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Installation Press for Heat Set Inserts

Maxwell Warren

INSTALLATION PRESS FOR HEAT SET INSERTS

By

Maxwell Dean Warren

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

Oxford, MS

May 2021

Approved By

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Advisor: Dr Tejas Pandya

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Reader: Dr Yiwei Han

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Reader: Professor Damian Stoddard

DEDICATION

This thesis is dedicated to my team members Jack Bolton and Dylan Douglas.

Thank you.

ACKNOWLEDGEMENTS

Dr. Tejas Pandya, Professor at The University of Mississippi, who provided us with guidance along the planning process. Matt Lowe for machining and technical supports. Pam McCulley and Cody Berry of General Atomics for sponsoring and providing resources along the design process.

PANDEMONIUM

Pandemonium was founded April 1, 2020 in Oxford, Mississippi. Members of the team include Jack Bolton, Undergraduate BSME at the University of Mississippi, Dylan Douglas, Undergraduate BSME at the University, and Max Warren, Undergraduate BSME at the University of Mississippi.

ABSTRACT

3D printing has evolved from a slow, laborious process in the 1980s's to a cutting-edge technology that is being used in industries such as aerospace and medical. Though the technology is relatively new in comparison to CNC machines and other items found in a typical machine shop, additive manufacturing is growing towards a multibillion-dollar industry. For this reason, many industries are turning to 3D printing for research and development tasking as well as just using it to supplement for parts until they have been manufactured through more traditional means. The downside of 3D printing is that it is commonly done with types of thermoplastics, and issue arises when there is a need for threaded parts. 3D printing is advanced enough to do this; however, if a part requires a fastener to thread and unthread numerous times, the plastic will wear and lead to the stripping of the threads. Heat set inserts provide a solution to this problem. Heat set inserts are a type of threaded insert that provides the ability to specifically implement threads into a 3D printed part. This is achieved by heating the insert with a soldering iron and placing it into a slightly undersized hole. The heat of the insert melts the plastic as it is pressed into the hole, and the cooling of the plastic secures and locks it into place. These inserts can be done by hand; however, it is difficult to keep the insert aligned with the hole, and misalignment of an insert can result in the scrapping of a part. Therefore, the scope of this report is to design, test, and fabricate a device that will allow heat set inserts to be installed to thermoplastics easily and accurately. This device should be similar to that of a drill press and will control horizontal motion and run out while providing adjustable vertical motion. A combination of 3D printed materials and standard components will be used to develop the prototype.

PREFACE

The basis of the project came from the need of a better way to install heat set inserts for professional engineering use. As technology in the additive manufacturing world improves, developers' equipment needs to do the same.

The creation of this installation press has truly been a joy and learning experience. I could not have done this without the help and support of the sponsors- Pam McCulley and Cody Berry. Also, Jack Bolton and Dylan Douglas for their partnership throughout the design process.

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1. Installation Press of Heat Set Inserts

1.1 Identification of Need

Pam McCulley and Cody Berry (referred to as 'Sponsors' proceeding) have tasked Pandemonium with the duty of designing and manufacturing an assembly that will aid with their application of using heat set insert with their 3D printing efforts. The problem the Sponsors are facing is an inconsistency with the accuracy they are able to install heat set inserts into various thermoplastic parts they create. The importance of these added inserts is that they add threads to 3D printed parts. If the threaded part is not inserted correctly, then components will not align correctly, or the part may be scrapped entirely.

1.2 Proof of Concept

The goal of this project is to design and manufacture an assembly that will improve the process of installing heat set inserts into 3-D printed parts. 3D printing and other types of additive manufacturing are quickly becoming a staple in the engineering field today due to the ease and accessibility of these machines. 3D printers allow for rapid prototyping, more designing freedom, and the ability to test out an idea quickly without the need of a machine shop. Time is one of the most important factors when it comes to manufacturing and producing ideas. The rapid prototyping of parts is a great way to test an idea before spending the time and money it would take a machine shop. Parts can be converted to .STL files from the CAD software of choice and be printed within hours to see the validity of an idea or be used as a stand in while waiting on machined parts.

The technological advancements of 3D printing have expanded the applications from weekend hobby to vast engineering applications. For this reason, heat set inserts have become great tools fitting 3D printed parts into assemblies for use or for place holders before the true part is machined.

Additionally, Mordor Intelligence states that the 3D printing market was valued at 13.7 billion dollars in 2020, and the market is expected to reach a value of 63.46 billion dollars by 2026. In **Fig. 1**, Fortune Business projects what the industrial 3D printing market could look like by 2027.

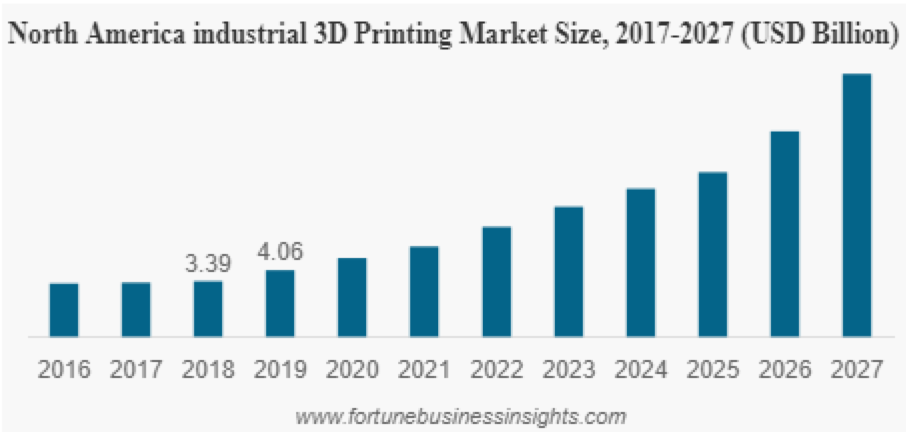

Figure 1: Estimated North American Industrial 3D Printing Market 2017-2027

They attribute the increase to the fact that many of the world's leading industries such as automotive, aerospace/defense, and healthcare have taken true interest in developing their manufacturing processes. COVID-19 has even boosted the market because it has been a major asset in the production of personal protective equipment (PPE). **Fig. 2** shows the 2019 breakdown of the application of 3D printing by industry type.

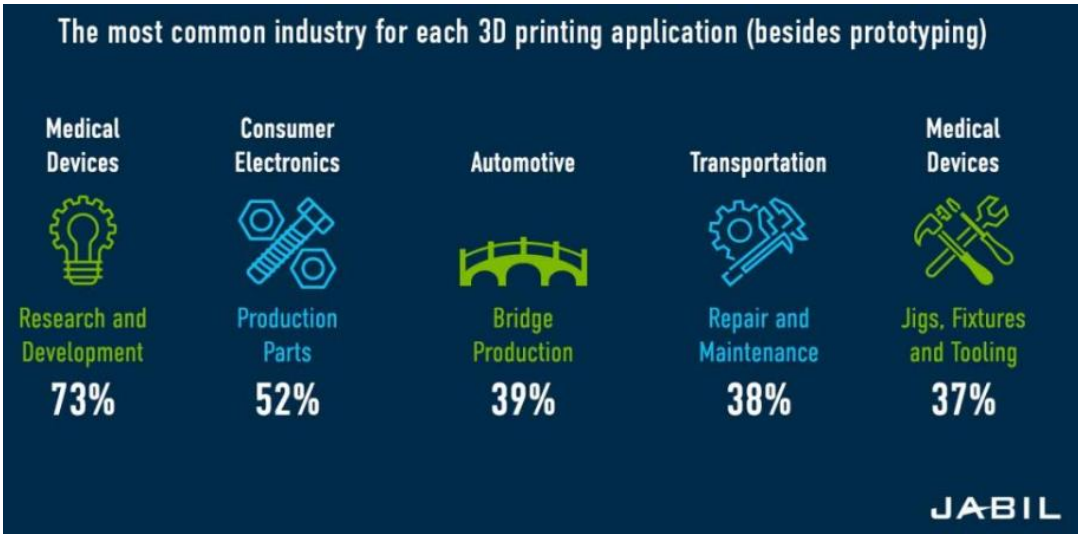

Figure 2: 3D Printing Application by Industry

1.3 Key Aspects of Design Process

The first step in creating the design was to meet with the sponsors and determine their needs. From multiple discussions, they tasked Pandemonium to create a device that will securely hold a soldering iron and allow only one degree of freedom up and down to avoid deviation while inserting heat set inserts. The total footprint of the device could not exceed a 2' x 2' area in order to keep the workspace available for other needs. The sponsors provided materials available in their lab to construct the assembly as well as access to their 3D printers to design and produce needed parts.

1.4 Progress to Date

The first step in the initial design process was to determine how the configuration would obtain its vertical motion while limiting horizontal motion. After some preliminary discussions with the sponsors, they provided various lengths of 80/20 aluminum extrusion to be used as a track to base the design around. The extrusion provided a rigid, lightweight structure to support the rest of the assembly while remaining cost effective. Due to its commonalty, the 80/20 extrusion has a wide range of standard components available that aided in the design process.

Figure 3: 80/20 Aluminum Extrusion

To induce vertical motion along the track, the preliminary design ideas were to use a spring loaded press or pulley system. The pulley system was chosen over the spring design due to its simplicity. It involved fewer parts and would have an overall lower cost than a spring based system.

The initial ideas were to create a roller carriage system that would have an outreaching arm that would hold the soldering iron via a clamp. In order to move, the roller carriage would have roller bearings attached to it, allowing for smooth motion up and down the 80/20 track. This system would have a counterweight connected to it on the other side of the extrusion. All of this would be connected together by a pulley system at the top of the aluminum body.

Ideas began to take form in Solidworks, a solid CAD modeling program, to test validity. The counterweight and slider carriage were designed to have a tongue and groove fit that would allow sliding fits in between the grooves of the aluminum extrusion. This provided a secure fit and limited unnecessary motion. The base of the assembly was designed to be a female receptor for the aluminum extrusion and have a similar tongue and grove fit into two channels on the aluminum to prevent any motion. **Fig. 4-6** show the initial CAD models that were printed for testing.

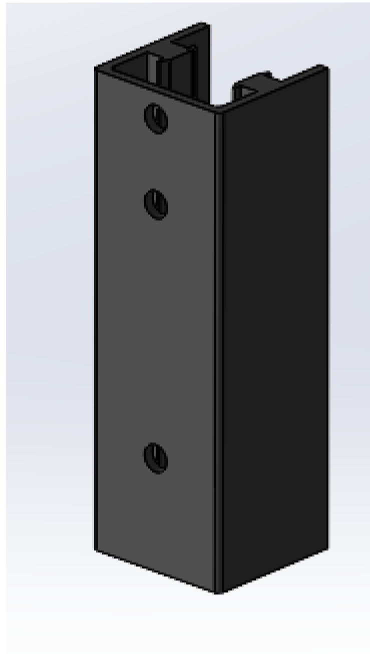

Figure 4: Initial Slider Carriage

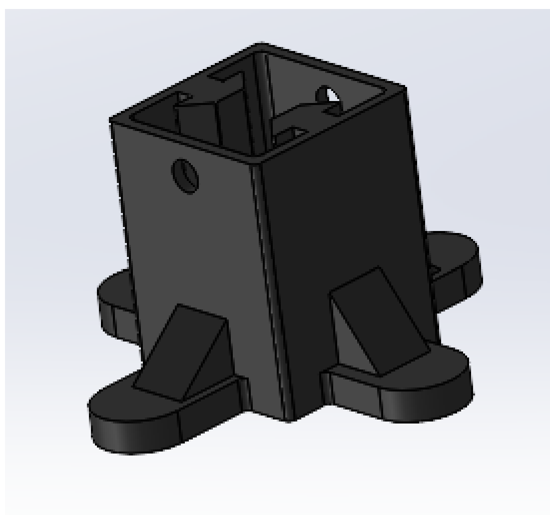

Figure 5: Initial Base

Figure 6: Initial Counterweight

With the initial models prototyped, they were printed in a Ultimaker s3 3D printer. These initial prints were a great example of the benefits of rapid prototyping. These models were just starting places to see the validity of the design, so being able to print the parts on demand without the need of a machine shop made this quite easy. **Fig. 7** shows the slicing software used to set up the initial prints. It took 8 hours and 15 minutes to set up the prints and finish. All parts were printed from generic polylactic acid (PLA) that was purchased from McMaster-Carr. PLA was chosen over other materials, such as ABS, for material availability and low cost.

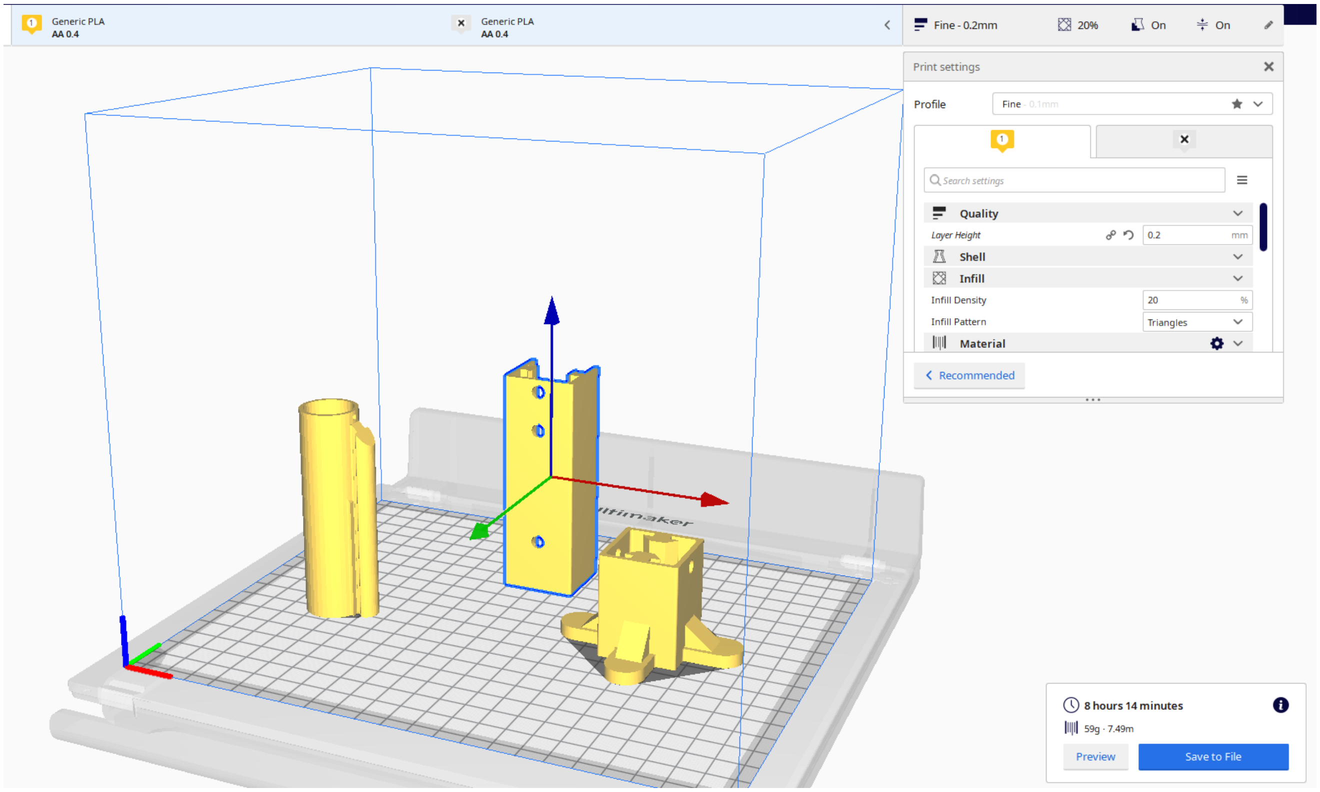

Figure 7: Initial 3D Print Setup

After the initial round of parts were printed, the counterweight and base fit as intended, but the slider carriage's track on both sides had clearance issues with the aluminum extrusion. This part was edited and reprinted multiple times to try to resolve this issue, but the conclusion made by the team is that, even though the model worked in Solidworks, the print had slight manufacturing deviations from the model to what was printed. The slider had the right shape and overall form, but upon measurements taken after, the inside length would shrink causing interference that prevented the part from easily sliding up and down the railing. The solution to this problem was to try having a square platform with standoffs to hold roller bearings that would allow for a sliding motion and not have to worry about the part fitting in between the slots of the aluminum extrusion **Fig. 8** shows the slider carriage redesign. Roller bearings were supplied by BIQU Store and sourced online. These were chosen on the factors of price and that the bearings were the size needed to fit along the extrusion. The parts were purchased for only seven dollars.

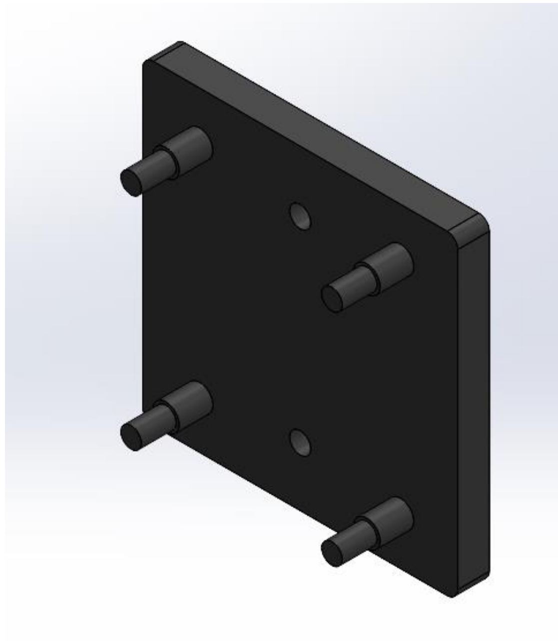

Figure 8: Slider Carriage Redesign

The next production was of the arm to hold the soldering iron, the top pulley assembly, a clamp to hold the soldering iron, and a plate that attached to the clamp and arm to provide easy access to change soldering irons if needed. **Fig. 9** shows the second round of printed parts. These took around 5 hours to complete. The pulley was designed to sit atop of the 80/20 extrusion. The pulley was designed to operate on a RM2-2RS guide bearing. The guide bearing was chosen after meeting with Ole Miss Machine Shop Supervisor, Matt Lowe. Matt provided the bearings at no cost.

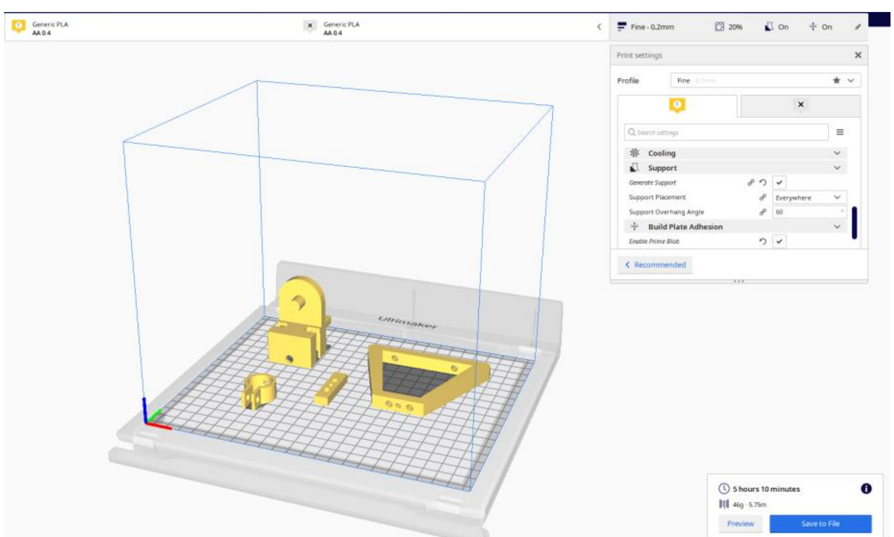

Figure 9: Second Round of 3D Prints

The only change that was made after testing these prints was to opt for a hose clamp to be used in lieu of the printed clamp because it provided better security while holding the soldering iron. After all the prints were finished, the prototype was assembled to see how the idea transitioned from CAD to real world. After assembly, it was determined that the legs of the base needed to be larger to provide adequate stability. Initially the legs of the base were 1" but were lengthened to 1.45" **Fig. 10** shows the first assembly model presented to the sponsors for comment.

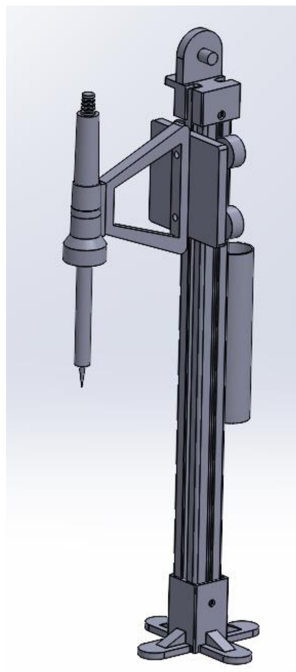

Figure 10: Initial Assembly Model in Solidworks

Now that all the parts are assembled, Pandemonium needed to figure out how much the counterweight needed to be. This step required a visit to Matt Lowe again. In the visit to the machine shop, there were three items to tackle: the mass of the slider, arm, and soldering iron side of the assembly, how much mass was needed to overcome that so the pulley would never allow the soldering iron to fall down the track for safety purposes and determine what would be used for the mass. The soldering plus the arm plus the slider carriage combined for a mass of 232 g (0.51 lb) while the counterweight holder only weighed 30 g (0.07 lb). Calibrated masses were attached to the counterweight, until the soldering iron began to rise. This mass was 314g (0.69 lb). The coefficient of friction, m, was found using Eq. 1. One inch diameter solid brass rod was chosen as the counterweight material due to its high density and material availability. The minimum weight of the counterweight was determined to be a minimum of 25% greater than the weight required to overcome the force of friction and lift the soldering iron. This was calculated in Eq 3. This ensures that if left unattended, the soldering iron will remain in the upward position. The required length of the brass tube found using Eq. 2, and a tolerance of $\pm\frac{1}{16}$" was applied to the component.

Eq. 1 $$\mu = \frac{W_{solder\ iron+holder}}{W_{Calibrated\ mass+holder}} = \frac{.51\ lb}{.75\ lb} = 0.67$$

Eq. 2 $$W_{req} = 0.75\ lb + (0.25 \times 0.75\ lb) = 0.94\ lb$$

Eq. 3 $$L_{req} = \frac{W_{req}}{\frac{\pi}{4}\rho d^2} = \frac{0.94\ lb}{\frac{\pi}{4}\left(0.3\frac{lb}{in^3}\right)1^2\ in} = 4\ in\ \pm \frac{1}{16}$$

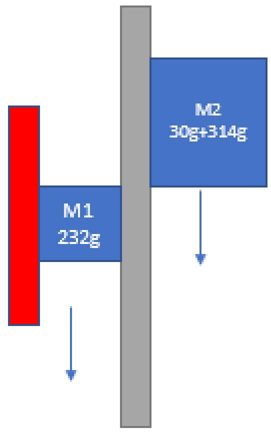

Figure 11: Freebody Diagram of Assembly

Before Matt could process a brass rod to the needed lengths, a stress analysis needed to be conducted to ensure the assembly could withstand the force. This analysis run was a simplified loading condition for the soldering iron arm to ensure it could withstand the downward force it would experience while in operation. PLA's material properties applied in Solidworks are shown in figure 12 below. A load of 2 psi was determined as a sufficient force due to that fact that the opposing force of the counterweight is only 0.9lbs. Results of the tests are shown in Figures 13-15. Initial results of the testing showed that the part would pass the stresses applied. The total displacement of the arm was 0.07 inches with no severe stress concentrations.

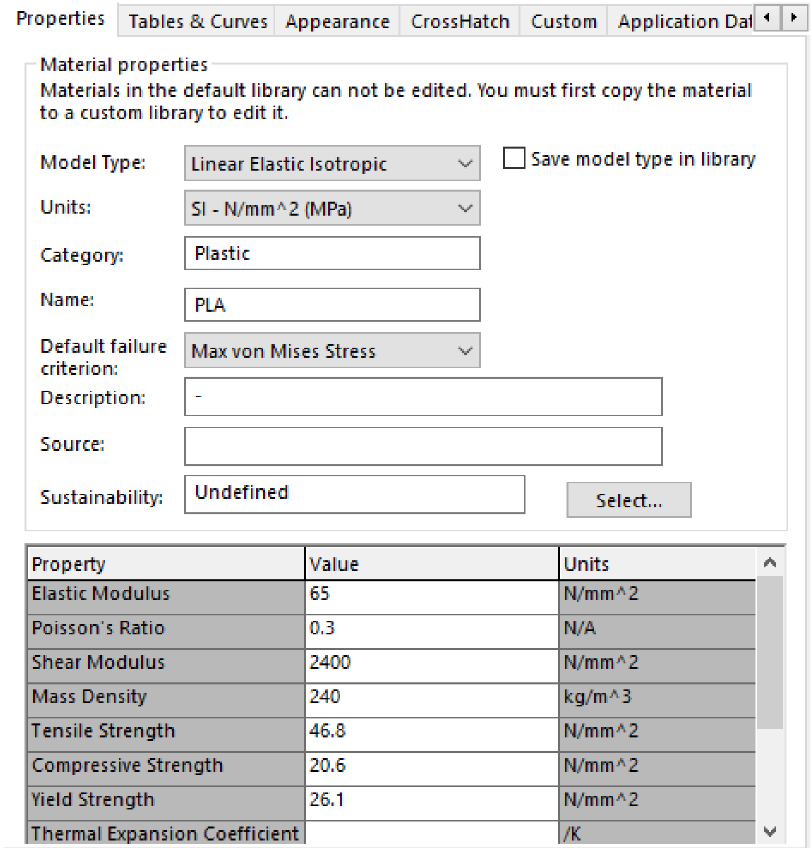

Figure 12: PLA Material Properties in Solidworks

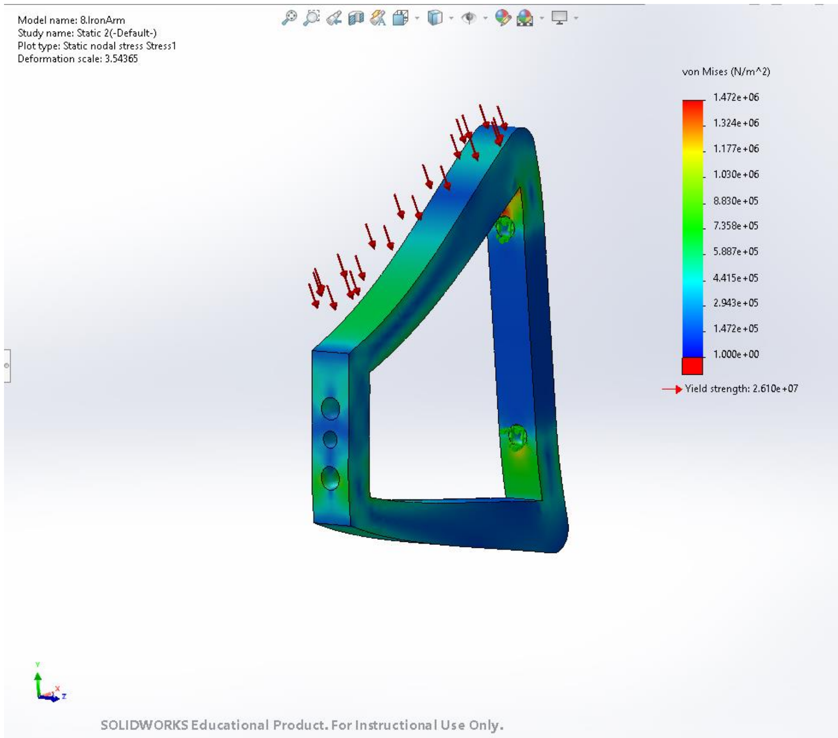

Figure 13: Stress Analysis in Solidworks

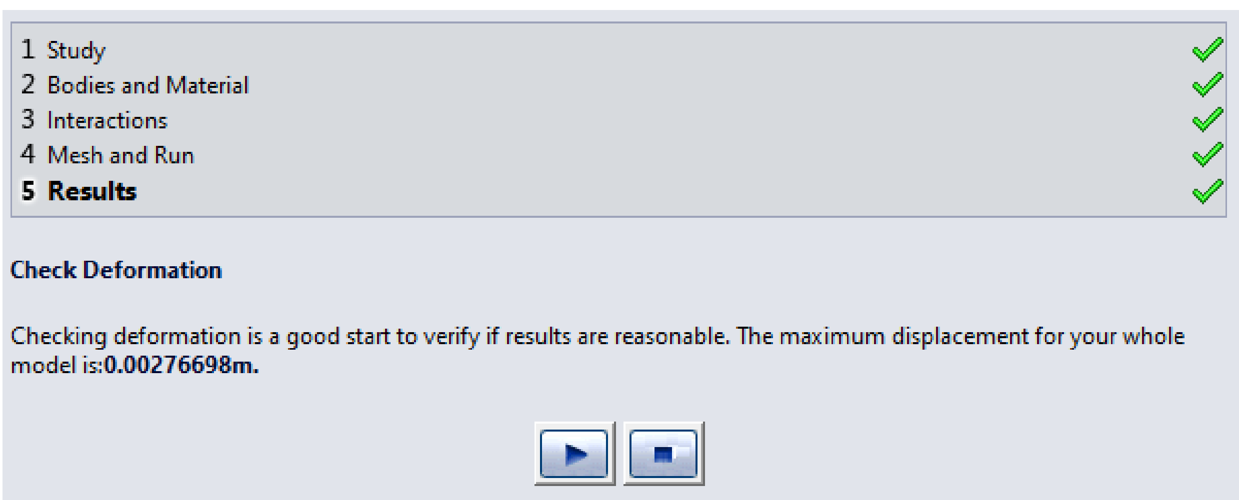

Figure 14: Displacement Results from Stress Analysis

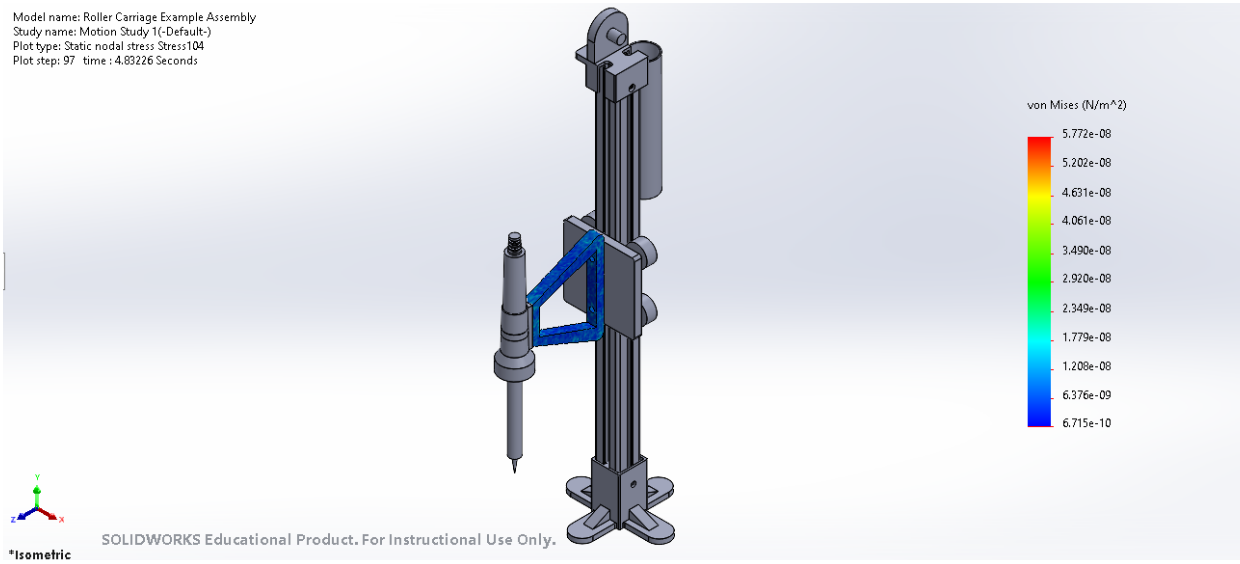

Figure 15: Stress Analysis Shown in Assembly

After the model passed the stress analysis tests, a brass rod at a 4-inch length was cut and placed in the counterweight holder. Testing then proceeded to physical application to ensure functionality of the assembly.

Now the official release process of the drawings to the Sponsor was started. All released drawings are presented in the Appendix at the end of this report. The drawing release process was conducted by initial drawings being reviewed by the Pandemonium team. After the team agreed on the drawings, they were sent to Pam McCulley to get final approval.

1.5 Final Design Specifications

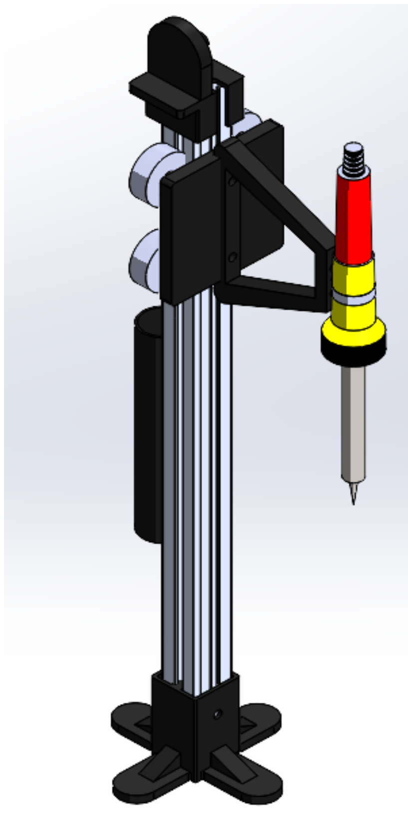

Figure 16: Final Assembly

The **Fig. 16** details a sketch of the assembly. The drawing is not to scale, but it does show how the parts will be assembled. The slider carriage and counterweight will move in opposing motion to each other to operate the pulley system. For more stability, the base will be secured to a workstation to prevent any sliding or tipping while being used.

1.6 Cost Analysis

Cost is always an important factor when it comes to the design of anything. Table 1 below shows the pricing breakdown of the Installation Press. Pandemonium was fortunate to have access to the lab materials provided by the Sponsors. Almost all the materials and fasteners required to make the press were available to the team. The only item that needed to be purchased were the pulley wheels from BIQU. Table 1 also shows a breakdown of what the cost would have been if all items needed to be purchased during production versus what was spent. With only using in house items, Pandemonium was able to design and produce a working prototype of the Installation Press for just 12% of the cost.

QTY. REQ'D	ITEM NO.	PART NO.	MFR/SUPPLIER	DESCRIPTION	COST SPENT	COST ACTUAL	
6	1	93365A130	MCMASTER-CARR	TAPERED HEAT SET INSERTS SIZE 6-32	IN HOUSE	$13.35/100 UNITS	
2	2	93365A120	MCMASTER-CARR	TAPERED HEAT SET INSERTS SIZE 4-40	IN HOUSE	$11.19/100 UNITS	
1	3	N/A	MATT LOWE	RM2-2RS GUIDE BEARING	IN HOUSE	$5.55/UNIT	
4	4	N/A	BIQU/AMAZON	PULLEY WHEEL	$7	$7/UNIT	
6	5	91251A148	MCMASTER-CARR	#6-32 SOCKET HEAD CAP SCREWS	IN HOUSE	$9.59/100 UNITS	
1	6	91251A110	MCMASTER-CARR	#4-40 SOCKET HEAD CAP SCREWS	IN HOUSE	$9.85/100 UNITS	
1	7	N/A	GENERAL ATOMICS	80/20 ALLUMIUM EXTRUSION	IN HOUSE	$7.47/FOOT	
					$7	$57	TOTAL

Table 1: Bill of Materials

1.7 Possible Future Revisions

While the final product of this report operates and functions to the needs of the Sponsors, Pandemonium is always looking for ways to improve and innovate. The two main improvements could be with the slider carriage and the arm holding the soldering iron. The initial idea of having two standoffs to slide along the 80/20 track was good in theory but would not print efficiently. The roller bearing idea used in the assembly works, but a more secure fit might be better. The improvement that could be made would have a single standoff like the counterweight holder on the back of the slider carriage and eliminate the four posts used to hold the wheels. This would prevent any sliding and it reduces the number of members that could break from normal use. Two more improvements that can be made are on the arm that supports the soldering iron. There were no high stress concentrations that would lead to failures, but the middle of the part had the highest stress concentration. So, the improvement would be to add a bracing arm that would connect the top and bottom faces to add support. The next improvement would be to filet the corners inside on the arm to reduce any stress concentrations at the sharp edges.

1.8 Conclusion

In conclusion, the task presented by the Sponsors was to design a tool that would improve the accuracy of installing heat set inserts to 3D printed parts. This task was successfully accomplished by designing and 3D printing parts that mate to a piece of 80/20 aluminum extrusion. The validity of the idea was confirmed through stress analysis testing in Solidworks that showed the assembly was able to withstand an applied load over what it would face in true application. After the theoretical testing, an assembly was created, and real-world testing was performed. Once true testing was performed, the Sponsors approved drawings and approved the assembly.

2. Individual Contributions

2.1 Research on the need of inserts in 3D printed parts and additive manufacturing

- Jack Bolton, Dylan Douglas, Max Warren

2.2 Fundamental Calculations

- Jack Bolton, Dylan Douglas

2.3 Solidworks/ 3D Printing Design

- Max Warren

2.4 Solidworks Review

- Pam McCulley
- Cody Berry

2.5 Cost and Material Analysis

- Dylan Douglas

2.6 Material Processing Assistance

- Matt Lowe

2.7 Project Report

- Jack Bolton, Dylan Douglas, Max Warren

2.8 Presentation

- Jack Bolton, Dylan Douglas, Max Warren

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Appendix:

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DRAWINGS OF MODELS TO FOLLOW

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
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NOTES: UNLESS OTHERWISE SPECIFIED

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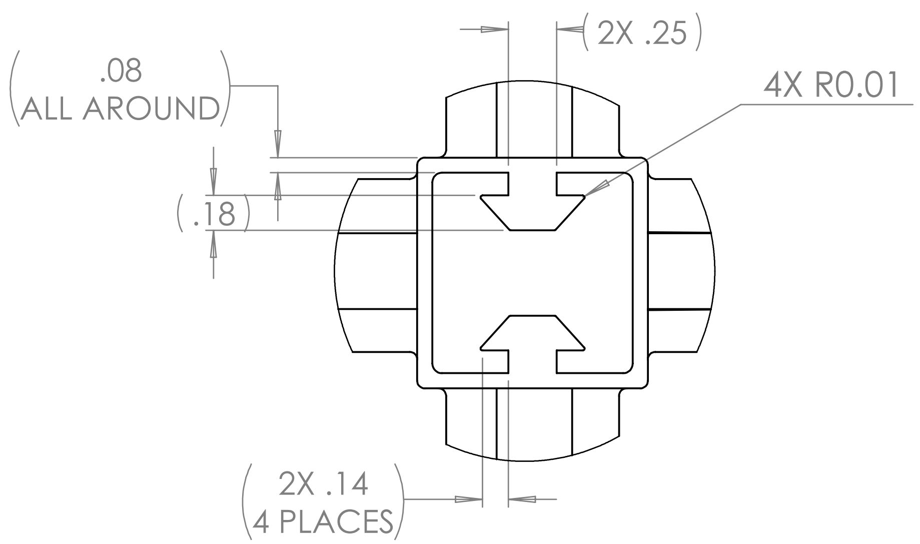
MATERIAL: POLYLACTIC ACID (PLA) FILAMENT

BAG AND TAG WITH PART NUMBER AND CURRENT REVISION LEVEL. PER MIL-STD-130 IN THE FOLLOWING FORMAT

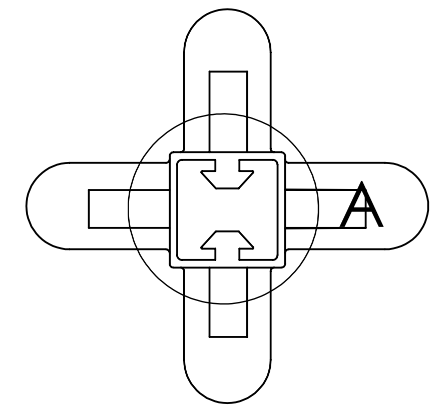
XXXXXX, REV A

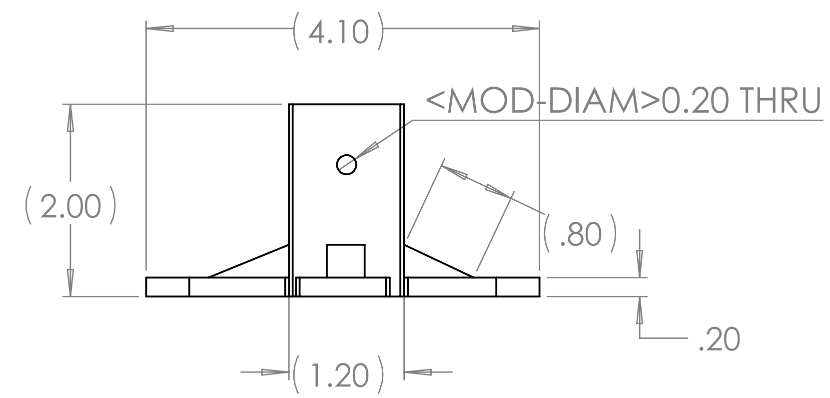
INSTAL INSERT PER MANUFACTURER'S SPECIFICATION

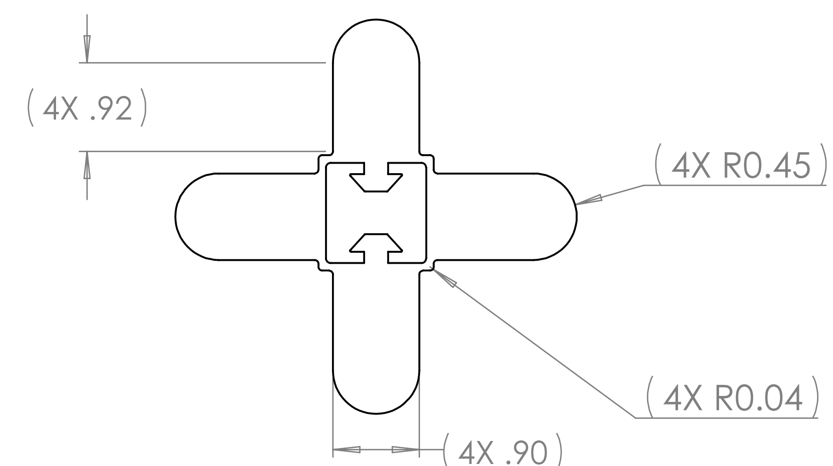
5. FINISHED PARTS SHALL BE CLEAN AND FREE OF ALL CHIPS, DEBRIS, CUTTING FLUIDS, PROCESSING RESIDUE, AND OTHER CONTAMINANTS



DETAIL A







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FOR REFERENCE ONLY
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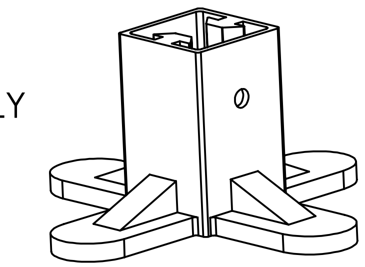

UNLESS OTHERWISE SPECIFIED
ALL DIMESNSIONS ARE IN INCHES
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INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14.5M-2009
DO NOT SCALE DRAWINGS

PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF PANDEMONIUM. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF PANDEMONIUM IS PROHIBITED.

THIRD ANGLE PROJECTION

CONTRACT NUMBER: N/A

MATERIAL

FINISH N/A

	NAME	DATE
DRAWN	M. Warren	4/2/21
CHECKED	J. Bolton	4/3/21
ENG APPR.	D. Douglas	4/3/21

TITLE: Base

SIZE	DWG. NO.	REV
B	001	A

SCALE: 1:1 WEIGHT: 0.02LBS SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE- PER ECN#9724	4/13/21	P. McCulley

NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME STANDARDS Y14.24-1999, Y14.34M-1996, Y14.35M-1997, AND Y14.100-2013

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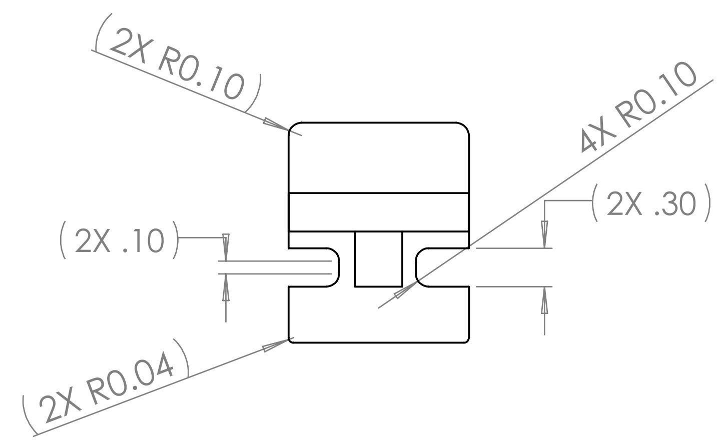
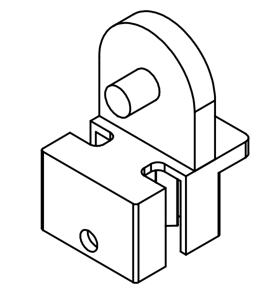
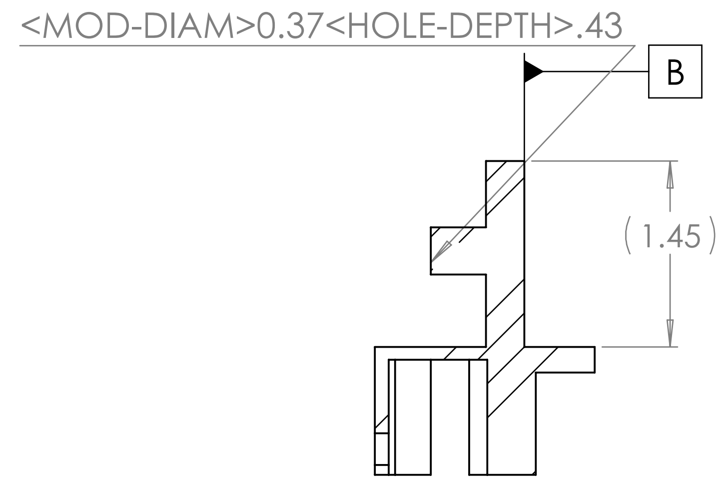
4. FINISHED PARTS SHALL BE CLEAN AND FREE OF ALL CHIPS, DEBRIS, CUTTING FLUIDS, PROCESSING RESIDUE, AND OTHER CONTAMINANTS



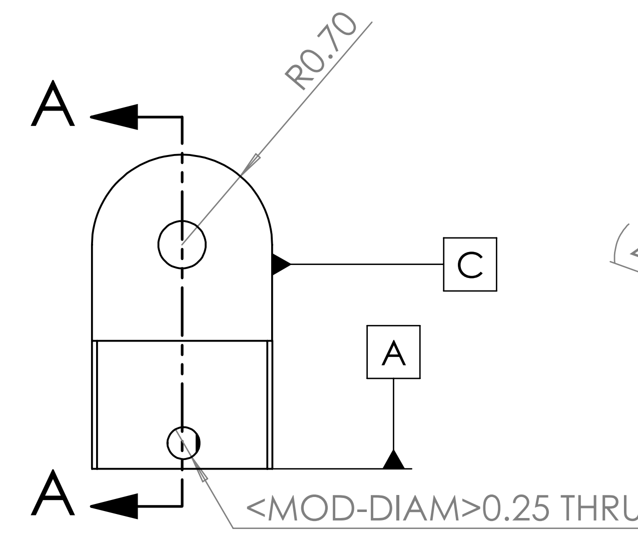


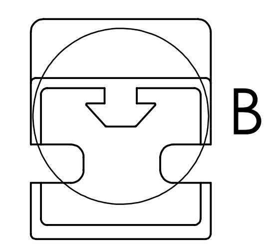
ISO VIEW
FOR REFERENCE ONLY
SCALE NONE

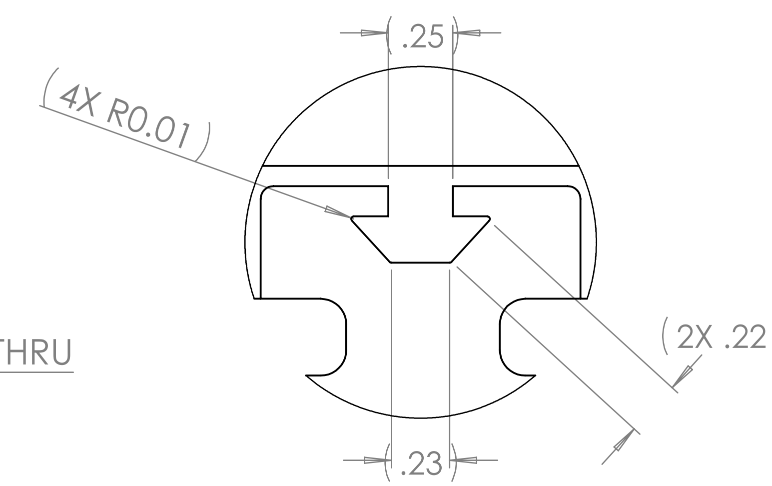


SECTION A-A

SCALE 1 : 1.5







DETAIL B

SCALE 2 : 1.5

UNLESS OTHERWISE SPECIFIED
ALL DIMESNSIONS ARE IN INCHES
TOLERANCE OF ANGLE 0.5
.X : 0.03 .XX: 0.01 .XXX: 0.005
INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14.5M-2009
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

CONTRACT NUMBER: N/A

MATERIAL

FINISH N/A

	NAME	DATE
DRAWN	M. Warren	4/2/21
CHECKED	J. Bolton	4/3/21
ENG APPR.	D. Douglas	4/3/21

TITLE: Top Pulley Bracket

SIZE	DWG. NO.	REV
B	002	A

SCALE: 1:1 WEIGHT: 0.01LBS SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME STANDARDS Y14.24-1999, Y14.34M-1996, Y14.35M-1997, AND Y14.100-2013

MATERIAL: POLYLACTIC ACID (PLA) FILAMENT

BAG AND TAG WITH PART NUMBER AND CURRENT REVISION LEVEL. PER MIL-STD-130 IN THE FOLLOWING FORMAT

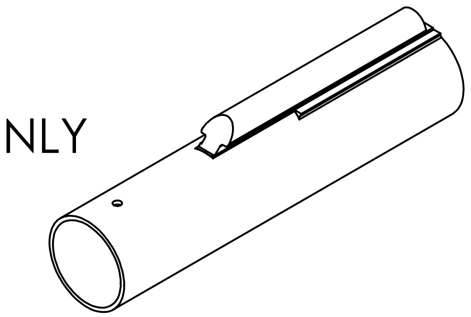
XXXXXX, REV A

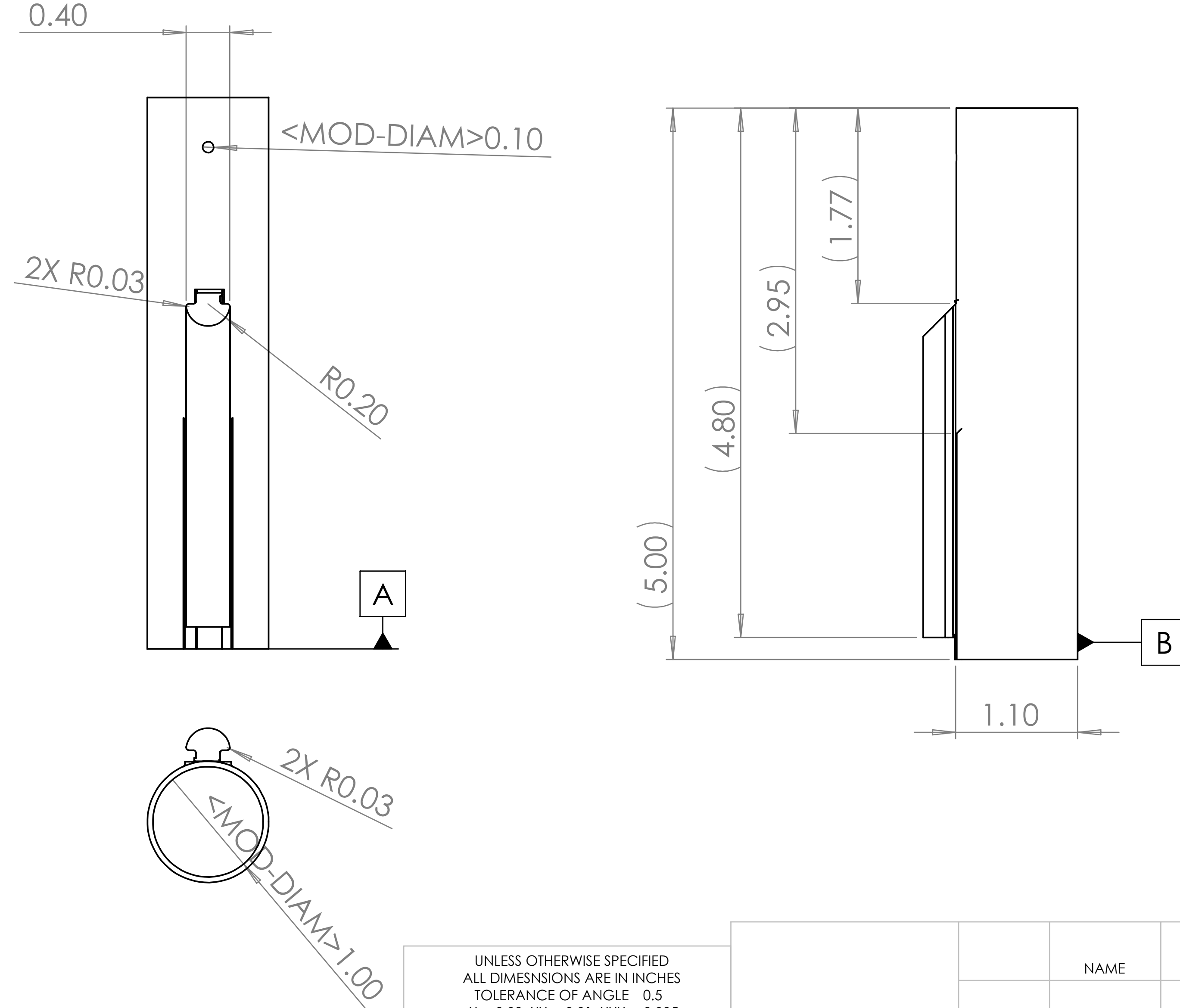
INSTAL INSERT PER MANUFACTURER'S SPECIFICATION

5. FINISHED PARTS SHALL BE CLEAN AND FREE OF ALL CHIPS, DEBRIS, CUTTING FLUIDS, PROCESSING RESIDUE, AND OTHER CONTAMINANTS

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE- PER ECN#9724	4/13/21	P. McCulley

ISO VIEW
FOR REFERENCE ONLY
SCALE NONE





UNLESS OTHERWISE SPECIFIED
ALL DIMESNSIONS ARE IN INCHES
TOLERANCE OF ANGLE 0.5
.X : 0.03 .XX: 0.01 .XXX: 0.005
INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14.5M-2009
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

CONTRACT NUMBER: N/A

MATERIAL

FINISH N/A

	NAME	DATE
DRAWN	M. Warren	4/2/21
CHECKED	J. Bolton	4/3/21
ENG APPR.	D. Douglas	4/3/21

pandemonium

TITLE:
Counterweight

SIZE	DWG. NO.	REV
B	003	A
SCALE: 1:2	WEIGHT: 0.01LBS	SHEET 1 OF 1

NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME STANDARDS Y14.24-1999, Y14.34M-1996, Y14.35M-1997, AND Y14.100-2013

2. MATERIAL: POLYLACTIC ACID (PLA) FILAMENT

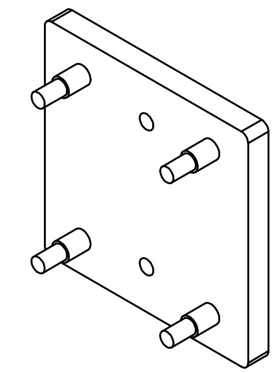
3. BAG AND TAG WITH PART NUMBER AND CURRENT REVISION LEVEL. PER MIL-STD-130 IN THE FOLLOWING FORMAT

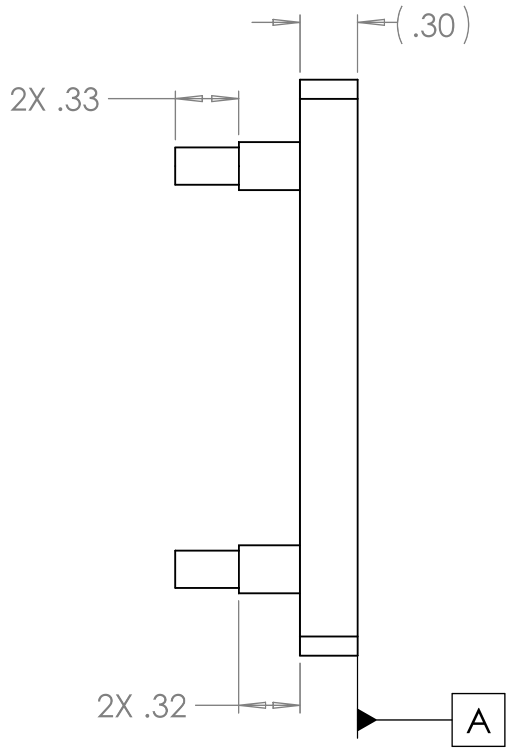
XXXXXX, REV A

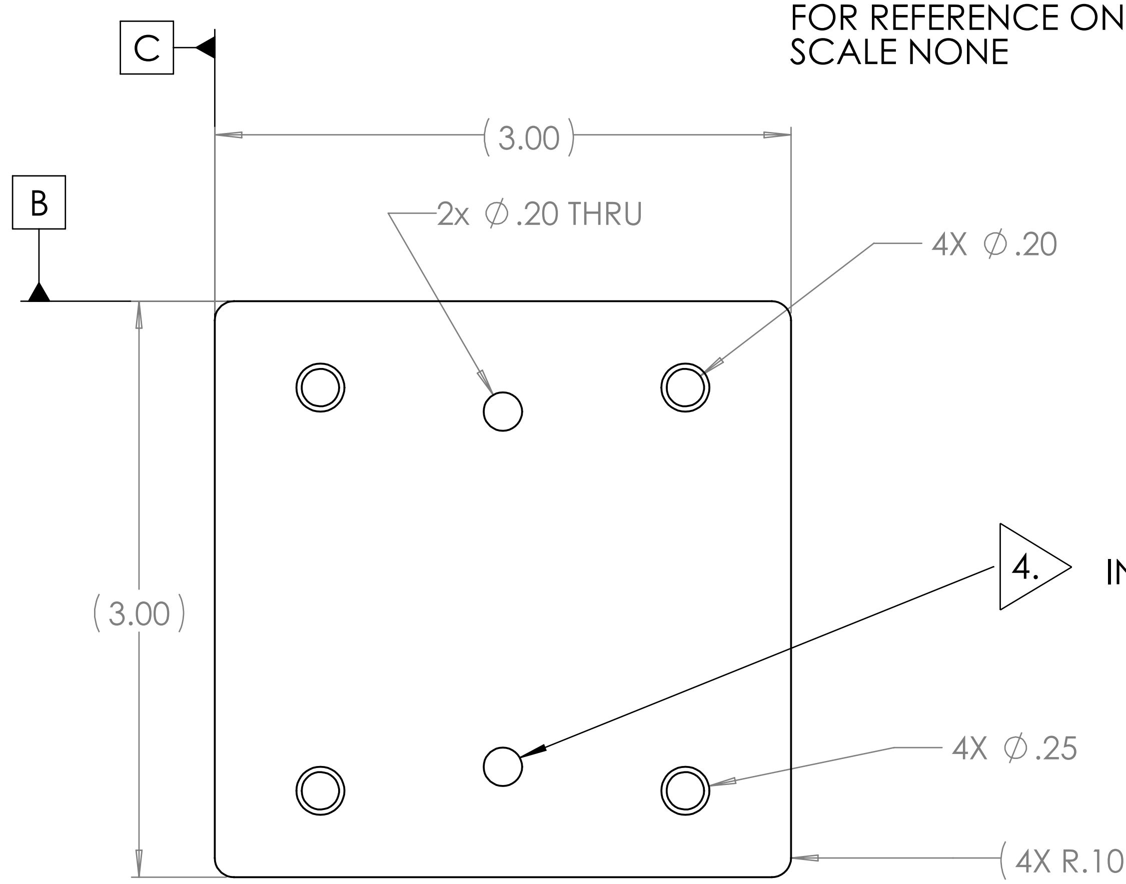
4. INSTAL INSERT PER MANUFACTURER'S SPECIFICATION

5. FINISHED PARTS SHALL BE CLEAN AND FREE OF ALL CHIPS, DEBRIS, CUTTING FLUIDS, PROCESSING RESIDUE, AND OTHER CONTAMINANTS

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE- PER ECN#9724	4/13/21	P. McCulley







4.

QTY. REQ'D	ITEM NUMBER	PART NUMBER	MFR/SUPPLIER	DESCRIPTION
2	1	93365A130	MCMASTER-CARR	TAPERED HEAT-SET INSERTS SIZE 6-32

UNLESS OTHERWISE SPECIFIED
ALL DIMESNSIONS ARE IN INCHES
TOLERANCE OF ANGLE ±0.5°
.X : ±0.03 .XX: ±0.01 .XXX: ±0.005
INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14.5M-2009
DO NOT SCALE DRAWINGS

PROPRIETARY AND CONFIDENTIAL

THIRD ANGLE PROJECTION

CONTRACT NUMBER: N/A
MATERIAL 2.
FINISH N/A

	NAME	DATE
DRAWN	M. Warren	4/2/21
CHECKED	J. Bolton	4/3/21
ENG APPR.	D. Douglas	4/3/21

pandemonium

TITLE:

Roller Carriage

SIZE	DWG. NO.	REV
B	004	A
SCALE: 1:1	WEIGHT: 0.02LBS	SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE- PER ECN#9724	4/13/21	P. McCulley

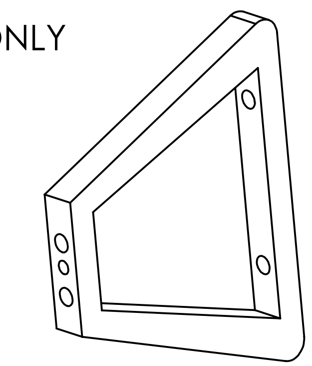
NOTES: UNLESS OTHERWISE SPECIFIED

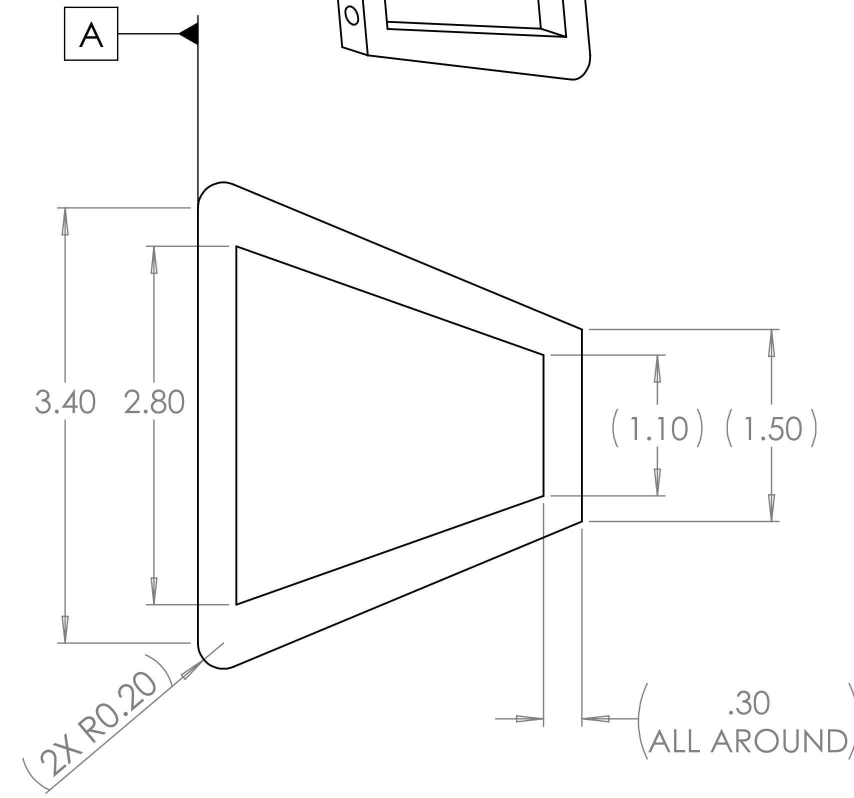
1. INTERPRET DRAWING PER ASME STANDARDS Y14.24-1999, Y14.34M-1996, Y14.35M-1997, AND Y14.100-2013
2. MATERIAL: POLYLACTIC ACID (PLA) FILAMENT
3. BAG AND TAG WITH PART NUMBER AND CURRENT REVISION LEVEL. PER MIL-STD-130 IN THE FOLLOWING FORMAT

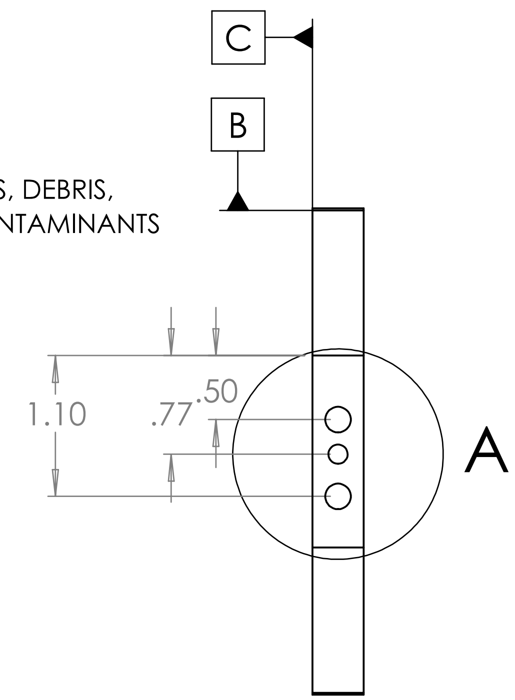
   XXXXXX, REV A

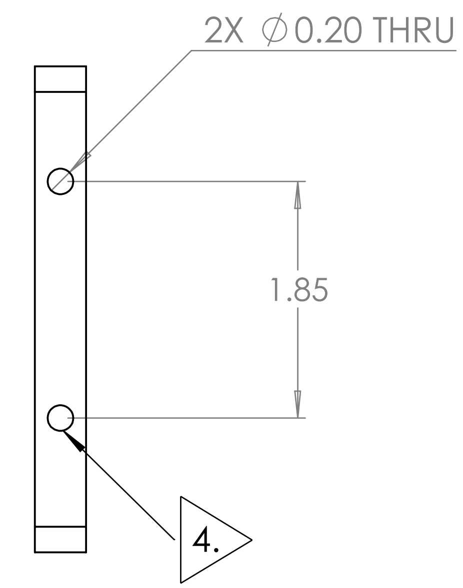
4. INSTAL INSERT PER MANUFACTURER'S SPECIFICATION
5. FINISHED PARTS SHALL BE CLEAN AND FREE OF ALL CHIPS, DEBRIS, CUTTING FLUIDS, PROCESSING RESIDUE, AND OTHER CONTAMINANTS

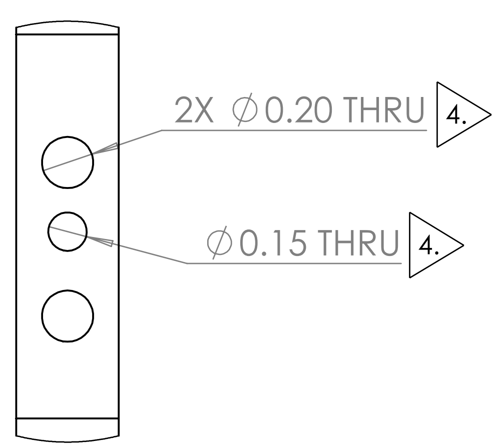
ISO VIEW
FOR REFERENCE ONLY
SCALE NONE











INSERTS NOT SHOWN FOR CLARITY

DETAIL A
SCALE 2 : 1.5

4.	1	2	93365A120	MCMASTER-CARR	TAPERED HEAT-SET INSERTS SIZE 4-40
4.	4	1	93365A130	MCMASTER-CARR	TAPERED HEAT-SET INSERTS SIZE 6-32
	QTY. REQ'D	ITEM NUMBER	PART NUMBER	MFR/SUPPLIER	DESCRIPTION

UNLESS OTHERWISE SPECIFIED
ALL DIMESNSIONS ARE IN INCHES
TOLERANCE OF ANGLE ±0.5°
.X : ±0.03 .XX: ±0.01 .XXX: ±0.005
INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14.5M-2009
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

CONTRACT NUMBER: N/A
MATERIAL 2.
FINISH N/A

	NAME	DATE
DRAWN	M. Warren	4/2/21
CHECKED	J. Bolton	4/3/21
ENG APPR.	D. Douglas	4/3/21

pandemonium

TITLE: Mount Arm

SIZE	DWG. NO.	REV
B	005	A
SCALE: 1:1	WEIGHT: LBS	SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE- PER ECN#9724	4/13/2021	P. McCulley

NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME STANDARDS Y14.24-1999, Y14.34M-1996, Y14.35M-1997, AND Y14.100-2013

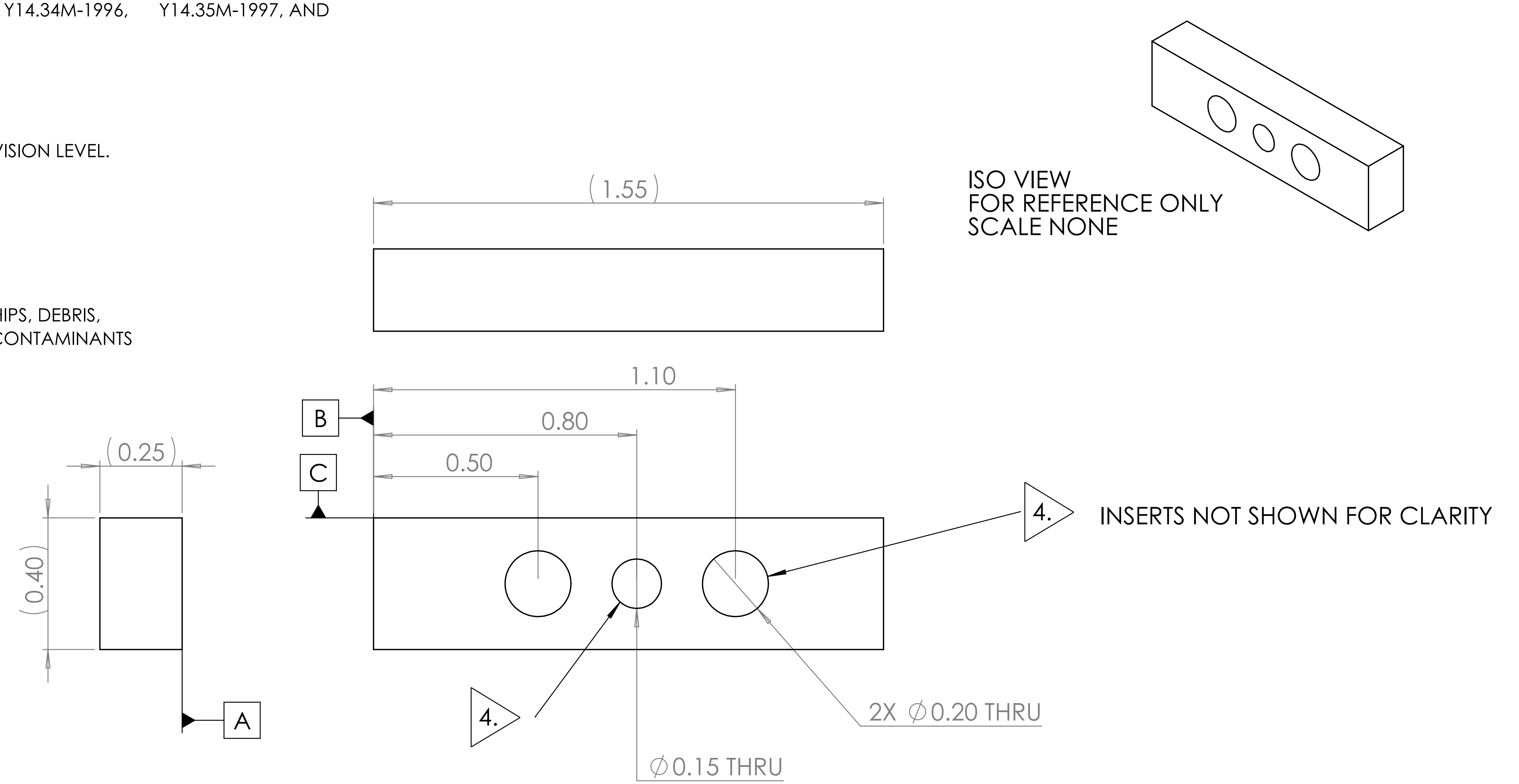
2. MATERIAL: POLYLACTIC ACID (PLA) FILAMENT

3. BAG AND TAG WITH PART NUMBER AND CURRENT REVISION LEVEL. PER MIL-STD-130 IN THE FOLLOWING FORMAT

   XXXXXX, REV A

4. INSTAL INSERT PER MANUFACTURER'S SPECIFICATION

5. FINISHED PARTS SHALL BE CLEAN AND FREE OF ALL CHIPS, DEBRIS, CUTTING FLUIDS, PROCESSING RESIDUE, AND OTHER CONTAMINANTS



	QTY. REQ'D	ITEM NUMBER	PART NUMBER	MFR/SUPPLIER	DESCRIPTION
4.	1	2	93365A120	MCMASTER-CARR	TAPERED HEAT-SET INSERTS SIZE 4-40
4.	4	1	93365A130	MCMASTER-CARR	TAPERED HEAT-SET INSERTS SIZE 6-32

UNLESS OTHERWISE SPECIFIED
ALL DIMESNSIONS ARE IN INCHES
TOLERANCE OF ANGLE ±0.5°
.X : ±0.03 .XX: ±0.01 .XXX: ±0.005
INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14.5M-2009
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

CONTRACT NUMBER: N/A

MATERIAL 2.

FINISH N/A

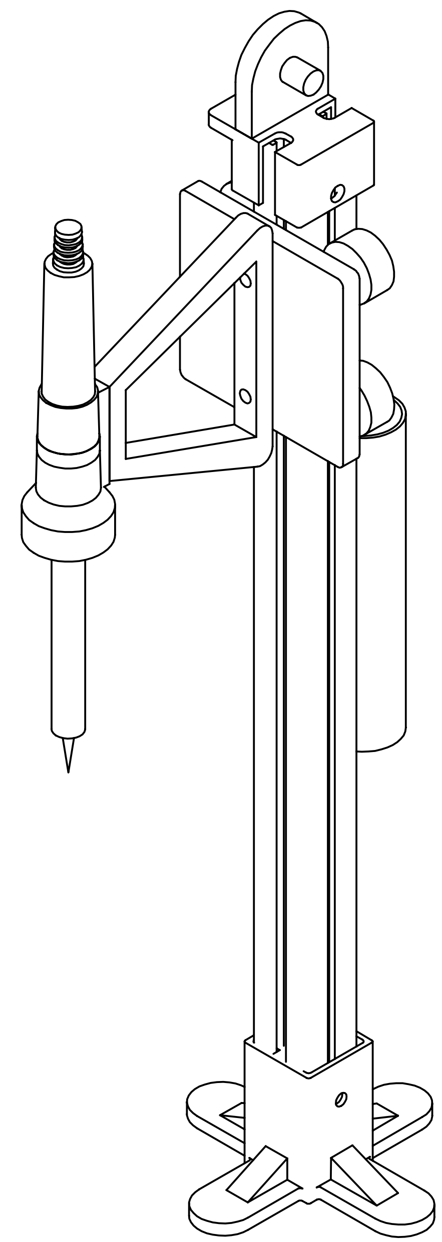
	NAME	DATE
DRAWN	M. Warren	4/2/21
CHECKED	J. Bolton	4/3/21
ENG APPR.	D. Douglas	4/3/21

pandemonium

TITLE:

Mount Plate

SIZE	DWG. NO.	REV
B	006	A
SCALE: 4:1	WEIGHT: 0.00LBS	SHEET 1 OF 1



R&D
FOR ENGINEERING USE ONLY

UNLESS OTHERWISE SPECIFIED
ALL DIMESNSIONS ARE IN INCHES
TOLERANCE OF ANGLE ±0.5°
.X :±0.03 .XX: ±0.01 .XXX: ±0.005
INTERPRET DIMENSIONS AND TOLERANCES
PER ASME Y14.5M-2009
DO NOT SCALE DRAWINGS

THIRD ANGLE PROJECTION

PROPRIETARY AND CONFIDENTIAL

CONTRACT NUMBER: N/A
MATERIAL
FINISH N/A

	NAME	DATE
DRAWN	M. Warren	4/2/21
CHECKED	J. Bolton	4/3/21
ENG APPR.	D. Douglas	4/3/21

pandemonium

TITLE:
Heat Set Insert Rig Assembly

SIZE	DWG. NO.	REV
B	007	A

SCALE: 1:8 WEIGHT: 1.23LBS SHEET 1 OF 1