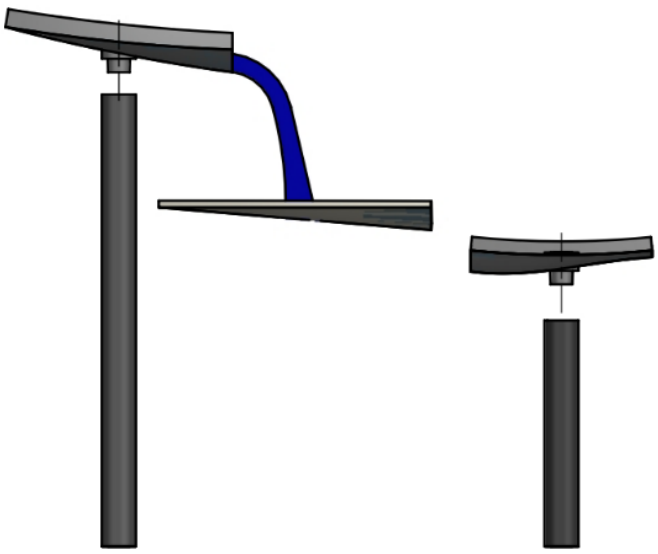
PT NO:	X.X	
TOL. (UNLESS NOTED)		
DECIMAL:	X.X: ±0.015	
	X.XX: ±0.01	
	X.XXX: ±0.005	
FRACT.:	±1/32	

Rensselaer

RENSSELAER POLYTECHNIC INSTITUTE 1824

TITLE	MiddleBowlFixtureAssembly_1000F		
MATERIAL	Misc		
AUTHOR	Anthony Mazzella		
SIZE B	CAD FILE MIddle Bowl Fixed Fix		QTY. REQUIRED
	SCALE 1:1	SHEET 1 OF 1	1

6.4 Bowls to Pipe Assembly

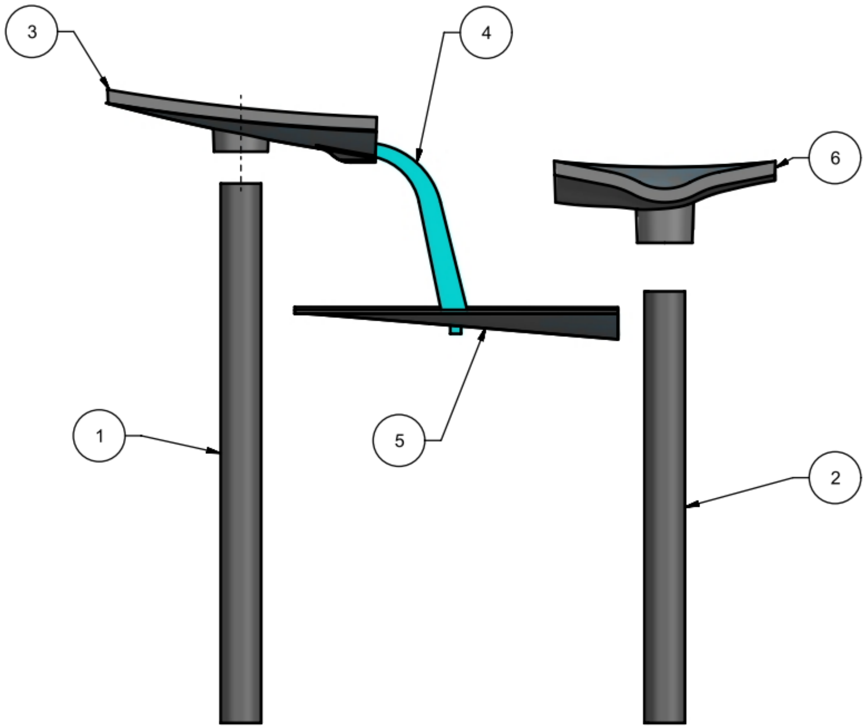
<table>
<tr><th>BOM #</th><th>Assembly or Subassembly Isometric View</th></tr>
<tr><td>5A</td><td rowspan="6"></td></tr>
<tr><th>BOM/3D Model Name</th></tr>
<tr><td>Bowls to Pipe Assembly</td></tr>
<tr><th>Drawing Title</th></tr>
<tr><td>Bowls_Pipe_Assembly_5A</td></tr>
<tr><td></td></tr>
</table>

<table>
<tr><th colspan="6">Proposed Assembly Process Plan</th></tr>
<tr><th>Process</th><td colspan="5">Press Fit</td></tr>
<tr><th>Equipment</th><td colspan="5">Manual</td></tr>
<tr><th rowspan="4">Parts Needed</th><th>BOM #</th><th>BOM/3D Model Name</th><th colspan="2">Drawing Title</th><th>Quantity</th></tr>
<tr><td>3C</td><td>End Bowl</td><td colspan="2">EndBowl_3C</td><td>1</td></tr>
<tr><td>4A</td><td>Bowl to Bridge Assembly</td><td colspan="2">BowltoBridgeAssembly_4A</td><td>1</td></tr>
<tr><td>3A</td><td>Horizontal Press Assembly</td><td colspan="2">Horizontal_Press_Assembly_3A</td><td>1</td></tr>
<tr><th rowspan="2">Tooling Needed</th><th>BOM #</th><th>BOM/3D Model Name</th><th colspan="3">Drawing Title</th></tr>
<tr><td>N/A</td><td>N/A</td><td colspan="3">N/A</td></tr>
<tr><th>Associated Assembly Parameters</th><td colspan="5">Press fit should be tight, with minimal movement</td></tr>
<tr><th>Quality Control</th><td colspan="5">Assembler pull test and inspection for a flush press fit</td></tr>
<tr><th>Associated Assembly Process Calculations</th><td colspan="5">Bowl Inner Diameter is 0.375 ± 0.005
Pipe Outer Diameter is 0.375 ± 0.005</td></tr>
<tr><th>Notes</th><td colspan="5">N/A</td></tr>
</table>

<table>
<tr><th rowspan="2">Responsible Team Members</th><th>Name</th><th>Date</th></tr>
<tr><td>Kenen Otake</td><td>11/15/2022</td></tr>
</table>

Assembly/Subassembly Workstation Overhead View

MODEL REV	SHEET REV	DESCRIPTION	DATE(YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



PC NO	PART NAME	QTY
1	PIPETALL	1
2	PIPE	1
3	TOPBOWL_OUT	1
4	BRIDGESTAKED_11_14	1
5	MIDDLEBOWL	1
6	ENDBOWL	1

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO: 5.A

TOL. (UNLESS NOTED)

DECIMAL: X.X: ±0.015 X.XX: ±0.01 X.XXX: ±0.005

FRACT.: ±1/32

Rensselaer

TITLE Bowls_Pipe_Assembly_5A

MATERIAL

AUTHOR Abdullah Abid

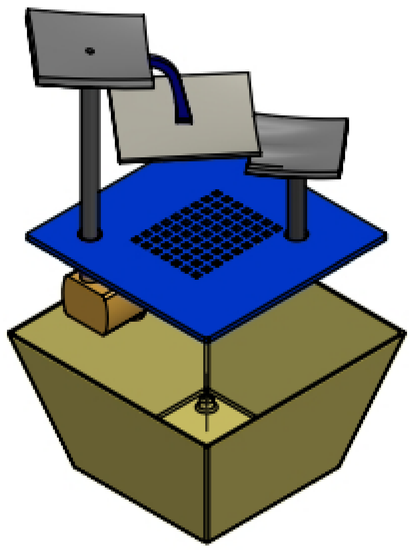
SIZE B

CAD FILE

SCALE 1:1 SHEET 1 OF 1

QTY. REQUIRED 1

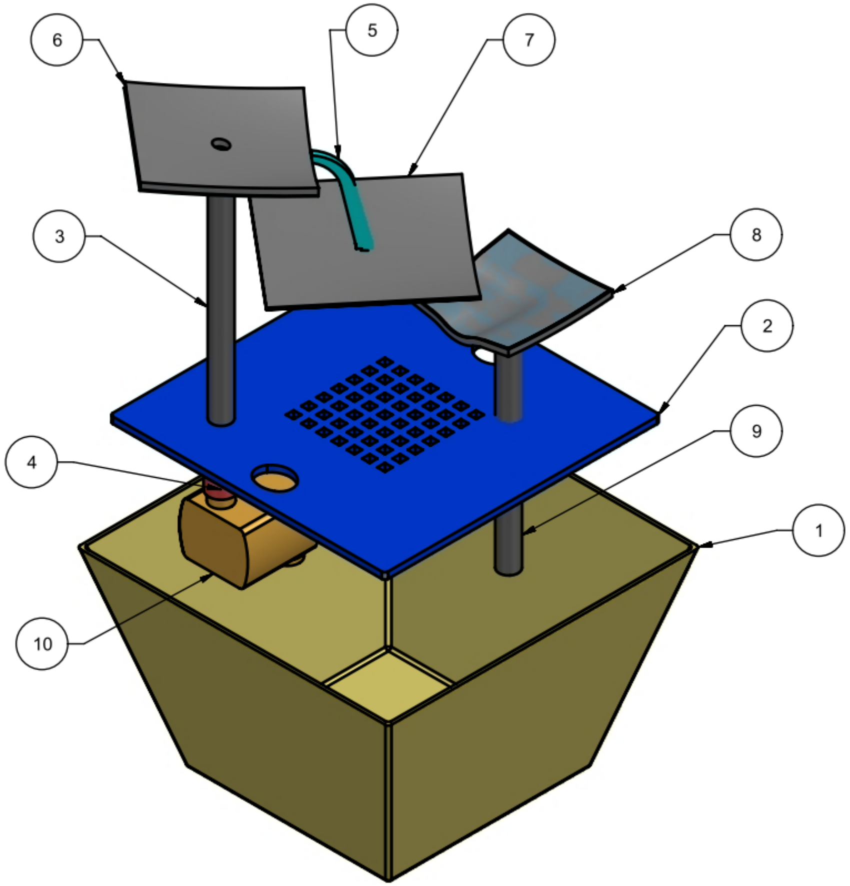
6.5 Final Assembly

BOM #	Assembly or Subassembly Isometric View
1A	
BOM/3D Model Name	
Full Fountain Assembly Labeled	
Drawing Title	
Final_Assembly_1A	

<table>
<tr><th colspan="5">Proposed Assembly Process Plan</th></tr>
<tr><td>Process</td><td colspan="4">Press-Fit Assembly of Grate System to Basin</td></tr>
<tr><td>Equipment</td><td colspan="4">Manual</td></tr>
<tr><td rowspan="4">Parts/Subassemblies Needed</td><td>BOM #</td><td>BOM/3D Model Name</td><td>Drawing Title</td><td>Quantity</td></tr>
<tr><td>1C</td><td>Basin</td><td>Basin_1C</td><td>1</td></tr>
<tr><td>5A</td><td>Bowls to Pipe Assembly</td><td>Bowls_Pipe_Assembly_5A</td><td>1</td></tr>
<tr><td>2PD</td><td>Plastic Rock Bag</td><td>Rock_Bag</td><td>1</td></tr>
<tr><td rowspan="2">Tooling Needed</td><td>BOM #</td><td>BOM/3D Model Name</td><td colspan="2">Drawing Title</td></tr>
<tr><td>N/A</td><td>N/A</td><td colspan="2">N/A</td></tr>
<tr><td>Associated Assembly Parameters</td><td colspan="4">The rocks are placed in the basin. Assembly 5A is then placed into a basin around rocks by hand.
Grate and bowls should appear level and feel stable.</td></tr>
<tr><td>Quality Control</td><td colspan="4">Visual inspection of assembly to make sure parts appear level and properly seated in the basin. Light hand force will confirm stability of the assembly.</td></tr>
<tr><td>Associated Assembly Process Calculations</td><td colspan="4">N/A</td></tr>
<tr><td>Notes</td><td colspan="4">N/A</td></tr>
</table>

<table>
<tr><td rowspan="2">Responsible Team Members</td><td>Name</td><td>Date</td></tr>
<tr><td>James Johnson</td><td>04/20/23</td></tr>
</table>

MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION		



PC NO	PART NAME	QTY
1	BASIN	1
2	GRATEV3	1
3	PIPETALL	1
4	CONNECTION (PUMP_PIPE)	1
5	BRIDGESTAKED_11_14	1
6	TOPBOWL_OUT	1
7	MIDDLEBOWL	1
8	ENDBOWL	1
9	PIPE	1
10	PUMP	1

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)

PT NO:	1A
TOL. (UNLESS NOTED)	
DECIMAL:	X.X: ±0.015
	X.XX: ±0.01
	X.XXX: ±0.005
FRACT.:	±1/32

Rensselaer

TITLE: Final_Assembly_1A

MATERIAL:

AUTHOR: Abdullah Abid

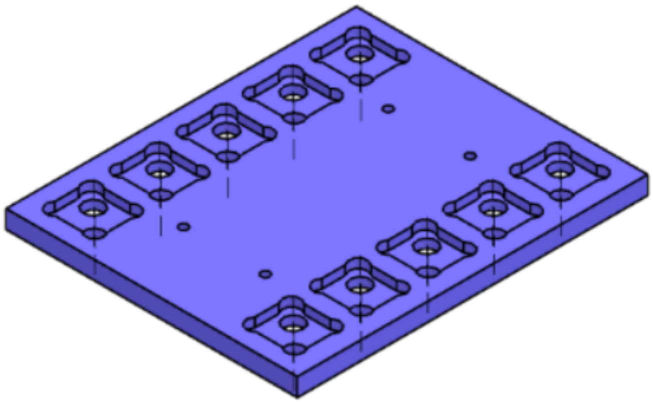
SIZE: B | CAD FILE: | QTY. REQUIRED:

SCALE 2:3 | SHEET 1 OF 1

Section 7: Assembly Tooling Manufacturing Sheets

7.1 Pump to Connection Assembly Fixture Manufacturing Sheets

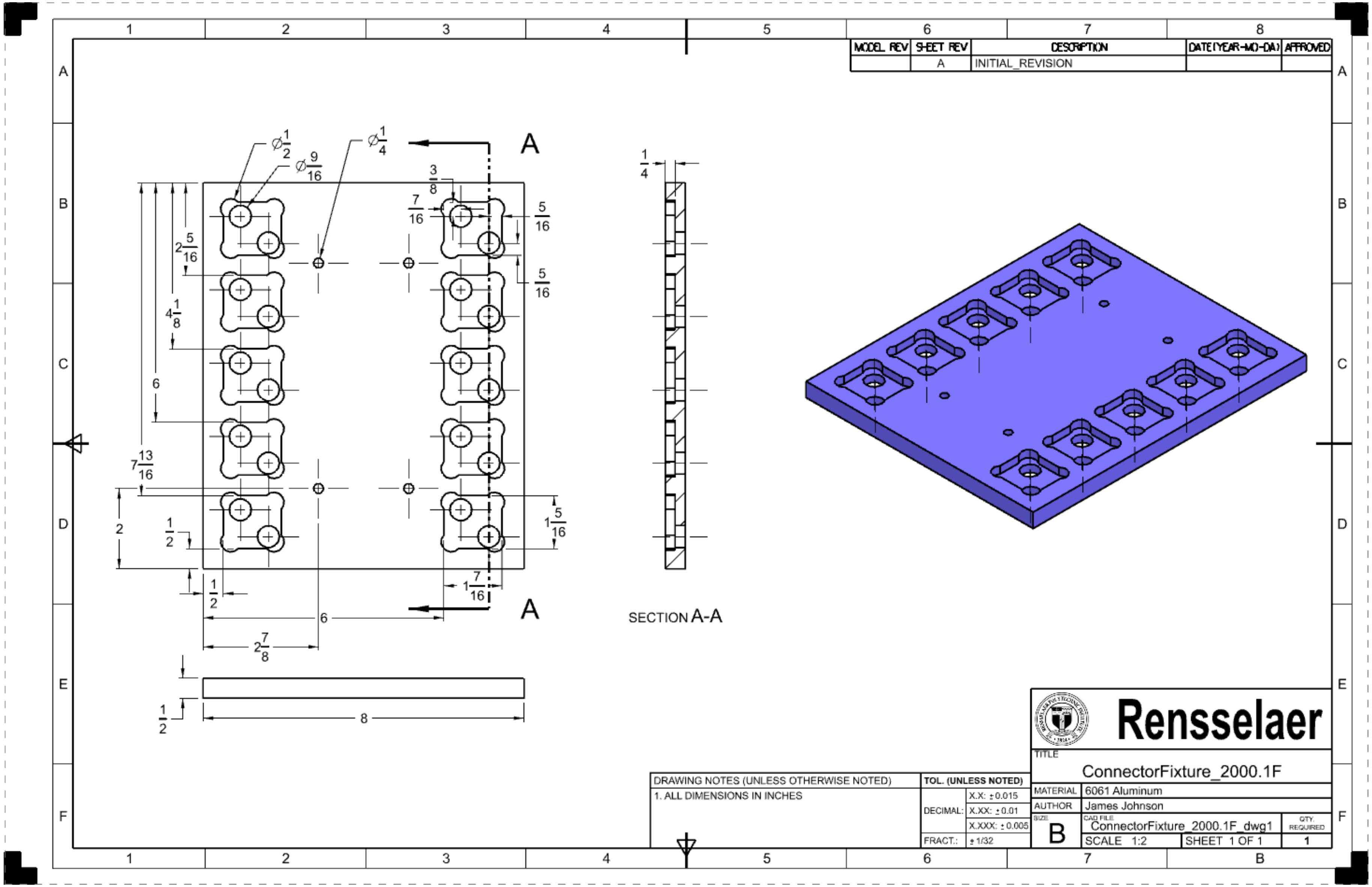
7.1.1 Connector Fixture Tooling Manufacturing Sheet

BOM #	Isometric View
2000.1F	
BOM/3D Model Name	
Connector Fixture	
Drawing Title	
ConnectorFixture_2000.1F	

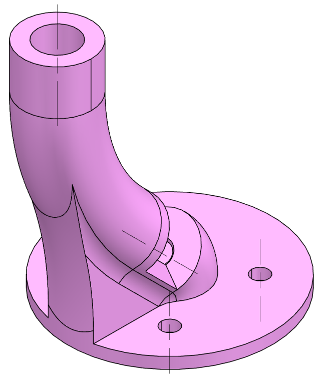
Part Information	
Material Type	**6061 Aluminum**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	CNC Milling
Machine Tool	Haas Mill
Associated Manufacturing Parameters	RPM = Spindle Speed CS = Cutting Speed in Surface Feet per Minute D = Cutter Diameter in Inches F= Feed Rate per Tooth in Inches F_{pt} = Feed per Tooth in Inches N_t = Number of teeth/Flutes on Cutter
Quality Control	Part must be inspected to ensure a clean surface finish. Part should have critical dimensions measured with a caliper to ensure tolerancing is met. Test by inserting the pump for secure fit.
Associated Manufacturing Process Calculations	$RPM = \frac{4(CS)}{D}$ $F = F_{pt}(RPM)(N_t)$
Notes	N/A

Responsible Team Member(s)	Name	Date
	James Johnson	02/21/23


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
A
SECTION A-A
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015 X.XX: ±0.01 X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
ConnectorFixture_2000.1F
MATERIAL 6061 Aluminum
AUTHOR James Johnson
SIZE B
CAD FILE ConnectorFixture_2000.1F_dwg1
QTY. REQUIRED 1
SCALE 1:2
SHEET 1 OF 1

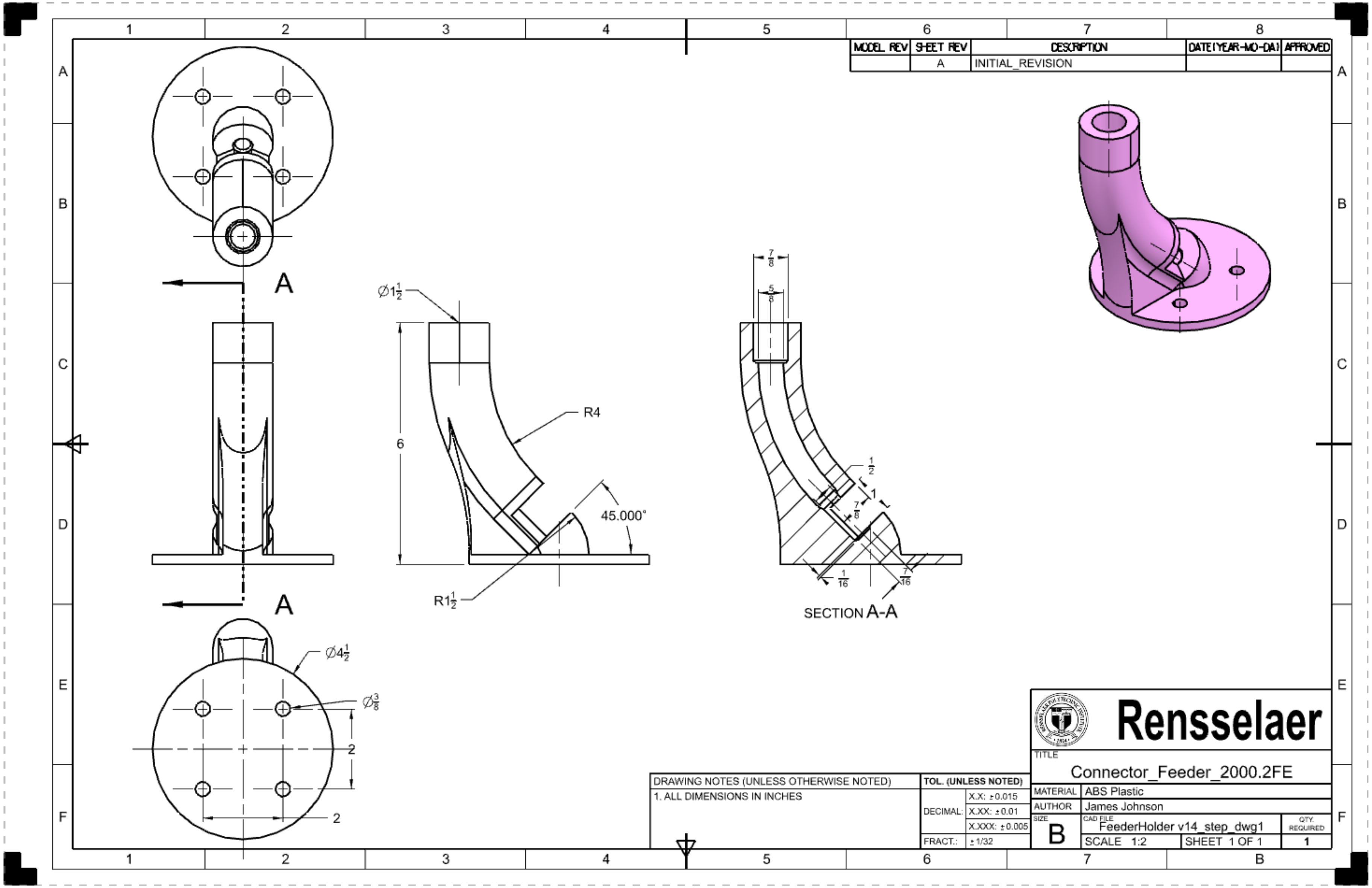
7.1.2 Connector Feeder Tooling Manufacturing Sheet

<table>
<tr><th>BOM #</th><th>Isometric View</th></tr>
<tr><td>2000.2FE</td><td rowspan="6"></td></tr>
<tr><th>BOM/3D Model Name</th></tr>
<tr><td>Connector Feeder</td></tr>
<tr><th>Drawing Title</th></tr>
<tr><td>Connector_Feeder_2000.2FE</td></tr>
</table>

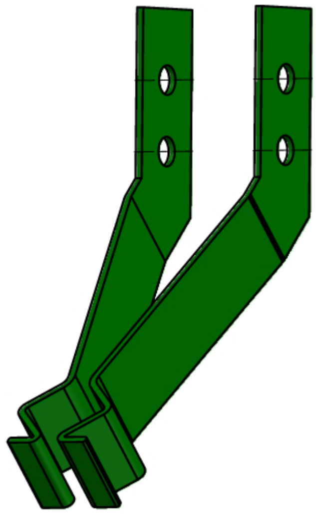
Part Information	
Material Type	**3D Printed ABS**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	FDM 3D Printing
Machine Tool	Stratasys F170
Associated Manufacturing Parameters	Infill: 30% Layer Height: 0.3mm Support material: Yes Print as pictured with the flange on the bottom.
Quality Control	Verify that the ID allows pipe connectors to easily drop through the feeder. Verify that a standard 0.5” ID PVC tube fits snugly into the top of the feeder.
Associated Manufacturing Process Calculations	N/A
Notes	N/A

Responsible Team Member(s)	Name	Date
	James Johnson	04/24/2023


MODEL REV
SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
A
A
Ø1½
R4
6
45.000°
R1½
⅞
⅝
½
1
⅞
1/16
7/16
SECTION A-A
Ø4½
Ø⅜
2
2
Rensselaer
TITLE
Connector_Feeder_2000.2FE
MATERIAL
ABS Plastic
AUTHOR
James Johnson
SIZE
B
CAD FILE
FeederHolder v14_step_dwg1
QTY. REQUIRED
1
SCALE 1:2
SHEET 1 OF 1
DRAWING NOTES (UNLESS OTHERWISE NOTED)
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32

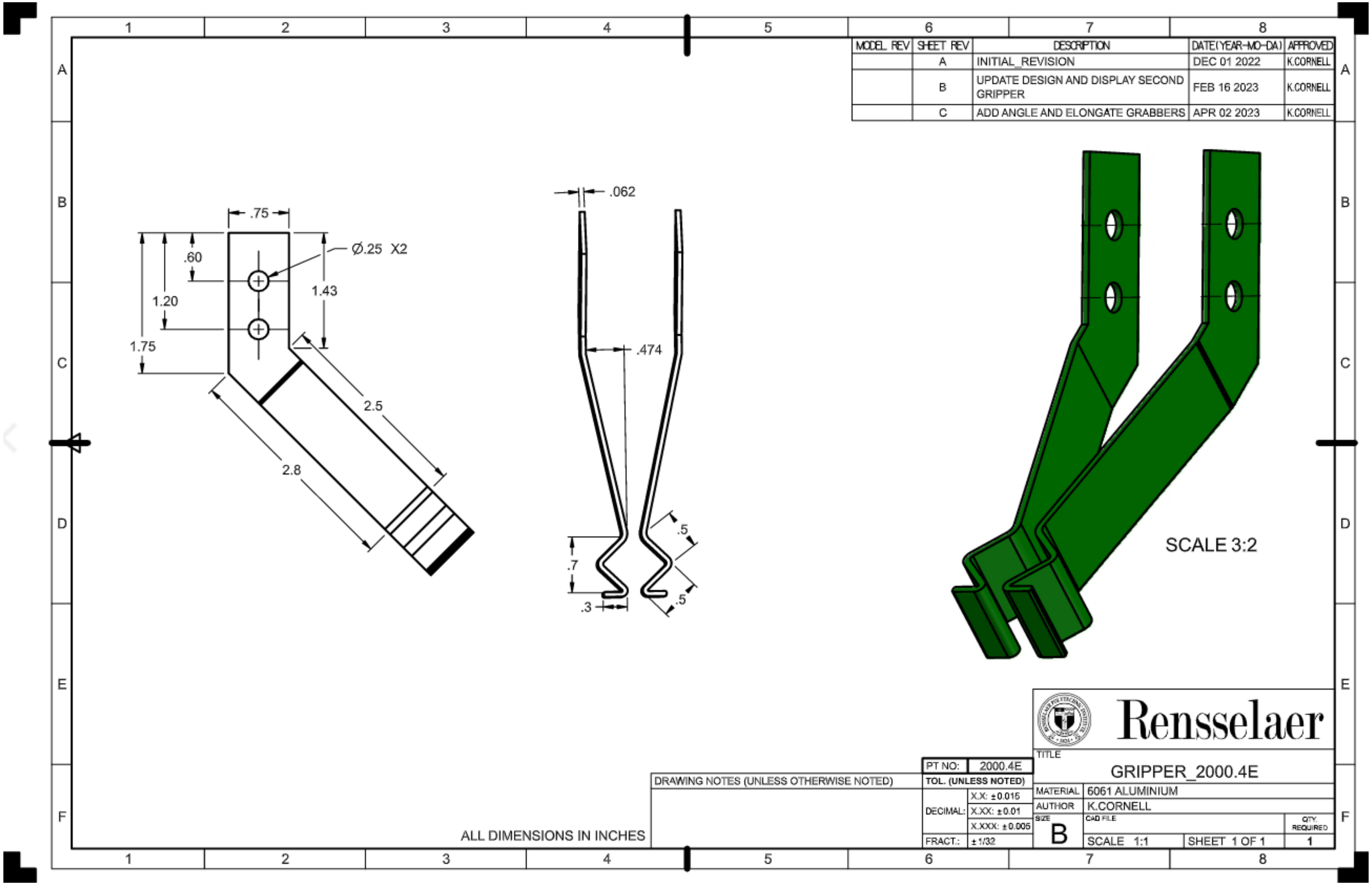
7.1.3 Grippers Tooling Manufacturing Sheet

BOM #	Isometric View
2000.4E	
BOM/3D Model Name	
Gripper	
Drawing Title	
Gripper_2000.4E	

Part Information	
Material Type	**6061 Aluminum**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**

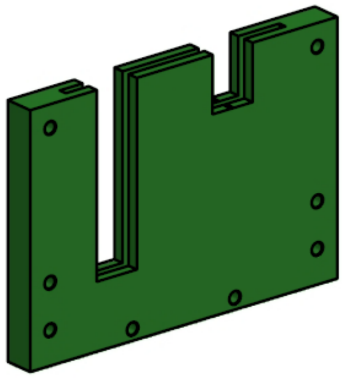
Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	Manual Machining
Machine Tool	Vertical Drill Press
Associated Manufacturing Parameters	RPM = 3055 r/min CS = 200 ft/min D = ¼ inch F_{pt} = 0.002-0.004 in/tooth F = 12 in/min N_t = 2 flutes
Quality Control	Grippers must be inspected to ensure a smooth surface finish. Verify that Grippers fit the outside of the Pump Connector tightly.
Associated Manufacturing Process Calculations	$RPM = \frac{4(CS)}{D}$ $F = F_{pt}(RPM)(N_t)$
Notes	N/A

Responsible Team Member(s)	Name	Date
	Katherine Cornell	2/16/23


MODEL REV | SHEET REV | DESCRIPTION | DATE(YEAR-MO-DA) | APPROVED
A | INITIAL_REVISION | DEC 01 2022 | K.CORNELL
B | UPDATE DESIGN AND DISPLAY SECOND GRIPPER | FEB 16 2023 | K.CORNELL
C | ADD ANGLE AND ELONGATE GRABBERS | APR 02 2023 | K.CORNELL
.75
Ø.25 X2
.60
1.20
1.43
1.75
2.5
2.8
.062
.474
.5
.7
.3
.5
SCALE 3:2
ALL DIMENSIONS IN INCHES
DRAWING NOTES (UNLESS OTHERWISE NOTED)
PT NO: 2000.4E
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
GRIPPER_2000.4E
MATERIAL 6061 ALUMINIUM
AUTHOR K.CORNELL
SIZE B
CAD FILE
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

7.2 Horizontal Press Assembly Fixture Manufacturing Sheets

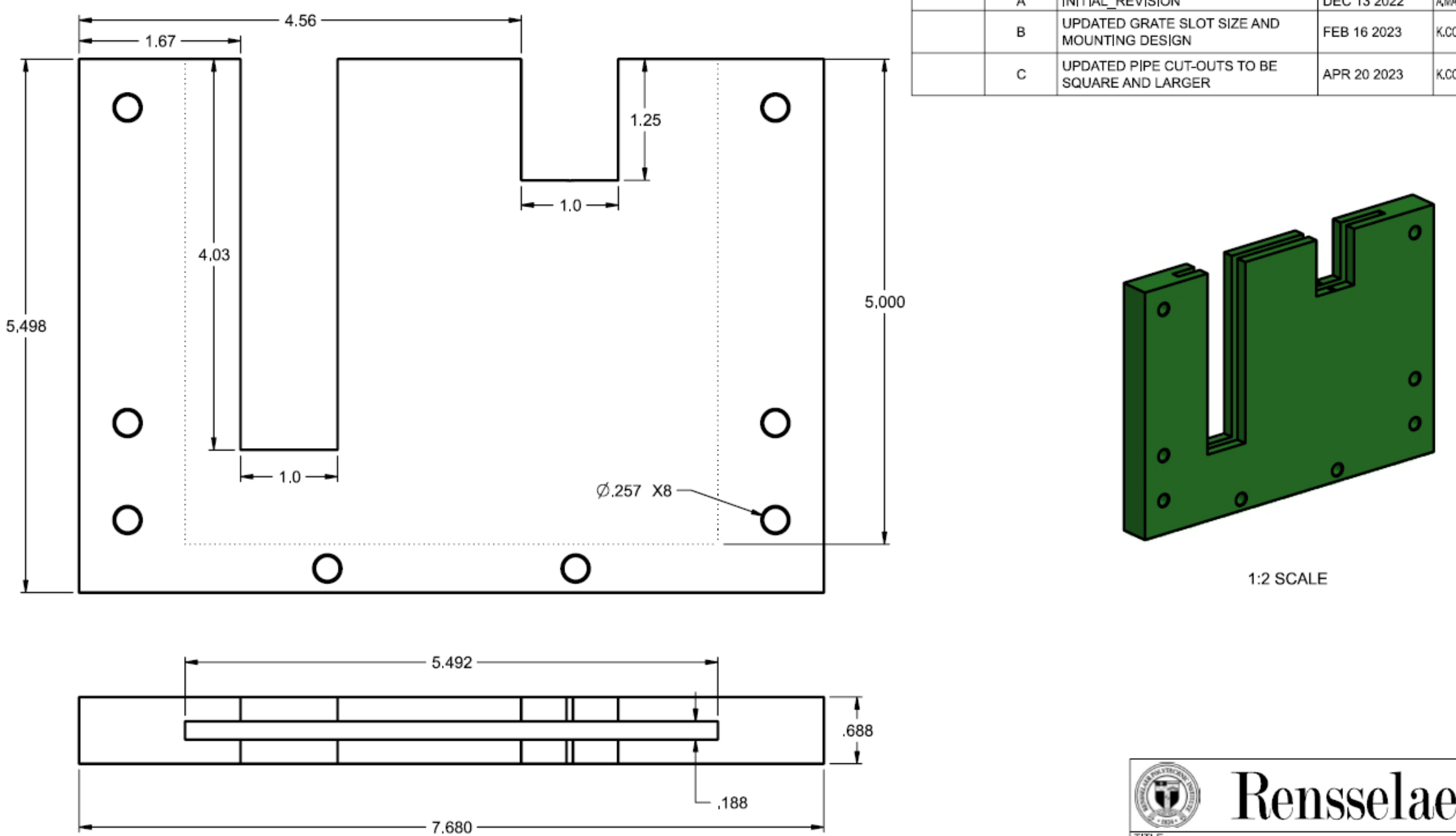
7.2.1 Grate Fixture Manufacturing Sheet

BOM #	Isometric View
3000.1F	
BOM/3D Model Name	
Grate Fixture	
Drawing Title	
Grate_Fixture_3000.1F	

Part Information	
Material Type	**Acrylic and ABS**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	Manual Machining
Machine Tool	Vertical Drill Press, Vertical Band Saw
Associated Manufacturing Parameters	RPM = 3055 r/min, 1500 r/min CS = 200 ft/min, 150 ft/min D = ¼ inch, ⅜ inch F_{pt} = 0.002 in/tooth, 0.015 in/rev F = 12 in/min, 22.5 in/min N_t = 2 flutes
Quality Control	Inspect for defects and verify that the grate fits snugly in the fixture while still being easily inserted and removed.
Associated Manufacturing Process Calculations	$RPM = \frac{4(CS)}{D}$ $F = F_{pt}(RPM)(N_t)$
Notes	N/A

Responsible Team Member(s)	Name	Date
	Katie Cornell	04/24/2023

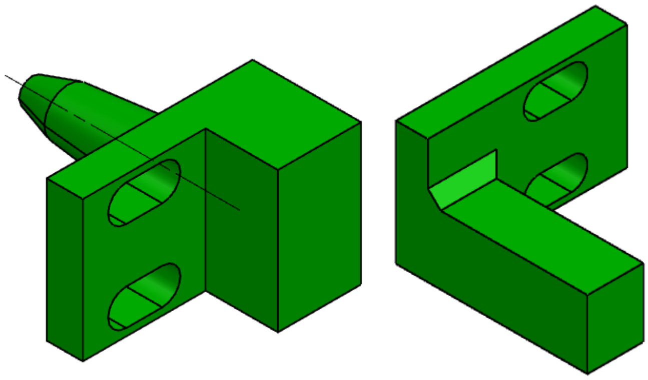


MODEL REV	SHEET REV	DESCRIPTION	DATE (YEAR-MO-DA)	APPROVED
	A	INITIAL_REVISION	DEC 13 2022	A.MAZZELLA
	B	UPDATED GRATE SLOT SIZE AND MOUNTING DESIGN	FEB 16 2023	K.CORNELL
	C	UPDATED PIPE CUT-OUTS TO BE SQUARE AND LARGER	APR 20 2023	K.CORNELL

ALL DIMENSIONS IN INCHES

DRAWING NOTES (UNLESS OTHERWISE NOTED)	PT NO: 3000.1F		Rensselaer	
	TOL. (UNLESS NOTED)		TITLE: Grate_Fixture_3000.1F	
	DECIMAL:	X.X: ±0.015	MATERIAL: Misc	
		X.XX: ±0.01	AUTHOR: Anthony Mazzella	
		X.XXX: ±0.005	SIZE: B / CAD FILE: Grate Fixture	QTY. REQUIRED: 1
	FRACT.:	±1/32	SCALE 1:1 / SHEET 1 OF 1	1

7.2.2 Press End Fixture Manufacturing Sheet

BOM #	Isometric View
3000.2F 3000.4F	
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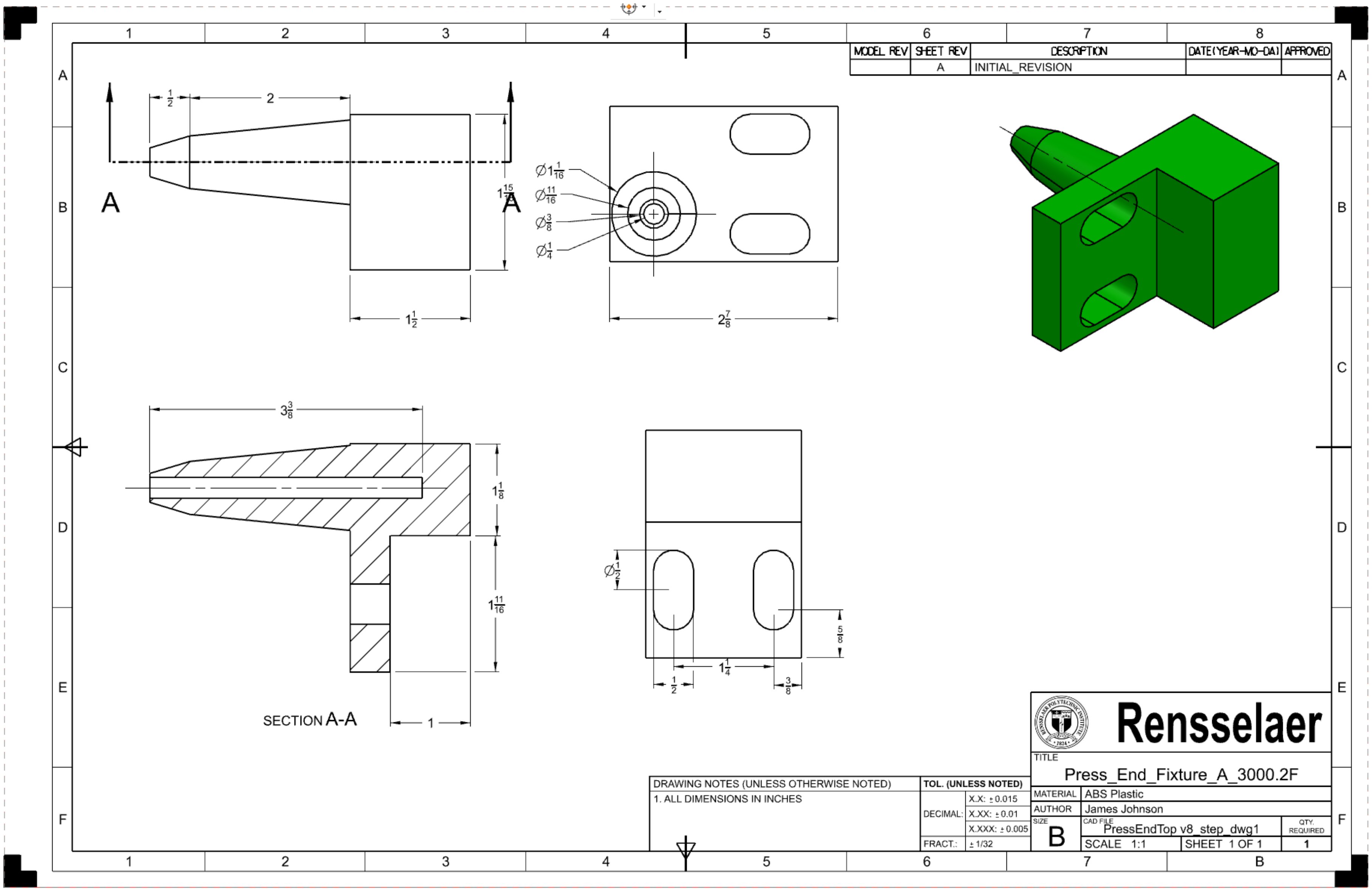
Press End Fixture A Press End Fixture B	
Drawing Title	
Press_End_Fixture_A_3000.2F Press_End_Fixture_B_3000.2F	

Part Information	
Material Type	**3D Printed ABS**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	FDM 3D Printing
Machine Tool	Stratasys F170
Associated Manufacturing Parameters	Infill: 30% Layer Height: 0.3mm Support material: No Print with the tube guides oriented vertically and the flat square plate on the bottom.
Quality Control	Inspect for defects and verify that the pipes fit snugly on the fixture while still being easily placed and removed.
Associated Manufacturing Process Calculations	N/A
Notes	N/A

Responsible Team Member(s)	Name	Date
	James Johnson	04/24/23
	Katherine Cornell	02/21/23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DATE (YEAR-MO-DA)
APPROVED
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INITIAL_REVISION
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TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Press_End_Fixture_A_3000.2F
MATERIAL ABS Plastic
AUTHOR James Johnson
SIZE B
CAD FILE PressEndTop v8_step_dwg1
QTY. REQUIRED 1
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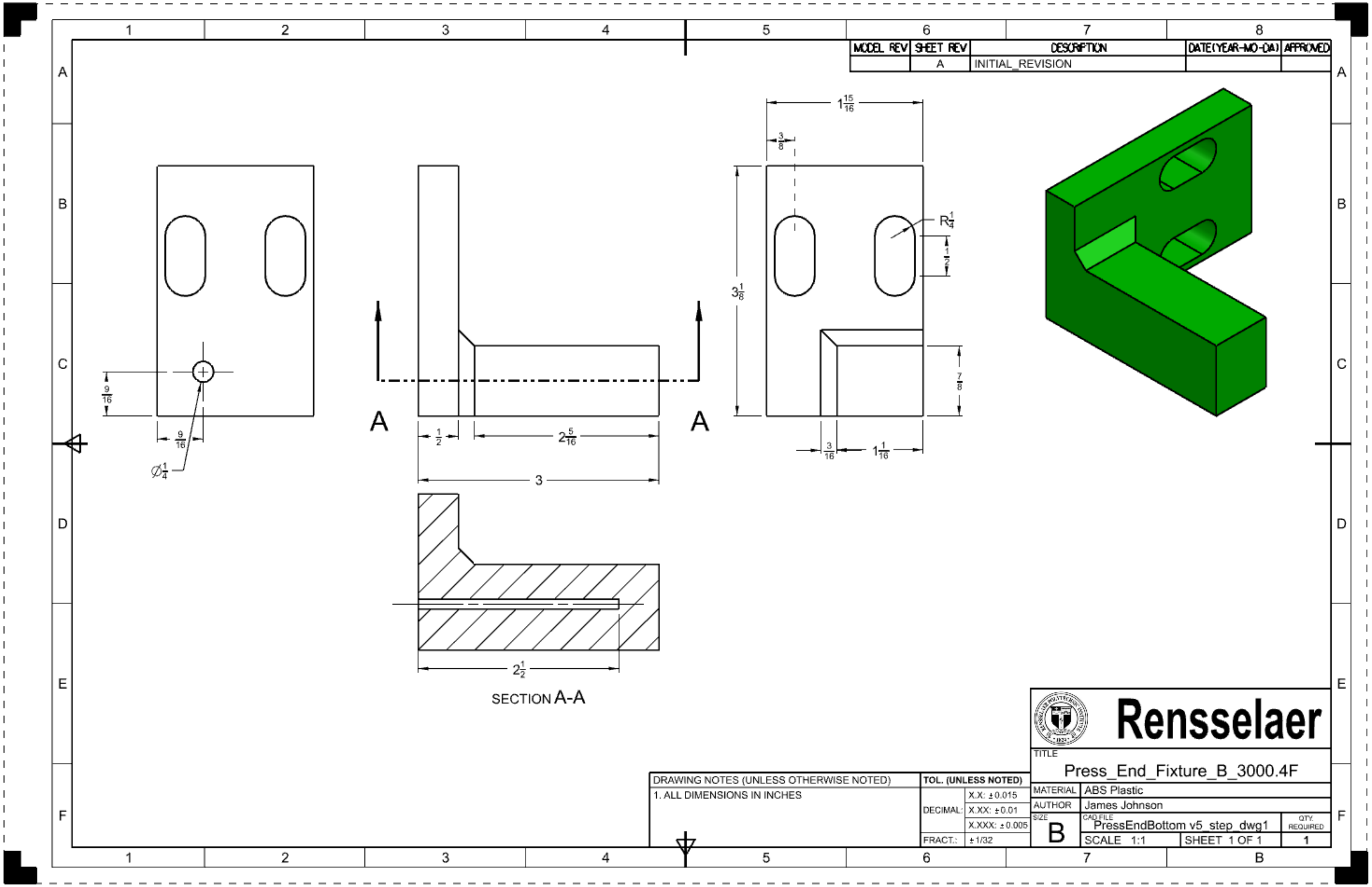
SHEET 1 OF 1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SHEET REV
DESCRIPTION
DATE (YEAR-MO-DA)
APPROVED
A
INITIAL_REVISION
SECTION A-A
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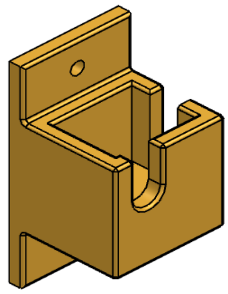
1. ALL DIMENSIONS IN INCHES
TOL. (UNLESS NOTED)
DECIMAL: X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
Rensselaer
TITLE
Press_End_Fixture_B_3000.4F
MATERIAL ABS Plastic
AUTHOR James Johnson
SIZE B
CAD FILE PressEndBottom v5_step_dwg1
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

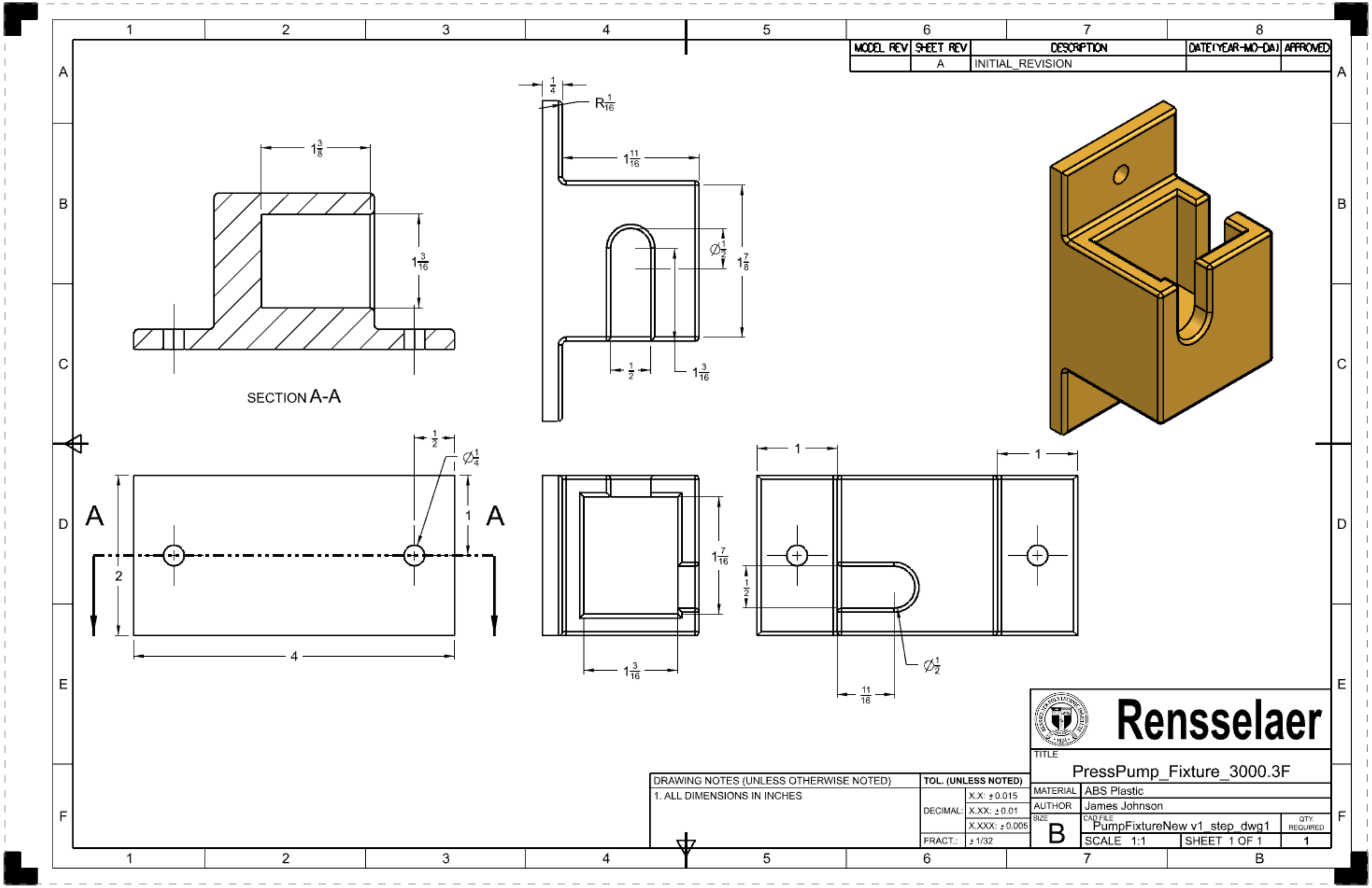
7.2.3 Press Pump Fixture Manufacturing Sheet

BOM #	Isometric View
3000.3F	
BOM/3D Model Name	
Press Pump Fixture	
Drawing Title	
PressPump_Fixture_3000.3F	

Part Information	
Material Type	**3D Printed ABS**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**

Proposed Manufacturing Process Plan	
Primary Manufacturing Process	
Process	FDM 3D Printing
Machine Tool	Stratasys F170
Associated Manufacturing Parameters	Infill: 30% Layer Height: 0.3mm Support material: Yes Print as pictured with the mounting brackets on the bottom.
Quality Control	Inspect for defects and verify that the pump fits snugly in the fixture while still being easily inserted and removed.
Associated Manufacturing Process Calculations	N/A
Notes	N/A
Secondary Manufacturing Process/Post-Processing	
Process	Support Material Removal
Machine Tool	Parts Cleaner
Associated Manufacturing Parameters	6 hrs in parts wash bin to dissolve support material
Quality Control	N/A
Associated Manufacturing Process Calculations	N/A
Notes	N/A

Responsible Team Member(s)	Name	Date
	James Johnson	04/24/23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INITIAL_REVISION
SECTION A-A
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Rensselaer
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DRAWING NOTES (UNLESS OTHERWISE NOTED)
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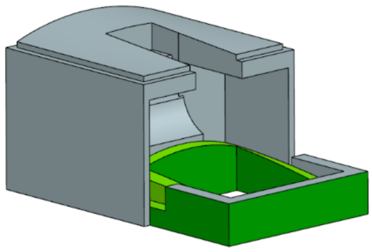
TOL. (UNLESS NOTED)
DECIMAL:
X.X: ±0.015
X.XX: ±0.01
X.XXX: ±0.005
FRACT.: ±1/32
MATERIAL ABS Plastic
AUTHOR James Johnson
SIZE B
CAD FILE PumpFixtureNew v1_step_dwg1
QTY. REQUIRED 1
SCALE 1:1
SHEET 1 OF 1

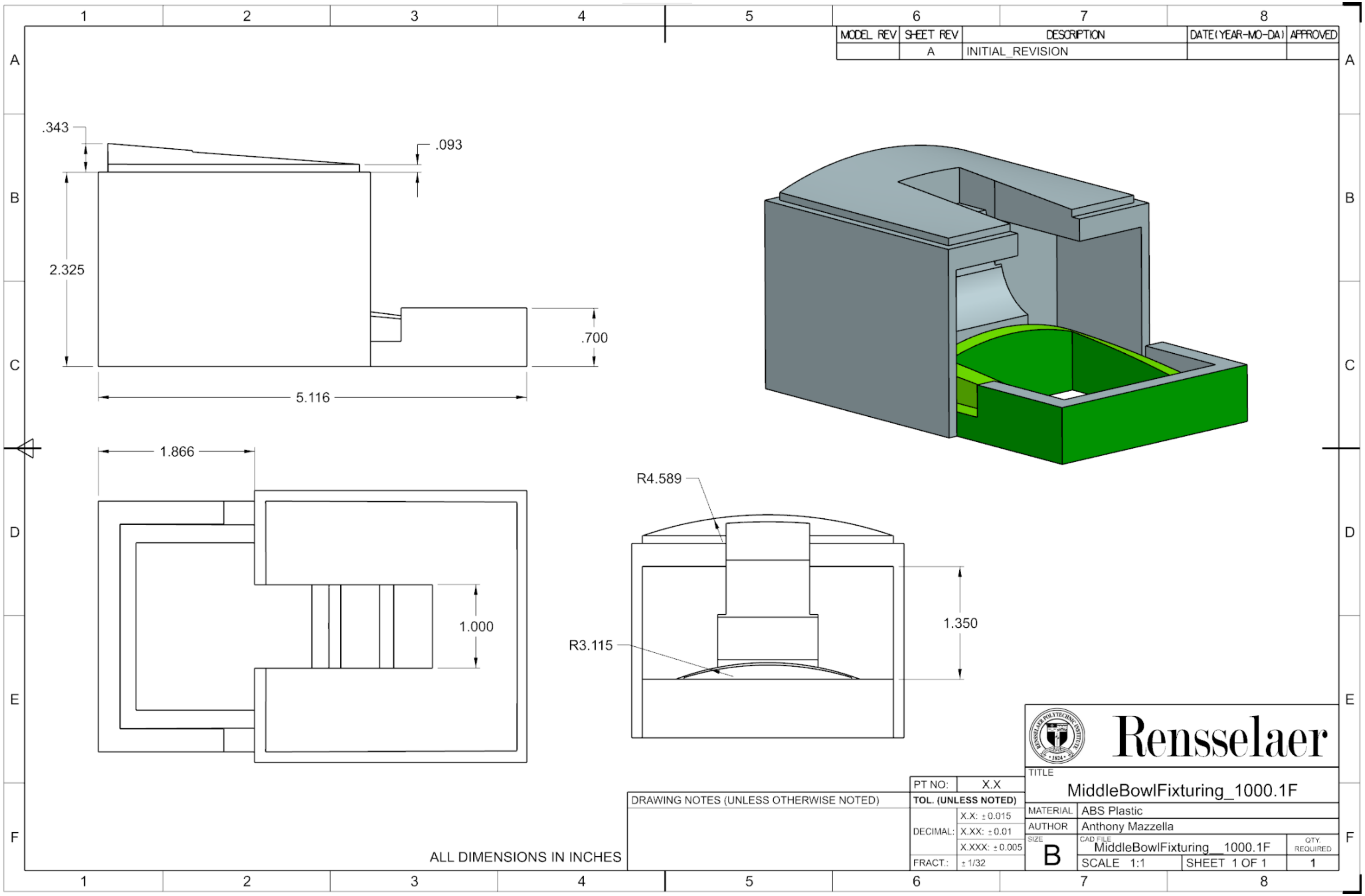
7.3 Bowl-Bridge Assembly Fixture Manufacturing Sheet

BOM #	Isometric View
1000.1F	
BOM/3D Model Name	
Heat Staking Fixture	
Drawing Title	
MiddleBowlFixturing_1000.1F	

Part Information	
Material Type	**ABS Plastic Filament**
Material Resource Planning (Raw Material Needed)	**Provided by MILL**
Part Count Required	**1**

Proposed Manufacturing Process Plan			
Primary Manufacturing Process			
Process	FDM 3D Printing		
Machine Tool	Stratasys F170		
Associated Manufacturing Parameters	N/A		
Quality Control	Make sure the print has a clean surface finish and has had all supports removed. Make sure a top and middle bowl sit on the fixture correctly.		
Associated Manufacturing Process Calculations	N/A		
Notes	N/A		
Secondary Manufacturing Process/Post-Processing			
Process	Support Material Removal		
Machine Tool	Parts Cleaner		
Tooling Needed	**Name**	**BOM #**	**Drawing #**
	N/A	N/A	N/A
Associated Manufacturing Parameters	6 hrs in parts wash bin to dissolve support material		
Quality Control	N/A		
Associated Manufacturing Process Calculations	N/A		
Notes	N/A		

Responsible Team Member(s)	Name	Date
	Anthony Mazzella	12/4/2022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X.XXX: ±0.005
FRACT.:
±1/32
Rensselaer
TITLE
MiddleBowlFixturing_1000.1F
MATERIAL
ABS Plastic
AUTHOR
Anthony Mazzella
SIZE
B
CAD FILE
MiddleBowlFixturing__1000.1F
QTY. REQUIRED
1
SCALE 1:1
SHEET 1 OF 1

Section 8: Prototype Testing

8.1 Prototype Testing

Figure 8.1 Prototype *Magic Fountain*

The prototype is shown above in Figure 8.1. It is vital to test the prototype because it will ensure that the fountain design is stable and can withstand any accidental forces applied to it, such as being knocked over by accident. Testing can also determine how long the product can work until failure. An unstable or weak product or one that fails quickly will lead to customer dissatisfaction.

The bridge is the most vital element of the fountain as it supports the middle bowl, which is the focal point of the design. Any breakage in it may impede the flow of water. If it fractures completely, the fountain will cease to work as intended. Testing the bridge by applying a load until failure will help evaluate the validity of the bridge design.

If the fountain is knocked over, it will spill water all over a user's desk, possibly drenching electronics or papers in the process. This is an undesirable outcome. Determining the amount of force required to move the product should help validate the product's integrity.

Because the prototype is made of PLA filament and not the 304 stainless steel used in the final product, mass must be added to the middle bowl for testing so that it weighs what the actual middle bowl will weigh. It is crucial to get accurate results on the bridge testing analysis. The prototype PLA middle bowl weighs 5.94 grams, while the finished product stainless steel bowl will weigh roughly 42.5 grams, so the team added the difference in mass to the bowl for testing.

8.1.1 Standard Testing Procedure

- Attach 36g of mass to the bottom of middle bowl. See Figure 8.1.1
- Set fully assembled product on flat surface
- Fill product with water and rocks
- Testing bridge strength:
    - Drill ⅛" hole through edge of middle bowl
    - Hook a Mark-10 Digital Force Gauge through hole in edge of middle bowl
    - Set gauge to measure peak tension
    - Slowly Pull gauge away in appropriate direction
    - Do this testing for three different directions:
        - Pulling up on the bowl as shown in Figure 8.1.2
        - Pulling down on the bowl as shown in Figure 8.1.3
        - Pulling to the side of the bowl as shown in Figure 8.1.4
    - Record findings
- Testing force required to move product:
    - Use the flat head attachment for the Mark-10 Digital Force Gauge to push on the basin of the product until there is noticeable movement
        - Setup shown in Figure 8.1.5
    - Record findings

Figure 8.1.1 Weighted PLA Middle Bowl

Figure 8.1.2 Downward Pull Test on Bridge

Figure 8.1.3 Upward Pull Test on Bridge

Figure 8.1.4 Sideways Pull Test on Bridge

Figure 8.1.5 Force Test on Basin

8.1.2 Assumptions

Many assumptions were made before running the prototype tests. Most of the testing revolves around the bridge to top bowl connection. This is where the team believes their product is the weakest. The prototype connection between bridge and top bowl is a snap-fit, not overmolding like in the actual product. The team assumed that the strength of this connection would not be as admirable. They believe that because of this, the bridge will be the first part of the product that will break during testing. Aside from this connection, the product seems structurally sound. The team assumed that it would take an excessive amount of force to deflect the top assembly (tall pipe, top bowl, bridge and middle bowl) such that failure occurs. The other main assumption is that with rocks and water in the basin to weigh it down, it will be very hard to jolt the fountain. Also, when force is applied to the product, the fountain will move very little.

8.1.3 Results

Table 8.1.3 Testing Results

Direction of Applied Force	**Max Force (lbs)**
Bridge Testing	
Vertical- Up	1.21
Vertical - Down	0.40
Horizontal - Left	1.75
Resistance to Sliding Test	
Horizontal - Into Basin	0.79

8.1.4 Conclusion

The prototype testing was very helpful in the design process for both confirming the team's assumptions and finding new areas of improvement. Overall, results were satisfactory and showed that the product will be ready for production. This is a prototype, and all bowls for testing were 3D printed PLA, not the ABS plastic that will constitute the top bowl or the stainless steel from which the middle bowl will be manufactured.

The bridge is the weakest point of the bowl assembly as far as accidental breakage by the user. The bridge connection to the top bowl is a snap-fit connection for the prototype, but will be overmolded for the final product. Pulling the bridge upward or horizontally took a considerable amount of force before failure. It is important to note that the bridge allowed for a significant deflection before it failed, which means that it would withstand most accidental bumps. The press fit connection on the top bowl also allows for rotation and will rotate under less force than the 1.75 lbs that it took to break the bridge due to a horizontally applied force. The worst performance of the bridge can be seen in the downward force test where the part only withstood 0.4 lbs of applied force. This test was conducted on the front edge of the bowl, which resulted in the greatest moment exerted on the top of the bridge of all tests. The middle bowl is most likely to be faced with a force in the horizontal direction, and it is partially protected from a downward force by the top bowl if something were dropped on top of the product. In each trial, the top bowl had to be held in place to get a true strength test for the bridge. Otherwise for each test, before the bridge reached failure, the joint between the tall pipe and the top bowl would rotate. If any force were applied to this area, the attachment would rotate instead of breaking. With these factors considered, the tests can be concluded as acceptable for the final product.

Lastly, the Resistance Test was another positive result for testing. The fully assembled fountain weighs about 4 pounds and has a low center of mass. This allows the product to take about 0.8 pounds of force before moving on a hardwood surface. Even with this, when faced with any force, the fountain will slide before any part of the product breaks or tips over. The product can be moved across a surface by pulling the top bowl and the pipe only deflects ¼”. With these factors in mind, the testing provides confidence that the product can withstand any minor force that will be applied to it within its intended use.

Section 9: Standard Operating Procedures

9.1 Manufacturing Standard Operating Procedures

9.1.1 Basin Standard Operating Procedure
Refer to Guide number 46820 on the VKS named Basin Creation.

9.1.2 Top and End Bowl Standard Operating Procedure
Refer to Guide number 46919 on the VKS named Plastic Injection-Molding (Top and End Bowls).

9.1.3 Middle Bowl Shearing Standard Operating Procedure
Refer to Guide number 46815 on the VKS named Middle Bowl Shearing Process.

9.1.4 Middle Bowl Forming Standard Operating Procedure
Refer to Guide number 46880 on the VKS named Middle Bowl Forming and Finishing.

9.1.5 Bridge Standard Operating Procedure
Refer to Guide number 46801 on the VKS named Bridge SOP.

9.1.6 Grate Standard Operating Procedure
Refer to Guide number 46804 on the VKS named Grate Laser Cuttin Process.

9.1.7 Short Pipe Standard Operating Procedure
Refer to Guide number 46826 on the VKS named Short Pipe Production.

9.1.8 Tall Pipe Standard Operating Procedure
Refer to Guide number 46808 on the VKS named 5.5" Tall Pipe Production.

9.1.9 Pump Connector Standard Operating Procedure
Refer to Guide number 46847 on the VKS named Pump Connection Production.

9.2 Assembly Standard Operating Procedures

9.2.1 Assembly 2 Standard Operating Procedure
Refer to Guide number 46877 on the VKS named Pump Connector Assembly (2).

9.2.2 Assembly 3 Standard Operating Procedure
Refer to Guide number 46883 on the VKS named Horizontal Press Assembly (3).

9.2.3 Assembly 4 Standard Operating Procedure
Refer to Guide number 46907 on the VKS named Bowl to Bridge Assembly (4).

9.2.4 Assembly 5 Standard Operating Procedure
Refer to Guide number 46904 on the VKS named Bowls to Pipe Assembly (5).

9.2.5 Assembly 1 Standard Operating Procedure
Refer to Guide number 46901 on the VKS named Finale Assembly (1).

9.3 Packaging Standard Operating Procedure

9.3.1 Laser Cutting Box Standard Operating Procedure
Refer to Guide number 46805 on the VKS named Packaging Box Laser Cutting SOP.

9.3.2 Box Folding Standard Operating Procedure
Refer to Guide number 46973 on the VKS named Packaging Box Folding Assembly.

9.3.3 Plaque Engraving Standard Operating Procedure
Refer to Guide number 46844 on the VKS named Magic Fountain-Plaque Laser Engraving.

9.3.4 Plaque Attachment Standard Operating Procedure
Refer to Guide number 46949 on the VKS named Plaque Attachment.

9.3.5 Rock Bag Sealing Standard Operating Procedure
Refer to Guide number 46975 on the VKS named Bag Sealing of Rocks and Packaging.

9.3.6 Pump Testing Standard Operating Procedure
Refer to Guide number 46978 on the VKS named Incoming Pump Test Procedure.

Section 10: Technical Challenges Encountered and Solutions

10.1 Manufacturing Challenges and Solutions

Throughout this semester, MPS Team C has had a variety of challenges in our design process. This semester has focused on manufacturing production, which naturally lead to many challenges that the team did not foresee when designing these parts. Not until actually using the production machines to manufacture these components did the group realize the different tolerancing and structural challenges that could arise. Through these challenges, the team is learning more about tolerancing and quality checks, fixture design, and manufacturing as a whole.

10.1.1 Middle Bowl Shearing

For the stainless steel middle bowls, the team is using a Pexto manual kick shear to cut the material. For most of the bowls, they are using excess material that has been in the MILL since 1985: coiled T-410 Stainless Steel. When it is used up, the group will begin using 204 Stainless Steel to make the bowls. Due to the coiled nature of the T-410 material and the accuracy of the kick shear, the team has run into some tolerancing challenges.

Originally, the team was unsure if they would cut these components via waterjet or use the kick shear. Ultimately, they decided to use the shear due to its availability, ease of use, and cost savings, at the cost of the cuts being less accurate. The team had hoped for a tolerance of +/- 0.020” for each side length of the bowl, but after testing on the shear, they found that these tolerances were not viable.

One reason for this inaccuracy is the setup of the shear. To set the cut size, the team places a 1-2-3 gauge block in between the stop and the blade of the shear and adjusts the stop accordingly. Once the stop is set, however, the gauge block must be removed from behind the blade, which allows for some wiggle room in the tolerance. Another potential reason for this inaccuracy is that the raw material is coiled spring steel. No matter how securely the material is held down, it has a slight downward curve which could lead to a slightly larger dimension.

This tolerancing nonconformity led to discussion about whether the part can fit into the punch and die to form the bowl and if the desired results would be attainable. The group contemplated creating an L-shaped design where one piece would hold the origin of the part and the other would slide inwards to hold the part in place. However, the group discussed this possibility with their instructors. The instructors suggested opening up tolerancing for the die so that the blank would fit. If the team were working for a manufacturing company, it would be more efficient to open up the tolerances and move forward rather than keep problem solving and wasting time and money to get those tolerances down, especially given that the tolerances are not crucial to the design of the product. This was a great learning experience. Ultimately, the tolerancing opened up to +/- 0.03125 for each dimension. The die now has a cutout to allow operators to eject the blank from the die once it is fully formed and processed.

10.1.2 Middle Bowl Depth in Die

Preliminary calculations done in the fall suggested that the die would require up to 4000 lb of force to form the desired shape. The calculations used to generate the 4000 lb value were primarily used for deep drawing, the process used for creating metal tubing. The required process is forming the metal into the desired curve rather than extruding it. After evaluation of the 4000 lb calculation, the team was advised to print a 3D model of the punch and die to conduct hand testing. After testing, it was found that only 1/10 of the original estimate (400 lb) was necessary to form the metal.

The secondary issue concerning the die is the springback of the sheet metal after being formed. Because the desired shape is only a shallow arc, the metal is not strained into the plastic region and will not hold the desired shape. A series of hand tests were conducted using 3D printed dies to find the curve that would create the desired shape with springback. Therefore, the final shape of the die is dissimilar to the final shape of the middle bowl in all project drawings.

10.1.3 Middle Bowl Aluminum Material

Once the team sheared all of the coiled T-410 stainless steel material in the MILL, instead of ordering the 204 stainless they wanted to see if they could continue to be sustainable and use any other excess material around campus. When going through the MILL, they found some aluminum material that was of a similar thickness to the T-410. With this, the team was able to shear the roughly 50 additional components that we needed to reach 300 total.

However, once the team put the aluminum into the compound die, they ran into some springback issues. The die was shaped based on calculations on using stainless steel. Because of this, when they tried a different material in aluminum, the springback was not as expected. When the punch would compress the aluminum into the die, it did not form a deep enough arc for the aluminum, and the material would spring right back to the pre-formed blank state. With this material not taking shape to the die, the blank would get caught onto the punch and tooling had to be used to remove it. Because of this, the team decided to stop production and continue with the 250 stainless steel middle bowls as they were running out of time and were not able to order more stainless steel in short notice. In the future, the team would have to either order additional stainless material earlier in the semester, or find a material with properties more similar to those of stainless steel.

10.1.4 Laser Cutting the Bridge

Many unforeseen challenges were encountered while cutting the bridge with the Thunder Laser machine. When testing with a smaller batch size, issues dealing with data starvation and the laser cutter's belt tension were not apparent. These issues critically affected the structural integrity of the bridge, particularly the junction between the overmolding peg and the body of the bridge. Due to the 90 degree turn in the dxf file, the laser would cut into the specimen, causing it to no longer be a conforming part. The solution was to put a small radius on this junction so that the machine would not pause in this location and to tighten the belt on the machine to fix any lag and unwanted movement of the laser.

The dxf file was additionally altered to give the bridge a better appearance, as burns and alignment issues were apparent. Due to the outside edge previously being a connected line and spline, the machine would make two separate cuts and meet at the connection node. This was altered so that the cut was done with one sweep and the spline was changed to an arc. The speed and power were two key elements of dialing in this process all while battling a laser lens that was becoming more clogged with each use.

10.1.5 Laser Cutting the Basin

A fixture was created to aid in trimming the thermoformed basin. This fixture consists of two components: a holding element and an alignment element. The holding element is made of two square frames held together by four nuts and bolts. The basin is pressed into the frames which creates a snug fit and ensures proper orientation of the basin inside the laser cutter. The technical issue stems from the alignment element. In order to have a simple and efficient laser cutting process, the holding fixture must be set in one specific location within the laser. This allows the trimming process to be fast and precise. To create this alignment element, a polystyrene sheet is pushed into the corner of the laser cutter and the opposite corner is secured by magnets. Holes are cut into the sheet to allow the bolts of the holding fixture to fit inside. These holes create a specific location for the holding fixture. The combination of these two elements were used to manufacture about 100 basins when the group decided the process was unsatisfactory.

The manufacturing process left small imperfections like waves or wide edges. The method for trimming needed to be very precise to look good, so many basins came out imperfect. The team overhauled their molding and trimming process moving forward in order to account for imperfections and create an overall more consistent looking product. The first and most notable change made was creating a flat lip around the basin to cut on instead of trying to cut exactly on the edge. Cutting right on the edge leaves no room for error so adding a quarter inch lip to the basin allows for very slight shifts of the basin being molded or sitting in the laser cutter to be masked. Figure 10.1.5 shows the difference in the basin edges.

Figure 10.1.5 Old vs New Trimming Method

The group made some other changes within the vacuum former to help create more consistent basins. It was observed that most of the basins being made were not completely vacuumed because the ABS popped along the corners of the vacuum former and all suction was lost due to an insufficient seal. The group was able to switch the metal seal which had different corner geometry which stopped the ABS from popping. Now that the vacuum could be held for longer, the formed basin shape was more consistent and precise.

The last change was plugging the hole in the mold. Originally a hole passed through the entire mold which helped form the dimple in the bottom of the basin. When the previous suction problem was fixed, the dimple would occasionally pop rendering the basin useless as it would no longer be able to hold water. To combat this, the team plugged the hole and manually made the dimple for the remaining basins.

10.1.6 Band Saw with Pipes

The initial cutting process for the acrylic tubes resulted in chipping on the cut edge of pipes that made chamfering difficult and would not result in a clean edge for press fit assembly. This was solved by changing orientation of the pipe bundles so more saw blade teeth are running through pipes at any time and the blade does not chip the top edge on initial contact. Another issue was initial chamfering of the rough cut edge resulting in chipping. This was solved by creating a scraping tool to knock excess melted acrylic off the outside edge before chamfering. These two changes have greatly reduced the nonconforming numbers.

10.2 Assembly Challenges and Solutions

While the team's main focus so far this semester has been manufacturing, they have been working on assembly as well. While they have not finished enough of production to start full assembly of their components, the group's goal is to frontload this work so that when they are ready for assembly, they will have flushed out all potential challenges and will be ready to assemble. The team is making custom fixtures to assemble their components. Some challenges have arisen along the way.

10.2.1 Assembly 2 Gripper

Assembly 2 uses a custom metal gripper end effector to pick and place pump connectors from connector feeder to pumps loaded onto the connector fixture. The first design for the gripper end effector (shown below) was unable to grab the connectors because the robot end effector stand would bump into the feeder. The team redesigned the gripper end effector to be further from the robot as well as angled at 45 degrees (as shown in Figure 10.2.1). This made it possible to grab and place the connectors without interference from the robot.

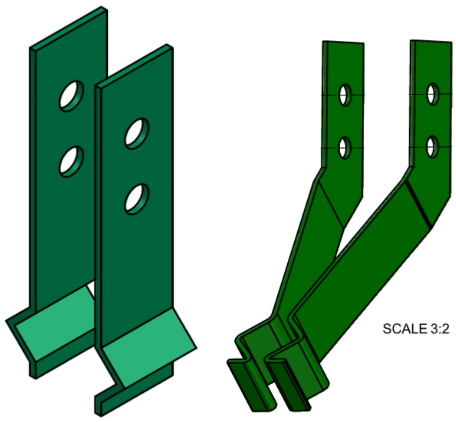

Figure 10.2.1 Assembly 2 Gripper Original Design (left), Final Design (right)

10.2.2 Assembly 3 Grate Holder

The Assembly 3 fixture requires several intermediary fixtures: one to hold Assembly 2, one to hold and press the pipes, and one to hold the grate. These components were all designed to be mounted on 80/20 T-slot extrusion for adjustability purposes. The grate fixture (part no. 3000.1F) was designed to fit and constrain the grate, but was not designed to be flexible if the grates were produced slightly larger or smaller or to account for any shrinkage from the 3D printing process. Upon printing the fixture and testing it with a grate, the grate fit too tightly and couldn't be easily loaded or unloaded. In order to fix this issue, the team redesigned the fixture to be more flexible. This was done by changing the manufacturing method from 3D printing to manual machining as well as having the fixture be held together using bolts, nuts, and washers. These changes gave it the flexibility to accommodate any grate and to hold the grates tighter or looser.

10.2.3 Assembly 3 Piston

Assembly 3 uses a pneumatic piston to push the pipes through the grate and into Assembly 2. One issue was that the piston rod could rotate. This would cause the pipe fixture to rotate and could cause the pipes to not be properly pushed through the grate. In order to stop the piston rod from rotating, the team used linear guide bushings and two stabilizing rods mounted to the outside of the piston (see Figure 10.2.2). This forced the pipe fixture to not rotate.

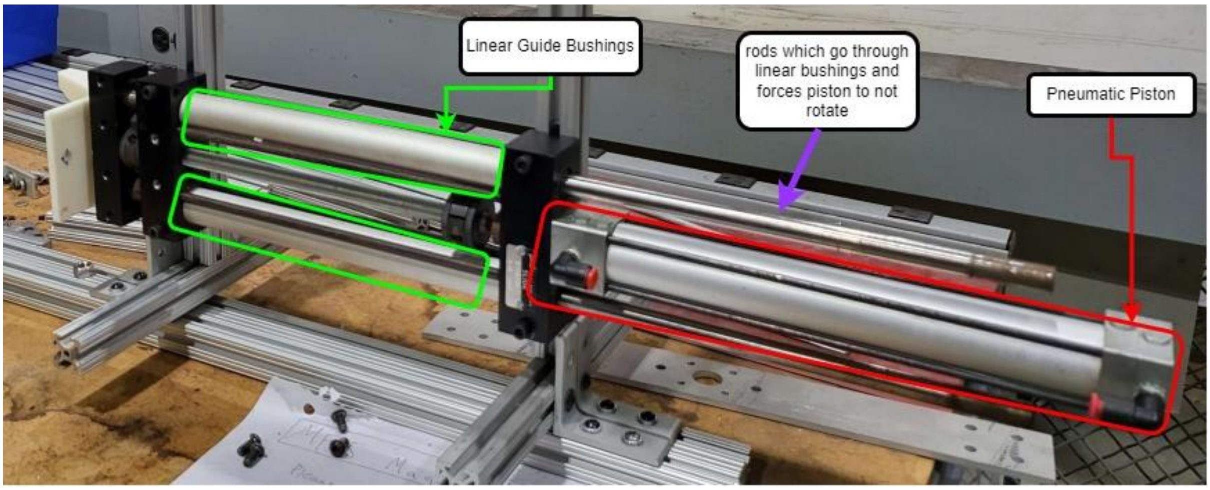

Figure 10.2.2 Assembly 3 Piston

In conclusion, the team has built lots of flexibility into the assembly systems to prevent issues with alignment and to be able to fix issues easily. Because the team has not started producing assemblies yet, it is hard to gauge if more issues will arise. As seen above, testing fixtures before starting production has been key and will continue to be a vital practice.

10.2.4 Assembly 3 Alignment and Press End Fixture

Assembly 3 relies on the two pipes being very precisely aligned with the holes in the grate. Even with the chamfered ends on the pipes, small misalignments caused the grate to crack. The original press end fixture was a single piece, but this was changed to a two piece system (3000.2F and 3000.4F) so that each pipe could individually be adjusted and aligned with the holes.

After switching to the two piece press end fixture, the alignment was still unreliable. After being used, the alignment would slowly drift off-center and begin cracking grates. This off-center drift was always in the same direction, and it was eventually determined that the pressure of tightening the bolts had created a slight indent in the soft 3D printed fixture's mounting slots. This indent caused the fixture to slowly move and center the indent on the bolt head. A set of extra wide washers was used to flatten the surface and better distribute the load, and this eliminated the off-center alignment drift issue.

10.2.5 Assembly 4 Heat Staking Loose Fit

Assembly 4 is the process of heat staking the acrylic bridge which was overmolded into the top ABS bowl to the middle stainless steel bowl. Though the task is simple, many trivial unforeseen events occurred due to the choice of material and previously chosen manufacturing processes. One challenge that arose was the length of the bottom nub of the bridge that was being heat staked. Due to negligence of thinking that the burr due to the middle bowl punch would not make much of a difference, the connection between the bridge and the bowl was not as snug as the team desired. The solution to the lack of deburr and too short of a bridge was the application of super glue to each of those heat staked portions. If the team were to start over, the best manufacturing method would have been to go with cold forming. This would have required another material for the bridge as acrylic is too brittle to be cold formed. If the team were to continue manufacturing these for future endeavors, other material selection and methods would be best to consider.

10.2.6 Pump Supply Chain Issue

The pump, a purchased component that had the largest wait time due to overseas shipping, arrived with the wrong connection. The selected plug was a 5V USB connection while the pumps arrived with a 12V barrel plug. After testing with an adapter it was found that pump internals were identical, meaning that an adapter could be used. With only a month left to complete the project, the supplier agreed to send pumps with the correct connection. In the event that the pumps did not arrive in time, barrel plug to USB adapters were ordered as well so the original pumps could be used. The new pumps did ship in time, and the original pumps were removed, leaving the pump outlet fitting in the pump connector for ease of exchange.

10.3 Current and Future Work

10.3.1 Current Work

So far this semester, the team has focused on manufacturing and working in conjunction with our eventual assembly. For manufacturing, the team has so far focused on producing the simpler parts, such as the grates and bridges. As of the time of writing, the team has produced every bridge and 250 grates. They have also started production on basin, pipes, and the middle bowl. Due to the nature of the tooling design, the team has made a point to complete the mold for the plastic injection bowls along with the punch and die for the middle bowl.

In regards to assembly, the team has begun to set up assembly cells and is working towards completion of fixtures for assemblies 2 and 3. Assemblies 2 and 3 are the most complex. Assembly 2 uses the robots, conveyor and vertical press located in the MILL and requires several custom fixtures. Assembly 3 uses a complex custom built horizontal press. Because of their complexity and out of an abundance of caution, the team decided to focus their efforts on making and calibrating those two assemblies.

10.3.2 Future Work

For the remainder of the semester, the team should focus on ramping up production and assembling the full product. They must continue to manufacture parts. Once all parts are completed, the team will begin assembly using the completed assembly jigs and fixtures. Finally, the team will package their product, and they will be ready for consumers!

Section 11: Ramping Up for the Spring Semester

11.1 Ramping Up

As MPS Team C moves into production during the spring semester, they need to maneuver into a position that will set them up for success. In the first few weeks of the spring semester, they need to build and test all of the assembly fixtures and molds that were designed in the fall semester. Any necessary adjustments should be made as soon as possible.

Another action item that must be completed early on is ordering materials. It is important to order stock early just in case there are any shipping delays. In particular, the fountain pump is sourced from an Asian manufacturer called AliBaba. With the Chinese New Year in February, the company will most likely have reduced operations for an extended period of time right as fountain production starts. It is especially important in this case to make sure that the pump is ordered early and confirm that the product will arrive in a timely fashion.

Finally, the team needs to continue to work together and stay on the same page throughout the semester. With the spring semester having less formal class time, there is less scheduled time for team members to check up on each other's progress. They will continue to meet frequently outside of class and assign tasks to team members so that they can produce their product efficiently.