



MECH 202 PROJECT 1 GROUP 17

Staple Gun Reverse Engineering + Analysis

3/15/2019

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Photos of Device Overlaid



Figure 2.1: Image of Actual Assembled Staple Gun

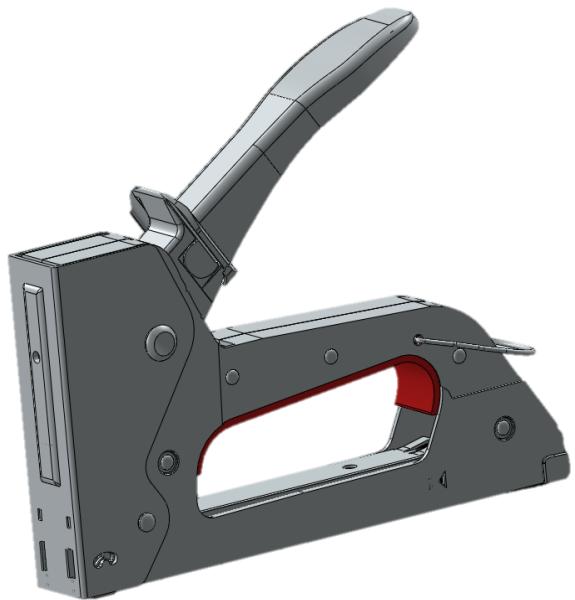


Figure 2.2 : 3D Model Image



Figure 2.3: Superimposed image



Project Plan

The team met every week on Mondays from 11 am to 2 pm. Each week members were given individual as well as group tasks to get done before the next meeting. Tasks were given based on the project plan and deliverables. The Gantt Chart was updated each week to keep track of group progress. Team Dynamics were assessed each week as well.



MECH 202 PROJECT 1

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Table 3.1: Project Planning for Group 17

Project Planning	
Design Organization: Mech 202 Group 17	Date: 2/5/19
Product Name: Staple Gun Analysis	
Task: #1	Name of Task: Pick up Staple Gun Objective: Obtain staple gun from Dr. Roberts Deliverables: <u>Arrow model JT27 staple gun in package</u> Decisions/Milestones with Dates: 1. Who will obtain staple gun? 2. Who will hold on to staple gun until disassembly? Personnel Needed: Title: Garrett Hours: 1 Percent full time: 2.86% Time: Estimated Total Hours: 1 Actual Total Hours: 1 Sequence: Predecessors: none Successors: Tasks 2-10 Planned Start Date: 1/24/19 Planned Finish Date: 1/24/19 Actual Start Date: 1/24/19 Actual Finish Date: 1/24/19 Costs: Capital Equipment: \$0 (paid by fees) Disposables: \$0
Task: #2	Name of Task: Disassemble staple gun Objective: Acquire information on how staple gun works by disassembly Deliverables: Determine the 20 most important parts Determine 6 customer requirements Decide on recommended improvement for design of staple gun Decisions/Milestones with Dates: 1. What is the best way to disassemble? 2. How will the disassembly be recorded? Personnel Needed: Title: Hunter B Hours: 2 Percent full time: 14.3% Title: Alec D Hours: 2 Percent full time: 15.4% Title: Josh E Hours: 2 Percent full time: 15.4% Title: Garrett J Hours: 2 Percent full time: 5.71% Title: Jethro L Hours: 2 Percent full time: 6.1% Time: Estimated Total Hours: 5 Actual Total Hours: 10 Sequence: Predecessors: Task 1 Successors: Tasks 3-10 Planned Start Date: 1/30/19 Planned Finish Date: 1/30/19 Actual Start Date: 1/30/19 Actual Finish Date: 1/30/19 Costs: Capital Equipment \$0 Disposables: \$0
Team member: Hunter B	Team member: Alec D
Team member: Josh E	Prepared by: Hunter B and Alec D
Team member: Garrett J	Checked by: Josh E
Team member: Jethro L	Approved by: Jethro L and Garrett J
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MECH 202 PROJECT 1

GROUP 17

Project Planning

Design Organization: Mech 202 Group 17 **Date:** 2/5/19

Product Name: Staple Gun Analysis

Task: #3	Name of Task: Create bill of Materials (BOM) Objective: Provide enough information about materials that someone unfamiliar with the product could find and order every component in the device Deliverables: Determine how each part was manufactured Identify dimensions, quantities, and type of material for each manufactured part Decisions/Milestones with Dates: 1. How will we determine manufacturing processes and material used? 2. What units will we use (US or metric)? Personnel Needed: Title: Hunter Hours: 3 Percent full time: 21.4% Title: Alec D Hours: 3 Percent full time: 23.1% Title: Josh E Hours: 3 Percent full time: 23.1% Time: Estimated Total Hours: 5 Actual Total Hours: 9 Sequence: Predecessors: Task 1 and 2 Successors: Tasks 4-10 Planned Start Date: 2/9/19 Planned Finish Date: 2/16/19 Actual Start Date: 2/6/19 Actual Finish Date: 2/25/19 Costs: Capital Equipment: \$0 (paid by fees) Disposables: \$0
Task: #4	Name of Task: 3D Models of 20 Parts Objective: Using Solidworks, 3D model the 20 most significant parts. Take images of 3D models Deliverables: Create 20 Solidwork parts using correct dimensions Identify how the 20 parts fit together in a subassembly Decisions/Milestones with Dates: 1. What units to use? 2. How will we check if the parts will assemble together? 3. How tight of tolerance should the dimensions be within? Personnel Needed: Title: Garrett J Hours: 20 Percent full time: 57.1% Title: Jethro L Hours: 20 Percent full time: 60.6% Title: Hunter B Hours: 1 Percent full time: 7.14% Time: Estimated Total Hours: 40 Actual Total Hours: 40 Sequence: Predecessors: Task 1-3 Successors: Tasks 5-10 Planned Start Date: 2/7/19 Planned Finish Date: 2/18/19 Actual Start Date: 2/7/19 Actual Finish Date: 2/25/19 Costs: Capital Equipment \$0 Disposables: \$0
Team member: Hunter B	Team member: Alec D
Team member: Josh E	Prepared by: Hunter B and Alec D
Team member: Garrett J	Checked by: Josh E
Team member: Jethro L	Approved by: Jethro L and Garrett J
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GROUP 17

Project Planning

Design Organization: Mech 202 Group 17 **Date: 2/5/19**

Product Name: Staple Gun Analysis

Task: #5	Name of Task: 2D Engineering Drawings Objective: Create 2D engineering drawings for the 20 most significant components with 3-6 most important dimensions (related to assembly) labelled Deliverables: Determine the most significant dimensions related to assembly Understand how all the parts interact and assemble together Decisions/Milestones with Dates: 1. How will we determine most important dimensions? 2. How will we format these drawings? Personnel Needed: Title: Garrett J Hours: 5 Percent full time: 14.3% Time: Estimated Total Hours: 4 Actual Total Hours: 5 Sequence: Predecessors: Task 1-4 Successors: Tasks 6-10 Planned Start Date: 2/19/19 Planned Finish Date: 2/22/19 Actual Start Date: 2/21/19 Actual Finish Date: 3/10/19 Costs: Capital Equipment: \$0 (paid by fees) Disposables: \$0
Task: #6	Name of Task: Create Assembly Objective: Create a solid model assembly of entire device. Create an exploded assembly diagram of whole device with parts referenced to BOM Deliverables: Understand how certain parts meet functionality of the staple gun Understand how the part is assembled Decisions/Milestones with Dates: Milestone 1: Assembly of entire staple gun Milestone 2: Create a subassembly of staple gun Personnel Needed: Title: Jethro L Hours: 4 Percent full time: 12.12% Time: Estimated Total Hours: 6 Actual Total Hours: 4 Sequence: Predecessors: Task 1-5 Successors: Tasks 7-10 Planned Start Date: 2/22/19 Planned Finish Date: 3/1/19 Actual Start Date: 2/22/19 Actual Finish Date: 2/26/19 Costs: Capital Equipment \$0 Disposables: \$0
Team member: Hunter B	Team member: Alec D
Team member: Josh E	Prepared by: Hunter B and Alec D
Team member: Garrett J	Checked by: Josh E
Team member: Jethro L	Approved by: Jethro L and Garrett J
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Project Planning

Design Organization: Mech 202 Group 17

Date: 2/5/19

Product Name: Staple Gun Analysis

Task: #7	Name of Task: Product Improvement (on going)
	Objective: Identify improvements that could be made to the staple gun
	Deliverables: Understand target customer and their needs for the device Determine competition in staple gun field
	Decisions/Milestones with Dates:
	Milestone 1: Quality Function Deployment (QFD) template
	Milestone 2: Customer Requirements Developed template
	Personnel Needed:
	Title: Hunter B Hours: 2 Percent full time: 14.3%
	Title: Alec D Hours: 2 Percent full time: 15.4%
	Title: Josh E Hours: 2 Percent full time: 15.4%
	Title: Garrett J Hours: 2 Percent full time: 5.71%
	Title: Jethro L Hours: 2 Percent full time: 6.1%
	Time: Estimated Total Hours: 10 Actual Total Hours: 10
	Sequence: Predecessors: Task 1-6 Successors: Tasks 8-10 Planned Start Date: 3/1/19 Planned Finish Date: 3/5/19 Actual Start Date: 2/26/19 Actual Finish Date: 3/10/19
	Costs: Capital Equipment: \$0 (paid by fees) Disposables: \$0
Task: #8	Name of Task: Modeling Improvements
	Objective: Create a model of an improved (redesigned) staple gun
	Deliverables: A 3D model of the staple gun with the advancement
	Decisions/Milestones with Dates: How will we execute improvements to the 3D model of the staple gun?
	Personnel Needed:
	Title: Hunter B Hours: 2 Percent full time: 14.3%
	Title: Alec D Hours: 2 Percent full time: 15.4%
	Title: Josh E Hours: 2 Percent full time: 15.4%
	Title: Garrett J Hours: 2 Percent full time: 5.71%
	Title: Jethro L Hours: 2 Percent full time: 6.1%
	Time: Estimated Total Hours: 10 Actual Total Hours: 10
	Sequence: Predecessors: Task 1-7 Successors: Tasks 9-10 Planned Start Date: 3/5/19 Planned Finish Date: 3/9/19 Actual Start Date: 2/26/19 Actual Finish Date: 3/10/19
	Costs: Capital Equipment \$0 Disposables: \$0
Team member: Hunter B	Team member: Alec D
Team member: Josh E	Prepared by: Hunter B and Alec D
Team member: Garrett J	Checked by: Josh E
Team member: Jethro L	Approved by: Jethro L and Garrett J
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Project Planning

Design Organization: Mech 202 Group 17

Date: 2/5/19

Product Name: Staple Gun Analysis

Task: #9	Name of Task: Prepare Report Objective: Complete all project requirements and proofread for errors Deliverables: A well written report that meets our team goals and expectations Decisions/Milestones with Dates: How do we organize the information in our report? How do we create a wow factor in our report? Personnel Needed: Title: Hunter B Hours: 3 Percent full time: 21.4% Title: Alec D Hours: 3 Percent full time: 23.1% Title: Josh E Hours: 3 Percent full time: 23.1% Title: Garrett J Hours: 2 Percent full time: 5.71% Title: Jethro L Hours: 2 Percent full time: 6.1% Time: Estimated Total Hours: 7 Actual Total Hours: 13 Sequence: Predecessors: Task 1-8 Successors: Tasks 10 Planned Start Date: 3/9/19 Planned Finish Date: 3/13/19 Actual Start Date: 3/10/19 Actual Finish Date: 3/11/19 Costs: Capital Equipment: \$0 (paid by fees) Disposables: \$0
Task: #10	Name of Task: Turn in Report Objective: Turn in an excellent project #1 Deliverables: A final project worthy of an A Decisions/Milestones with Dates: How do we make our project stand out? Personnel Needed: Title: Hunter B Hours: 1 Percent full time: 7.14% Title: Alec D Hours: 1 Percent full time: 7.7% Title: Josh E Hours: 1 Percent full time: 7.7% Title: Garrett J Hours: 1 Percent full time: 2.86% Title: Jethro L Hours: 1 Percent full time: 3.03% Time: Estimated Total Hours: 10 Actual Total Hours: 5 Sequence: Predecessors: Task 1-9 Successors: Tasks None Planned Start Date: 3/14/19 Planned Finish Date: 3/14/19 Actual Start Date: Actual Finish Date: Costs: Capital Equipment \$0 Disposables: \$0
Team member: Hunter B	Team member: Alec D
Team member: Josh E	Prepared by: Hunter B and Alec D
Team member: Garrett J	Checked by: Josh E
Team member: Jethro L	Approved by: Jethro L and Garrett J
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Table 3.2: Design Structure Matrix

DESIGN STRUCTURE MATRIX												
TASKS		A	B	C	D	E	F	G	H	I	J	
Pick Up Staple Gun	A	A										
Disassemble Staple Gun	B	X	B									
Create BOM	C		X	C								
Create 3D Models of Parts	D		X		D							
Compile Engineering Drawings	E				X	E						
Create 3D Assembly	F					X	F					
Identify Product Improvements	G						X	G				
Model Improvements	H	X	X	X	X	X	X	X	H			
Prepare Report	I	X	X	X	X	X	X	X	X	I		
Turn in Report	J	X	X	X	X	X	X	X	X	J		

*X in row show inputs to row element from other elements. X in column show outputs from column element to other elements.



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Gantt Charts

Tasks:

Task Number	Task Name	Start Date	Due Date
1	Project Conception and Initiation		
1	Pick up Staple Gun	Expected	1/29/19
	Personel: All	Actual	1/29/19
2	Disassemble staple gun	Expected	2/1/19
	Personel: All	Actual	2/1/19
3	Create bill of Materials (BOM)	Expected	2/6/19
	Personel: HB AD	Actual	2/6/19
4	3D Models of Parts	Expected	2/7/19
	Personel: GJ JL	Actual	2/7/19
5	2D Engineering Drawings	Expected	2/21/19
	Personel: GJ JL	Actual	2/21/19
6	Create Assembly	Expected	2/22/19
	Personel: JE	Actual	2/22/19
7	Product Improvement	Expected	2/25/19
	Personel: All	Actual	2/26/19
8	Modeling Improvements	Expected	2/26/19
	Personel: All	Actual	2/26/19
9	Prepare Report	Expected	3/4/19
	Personel: All	Actual	3/7/19
10	Turn in Report	Expected	3/15/19
	Personel: All	Actual	3/15/19

Figure 3.1: Gantt Chart Tasks and Progress



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Week 1

GANTT CHART



Figure 3.2: Gantt Chart Week 1



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Week 2

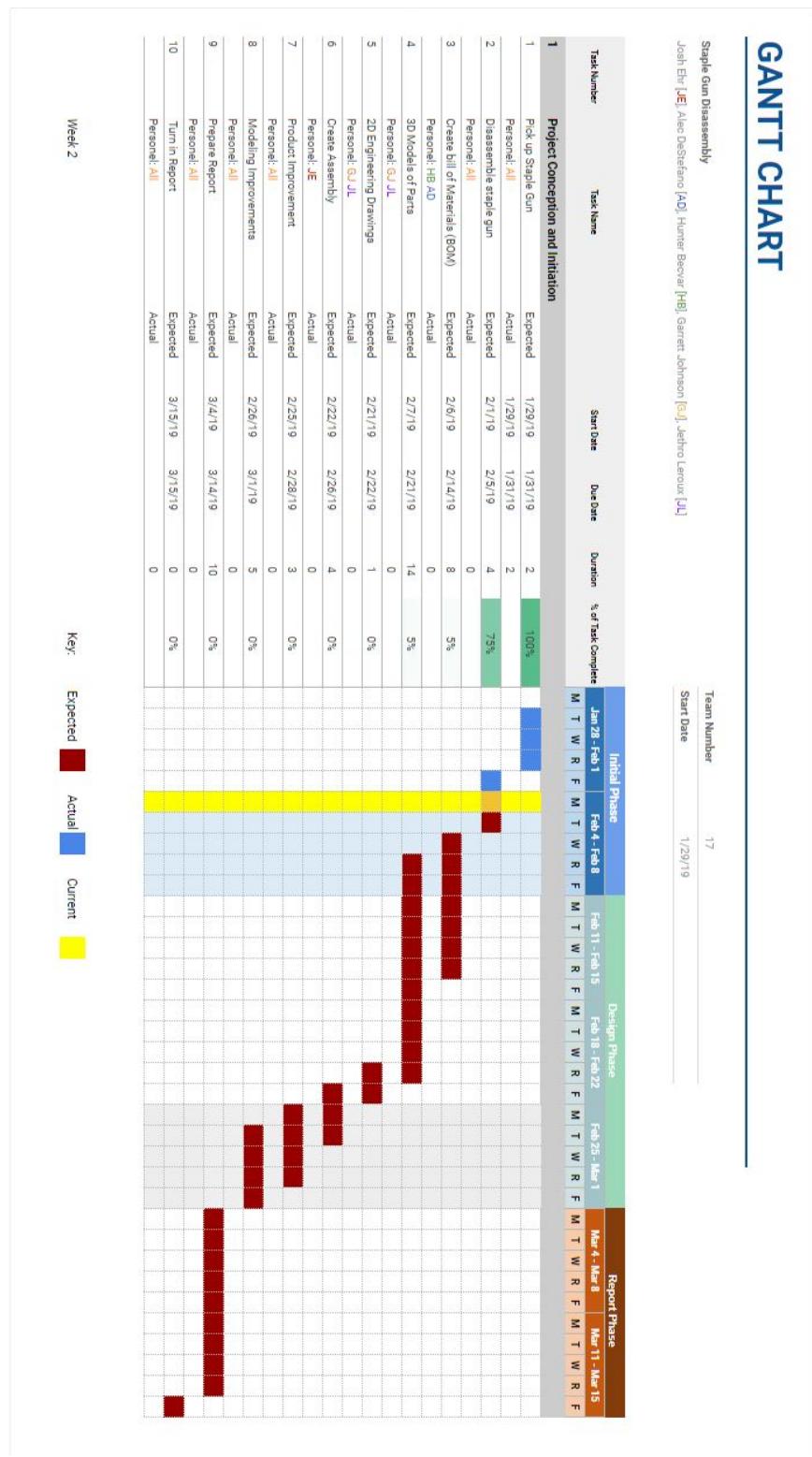


Figure 3.3: Gantt Chart Week 2



MECH 202 PROJECT 1

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Week 3

GANTT CHART

Staple Gun Disassembly
Josh Ehr [JE], Alec DeStefano [AD], Hunter Beccar [HB], Garrett Johnson [GJ], Jethro Leroux [JL]

Team Number: 17
Start Date: 1/29/19

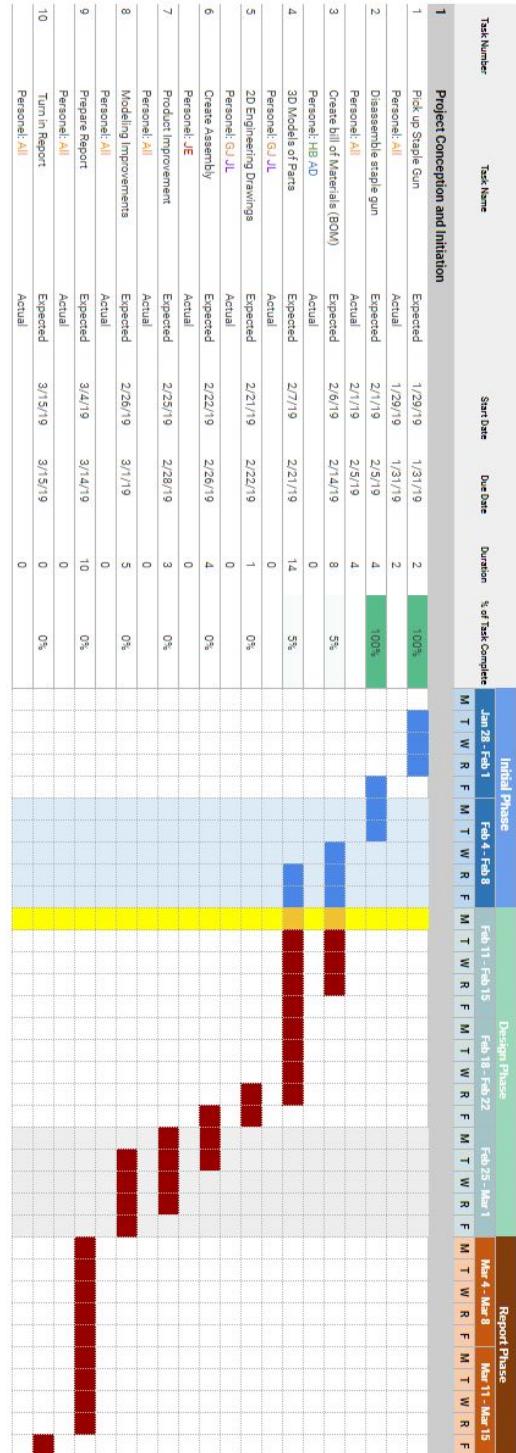


Figure 3.4: Gantt Chart Week 3



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Week 4

GANTT CHART

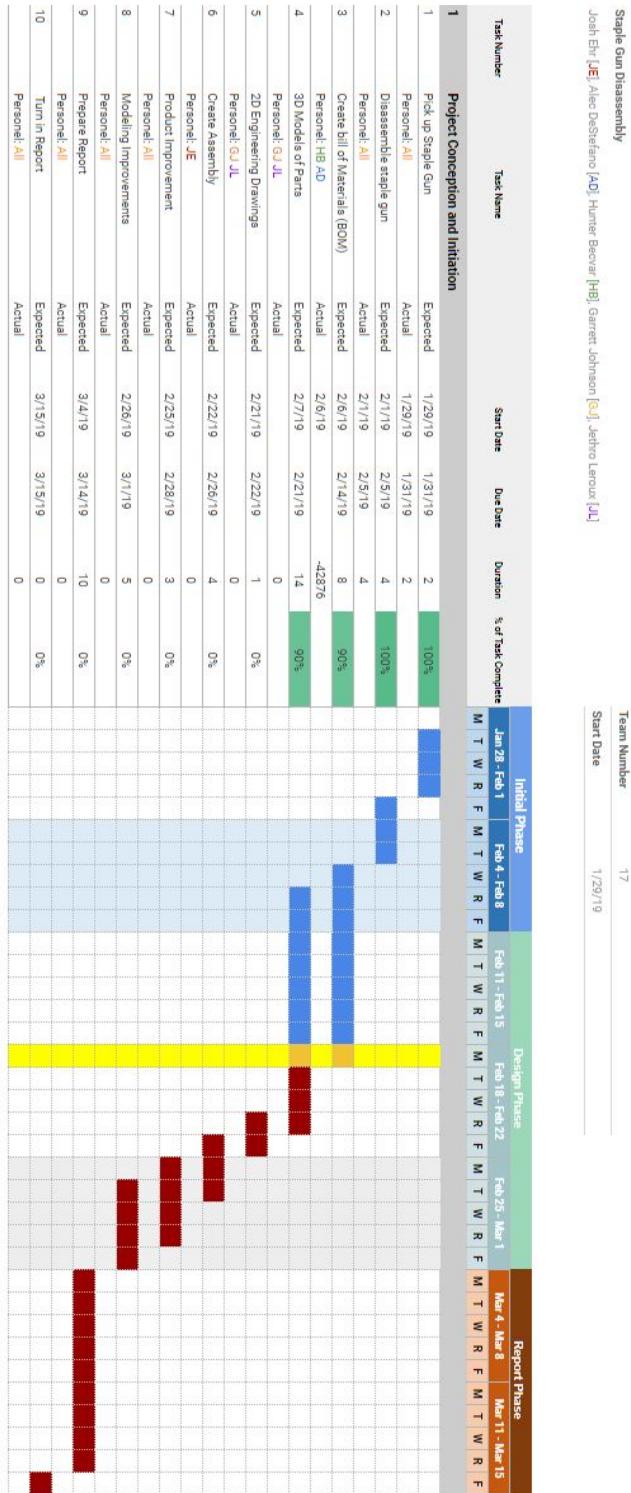


Figure 3.5: Gantt Chart Week 4



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Week 5

GANTT CHART

Team Number	17
Start Date	1/29/19

Staple Gun Disassembly

Josh Bir [JE], Alec DeStefano [AD], Hunter Bevar [HB], Garrett Johnson [GJ], Jethro Leroux [JL]



Week 5

Key:

Expected ■

Actual ■

Current ■

Figure 3.6: Gantt Chart Week 5



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Week 6

GANTT CHART

Staple Gun Disassembly
Josh Ehr [JE], Alec DesStefano [AD], Hunter Beccar [HB], Garrett Johnson [GJ], Jethro Letoux [JL]

Team Number	17
Start Date	1/29/19



Week 6

Key: Expected Actual Current

Figure 3.7: Gantt Chart Week 6



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Week 7

GANTT CHART



Figure 3.8: Gantt Chart Week 7



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Table 4.1: Bill of Materials

Bill of Materials

Product Decomposed: **Staple Gun - Arrow JT27**

Part #	Part Name	Qty	Material	Mfg Process	Image
1	.2" diameter Pin (1" length),	1	Steel with chrome finish	Cut from bar stock then the end formed with mechanical hammer	
2	.12" diameter Pin (1" length)	1	Steel with chrome finish	Cut from bar stock then the end formed with mechanical hammer	
3	.1" Diameter Pin (.7" length)	5	Steel with chrome finish	Cut from bar stock then the end formed with mechanical hammer	
4	Pin Casing	5	Steel with chrome finish	Cut from tube stock	



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5	Large Snap Ring (0.24" OD)	1	Steel with chrome finish	Stamped	
6	Trigger	1	Steel with chrome finish	Stamped and folded grip stopper spot welded to trigger	
7	Front Guard	1	Steel with chrome finish	Stamped and Folded	
8	Body Frame (L)	1	Steel with chrome finish	Stamped and folded	



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9	Hammer Spring	1	Steel	Wound wire	
10	Handle	1	Elastomer grip side and ABS plastic on the backside	Double injection mold (Soft and hard side)	
11	Trigger safety	1	Steel with chrome finish	Roll formed bar stock	
12	Inner Rod (.75" length, .15" diameter)	1	Steel with chrome finish	Cut from tube stock	



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13	Magazine Cover	1	Steel with chrome finish	Stamped and Folded	
14	Magazine	1	Steel with chrome finish	Stamped and Folded	
15	Magazine slider	1	Steel with chrome finish	Stamped and Folded	



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16	Magazine spring	1	Steel	Wound wire	
17	Spring Plates	3	Steel	Stamped then heat treated/black oxide finish	
18	Shock Reducer	1	High density polyethylene	Injection molded	
19	Casing Support (metal)	1	Steel	Stamped and folded then heat treated/black oxide finish	



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20	Hammer Strut	1	Steel	Stamped and folded then heat treated/black oxide finish	
21	Small Snap Ring (0.15" OD)	1	Steel with chrome finish	Stamped	
22	Body Frame (R)	1	Steel with chrome finish	Stamped and folded	
23	Magazine Grip	1	Polyethylene	Injection moulded	



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Exploded Assembly Diagram

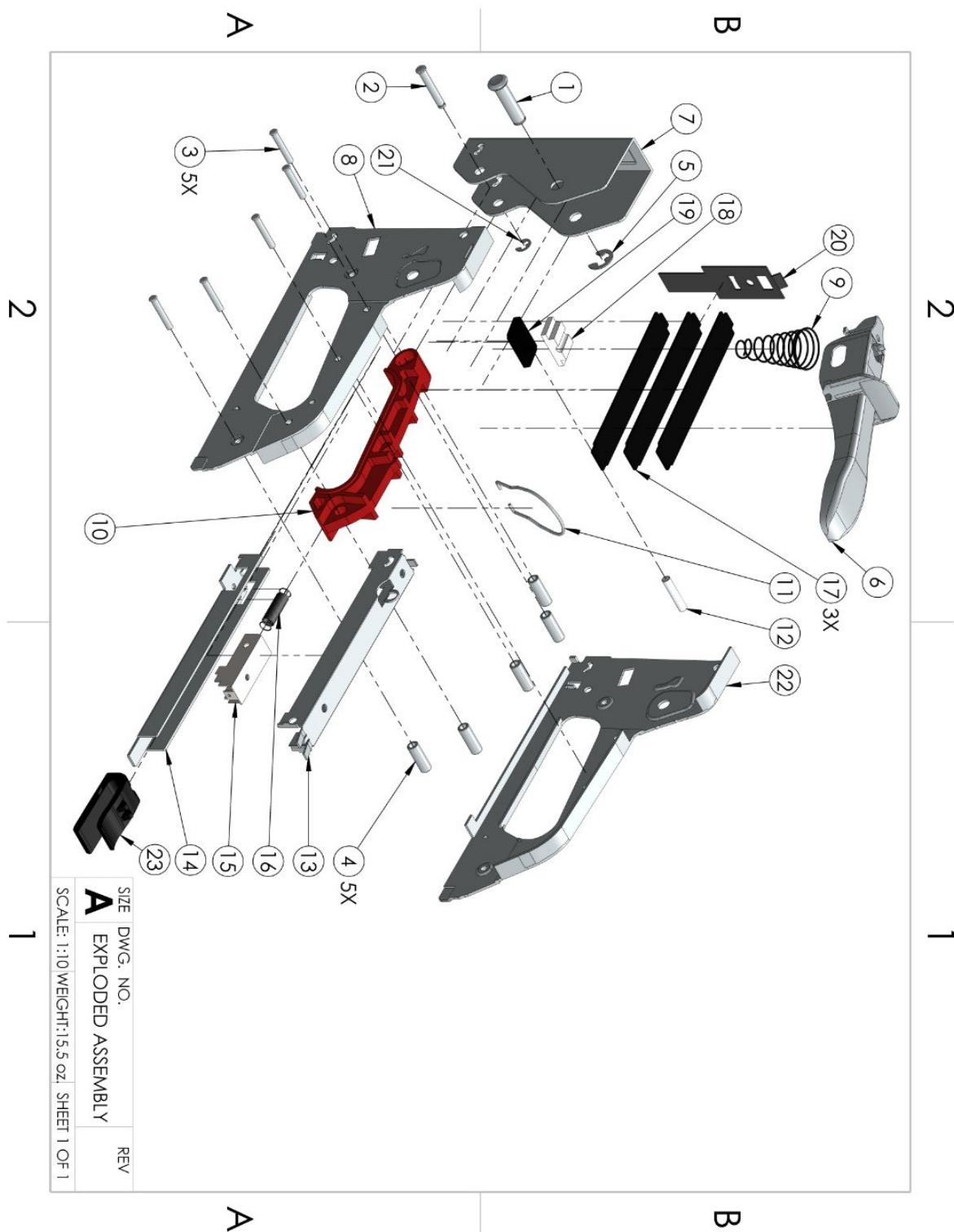


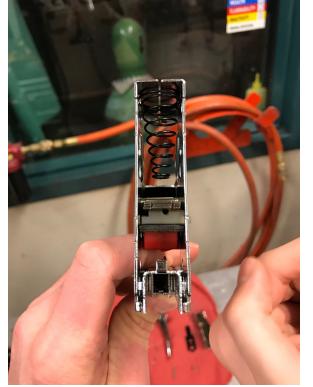
Figure 5.1: Exploded Assembly Diagram



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Detailed Device Description

Table 6.1: Reverse Engineering Disassembly (Template)

Step #	Procedure	Part # Removed	Image
1	Remove .2" diameter pin and large snap ring to release trigger from staple gun	1, 5, 6	
2	Removed front guard by breaking .12" pin and small snap ring. Inner rod and hammer strut were removed as a result disassembly	2, 7, 12, 20, 21	
3	Removed spring, staple hammer, spring plates, and shock reducer (image shows items still intact before assembly) with hammering and human force.	9, 17, 18, 19	
4	Removed trigger safety with human force.	11	



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5	Removed five rivets on the five .1" diameter pins with center drill. Then used a hammer to punch out pins. (image is pin and pin sleeve).	3, 4	
6	Removed one body frame and sorted out all parts. All major parts were disassembled or separated during this step.	22, 10	
7	Separated magazine parts (slider, cover, magazine, grip) with human force. The parts are not separated in image.	13, 14, 15, 23	
8	Removed spring from magazine with human force.	16	



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Table 6.2: Reverse Engineering Interface (Template)

Interfaces with Other Objects (Flows of Energy, Information, and/or Materials):

Part #	Interface Part #	Energy Flow	Information Flow	Material Flow	Image
1	Trigger	User pulls the trigger back.	Trigger pulled back moves the hammer strut up and pulls pieces in order to release staple.	User's hand pulls the trigger and releases it back.	
2	Hammer Strut	Trigger pulls the hammer strut which pulls the spring plates.	When pulled it moves the pieces which release the staple.	Hammer strut slides up and pulls the pieces connected to it.	
3	Spring Plates	Energy from the hammer strut pulls the plates back, transferring some energy into spring potential.	When the spring plates are drawn back they store energy from strain as spring potential energy	The hammer strut hooks over the spring plates and draws them back.	
4	Shock reducer	The shock reducer creates a force that opposes rotation of the spring plates and causes the plates to store energy instead of transfer.	The shock reducer is fixed in place with the staple hammer at the lower end of the spring plates. Together they act as a fixed point for the spring plates to pivot around, providing a consistent position for the spring plates to rest at.	The opposite end of the spring plates presses against the shock reducer and staple hammer so they're held in place at one end.	



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5	Strip of Staples	The hammer strut impacts the staple at the top of the strip, creating a force from the energy stored in the spring plates which releases the staple from strip of staples glued together.	The strip of staples is inserted into the magazine beforehand and is pressed against the top of the magazine. This allows the hammer strut to consistently hit the top staple without a misfire.	When pulled back far enough, the hammer strut slips off the trigger and propels forward, hitting the next staple in the strip.	
6	Hammer Spring	The hammer spring stores a small portion of energy as spring potential to push the trigger back underneath the spring plates to re connect the hook on the top of the trigger.	This final process assures that after the trigger releases the hammer strut that the trigger will re engage with the hammer strut after giving the user the option to quit stapling and attach the trigger safety or allow the handle to be pushed back into place to fire another staple.	After the hammer strut has slipped from the trigger, the hammer spring pushes the trigger forward and hooks the spring plates with the trigger.	



Device Function (Solid models of each part in engineering drawings section)

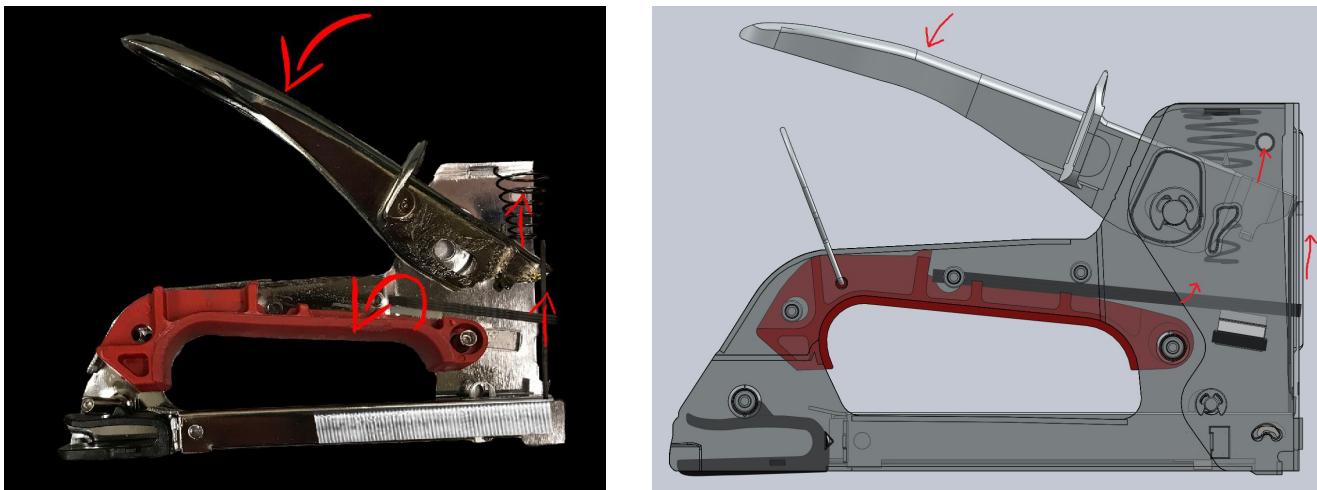


Figure 6.1: External to Internal Energy Flow (Actual + 3D Model)

The trigger used force applied by the user to draw the hammer strut back, thus pulling the spring plates back and storing energy as tension. As the trigger is squeezed the hammer spring in the rear of the staple gun compresses, creating negligible resistance to squeezing force. (Solid model does not show proper compression of spring and bending of spring plates).



Figure 6.2: Collapsed Trigger Image

When the trigger reaches a certain point, the tip of the trigger slips off the hammer strut and keeps the spring plates as the only part in contact with the hammer strut.



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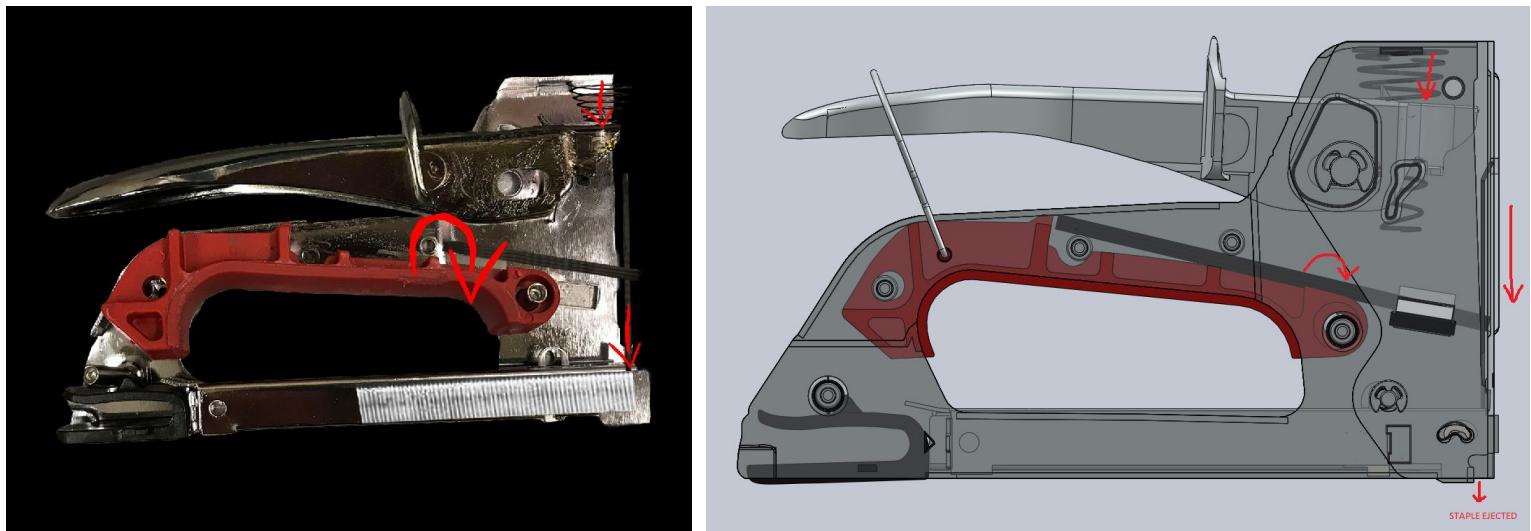


Figure 6.3: Internal Energy Flow after Pulled Trigger (Actual + 3D Model)

The tension in the spring plates has released causing the hammer strut to quickly slam forwards jarring a staple loose from the staple strip and delivering an impulse powerful enough to cause it to stick into the item being stapled. At this time, the hammer spring in the rear of the gun releases stored energy, propelling the trigger back to its original position. The spring in the magazine pulls the next staple forward to be shot next.



Figure 6.4: Energy Flow back to Initial State

The trigger is pushed underneath the hammer strut and back into position for another staple to be fired out of the gun. The strip of staples is also propelled upwards by the magazine slider, placing another staple in position to be fired.



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Table 6.3: Energy Flow Design Structure Matrix

Energy Flow DSM							
Part		A	B	C	D	E	F
Trigger	A	A	X		X		
Hammer Strut	B		B	X			X
Spring Plates	C			C		X	
Hammer Spring	D				D		
Shock Reducer	E					E	
Staple Strip	F						F

"X" shows transfer or flow of energy from one part to another via impact.



Engineering Drawings

Part 1

This .2" diameter Pin (1" length) held the trigger (part 6) in place in between the 2 body frames. The pin was inserted through the front guard (part 7) and the left body frame(part 8). It was fastened using the 0.24" OD snap ring (part 5) on the outside of the right body frame (part 22).



Figure 9.1.1: Comparison of Solid Model and Physical Part (Part 1)



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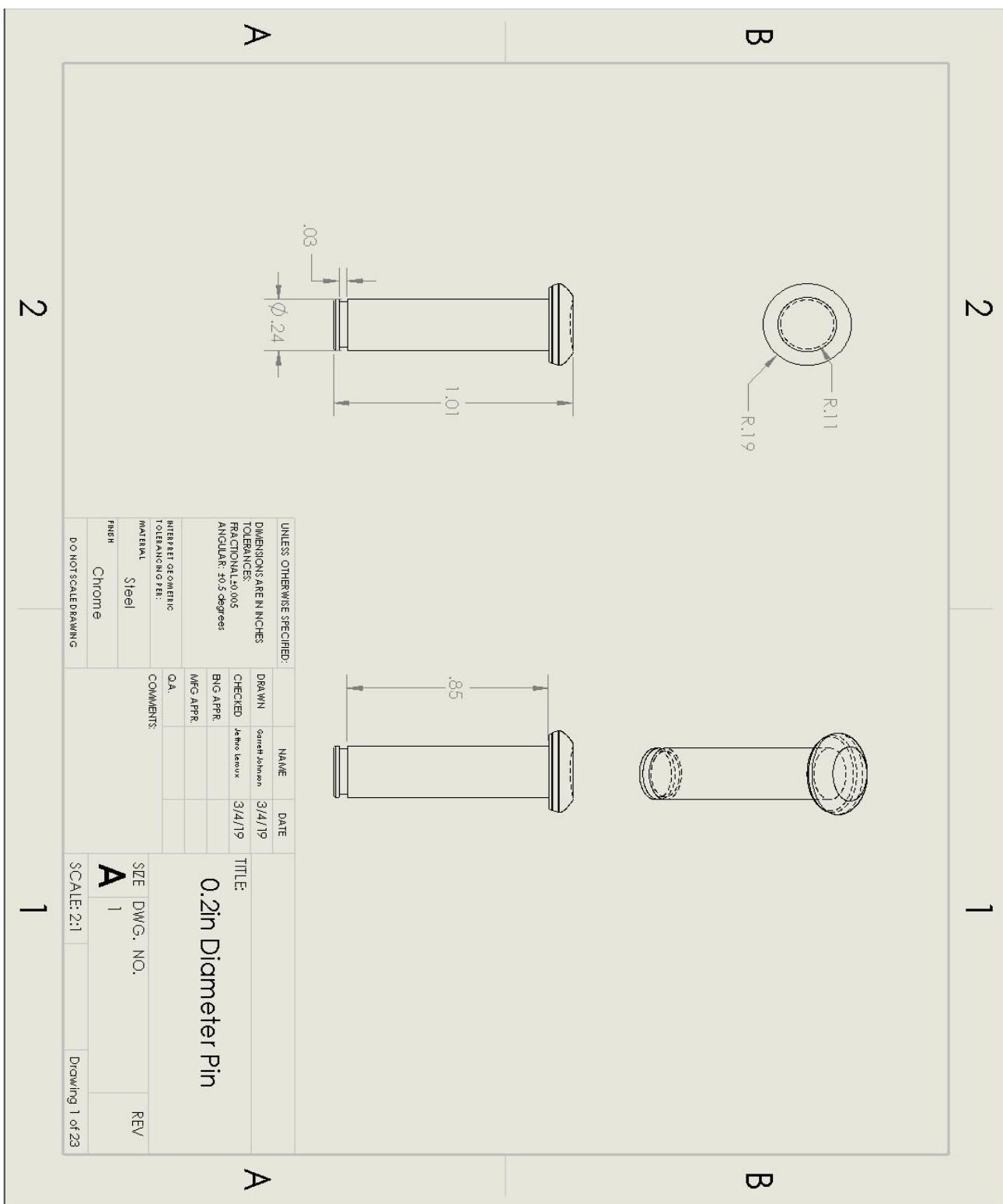


Figure 9.1.2: Engineering Drawing (Part 1)



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Part 2

This .12" diameter Pin (1" length) also went through holes in the front guard (part 7), left body frame (part 8) and the right body frame (part 22), similarly to part 1. A 0.15" OD snap ring (part 21) was used to fasten the pin on the outside of the right body frame. Using the same size pins for part 1 and part 2 could possibly result in cheaper manufacturing practices as 2 separate parts would not have to be manufactured/outsourced and the snap rings would also be the same size.



Figure 9.2.1: Comparison of Solid Model and Physical Part (Part 2)



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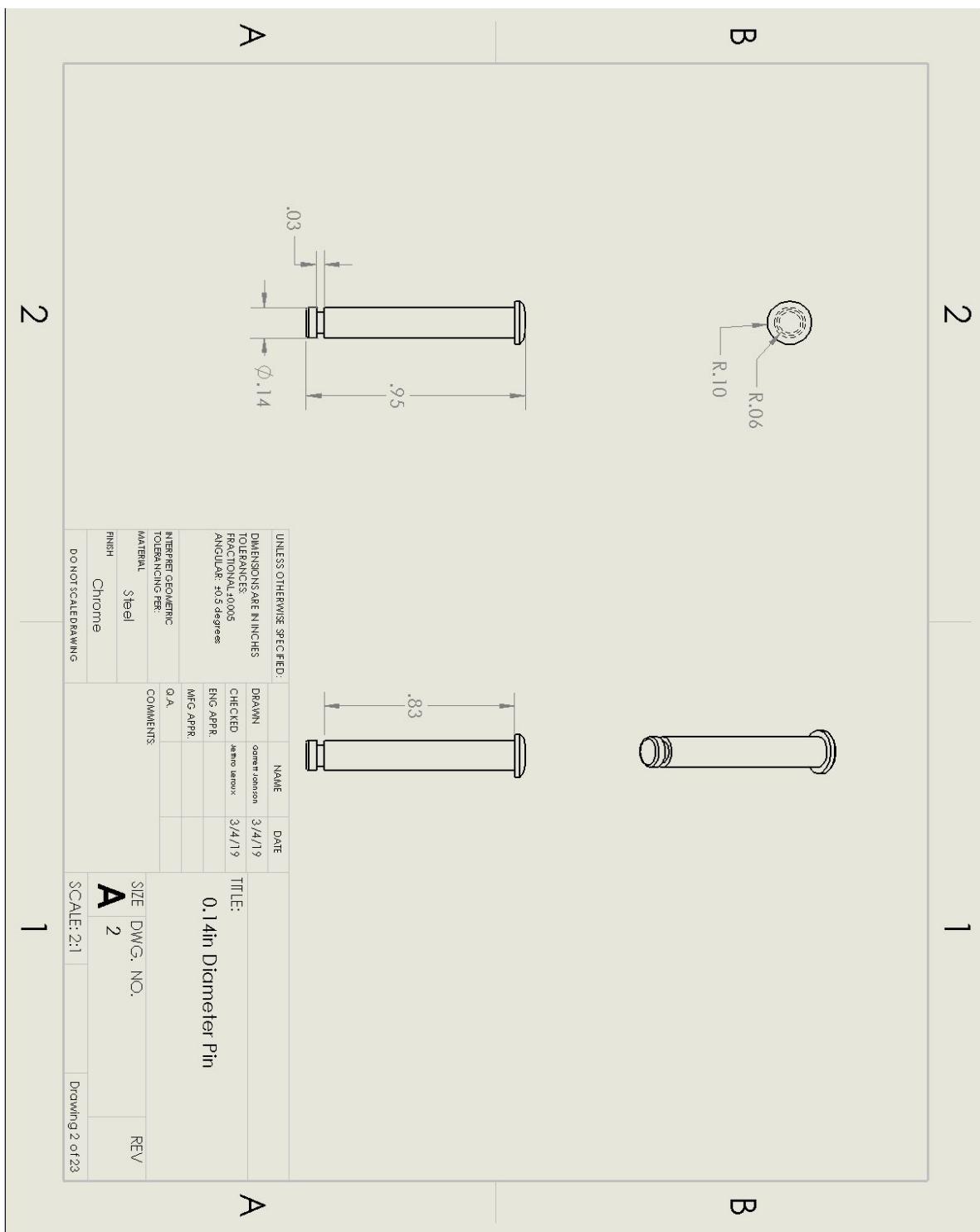


Figure 9.2.2: Engineering Drawing (Part 2)



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Part 3

This .1" Diameter Pin (.7" length) was used to hold multiple parts together inside the staple gun. There were 5 of these pins used, each used for different purposes. Two of the pins held separate ends of the red handle (part 10) inside the staple gun via through holes in the handle between the left and right body frames. One pin was used to keep the magazine (part 14) in place by having the top part of magazine grip (part 23) push up and rest underneath the pin near the back end of the staple gun. The other two pins were used to mount the spring plates (parts 17) in between. This created a bend in the spring plates which was utilized to provide a force used to shoot the staples (see energy flow section for further details)..



Figure 9.3.1: Comparison of Solid Model and Physical Part (Part 3)



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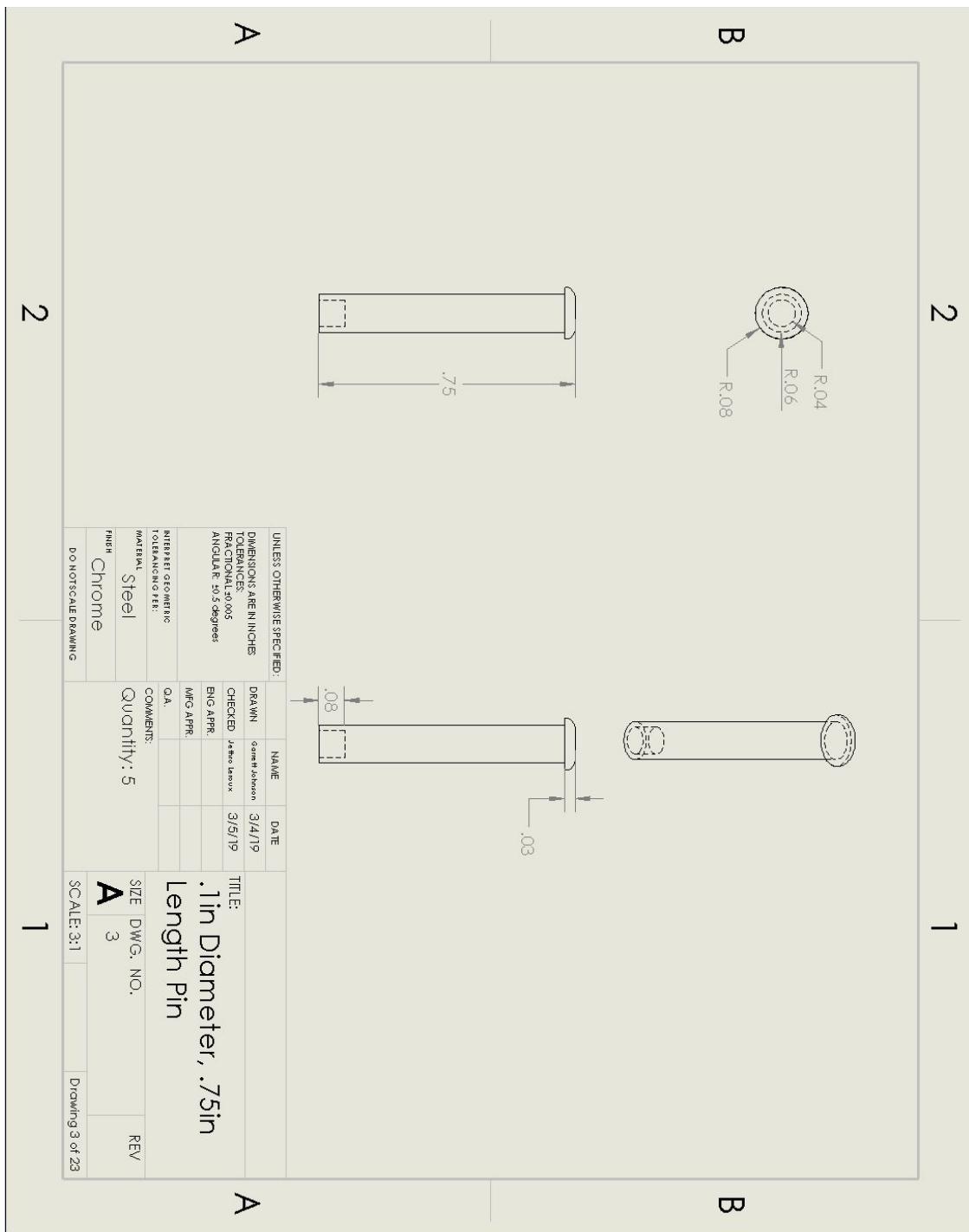


Figure 9.3.2: Engineering Drawing (Part 3)



Part 4

These pin casings went over the five .1" Diameter Pins (part 3). The casings main purpose is to support the two body frames and prevent them from collapsing or bending inwards. They are also used to support the pins and keep them bending.



Figure 9.4.1: Comparison of Solid Model and Physical Part (Part 4)



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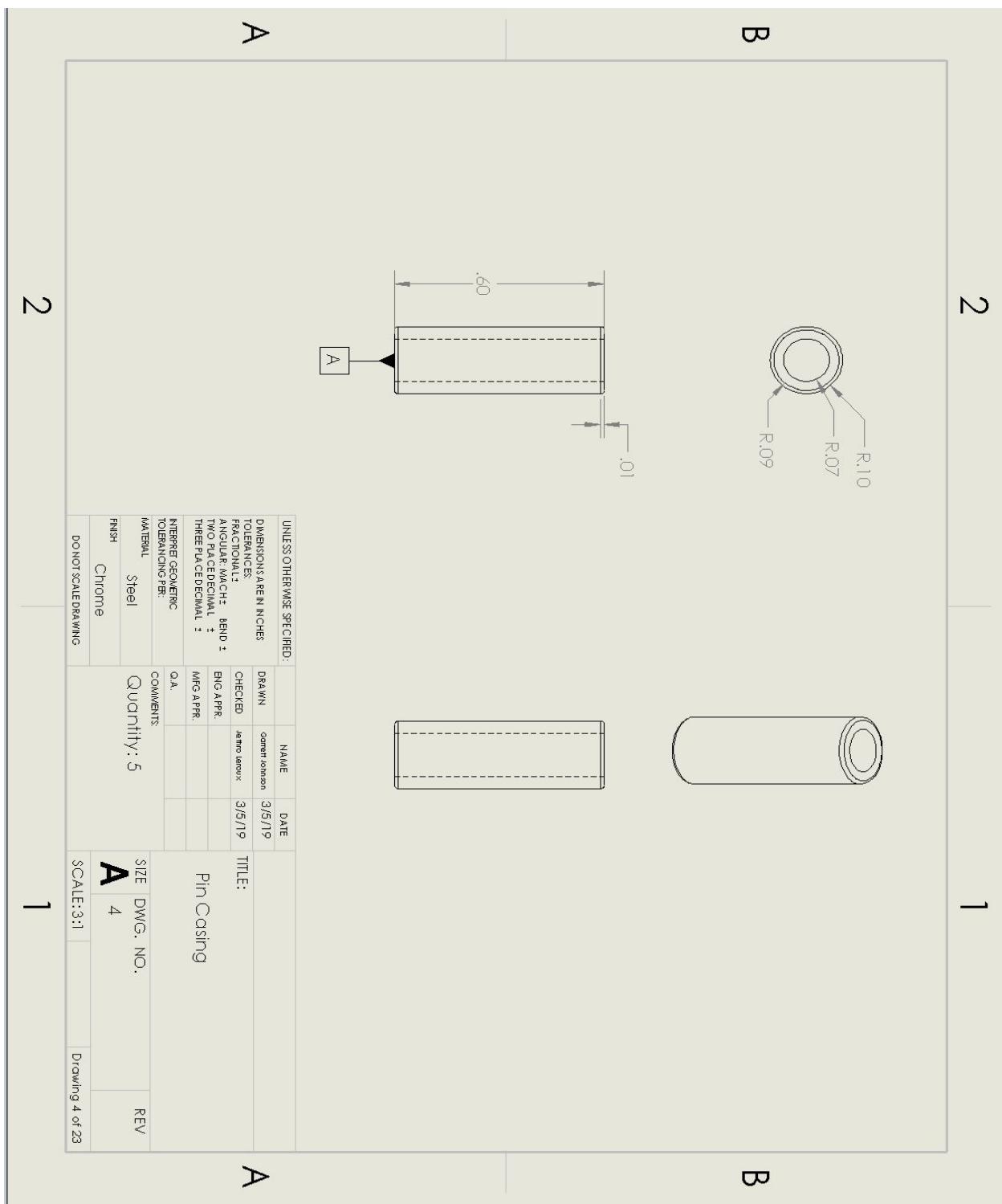


Figure 9.4.2: Engineering Drawing (Part 4)



Part 5

The large snap ring (0.24" OD) was used to fasten the .2" diameter Pin (part 1), which held together the front guard(part 7), left body frame (part 8), right body frame (part 22) and the trigger (part 6) together.



Figure 9.5.1: Comparison of Solid Model and Physical Part (Part 5)



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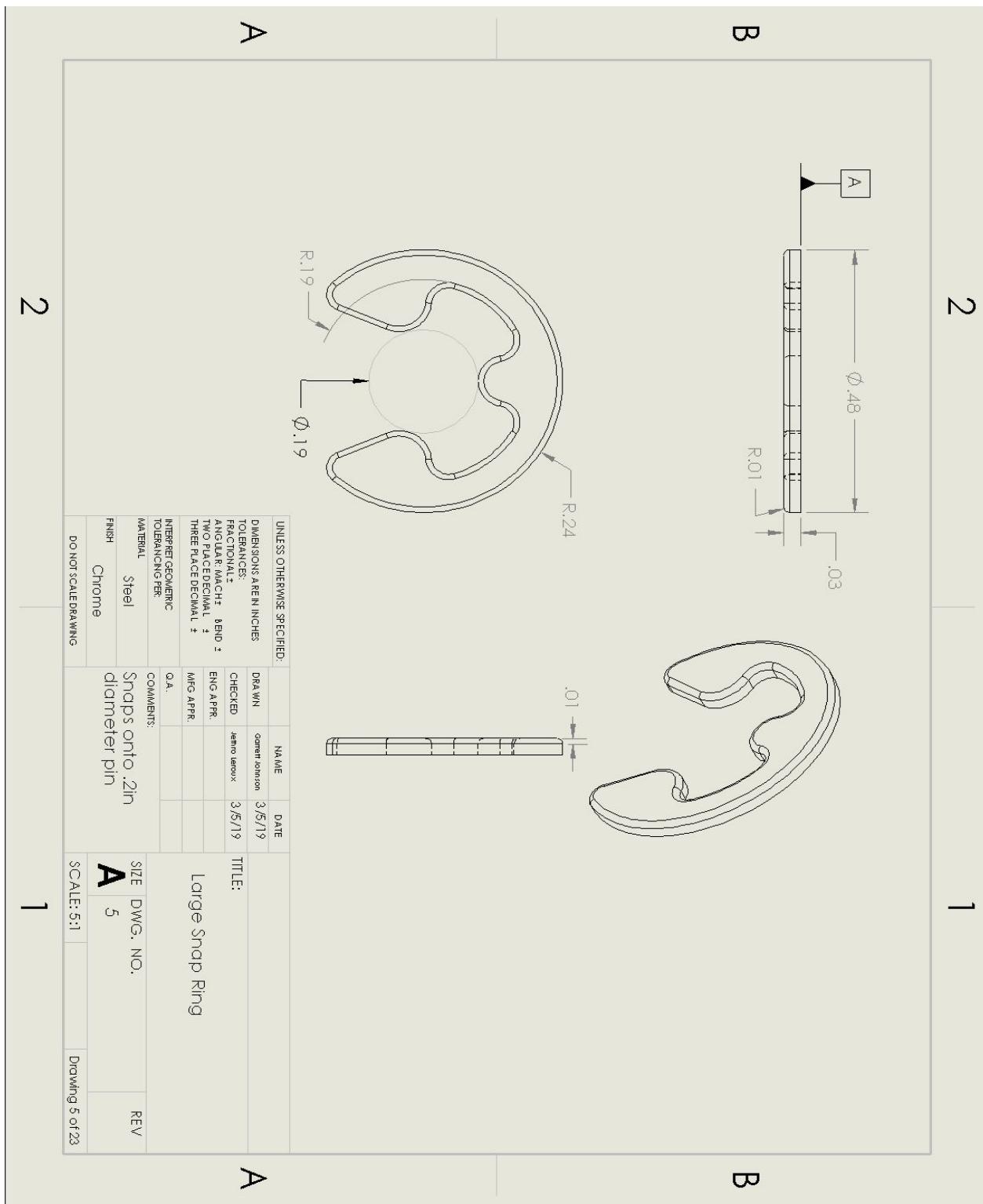


Figure 9.5.2: Engineering Drawing (Part 5)



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Part 6

This trigger was held in place by a pin (part 1) through the through hole seen in the below pictures and drawings. The hammer spring (part 9) pushed downwards on the top of the left side of the part as seen in the pictures below. This reset the trigger each time after a staple was ejected.

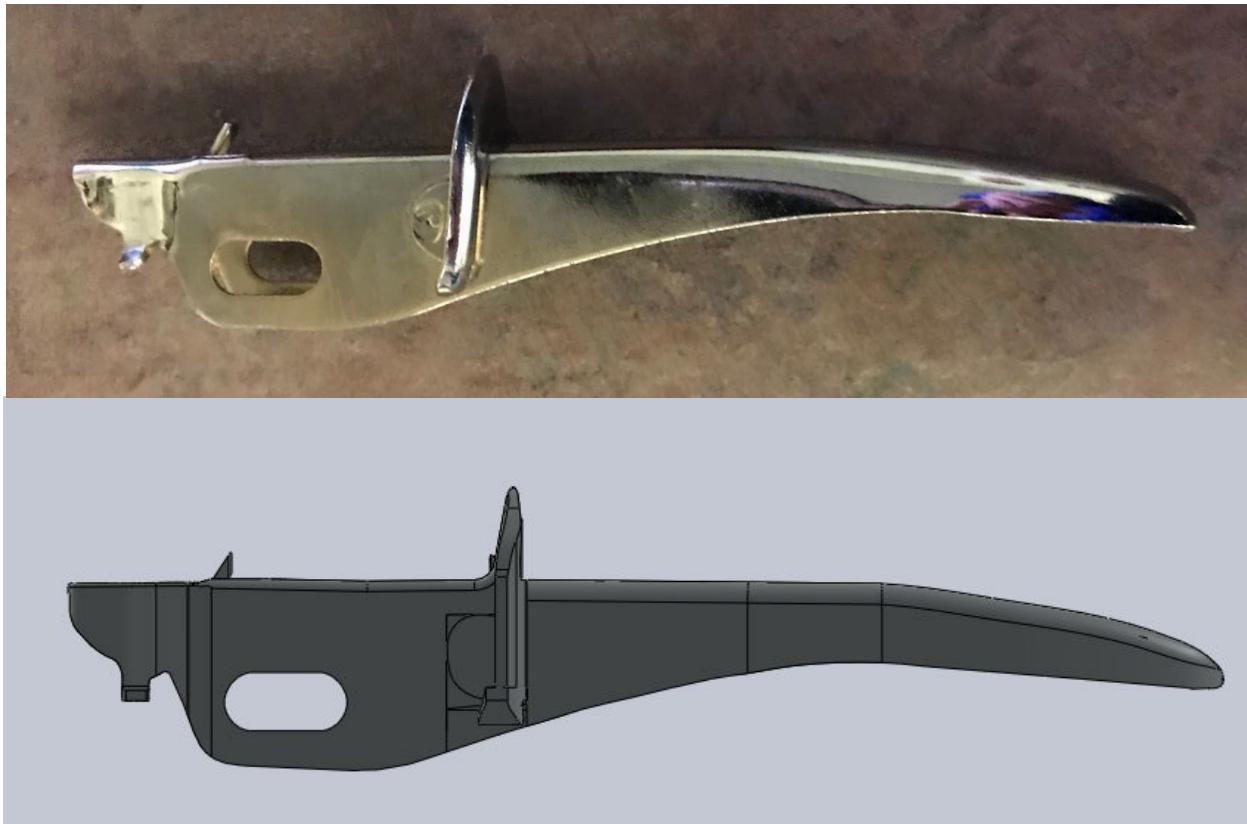


Figure 9.6.1: Comparison of Solid Model and Physical Part (Part 6)



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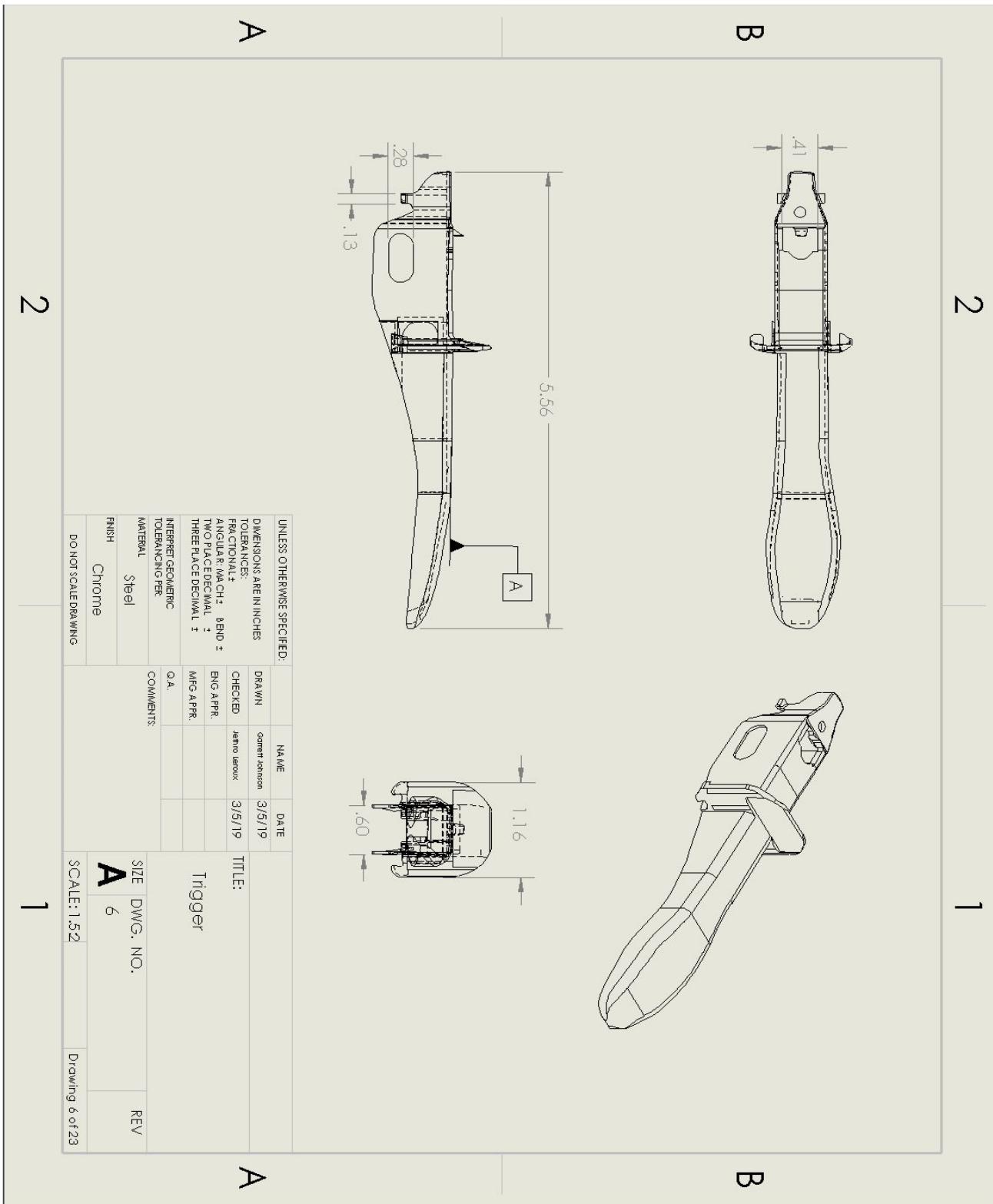


Figure 9.6.2: Engineering Drawing (Part 6)



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Part 7

This front guard was used to enclose the front section of the staple gun and to hold all the most integral moving parts together. The hammer strut (part 20) slid up and down inside the front guard against the indented section which can be seen in the 3D model picture and drawing below. The front guard also has a hole through this indented section to allow maintenance and oiling of the moving parts to allow lubrication, making the staple gun operate smoother and last longer.



Figure 9.7.1: Comparison of Solid Model and Physical Part (Part 7)



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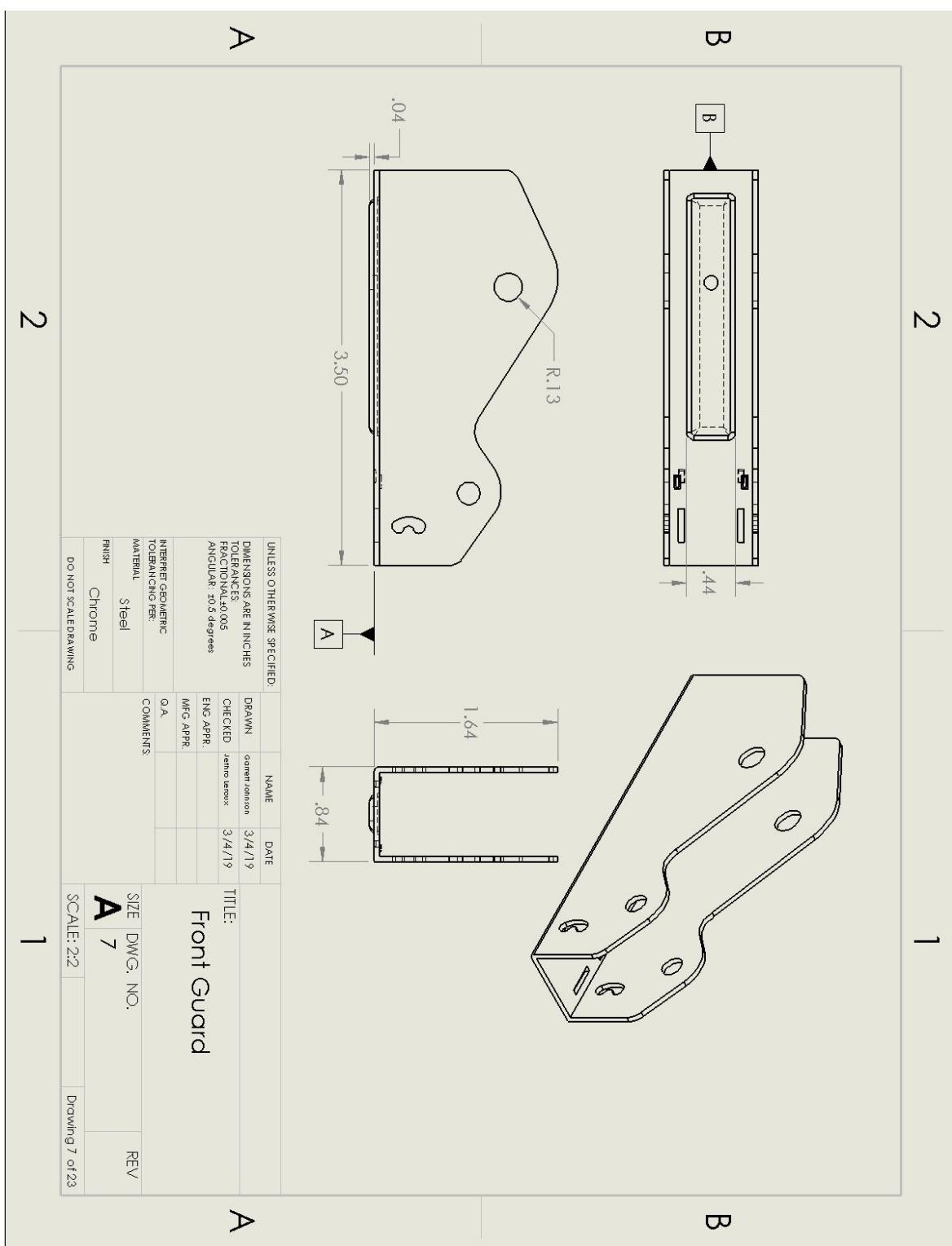


Figure 9.7.2: Engineering Drawing (Part 7)



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Part 8

The left body frame is the structural base for the staple gun. All pins (parts 1, 2, and 3) pass through the left body to the right body and support the front guard (part 7), handle (part 10), magazine (part 14), and internal structures. The left and right body frames are just mirrored versions of each other.

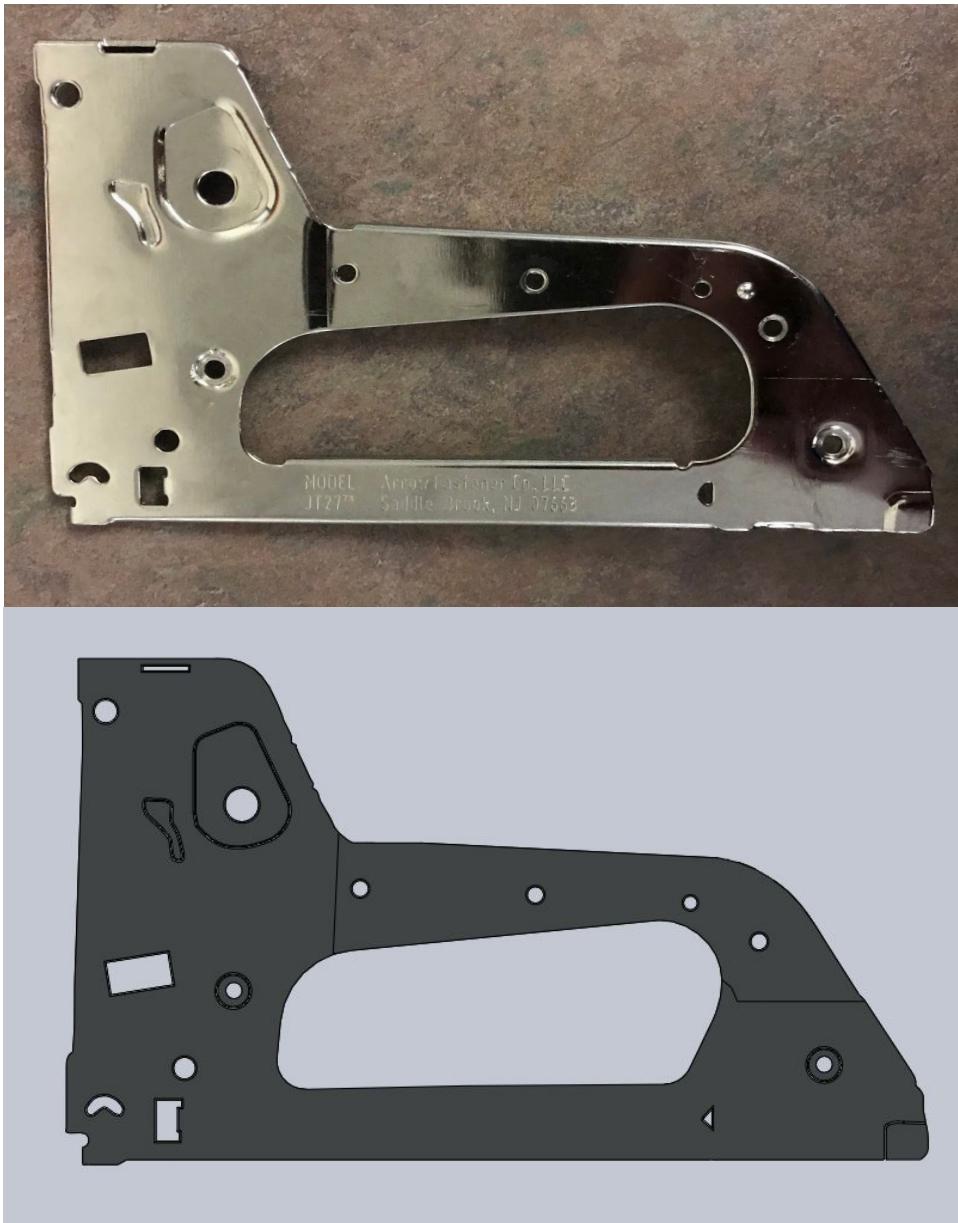


Figure 9.8.1: Comparison of Solid Model and Physical Part (Part 8)



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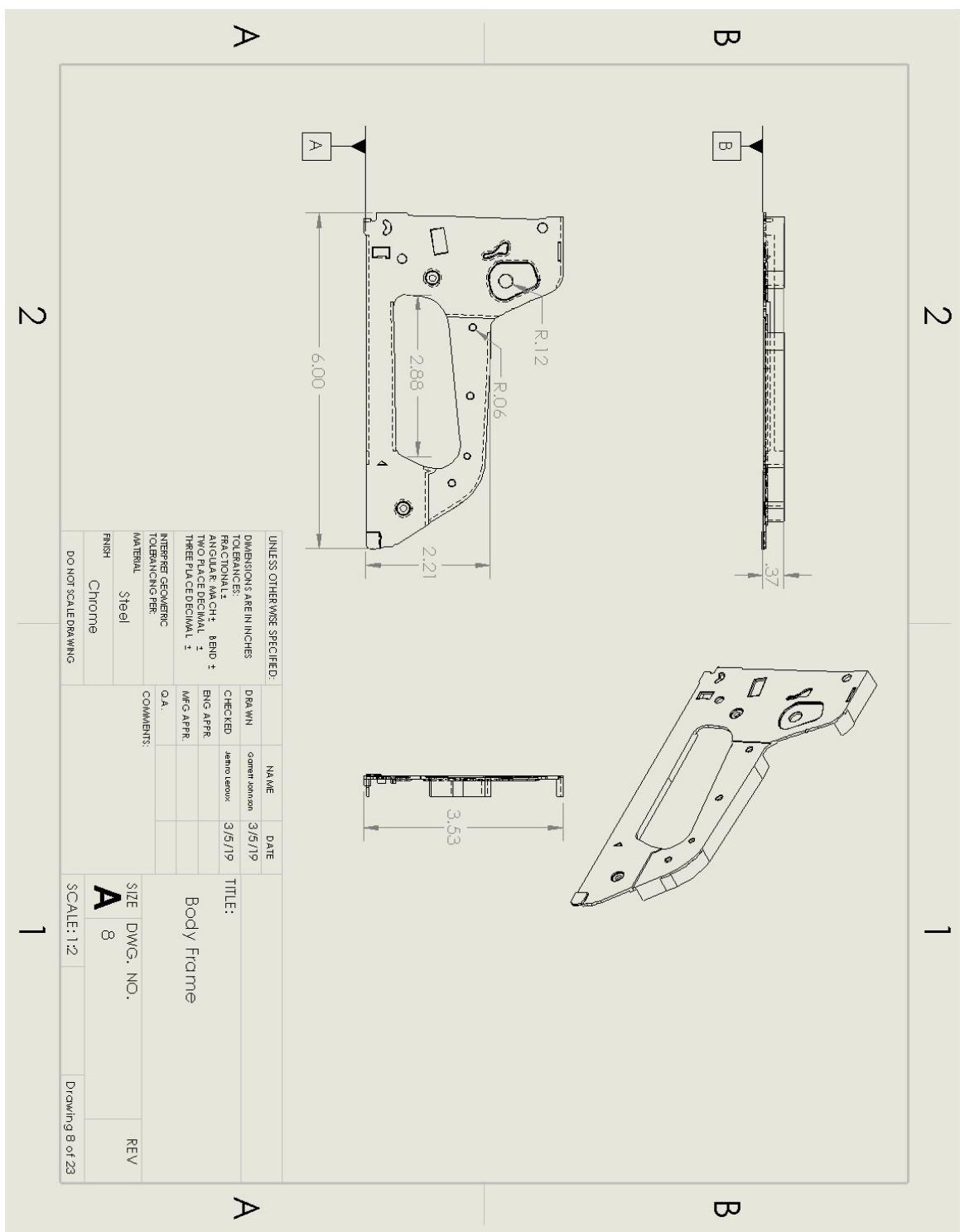


Figure 9.8.2: Engineering Drawing (Part 8)



Part 9

The spring is used to maintain the position of the trigger (part 6) after being compressed by mechanical force. The user pulls the trigger to initiate the staple force and then the spring moves the trigger back into its initial position.

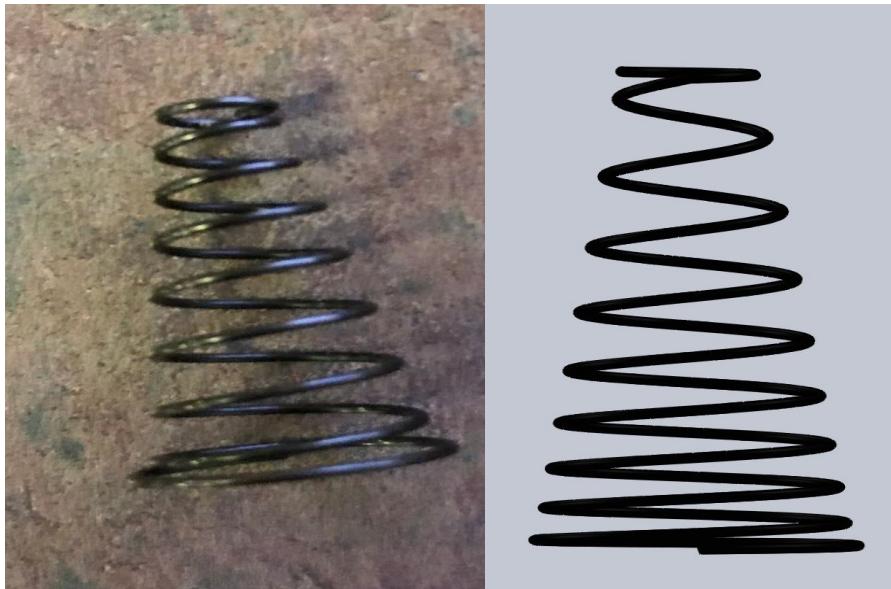


Figure 9.9.1: Comparison of Solid Model and Physical Part (Part 9)



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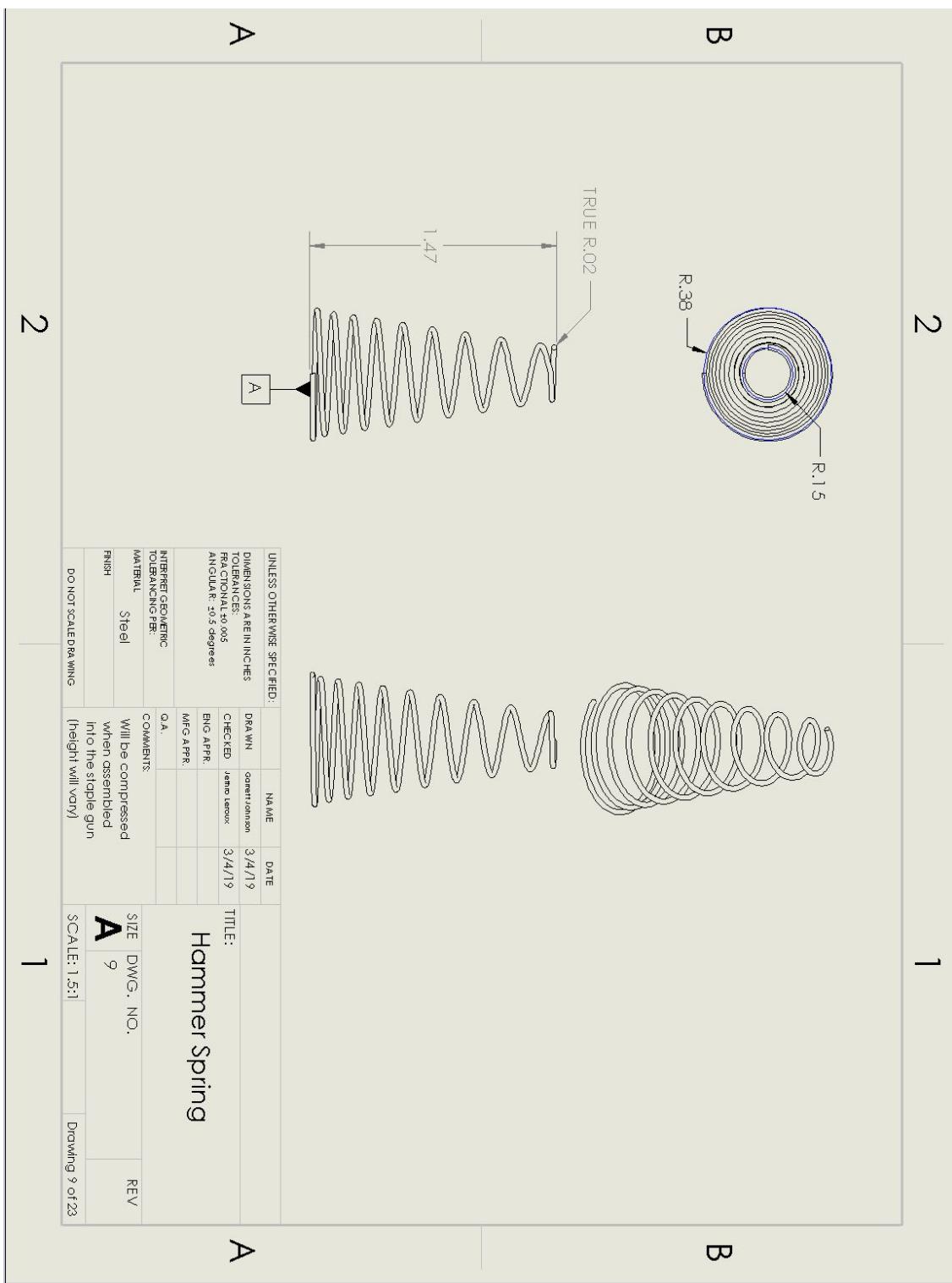


Figure 9.9.2: Engineering Drawing (Part 9)



Part 10

The handle is used both as a grip for the user as well as a structural piece. The side the user touches is soft while the structural backing is a hard plastic. Two .1" Diameter Pins (part 3) keep the handle in place.

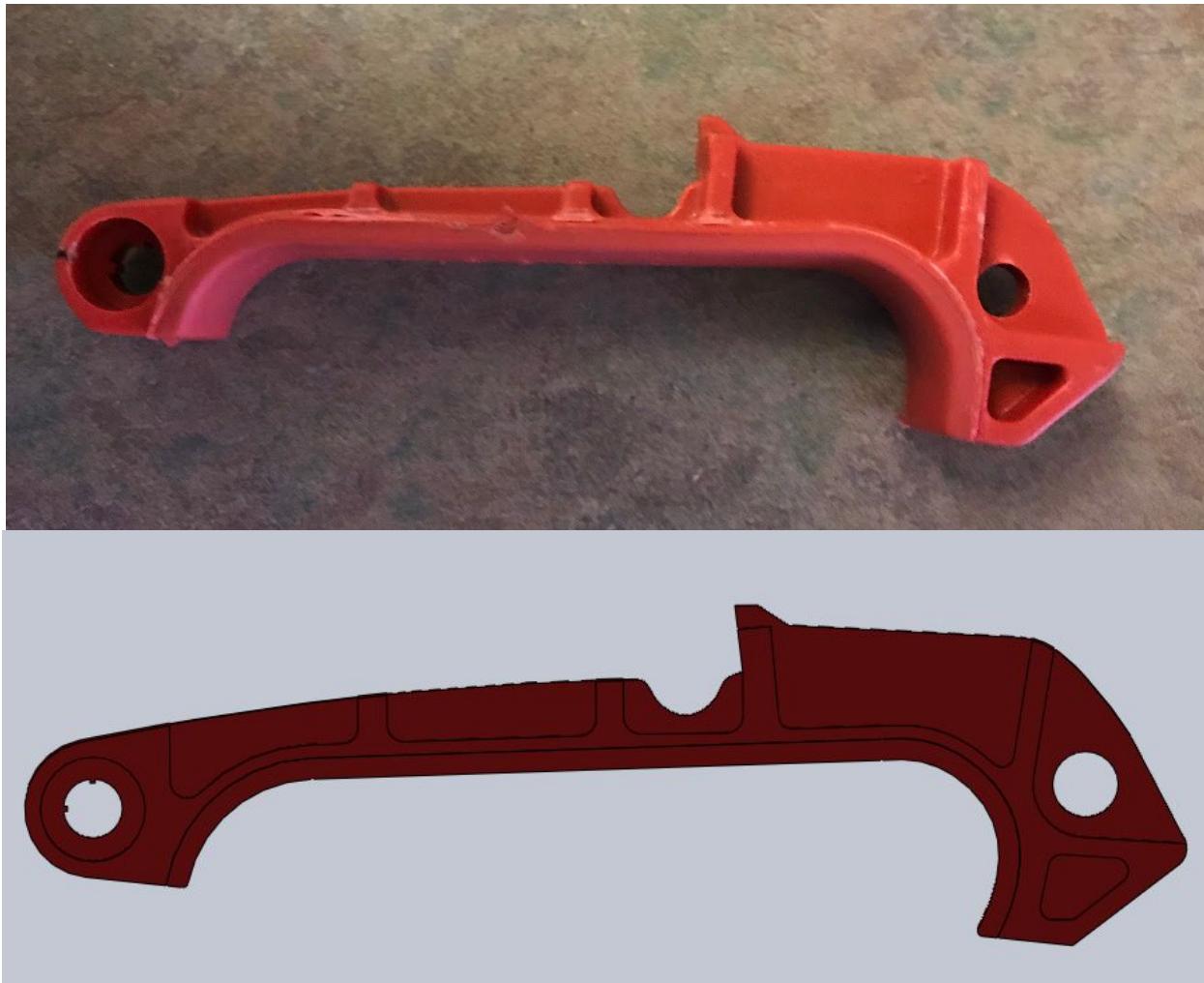


Figure 9.10.1: Comparison of Solid Model and Physical Part (Part 10)

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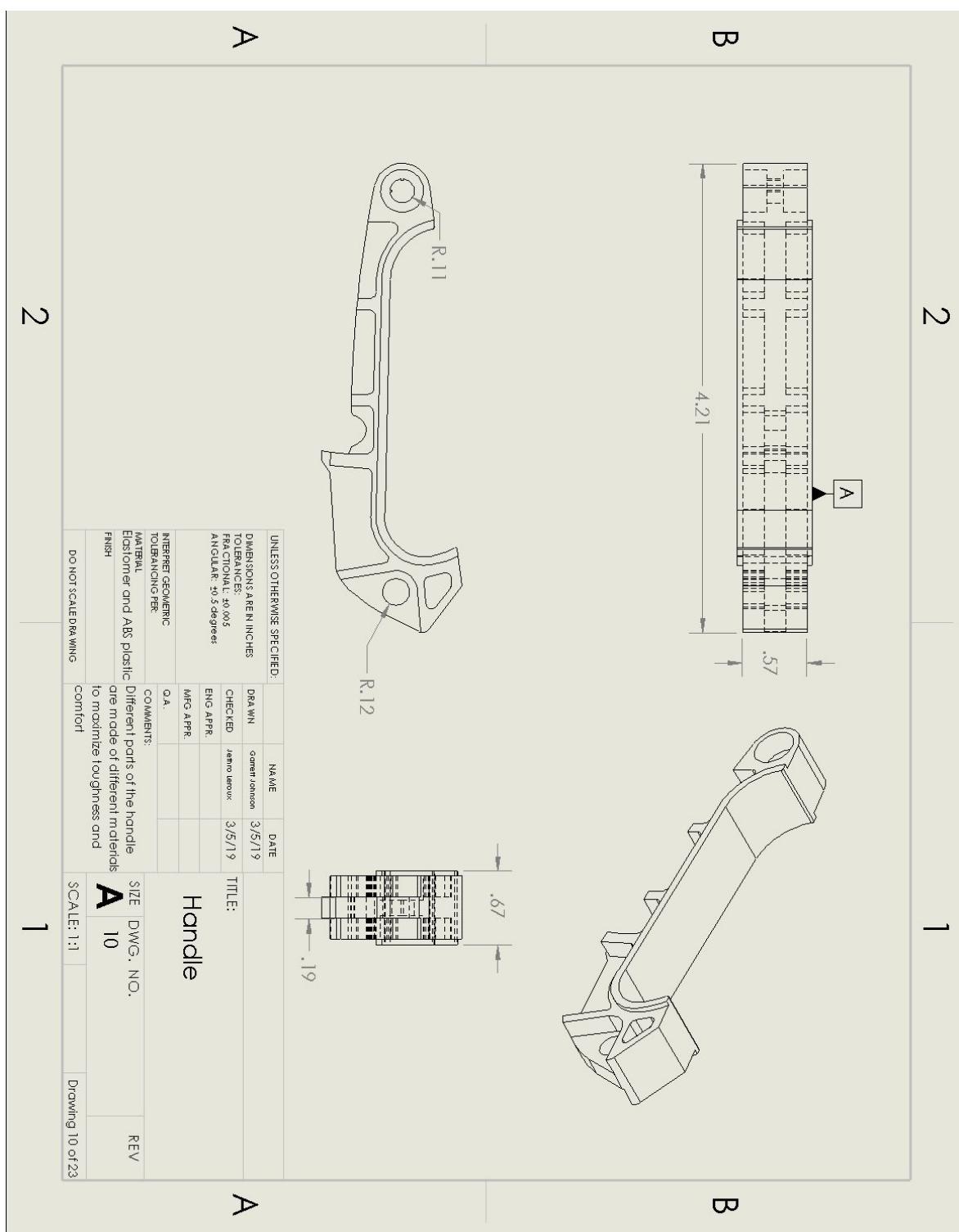


Figure 9.10.2: Engineering Drawing (Part 10)



Part 11

The trigger safety is held in place by the left and right body frames (part 8) that form the structure. The trigger safety holds the trigger (part 6) in place in order to keep the staple gun from shooting a staple out when it is pressed down by accident.



Figure 9.11.1: Comparison of Solid Model and Physical Part (Part 11)

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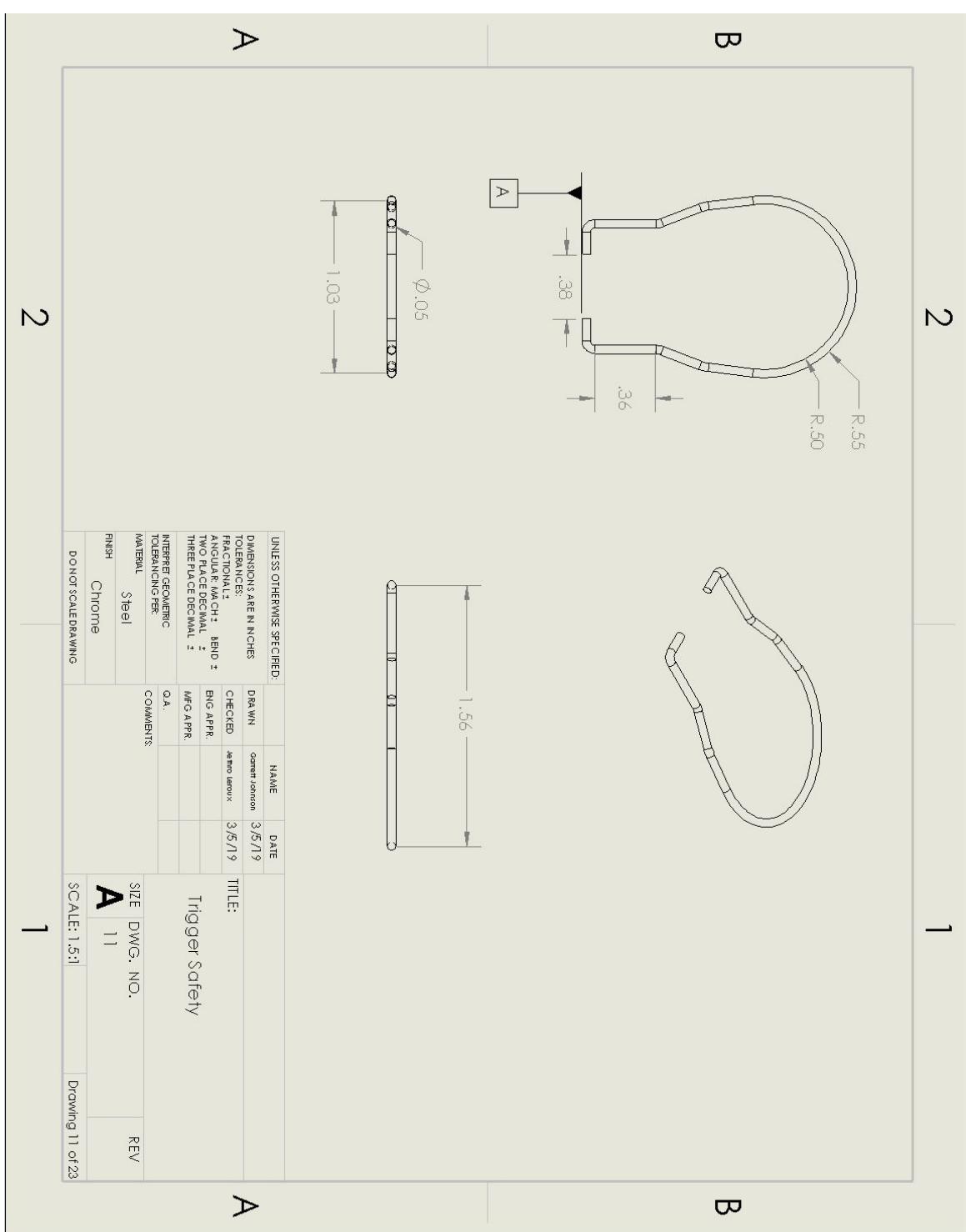


Figure 9.10.2: Engineering Drawing (Part 11)



Part 12

The inner rod is used as an inner support for the two body frames (parts 8 and 22). The rod was located between the two frames under the front guard.



Figure 9.12.1: Comparison of Solid Model and Physical Part (Part 12)



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2

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2

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A diagram showing a rectangle with a width of .75 and a height of .74.

UNLESS OTHERWISE SPECIFIED:	
DIMENSIONS ARE IN INCHES	
TOLERANCES	
FRACTIONAL	
ANGULAR MACH ¹	BEND ²
TWO PLACE DECIMAL	$\frac{1}{16}$
THREE PLACE DECIMAL	$\frac{1}{32}$
INTERPRET GEOMETRIC TOLERANCING PER:	
MATERIAL	Steel
FINISH	Chrome
DO NOT SCALE DRAWING	
DRAWN	
NAME	James Johnson
DATE	3/5/19
COMMENTS	
CHECDED	As per drawing
ENG APPR	
MFG APPR	
O.A.	
SIZE	DWG. NO.
A	12
SCALE	2.5:1
TITLE:	
Inner Rod	
REV	
Drawing 12 of 2	

2

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>



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Figure 9.12.2: Engineering Drawing (Part 12)

Part 13

The magazine cover is held in place by the front guard (part 7) and the body frame pieces (part 8). The magazine cover works to protect the magazine (part 14) and cover it as it moves in and out of the staple gun.

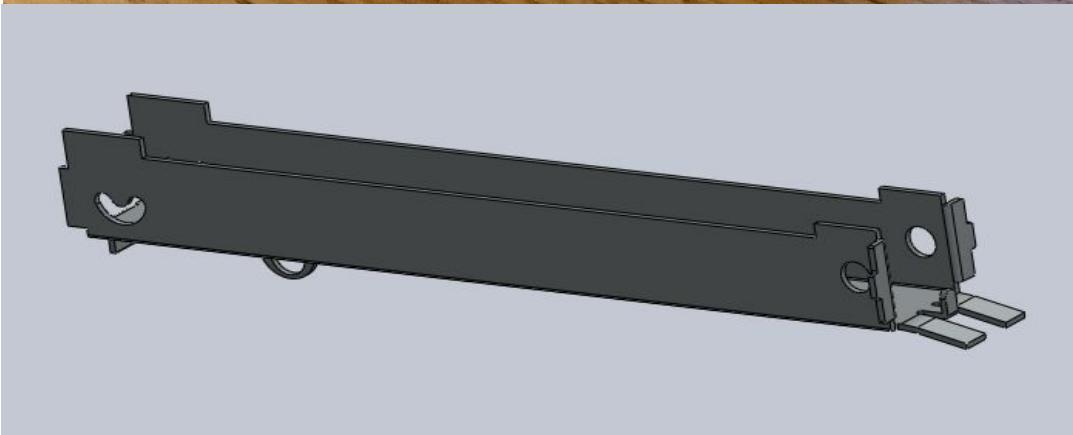


Figure 9.13.1: Comparison of Solid Model and Physical Part (Part 13)



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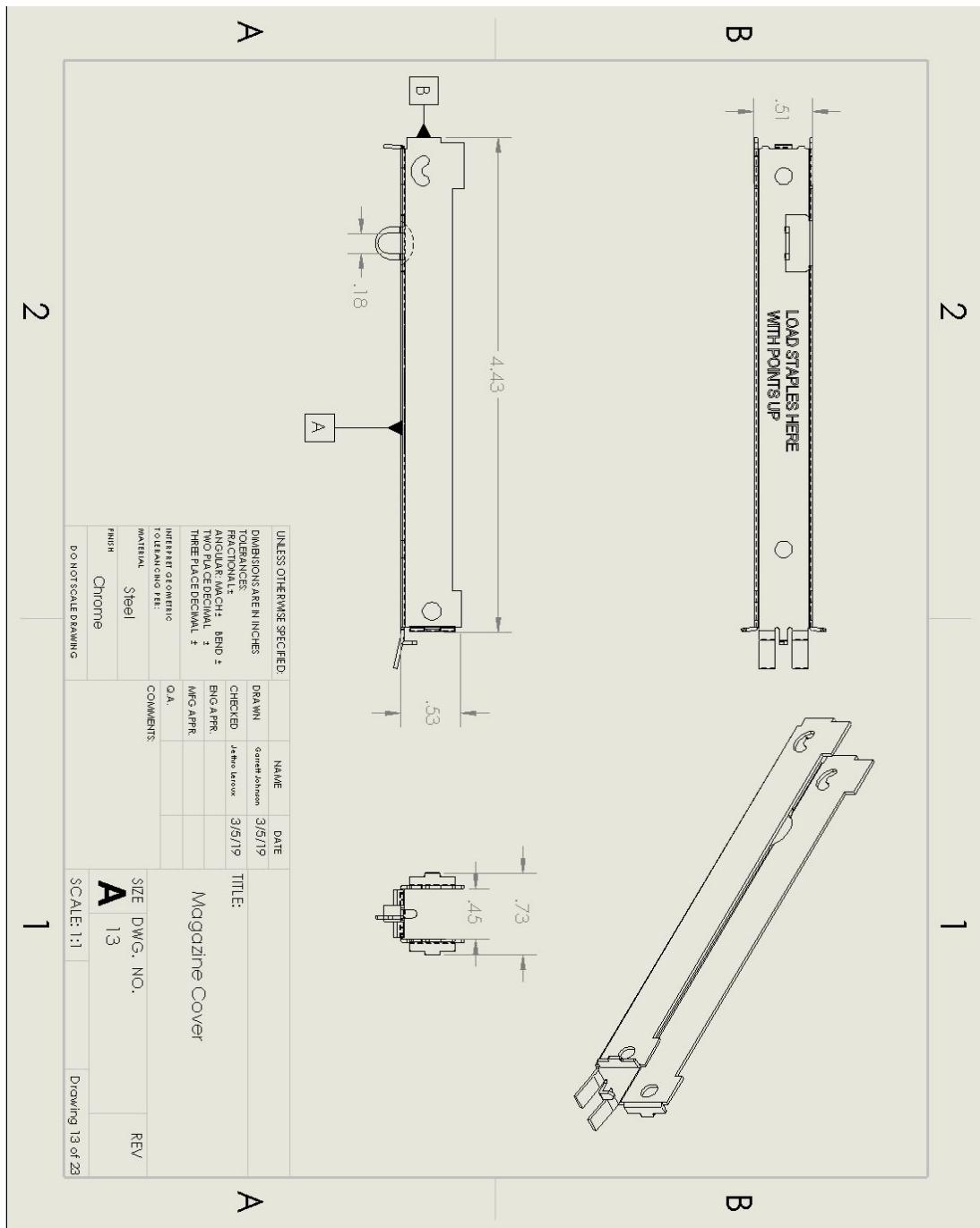


Figure 9.13.2: Engineering Drawing (Part 13)



Part 14

The magazine works to bring staples forward to be in position to get shot out. The body frame pieces (part 8) and the front cover (part 6) hold the magazine in place, while the magazine cover (part 13) protects the magazine and holds the staples in place.

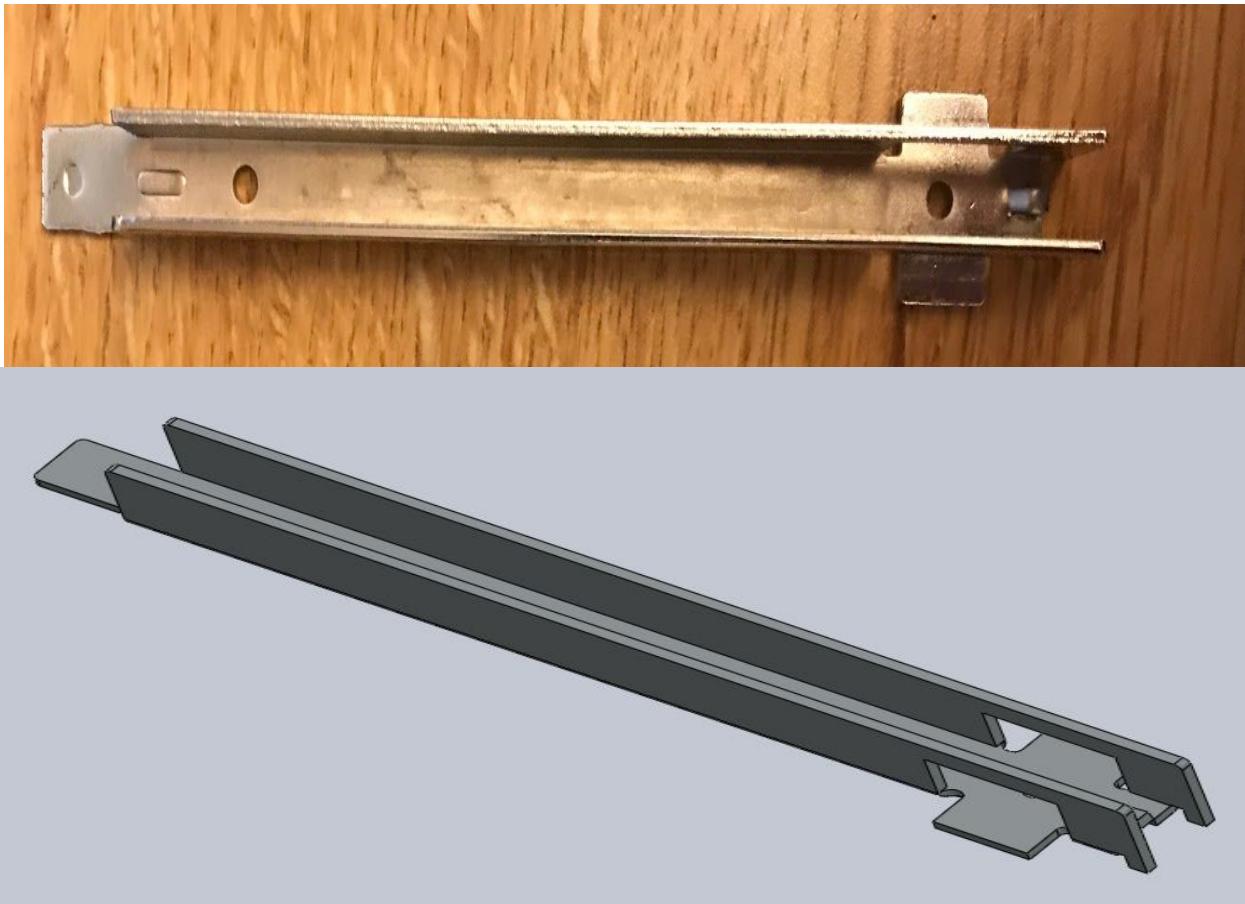


Figure 9.14.1: Comparison of Solid Model and Physical Part (Part 14)



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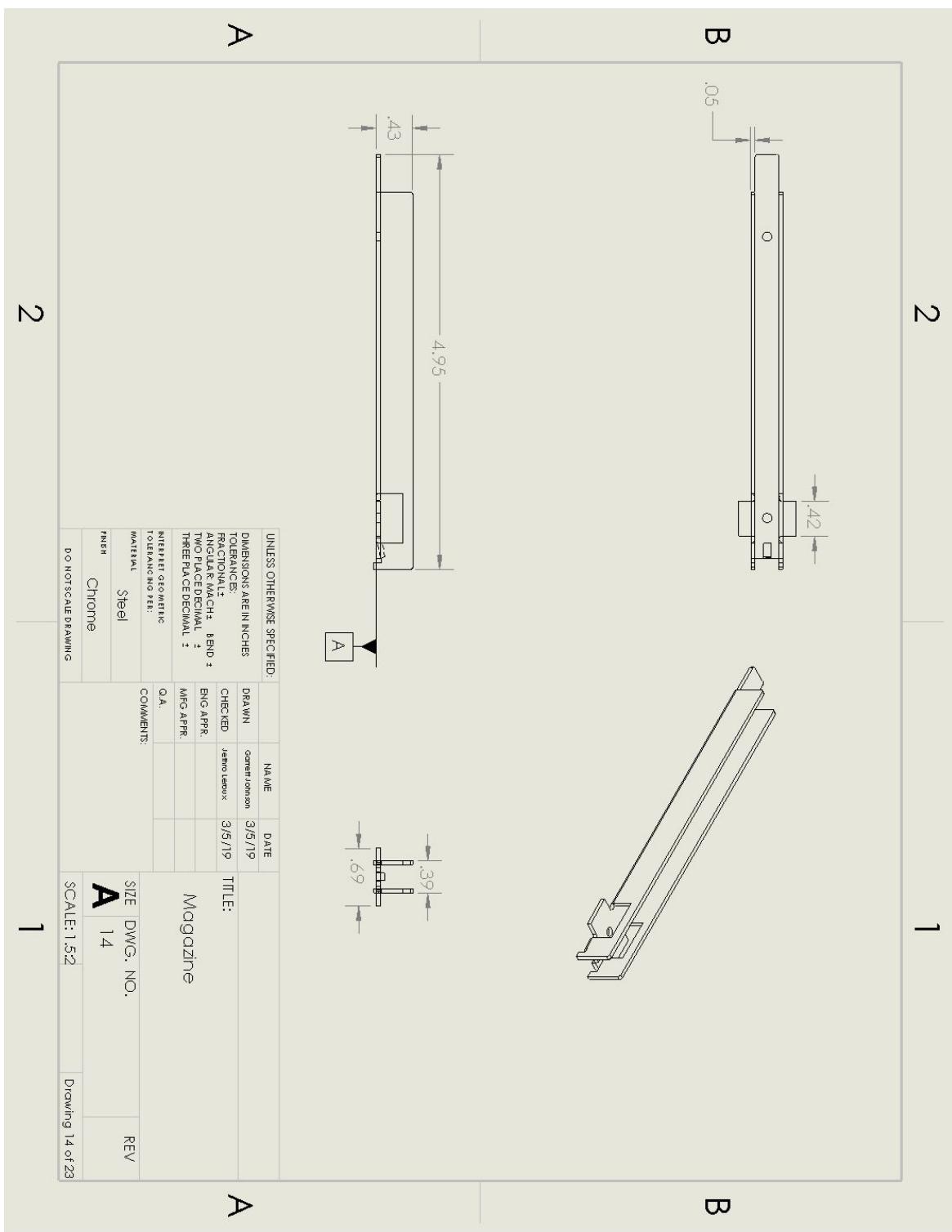


Figure 9.14.2: Engineering Drawing (Part 14)



Part 15

The magazine slider is connected to the magazine (part 14) and the magazine cover (part 13). The magazine slider assists in sliding the magazine up the staple gun in order to get it into place to shoot the next staple out.

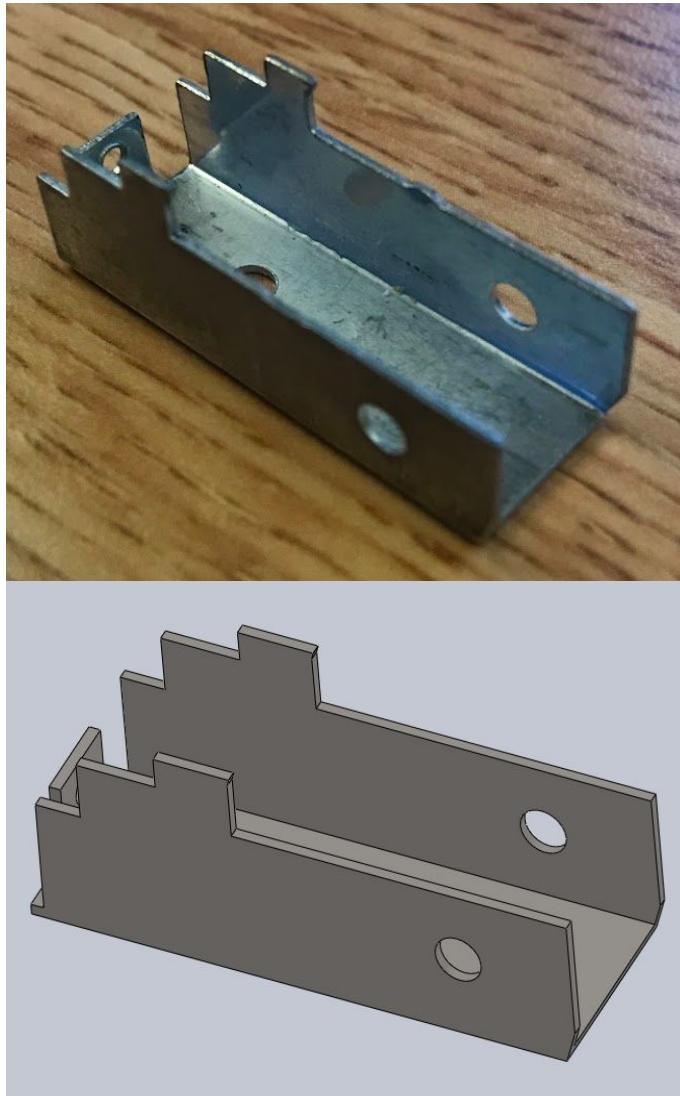


Figure 9.15.1: Comparison of Solid Model and Physical Part (Part 15)



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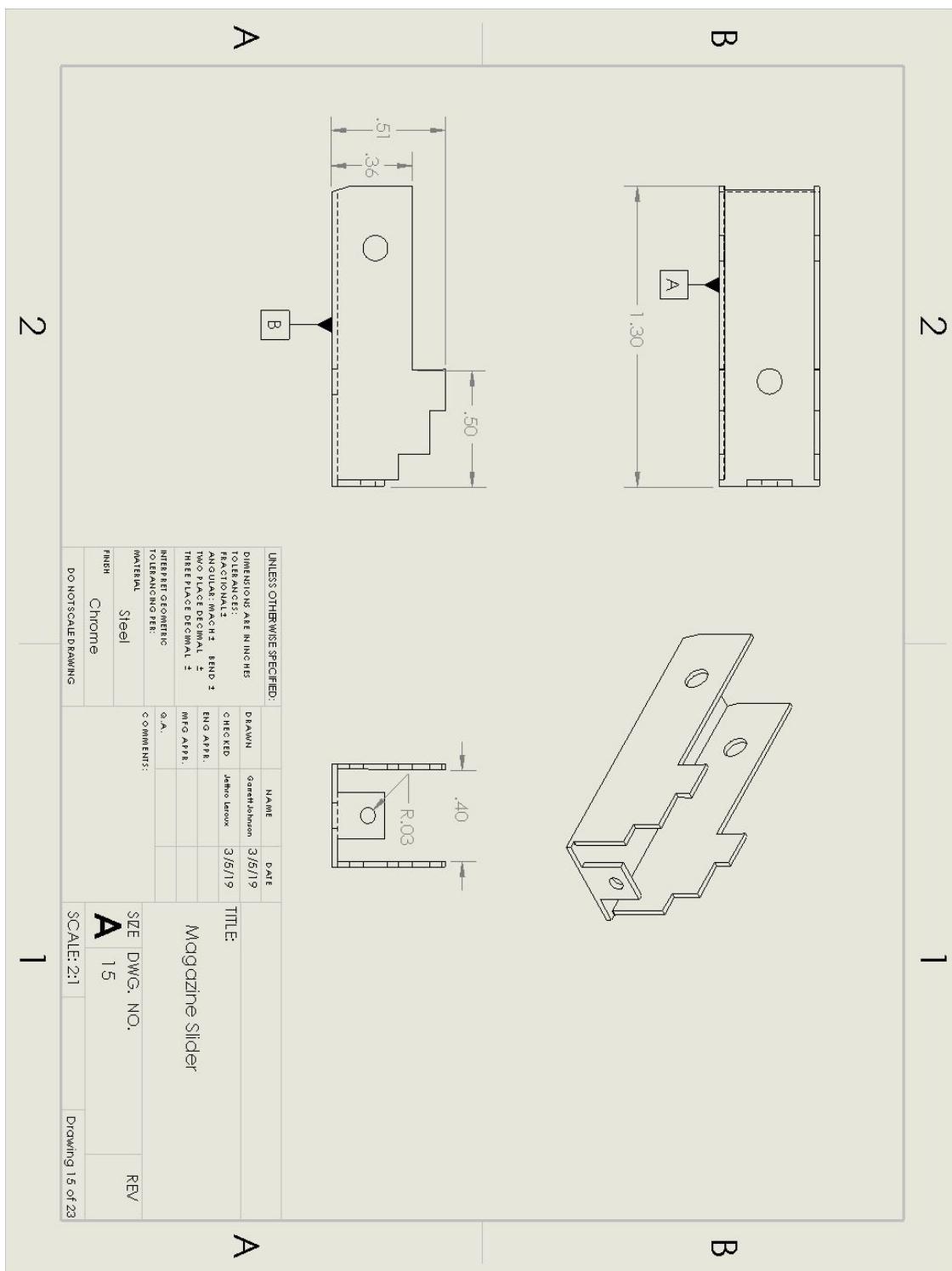


Figure 9.15.2: Engineering Drawing (Part 15)



Part 16

The magazine spring, with the help of the magazine slider (part 15), keeps the staples at the top of the gun to feed them to the actual forcing mechanism.



Figure 9.16.1: Comparison of Solid Model and Physical Part (Part 16)



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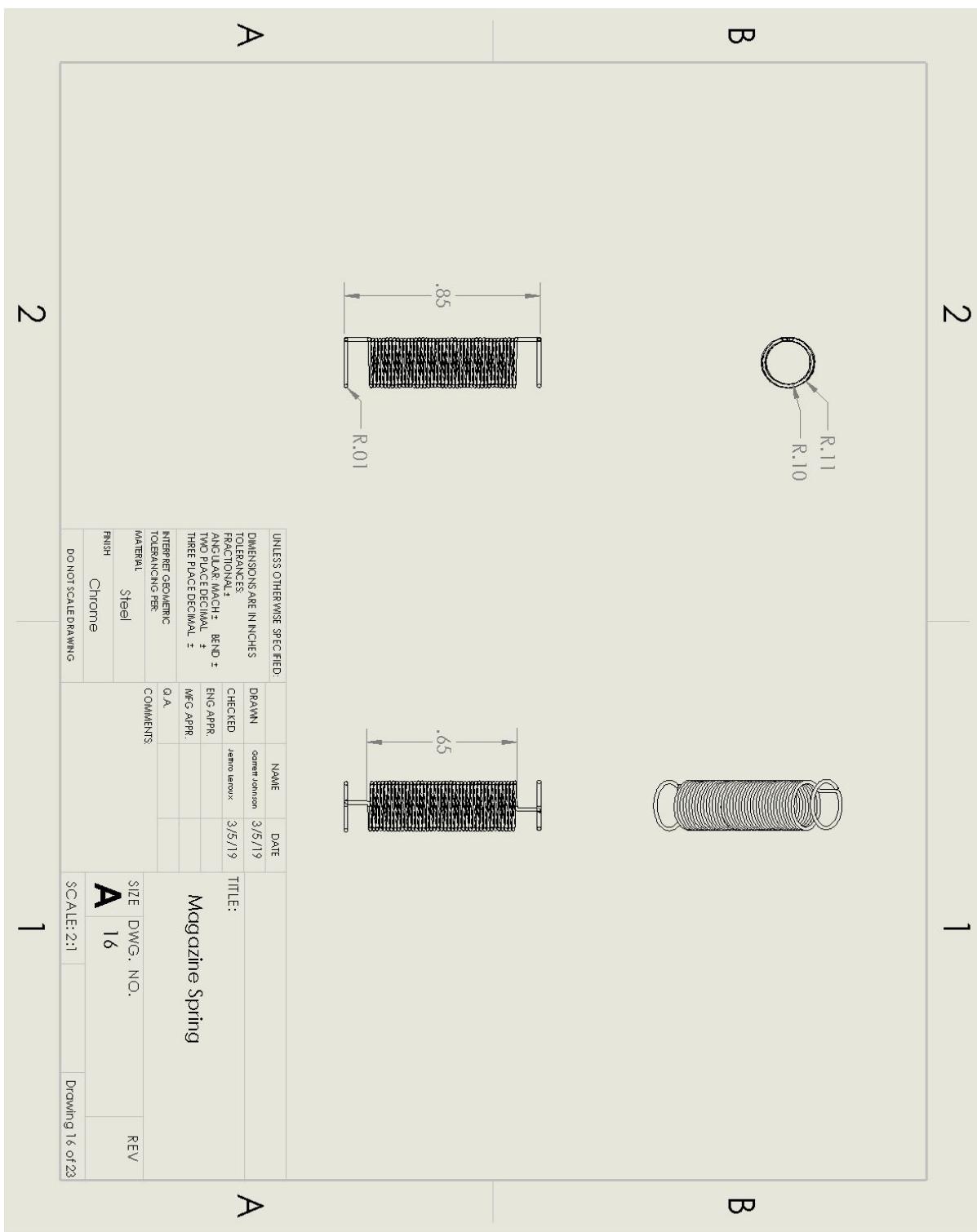


Figure 9.16.2: Engineering Drawing (Part 16)



Part 17

The spring plates get pulled back by the trigger (part 6) via the hammer strut (part 20) to initiate force on staple. The spring plates generate all the forcing power that pushes the staple off of the staple strip and out of the staple gun.



Figure 9.17.1: Comparison of Solid Model and Physical Part (Part 17)



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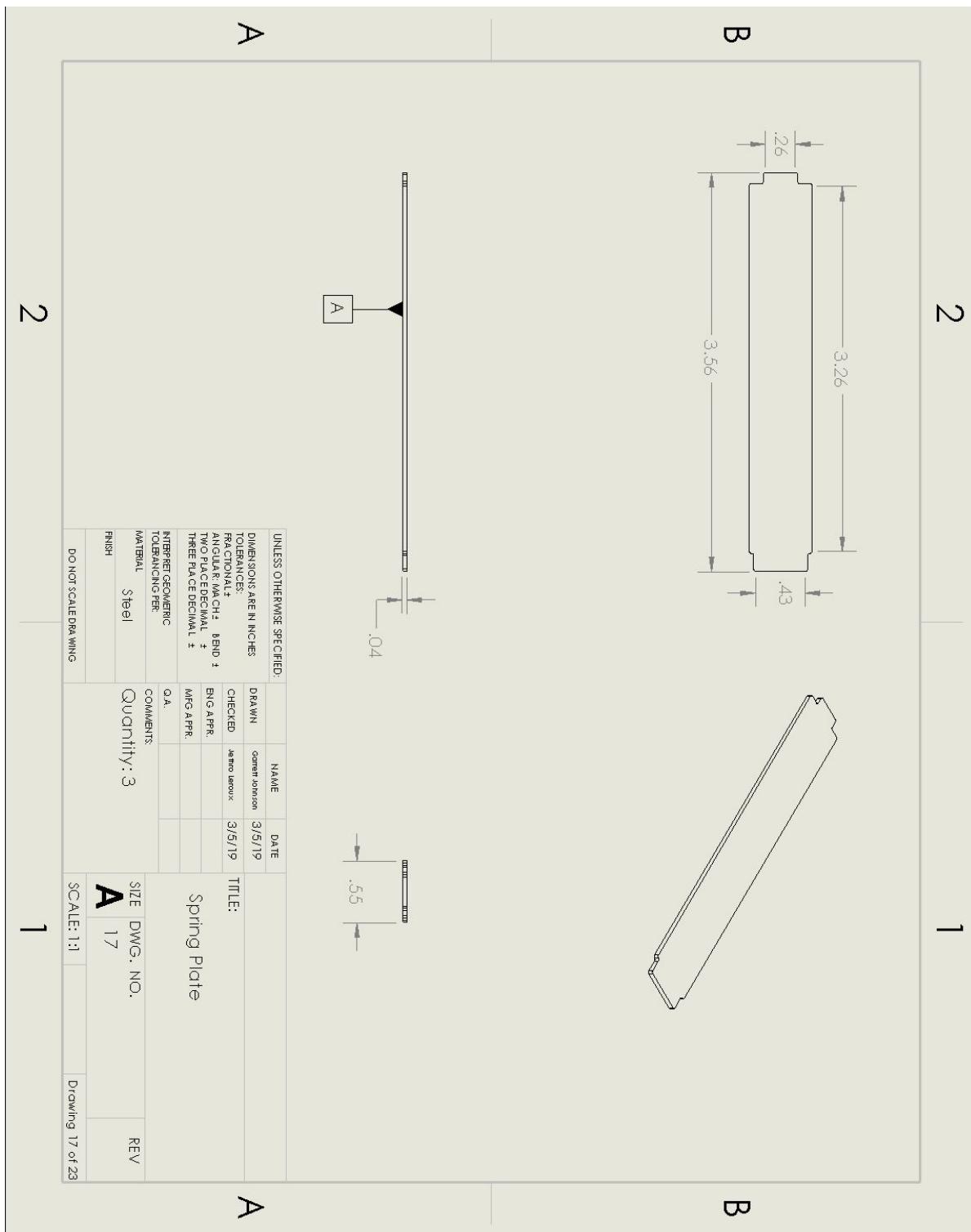


Figure 9.17.2: Engineering Drawing (Part 17)



Part 18

The shock reducer is used to reduce the physical force as well as the sound that would come from the spring plates (part 17) additional force post-staple contact.

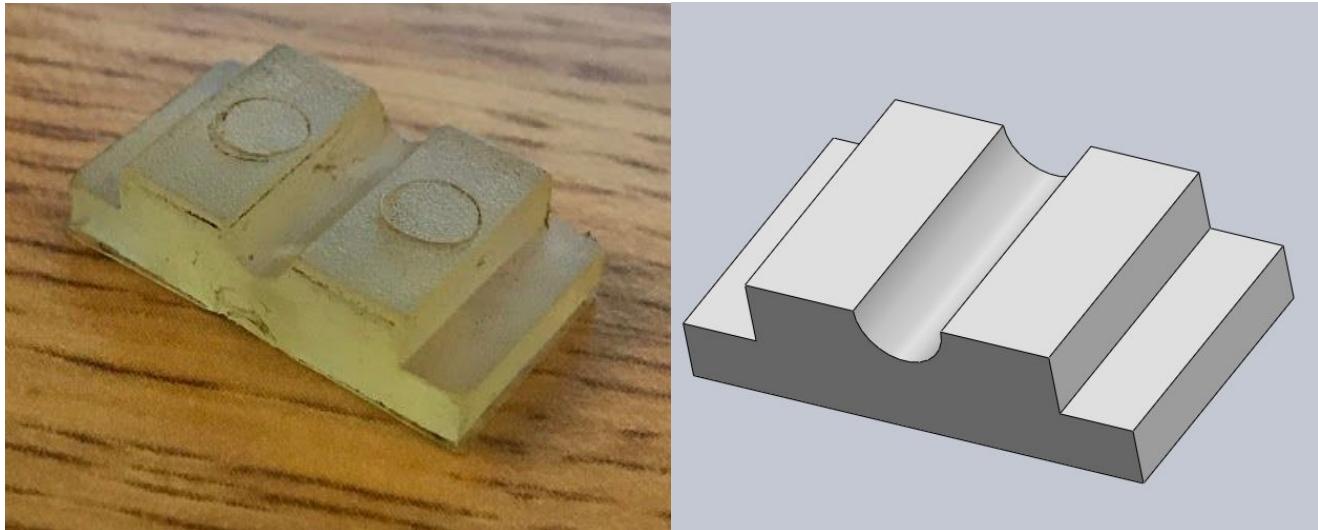


Figure 9.18.1: Comparison of Solid Model and Physical Part (Part 18)

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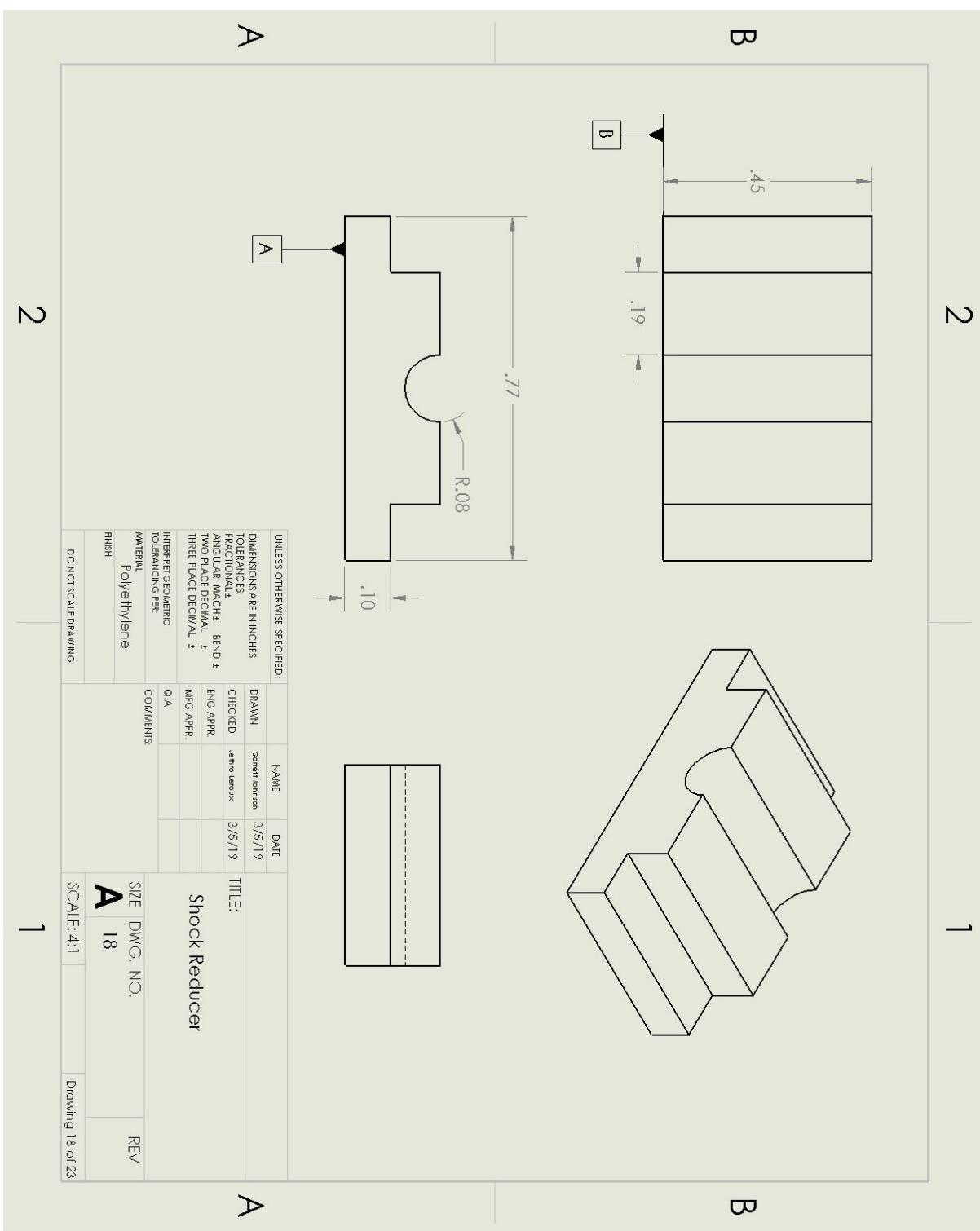


Figure 9.18.2: Engineering Drawing (Part 18)



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Part 19

The casing support is used to absorb the leftover force from the spring plates (part 17) and keep that extra force from damaging the staple gun structure.



Figure 9.19.1: Comparison of Solid Model and Physical Part (Part 19)



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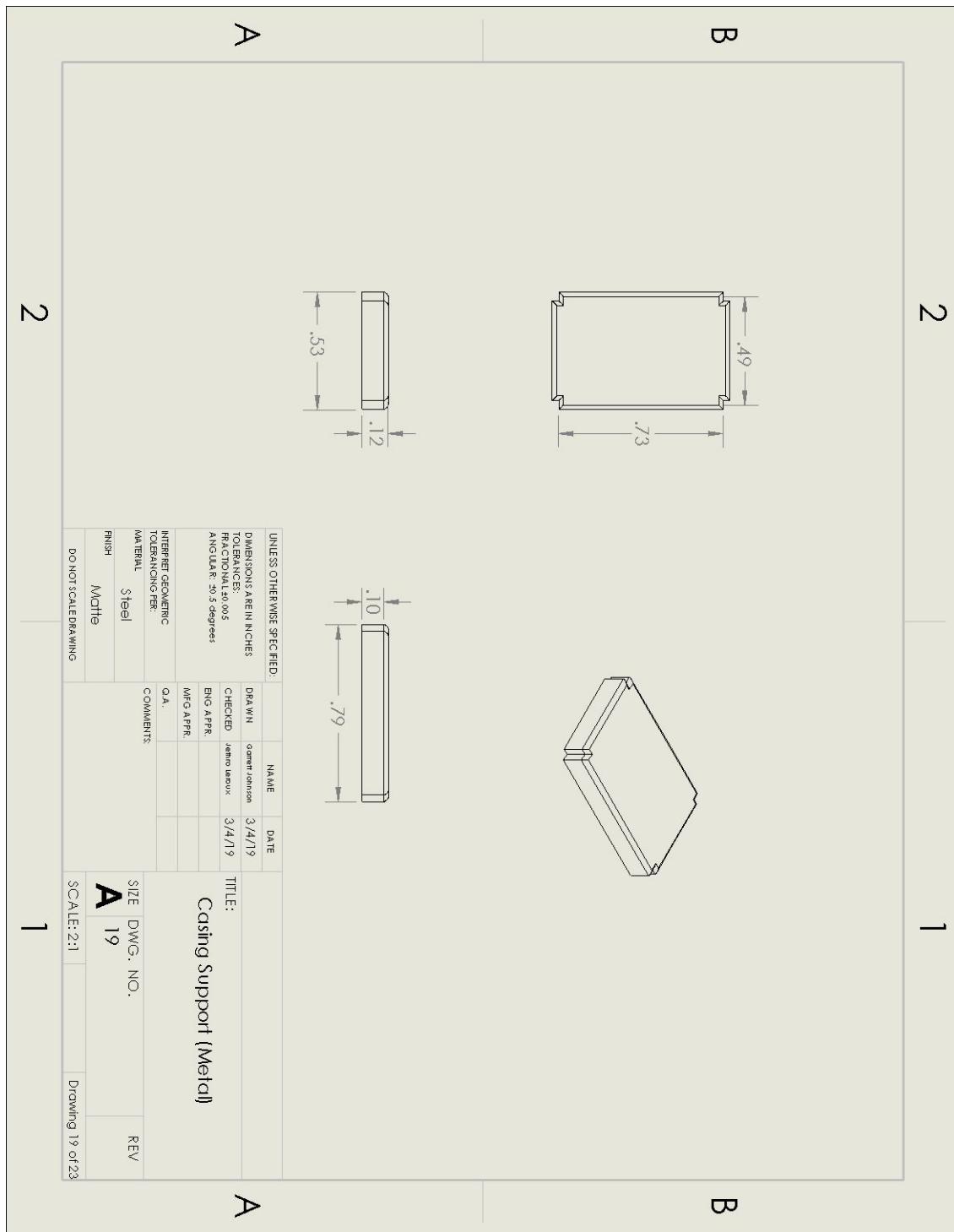


Figure 9.19.2: Engineering Drawing (Part 19)



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Part 20

The hammer strut is used to initiate the staple as well as transfer power from the spring plates (part 17) to the staple from the trigger (part 6). The hammer strut is located under the front guard (part 7).

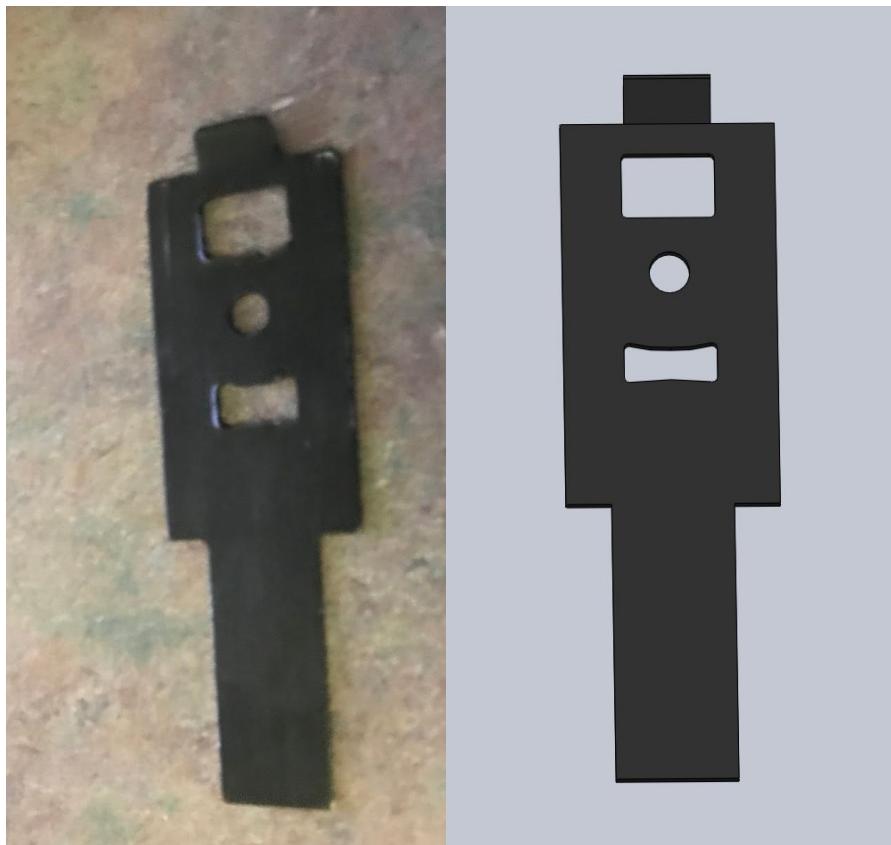


Figure 9.20.1: Comparison of Solid Model and Physical Part (Part 20)



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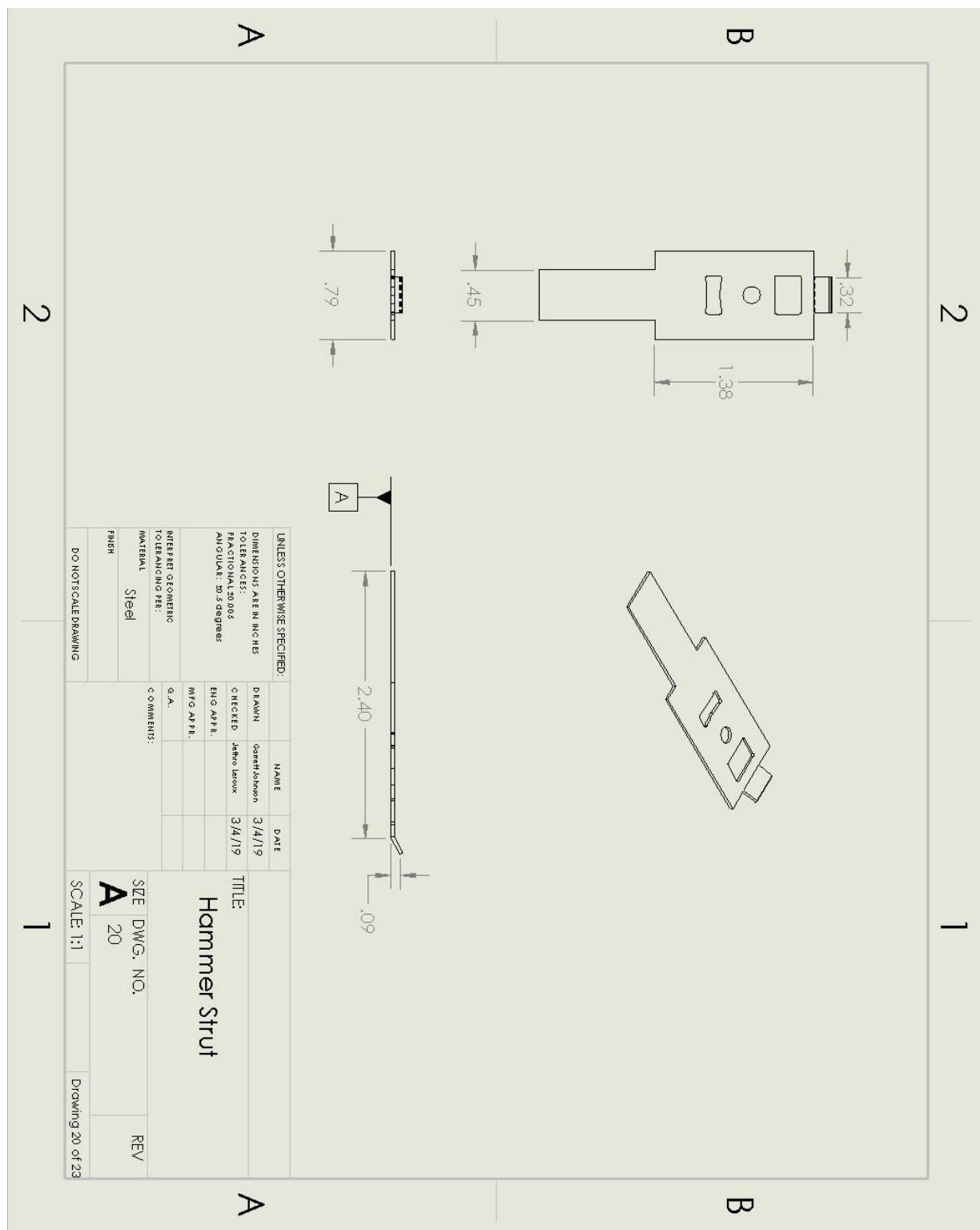


Figure 9.20.2: Engineering Drawing (Part 20)



Part 21

The small snap ring (0.15" OD) was used to fasten the .12" diameter pin (part 2), which held together the front guard(part 7), left body frame (part 8), and right body frame (part 22).



Figure 9.21.1: Comparison of Solid Model and Physical Part (Part 21)



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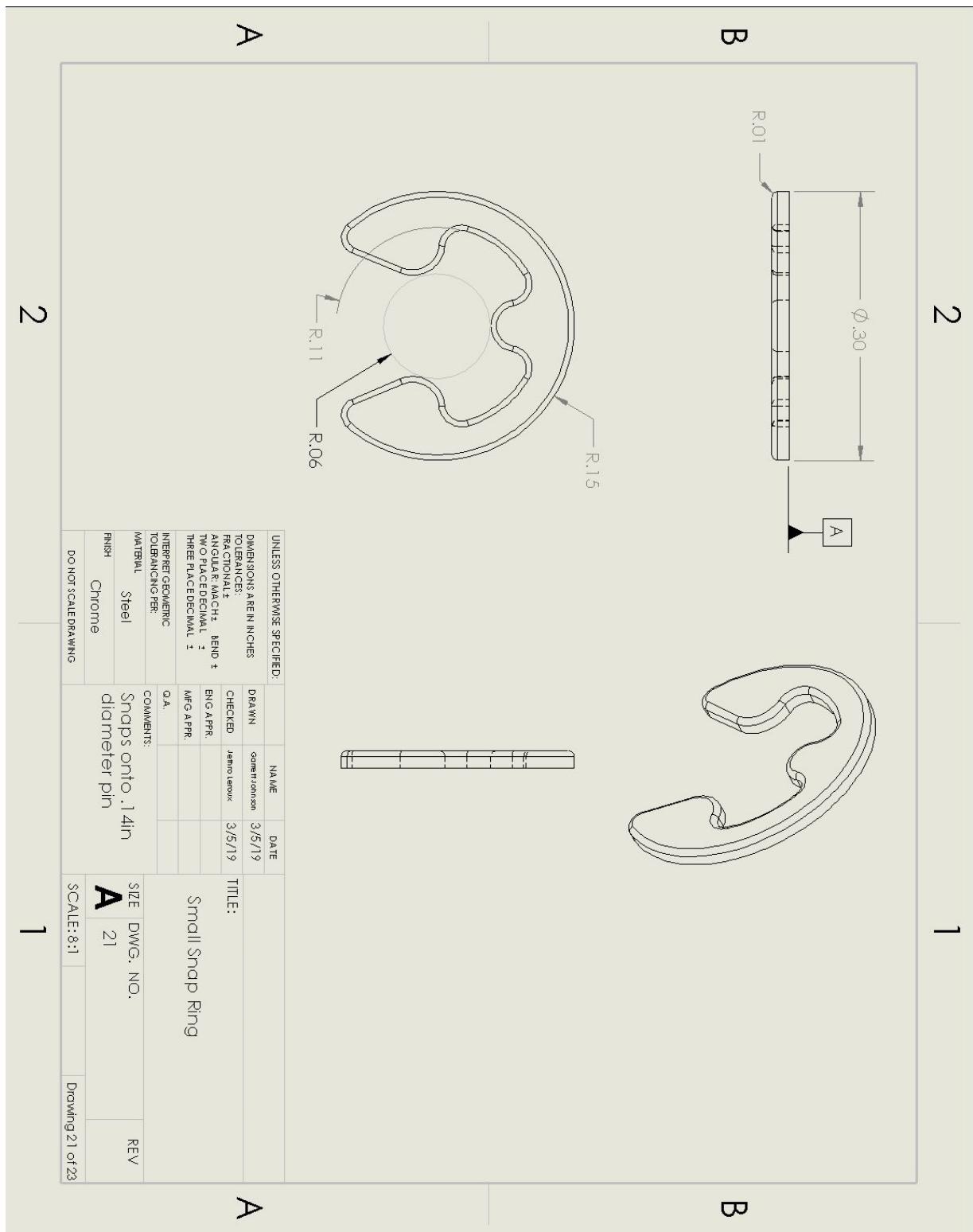


Figure 9.21.2: Engineering Drawing (Part 21)



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Part 22

The right body frame is the structural base for the staple gun. All pins (parts 1, 2, and 3) pass through the left body to the right body and support the front guard (part 7), handle (part 10), magazine (part 14), and internal structures. The left and right body frames are just mirrored versions of each other.



Figure 9.22.1: Comparison of Solid Model and Physical Part (Part 22)



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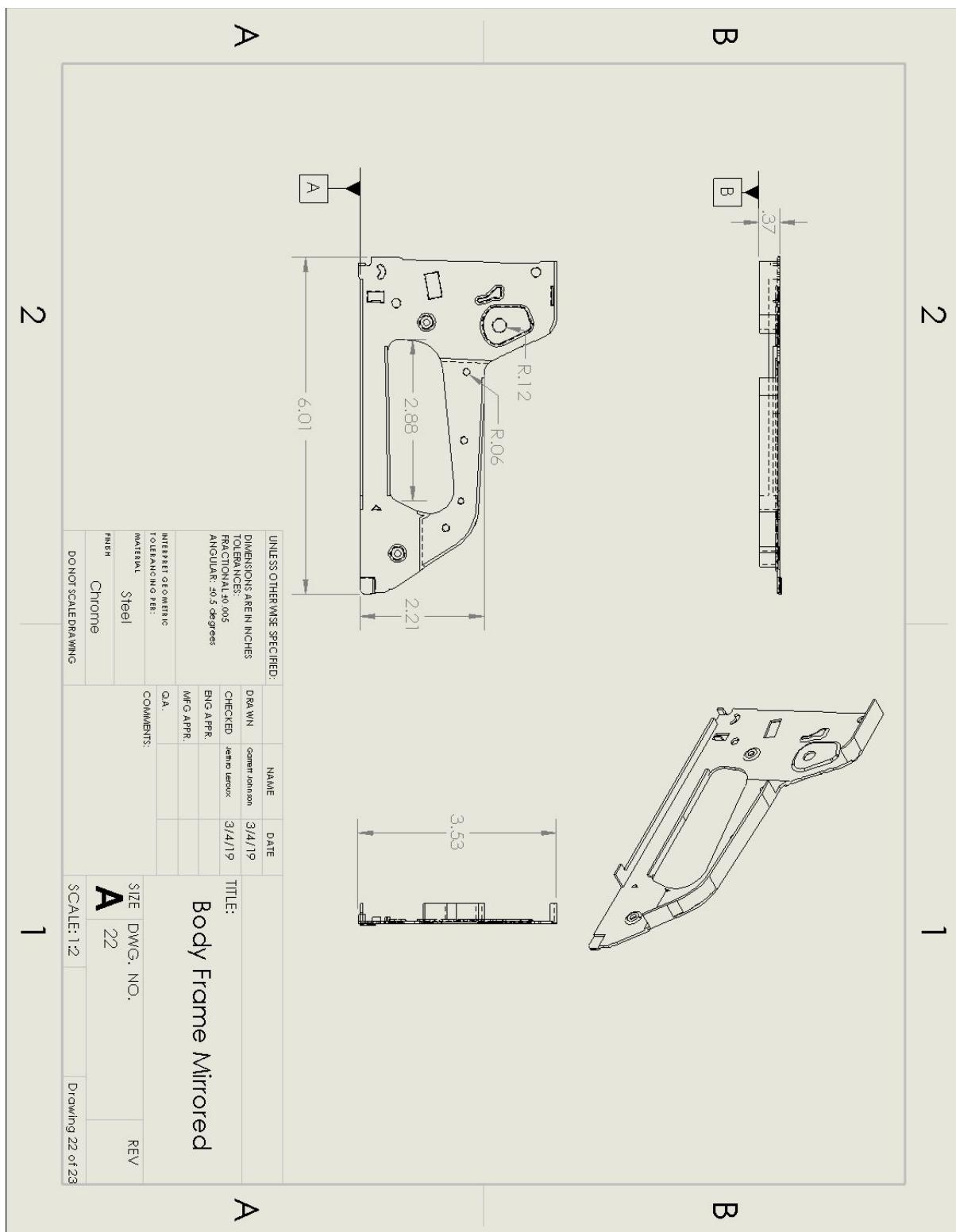


Figure 9.22.2: Engineering Drawing (Part 22)



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Part 23

The magazine grip is used to insert and remove magazine (part 14) so staples can be inserted into the staple gun.



Figure 9.23.1: Comparison of Solid Model and Physical Part (Part 23)

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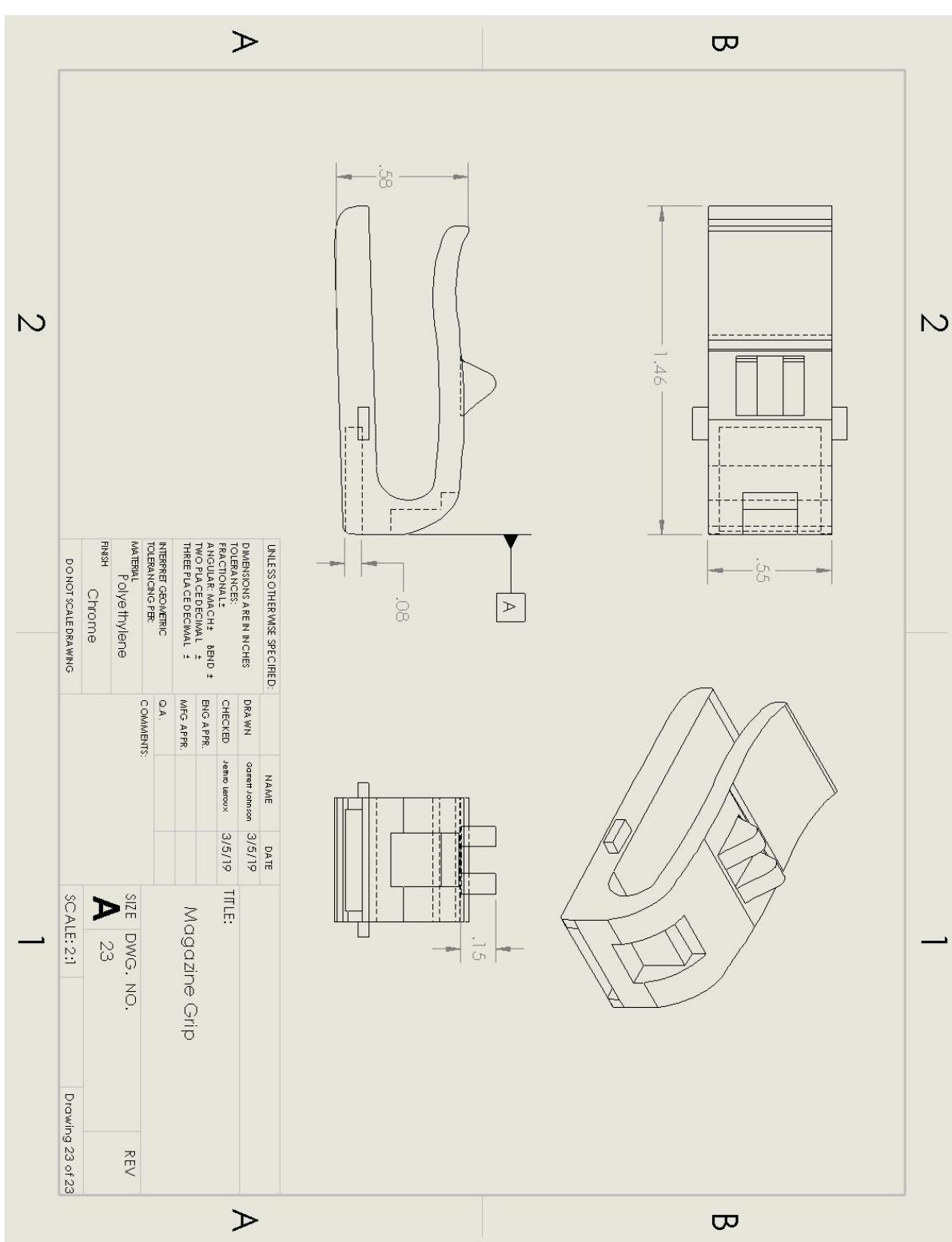


Figure 9.23.2: Engineering Drawing (Part 23)



Competitive Analysis

The Arrow JT27 was a top product on Amazon in the staple gun disciplinary but there was many direct competitors. In order to gain knowledge on the competitive field, group members went to Home Depot and asked workers for opinions on certain staple guns. The main thing the employee said was that shoppers are looking for the most reliability for the cheapest cost. Since the Arrow JT27 is extremely affordable, as a group, we decided to select competitors that were in a similar price range. The competitors selected were:

- Stanley TR150 SharpShooter Heavy-Duty Staple Gun
- DeWalt Heavy-Duty Compact Staple Gun
- 2-in-1 Stanley Electric Stapler and Strip Brad Nailer



Competitor 1: Stanley TR150 SharpShooter Heavy-Duty Staple Gun



Figure 7.1: Stanley TR150 Sharpshooter Heavy-Duty Staple Gun Image [8]

This Stanley Staple Gun is Arrows most direct competition based on cost. This staple gun retails for \$16 on the Home Depot website and is the next cheapest option for a reputable brand. The product has a 4.2 star rating on Amazon. The majority of the good reviews involved the high quality for little cost. Negative reviews were about the weight and force required to staple as well as the inability of staples to penetrate harder materials. Compared to the Arrow JT27, this product had better reviews. Home Depot and the Stanley webpage had three reviews combined and they were all negative and vague with their reasoning.

Linked to Amazon Reviews:

https://www.amazon.com/Stanley-TR150-SharpShooter-Heavy-Staple/product-reviews/B000BQWH40/ref=cm_cr_arp_d_hist_1?ie=UTF8&filterByStar=one_star&reviewerType=all_reviews&pageNumber=1#reviews-filter-bar

Home Depot Review:

<https://www.homedepot.com/p/Stanley-SharpShooter-Heavy-Duty-Staple-Gun-TR150/203754478>



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Product on Stanley Website:

<https://www.stanleytools.com/products/hand-tools/manual-fastener-tools/staplers-tackers/sharpshooter-heavy-duty-staple-gun/tr150>

Amazon Product Information:

Technical Details

Part Number	TR150
Item Weight	1.5 pounds
Product Dimensions	10 x 1.5 x 8.9 inches
California residents	Click here for Proposition 65 warning
Item model number	TR150
Size	samsung
Color	Yellow
Material	Aluminum
Item Package Quantity	1
Included Components
Batteries Included?	No
Batteries Required?	No
Warranty Description	Stanley warrants this product to the original purchaser for its useful life against deficiencies in material and workmanship. This LIMITED LIFETIME WARRANTY does not cover products that are improperly used, abused, altered or repaired. Deficient products will be replaced or repaired.

Figure 7.2: Stanley TR150 Sharpshooter Amazon Product Details [3]



Competitor 2: DeWalt Heavy-Duty Compact Staple Gun



Figure 7.3: DeWalt Heavy-Duty Compact Staple Gun Image [4]

The DeWalt Heavy-Duty Compact Staple Gun ranges in price from \$20 on Amazon and up on its competitor's sites. This product has 2.6 stars out of 5 on Amazon. The reviews are very mixed on this item, as some people say it is excellent and others say that it rarely works well for them. The main issue in the reviews was that the gun doesn't eject staples when it is supposed to, so the user must pull the trigger time after time to get the gun to eject a staple. These reviews are very similar to the Arrow JT27, as the reviews are within .1 stars of each other.

Linked to Amazon Reviews:

https://www.amazon.com/DEWALT-Compact-Staple-Gun-Staples/product-reviews/B017WXRPZ0/ref=cm_cr_dp_d_show_all_top?ie=UTF8&reviewerType=all_reviews

-Home Depot Review:

<https://www.homedepot.com/p/DEWALT-Heavy-Duty-Compact-Staple-Gun-DWHTTR130LH/204269388>

Product on Dewalt Website:

<https://www.dewalt.com/products/hand-tools/manual-fasteners/heavy-duty-staple-and-brad-tacker/dwhtr350>



Amazon Product Information:

Technical Details

Part Number	DWHT74841
Item Weight	1.85 pounds
Product Dimensions	11.2 x 2 x 10 inches
Item model number	DWHT74841
Item Package Quantity	1
Batteries Included?	No
Batteries Required?	No

Figure 7.4: DeWalt Heavy-Duty Compact Staple Gun Amazon Product Details [1]



Competitor 3: 2-in-1 Stanley Electric Stapler and Strip Brad Nailer



Figure 7.5: 2-in-1 Stanley Electric Stapler Image [5], [7]

The 2-in-1 Stanley Electric Stapler and Strip Brad Nailer is selling for \$35 on Amazon and up on competitor's sites. This product has gotten 3.9 stars on Amazon. The reviews are mainly good, with only a few issues brought up. The issues were with the ability of the gun to shoot staples through thicker wood. The staple gun has problems going through hardwood that is thicker than about half an inch. The other issue shown was that the gun doesn't work well at odd angles; the gun only works well when pressing downward. These reviews are altogether better than the reviews for the Arrow JT27. However, the price of the 2-in-1 Stanley Electric Stapler and Strip Brad Nailer is over 3 times the price of the Arrow JT27, so that is something to take into consideration.

Linked to Amazon Reviews:

https://www.amazon.com/Stanley-TRE550Z-Electric-Staple-Brad/product-reviews/B000BPSUTM/ref=cm_cr_dp_d_show_all_top?ie=UTF8&reviewerType=all_reviews



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Home Depot Review:

<https://www.homedepot.com/p/Stanley-2-in-1-Electric-Stapler-and-Strip-Brad-Nailer-TRE550Z/100388382>

Product on Stanley Website:

<https://www.stanleytools.com/products/hand-tools/manual-fastener-tools/staplers-tackers/electric-staplebrad-nail-gun/tre550>

Amazon Product Information:

Technical Details

Part Number	TRE550Z
Item Weight	1.44 ounces
Product Dimensions	5.9 x 3 x 3.6 inches
California residents	Click here for Proposition 65 warning
Item model number	TRE550Z
Style	TRE550Z
Material	plastic
Power Source	Corded Electric
Item Package Quantity	1
Included Components	stand
Batteries Included?	No
Batteries Required?	No
Warranty Description	Stanley warrants this product to the original purchaser for its useful life against deficiencies in material and workmanship. This LIMITED LIFETIME WARRANTY does not cover products that are improperly used, abused, altered or repaired. Deficient products will be replaced or repaired.

Figure 7.6: 2-in-1 Stanley Electric Stapler Amazon Product Details [2]



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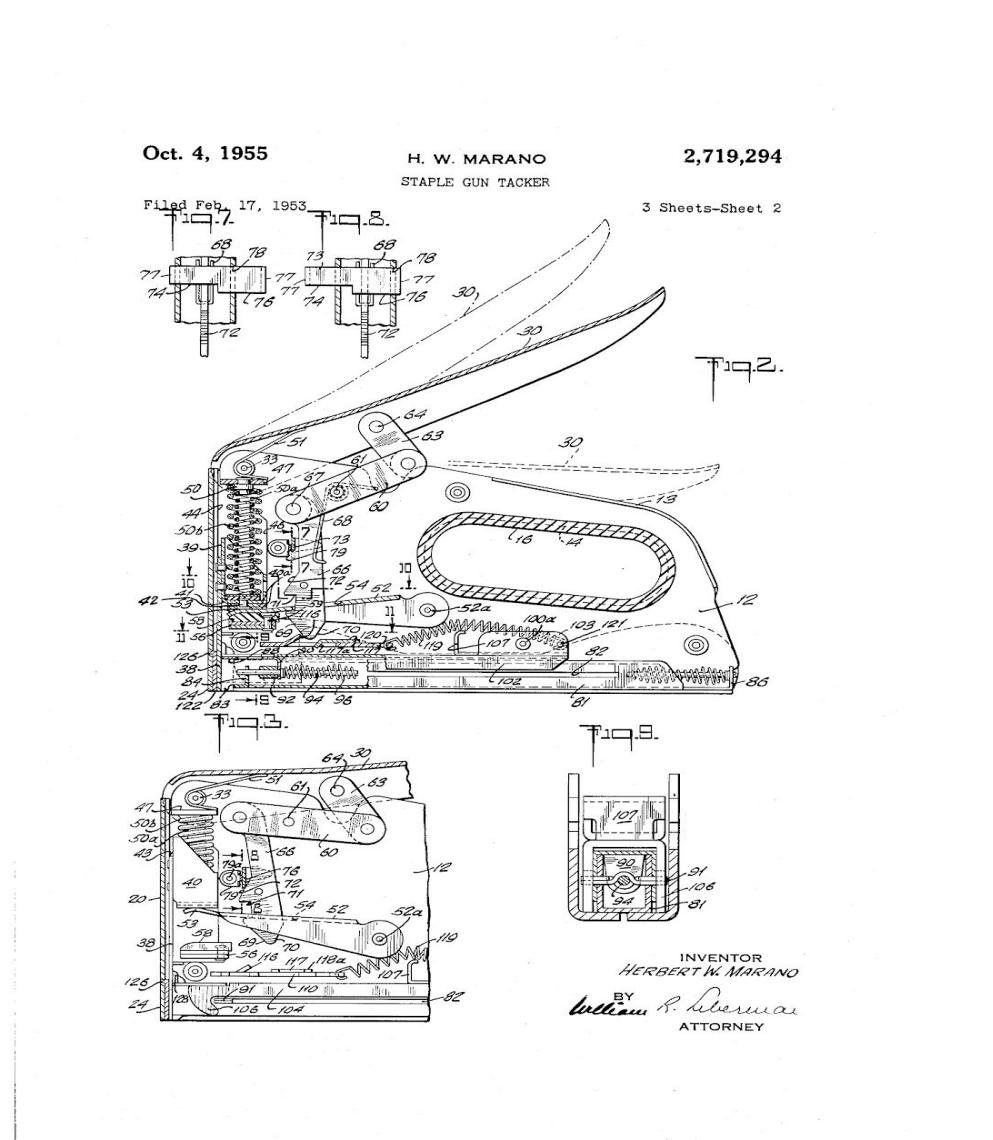


Figure 7.7: Initial Staple Gun Patents 1955 [9]

This photo of an early patent for the staple gun shows the complexity of the staple gun. This patent shows all of the different design infringements.



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Product Improvement

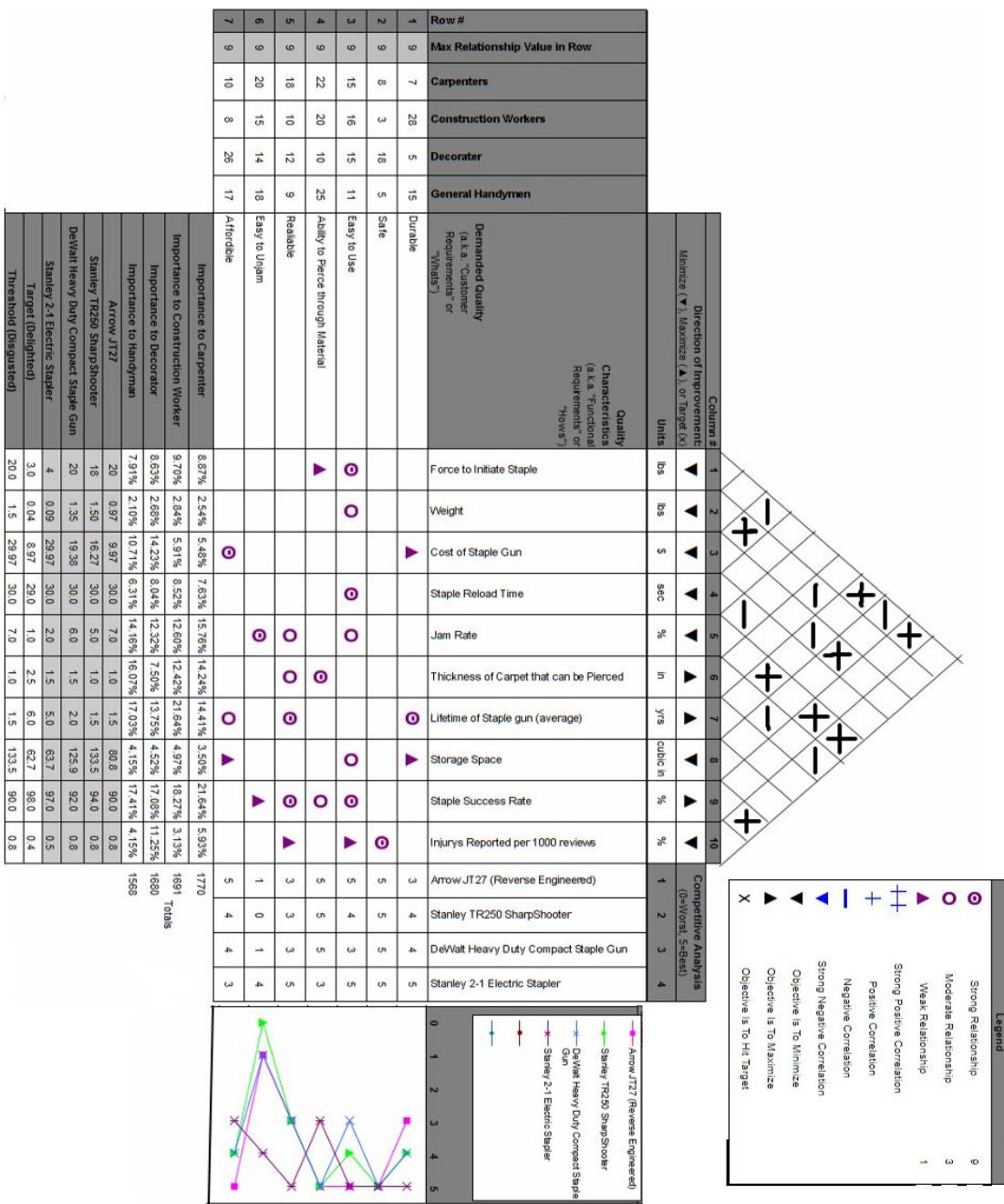


Figure 8.1: Quality Function Development (QFD) Chart



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The Quality Function Deployment (QFD) chart completed on the previous page shows how customers, customer requirements, competition, and quality specifications relate to meet customer needs.

The major customers that are studied in the QFD are:

- Carpenters
- Construction Workers
- Decorators
- General Handymen

The determined customer requirements are:

- Durable
- Safe
- Easy to Use
- Ability to Pierce through Material
- Reliable
- Easy to Unjam
- Affordable

The customer requirements were established from reading customer reviews on general staple guns on Amazon, Home Depot, and company webpages. Characteristics that were present in happy reviews and absent in negative reviews were studied in depth.

The chart below shows how important each customer requirement is to a specific customer. These values were decided upon from the function the staple gun performs for each customer.

Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")				
Demanded Quality (a.k.a. "Customer Requirements" or "Whats")				
Carpenters	Construction Workers	Decorator	General Handymen	
7	28	5	15	Durable
8	3	18	5	Safe
15	16	15	11	Easy to Use
22	20	10	25	Ability to Pierce through Material
18	10	12	9	Reliable
20	15	14	18	Easy to Unjam
10	8	26	17	Affordable

Figure 8.2: QFD Who versus What



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In order to fully understand a product, competitor products must be evaluated. Certain products are better at specific requirements compared to competitors.

The top three competitors to the Arrow Staple Gun determined mainly by price range are:

1. Stanley TR250 SharpShooter
2. DeWalt Heavy Duty Compact Staple Gun
3. Stanley 2-1 Electric Stapler

During competitive analysis, products were researched on Amazon, Home Depot, and their own company webpage. Physical details of the staple guns as well as reviews were examined.

Competitive Analysis (0=Worst, 5=Best)				
	1	2	3	4
Arrow JT27 (Reverse Engineered)				
Durable	3	4	4	5
Safe	5	5	5	5
Easy to Use	5	4	3	5
Ability to Pierce through Material	5	5	5	3
Reliable	3	3	3	5
Easy to Unjam	1	0	1	4
Affordable	5	4	4	3
DeWalt Heavy Duty Compact Staple Gun				
Stanley 2-1 Electric Stapler				

Figure 8.3: QFD Now vs What

The table shows how well each product meets customer requirements. The Stanley 2-1 Electric Staple Gun meets all customer requirements very well. This is mainly due to it being electric and requiring less force to initiate staple. A requirement that most competitors failed to meet was the ability to unjam easily. There was an overwhelming number of reviews that involved issues with jamming.



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In order to evaluate each product scientifically, quality characteristics/ specifications were determined that could be analyzed quantitatively.

The specifications elected based on customer essentials are:

- Force to Initiate staple
- Weight
- Cost of Staple Gun
- Staple Reload Time
- Jam Rate
- Thickness of Carpet that can be Pierced
- Lifetime of Staple Gun (average)
- Storage Space
- Injuries Reported (per 1000 reviews)

Units and direction improvement are show in the engineering specifications.

Column #	1	2	3	4	5	6	7	8	9	10
Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▼ ▾	▼ ▾	▼ ▾	▼ ▾	▼ ▾	▲ ▾	▲ ▾	▼ ▾	▲ ▾	▼ ▾
Units	lbs	lbs	\$	sec	%	in	yrs	cubic in	%	%
Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Force to Initiate Staple	Weight	Cost of Staple Gun	Staple Reload Time	Jam Rate	Thickness of Carpet that can be Pierced	Lifetime of Staple gun (average)	Storage Space	Staple Success Rate	Injuries Reported per 1000 reviews

Figure 8.4: QFD Engineering Specifications

There are limitations on each improvement. Obviously, there is no such thing as a perfect staple gun that never jams or is always successful. No staple gun can take up zero space or weigh nothing.



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When deciding upon quality characteristics, it's important to have at least one characteristic that has a strong relationship with each customer requirement. This allows for engineers and product designers to know that a customer requirement has been met. The figure below shows these correlations.

Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")									
	Force to Initiate Staple	Weight	Cost of Staple Gun	Staple Reload Time	Jam Rate	Thickness of Carpet that can be Pierced	Lifetime of Staple gun (average)	Storage Space	Staple Success Rate	Injuries Reported per 1000 reviews
Durable			▲				○	▲		
Safe										○
Easy to Use	○	○		○	○		○	○	▲	
Ability to Pierce through Material	▲					○		○		
Reliable					○	○	○	○	▲	
Easy to Unjam					○				▲	
Affordable			○			○	○	▲		

Figure 8.5: QFD How versus What

$$\Delta = 1, \circ = 3, \ominus = 9$$

After deciding correlations, it is a key step to determine how important each characteristic is to the customer. This can be determined by scaling the importance of each customer requirement with the correlations of the quality characteristics. The diagram on the next page shows customer importance.



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Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")									
	Force to Initiate Staple	Weight	Cost of Staple Gun	Staple Reload Time	Jam Rate	Thickness of Carpet that can be Pierced	Lifetime of Staple gun (average)	Storage Space	Staple Success Rate	Injuries Reported per 1000 reviews
Importance to Carpenter	8.87%	2.54%	5.48%	7.63%	15.76%	14.24%	14.41%	3.50%	21.64%	5.93%
Importance to Construction Worker	9.70%	2.84%	5.91%	8.52%	12.60%	12.42%	21.64%	4.97%	18.27%	3.13%
Importance to Decorator	8.63%	2.68%	14.23%	8.04%	12.32%	7.50%	13.75%	4.52%	17.08%	11.25%
Importance to Handyman	7.91%	2.10%	10.71%	6.31%	14.16%	16.07%	17.03%	4.15%	17.41%	4.15%
Arrow JT27	20	0.97	9.97	30.0	7.0	1.0	1.5	80.8	90.0	0.8
Stanley TR250 SharpShooter	18	1.50	16.27	30.0	5.0	1.0	1.5	133.5	94.0	0.8
DeWalt Heavy Duty Compact Staple Gun	20	1.35	19.38	30.0	6.0	1.5	2.0	125.9	92.0	0.8
Stanley 2-1 Electric Stapler	4	0.09	29.97	30.0	2.0	1.5	5.0	63.7	97.0	0.5
Target (Delighted)	3.0	0.04	8.97	29.0	1.0	2.5	6.0	62.7	98.0	0.4
Threshold (Disgusted)	20.0	1.5	29.97	30.0	7.0	1.0	1.5	133.5	90.0	0.8

Figure 8.6: QFD Specifications Target

Values for the staple gun products were determined from available product information in manuels as well as estimations. By knowing what each customer wants, a product can be developed around these qualities to sell well. Targets and thresholds are created to make sure the final product is a good design.



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Some quality characteristics have have an inverse relationship with other characteristics. It's important to study these to understand trade offs between specifications.

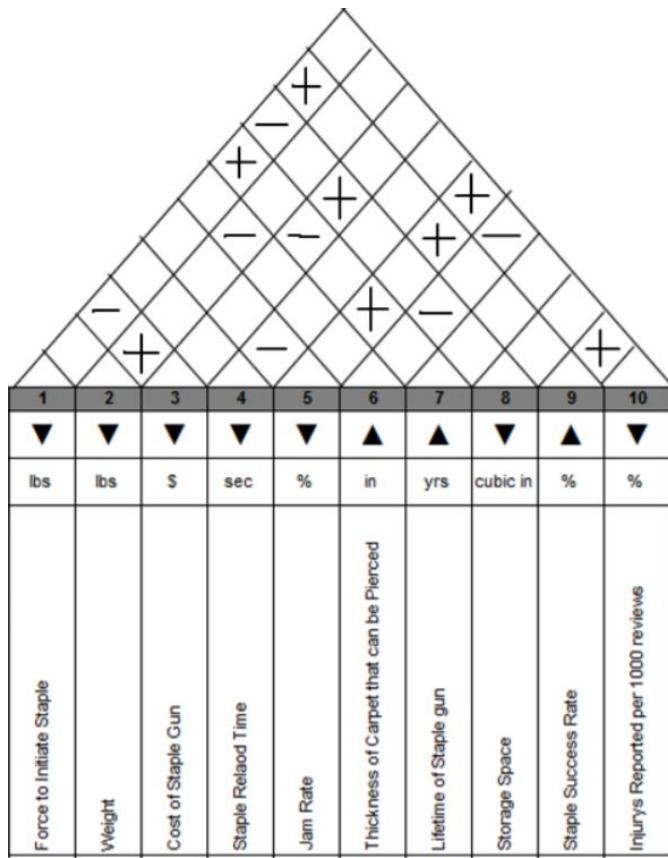


Figure 8.7: QFD How vs. How

A positive sign symbolizes a positive correlation, meaning that if one specification improves in the indicated direction so will the other characteristic. For example, If the jam rate decreases, the success staple rate increases implying that these two specifications are positively correlated. A negative correlation implies an inverse relationship. For example, if the cost of a staple gun goes down, its average lifetime will probably go down due to a lower quality manufacturing and materials. Therefore, as a designer you must try to balance these two specifications.



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Table 8.1: Customer Requirements (Template)

Customer Requirements	
Design Organization: Mech 202 Group 17	Date: 3/15/19
Product: Staple Gun	
Who:	
1. Who are the primary users of the product? Carpenters, Decorators, Handymen, Construction workers. 2. What skills or education will the primary users have? Wood/building material knowledge, building/renovating experience 3. Describe any primary user physical conditions that affect the design of the product. Must be strong enough to go through sturdy materials 4. Who will purchase the product? Carpenters, Decorators, Handymen, Construction companies 5. Who else is a stakeholder in the design of the product? The company and workers that design and make the staple guns, customers/product users 6. Describe any cultural practices or customs related to the product. NA 7. How much is the purchaser willing to pay for the product? \$5-\$300 (the expensive ones are generally electric and have other special features not associated with the specific staple gun used in this project). 8. How much is the user willing to pay to operate the product? Staples for the staple gun range from \$2-\$20. 9. How much is the user willing to pay to maintain the product? Fixing the staple gun ranges from \$1-\$40	
How:	
1. For what specific purposes will the product be used? Putting carpet in place, attaching things to wood, putting furniture together, building varieties of things 2. What is the current process used? Pressing the staple gun down, and inserting a staple through to whatever needs to be attached 3. How often will it be used? Depending on the customer anywhere from once a year to daily work. 4. How long will it be used each time? Depending on the project, only a few times or hundreds of times in order to complete a big project. 5. Describe the quality expected by the user. The staple gun must be sturdy, long-lasting, and easy to use. It must be comfortable to hold and use, not painful to the hand. It must be able to be used many times and not break easily.	



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6. How far, how often and in what way will product be transported? In a toolbox from different job locations, and however often the customer does projects or jobs.

Where:

1. Describe the surroundings for normal use. In a semi-finished construction development or a fully built structure that just needs finishing touches. Around other building equipment and tools, in a busy workplace normally.
2. Describe the noise, weather, temperature or other environmental factors that may affect the design of the product. The staple gun will be generally used in a somewhat loud environment with other building tools and equipment. The weather and temperature could range from hot and dry to very cold and wet, so the staple gun must be able to work well in a wide range of temperatures and weathers.
3. Describe any size or weight limitations. Must fit in the hand comfortably and be able to be picked up and carried easily and often.
4. Describe the energy available when the product is in use. A person's hand strength is the energy needed to press the staple gun and release a staple. This ranges on different staple guns, but the staple gun used in this project is relatively low energy to use.

Customer Requirements (include how well the product fulfills each requirement from 1-5, 5 being the best):

- | | |
|-------------------------------|---|
| 1. Durable | 3 |
| 2. Safe | 5 |
| 3. Easy to Use | 5 |
| 4. Ability to Pierce Material | 5 |
| 5. Reliable | 3 |
| 6. Easy to Unjam/Fix | 1 |
| 7. Inexpensive | 5 |

Who Else (List other products that fulfill the requirements):

1. Stanley TR250 Sharpshooter Staple Gun
2. DeWalt Heavy Duty Compact Staple Gun
3. Stanley 2-1 Electric Stapler



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Improvement Concepts

In order to come up with improvement, a decision matrix (Pugh's Diagram) was used to determine the top competitor to the Arrow JT27 staple gun. In the diagram below, min means minimize and max means maximize.

Quality Characteristic (units, direction of improvement)			Importance	REFERENCE	Arrow JT27 (Reversed Engineered)	Stanley TR250 SharpShooter	Dewalt Heavy Duty Compact Staple Gun	Stanley 2 1 Electric Stapler
Force to Initiate Staple	lbs	Min	8.78%		1	0	1	
Weight	lbs	Min	2.54%		-1	-1	1	
Cost of Staple Gun	\$	Min	9.08%		-1	-1	-1	
Staple Reload Time	sec	Min	7.62%		0	0	0	
Jam Rate	%	Min	13.71%		1	1	1	
Thickness of Carpet that can be Pierced	in	Max	12.56%		0	1	1	
Lifetime	yrs	Max	16.71%		0	1	1	
Storage Space	cubic in	Min	4.28%		-1	-1	1	
Staple Success Rate	%	Max	18.60%		1	1	1	
Injuries Reported Rate	%	Min	6.12%		0	0	1	
			Total		0	1	7	
			Weighted Total		25.19	45.68	74.22	

Figure 8.8: Decision Matrix of Competitors (Pugh's Diagram)

In a Pugh diagram, +1 means that competitor product outperformed the reference product, -1 means it underperformed, and zero signifies that it performed equal. It's important to use Pugh's method to determine the best competing product. As a designer, you know what product you should be trying to outperform and model your product after.



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As a group, ideas were generated by examining with the Arrow JT27 staple gun as well as evaluating the QFD for specifications in which the product underperformed in comparison to competitors. The improvement ideas generated were:

- Lessen the force to initiate staple
- A way to know where the staple is going, specifically
- A safety on the trigger
- Ergonomic improvements on the hand grips

In order to evaluate these four ideas, Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis was used. This is a great technique to understand both the positive and negatives of an idea as well as how the business side will be affected.



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Idea #1:

SWOT Analysis	
Topic: Lesson the force to initiate staple	
Strengths: 1. Many customers directly asked for this in comments 2. Would minimize a quality characteristic 3. Easier to use in general	Weaknesses: 1. By doing so, there is a high chance the power of the staple gun goes down. The staples ability to penetrate thicker materials would weaken. 2. Would require addition parts and possibly a redesign to fit new parts
Opportunities: 1. Makes the product more attractive in the marketplace 2. Helps the product target consumers who do not have great hand strength	Threats 1. Cost more money to add and manufacture extra parts which would increase the overall price of the staple gun. Customers may or may not be willing to pay for this 2. If the function of the staple gun was weakened, customers would quit buying the product

Figure 8.9: SWOT Analysis of Idea 1

Even though customers directly asked for this in reviews, the weaknesses outweigh the positives for a mechanical based staple gun. By reducing the initial force, the overall function of the staple gun is at risk. This idea was rejected.



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Idea #2:

SWOT Analysis	
Topic: A way to know where the staple is going, specifically	
Strengths: 1. Would allow customers to know where the staple is going beforehand 2. Customers could use staples more efficiently because no wasted staples on an improper location 3. Could be done with little cost addition to final product	Weaknesses: 1. Not directly asked for by customers in reviews or in QFD 2. Few customers need to know exactly where their staple is going (small market) 3. A customer can easily estimate the location of the staple without additional technology
Opportunities: 1. Could open up a new market with very little competition because of how unique the product is	Threats 1. Does not add any value to the product in the general marketplace 2. Too small of a market could result in major financial loss

Figure 8.10: SWOT Analysis of Idea 2

Idea two did not impact the product enough to be worth doing. Since the addition doesn't add any value to the product in the general marketplace, the idea was scrapped.



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Idea #3:

SWOT Analysis	
Topic: A safety on the trigger	
Strengths: 1. Would reduce number of injuries reported 2. Improve general safety (especially around kids) 3. Would meet what customers are asking for in reviews (small portion) 4. Not currently seen in the marketplace, very few products have it	Weaknesses: 1. Would require an additional part 2. Possible redesign of interior spring system
Opportunities: 1. Would make the product more appealing in general 2. Would specifically appeal to customers with younger children 3. Gives the customer something they do not expect	Threats 1. The extra part adds addition cost that some customers may or may not be willing to pay for

Figure 8.11: SWOT Analysis of Idea 3

Due to the chance of having to redesign whole spring system, this idea was scrapped. A spring system redesign would be an extreme financial risk to add a trigger that would not increase the products appeal very much.



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Idea #4:

SWOT Analysis	
Topic: Ergonomic improvements on the hand grips	
Strengths: 1. Would make the staple gun fit more comfortably on the hand 2. Would reduce recoil force on hands 3. Would meet customer reviews that claimed the staple guns was uncomfortable 4. Simple addition	Weaknesses: 1. New grip might not fit all peoples hands size 2. Would take an extra grip on trigger
Opportunities: 1. Would make the product slightly more appealing in general 2. Would give the customer something they wouldn't expect	Threats 1. The extra part adds addition cost that some customers may or may not be willing to pay for

Figure 8.12: SWOT Analysis of Idea 4

This idea had more strengths than weaknesses and was extremely simple so it was chosen. Customer complaints would be met with a simple fix that is also extremely cheap.



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Chosen Improvement: Elastomer Trigger Grip

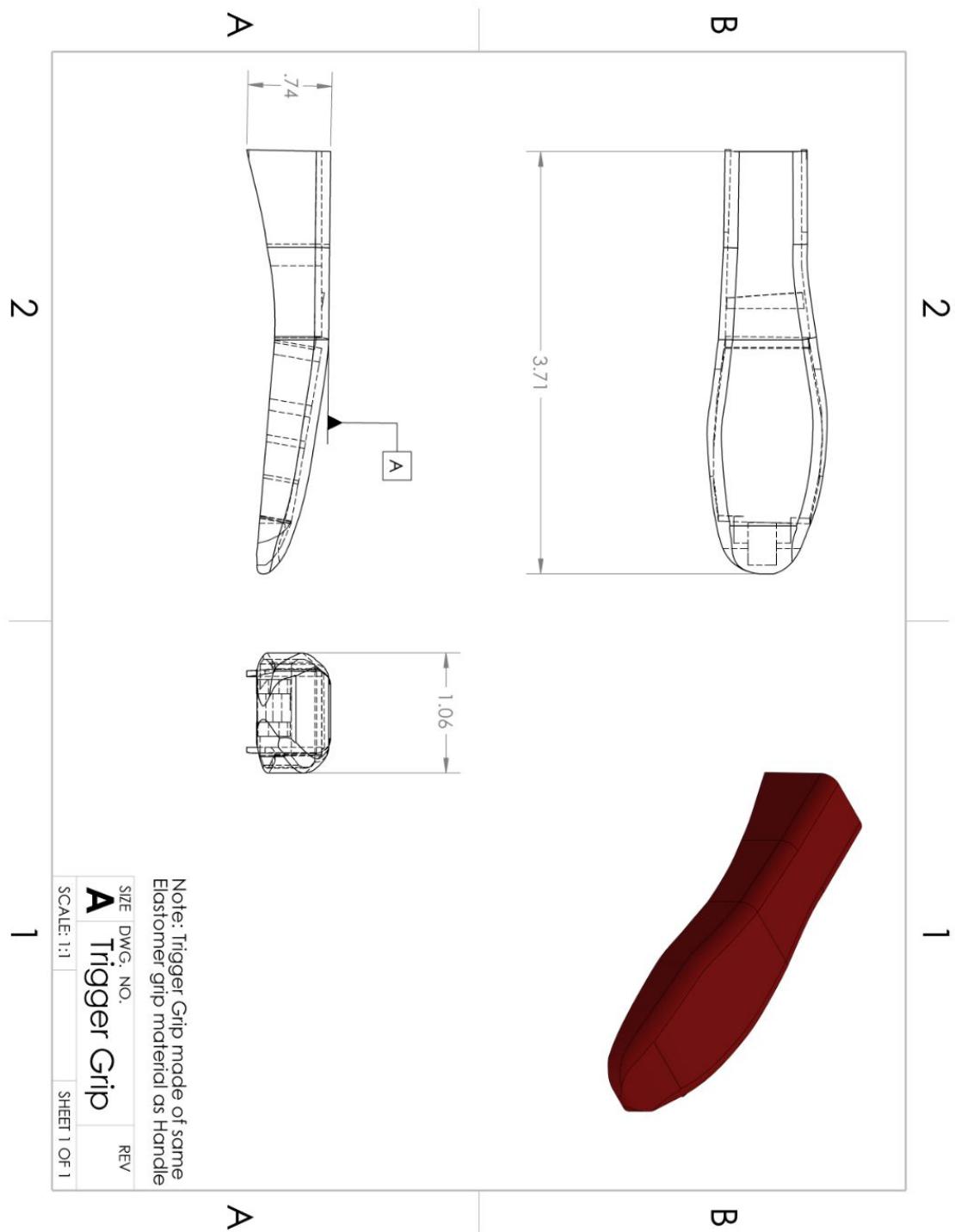


Figure 8.13: Design Improvement Drawing



Team Assessment

Our team decided to take on different jobs based upon previous skill sets coming into this project. All of the members performed different tasks in order to get the entire project done well. Garrett and Jethro have strong skills in Solidworks, so they worked on building the parts, the drawings, and the assembly on Solidworks. Alec, Hunter, and Josh utilized their skills in order to complete the QFD, the templates, and the more “paperwork” side of the project. Overall, there were not any real issues between members of the group, the teamwork flowed very smoothly. All of the partners had a say in what, when, and how everything would get done in order to accomplish the project. We worked together for a couple hours every week, and that allowed us to help each other in person and bounce ideas off of each other very quickly. This proved to be very successful because it allowed us to get everything finished in an efficient manner. The team worked very well as a group, and incorporated every person to get the full project together. We learned that teamwork involves different skill sets that come together in order to accomplish a common goal. Instead of trying to find people just like us to work with, it is good to find people that think differently in order to get a different perspective on a project. Teams only work when all of the members have a say in what is going on, and all of the members are allowed to be involved in working on a project.

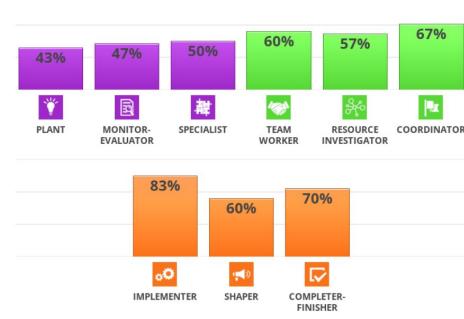


MECH 202 PROJECT 1 GROUP 17

Team Contract

Team Role Test Results

Hunter Becvar



Alec Destefano



Josh Ehr



Garrett Johnson



Jethro Leroux



Figure 10.1: Team Role Assessment



MECH 202 PROJECT 1 GROUP 17

Team Member Personality Traits

The following table summarizes each members top 3 roles from the test and their subsequent traits.

Table 10.1: Team Member Personality Traits

Hunter Becvar	<ol style="list-style-type: none">1. Implementer: Implementers take the suggestions and ideas of their teammates and turn them into action.2. Completer-Finisher: Completer-Finishers are perfectionists and will often go the extra mile to make sure everything is exactly right.3. Coordinator: are most often the chairperson of a team, since they have a talent for taking a step back and seeing the bigger picture.
Alec DeStefano	<ol style="list-style-type: none">1. Implementer: Implementers take the suggestions and ideas of their teammates and turn them into action.2. Plant: Plants are creative and unorthodox generators of ideas. Plants can also have a tendency to ignore details and specifics.3. Completer-Finisher: Completer-Finishers are perfectionists and will often go the extra mile to make sure everything is exactly right.
Josh Ehr	<ol style="list-style-type: none">1. Coordinator: are most often the chairperson of a team, since they have a talent for taking a step back and seeing the bigger picture.2. Monitor-Evaluator: Monitor-Evaluators are fair and logically-minded observers and judges of what is going on with the team.3. Completer-Finisher: Completer-Finishers are perfectionists and will often go the extra mile to make sure everything is exactly right.
Garrett Johnson	<ol style="list-style-type: none">1. Implementer: Implementers take the suggestions and ideas of their teammates and turn them into action.2. Shaper: are task-focused and driven by tremendous energy and the need to achieve. For them, winning is the name of the game.3. Completer-Finisher: Completer-Finishers are perfectionists and will often go the extra mile to make sure everything is exactly right.
Jethro Leroux	<ol style="list-style-type: none">1. Implementer: Implementers take the suggestions and ideas of their teammates and turn them into action.2. Monitor-Evaluator: Monitor-Evaluators are fair and logically-minded observers and judges of what is going on with the team.3. Completer-Finisher: Completer-Finishers are perfectionists and will often go the extra mile to make sure everything is exactly right.



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Team Dynamics

Given our unique personality traits, we as a team decided to delegate certain tasks based on our individual strengths, as well as keep some tasks as a group effort in order to let each of our strengths culminate into an ideal finished product that the entire team is happy with. A summary of each team members roles based on their strengths can be found in the Team Contract below.

Table 10.2: Team Contract

Team Member	Role	Initials
Hunter Becvar	Timeline Management	HB
Alec DeStefano	Market/Competition Analyst	AD
Josh Ehr	Project Manager	JE
Garrett Johnson	Design Engineer	GJ
Jethro Leroux	Design Engineer	JL
Team Goals	Responsible Member	
1. Research six important customer requirements for staple gun	AD	
2. Disassemble staple gun	HB AD JE GJ JL	
3. Create a comprehensive Bill of Materials for assembly	HB AD	
4. 3D Model all parts of staple gun in Solidworks	GJ JL	
5. Develop engineering drawings for 20 most important parts	GJ JL	
6. Create an exploded assembly diagram of staple gun	JE	
Team Performance Expectations	Initials	
1. Strive to complete all assigned tasks before or by deadline	HB AD JE GJ JL	
2. Complete all tasks to the best of ability	HB AD JE GJ JL	
3. Listen carefully and attentively to all comments at meetings	HB AD JE GJ JL	
4. Accept and give criticism in a professional manner	HB AD JE GJ JL	
5. Focus on results before the fact, rather than excuses after	HB AD JE GJ JL	
6. Provide as much notice as possible of commitment problems	HB AD JE GJ JL	



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7. Attend and participate in all scheduled group meetings	HB AD JE GJ JL
8. Obtain a grade of A or better	HB AD JE GJ JL
Strategies for Conflict Resolution	Initials
1. Hold a group meeting with all members.	
2. Have the involved members explain their situations.	
3. Group vote.	
4. If a unanimous decision cannot be reached, Project Manager will decide on the outcome and solution.	HB AD JE GJ JL



MECH 202 PROJECT 1 GROUP 17

Table 10.3: Team Meeting Minutes

Team Meeting Minutes		
Design Organization: 17		Date: 2/4/19
Agenda:		
<ol style="list-style-type: none">1. Figure out who needs to do what for the team contract2. Figure out when/where/how to disassemble the staple gun3. Determine what everyone is going to complete the project		
Discussion: How do we fill out and finish the team contract? Where should we go to disassemble the staple gun? When can we all meet to do it? Who wants to the different tasks in order to complete the project?		
Decisions Made: Each person will enter their picture and info into the team contract. We will meet in the next week to disassemble the staple gun. We will do it in Doc's lab in the basement of the engineering building. Jethro and Garrett will focus on the Solidworks aspects of the project, while the other three will do the remainder of the QFDs, templates, and paperwork.		
Action Items	Person Responsible	Deadline
Finish Team Contract	Full Group	2/5/19
Begin Disassembly	Full Group	2/10/19
Team member: Hunter Becvar	Date for next meeting: 2/11/19	
Team member: Alec DeStefano		
Team member: Josh Ehr		
Team member: Garrett Johnson		
Team member: Jethro Leroux		
<i>The Mechanical Design Process</i> Ullman	Copyright 2018, David G.	



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Team Meeting Minutes

Design Organization: 17

Date: 2/11/19

Agenda:

1. Figure out when to finish disassembly
2. Determine who is going to help complete Project 1 plan and Gantt chart
3. Begin looking into customer requirements and competitors

Discussion: When can we get together to finish disassembly of the staple gun? What do we need to do to finish project 1 plan? Who will work on the Gantt chart? What customer requirements are more important than others?

Decisions Made: . We will finish the disassembly tomorrow. Hunter and Josh will split up the work for project 1 plan. Alec will do the Gantt chart. Jethro and Garrett will begin creating the parts in Solidworks later this week after the disassembly is finished.

Action Items	Person Responsible	Deadline
Project 1 plan	Josh and Hunter	2/12/19
Gantt Chart	Alec	2/12/19
Disassembly	Full Group	2/12/19
Solidworks Parts Creation	Jethro and Garrett	2/28/19
Team member: Hunter Becvar	Date for next meeting:	2/18/19
Team member: Alec DeStefano		
Team member: Josh Ehr		
Team member: Garrett Johnson		
Team member: Jethro Leroux		

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MECH 202 PROJECT 1 GROUP 17

Team Meeting Minutes

Design Organization: 17

Date: 2/18/19

Agenda:

1. Make a plan and Gantt chart for project 2
2. Continue filling out templates for project 1
3. Work on building Solidworks parts

Discussion: Who will complete the project 2 plan and Gantt chart? How many parts have been modeled, and how many more need to be? Who will fill out the templates that need to be completed?

Decisions Made: Hunter and Josh will split up the work for project 2 plan. Alec will do the Gantt chart. Jethro and Garrett will continue creating the parts in Solidworks. Josh will complete the customer requirements template. Hunter and Josh will work on the competitive analysis for project 1.

Action Items	Person Responsible	Deadline
Finish Project 2 Plan	Josh and Hunter	2/19/19
Complete Project 2 Gantt Chart	Alec	2/19/19
Continue Working on Solidworks	Jethro and Garrett	2/28/19
Fill out Templates for Project 1	Hunter and Josh	2/28/19
Team member: Hunter Becvar	Date for next meeting:	2/25/19
Team member: Alec DeStefano		
Team member: Josh Ehr		
Team member: Garrett Johnson		
Team member: Jethro Leroux		

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MECH 202 PROJECT 1 GROUP 17

Team Meeting Minutes

Design Organization: 17

Date: 2/25/19

Agenda:

1. Figure out the plans for Project 1 QFD
2. Assess where we are at in terms of finishing the entire project
3. Determine who will complete the tasks are still left to complete

Discussion: Who will work on the QFD? What else is left to complete? Who will do all of those steps? How is the parts creation in Solidworks going?

Decisions Made: Alec, Hunter, and Josh will complete the QFD. Garrett and Jethro have made great headway in Solidworks, and will continue doing great work on those parts and drawings. We will continue filling out the various templates needed to finish project 1.

Action Items	Person Responsible	Deadline
Finish QFD	Alec, Hunter, Josh	2/26/19
Bill of Materials	Hunter	3/1/19
Reverse Engineering Template	Alec, Hunter, Josh	3/9/19
Finish the Solidworks work	Jethro and Garrett	3/9/19
Team member: Hunter Becvar	Date for next meeting:	3/4/19
Team member: Alec DeStefano		
Team member: Josh Ehr		
Team member: Garrett Johnson		
Team member: Jethro Leroux		

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MECH 202 PROJECT 1 GROUP 17

Team Meeting Minutes

Design Organization: 17

Date: 3/4/19

Agenda:

1. Figure out the last things that need to get done
2. Finish the part drawings
3. Complete the assembly
4. Fill out the product improvement section

Discussion: What else needs to get done in order to complete the final steps of the project? Who will do all of those steps? When does each step need to be done by?

Decisions Made: We need to finish the team assessment, the team health assessments, the product improvement, the part drawings, and the full assembly.

Action Items	Person Responsible	Deadline
Complete Team Assessment	Josh	3/9/19
Finish Team Health Assessments	Full Group	3/9/19
Create Part Drawings	Jethro	3/9/19
Finish Product Improvement	Hunter	3/9/19
Team member: Hunter Becvar	Date for next meeting:	3/11/19
Team member: Alec DeStefano		
Team member: Josh Ehr		
Team member: Garrett Johnson		
Team member: Jethro Leroux		
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MECH 202 PROJECT 1 GROUP 17

Team Meeting Minutes		
Design Organization: 17	Date: 3/11/19	
<p>Agenda:</p> <ol style="list-style-type: none">1. Figure out the very last steps that need to be completed2. Ensure the parts, drawings, and assembly is finished3. Put the project report together4. Double check that everything is finished and done well.		
<p>Discussion: What else needs to get done? Who will add what to the Project Report? Does anyone need help with their tasks? Is this report good enough to turn in right now?</p>		
<p>Decisions Made: The final templates and resources need to get finished by Alec, Hunter, and Josh. Garrett and Jethro will add all of the Solidworks parts, drawings, and assembly to the report. Josh and Alec will add other templates and pages to the final report. Hunter will organize the report and ensure it is ready to be graded entirely.</p>		
Action Items	Person Responsible	Deadline
Add Everything to Project Report	Full Group	3/12/19
Fill out all of the final templates/pages	Josh and Alec	3/12/19
Organize and Finalize Project Report	Hunter	3/12/19
Team member: Hunter Becvar	Date for next meeting: 3/25/19	
Team member: Alec DeStefano		
Team member: Josh Ehr		
Team member: Garrett Johnson		
Team member: Jethro Leroux		
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MECH 202 PROJECT 1 GROUP 17

Table 10.4: Team Health Assessment (Hunter Becvar)

Team Health Assessment							
Team Assessed: 17		Date: 3/4/19					
Measure		SA	A	N	D	SD	NA
1	Team mission and purpose are clear, consistent and attainable.	X					
2	I feel that I am part of a team.	X					
3	I feel good about the team's progress	X					
4	Respect has been built within the team for diverse points of view.	X					
5	Team environment is characterized by honesty, trust, mutual respect, and teamwork	X					
6	The roles and work assignments are clear	X					
7	Team treats every member's ideas as having potential value		X				
8	Team encourages individual differences.	X					
9	Conflicts within the team are aired and worked to resolution.	X					
10	Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution	X					
11	Decisions are made with input from all in a collaborative environment.	X					
12	The environment encourages communication and does not "kill the messenger" when the news is bad.	X					



MECH 202 PROJECT 1 GROUP 17

13	When one team member has a problem others jump in to help	X						
14	Dysfunctional behavior is dealt with in an appropriate manner	X						
15	When someone on the team says they are going to do something, the team can count on it being done.		X					
16	There is no "them and us" on the team	X						
17	Our team cultivates a "what we can learn" attitude when things do not go as expected.		X					

Remedies for improving the Neutral (N), Disagree (D) and Strongly Disagree (SD) responses:

Assessor: Hunter Becvar

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Table 10.5: Team Health Assessment (Alec Destefano)

Team Health Assessment							
Team Assessed: 17		Date: 3/5/19					
Measure		SA	A	N	D	SD	NA
1	Team mission and purpose are clear, consistent and attainable.	X					
2	I feel that I am part of a team.		X				
3	I feel good about the team's progress	X					
4	Respect has been built within the team for diverse points of view.	X					
5	Team environment is characterized by honesty, trust, mutual respect, and teamwork		X				
6	The roles and work assignments are clear	X					
7	Team treats every member's ideas as having potential value	X					
8	Team encourages individual differences.	X					
9	Conflicts within the team are aired and worked to resolution.	X					
10	Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution	X					
11	Decisions are made with input from all in a collaborative environment.	X					
12	The environment encourages communication and does not "kill the messenger" when the news is bad.	X					



MECH 202 PROJECT 1 GROUP 17

13	When one team member has a problem others jump in to help	X						
14	Dysfunctional behavior is dealt with in an appropriate manner		X					
15	When someone on the team says they are going to do something, the team can count on it being done.	X						
16	There is no "them and us" on the team	X						
17	Our team cultivates a "what we can learn" attitude when things do not go as expected.	X						

Remedies for improving the Neutral (N), Disagree (D) and Strongly Disagree(SD) responses:

Assessor: Alec Destefano

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Table 10.6: Team Health Assessment (Josh Ehr)

Team Health Assessment							
Team Assessed: 17		Date: 3/4/19					
Measure		SA	A	N	D	SD	NA
1	Team mission and purpose are clear, consistent and attainable.	X					
2	I feel that I am part of a team.		X				
3	I feel good about the team's progress		X				
4	Respect has been built within the team for diverse points of view.	X					
5	Team environment is characterized by honesty, trust, mutual respect, and teamwork	X					
6	The roles and work assignments are clear	X					
7	Team treats every member's ideas as having potential value	X					
8	Team encourages individual differences.	X					
9	Conflicts within the team are aired and worked to resolution.	X					
10	Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution	X					
11	Decisions are made with input from all in a collaborative environment.	X					
12	The environment encourages communication and does not "kill the messenger" when the news is bad.	X					



MECH 202 PROJECT 1 GROUP 17

13	When one team member has a problem others jump in to help	X						
14	Dysfunctional behavior is dealt with in an appropriate manner		X					
15	When someone on the team says they are going to do something, the team can count on it being done.	X						
16	There is no "them and us" on the team	X						
17	Our team cultivates a "what we can learn" attitude when things do not go as expected.	X						

Remedies for improving the Neutral (N), Disagree (D) and Strongly Disagree(SD) responses:

Assessor: Josh Ehr

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Table 10.7: Team Health Assessment (Garrett Johnson)

Team Health Assessment							
Team Assessed: 17		Date: 3/6/19					
Measure		SA	A	N	D	SD	NA
1	Team mission and purpose are clear, consistent and attainable.	X					
2	I feel that I am part of a team.	X					
3	I feel good about the team's progress	X					
4	Respect has been built within the team for diverse points of view.		X				
5	Team environment is characterized by honesty, trust, mutual respect, and teamwork			X			
6	The roles and work assignments are clear	X					
7	Team treats every member's ideas as having potential value	X					
8	Team encourages individual differences.	X					
9	Conflicts within the team are aired and worked to resolution.	X					
10	Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution			X			
11	Decisions are made with input from all in a collaborative environment.	X					
12	The environment encourages communication and does not "kill the messenger" when the news is bad.	X					



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13	When one team member has a problem others jump in to help	X						
14	Dysfunctional behavior is dealt with in an appropriate manner	X						
15	When someone on the team says they are going to do something, the team can count on it being done.		X					
16	There is no "them and us" on the team	X						
17	Our team cultivates a "what we can learn" attitude when things do not go as expected.	X						

Remedies for improving the Neutral (N), Disagree (D) and Strongly Disagree (SD) responses:

Assessor: Garrett Johnson

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Table 10.8: Team Health Assessment (Jethro Leroux)

Team Health Assessment							
Team Assessed: 17		Date: 3/7/19					
Measure		SA	A	N	D	SD	NA
1	Team mission and purpose are clear, consistent and attainable.	X					
2	I feel that I am part of a team.	X					
3	I feel good about the team's progress	X					
4	Respect has been built within the team for diverse points of view.		X				
5	Team environment is characterized by honesty, trust, mutual respect, and teamwork	X					
6	The roles and work assignments are clear	X					
7	Team treats every member's ideas as having potential value		X				
8	Team encourages individual differences.	X					
9	Conflicts within the team are aired and worked to resolution.	X					
10	Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution	X					
11	Decisions are made with input from all in a collaborative environment.		X				
12	The environment encourages communication and does not "kill the messenger" when the news is bad.	X					



MECH 202 PROJECT 1 GROUP 17

13	When one team member has a problem others jump in to help	X						
14	Dysfunctional behavior is dealt with in an appropriate manner		X					
15	When someone on the team says they are going to do something, the team can count on it being done.			X				
16	There is no "them and us" on the team	X						
17	Our team cultivates a "what we can learn" attitude when things do not go as expected.			X				

Remedies for improving the Neutral (N), Disagree (D) and Strongly Disagree (SD) responses:

Assessor: Jethro Leroux

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