Popup Fixture

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Senior Design
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Abstract

This paper outlines the details of the senior design project of Aaron Lute and Stephen England. It explains the problem that needs solved with the current fixture and their solution to the various problems of that fixture. It talks about the goals of the project and the initial specifications that were laid out. It goes over the fabrication procedure and the testing done to make sure the fixture held up to the needs of the machine. It then displays the testing results and analyzes them. It shows the overall cost of the project and concludes with talking about the project's success.

Introduction

The sponsor for this project was Avalign Cutting Instruments. They were having some trouble with a fixture for their Excalibur E60 machine. This machine is used to grind and sharpen medical grade drills. The purpose of this paper is to explain our project and how we solved the problem Avalign had with its current fixture. First the paper will give some background on the team working on the project. The paper will then go over the problems with the current fixture. It will then state our solution to the problem and how we plan to improve upon the problems. Then the paper will outline the testing procedures that were used and then show the test results and the analysis of those results. After that the paper will show the overall costs of the project. Lastly is the conclusion, which will state whether the project did an adequate job of solving the problem or not.

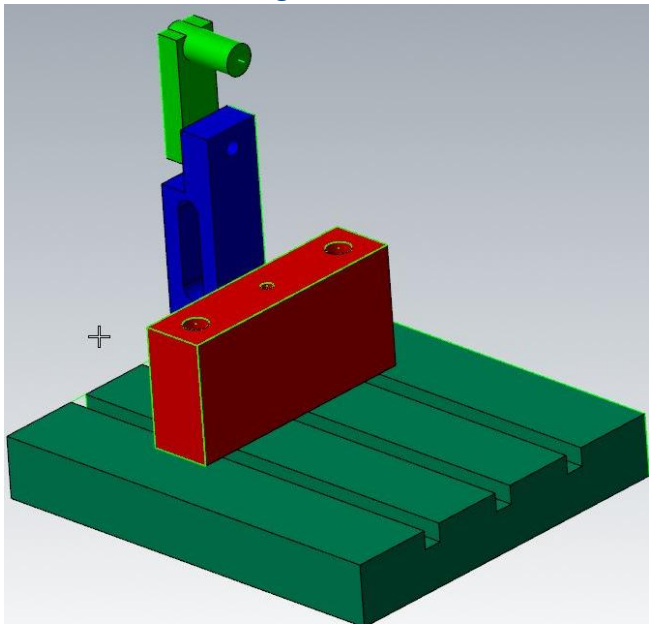
Background

The team working on this project consisted of two members: Aaron Lute, and Stephen England. Both team members are about to graduate with degrees while studying Mechanical Engineering Technology at IPFW. This gave the team the knowledge needed to undertake a project like this. Stephen had also worked at Avalign for a number of years before this, therefore giving him experience with fixtures and machines like the one being worked on. So the background of the team was sufficient to undergo this project.

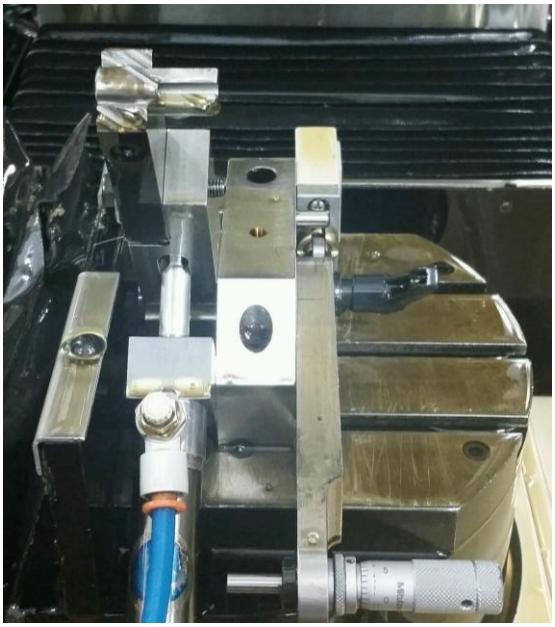
Problem Statement

The problem with the current situation is the fixture holding the work piece. The current fixture uses an arm attached to a base via a guide pin and bearings. It uses an air cylinder to rotate the arm to an upward position where it is held against a hard stop. Another holding fixture is attached to the top of the arm by the use of a bolt. The height is not perfectly aligned to center and has to be set by feel by the operator.

A CAD drawing of the current fixture



And a picture of the current fixture.



The design of the current fixture causes a number of problems. One problem is that there can be no fine adjustment in the vertical up or down directions. The motion of the fixture makes it possible for the upper fixture to shift from side to side. There are also some problems with the actuating cylinder. The pressure has to be just right for it to work correctly. If there is too much pressure the fixture will shift due to the impact. However if there is too little pressure the fixture will not stay in place. Perhaps the biggest problem is the pin that the fixture arm rides on. This pin is .250 inches in diameter and is designed to be the breaking point, and is therefore made of a softer material. Since this is the case the pin is easily bent and the shaft then has to be replaced. It then takes about two hours to replace it and to realign the fixture. So all the problems with the current fixture combine to make it inaccurate and it has a lot of downtime because of the pin needing to be frequently replaced.

Solution

The solution to the problems presented by the current fixture is to design and create a new fixture that improves in accuracy and reduces the down time. The group came up with an idea for a fixture called a pop up fixture. The pop up fixture will be able to adjust in the vertical up and down directions and will use easily interchangeable parts.

Goals for New Fixture

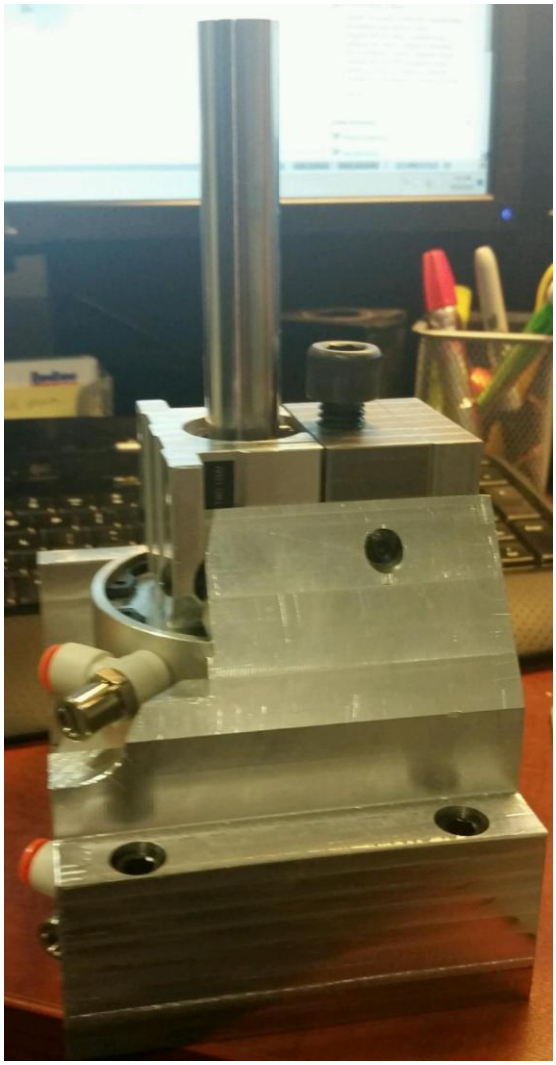
The goals for the new fixture are basically to try and remove the problems of the old fixture. The fixture will allow for extended height to be adjusted and all motion is only in the vertical up or down directions. Eliminate the ability of the upper fixture to shift to the sides due to motion. The soft break point will be replaced with the force of an impact being focused back onto the cylinder which will protect the fixture. The downtime will be heavily reduced because of the soft break point of the pin being replaced.

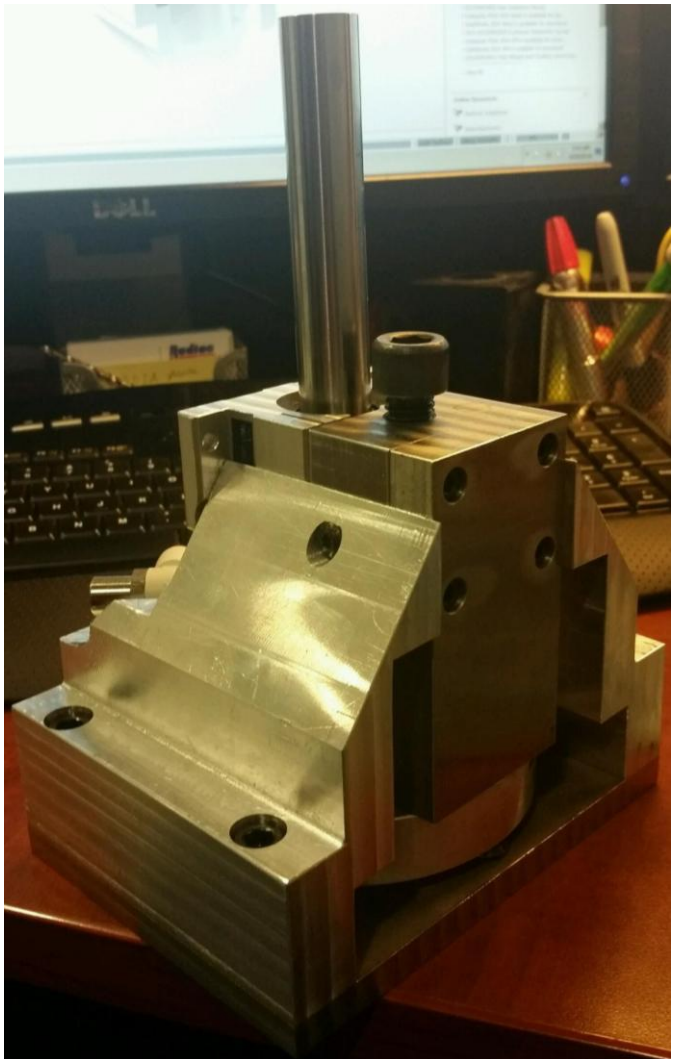
Initial Performance Specifications

The fixtures initial performance specifications were as follows. The fixture will have the ability to be adjusted up and down. The fixture will have repeatability within .0005. Lastly the fixture should have parts that are easily interchangeable.

Fabrication Procedure

For fabricating the fixture a good portion of the parts were ordered from McMaster-Carr. The parts that were actually fabricated by the group were done on lathes, mills and wire emd machines. The parts were then assembled and the following pictures show what the completed fixture looks like.



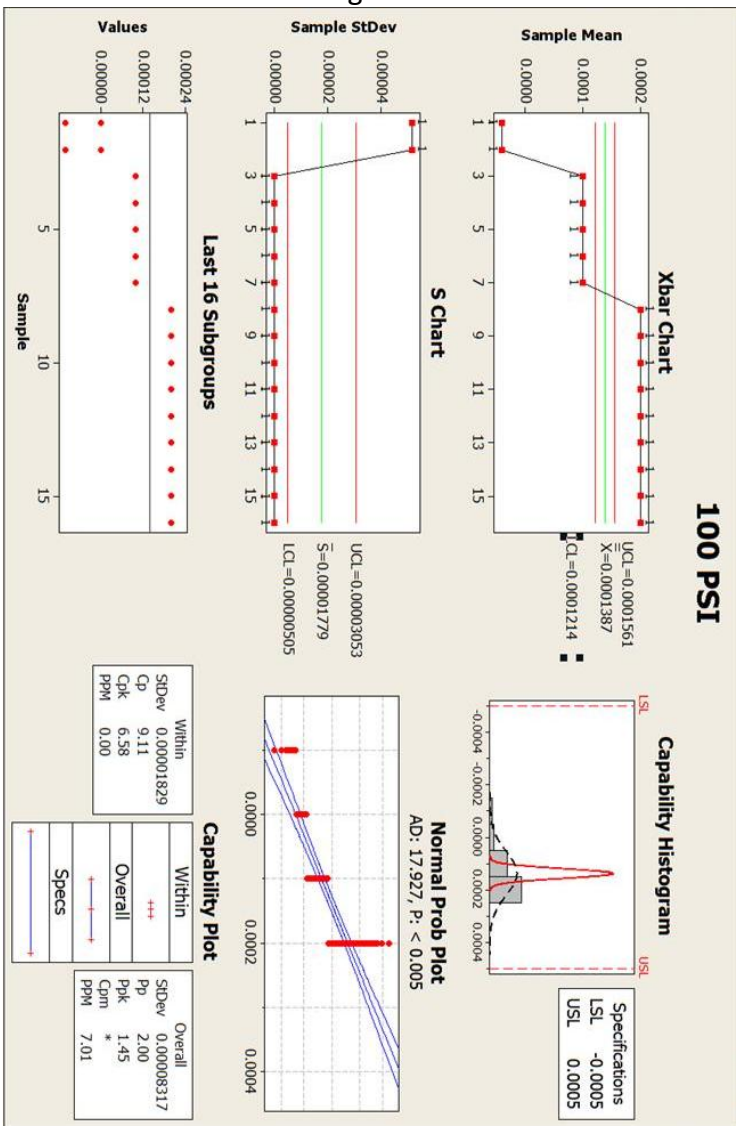


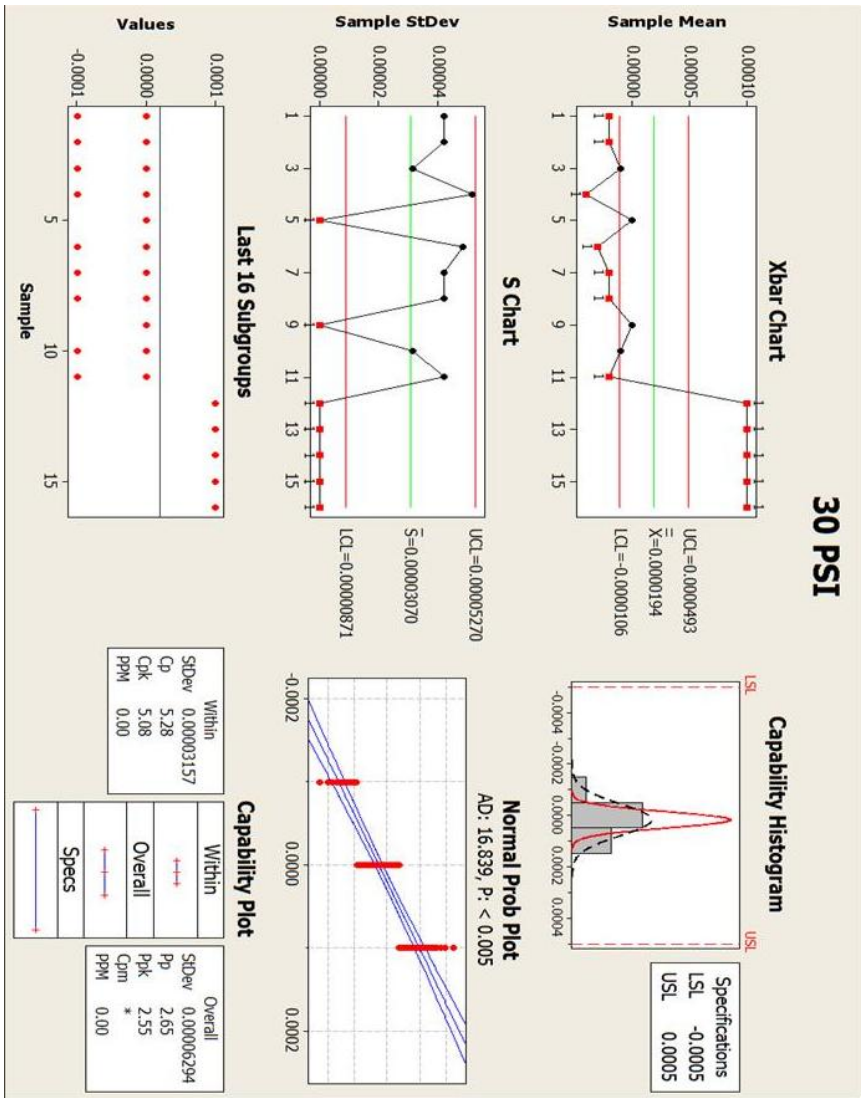
Testing Procedures

The testing done was to test for static repeatability at the maximum and minimum psi. For testing the maximum and minimum allowed by the machine will be used to test the fixture. The fixture was clamped to a surface plate and a pressure regulator along with some air valves were used to monitor the pressure. Using a height gage and a dial indicator with 0.0001 precision the indicator was mounted in the height gage and the dial indicator was zeroed to the extended position of the fixture. The cylinder was then actuated and the results were recorded. The measurements were taken 10 cycles at a time every 50th cycle for the first 500 cycles. After that measurements were taken every 100th cycle.

Testing Results

The results of the testing showed that the fixture would hold up to the maximum and minimum of the machine. The Results are in the following charts. The measurements are in appendix A.





Comparison of Initial Specifications and Test Results

The initial specifications planned for a 2.5 inch stroke length. This was changed to a length of 1.1 inches because the current work envelope was limited. It was planned to be an indirect driven fixture but was changed to direct driven due again to limited space. The cylinder pressure desired had to be changed as well. The initial specification was going to be a desired force of 300 lbs at 100 psi but it changed to a cylinder with a force of 700 lbs at 100 psi. This made for a more ridged system.

Overall Costs

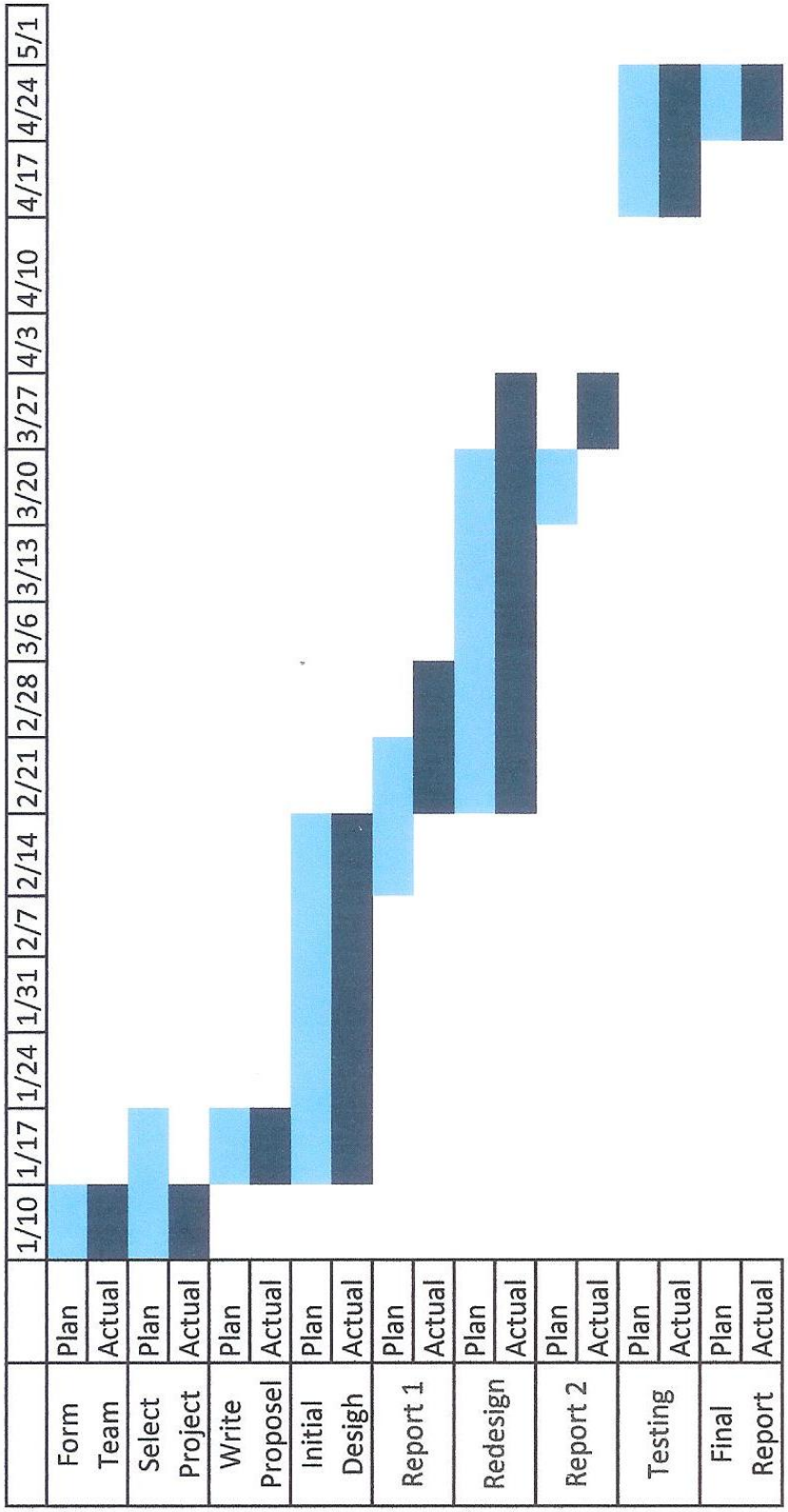
Original units cost $1400 each

Materials			Cost	Cost 15
Main Housing	T6061 Aluminum	MSC	159.73	479.19
Control Featuring	A2 Tool Steel	MSC	86.53	86.53
Bearing	6489K53	McMaster-Carr	57.35	860.25
Air Cylinder	6212K296	McMaster-Carr	153.65	2304.75
Shaft (Steel)	6649K71	McMaster-Carr	38.62	579.3
Air Fittings	on Hand	on Hand		
Machine time cost	6 hrs.			216
			495.88	4526.02

Conclusion

The fixture accomplished all of the goals that were set for this project. It solved the problems of low accuracy and high down time that the old fixture had and the testing showed that it would hold up to the maximum and minimum pressures that the machine would apply to the fixture. The costs of the fixture were within the budget and the project was completed without any big problems. Therefore the project would be considered successful on all accounts.

Gantt Chart


1/10
1/17
1/24
1/31
2/7
2/14
2/21
2/28
3/6
3/13
3/20
3/27
4/3
4/10
4/17
4/24
5/1
Form Team
Plan
Actual
Select Project
Plan
Actual
Write Proposel
Plan
Actual
Initial Desigh
Plan
Actual
Report 1
Plan
Actual
Redesign
Plan
Actual
Report 2
Plan
Actual
Testing
Plan
Actual
Final Report
Plan
Actual

Appendix A

PSI~100															
Cycle #	1-10	50-60	100-110	150-160	200-210	250-260	300-310	350-360	400-410	450-460	500-510	600-610	700-710	800-810	900-910
1	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
2	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
3	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
4	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
5	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
6	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
7	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
8	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
9	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
10	.0000	.0000	.0001	.0001	.0001	.0001	.0001	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002

PSI~30															
Cycle #	1-10	50-60	100-110	150-160	200-210	250-260	300-310	350-360	400-410	450-460	500-510	600-610	700-710	800-810	900-910
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
3	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
4	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
5	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
6	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
7	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0001	.0001	.0001
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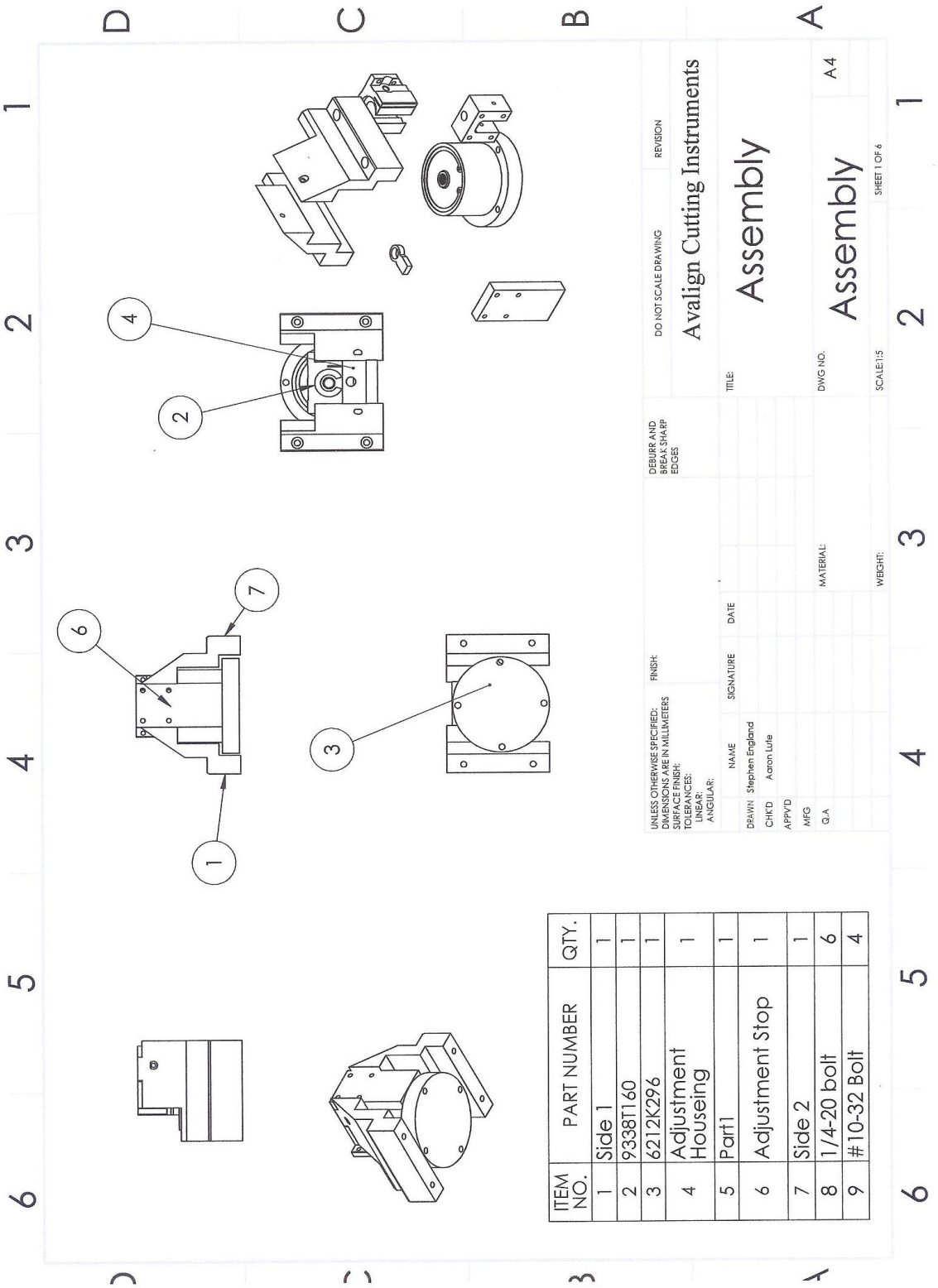
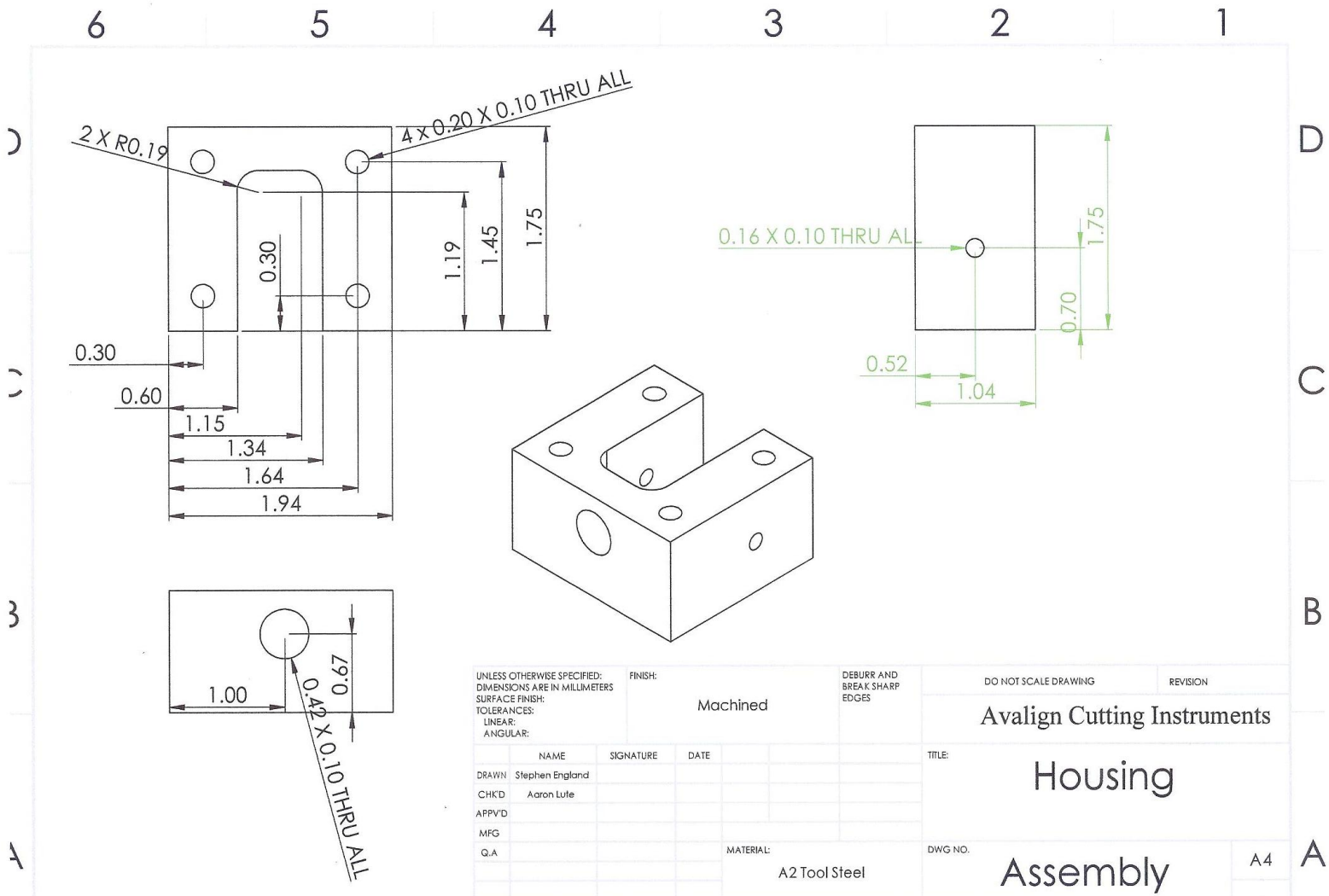
Appendix B



ITEM NO.	PART NUMBER	QTY.
1	Side 1	1
2	9338T160	1
3	6212K296	1
4	Adjustment Houseing	1
5	Part1	1
6	Adjustment Stop	1
7	Side 2	1
8	1/4-20 bolt	6
9	#10-32 Bolt	4


6
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4
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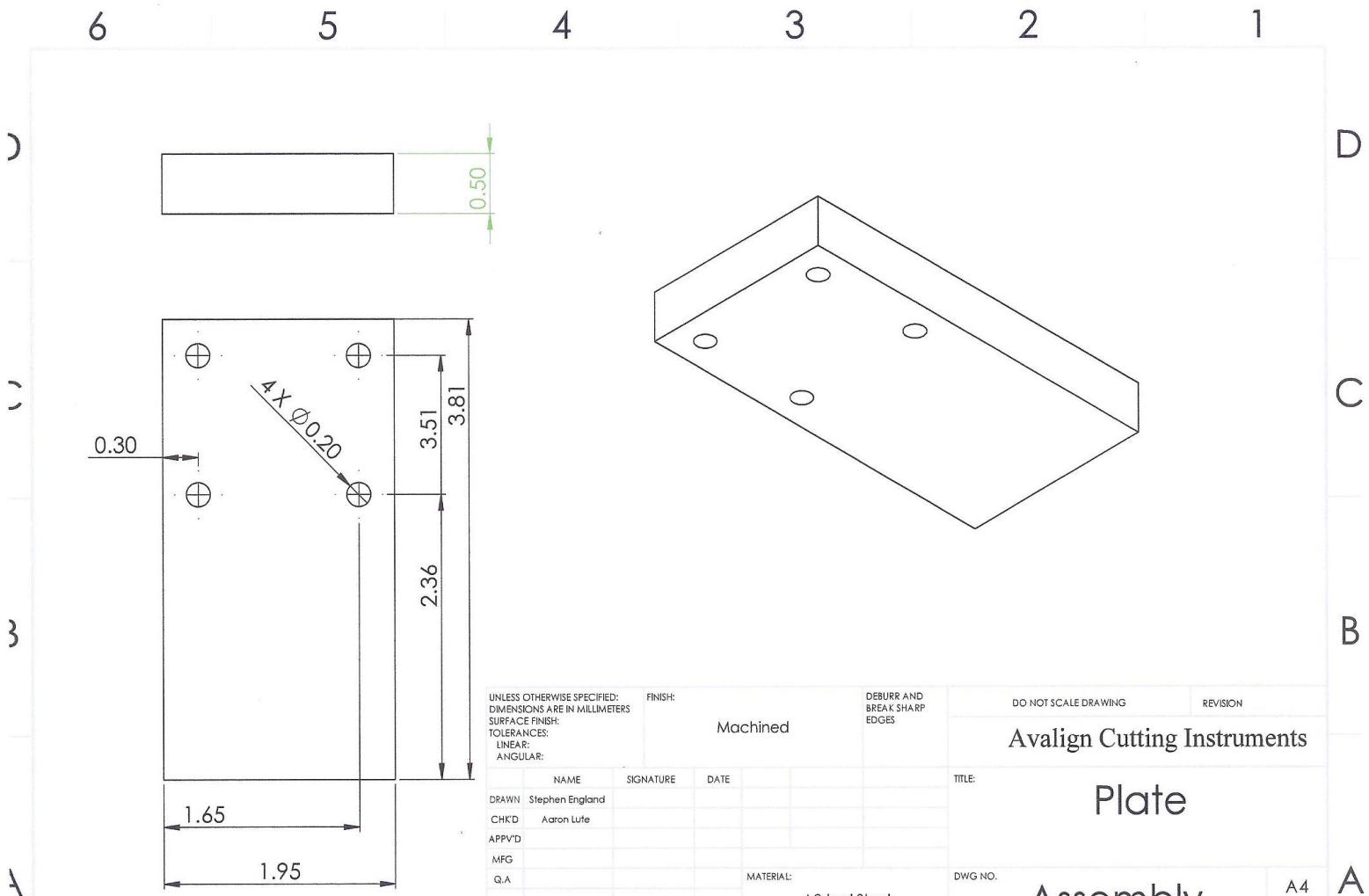
1
D
C
B
A
2 X R0.19
4 X 0.20 X 0.10 THRU ALL
0.30
1.19
1.45
1.75
0.30
0.60
1.15
1.34
1.64
1.94
0.16 X 0.10 THRU ALL
1.75
0.70
0.52
1.04
1.00
0.67
0.42 X 0.10 THRU ALL
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
Machined
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
Avalign Cutting Instruments
NAME
SIGNATURE
DATE
DRAWN Stephen England
CHK'D Aaron Lute
APPV'D
MFG
Q.A
TITLE:
Housing
MATERIAL:
A2 Tool Steel
DWG NO.
Assembly
A4
WEIGHT:
SCALE:1:1
SHEET 2 OF 6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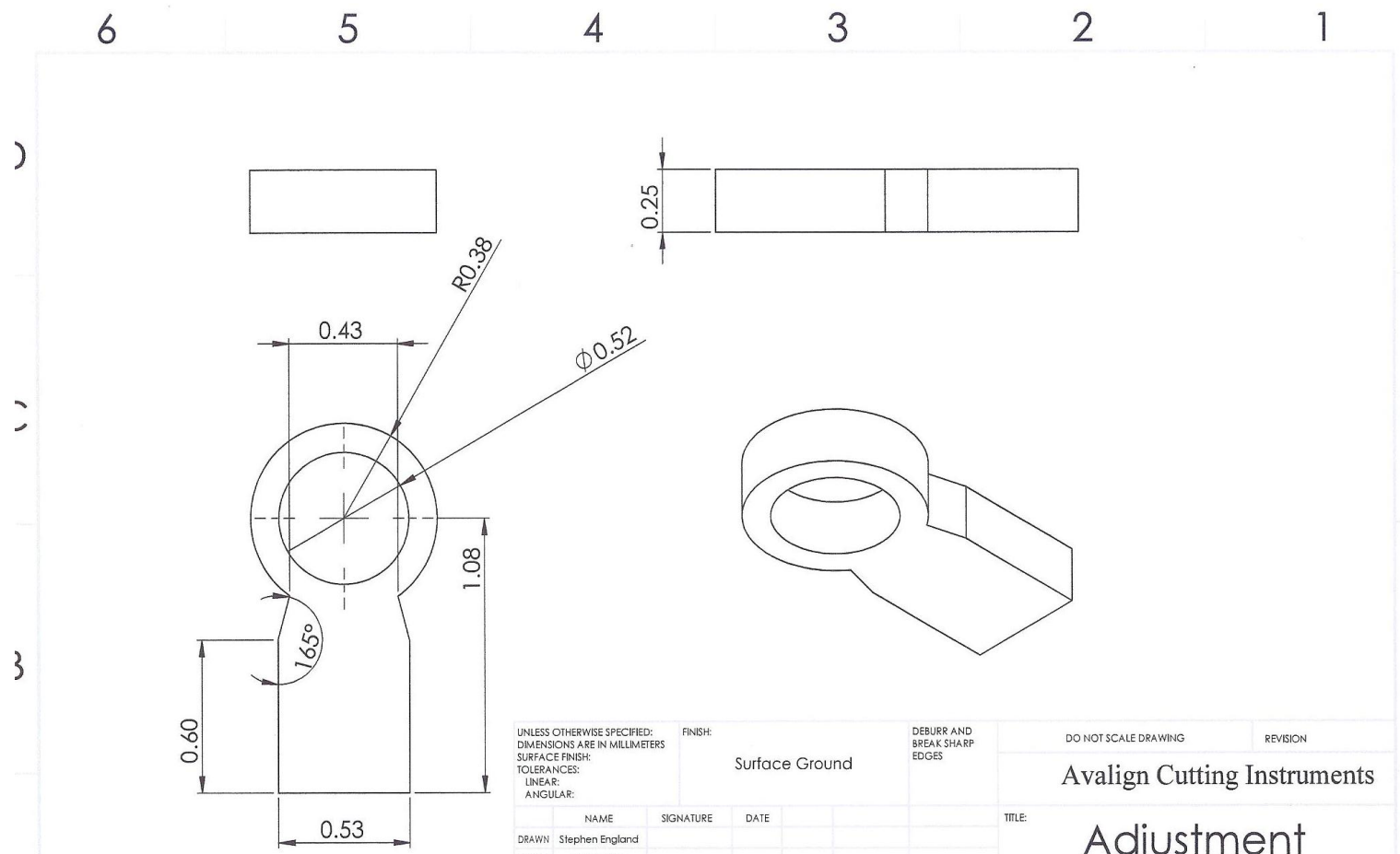
TOLERANCES:
LINEAR:
ANGULAR:
FINISH:
Machined
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
Avalign Cutting Instruments
NAME
SIGNATURE
DATE
DRAWN Stephen England
CHK'D Aaron Lute
APPV'D
MFG
Q.A
TITLE:
Plate
MATERIAL:
A2 tool Steel
DWG NO.
Assembly
A4
WEIGHT:
SCALE:1:1
SHEET 3 OF 6



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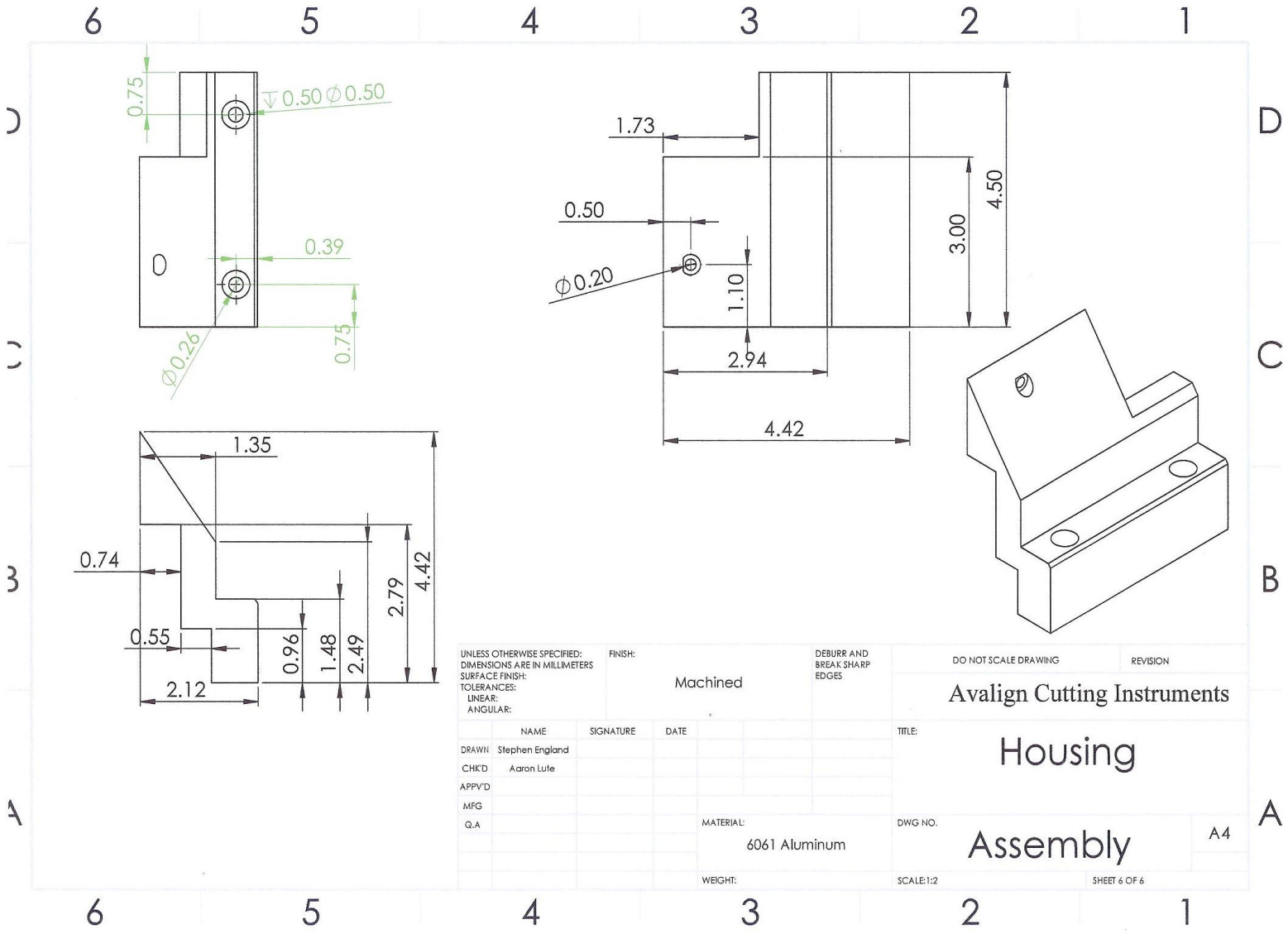
	NAME	SIGNATURE	DATE	Avalign Cutting Instruments		
DRAWN	Stephen England			TITLE: Adjustment Stop Assembly		
CHK'D	Aaron Lute					
APPV'D						
MFG						
Q.A				MATERIAL: A2 Tool Steel	DWG NO.	A4
				WEIGHT:	SCALE:2:1	SHEET 4 OF 6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3.00
4.50
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UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
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FINISH:
Machined
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
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Avalign Cutting Instruments
NAME
SIGNATURE
DATE
DRAWN Stephen England
CHK'D Aaron Lute
APPV'D
MFG
Q.A
TITLE:
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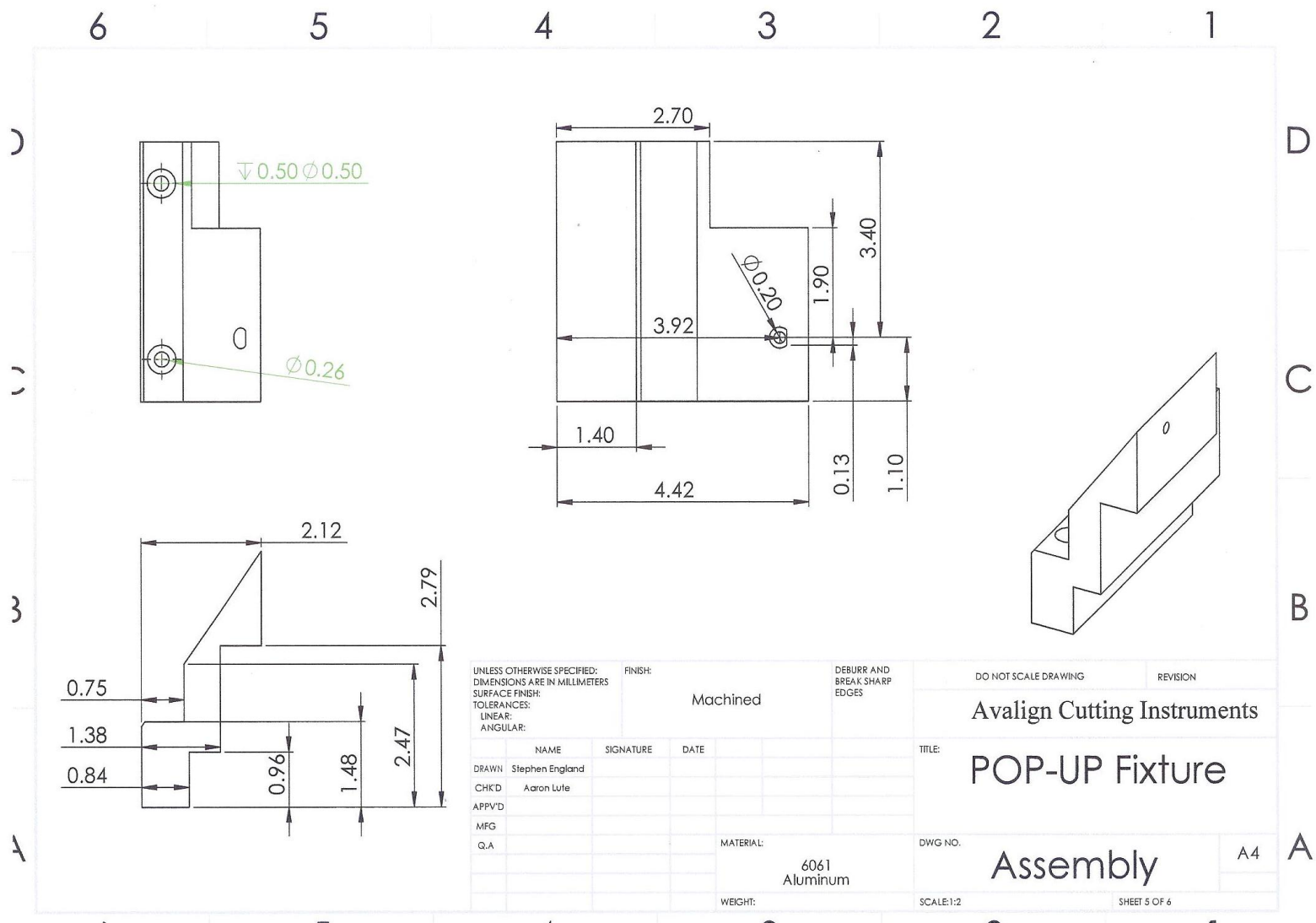
SHEET 6 OF 6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DIMENSIONS ARE IN MILLIMETERS
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LINEAR:
ANGULAR:
FINISH:
Machined
DEBURR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
REVISION
Avalign Cutting Instruments
NAME
SIGNATURE
DATE
DRAWN Stephen England
CHK'D Aaron Lute
APPV'D
MFG
Q.A
TITLE:
POP-UP Fixture
MATERIAL:
6061
Aluminum
DWG NO.
Assembly
A4
WEIGHT:
SCALE:1:2
SHEET 5 OF 6