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Plastic Injection Mold

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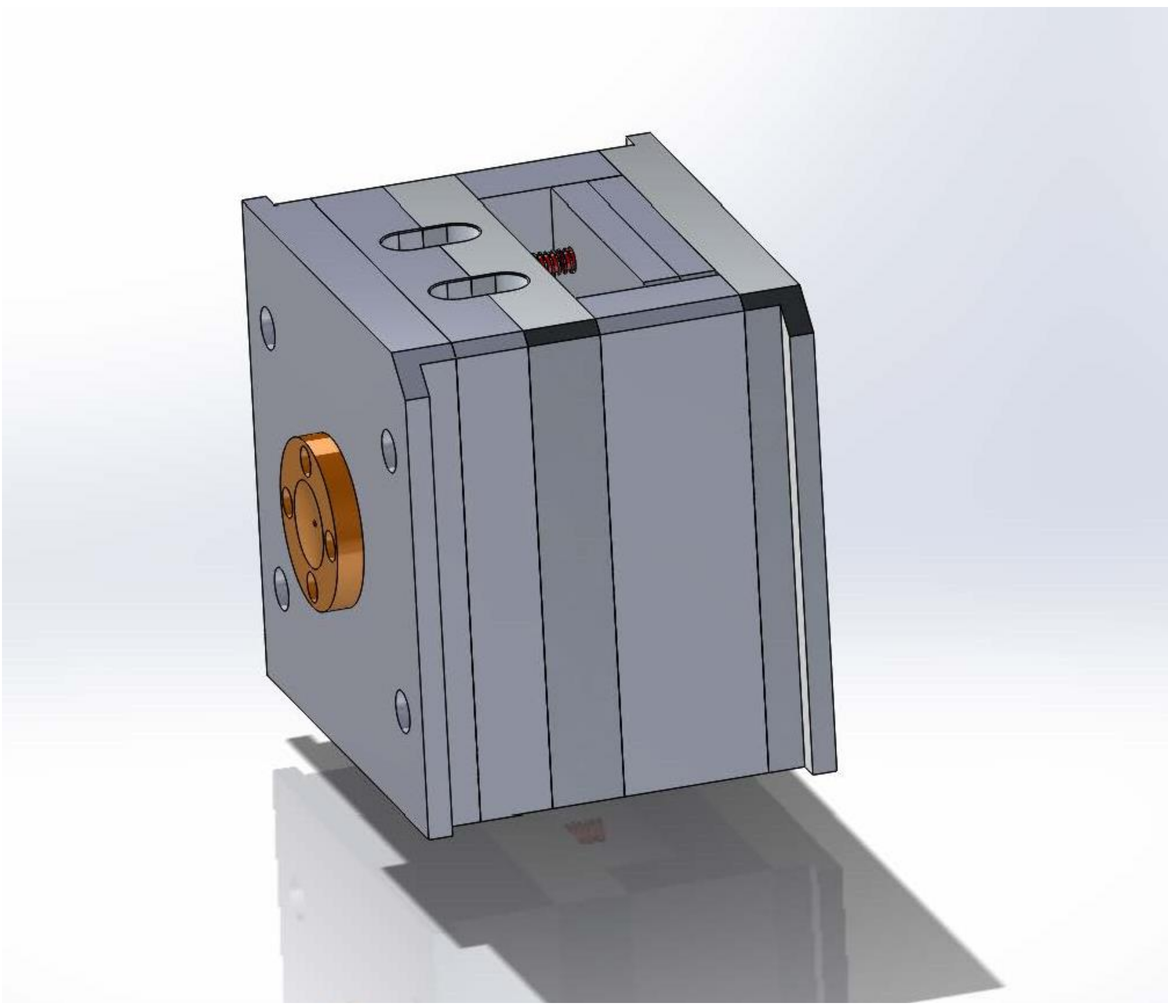
By

Ryan Heaton



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Introduction

Problem

The problem being faced is that more molds are needed for the plastic injection presses. The professor for the Plastics course has personally expressed that more usable molds are needed for his plastics and composites class. So the design and fabrication of a functional mold to help the CWU engineering department is being proposed for this project.

Motivation

Realizing the university had a plastic injection press that was not being used, the thought of making a functional mold that was to be used in said press became very intriguing. The design of the mold will come from personal research and experience gained from working at a plastic injection molding company for multiple years. After talking to my professor about the idea he even expressed how he needs more molds to use in the press and would love to have one made.

Making a mold will not only be a serious designing challenge for me but it will also support the school. The mold will be used as a tool and teaching aid in the Plastics and Composites class taught but Dr. Johnson.

Function Statement

The mold created will be used in the plastic injection press owned by the university's engineering department to produce quality parts. The mold and parts produced will be used in Dr. Johnson's plastics and composites class as a teaching aid and as a tool for further study. The mold will also be designed to have removable inserts so that one could make a different part by making a new insert and swapping them instead of making an entirely new mold.

Requirements

- Can be operated by one person.
- Must be able to produce 25 acceptable parts in succession without failing.
- Flash can be no longer than 0.025".
- Insert must fit with a tolerance of 0.005".
- Project cost cannot exceed $1000.
- Cannot exceed 50lbs.
- Moving parts cannot jam or bind during operation.

Engineering Merit

The engineering merit for this project comes from the engineering concepts learned from the the CWU MET program. This mold project requires research and analysis such as strength of materials and material properties.

Success Criteria

The project would be considered a success if the above requirements are met. The mold needs to be operable by one person and weigh less than 50lbs. The cost of materials cannot exceed $1000. There shouldn't be any problems with the moving parts. And we should be able to produce 25 parts with very minimal flash.

Scope

The scope of this project will be to design, fabricate and test an injection mold that will be used in the materials lab on the plastic injection press to help students learn in the plastics and composites class. The design portion will consist of designing the mold to function in the Boy 15 plastic injection press and analyzing the parts of the mold to ensure proper performance. The manufacturing portion will consist of the fabrication of each part of the mold and the assembly of said mold. The testing portion will consist of setting the mold up in the Boy 15 injection press and testing the system to produce quality parts.

Design & Analysis

The design for this project comes from the experience acquired from working with Poly-Cast Inc. over the past couple years. With a moderate understanding of how the injection molds work, creating an original design that will make something new is very feasible.

The Design
The mold design consists of 4 main Plates, 2 inserts, and 2 ejector plates for ejector pins. The inserts are fixed inside Plates A and B so they can me taken out and/or replaced with a different cavity shape. While the 2 ejector plates are held within section 4 on guide pins so they can move forward and back. The plates hold the ejector pins in a fixed position so when the plates move forward they can eject the part after the injection is finished and the mold is opened.

For the ejector pins to work properly, guide pins are needed for the ejector plates to slide on. By analyzing the weight of the ejector plates we can calculate the proper size for the guide pins so they won't break or bend during use. (Calculations can be found in Appendix A) The guide pins will be made of tool steel and bought from McMaster-Carr.

In order to make sure that the ejector plates don't move forward too early springs are needed. By analyzing the weight of the plates and friction on the greased guide pins we can find the proper spring properties needed for operation. (Calculations can be found in Appendix A) And using the spring properties we can find the correct springs on McMaster-Carr or some similar place.

Performance Prediction
The performance predictions for this project are that all of the moving parts will function without jamming. The ejection process during the testing phase will also function properly with the part sticking to the B when it opens and the ejector pins pushing the part out.

Analysis
At first the mold was designed to be made out of steel. Figure 1 and 2 (Appendix A) shows the calculations for the estimated weight of the mold and the spring rate needed to operate the ejector plates. But since the material changed to 7075-T6 Aluminum these calculations will not be used.

The first analysis was to calculate the weight of the mold (Appendix A, Figure 3). Calculating the weight was based on the total volume of all the pieces of the mold multiplied by the density of the material. The calculations for the weight of the mold came out to be about 10lbs.

A specific spring rate was needed to hold the ejector plates back while the mold is being injected with plastic. There are four springs in the mold that hold the ejector plates in position. In order to calculate which springs would be needed, the weight of the Ejector plates was found and the friction they would put on the guide pins was calculated. With that, the minimum spring constant was found to be .304 for each spring (Appendix A, Figure 4).

There are four guide pins that need to be able to support the weight of the ejector plates. Using the weight of the ejector plates we can calculate the maximum moment the pins will experience to be about .08lb*in. Using the flexure formula and the yield strength of the pin material we can calculate the minimum diameter of the pins. It was found that the pins cannot be less than .025” in diameter. 3/16” diameter pins were chosen because of ease of use. (Appendix A, Figure 5)

There are two sets of four guide pins in the mold that need to be press fit so they don’t come out. From research online and talking to the tooling specialist at Poly-Cast Inc. it was found that an interference of between .001”-.0025” is good for a press fit steel pin in 7075-T6 aluminum. Taking the average of that, the ideal hole sizes were calculated. (Appendix A, Figure 6)

Knowing that the ideal injection temperature for ABS is 430 degrees F, the thermal expansion needed to be calculated in order to make sure the mold could handle the temperature. From these calculations the mold would expand by about .0165” when brought up to temp which is within tolerance. (Appendix A, Figure 7)

The product that the mold produces will shrink when it cools from its molten temperature of 430 degrees F to room temperature of about 73.4 degrees F. To combat this the cavity size would need to be scaled up so the part will be the perfect size after it’s cooled. The scale factor was found to be 1.018. (Appendix A, Figure 8)

Many tools were needed for this project. The speeds and feeds were needed for each in order to have clean, accurate cuts during the machining process. The speeds and feeds for all of the tools used are recorded in Appendix A, Figure 9.

Methods & Construction

This Project was conceived, analysed and designed at Central Washington University. The parts for this project will be fabricated and assembled in the CWU machining shop.

Construction
The mold will be made up of 4 main Plates, 2 inserts, and 2 ejector plates. Each main section will be milled from 7075-T6 Aluminum Stock. The cavity for this mold will be milled into inserts, a separate piece that will be interchangeable within Plates A and B (see Appendix B). That way multiple inserts can be exchanged to produce a new part instead of replacing the mold entirely. Other smaller pieces like the Sprew and Ejector knob will be made on a lathe and or manual milling machine.

Precision pieces like the springs, ejector pins, and guide pins will be bought because they are made of special material or hardened steel.

Part List	
Part Name	**Quantity**
Face Plate	1
Plate A	1
Plate B	1
Ejector Housing	1
Ejector Plate 1	1
Ejector Plate 2	1
Sprew	1
Ejector Knob	1
Insert 1	1
Insert 2	1
Spring	4
Ejector Pin 1/8”	6
Ejector Pin 1/4”	1
Guide Pin 3/16”	4
Guide Pin 3/8”	4

All of the plates and inserts were rough cut from 7075-T6 aluminum bar stock. It was decided that it would be more efficient to work on all of the parts at the same time than only doing one part at a time. That way, if mistakes were made, they would be found immediately.

Running the parts on the CNC had to wait for a while because of design issues. There were a few complications when it came to access to certain tools. The machine shop at CWU is not set up for high tolerance, high precision machining. We did not have some of the tools that would have made this project easier. So in order to combat this a lot of redesigning had to be done to make the building process work with the tools we have available.

Once all of the parts were cut to size a CNC program was written to mark and drill holes as well as mill out any other features that were in the design for that part. Once the parts had been run through the CNC the threaded holes were manually tapped and reamed to size.

Since all of the pieces were cut it was time for assembly and testing the fitment. So far there had not been any issues with the project. But once the pins were pressfit into their respective holes it was found that they were not perfectly straight. And because of that, the ejector plates did not slide easily across them. To combat this some guide holes were drilled into the B plate (the plate opposite of the one that had the press fit pins). The pins were held in position by the guide holes and that made them straight enough to allow the ejector plates to slide along the pins like they were designed to. Other than the guide pins being a bit crooked no other problems have surfaced as of now.

Operation
The mold will be mounted into the plastic injection press. The mold is then closed and the press will inject molten plastic into the open cavity. Once the plastic has cooled/hardened enough the mold will open between Plates A and B to reveal the part. While the mold is still open, sections 5 and 6 will be pushed forward to eject the part using the ejector pins.

Performance Predictions
The efficiency of this mold is predicted to be about 85%. So 15% of the parts produced would fail the success criteria.

Testing Method

Test Plan
Once the mold is completed and assembled it must be tested. To test the assembly, all moving parts should move smoothly without binding or jamming. And the plates should all fit together straight without any play room.

In order to test the mold itself it will be clamped into the plastic injection press and the press filled with plastic material. The press will melt the plastic and inject it into the mold. The mold will then open, split between Plates A and B, and eject the part by pushing the ejector plates/pins forward. The mold will then retract the ejector plates/pins and close. And the whole process repeats itself. If the mold is working properly, there will be no flash or defects in the part produced and the mechanical parts of the mold won't jam or bind. There also will not be any problems with plastic sticking to the inside of the mold and getting stuck. If that happens the mold will have failed to eject the part properly.

The testing procedure for this project starts with mounting the mold in the press. Once mounted the press is started and the mold will be run through the movement operations of the press to make sure there is no binding. A few test shots/warm up shots are done to adjust the proper temperature, pressure, shot size, and cycle time that's needed to produce quality parts. Then the official production of parts is started and both of the acceptable and defective parts will be counted.

Once the mold is producing parts on the press it will be run through a cycle of 25 parts at a time. The data recorded for those parts includes cycle time, # of good parts, # of bad parts, flash, burns, voids, extra notes.

Steps for testing:
- Mount mold in press so that the sprew is concentric with the injector.
- Run the opening, closing, and ejection processes to make sure everything works properly.
- Run some test parts while adjusting the pressure, temperature, shot size, and cooling time until the mold is producing parts without flash, burns, or voids.
- Start a production run where the mold makes 25 parts.
- Record data: cycle time, # of good parts, # of bad parts, flash, burns, voids, extra notes.

The press will be running at around 600 degrees F so make sure you know where the hot areas are. We're working with pressurized molten plastic so wear safety glasses.

Test Documentation & Deliverables

All data will be recorded on a pre-made table. The table will include; the number of parts run per day, the number of defect parts per run, a note section to explain complications or to suggest ideas for improvement. There will also be a checklist to make sure the mold holds up to the requirements. Photos will also be taken every step of the way.

Ryan Heaton

Senior Project
9/28/17

Budget/Project Management/Schedule

Item #	Item Description	Item Source	Size	Model/Part #	Price	Quantity	Total Est. Cost	Total Act. Cost	Notes
1	Spring	McMaster-Carr	1.25"	9657K112	$6.80	1	$6.80		Pack of 12
2	1/4" Ejector Pin	McMaster-Carr	3/16"	93772A118	$4.48	1	$4.48		
3	1/8" Ejector Pin	McMaster-Carr	5/32"	93772A112	$3.51	6	$21.06		
4	7075 Aluminum Bar Stock	McMaster-Carr	1"x6"x24"	8885K943	$265.99	1	$265.99		
5	7075 Aluminum Bar Stock	McMaster-Carr	.75"x6"x6"	8885k931	$72.52	2	$145.04		
6	7075 Aluminum Bar Stock	McMaster-Carr	.5"x6"x6"	8885K921	$41.67	2	$83.34		
7	7075 Aluminum Round Stock	McMaster-Carr	1.75"x6"	90465K17	$24.75	1	$24.75		
8	3/16" Pin	McMaster-Carr	3/16"	93772a115	$3.83	4	$15.32		
9	3/8" Pin	McMaster-Carr	3/8"	93772a124	$7.36	4	$29.44		

All parts were easily found on McMaster-Carr and are listed above. Originally the mold was to be made of steel. But aluminum has been used for production molds in some places for quite a while now. And with this project's production as small as it is, aluminum will work fine. Also, steel was found to be about four times more expensive.

Budget

The proposed budget for this project was no more than $1000. And with the material being steel, the total price was well above the projected budget. Thankfully, after switching the design material to 7075-T6 Aluminum the total price dropped by about 70% to $596.22.

Schedule

The schedule for this project is shown in Appendix E. The Proposal will be edited continuously from September when the project started to June when it ends. Fitment tests will be conducted regularly, once or twice a week as the project's construction progresses over the span of January-March. The Front and A plate is expected to be completed by the end of January. The B Plate, Ejector Housing, and ejector plates are expected to be completed by the end of February. And the inserts and sprew will be completed by the end of winter quarter March 8th. The testing portion was conducted over spring quarter (April-June).

The expected dates of completion were very far off from what the actual completion dates were. This project ran into many problems at the start. From problems of getting the right materials in early enough to having to edit designs to work with the equipment available. The first part to be considered completely done was on February 20th. Much later than predicted in the initial schedule.

Every part of the project was being worked on together at the same time. That was found to be more time efficient than focusing on one piece until completion before starting the next. First, all of the pieces were rough cut and squared. Then they were run on the CNC. After that was to drill and tap the holes. There was a struggle to get the pins in so some time was wasted on having to wait for them before proceeding with construction of the mold components.

Discussion

The evolution of the design for this project had progressed smoothly until it came time to calculate the price for materials. The initial design was made out of a type of hardened steel. A specific kind had not been decided on so mild steel was used to estimate the price. Using steel, the estimated price for the project was a littleover $2000. And with the special tools and mills needed to machine such material would cost a pretty penny as well. The hardened steel that is normally used would also be more expensive to work with. And the cwu machine shop does not have the proper equipment to mill hardened steel to this degree.

Needless to say, some more research was required to find a more cost efficient material. And that's how 7075-T6 aluminum was chosen. According to MoldMakingTechnology.com 7075-T6 would be perfect for this project. The cost is about 70% less than of the cost of mild steel. And aluminum dissipates heat better than steel.

During the fabrication portion of the project most of the designs had to be changed or revised. Mostly because of lack of the right equipment needed to make the part. The design for the cavity was changed three times because of tool sizes. The A and B plate designs were changed a few times because of fitment. The ejector housing design was split into three parts instead of one solid part in order to be cost effective. And the sprew design was changed at least five times because of lack of tools and differing ideas on how the sprew should be attatched.

There were also some fitment problems that came up during construction. The biggest problem, which has yet to be fixed, is that the guide pins are not perfectly straight. Which makes the two halves of the mold to be offset by about .003".

Conclusion

This project is a success because the mold held up to all of the requirements set for this project.

- The mold can easily hold up to multiple parts.
- The mold can easily be operated by one person.
- Total project cost came out to be $610.16
- The mold weighs only 9lbs.
- The moving parts of the mold work properly and do not jam.
- The mold was able to produce 25 acceptable parts in succession.
- The mold was found to work best at about 100-125 degrees F.

This injection mold project has all of the components of a successful senior project. It requires engineering from statics, strengths, and heat transfer. It provided educational experience of design and editing. And it proved to be a challenge that showed the designer's skills and knowledge of engineering techniques.

Acknowledgements

People

Andrew Regan – Tooling Specialist at Poly-Cast Inc., Master Machinist

Huge source of information on how molds work/designed/maintained.

Dr. Craig Johnson – CWU Professor, Senior Project Educator

Proposed the idea of making a mold. Helping with ideas for design and analysis.

Professor Charles Pringle – CWU Professor, Senior Project Educator

Help with analysis and calculations.

Professor Tedman Bramble – CWU Professor

Help with design and introducing new and worthwhile Solidworks skills.

Matthew Burvee – CWU Shop

Help with tools, machining, and acquiring materials.

Central Washington University

CWU Engineering Department

A special thanks to CWU for allowing me to use the machine shop and all of its tools in order to complete this project. Without it, this project would have been impossible.

Appendix A – Analyses

Spring Strength and Total Weight- (**Old/Data not going to be used**)

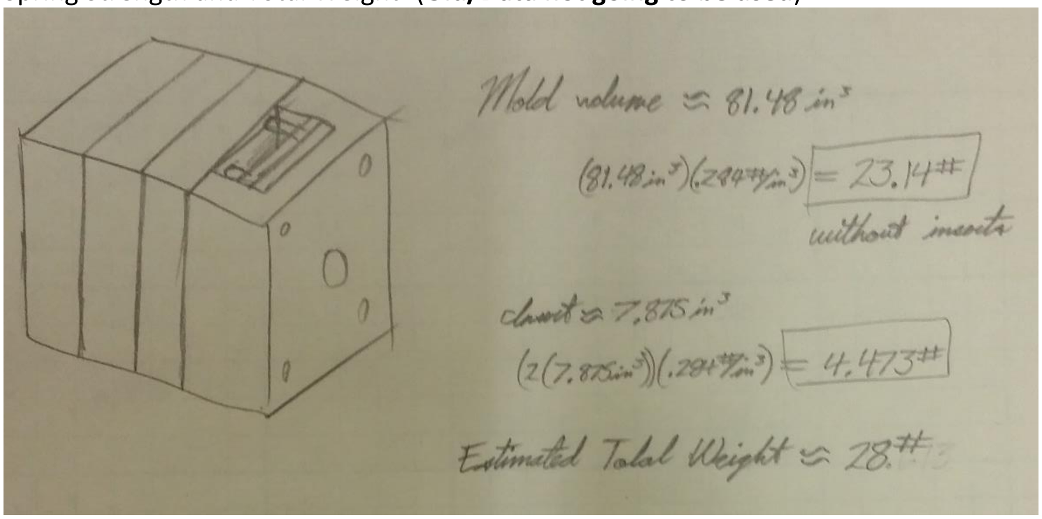


Figure 1.

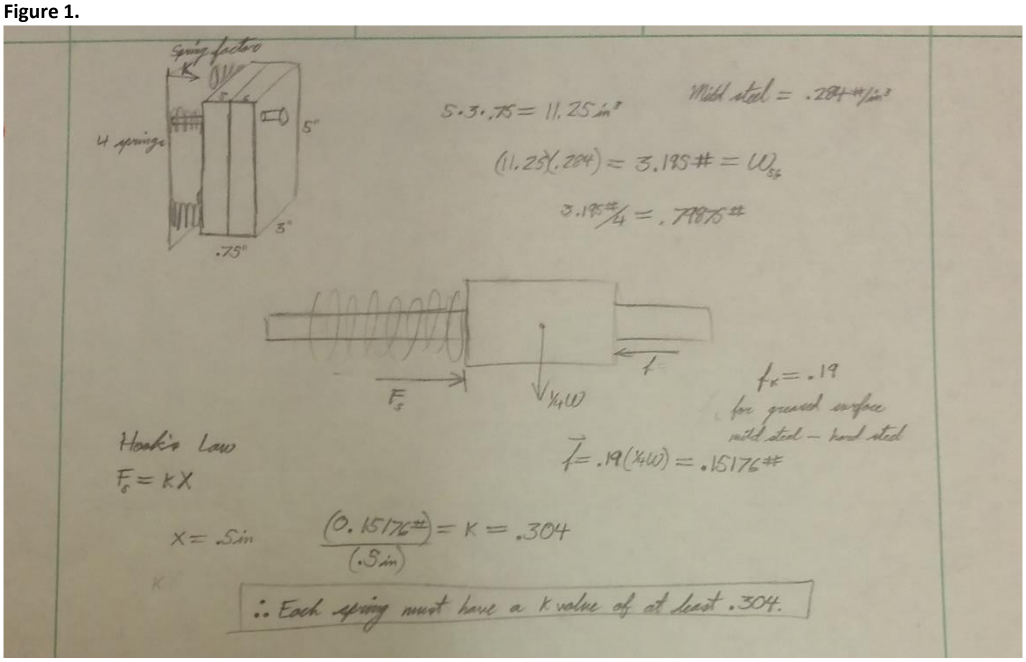


Figure 2.

The total weight and required spring rate were calculated. But it was later decided to change the material from steel to 7075-T6 Aluminum because it was more cost efficient.

Total Weight-

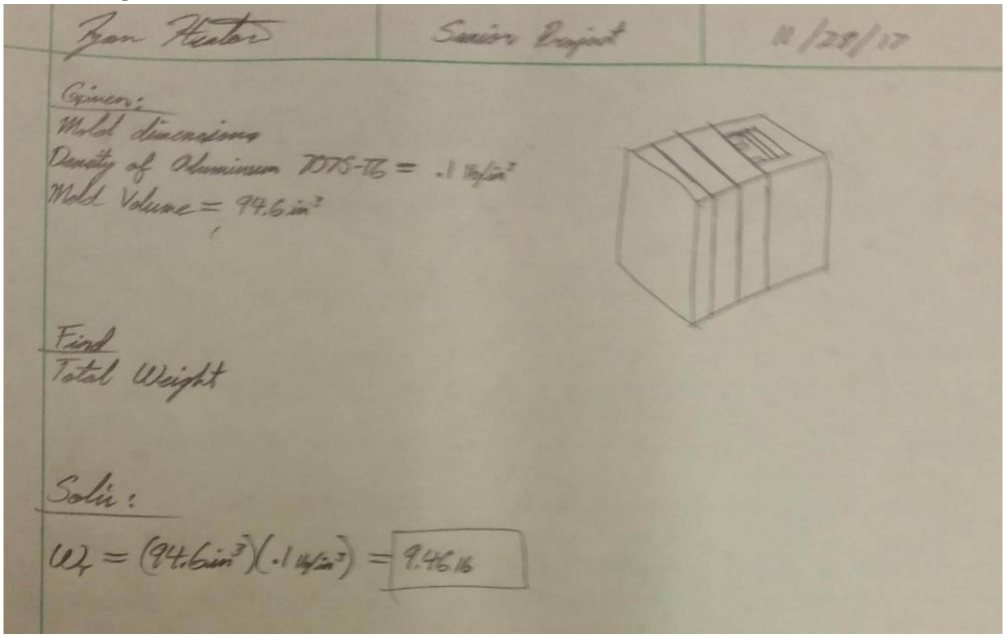
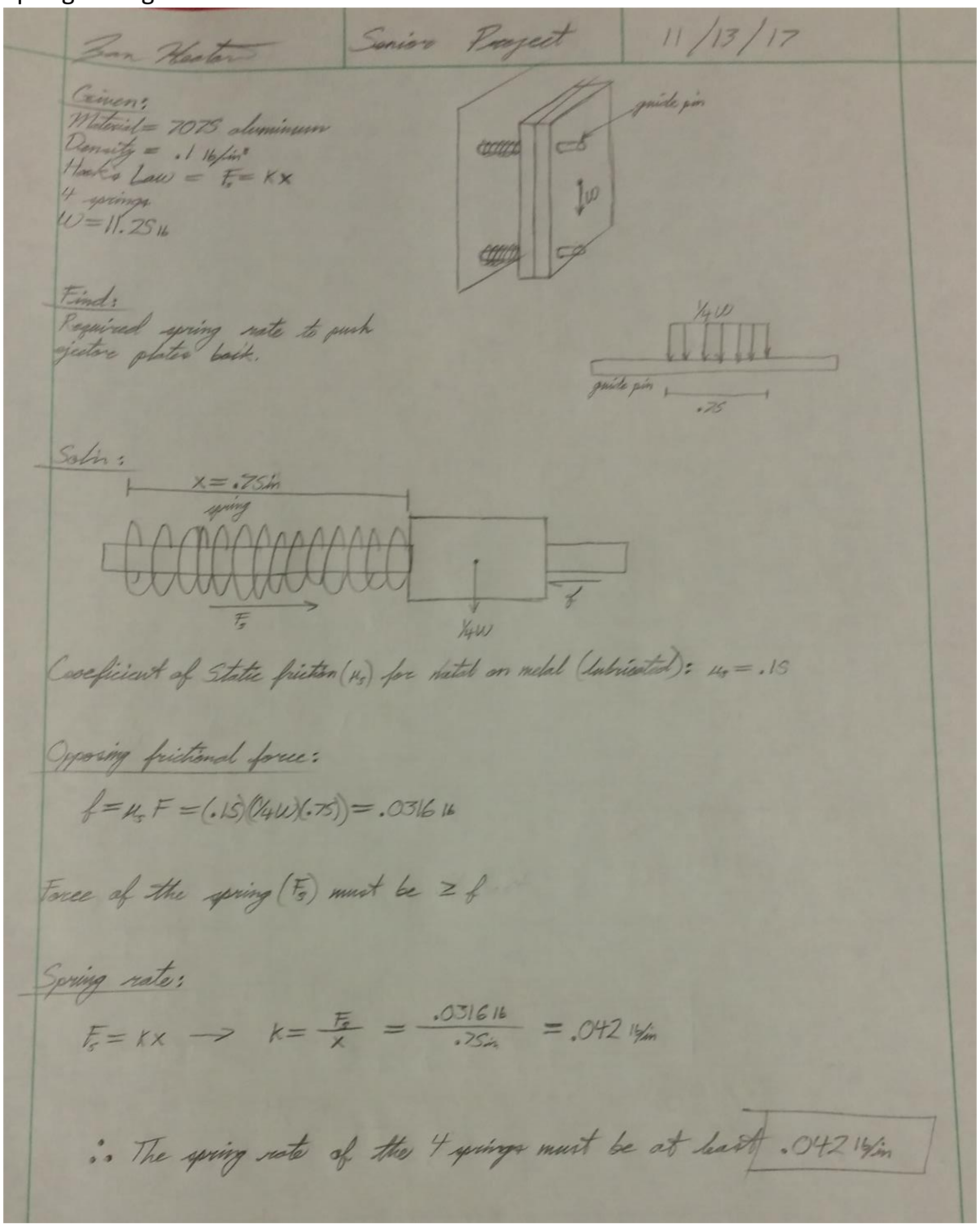


Figure 3.

From these calculations, the estimated total weight of the mold is around 9.43 pounds. This was done by multiplying the volume by the average weight per cubic inch of 7075-T6 Aluminum.

Spring Strength-



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Given:
Material = 7075 aluminum
Density = .1 lb/in^3
Hooke's Law = $F_s = kx$
4 springs
$W = 11.25$ lb

Find:
Required spring rate to push ejector plates back.

Soln:

Coefficient of static friction (μ_s) for metal on metal (lubricated): $\mu_s = .15$

Opposing frictional force:

$$f = \mu_s F = (.15)(\tfrac{1}{4}W)(.75) = .0316 \text{ lb}$$

Force of the spring (F_s) must be $\geq f$

Spring rate:

$$F_s = kx \rightarrow k = \frac{F_s}{x} = \frac{.0316 \text{ lb}}{.75 \text{ in}} = .042 \text{ lb/in}$$

$\therefore$ The spring rate of the 4 springs must be at least $\boxed{.042 \text{ lb/in}}$

Figure 4.

There are four springs in the mold that hold sections 5 and 6 back so the ejector pins are held back while plastic is injected. In order to calculate which springs would be needed, the weight of sections 5 and 6 were found and the friction they would put on the guide pins was calculated. With that, the minimum spring constant was found to be .304 for each spring.

Guide Pin Size-

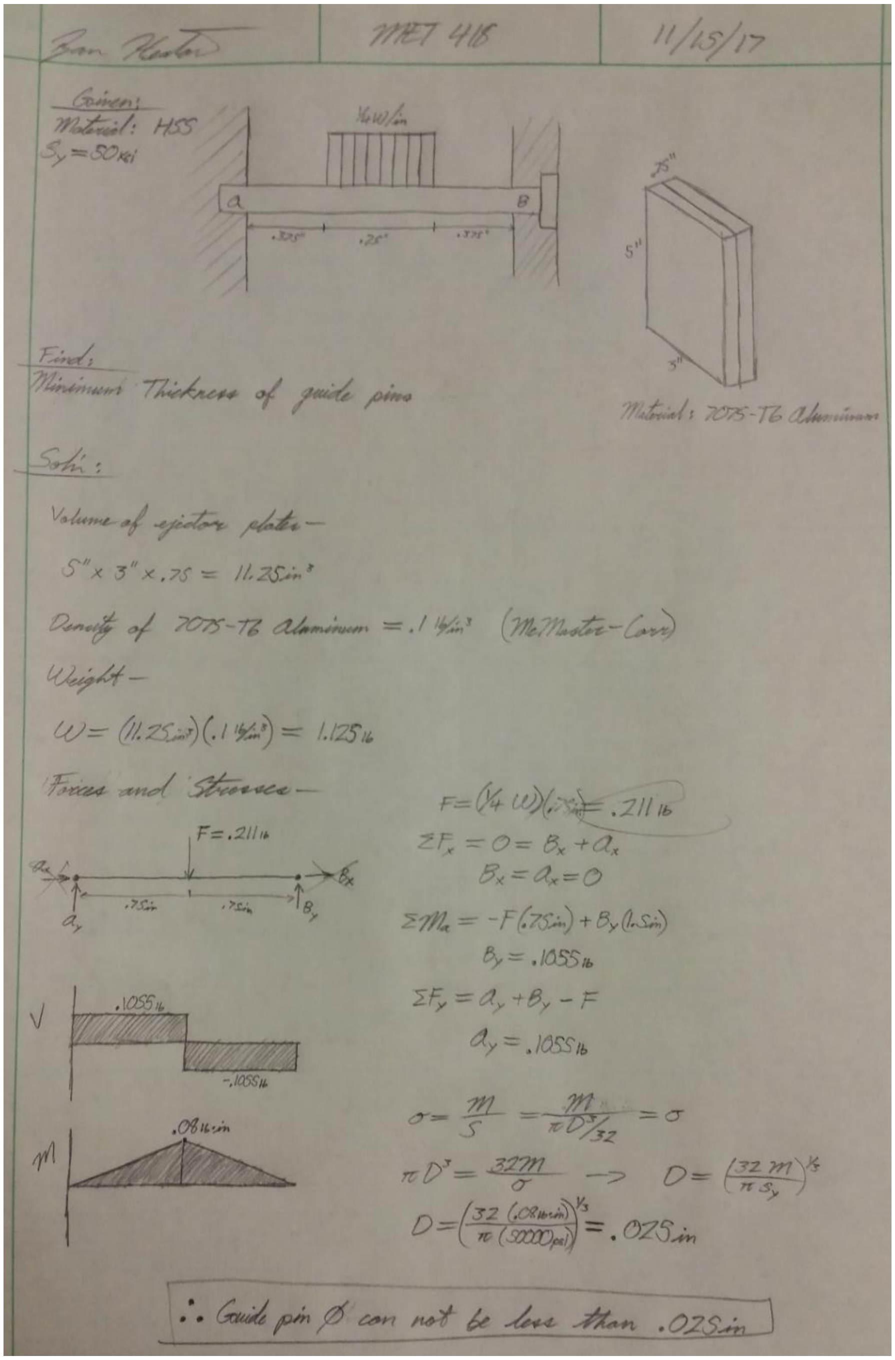
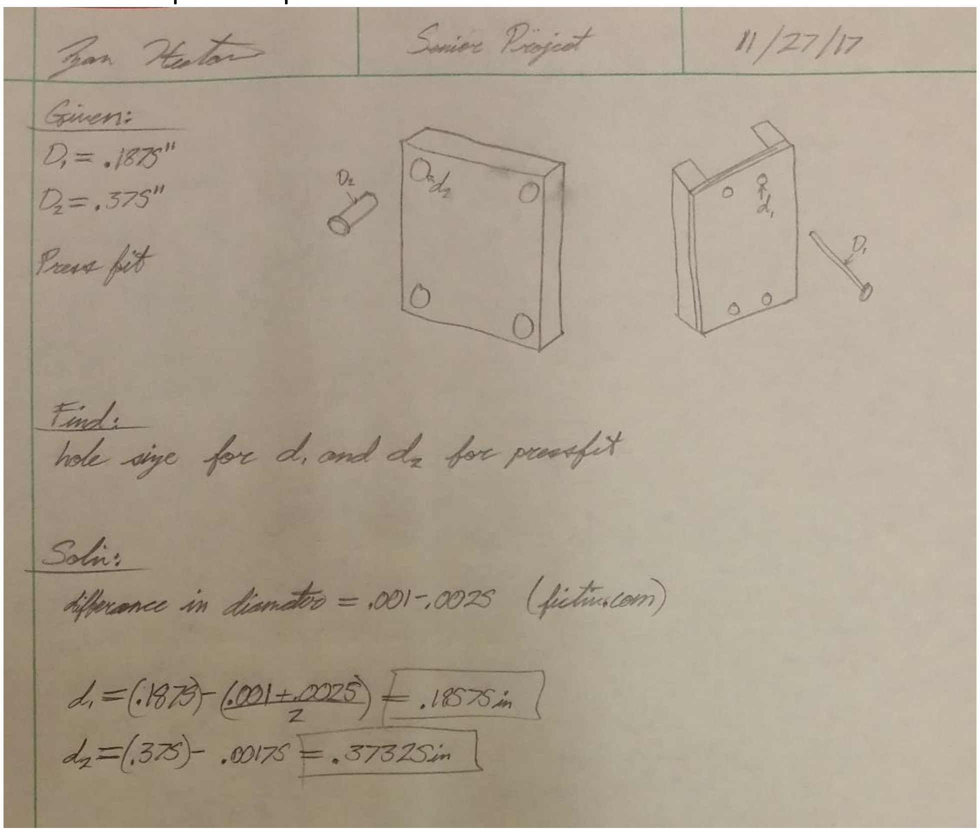


Figure 5.

The four guide pins need to be able to hold the weight of the ejector plates. From these calculations we can see that the maximum moment the pins will experience is only about .08lb*in. Using the flexure formula and the yield strength of the pin material we can calculate the minimum diameter of the pins. It was found that the pins cannot be less than .025" in diameter. 3/16" diameter pins were chosen.

Hole size for press fit pins-



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Given:

$D_1 = .1875''$

$D_2 = .375''$

Press fit

Find:

hole size for d_1 and d_2 for pressfit

Soln:

difference in diameter = .001-.0025 (fictiv.com)

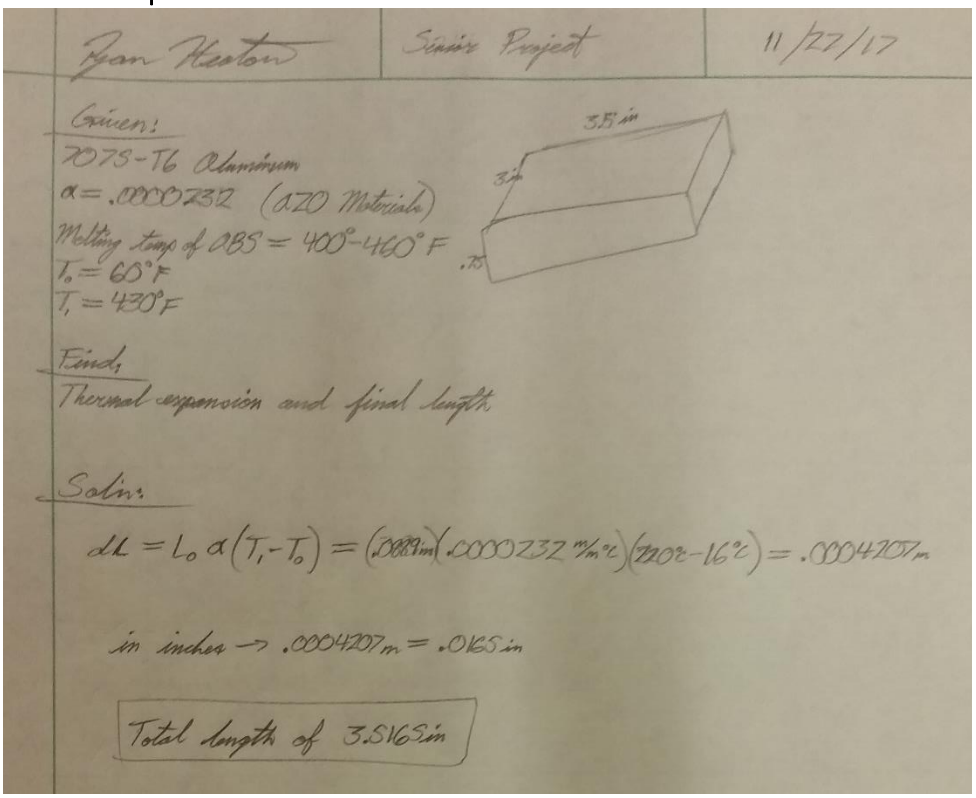
$d_1 = (.1875) - \left(\frac{.001 + .0025}{2}\right) = \boxed{.18575\,in}$

$d_2 = (.375) - .00175 = \boxed{.37325\,in}$

Figure 6.

There are two sets of four guide pins in the mold that need to be press fit so they don't come out. From my research online and talking to the tooling specialist at Poly-Cast Inc. it was found that an interference of between .001"-.0025" is good for a press fit steel pin in 7075-T6 aluminum. Taking the average of that, the ideal hole sizes were calculated.

Thermal Expansion-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Given:
7075-T6 Aluminum
$\alpha = .0000232$ (AZO Materials)
Melting temp of ABS = 400°-460° F
$T_0 = 60°F$
$T_1 = 430°F$

Find:
Thermal expansion and final length

Soln:

$$dL = L_0 \alpha (T_1 - T_0) = (.0889 m)(.0000232 \, m/m°C)(220°C - 16°C) = .0004207 m$$

in inches → .0004207 m = .0165 in

$\boxed{\text{Total length of } 3.5165 in}$

Figure 7.

Knowing that the ideal injection temperature for ABS is 430 degrees F, the thermal expansion needed to be calculated in order to make sure the mold could handle the temperature. From these calculations the mold would expand by about .0165”.

Thermal Expansion for Product-

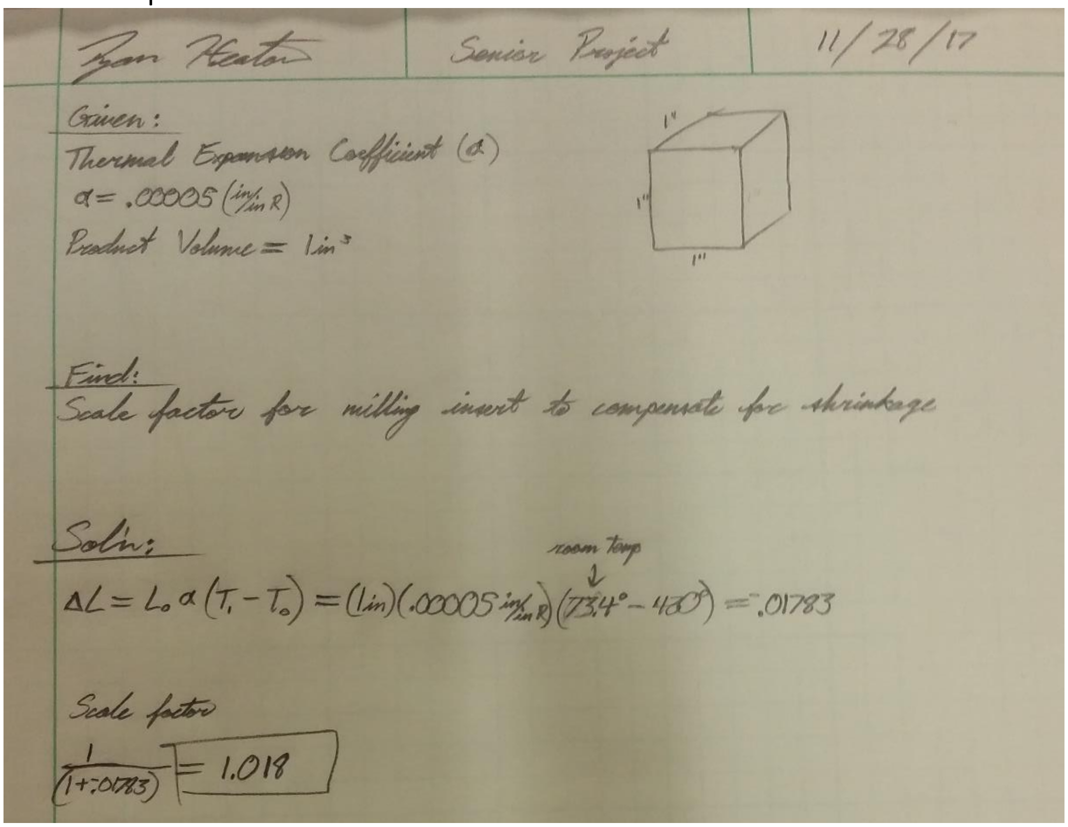

Figure 8.

The product that the mold produces will shrink when it cools from its molten temperature of 430 degrees F to room temperature of about 73.4 degrees F. To combat this the cavity size would need to be scaled up so the part will be the perfect size after it’s cooled. The scale factor was found to be 1.018.

Ryan Heaton

Tool Speeds & Feeds for CNC programs-

Ryan Heaton | Senior Project | 2/6/18 | 1/2

Given:
Material = 7075-T6 Aluminum

Mills:
.500" END MILL
4" face mill
.500" Ball Mill
1/4" mill
3/8" mill

Drills:
Center Drill 1/4"
#7 (.201")
#16 (.177")
5/16" CB
23/64" Drill
H Drill (.266")
#27 (.144)
#29 (.136")

Reamers
.377"
.201"
.126"

Drill Ø	(f_r) feed (in/rev)
under 1/8"	up to .002
1/8" - 1/4"	.002 - .004
1/4" - 1/2"	.004 - .008
1/2" - 1"	.008 - .012
Over 1"	.012 - .020

Find:
Speeds & Feeds

Soln:

Drills:

$$N_{rpm} = \frac{12\,in/ft \times V_{sfm}}{\pi\, D_{in/rev}} \qquad f = N \times f_r$$

V for aluminum = 250

Center Drill

$$N = \frac{12\,(250)}{\pi\,(.25)} = \boxed{3820\,rpm}$$

$$f = 3820(.003) = \boxed{12\,in/min}$$

#7

$$N = \frac{12\,(250)}{\pi\,(.201)} = \boxed{4750\,rpm}$$

$$f = \boxed{14\,in/min}$$

#16

$$N = \frac{3000}{\pi D} = \boxed{5395\,rpm}$$

$$f = \boxed{16\,in/min}$$

23/64"

$$N = \frac{3000}{\pi\,(23/64)} = \boxed{2657\,rpm}$$

$$f = \boxed{16\,in/min}$$

H Drill

$$N = \frac{3000}{\pi D} = \boxed{3590\,rpm}$$

$$f = \boxed{14\,in/min}$$

#27

$$N = \frac{3000}{\pi D} = \boxed{6630\,rpm}$$

$$f = \boxed{20\,in/min}$$

#29

$$N = \frac{3000}{\pi D} = \boxed{7020\,rpm}$$

$$f = \boxed{21\,in/min}$$

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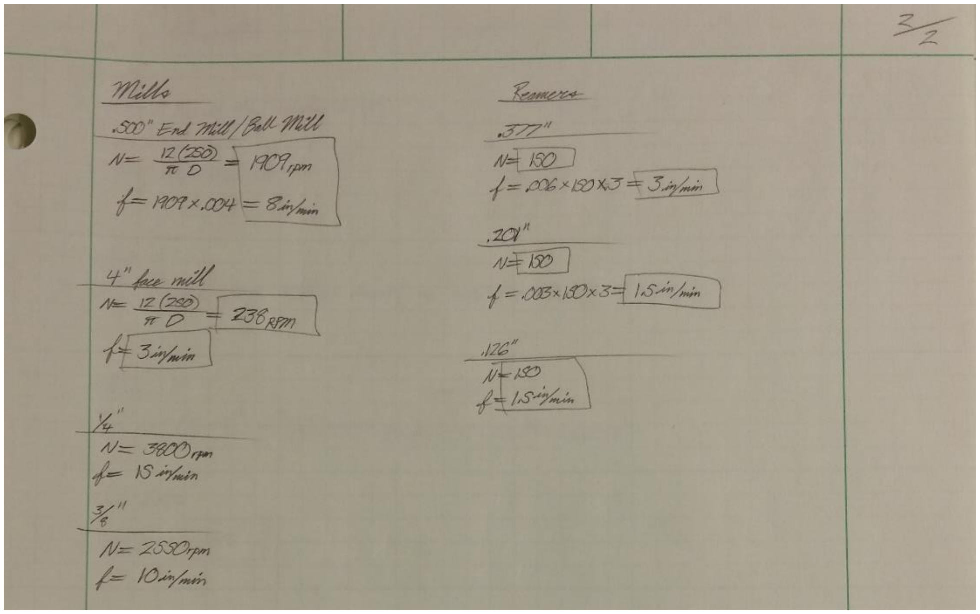

3/2

Mills

.500" End Mill/Ball Mill

$N = \frac{12(250)}{\pi D} = \boxed{1909 \text{ rpm}}$

$f = 1909 \times .004 = \boxed{8 \text{ in/min}}$

4" face mill

$N = \frac{12(250)}{\pi D} = \boxed{238 \text{ RPM}}$

$f = \boxed{3 \text{ in/min}}$

1/4"

N = 3800 rpm

f = 15 in/min

3/8"

N = 2550 rpm

f = 10 in/min

Reamers

.377"

$N = \boxed{150}$

$f = .006 \times 150 \times 3 = \boxed{3 \text{ in/min}}$

.201"

$N = \boxed{150}$

$f = .003 \times 150 \times 3 = \boxed{1.5 \text{ in/min}}$

.126"

$N = 150$

$f = 1.5 \text{ in/min}$

Figure 9.

Many tools were needed for this project. The speeds and feeds were needed for each in order to have clean, accurate cuts and milling.

Appendix B – Sketches/Drawings

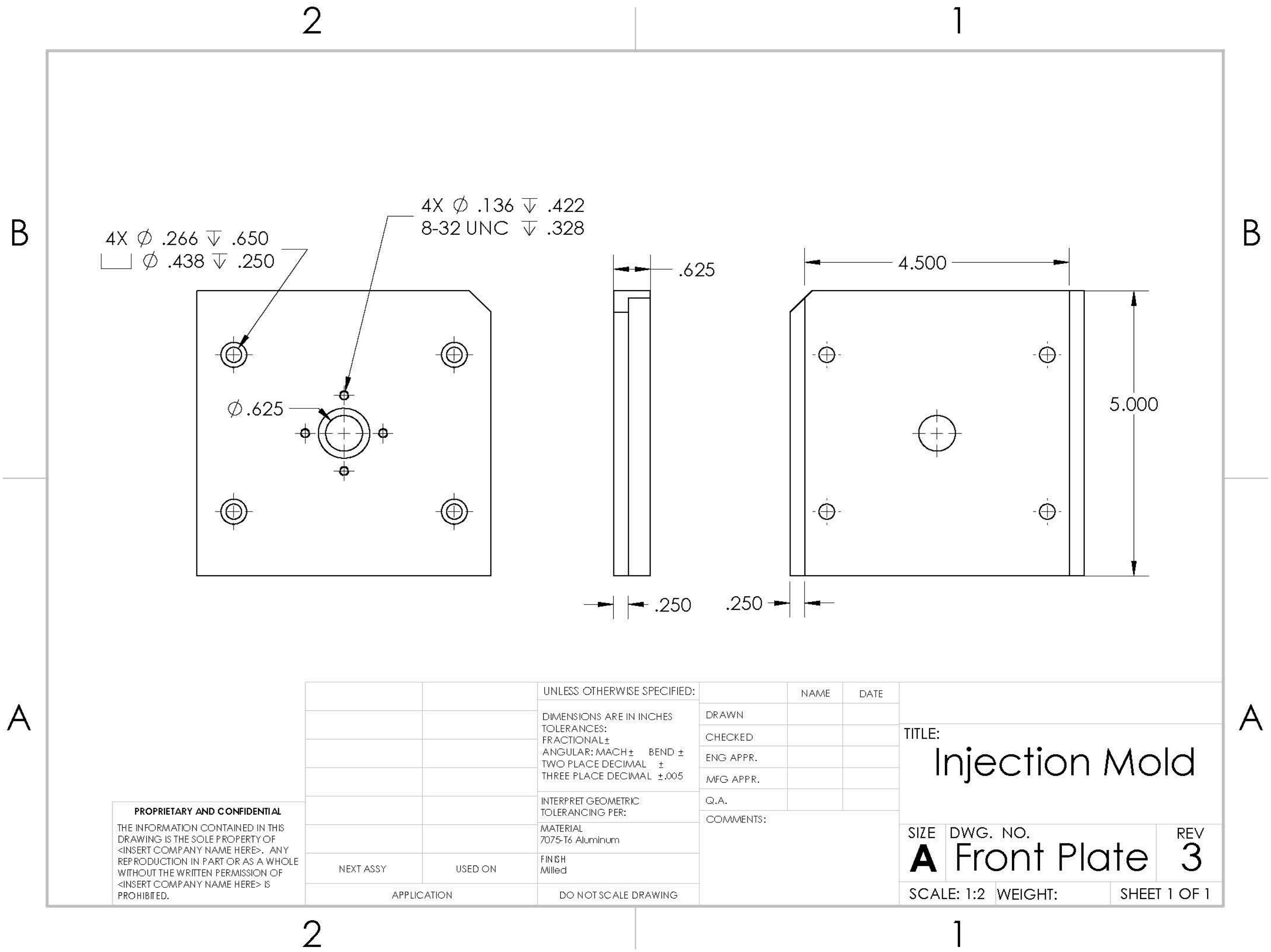

Figure 10.

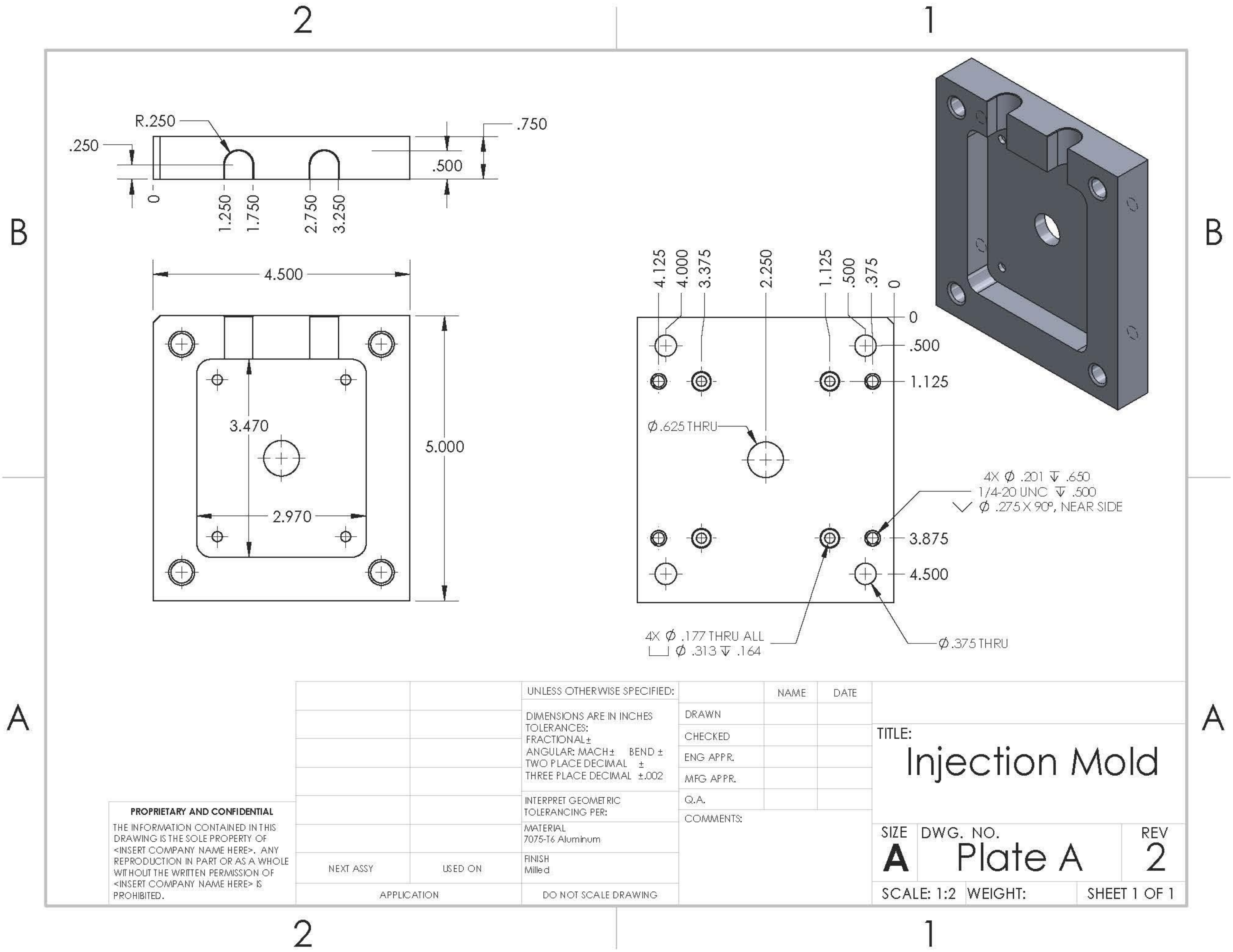
R.250
.250
.750
.500
0
1.250
1.750
2.750
3.250
4.500
5.000
3.470
2.970
4.125
4.000
3.375
2.250
1.125
.500
.375
0
.500
1.125
Ø .625 THRU
4X Ø .201 ↧ .650
1/4-20 UNC ↧ .500
⌵ Ø .275 X 90°, NEAR SIDE
3.875
4.500
4X Ø .177 THRU ALL
⌴ Ø .313 ↧ .164
Ø .375 THRU
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±.002
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
Milled
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
Plate A
REV
2
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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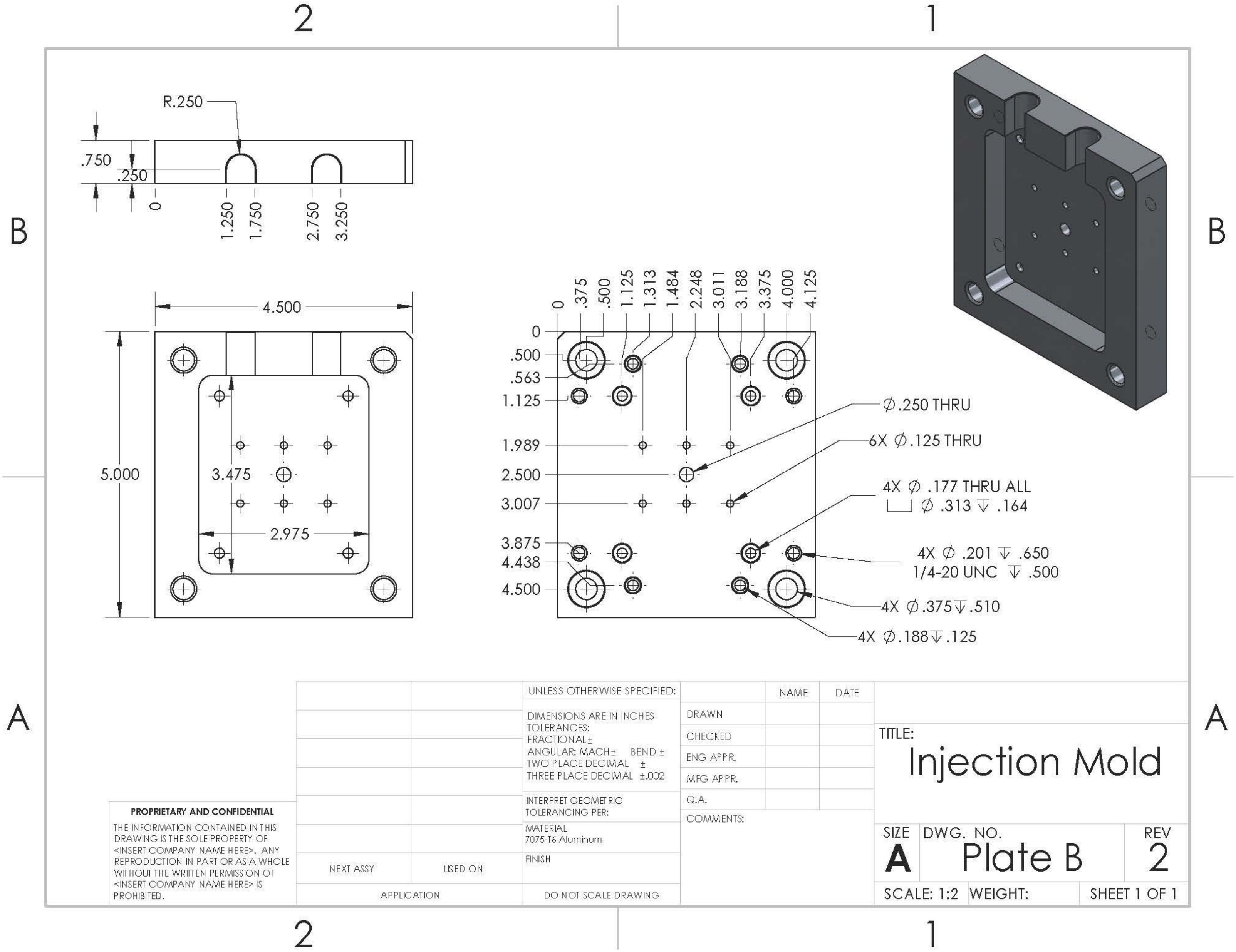
Figure 11.


2
1
B
A
R.250
.750
.250
0
1.250
1.750
2.750
3.250
4.500
5.000
3.475
2.975
0
.375
.500
1.125
1.313
1.484
2.248
3.011
3.188
3.375
4.000
4.125
0
.500
.563
1.125
1.989
2.500
3.007
3.875
4.438
4.500
∅.250 THRU
6X ∅.125 THRU
4X ∅ .177 THRU ALL
⌴ ∅ .313 ↧ .164
4X ∅ .201 ↧ .650
1/4-20 UNC ↧ .500
4X ∅.375↧.510
4X ∅.188↧.125
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±.002
INTERPRET GEOMETRIC
TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
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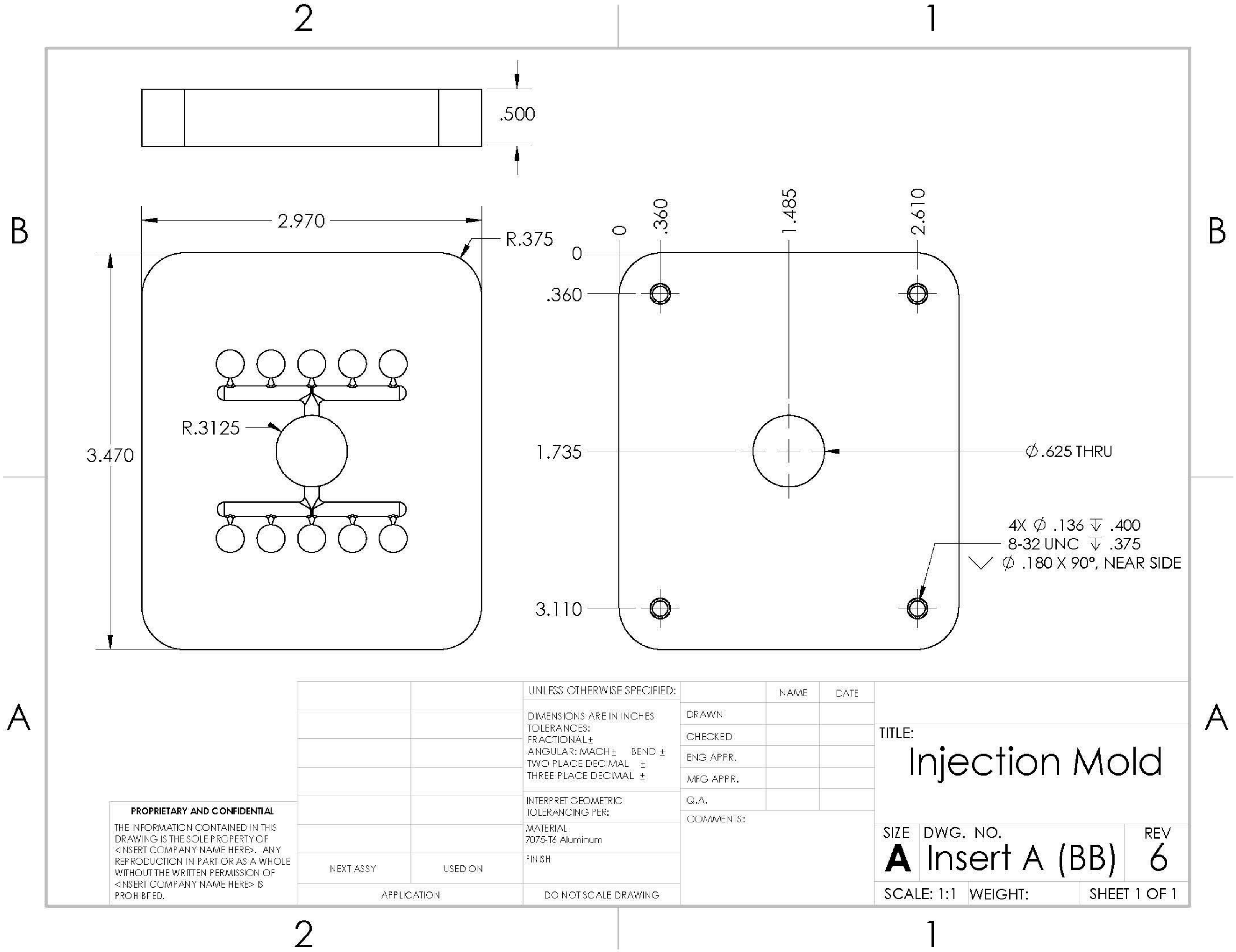
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
TITLE:
Injection Mold
SIZE
A
DWG. NO.
Plate B
REV
2
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1

Figure 12.



2
1
B
A
.500
2.970
R.375
3.470
R.3125
0
.360
1.485
2.610
.360
1.735
3.110
∅.625 THRU
4X ∅ .136 ↧ .400
8-32 UNC ↧ .375
⌵ ∅ .180 X 90°, NEAR SIDE
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
Insert A (BB)
REV
6
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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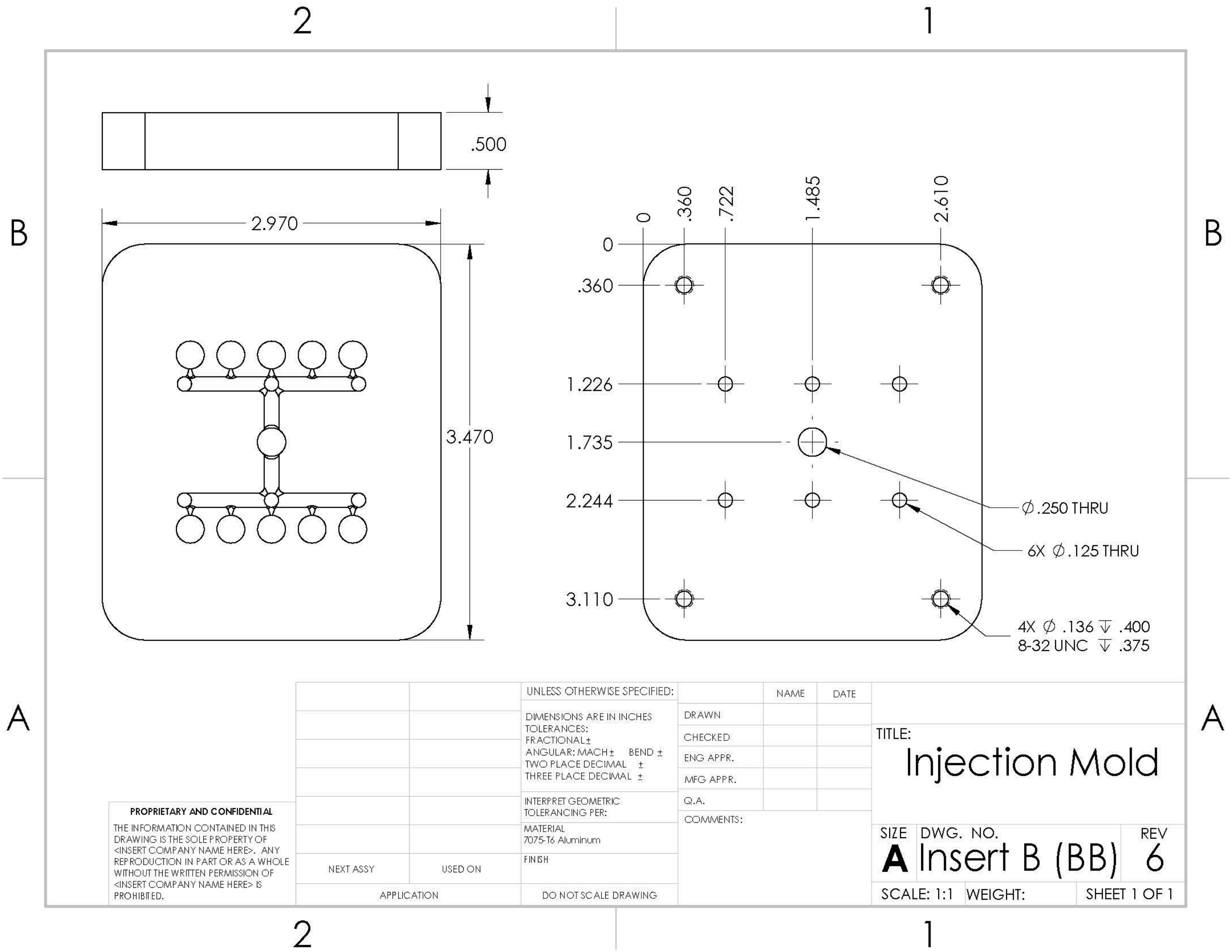
NEXT ASSY
USED ON
APPLICATION

Figure 13.


.500
2.970
3.470
0
.360
.722
1.485
2.610
1.226
1.735
2.244
3.110
∅.250 THRU
6X ∅.125 THRU
4X ∅ .136 ↧ .400
8-32 UNC ↧ .375
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
DWG. NO.
REV
A
Insert B (BB)
6
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING

Figure 14.

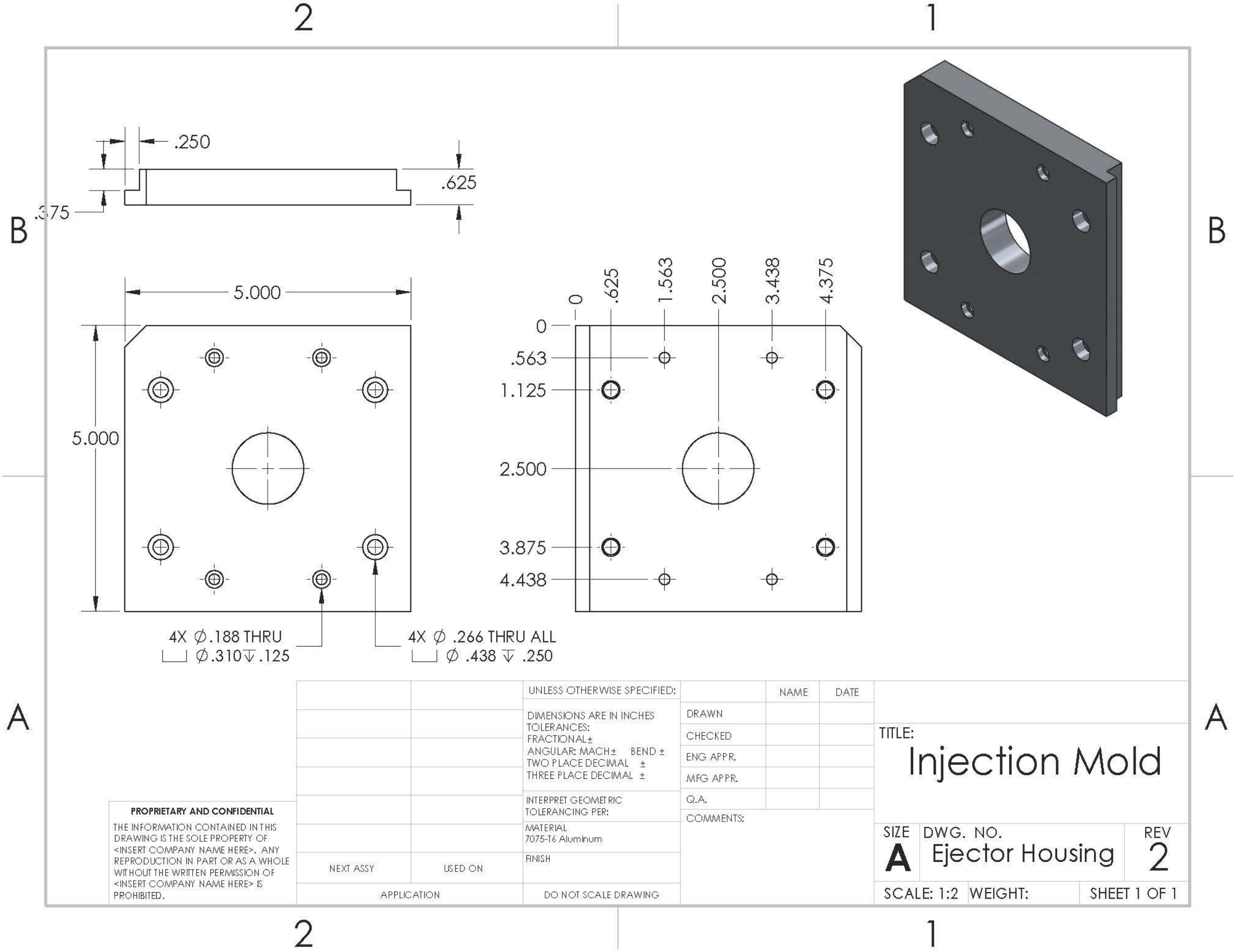
2
1
B
A
.250
.375
.625
5.000
5.000
0
.625
1.563
2.500
3.438
4.375
0
.563
1.125
2.500
3.875
4.438
4X Ø.188 THRU
⌴ Ø.310 ↧ .125
4X Ø .266 THRU ALL
⌴ Ø .438 ↧ .250
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
Ejector Housing
REV
2
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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Figure 15.

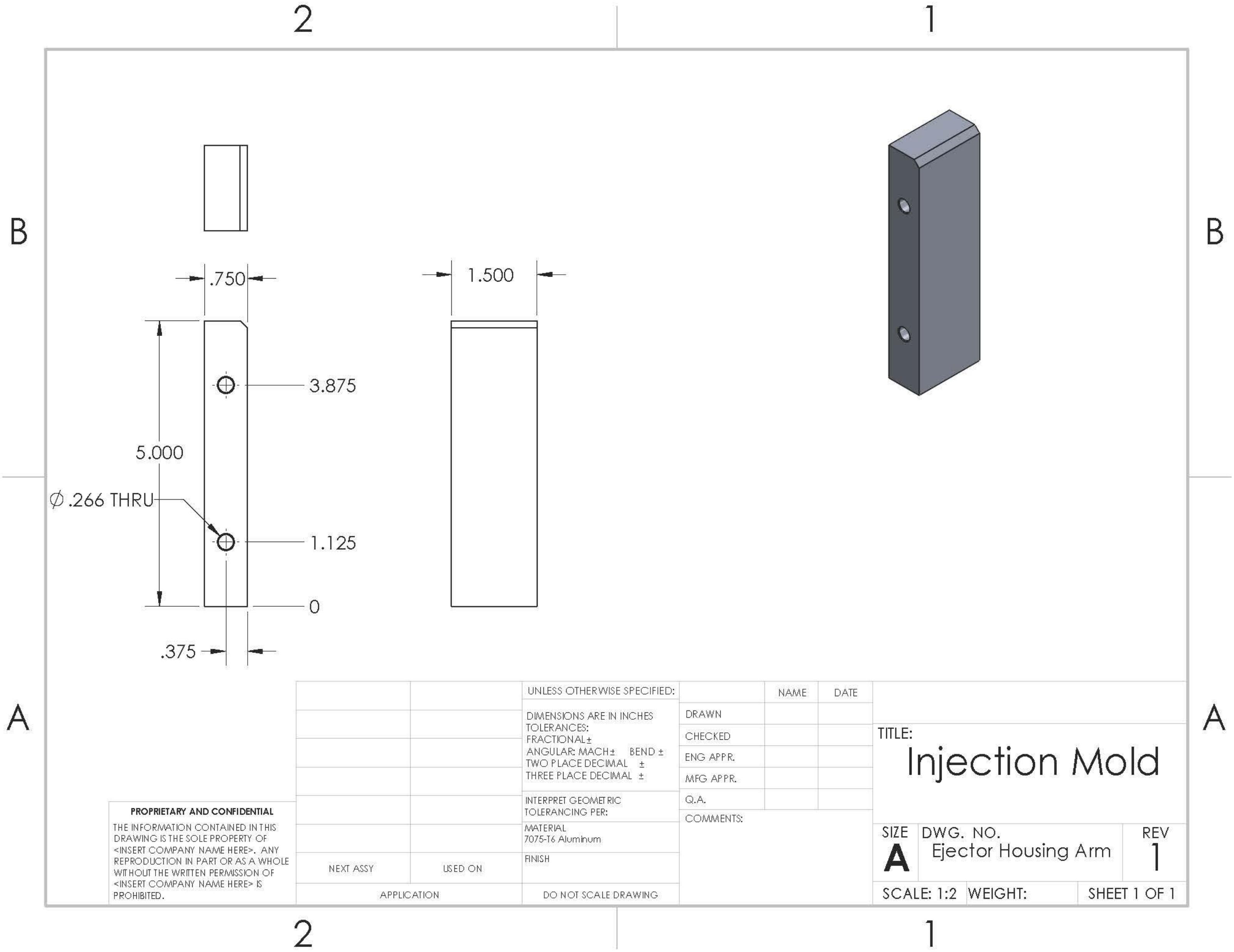
2
1
B
A
.750
1.500
3.875
5.000
∅ .266 THRU
1.125
0
.375
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC
TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
Ejector Housing Arm
REV
1
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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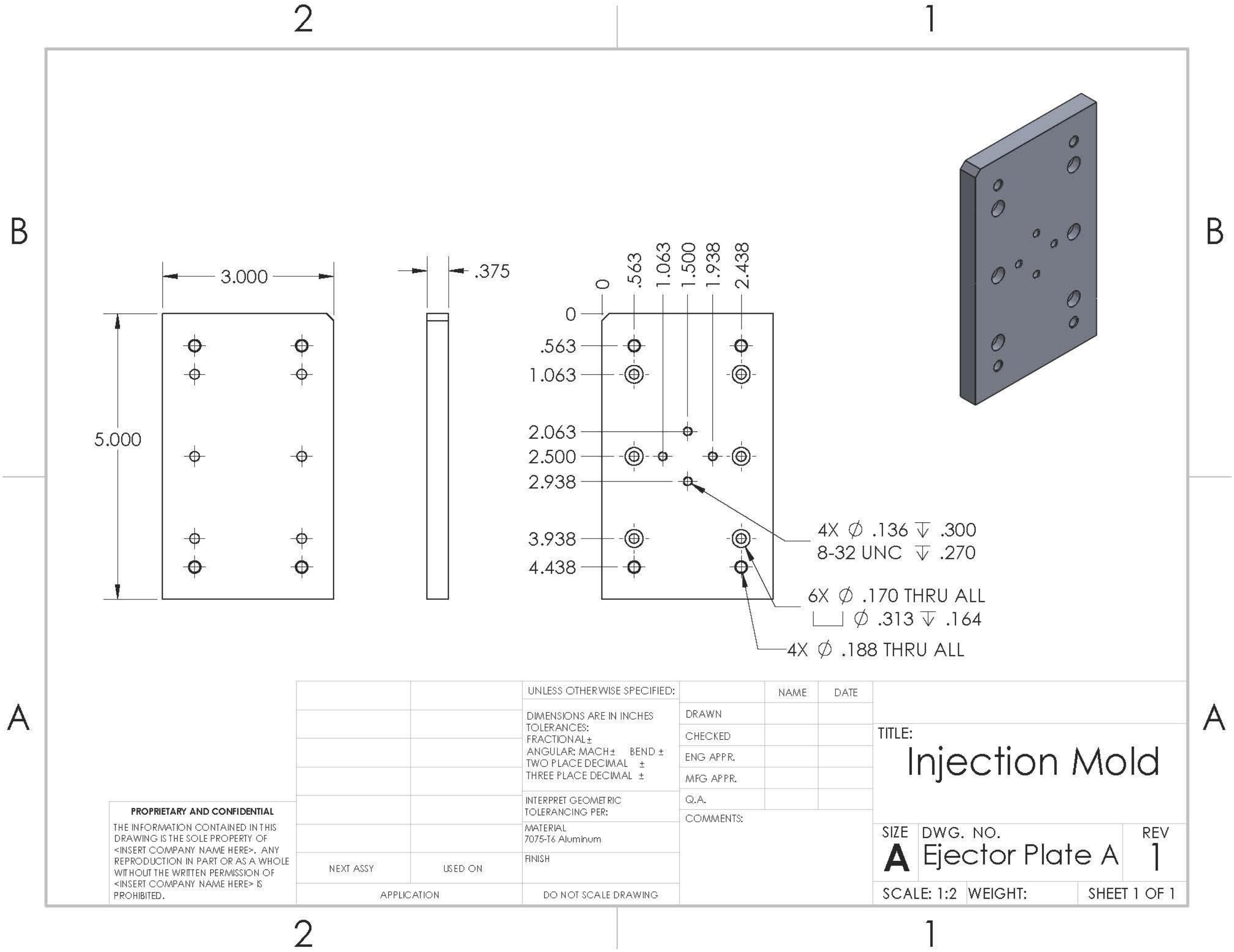
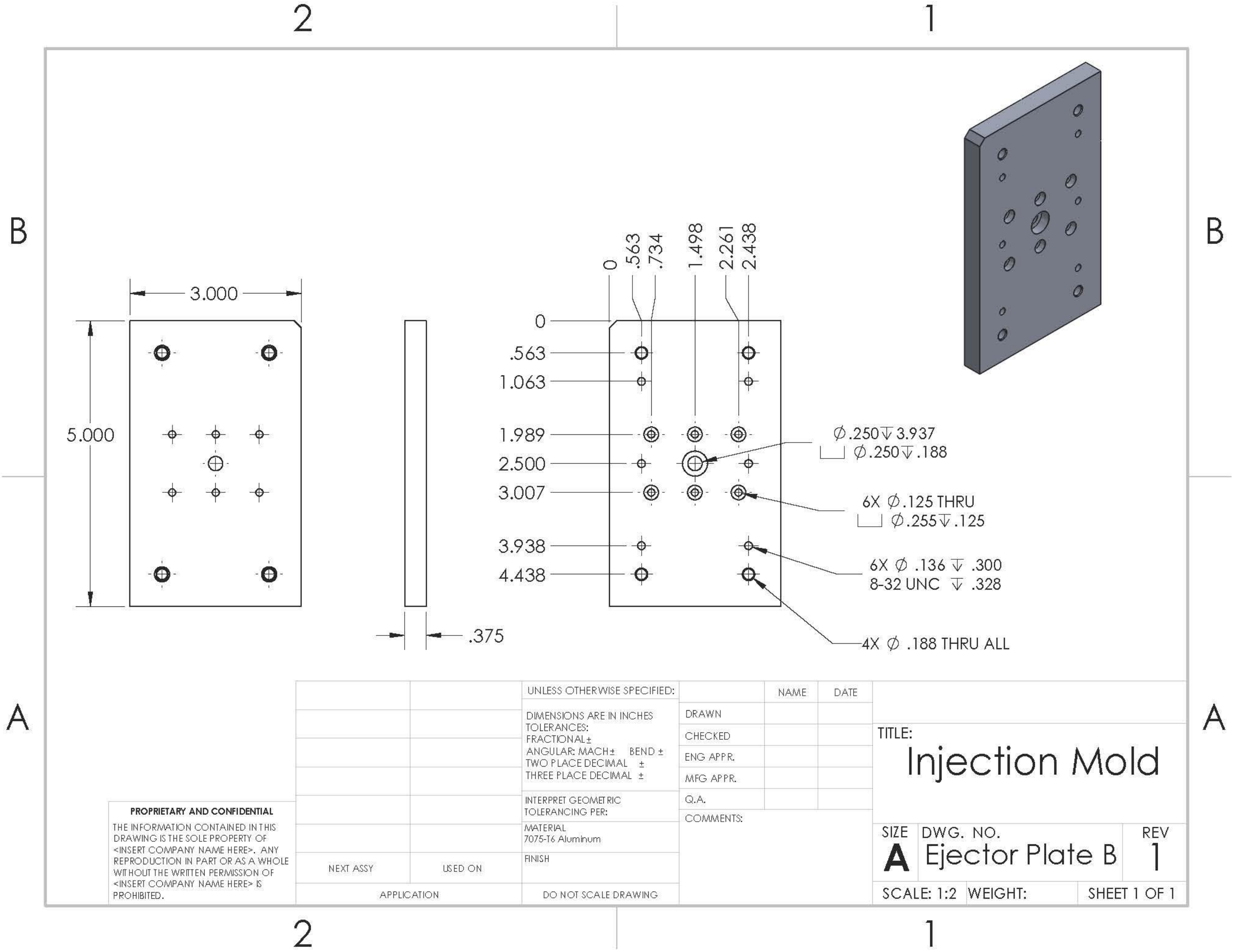
Figure 16.



2
1
B
A
3.000
5.000
.375
0
.563
1.063
1.500
1.938
2.438
0
.563
1.063
2.063
2.500
2.938
3.938
4.438
4X ∅ .136 ↧ .300
8-32 UNC ↧ .270
6X ∅ .170 THRU ALL
⌴ ∅ .313 ↧ .164
4X ∅ .188 THRU ALL
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
Ejector Plate A
REV
1
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1

Figure 17.


2
1
B
A
3.000
5.000
.375
0
.563
.734
1.498
2.261
2.438
0
.563
1.063
1.989
2.500
3.007
3.938
4.438
⌀.250↧3.937
⌴ ⌀.250↧.188
6X ⌀.125 THRU
⌴ ⌀.255↧.125
6X ⌀ .136 ↧ .300
8-32 UNC ↧ .328
4X ⌀ .188 THRU ALL
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
PROPRIETARY AND CONFIDENTIAL
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TITLE:
Injection Mold
SIZE
A
DWG. NO.
Ejector Plate B
REV
1
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1

Figure 18.

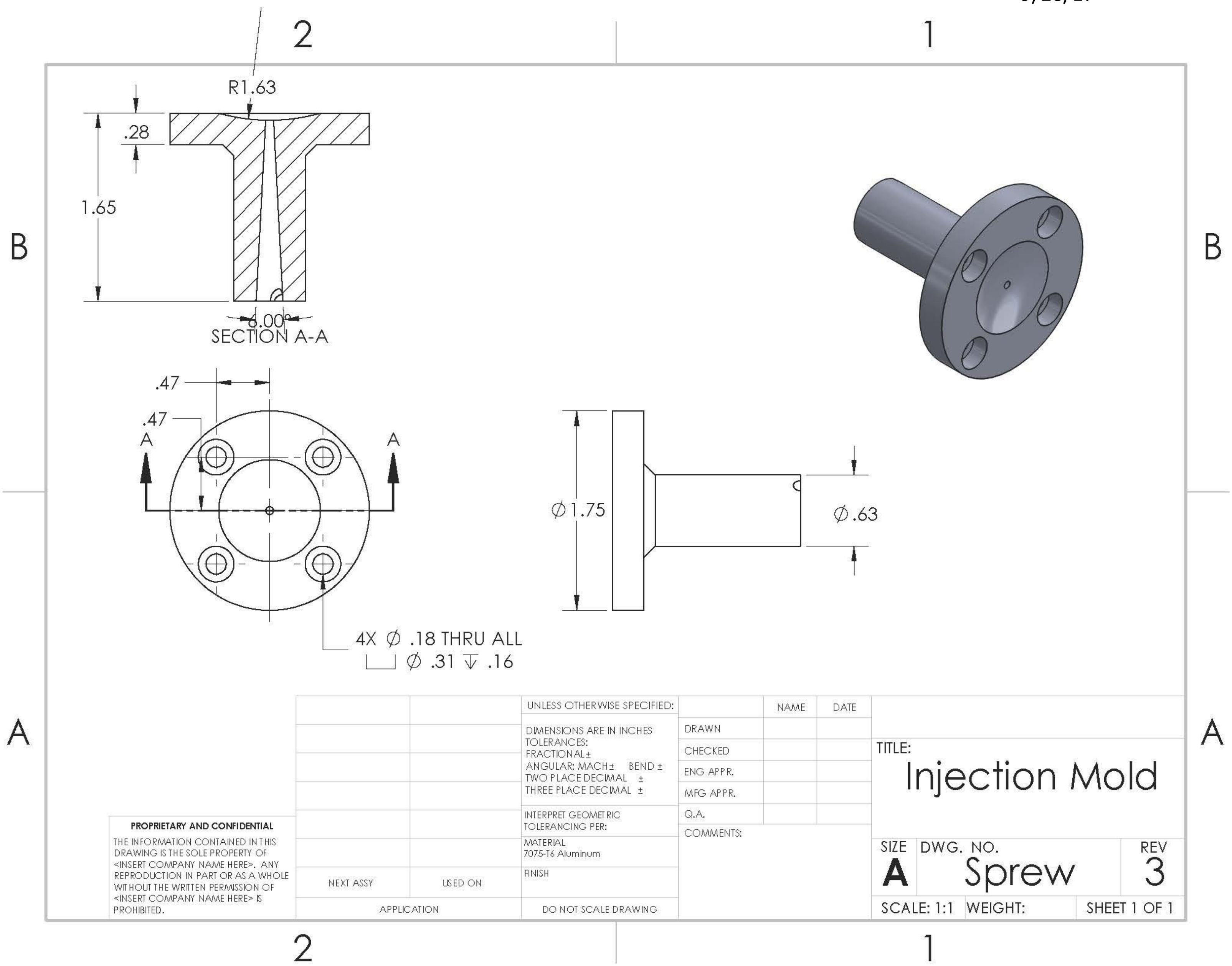
R1.63
.28
1.65
6.00°
SECTION A-A
.47
.47
A
A
Ø1.75
Ø.63
4X Ø .18 THRU ALL
Ø .31 ↧ .16
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
Sprew
REV
3
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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Figure 19.

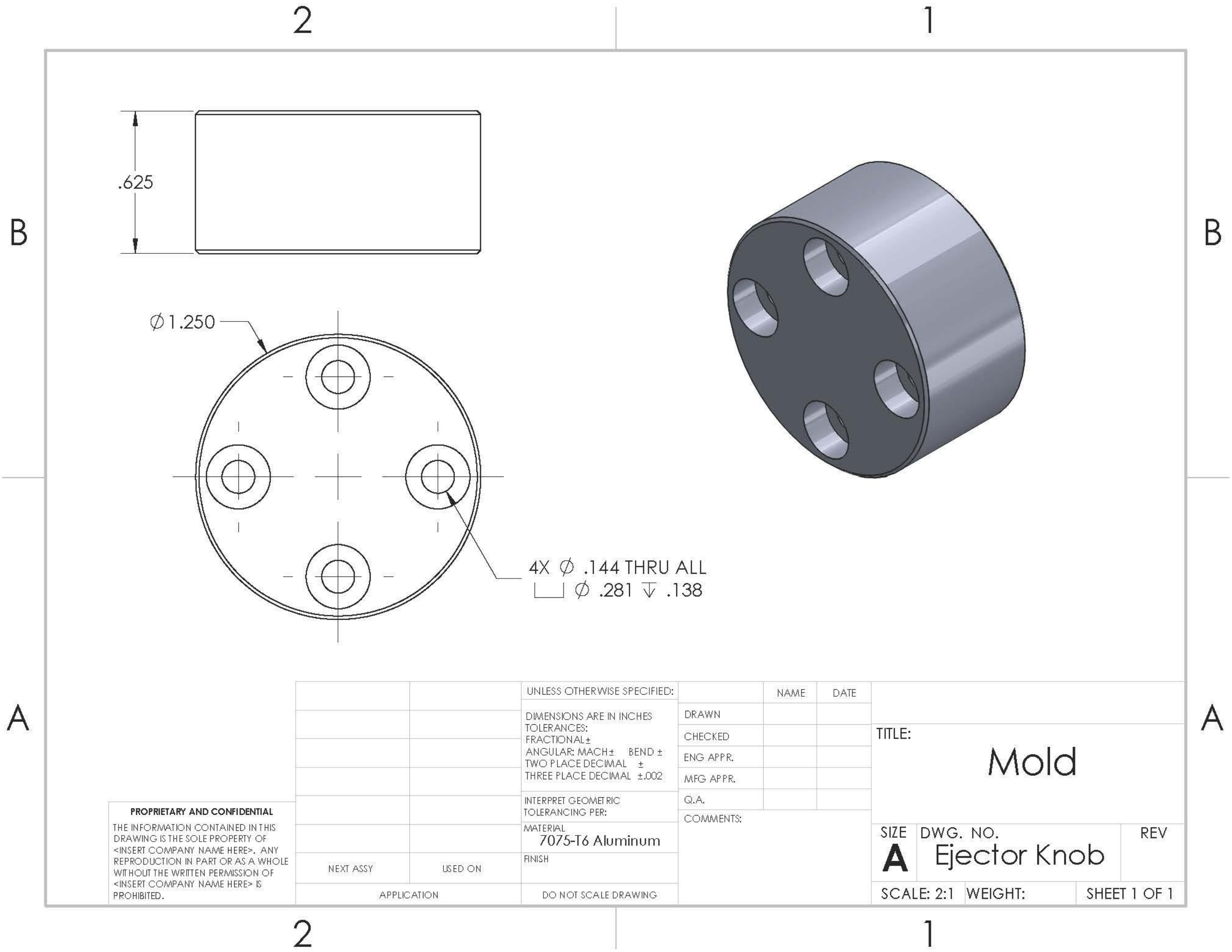
.625
Ø1.250
4X Ø .144 THRU ALL
⌴ Ø .281 ↧ .138
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±.002
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Mold
SIZE
A
DWG. NO.
Ejector Knob
REV
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
NEXT ASSY
USED ON
APPLICATION
PROPRIETARY AND CONFIDENTIAL
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Figure 20.

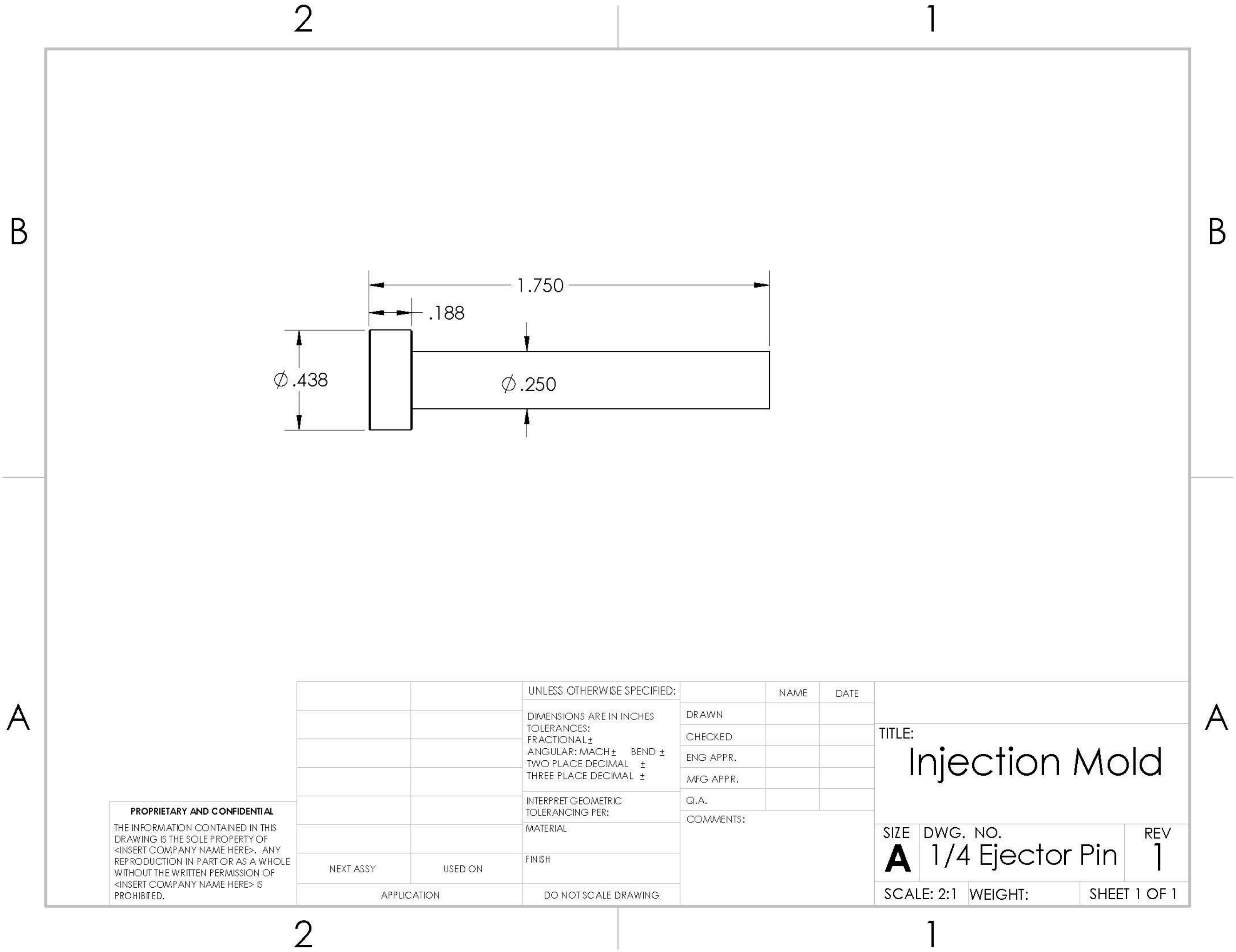
1.750
.188
∅.438
∅.250
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
1/4 Ejector Pin
REV
1
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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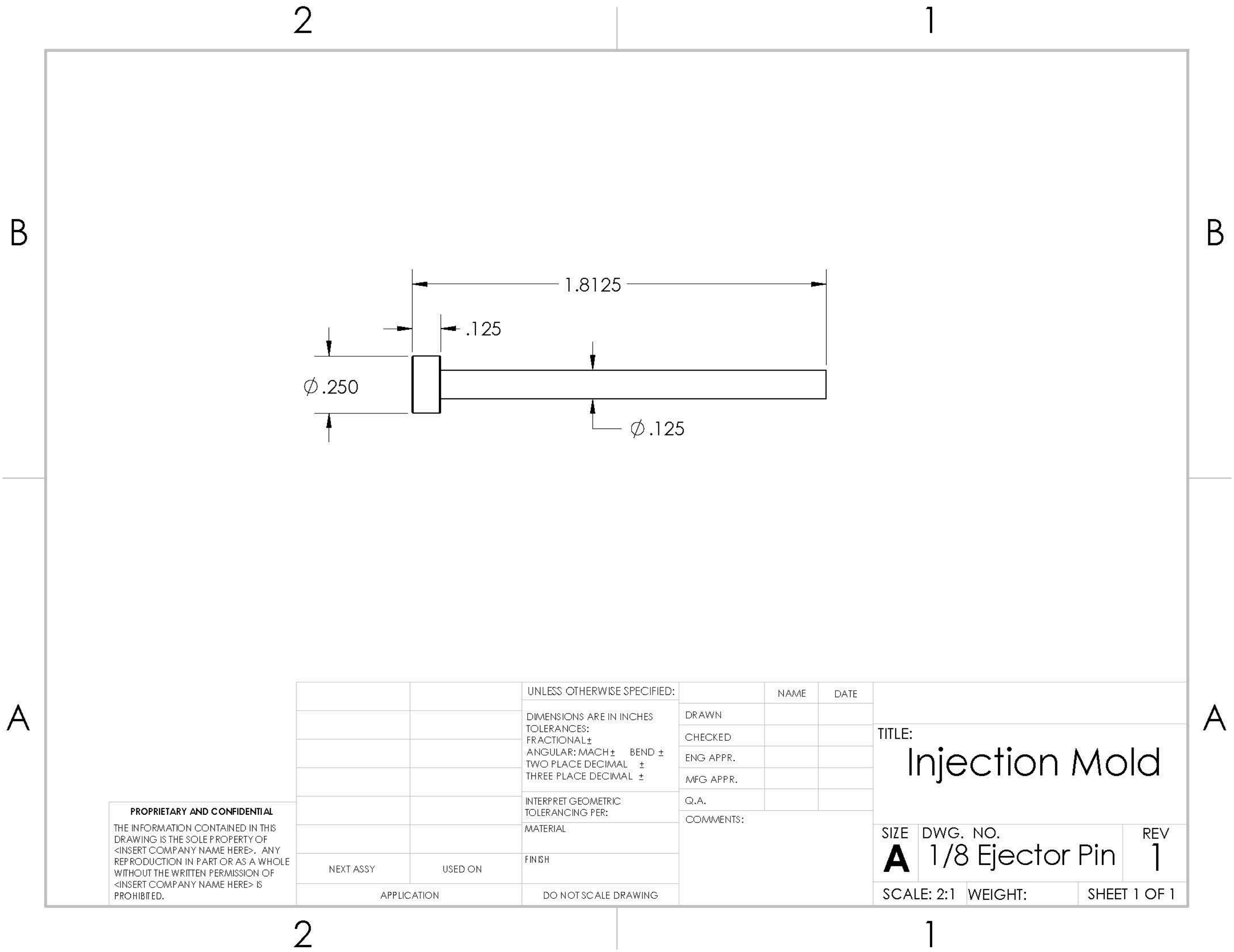
Figure 21.


2
1
B
B
1.8125
.125
∅.250
∅.125
A
A
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
INTERPRET GEOMETRIC
TOLERANCING PER:
MATERIAL
FINISH
TITLE:
Injection Mold
PROPRIETARY AND CONFIDENTIAL
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NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
SIZE
A
DWG. NO.
1/8 Ejector Pin
REV
1
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1
2
1

Figure 22.

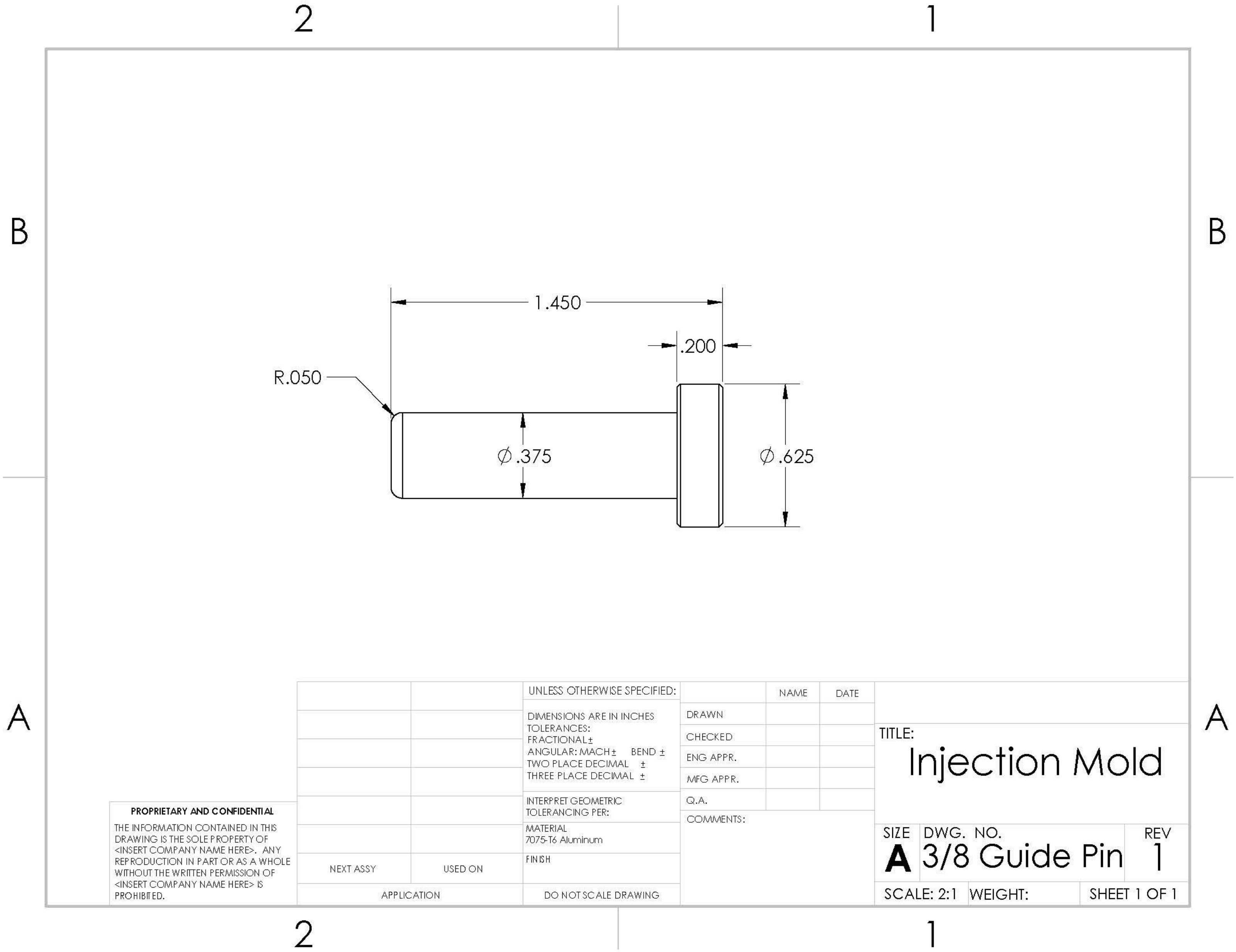
2
1
B
A
1.450
.200
R.050
∅.375
∅.625
UNLESS OTHERWISE SPECIFIED:
NAME
DATE
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.
TITLE:
Injection Mold
SIZE
A
DWG. NO.
3/8 Guide Pin
REV
1
SCALE: 2:1
WEIGHT:
SHEET 1 OF 1

Figure 23.

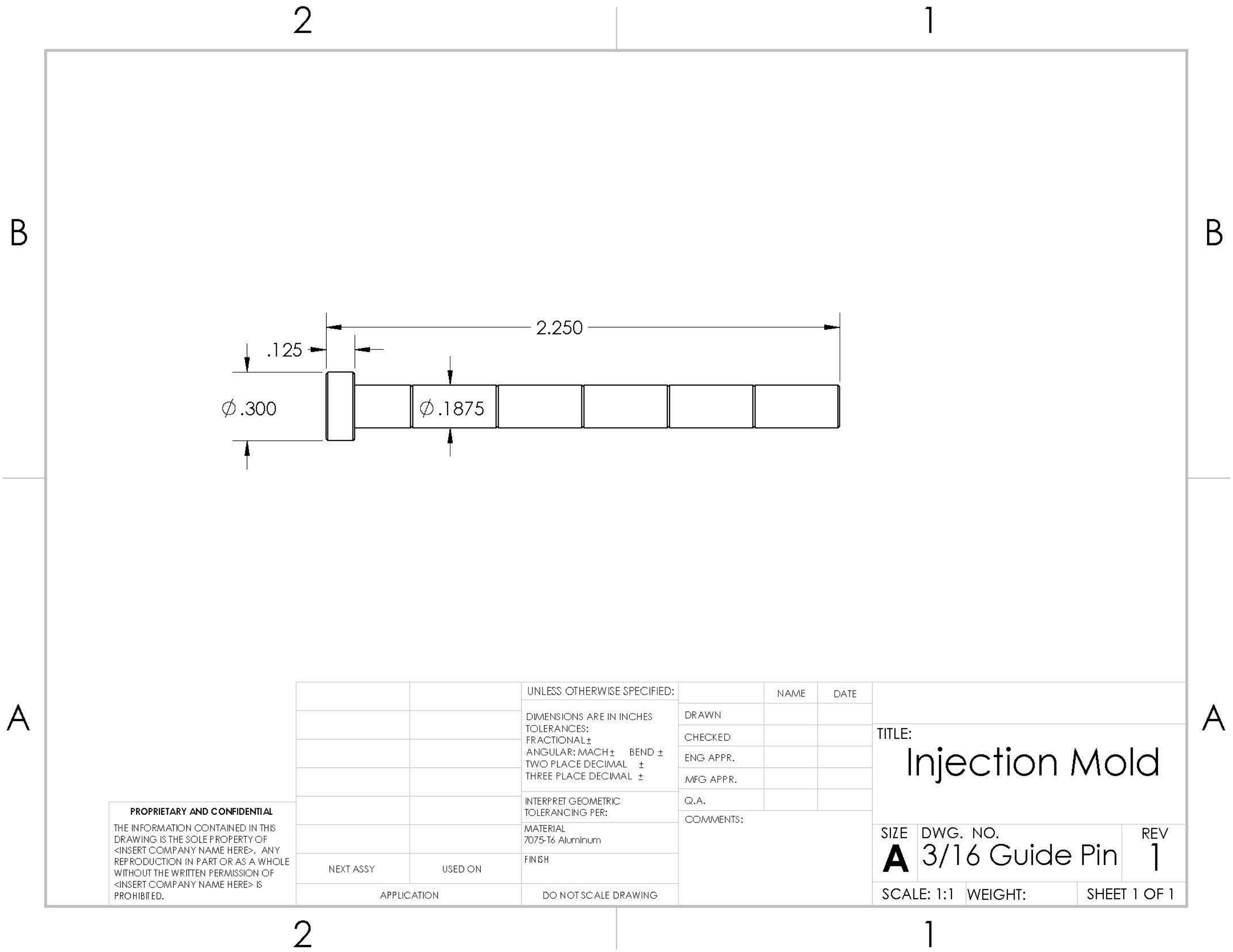
2
1
B
B
A
A
2
1
2.250
.125
Ø.300
Ø.1875
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL±
ANGULAR: MACH± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
7075-T6 Aluminum
FINISH
DO NOT SCALE DRAWING
NEXT ASSY
USED ON
APPLICATION
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
TITLE:
Injection Mold
SIZE
A
DWG. NO.
3/16 Guide Pin
REV
1
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL
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Figure 24.

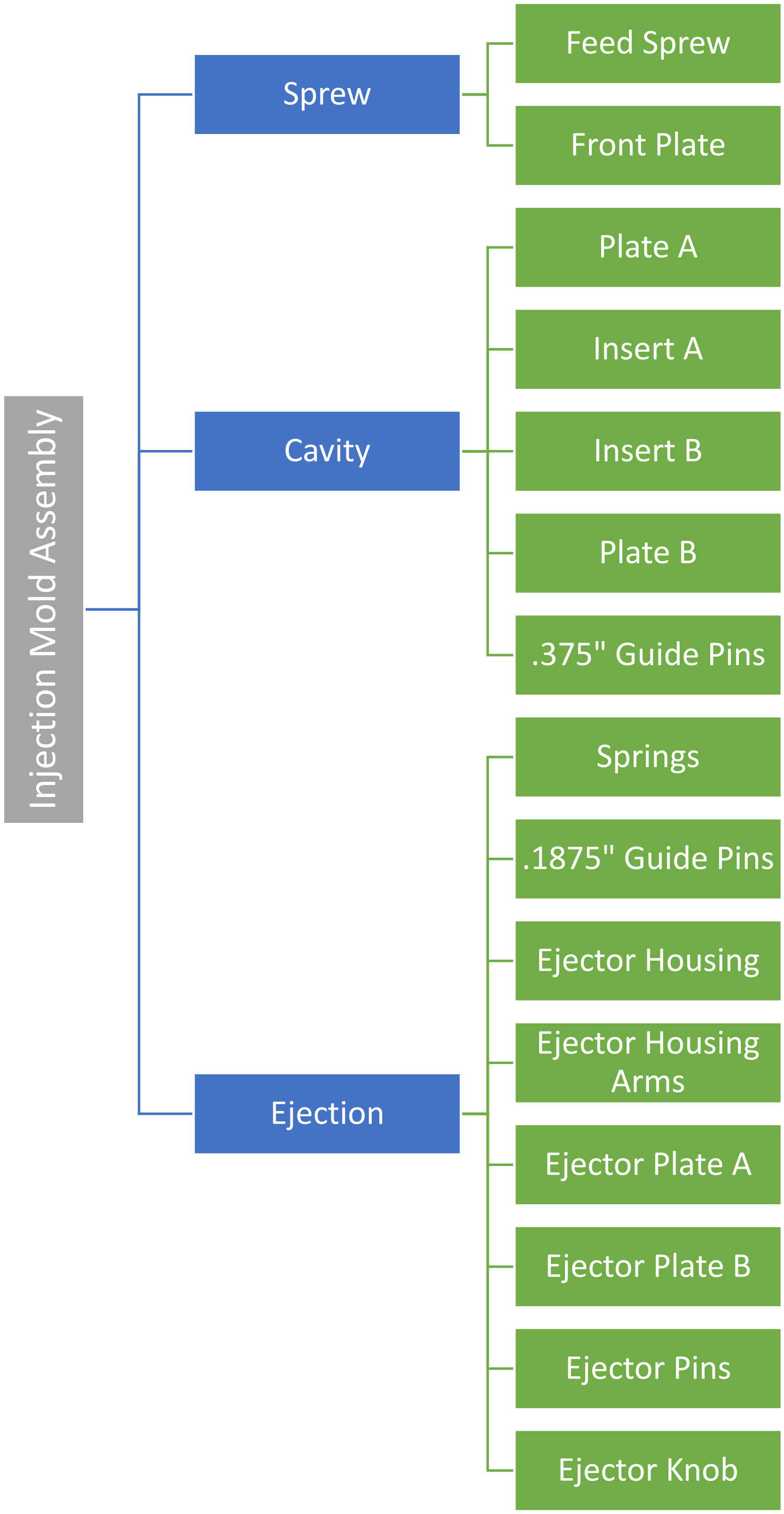
Injection Mold Assembly
Sprew
Cavity
Ejection
Feed Sprew
Front Plate
Plate A
Insert A
Insert B
Plate B
.375" Guide Pins
Springs
.1875" Guide Pins
Ejector Housing
Ejector Housing Arms
Ejector Plate A
Ejector Plate B
Ejector Pins
Ejector Knob

Figure 25.

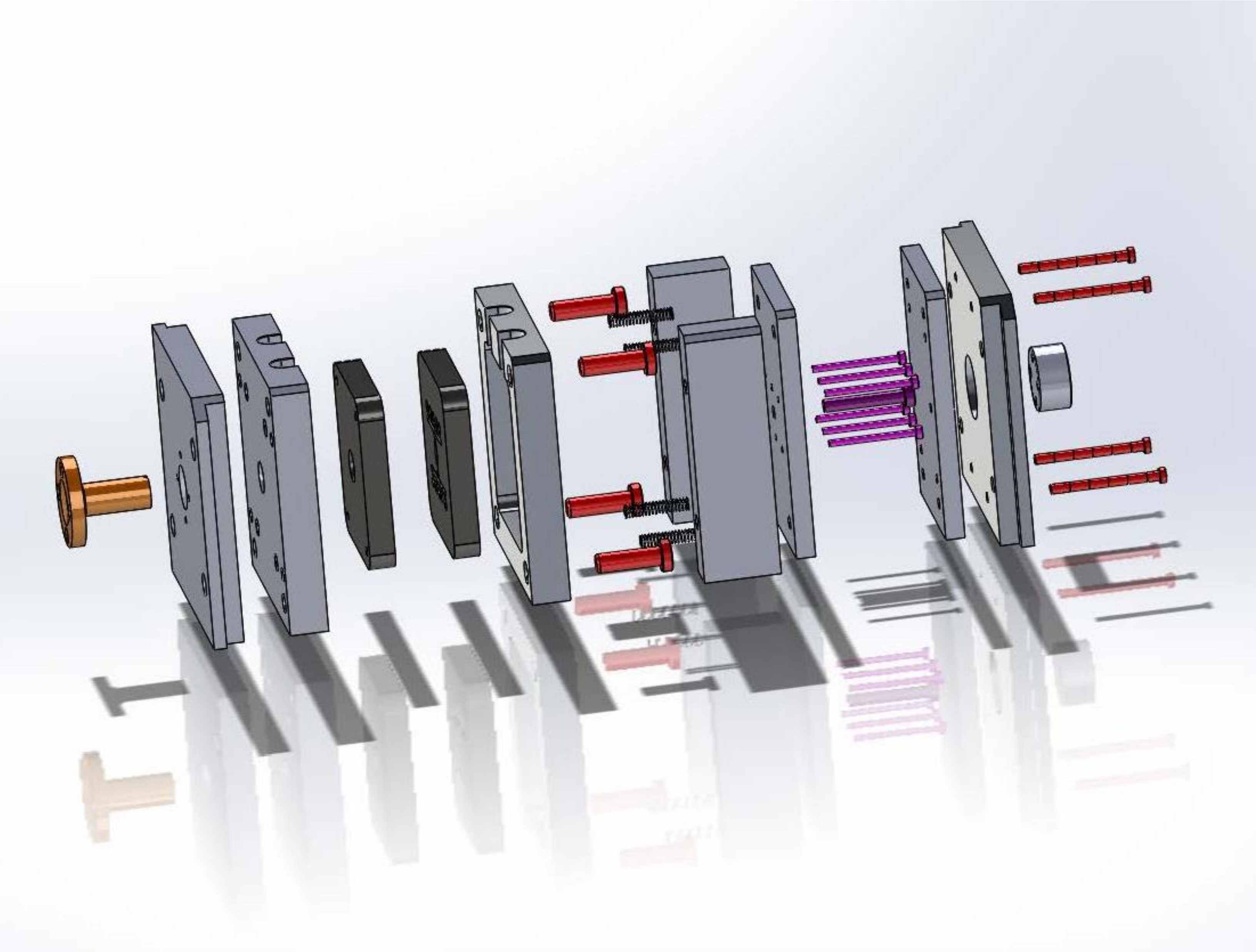

Figure 26.

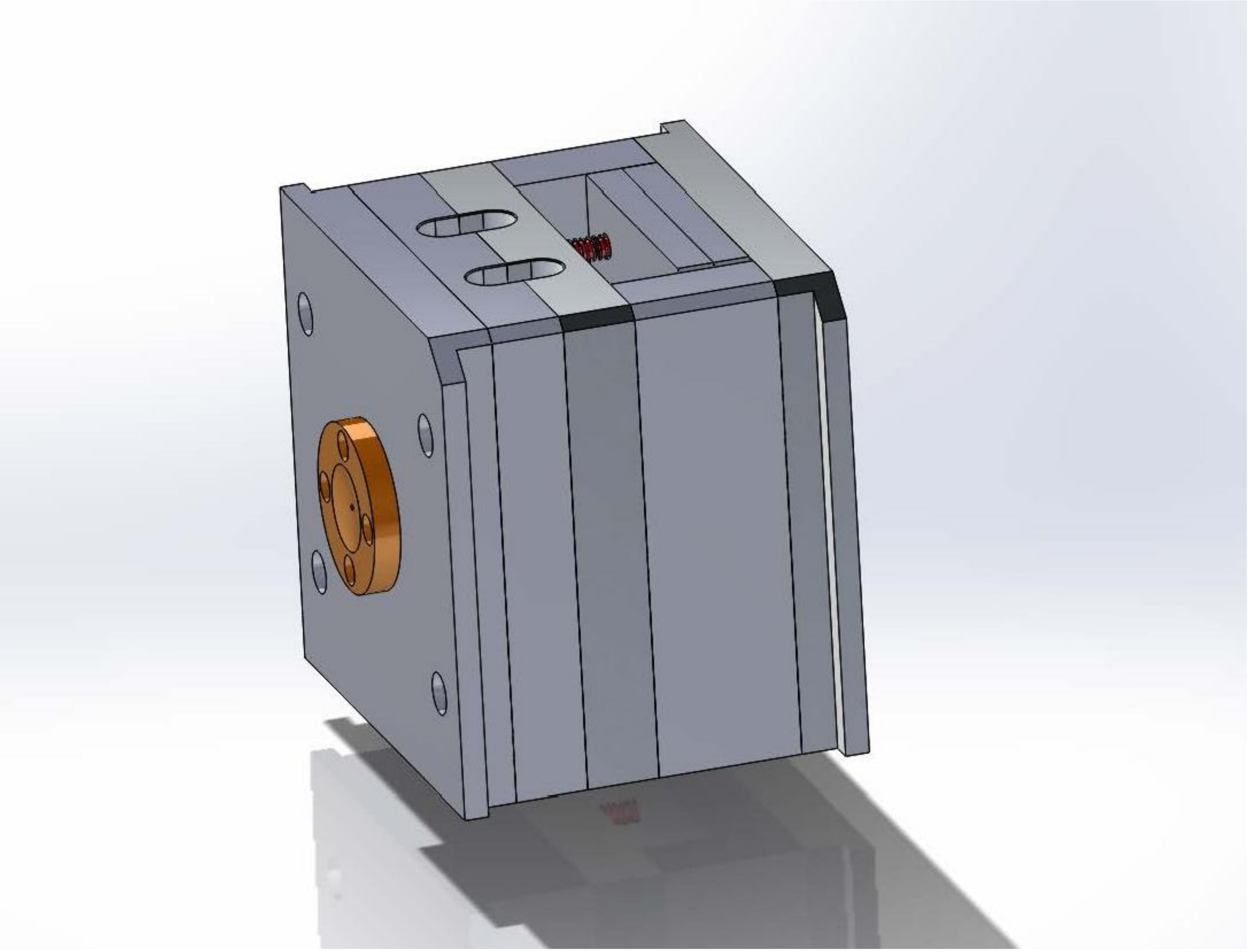

Figure 27.

Appendix C – Parts List

Part List	
Part Name	**Quantity**
Face Plate	1
Plate A	1
Plate B	1
Ejector Housing	1
Ejector Plate 1	1
Ejector Plate 2	1
Sprew	1
Ejector Knob	1
Insert 1	1
Insert 2	1
Spring	4
Ejector Pin 1/4”	1
Ejector Pin 1/8”	6
Guide Pin 3/8”	4
Guide Pin 3/16”	4

Appendix D – Budget

Item #	Item Description	Item Source	Size	Model/Part #	Price	Quantity	Total Est. Cost	Total Act. Cost	Notes
1	Spring	McMaster-Carr	1.25"	9657K112	$6.80	1	$6.80		Pack of 12
2	1/4" Ejector Pin	McMaster-Carr	3/16"	93772A118	$4.48	1	$4.48		
3	1/8" Ejector Pin	McMaster-Carr	5/32"	93772A112	$3.51	6	$21.06		
4	7075 Aluminum Bar Stock	McMaster-Carr	1"x6"x24"	8885K943	$265.99	1	$265.99		
5	7075 Aluminum Bar Stock	McMaster-Carr	.75"x6"x6"	8885k931	$72.52	2	$145.04		
6	7075 Aluminum Bar Stock	McMaster-Carr	.5"x6"x6"	8885K921	$41.67	2	$83.34		
7	7075 Aluminum Round Stock	McMaster-Carr	1.75"x6"	90465K17	$24.75	1	$24.75		
8	3/16" Pin	McMaster-Carr	3/16"	93772a115	$3.83	4	$15.32		
9	3/8" Pin	McMaster-Carr	3/8"	93772a124	$7.36	4	$29.44		
				Total Price			$596.22		

Appendix E – Schedule

Plastic Injection Mold

Ryan Heaton

Task:	ACTIVITY	PLAN DURATION (hours)	ACTUAL DURATION (hours)	% COMPLETE	PERIODS									
					Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June
1	Proposal													
1.1	Outline	1	1	100%										
1.2	Intro	1	1	100%										
1.3	Design & Analysis	1	1	100%										
1.4	Methods & Construction	1	1	100%										
1.5	Testing Method	1	1	100%										
1.6	Parts and Budget	1	1.5	100%										
1.7	Gantt Schedule	1	4	100%										
1.8	Discussion	1	1	100%										
1.9	Conclusion	1	1	100%										
1.10	Appendix	1	1	100%										
2	Design and Drawing													
2.1	Front Plate Design	1	1	100%										
2.2	Front Plate Drawing	1	1.5	100%										
2.3	A Plate Design	1	2.5	100%										
2.4	A Plate Drawing	1	1	100%										
2.5	B Plate Design	1	2.5	100%										
2.6	B Plate Drawing	1	1	100%										
2.7	Ejector Housing Design	1	1	100%										
2.8	Ejector Housing Drawing	1	1.5	100%										
2.9	Ejector Plates 1 & 2 Design	1	1	100%										
2.1	Ejector Plates 1 & 2 Drawing	1	1	100%										
2.1.1	Ejector Knob Design	1	1	100%										
2.1.2	Ejector Knob Drawing	1	0.5	100%										
2.1.3	Sprew Bushing Design	1	2	100%										
2.1.4	Sprew Bushing Drawing	1	0.5	100%										
2.1.5	Insert A Design	1	9.5	100%										
2.1.6	Insert A Drawing	1	0.5	100%										
2.1.7	Insert B Design	1	9.5	100%										
2.1.8	Insert B Drawing	1	0.5	100%										
3	Construction													
3.1	Aquire Materials	1	2	100%										
3.1.1	Rough Cut	1	26.1	95%										
3.2	Machine Setup - Front Plate	0.25	0.2	100%										

3.2.0.5	Make Toolpath	1	1.2	100%											
3.2.1	Contour Edges	0.2	1	100%											
3.2.2	Surface Faces	0.2	1	100%											
3.2.3	Run CNC Program	0.5	0.2	100%											
3.2.4	Drill/Tap Holes	0.1	0.2	100%											
3.2.5	Mill Clamp Slots	0.5	0.5	100%											
3.3	**Machine Setup - A Plate**	0.25	0.2	100%											
3.3.0.5	Make Toolpath	1	1.5	100%											
3.3.1	Contour Edges	0.2	1.5	100%											
3.3.2	Surface Faces	0.1	1	100%											
3.3.3	Run CNC Program	0.5	0.7	100%											
3.3.4	Drill/Tap Holes	0.2	0.5	100%											
3.3.5	Ream Guide Holes	0.1	0.5	100%											
3.3.6	Cut/fit Pins	0.2	6	100%											
3.4	**Machine Setup - B Plate**	0.25	0.2	100%											
3.3.0.5	Make Toolpath	1	1.5	100%											
3.4.1	Contour Edges	0.17	1.5	100%											
3.4.2	Surface Faces	0.17	1	100%											
3.4.3	Run CNC Program	0.17	0.7	100%											
3.4.4	Drill/Tap Holes	0.08	0.5	100%											
3.4.5	Ream Guide Holes	0.25	1.5	100%											
3.5	**Machine Setup - Ejector Housing**	0.25	0.2	100%											
3.5.0.5	Make Toolpath	1	0.5	100%											
3.5.1	Contour Edges	0.33	1.5	100%											
3.5.2	Drill Holes	0.17	0.5	100%											
3.5.3	Tap Holes	0.17	0.5	100%											
3.5.4	Ream Guide Pin Holes	0.08	1.5	100%											
3.5.5	Mill Ejector Plate Area/Clamp Slots	0.33	2	100%											
3.5.6	Finish Faces	0.5	1	100%											
3.5.7	Cut/Fit Pins	0.2	3	100%											
3.6	**Ejector Plates A&B**	0.25	0.4	100%											
3.6.0.5	Make Toolpath	1	1.5	100%											
3.6.1	Contour Edges	0.17	2	100%											
3.6.2	Drill Holes	0.17	2	100%											
3.6.3	Tap Holes	0.17	0.5	100%											
3.6.4	Ream Ejector Pin/Guide Pin Holes	0.08	3.5	100%											
3.6.5	Finish Faces	0.5	1	100%											
3.7	**Machine Setup - Sprew**	0.25	0.5	100%											
3.7.1	Turn Sprew on Lathe	2	2.5	100%											
3.7.2	Finish Faces	0.5	3	100%											
3.8	**Machine Setup - Ejector Knob**	0.33	0	100%											

3.8.0.5	Make Toolpath	1	0	100%
3.8.1	Turn on Lathe	0.5	0	100%
3.8.2	Drill holes	0.08	0	100%
3.9	**Machine Setup - Insert A & B**	0.25	0.5	100%
3.9.0.5	Make Toolpath	1	3	100%
3.9.1	Contour Edges	0.33	0.2	100%
3.9.2	Drill Holes	0.17	0.2	100%
3.9.3	Ream Holes	0.17	0.5	100%
3.9.4	Tap Holes	0.17	0.5	100%
3.9.5	Finish Faces	1	0.5	100%
3.9.6	Mill Cavity	2	2	100%
3.10	**Assembly, Fitment, Production Tests**	10	16	100%
4	**Deliverables**			
4.1	**Report Guide**	1	1	100%
4.2	**Report Outline**	1	2	100%
4.3	**Write Report**	1	14.5	100%
4.4	**Slide Outline**	1	1	100%
4.5	**Create Presentation**	1	1	100%
4.6	**Update Website**	1	12	100%

	Estimated	Actual
Total Time Required (hours)	68.51	185.2

Completed Part	
Completed Mold	

Key

Complete
Started
Planned

Appendix F – Expertise and Resources

Spring-
https://www.mcmaster.com/#9657k112/=19vrwec
3/16" Ejector Pin-
https://www.mcmaster.com/#93772a115/=19ze2aq
5/32" Ejector Pin-
https://www.mcmaster.com/#93772a114/=19ze4zm
7075 Aluminum Bar Stock 1x6x24
https://www.mcmaster.com/#8885k943/=19zeft0
7075 Aluminum Bar Stock .5x6x6
https://www.mcmaster.com/#8885k921/=19zeidc
7075 Aluminum Round Stock 1.75x6
https://www.mcmaster.com/#90465k17/=19zez3d

References

https://www.moldmakingtechnology.com/careers/choosing-the-right-aluminum-alloy-for-production-injection-molds

https://www.moldmakingtechnology.com/articles/why-offer-aluminum-molds-for-production

Mott, R. (2014). Machine elements in mechanical design (5th ed.). Upper Saddle River, N.J.: Pearson/Prentice Hall.

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Appendix G – Testing Report

Plastic Injection Molding Test

The purpose of this test is to see how the mold performs and how well it produces parts when injected with molten plastic.

- Requirements,
    - Can be operated by one person.
    - Must be able to produce 25 acceptable parts in succession without failing.
    - Flash can be no longer than 0.025”.
    - Insert must fit with a tolerance of 0.005”.
    - Project cost cannot exceed $1000.
    - Cannot exceed 50lbs.
    - Moving parts cannot jam or bind during operation.
- parameters of interest,
- The mold should be able to produce quality parts and the moving parts for the mold should not jam in any way.
- Data will be recorded on the Data Sheet in the appendix of this document.
    - Recording for test number, # of parts, # of good/bad parts, and any additional notes.

Method/Approach:

- The resources required for this test are the mold, the Morgan plastic injection press, and the ABS plastic shot material.
- Data will be recorded on the testing sheet (provided in the appendix of this report)
    - Data will include number of tests, number of good/bad parts, any extra notes, number of flash or burn marks.
- For this test the mold will be centered into the press, the press will be loaded with material, and the press will inject the plastic into the mold. Once the plastic has cooled enough to keep its shape the mold will be opened and the part will be removed and inspected while the mold is reinserted into the press to be used again.
- The mold was designed to be used in a horizontal injection press that is meant for mass production. Sadly the horizontal press we have at CWU cannot be used. So instead, the mold will be used in a vertical press that is more suited for one-offs. That being said, cycle time will be much longer than it should be.
- The test will be done many times to ensure accuracy within the data. The mold was designed for mass production so it should be able to produce a number of parts without problems.
- With the gathered data we can determine how well the mold works while performing the job it was designed for. Any burn marks will indicate that the plastic is getting too hot, and any flash shows that the mold is either not seating together properly or the injection pressure is too high.
- The data presentation will involve a table showing the tests, number of good/bad parts, and any changes made in order to increase the number of good parts.

Test Procedure:

- The testing procedure for this project starts with mounting the mold in the press. Once mounted the press is started and a few warm up shots are done to fine tune the proper temperature, pressure, and shot size that's needed to produce quality parts. Then the official production of parts is started and both of the acceptable and defective parts will be counted.
- Testing will commence on 5/3/18 at 4pm in the CWU metallurgy lab.
- Material: ABS Plastic
- Specific actions to complete the test:
    - Mount mold in press so that the sprew is concentric with the injector. There is a small guide pin on the bottom mount of the press. If the pin is aligned in the mold the sprew will be concentric.
    - Load the press with ABS shot material.
    - Set the press to the recommended temperature, clamping load, and injection pressure for the ABS shot material.
    - Inject the mold with plastic.
    - Remove the mold from the machine.
    - Open mold and remove the part.
    - Record any defects in the part.
        - If there are burn marks, decrease temperature.
        - If there are voids increase the pressure, if there is flash decrease the pressure or increase clamping load.
    - Reinsert the mold into the press and start again from step 4.
    - Record data: cycle time, # of good parts, # of bad parts, flash, burns, voids, extra notes.
- The press will be running at around 500 degrees F so make sure you know where the hot areas are and where hot gloves. We're working with pressurized molten plastic so wear safety glasses.
- This mold will not be using water to cool the mold down so the cycle times will be long. We also do not have access to the manual for the injection press so setup and adjusting the pressure, temp, shot size, and cycle time will be more difficult. Though after adjusting for the first time the settings will be recorded so we won't have to adjust it all over again.

Deliverables:

- The requirements will be reviewed to see if the mold has passed the tests.
    - The mold has already passed requirements 4-7.
- For this test to be a success the mold will be able to produce 25 parts in a row without voids or burn marks. Any flash should be less than .025". And the mold should be able to be operated by one person.

Appendix H – Testing Data

#	P clamp (tons)	P injector (psi)	Temp. barrel (F)	Temp. nozzle (F)	Timer setting		Pass/Fail	Notes:
1	7	70	600	600	0	0	BAD	Voids
2	7	80	600	600	0	0	BAD	Voids
3	7	90	600	600	1	0	BAD	Voids
4	8	100	600	600	2	0	BAD	Flash
5	9	100	600	600	2	0	BAD	Flash
6	10	100	600	600	1.5	0	BAD	Flash
7	11	100	600	600	1	0	BAD	Flash
8	12	100	600	600	0.8	0	BAD	Voids
9	12	100	600	600	1	0	BAD	Flash
10	12	95	600	600	1	0	BAD	Flash
11	12	90	600	600	1	0	BAD	Flash
12	12	90	550	550	1	0	BAD	Flash
13	12	80	550	550	1	0	BAD	Flash
14	12	80	500	500	0.8	0	BAD	Flash & Voids
15	13	70	500	500	0.5	0	BAD	Flash
16	13	70	500	500	0.2	0	BAD	Voids
17	13	70	500	500	0.3	0	BAD	Voids
18	13	60	500	500	1	0	BAD	Flash
19	13	60	450	450	0.5	0	BAD	Voids
20	13	40	450	450	1	0	BAD	Voids
21	13	40	450	450	2	0	BAD	Flash & Voids
22	13	50	450	450	2	0	BAD	Flash & Voids
23	13	55	450	450	1	0	BAD	Voids
24	13	55	500	600	1.2	0	BAD	Voids
25	13	80	500	600	0	0	BAD	small Voids
26	13	90	500	600	0	0	BAD	Flash
27	13	85	500	600	0	0	BAD	Flash
28	13	80	500	600	0	0	BAD	Flash
29	13	75	500	600	0	0	BAD	Flash
30	13	70	500	600	0	0	BAD	Flash
31	13	60	500	600	0	0	BAD	Flash
32	13	60	550	550	0	0	BAD	Voids
33	13	60	550	550	0	0	BAD	Voids
34	13	60	550	550	0	0	BAD	Voids

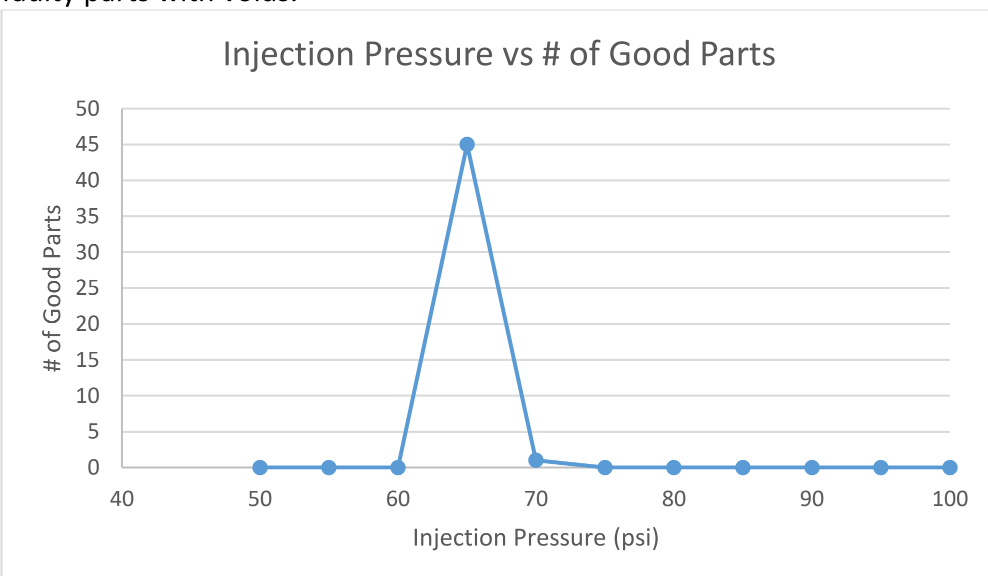
35	13	60	550	550	0	0	BAD	Voids
36	13	70	550	550	0	1	**GOOD!**	
37	13	70	550	550	0	0	BAD	Voids
38	13	70	550	550	0	0	BAD	small Flash
39	13	70	550	550	0	0	BAD	Flash
40	13	65	600	550	0	1	**GOOD!**	
41	13	65	600	550	0	0	BAD	Voids
42	13	65	600	550	0	0	BAD	small Flash
43	13	65	600	550	0	0	BAD	Voids
44	13	65	600	550	0	0	BAD	Voids
45	13	65	600	550	0	0	BAD	small Voids
46	13	65	600	550	0	0	BAD	Voids
47	13	65	600	550	0	0	BAD	Voids
48	13	65	600	550	0	0	BAD	small Flash
49	13	65	600	550	0	1	**GOOD!**	
50	13	65	600	550	0	0	BAD	Voids
51	13	65	625	575	0	0	BAD	Voids
52	13	65	625	575	0	0	BAD	Voids
53	13	65	625	575	0	0	BAD	Voids
54	13	65	625	575	0	1	**GOOD!**	
55	13	65	625	575	0	0	BAD	Voids
56	13	65	625	575	0	0	BAD	Voids
57	13	65	625	575	0	0	BAD	Voids
58	13	65	625	575	0	0	BAD	Voids
59	13	65	625	575	0	0	BAD	Voids
60	13	65	625	575	0	0	BAD	Voids
61	13	65	625	575	0	1	**GOOD!**	
62	13	65	625	575	0	0	BAD	Voids
63	13	65	625	575	0	0	BAD	Voids
64	13	65	625	575	0	0	BAD	Voids
65	13	65	625	575	0	0	BAD	Voids
66	13	65	625	575	0	0	BAD	Voids
67	13	65	625	575	0	0	BAD	Voids
68	13	65	625	575	0	0	BAD	Voids
69	13	65	625	575	0	1	**GOOD!**	
70	13	65	625	575	0	0	BAD	Voids
71	13	65	625	575	0	1	**GOOD!**	
72	13	65	625	575	0	0	BAD	Voids
73	13	65	625	575	0	0	BAD	Flash
74	13	65	625	575	0	1	**GOOD!**	

75	13	65	625	575	0	0	BAD	Flash
76	13	65	625	575	0	1	**GOOD!**	
77	13	65	625	575	0	1	**GOOD!**	
78	13	65	625	575	0	1	**GOOD!**	
79	13	65	625	575	0	0	BAD	Flash
80	13	65	625	575	0	0	BAD	Flash
81	13	65	625	575	0	0	BAD	Flash
82	13	65	625	575	0	0	BAD	Flash
83	13	65	625	575	0	1	**GOOD!**	
84	13	65	625	575	0	1	**GOOD!**	
85	13	65	625	575	0	1	**GOOD!**	
86	13	65	625	575	0	1	**GOOD!**	
87	13	65	625	575	0	0	BAD	Flash
88	13	65	625	575	0	0	BAD	Flash
89	13	65	625	575	0	1	**GOOD!**	
90	13	65	625	575	0	1	**GOOD!**	
91	13	65	625	575	0	1	**GOOD!**	
92	13	65	625	575	0	1	**GOOD!**	
93	13	65	625	575	0	1	**GOOD!**	
94	13	65	625	575	0	1	**GOOD!**	
95	13	65	625	575	0	1	**GOOD!**	
96	13	65	625	575	0	1	**GOOD!**	
97	13	65	625	575	0	1	**GOOD!**	
98	13	65	625	575	0	1	**GOOD!**	
99	13	65	625	575	0	1	**GOOD!**	
100	13	65	625	575	0	1	**GOOD!**	
101	13	65	625	575	0	1	**GOOD!**	
102	13	65	625	575	0	1	**GOOD!**	
103	13	65	625	575	0	1	**GOOD!**	
104	13	65	625	575	0	1	**GOOD!**	
105	13	65	625	575	0	1	**GOOD!**	
106	13	65	625	575	0	1	**GOOD!**	
107	13	65	625	575	0	1	**GOOD!**	
108	13	65	625	575	0	1	**GOOD!**	
109	13	65	625	575	0	1	**GOOD!**	
110	13	65	625	575	0	1	**GOOD!**	
111	13	65	625	575	0	1	**GOOD!**	
112	13	65	625	575	0	1	**GOOD!**	
113	13	65	625	575	0	1	**GOOD!**	
114	13	65	625	575	0	1	**GOOD!**	

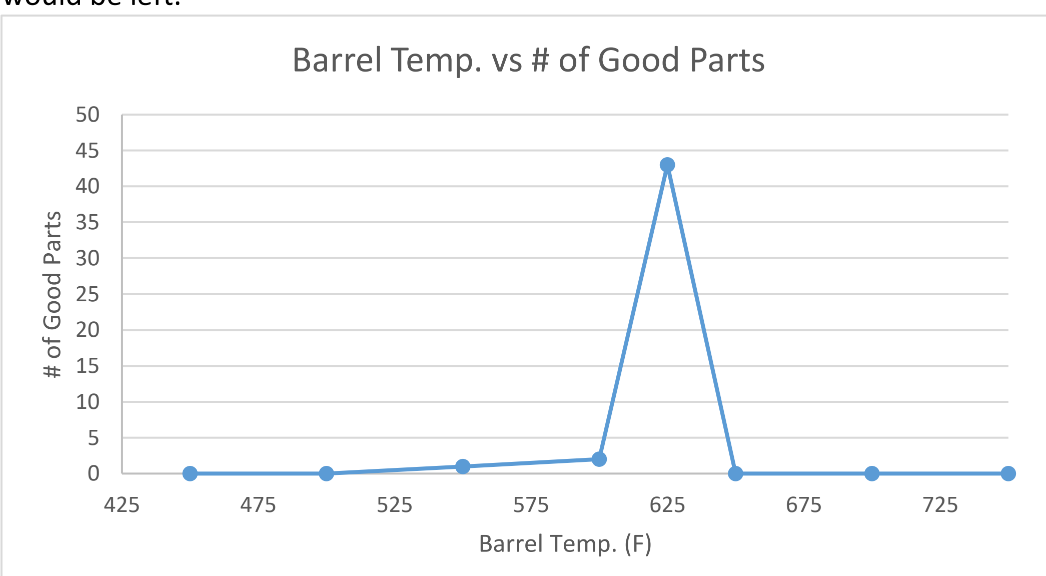
115	13	65	625	575	0	1	GOOD!
116	13	65	625	575	0	1	GOOD!
117	13	65	625	575	0	1	GOOD!
118	13	65	625	575	0	1	GOOD!
119	13	65	625	575	0	1	GOOD!
120	13	65	625	575	0	1	GOOD!

Data Evaluation

Higher than 65psi would result in a lot of faulty parts with flash. Under 65psi would result in faulty parts with voids.



Between 525 and 600 degrees the mold produced some good parts but the coloring was off (slightly burnt). 625 was found to be a good temperature. Too hot and the material would burn/blister and have flash. Too cool and the material would burn from rubbing and voids would be left.



Appendix I – Resume

RYAN **HEATON**

3711 Birch St. Washougal, WA 98671 · (360) 609-2120
Ryan.heaton8@gmail.com

Responsible Mechanical Engineering Student with experience in fabrication, technology, firefighting, and culinary services. Willing to ask questions in order to get the job down right the first time. Welcome constructive criticism.

EXPERIENCE

SUMMER 2016 – SUMMER 2017

TOOLING SPECIALIST, POLY-CAST INC.

Assisted in the design and fabrication of multiple cooling fixtures and tools. Tool repair and general maintenance on various injection molds.
Designed slides for each molding press in order to simplify the set-up, take-down, and material change processes.
Some design work/editing in Solidworks.

SUMMER 2014

WILDLAND FIREFIGHTER, PATRICK FIRE CORPORATION

Fought fires throughout the state of WA (averaging 80-100hr work week) including the Carlton Complex Fire – largest wild fire in the history of WA at the time.

EDUCATION

JUNE 2018

BS IN MECHANICAL ENGINEERING TECH., CENTRAL WASHINGTON UNIVERSITY

Senior project website: **ryanheaton8.wixsite.com/seniorproject**
Learned metal fabrication, problem solving, project design and analysis.

JUNE 2012

HIGH SCHOOL DIPLOMA, WASHOUGAL HIGH SCHOOL

Built a boat with a floor window, a semi-hollow electric guitar, and a Morris Chair. Took woodshop for all 4 years of high school. A lot of experience in wood working.

SKILLS

- Manual/CNC machining
- Metal/wood fabrication
- Solidworks
- Microsoft Office
- Critical Thinking
- Welding

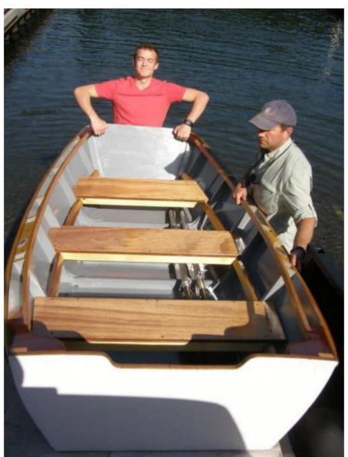
ACTIVITIES

Passions:
Projects/making things, working with my hands, high precision machining, attention to detail.
Learning how things work, how things are put together.

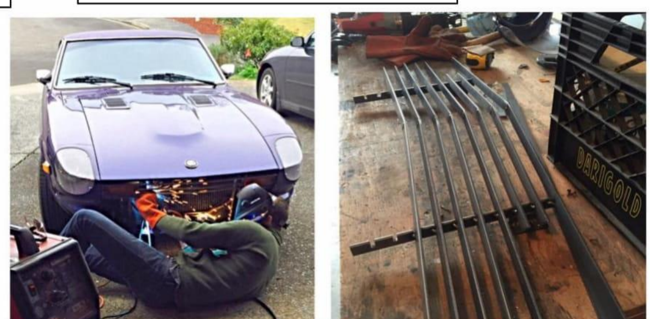
Past Projects:

Semi-Hollow electric guitar

Custom side plates for a café racer motorcycle

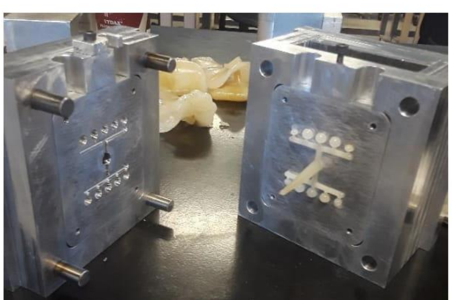


9ft boat with a floor window



Custom grill for the Datsun

College desk



Injection mold to make air soft BB's