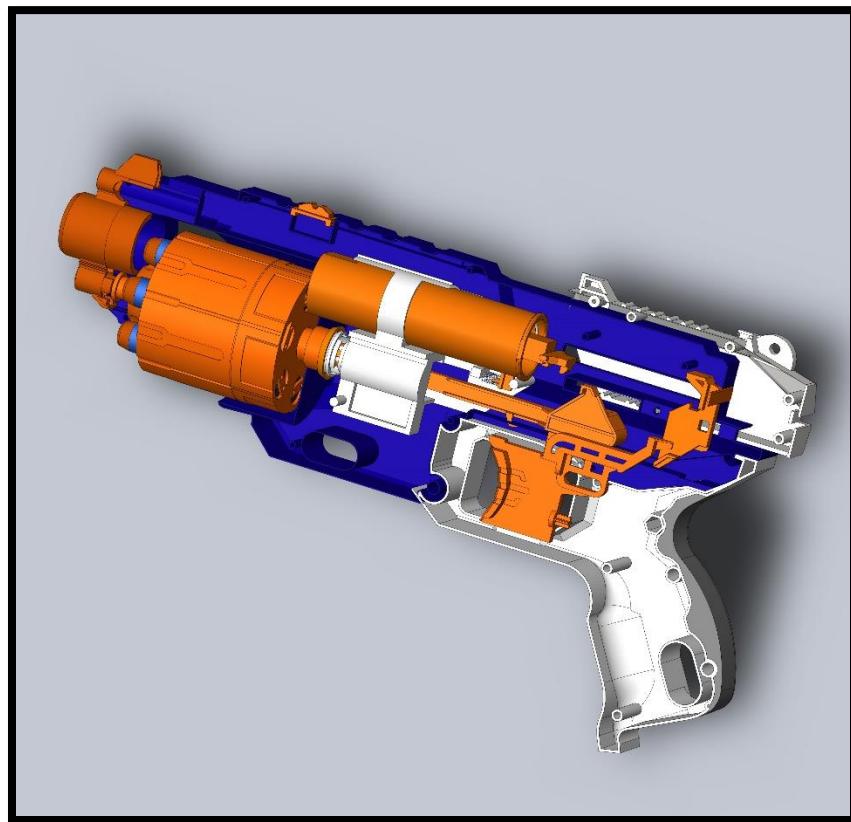




MECH 202 PROJECT 1

Team 9



MARCH 12, 2020
COLORADO STATE UNIVERSITY

Group Members	Email Addresses
Flynn Yoder	yoderf@rams.colostate.edu
Noah Schenck	noahls@rams.colostate.edu
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Sections	Page Ranges
Cover Page	0
Photo with Overlaid SOLIDWORKS Model	2
Project Planning	4-6
Gantt Charts	7-15
Bill of Materials	16
Exploded Assembly Diagram	17-18
Detailed Device Description	19-24
Engineering Drawings	25-44
Competitive Analysis	45-64
Product Improvement	65-71
Team Assessment	72-85
References	86

Figures	Page Ranges
3D Model Overlay	3
Exploded Assembly Diagrams	17-18
Individual Mechanism Diagrams	23-24
Engineering Drawings	25-44
Gantt Charts	8-15

3D Model Photo Overlay



Figure #1: 3D SOLIDWORKS model overlaid over product photo

The 3D SOLIDWORKS model that our team produced very closely resembles the product, even including the minor details such as exterior etchings for aesthetic purposes on parts such as the cylinder, trigger, and casing. The only detail left out are the decals on the casing (ELITE, DISRUPTOR, and Nerf) because those are added on after the manufacturing of the product.

Project Planning

Design Organization: Mech 202 Winning team	Date: 3/12/2020
---	------------------------

Product Name: Nerf Gun

Task 1	Name of Task: Nerf Gun disassembly	
Snapshots	Objective: Fully disassemble every component of the Nerf gun	
	Deliverables: Nerf pieces	
	Decisions/Milestones with Dates:	
	<ol style="list-style-type: none"> 1. Fully disassemble by 2/7/2020 2. Take pictures and document all steps by 2/7/2020 3. Create bill of materials by 2/7/2020 	
Personnel Needed:		
	Title: Student group hours: 1	Percent full time: 2%
Time:	Estimated Total Hours: 10	Actual Total Hours: TBD
Sequence:	Predecessors: N/A	Successors: Tasks 2-8
	Planned Start Date: 2/3/2020	Planned Finish Date: 2/5/2020
	Actual Start Date: 2/5/2020	Actual Finish Date: 2/5/2020
Costs:	Capital Equipment: Nerf Gun – Paid for by fees	Disposables: \$0
Task 2	Name of Task: Create documentation from disassembly	
Snapshots	Objective: Fill out all the documentation for reverse engineering the Nerf gun	
	Deliverables: Bill of materials, customer requirements, parts list, reverse engineering	
	Decisions/Milestones with Dates:	
	<ol style="list-style-type: none"> 1. Complete all documents by 2/12/2020 	
Personnel Needed:		
	Title: Student Hours: 5	Percent full time: 10%
Time:	Estimated Total Hours: 5	Actual Total Hours: 5

	<p>Sequence: Predecessors: Task 1 Successors: Tasks 3-8</p> <p>Planned Start Date: 2/05/2020 Planned Finish Date: 2/12/2020</p> <p>Actual Start Date: 2/05/2020 Actual Finish Date: 3/11/2020</p> <p>Costs: Capital Equipment: \$0 Disposables: \$0</p>
Task 3	<p>Name of Task: Model Nerf gun components</p>
Snapshots	<p>Objective: Model all pieces of the Nerf gun in SolidWorks</p>
	<p>Deliverables: SolidWorks models</p>
	<p>Decisions/Milestones with Dates:</p> <ol style="list-style-type: none"> 1. Complete outer case by 2/20/20 2. Complete internals and assemble by 2/25/20
	<p>Personnel Needed:</p> <p>Title: Student 1 Hours: 5 Percent full time: 10%</p> <p>Title: Student 2 Hours: 5 Percent full time: 10%</p>
	<p>Time: Estimated Total Hours: 10 Actual Total Hours: 30</p>
	<p>Sequence: Predecessors: Task 1 and 2 Successors: Task 4, 6, 7 and 8</p>
	<p>Planned Start Date: 02/12/2020 Planned Finish Date: 02/25/2020</p>
	<p>Actual Start Date: 2/5/2020 Actual Finish Date: 3/9/2020</p>
	<p>Costs: Capital Equipment: Computer - \$700 Disposables: \$0</p>
Task 4	<p>Name of Task: SolidWorks drawings</p>
Snapshots	<p>Objective: Create drawings of each modeled part with critical GD&T dimensions</p>
	<p>Deliverables: Drawings with 3-6 critical GD&T dimensions</p>
	<p>Decisions/Milestones with Dates:</p> <ol style="list-style-type: none"> 1. Complete drawings by 3/10/2020 2. Organize and compile drawings by 3/11/2020
	<p>Personnel Needed:</p> <p>Title: Student group work Hours: 15 Percent full time: 20%</p>

	<p>Time: Estimated Total Hours: 15 Actual Total Hours: 15</p> <p>Sequence: Predecessors: Tasks 1-3 Successors: Task 6, 7 and 8</p> <p>Planned Start Date: 2/25/2020 Planned Finish Date: 3/11/2020</p> <p>Actual Start Date: 3/9/2020 Actual Finish Date: 3/11/2020</p> <p>Costs: Capital Equipment: Computer - \$700 Disposables: \$0</p>
Task 5	<p>Name of Task: Create and revise documents</p>
Snapshots	<p>Objective: Revise project plan, QFD, Gantt chart, and bill of materials</p>
	<p>Deliverables: Documents listed above</p>
	<p>Decisions/Milestones with Dates:</p> <ul style="list-style-type: none"> 3. Create documents and fill out by 3/4/2020 4. Revise all documents by 3/11/2020 5. Review and turn in by 3/12/2020
	<p>Personnel Needed:</p> <p>Title: Student 1 Hours: 2 Percent full time: 4%</p> <p>Title: Student 2 Hours: 3 Percent full time: 6%</p>
	<p>Time: Estimated Total Hours: 5 Actual Total Hours: 5</p>
	<p>Sequence: Predecessors: none Successors: Task 7 and 8</p>
	<p>Planned Start Date: 02/12/2020 Planned Finish Date: 03/11/2020</p>
	<p>Actual Start Date: 2/5/2020 Actual Finish Date: 3/11/2020</p>
	<p>Costs: Capital Equipment \$0 Disposables: \$0</p>
Task 6	<p>Name of Task: SolidWorks parts assembly</p>
Snapshots	<p>Objective: Assemble all modeled parts into one assembly</p>
	<p>Deliverables: Full assembly of Nerf gun</p>
	<p>Decisions/Milestones with Dates:</p> <ul style="list-style-type: none"> 3. Fix all errors that prevent final assembly by 3/10/2020 4. Assemble Nerf gun by 3/11/2020

	<p>Personnel Needed:</p> <p>Title: Student 1 Hours: 10 Percent full time: 15%</p>
	<p>Time: Estimated Total Hours: 10 Actual Total Hours: 8</p>
	<p>Sequence: Predecessors: Task 1, 2, and 3 Successors: Task 7 and 8</p>
	<p>Planned Start Date: 3/9/2020 Planned Finish Date: 3/11/2020</p>
	<p>Actual Start Date: 3/9/2020 Actual Finish Date: 3/11/2020</p>
	<p>Costs: Capital Equipment: Computer - \$700 Disposables: \$0</p>
Task 7	<p>Name of Task: Prepare report</p>
Snapshots	<p>Objective: Gather all necessary documents and compile them into one project report</p>
	<p>Deliverables: The project report</p>
	<p>Decisions/Milestones with Dates:</p> <ul style="list-style-type: none"> 6. Gather all documents by 3/11/2020 7. Fill in report with missing information by 3/12/2020
	<p>Personnel Needed:</p> <p>Title: Student group work Hours: 20 Percent full time: 25%</p>
	<p>Time: Estimated Total Hours: 25 Actual Total Hours: 25</p>
	<p>Sequence: Predecessors: Tasks 1-6 Successors: Task 8</p>
	<p>Planned Start Date: 03/1/2020 Planned Finish Date: 03/12/2020</p>
	<p>Actual Start Date: 3/9/2020 Actual Finish Date: 3/12/2020</p>
	<p>Costs: Capital Equipment \$0 Disposables: \$0</p>

	<p>Name of Task: Turn in Project #1</p>
Snapshots	<p>Objective: Turn in Project #1</p>
	<p>Deliverables: Project #1 report</p>

Decisions/Milestones with Dates: 1. Submit report file with all necessary documents included by 3/12/2020	
Personnel Needed: Title: Student 1 Hours: 0.1 Percent full time: 0.3%	
Time: Estimated Total Hours: 0.1 Actual Total Hours: 0.1	
Sequence: Predecessors: Tasks 1-7 Successors: N/A Planned Start Date: 3/9/2020 Planned Finish Date: 3/11/2020 Actual Start Date: 3/9/2020 Actual Finish Date: 3/11/2020	
Costs: Capital Equipment: Computer - \$700 Disposables: \$0	
Team member: Nolan S.	Team member: Flynn Y.
Team member: Trevor L.	Prepared by: Noah S.
Team member: Noah S.	Checked by: Trevor L.
Team member: Ryan W.	Approved by: Nolan S.
<i>The Mechanical Design Process</i> Designed by Professor David G. Ullman	
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Final Project Planner

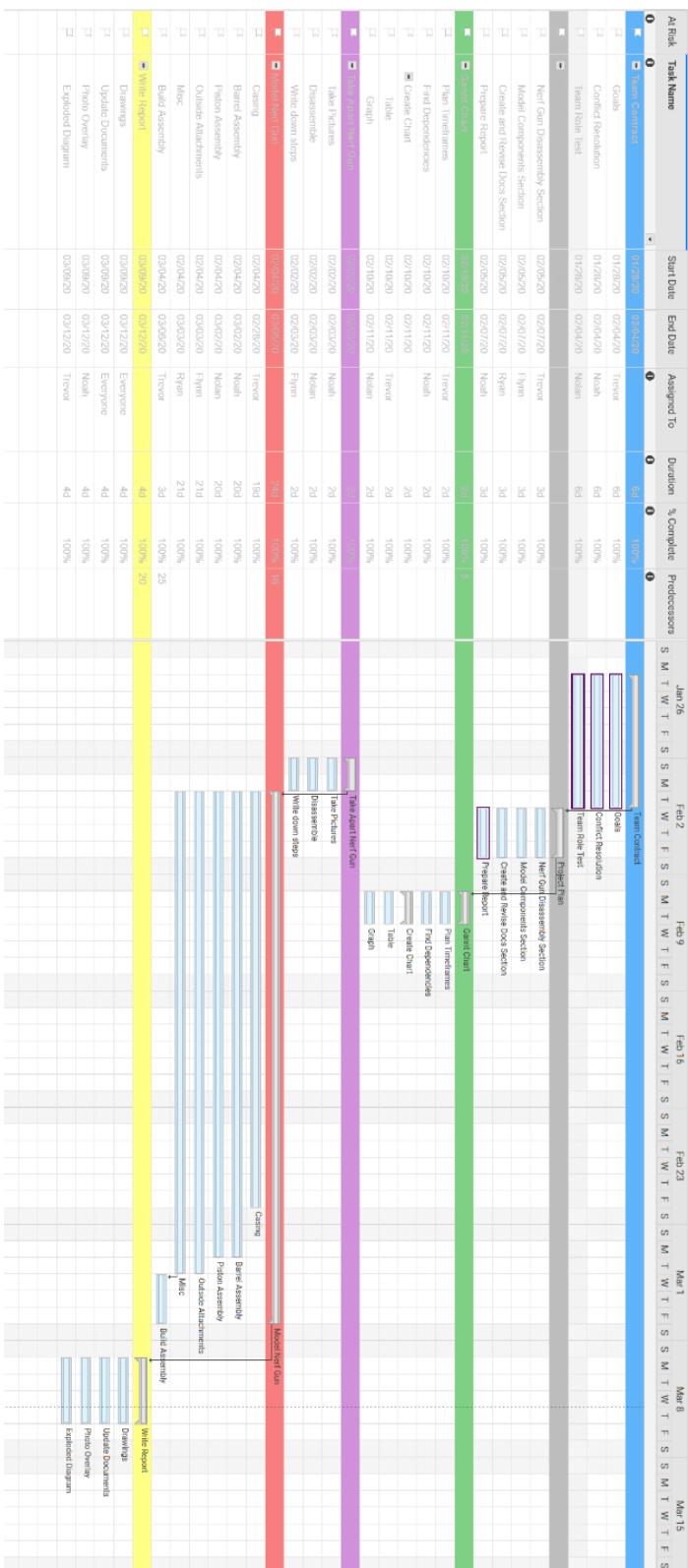


Figure #2: The Gantt chart which helps the team plan out the timelines for completing each required task.

Project Planner on Week 1 (Figure 2a)

At-Risk	Task Name	Start Date	End Date	Assigned To	Duration	% Complete	Predecessors	Jan 26	Feb 2	Feb 9	Feb 16	Feb 23	Mar 1	Mar 8	Mar 15
								S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F	S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F	S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F	S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F	S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F	S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F	S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F	
0	- Team Contract	01/28/20	02/04/20	Trevor	6d	0%									
	Goals	01/28/20	02/04/20	Nash	6d	0%		Goals							
	Conflict Resolution	01/28/20	02/04/20	Nash	6d	0%		Conflict Resolution							
	Team Role Test	01/28/20	02/04/20	Nolan	6d	0%		Team Role Test							
0	- Project Plan	02/05/20	02/07/20		3d	0%	1								
	Nerf Gun Disassembly Section	02/05/20	02/07/20	Trevor	3d	0%									
	Model Components Section	02/05/20	02/07/20	Flynn	3d	0%									
	Create and Revise Docs Section	02/05/20	02/07/20	Ryan	3d	0%									
	Prepare Report	02/05/20	02/07/20	Nash	3d	0%									
0	- Gantt Chart	02/10/20	02/11/20		2d	0%	5								
	Pain Timelines	02/10/20	02/11/20	Trevor	2d	0%									
	Find Dependencies	02/10/20	02/11/20	Nash	2d	0%									
■	Create Chart	02/10/20	02/11/20		2d	0%									
	Table	02/10/20	02/11/20	Trevor	2d	0%									
	Graph	02/10/20	02/11/20	Nolan	2d	0%									
■	- Take Apart Nerf Gun	02/02/20	02/03/20		2d	0%									
	Take Pictures	02/02/20	02/03/20	Nash	2d	0%									
	Disassemble	02/02/20	02/03/20	Nolan	2d	0%									
	Write down steps	02/02/20	02/03/20	Flynn	2d	0%									
■	- Model Nerf Gun	02/04/20	03/08/20		24d	0%	16								
	Casing	02/04/20	02/28/20	Trevor	18d	0%									
	Barrel Assembly	02/04/20	03/07/20	Nash	20d	0%									
	Piston Assembly	02/04/20	03/07/20	Nolan	20d	0%									
	Outside Attachments	02/04/20	03/07/20	Flynn	21d	0%									
	Misc	02/04/20	03/07/20	Ryan	21d	0%									
	Build Assembly	03/04/20	03/06/20	Trevor	3d	0%	25								
■	- Write Report	03/08/20	03/12/20		4d	0%	20								
	Drawings	03/08/20	03/12/20	Everyone	4d	0%									
	Documents	03/08/20	03/12/20	Everyone	4d	0%									
	Photo Overlay	03/08/20	03/12/20	Nash	4d	0%									
	Exploded Diagram	03/08/20	03/12/20	Trevor	4d	0%									

Project Planner on Week 2 (Figure 2b)

At Risk	Task Name	Start Date	End Date	Assigned To	Duration	% Complete	Predecessors	Jan 26	Feb 2	Feb 9	Feb 16	Feb 23	Mar 1	Mar 8	Mar 15										
								S	M	T	W	F	S	S	M	T	W	F	S	S	M	T	W	F	
■	■ Team Commitment	01/28/20	02/04/20	Trevor	6d	10%																			
■	■ Team Commitment	01/28/20	02/04/20	Nolan	6d	10%																			
■	Goals	01/28/20	02/04/20	Trevor	6d	10%																			
■	Conflict Resolution	01/28/20	02/04/20	Nolan	6d	10%																			
■	Team Role Test	01/28/20	02/04/20	Nolan	6d	10%																			
■	■ Project Plan	02/05/20	02/07/20		3d	0%	1																		
■	Net Gun Disassembly Section	02/05/20	02/07/20	Trevor	3d	0%																			
■	Model Components Section	02/05/20	02/07/20	Flynn	3d	0%																			
■	Create and Revise Docs Section	02/05/20	02/07/20	Ryan	3d	0%																			
■	Prepare Report	02/05/20	02/07/20	Noah	3d	0%																			
■	■ Gantt Chart	02/10/20	02/11/20		2d	0%	5																		
■	Plan Timelines	02/10/20	02/11/20	Trevor	2d	0%																			
■	Find Dependencies	02/10/20	02/11/20	Noah	2d	0%																			
■	Create Chart	02/10/20	02/11/20	Flynn	2d	0%																			
■	Table	02/10/20	02/11/20	Trevor	2d	0%																			
■	Graph	02/10/20	02/11/20	Nolan	2d	0%																			
■	■ Take Pictures	02/02/20	02/03/20	Noah	2d	100%																			
■	Disassemble	02/02/20	02/03/20	Nolan	2d	100%																			
■	Write down steps	02/02/20	02/03/20	Flynn	2d	100%																			
■	■ Model Net Gun Casing	02/04/20	02/06/20	Trevor	2d	0%	16																		
■	Barrel Assembly	02/04/20	02/07/20	Nolan	20d	0%																			
■	Prison Assembly	02/04/20	02/07/20	Nolan	20d	0%																			
■	Outside Attachments	02/04/20	02/07/20	Flynn	21d	0%																			
■	Misc.	02/04/20	02/06/20	Ryan	21d	0%																			
■	Build Assembly	03/09/20	03/12/20	Trevor	3d	0%	25																		
■	■ Write Report	03/09/20	03/12/20	Everyone	4d	0%	20																		
■	Drawings	03/09/20	03/12/20	Everyone	4d	0%																			
■	Update Documents	03/09/20	03/12/20	Noah	4d	0%																			
■	Photo Overlay	03/09/20	03/12/20	Trevor	4d	0%																			
■	Exploded Diagram	03/09/20	03/12/20		4d	0%																			

Project Planner on Week 3 (Figure 2c)

At-Risk Task Name	Start Date	End Date	Assigned To	Duration	% Complete	Predecessors	Jan '26					Feb '26					Feb '26					Mar '26					
							S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
Team Contract	01/20/20	01/01/20	Trevor	6d	100%																						
Goals	01/20/20	02/04/20	Noah	6d	100%																						
Conflict Resolution	01/28/20	02/04/20	Fynn	6d	100%																						
Team Rule Test	01/20/20	02/04/20	Nolan	6d	100%																						
Nerf Gun Disassembly Section	02/05/20	02/07/20	Trevor	3d	100%																						
Model Components Section	02/05/20	02/07/20	Fynn	3d	100%																						
Create and Revise Docs Section	02/05/20	02/07/20	Ryan	3d	100%																						
Prepare Report	02/05/20	02/07/20	Nolan	3d	100%																						
Game Chart	02/10/20	02/11/20		2d	100%																						
Plan Timelines	02/10/20	02/11/20	Trevor	2d	100%																						
Find Dependencies	02/10/20	02/11/20	Noah	2d	100%																						
Create Chart	02/10/20	02/11/20	Fynn	2d	100%																						
Table	02/10/20	02/11/20	Trevor	2d	100%																						
Graph	02/10/20	02/11/20	Nolan	2d	100%																						
Model Nerf Gun	02/04/20	03/09/20		24d	0%																						
Casing	02/04/20	02/28/20	Trevor	19d	0%																						
Barrel Assembly	02/04/20	03/02/20	Noah	20d	0%																						
Piston Assembly	02/04/20	03/02/20	Nolan	20d	0%																						
Outside Attachments	02/04/20	03/02/20	Fynn	21d	0%																						
Misc.	02/04/20	03/03/20	Ryan	21d	0%																						
Build Assembly	03/04/20	03/06/20	Trevor	3d	0%																						
Write Report	03/09/20	03/12/20		4d	0%																						
Drawings	03/09/20	03/12/20	Everyone	4d	0%																						
Update Documents	03/09/20	03/12/20	Everyone	4d	0%																						
Photo Overlay	03/09/20	03/12/20	Noah	4d	0%																						
Exploded Diagram	03/09/20	03/12/20	Trevor	4d	0%																						

Project Planner on Week 5 (Figure 2e)

At Risk	Task Name	Start Date	End Date	Assigned To	Duration	% Complete	Predecessors	Jan 25	Feb 2	Feb 9	Feb 16	Feb 23	Mar 1	Mar 8	Mar 15	
								S	M	T	W	F	S	S	M	
<input checked="" type="checkbox"/>	Team Contract	01/28/20	02/04/20	<input checked="" type="checkbox"/>	6d	100%										
<input type="checkbox"/>	Goals	01/28/20	02/04/20	Trevor	6d	100%										
<input type="checkbox"/>	Conflict Resolution	01/28/20	02/04/20	Noah	6d	100%										
<input type="checkbox"/>	Team Role Test	01/28/20	02/04/20	Nolan	6d	100%										
<input checked="" type="checkbox"/>	Net Gun Disassembly Section	02/05/20	02/07/20	Trevor	3d	100%										
<input type="checkbox"/>	Model Components Section	02/05/20	02/07/20	Fyann	3d	100%										
<input type="checkbox"/>	Create and Revise Docs Section	02/05/20	02/07/20	Ryan	3d	100%										
<input type="checkbox"/>	Prepare Report	02/05/20	02/07/20	Noah	3d	100%										
<input checked="" type="checkbox"/>	Gun/Craft	02/08/20	02/11/20		3d	100%										
<input type="checkbox"/>	Plan Timelines	02/10/20	02/11/20	Trevor	2d	100%										
<input type="checkbox"/>	Find Dependencies	02/10/20	02/11/20	Noah	2d	100%										
<input type="checkbox"/>	Create Chart	02/10/20	02/11/20		2d	100%										
<input type="checkbox"/>	Table	02/10/20	02/11/20	Trevor	2d	100%										
<input type="checkbox"/>	Graph	02/10/20	02/11/20	Nolan	2d	100%										
<input checked="" type="checkbox"/>	Take apart Net Gun	02/04/20	03/06/20		24d	28%		19d		50%						
<input checked="" type="checkbox"/>	Casing	02/04/20	02/28/20	Trevor												
<input type="checkbox"/>	Barrel Assembly	02/04/20	03/02/20	Noah	20d	40%										
<input type="checkbox"/>	Fretion Assembly	02/04/20	03/02/20	Nolan	20d	20%										
<input type="checkbox"/>	Outside Attachments	02/04/20	03/03/20	Fyann	21d	10%										
<input type="checkbox"/>	Misc	02/04/20	03/03/20	Ryan	21d	25%										
<input type="checkbox"/>	Build Assembly	03/04/20	03/12/20	Trevor	3d	0%										
<input checked="" type="checkbox"/>	Write Report	03/09/20	03/12/20		4d	0%										
<input type="checkbox"/>	Drawings	03/09/20	03/12/20	Everyone	4d	0%										
<input type="checkbox"/>	Update Documents	03/09/20	03/12/20	Everyone	4d	0%										
<input type="checkbox"/>	Photo Overlay	03/09/20	03/12/20	Noah	4d	0%										
<input type="checkbox"/>	Exploded Diagram	03/09/20	03/12/20	Trevor	4d	0%										

Bill of Materials					
Product: Nerf Disruptor					Date: 2/5/2020
Assembly: Nerf Gun					
Item #	Part #	Qty	Name	Material	Source
1	1	16	Phillips head screw	Steel	China
2	2	2	Screw with washer	Steel	China
3	3	5	Small springs	Spring steel	China
4	4	1	Small silver screw	Stainless steel	China
5	5	2	Slide half	ABS plastic	China
6	6	6	Darts	Closed cell polyfoam & nitrile rubber	China
7	7	1	Rotator slide	Abs plastic	China
8	8	1	Interior main holder	ABS plastic	China
9	9	1	Drum/ chamber	ABS plastic	China
10	10	1	Rotator	Abs plastic	China
11	11	1	Piston spring	Spring steel	China
12	12	1	Cylinder	ABS plastic and closed cell foam	China
13	13	2	Handle piece, small	ABS plastic	China
14	14	2	Handle piece, large	ABS plastic	China
15	15	2	Case half, large	ABS plastic	China
16	16	1	Trigger	ABS plastic	China
17	17	1	Rail attachment	Abs plastic	China
18	18	1	Front barrel	ABS plastic	China
19	19	1	Piston	ABS plastic with nitrile rubber O ring	China
Team member: Trevor Long			Prepared by: Nolan		
Team member: Noah			Checked by: Trevor		
Team member: Flynn Yoder			Approved by: Noah		
Team member: Nolan Sherrill					
Team member: Ryan Walkowicz					Page 1 /1
The Mechanical Design Process			Designed by Professor David G. Ullman		
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Exploded Assembly Diagram

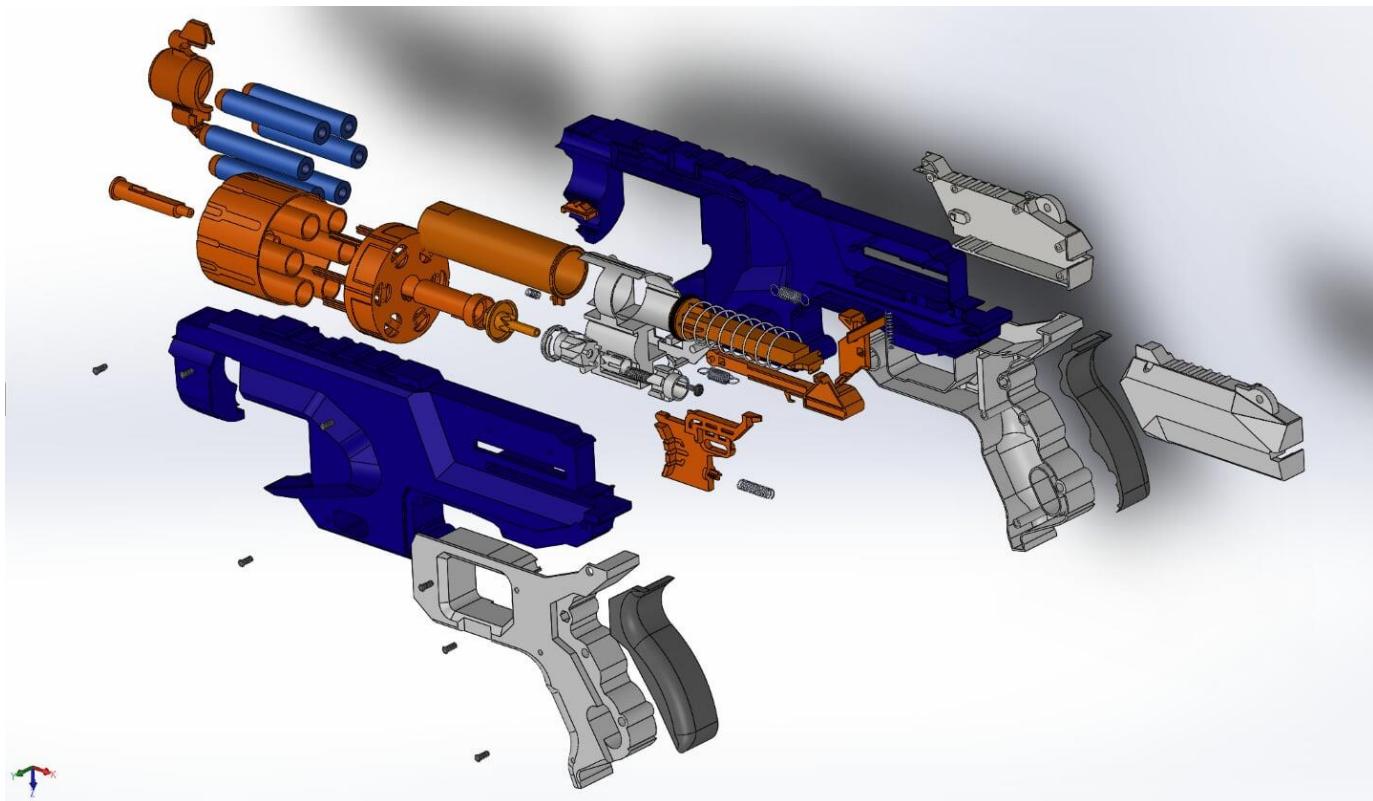


Figure #3: Exploded assembly of entire 3D SOLIDWORKS model

This 3D assembly assists in our teams understanding of how the device operates by showing where and how components interact. To reduce overall clutter on the image, the labels for the individual parts are contained in the following page with separated assemblies for both the internal and external portions of the Nerf gun. Labels for non-crucial parts (screws, small springs, etc.) were not included because they were already covered in the bill of materials, and parts such as these are not proprietary parts such as the casing and internals. They will also further be discussed in the interactions between parts, thus voiding the need to label them individually, as they are shown with the parts they interact with on the exploded assembly.

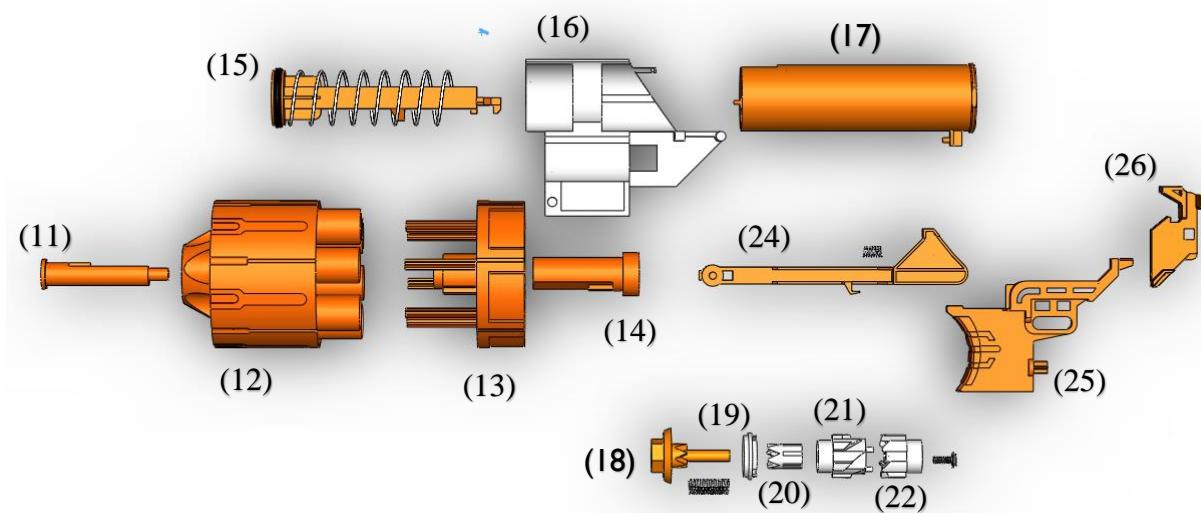


Figure #4: Exploded assembly of internal parts (with labels)

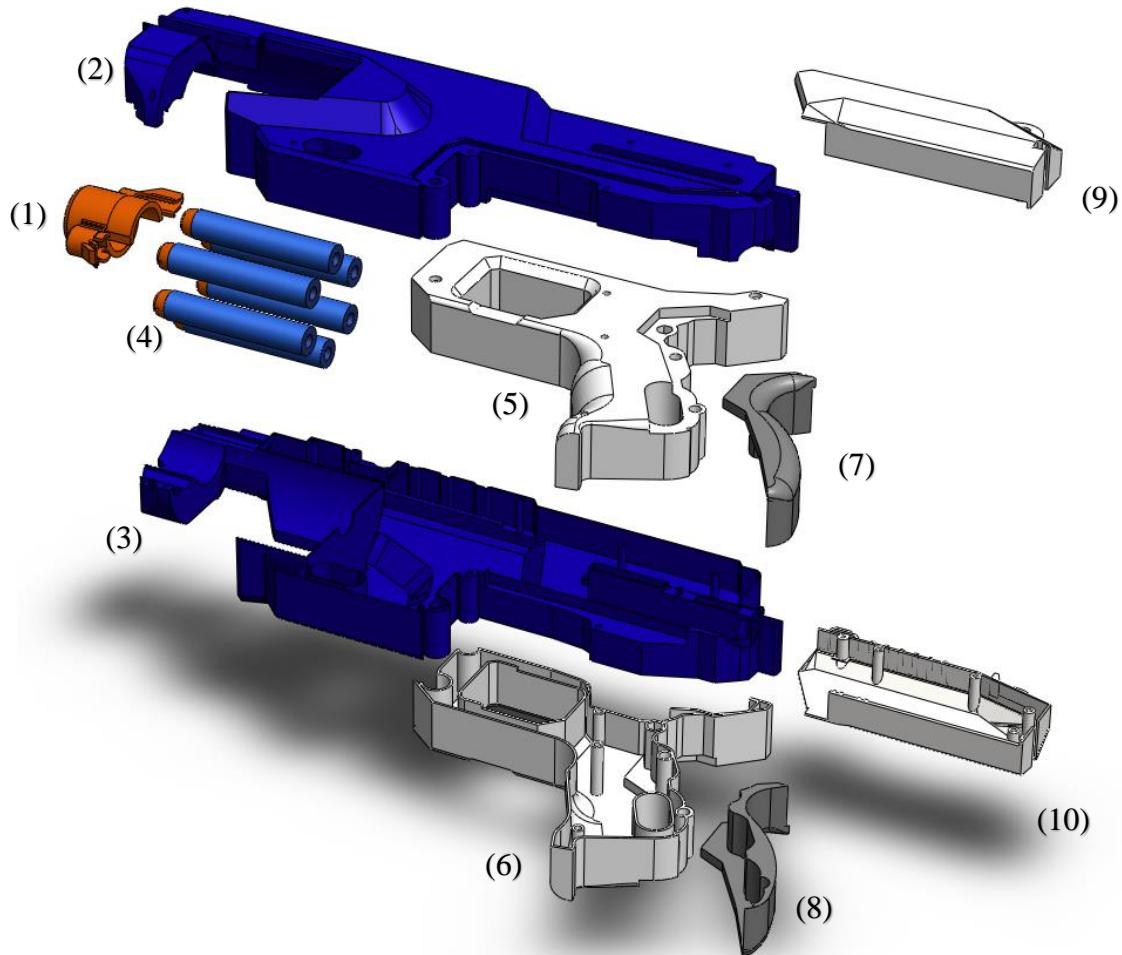


Figure #5: Exploded assembly of labelled external parts (with labels)

Detailed Device Description

The Nerf gun performs several related actions. There is the loading of the bullets, the cocking of the gun, pulling the trigger, delivering power to the dart, and having the dart exit the gun. These functions make up the main objective of shooting a nerf dart out of the gun. To accomplish this, energy needs to enter the system, parts need to move and interact, springs have to be compressed and released, and air has to be manipulated to fire the dart out of the barrel of the Nerf gun. There are a few systems within the Nerf gun that work together to fire the dart from the gun. These systems are the cylinder components, the rotational system, the slider and plunger system, and the trigger system.

The actions performed on or by the Nerf gun are listed below.

Loading the darts

To load the darts into the Nerf gun, the user simply has to insert the darts (4) into the holes in the cylinder of the gun (12). The cylinder needs to be rotated in order to fully load the Nerf gun. The cylinder can be rotated by pulling the trigger of the gun (25) without cocking it, or by rotating the cylinder (12) with one's hands, although this requires more force than pulling the trigger (25).

Cocking the gun

To cock the gun the user needs to grip the slider (9) of the Nerf gun firmly and pull it away from the front of the gun. This requires a few pounds of force and a strong grip. Once the slider (9) cannot be pulled back any further, the user must release the slider. The part should return to its original position. The slider (9) can be moved back and forth with little effort after being cocked the first time and before pulling the trigger (25). When the slider is pulled back the first time, the spring on the plunger part (15) is compressed. This spring will be released later in order to deliver power to the dart (4).

Pulling the trigger

Pulling the trigger is a very simple function for the user. The trigger (25) must be pulled towards the back of the gun. This is done easily by gripping the gun by the handle (5) and using one's forefinger to squeeze the trigger (25). When the trigger is pulled it causes a series of movements and interactions within the gun. The trigger (25) slides backwards, hitting part (26) and rotating this part about a fixed axis. The trigger also comes in contact with part (24), pulling this part towards the back of the gun, against the resistance of a spring which connects part (24) to part (16). Part (16) is a fastening component which holds many of the plunger and rotating components for the cylinder of the gun in place. When part (24) moves it also releases the spring on the plunger part (15). This provides the power that is supplied to the Nerf darts. Part (24) additionally moves part (22) backwards. When the trigger (25) is released part (22) moves

forward again, rotating because of contact with the angled parts of piece (21). The rotation of part (22) along with that of parts (20), (19), and (18) rotate the barrel of the gun (12) this allows the next Nerf dart (4) to be put in the right position to be fired the next time the trigger is pulled.

Delivering power to the dart

Power is delivered to the darts in the form of moving air. When part (24) is moved by the trigger (25), the compressed spring on the plunger (15) is released. The plunger then moves very rapidly through a partially enclosed tube (17) causing an increase in the pressure of the air in this tube. The air is then forced to escape through the only exit, the barrel of the gun. Air is pushed through parts (13) and (12) successively, and forced into the hollow cavity within the Nerf dart (4). The dart is then launched out of the tip of the gun (1).

Dart exiting the gun

When the spring of the plunger (15) is released, air is forced into the blind hole in the dart (4). The dart is then propelled off of part (13), out of the cylinder (12), and through the tip of the gun (1). The dart should fly at least 50 feet before falling to the ground.

Disassembly



Figure #6: Disassembly step 1

The first step to disassembling the product is removing the plastic casing (Parts 13-15) that forms the body of the blaster. From here the internal mechanisms are exposed and can be disassembled.

Individual pieces are removed as well including some aesthetic pieces (Parts 17-19) and the main drum (Part 9)



Figure #7: Disassembly Step 2

The firing mechanism is taken out next which consists of parts 10-12, which control the cocking and firing of the gun, and the rotation of the drum. The interfaces of each part are documented in the photo, and the mechanism is broken down into its individual pieces, ready to be modeled.



Figure #8: Disassembly of the rotator (Parts 21-22) and the associated springs and screws



Figure #9: Disassembly Step 3

The second subassembly that must be deconstructed is the trigger mechanism shown above (Parts 25 and 26). The mechanism is comprised of 2 plastic pieces and two springs, so the disassembly is straight forward. From here each part is documented and added to the parts list, and a complete 3D model can be started. To understand the Reverse Engineering process further, the part interactions are described in the following section.

Device Movement Interactions:

The Nerf gun has several moving parts that perform the functions during operation. The moving parts can all be actuated from 2 separate outside forces, as shown in the two diagrams. These movements are essential to the toy working as it is intended, and as the gun is used the user doesn't even have to think about how each one works internally.

The first outside force is to pull the slide and cock the mechanism (1). This movement pulls back the piston and latches it into the catch on the rear trigger release (2). This applies spring pressure on the piston, and stores some of the energy used to pull the slide as potential energy to be used later. The piston also catches on the lower hook to the drum rotator assembly, which pulls back a rod (3), that moves inside a cylinder, and converts the lateral motion into rotational motion (4). This rotational motion is then used to cycle the drum onto the next round, through the central shaft (5) and into the drum itself (6). These actions achieve the final goal of getting the gun ready to fire, as the piston is cocked back and the drum is cycled so that a new dart can be shot. When the slide is released, there are springs that return the components that have moved to their original positions, these forces are shown in green on the diagram below.

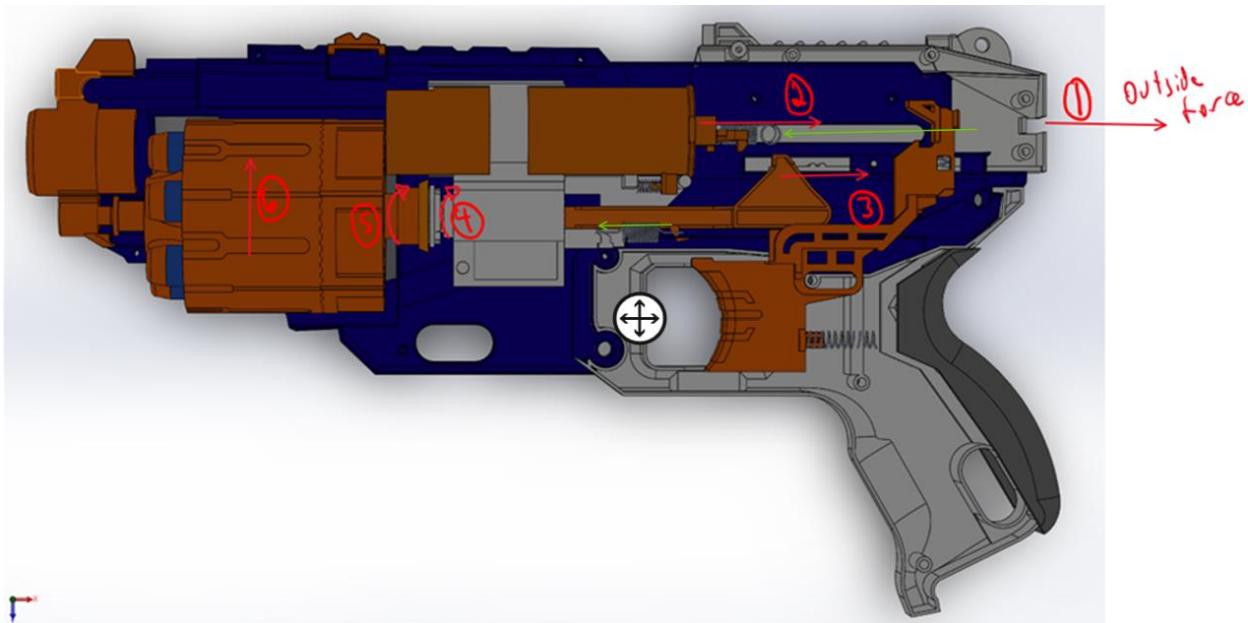


Figure #10: The motion and energy interactions caused by pulling back the slider of the Nerf gun

The second outside force enacted on the nerf gun is to pull the trigger. This sets off a chain of reactions that ultimately fires a dart. The first movement is within the trigger itself (1) which directly translates the movement to the trigger release, moving it down (2) so that the piston can be released (3) and slide forward due to the stored spring force (4). This compresses the air in the cylinder (5), and when it achieves a pressure large enough to overcome the friction of the dart in the magazine, the dart is propelled forwards and out of the device (6). After the trigger is released, there are return forces shown in green that reset the operation of the device using springs.

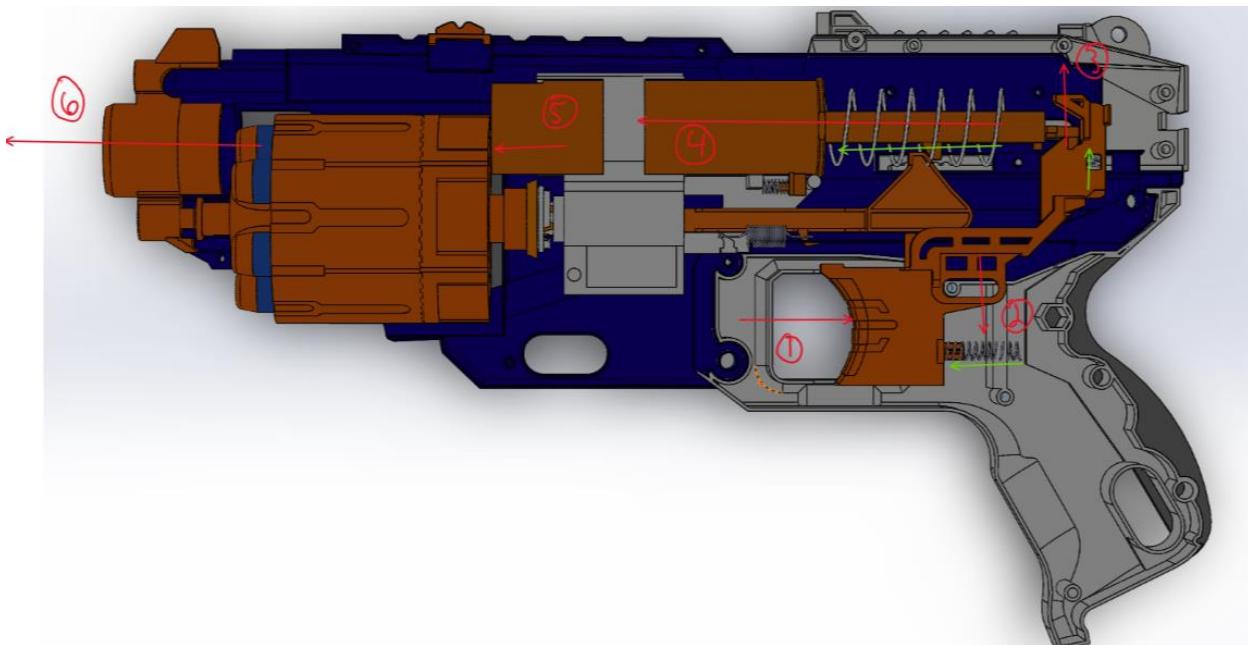


Figure #11: Figure #10: The motion and energy interactions caused by the trigger being pulled

Engineering Drawings

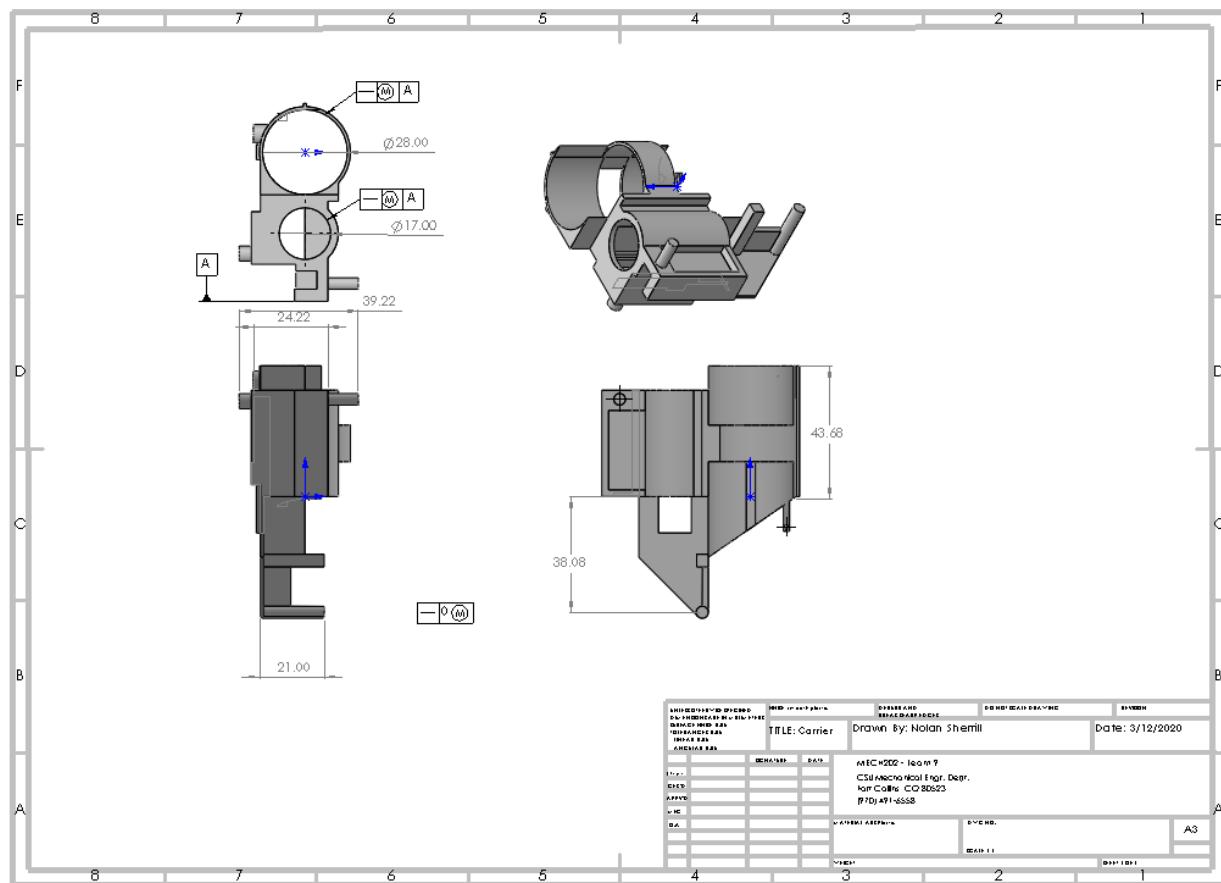


Figure #12: Engineering drawing of part (16)

The internal housing part's main purpose is to hold all the internal parts in place. It has direct interactions with part (17), part (21), part (22), and part (24). Part (17) is the housing for the air-plunger, which fits into the top cylindrical hole, holding it in place. Part (21) and (22) are the components of the cylinder rotator mechanism, which fit into the small cylindrical hole in the bottom, holding it into place. Part (24) is the arm that directly translates the trigger pulling action into the rotation of the cylinder, which also fits into the bottom cylindrical hole.



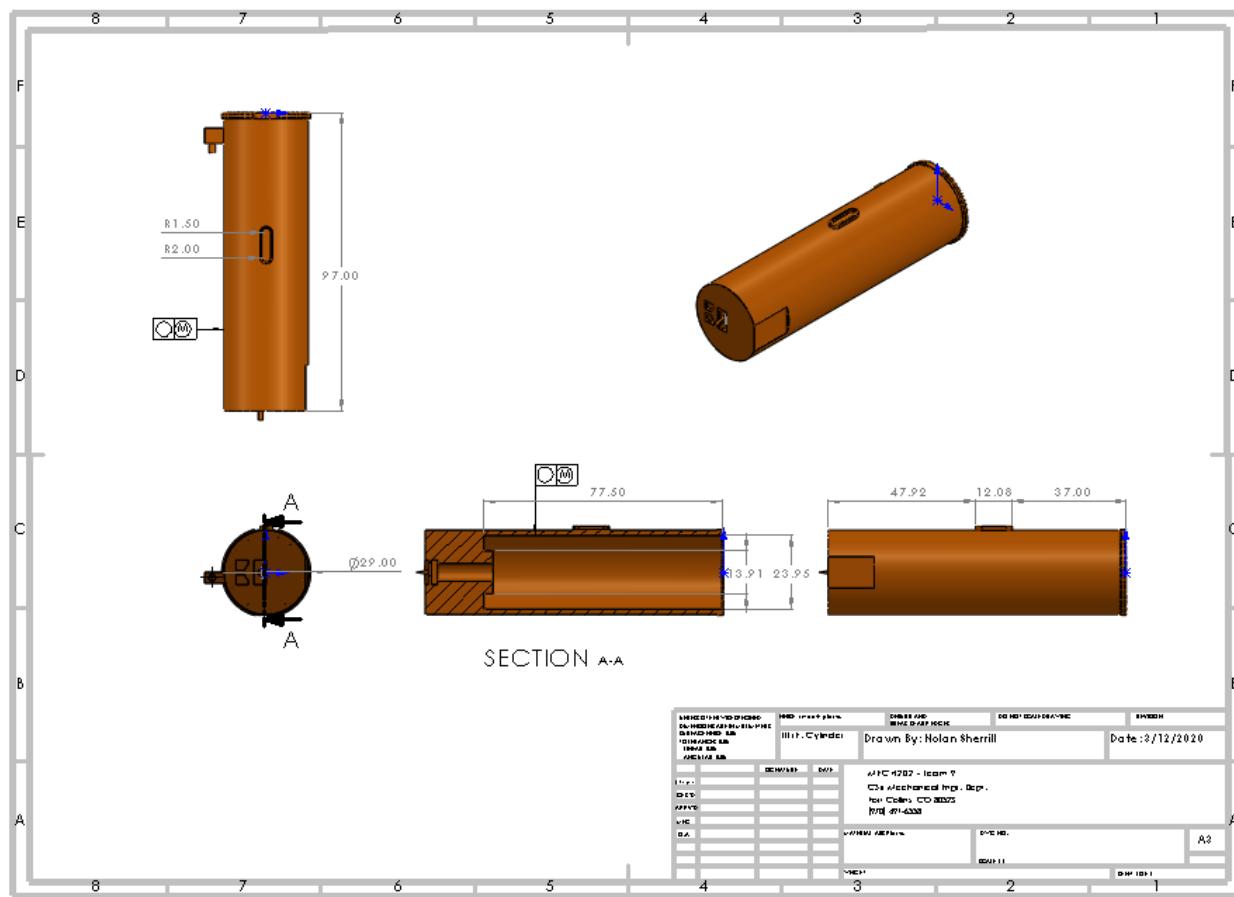
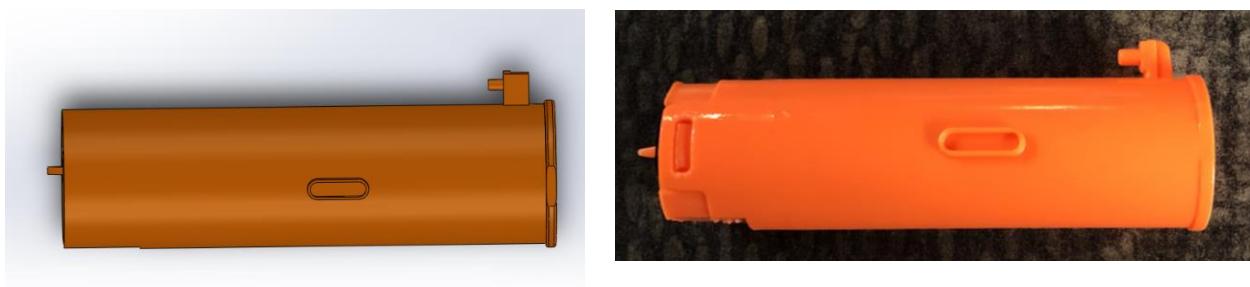


Figure #13: Engineering drawing of part (17)

The casing for the air-plunger's main purpose is to house the plunger, as well as allowing it to lock into place for firing when the slider is pulled back. It has direct interactions with part (15), part (16), and part (26). Part (15) is the spring-loaded air-plunger that pushes the air out of the cylinder to fire the darts that is housed directly inside of this part. Part (16) is the housing shell for this part that ensures it does not get out-of-line, causing an improper fire of the dart. Part (26) is a component of the trigger mechanism which interacts with this part to release the air-plunger, allowing the dart to fire.



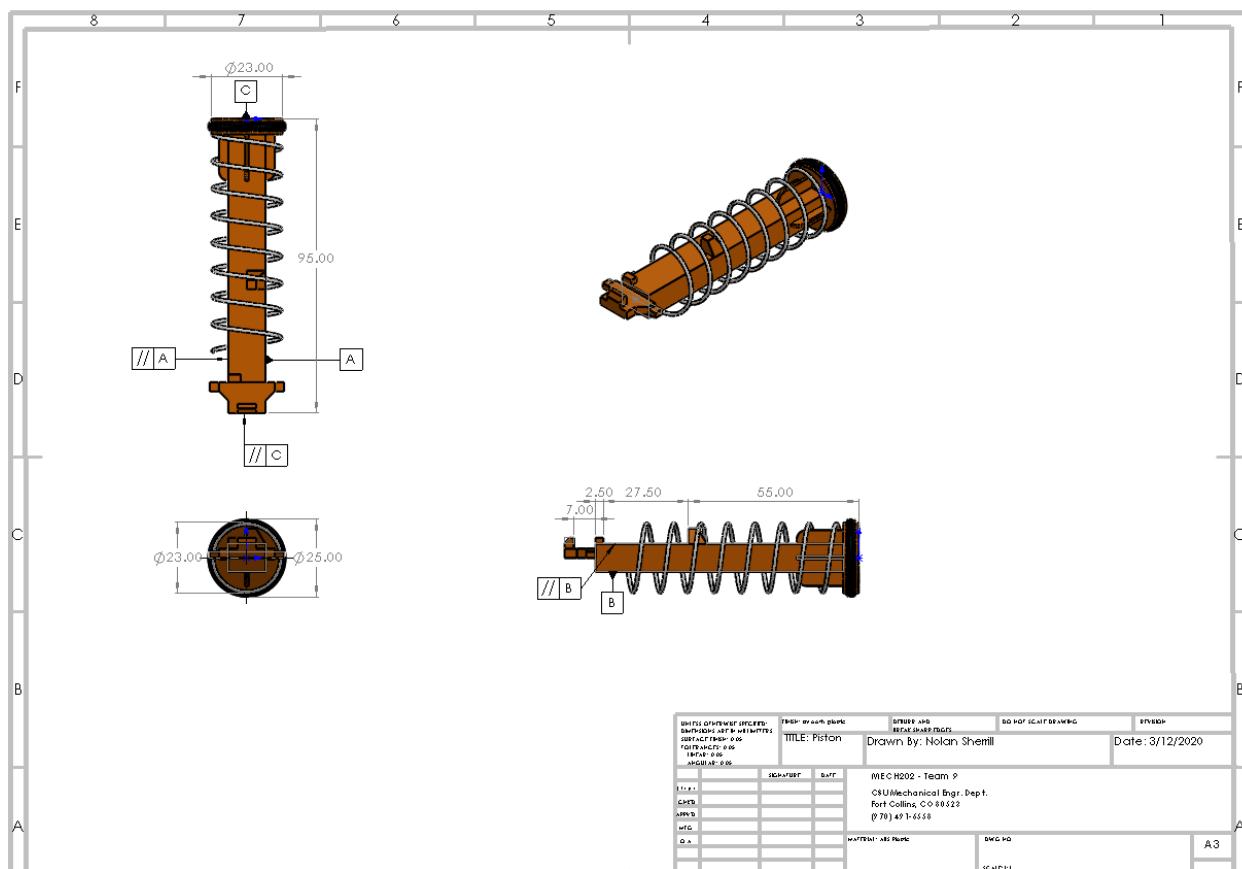
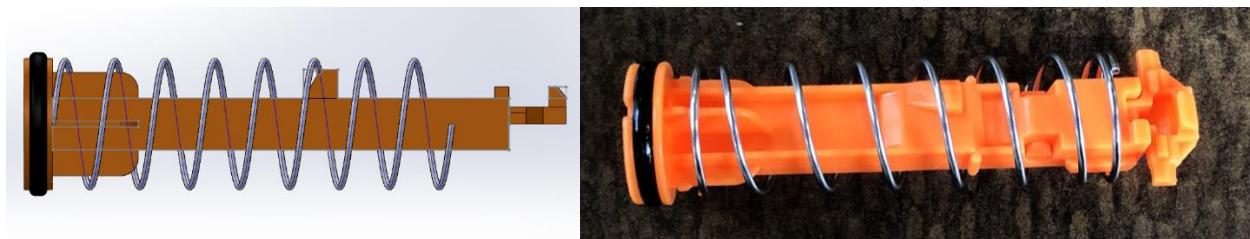


Figure #14: Engineering drawing of part (15)

The air plunger's main purpose is to create a seal within the casing, allowing it to push air towards the dart, allowing it to fire. It has direct interactions with part (17) and part (26). Part (17) is the casing component that it sits inside of and pushes air through to fire the dart. Part (26) is a piece of the trigger mechanism that it locks onto when the slider is pulled back, making it ready to fire when the trigger is pulled.



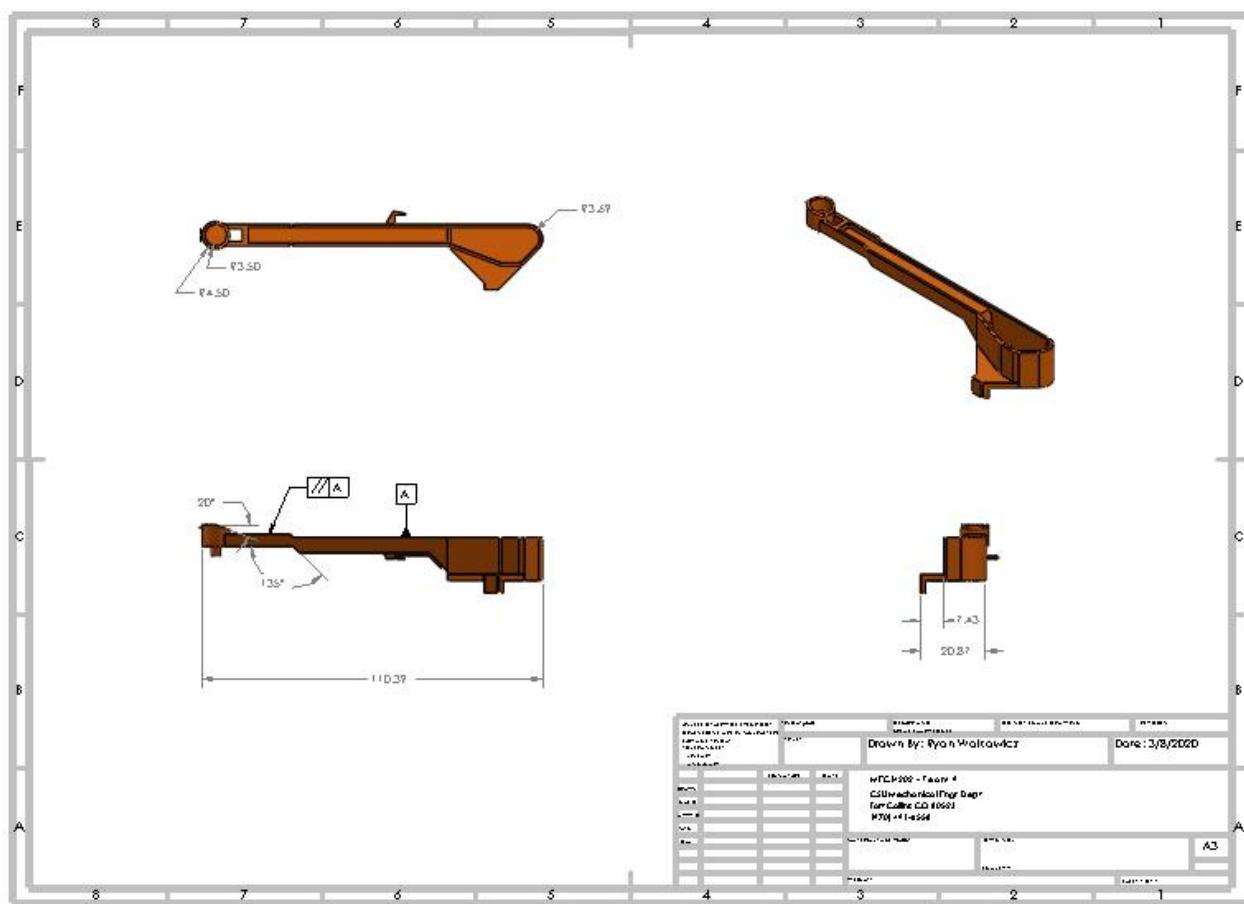
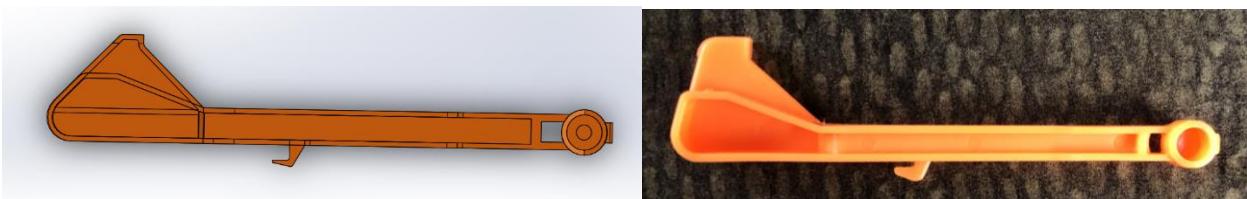


Figure #15: Engineering drawing of part (24)

The rotator arm's main purpose is to be the bridge between the trigger and the rotator mechanism to ensure that the cylinder rotates when the trigger is pulled, making it ready to fire the next dart. It has direct interactions with part (22) and part (25). Part (22) is a piece of the rotating mechanism that it directly goes into, translating the pulling of the trigger into cylinder rotation. Part (25) is the trigger, which it directly interlocks with, allowing this translation of action.



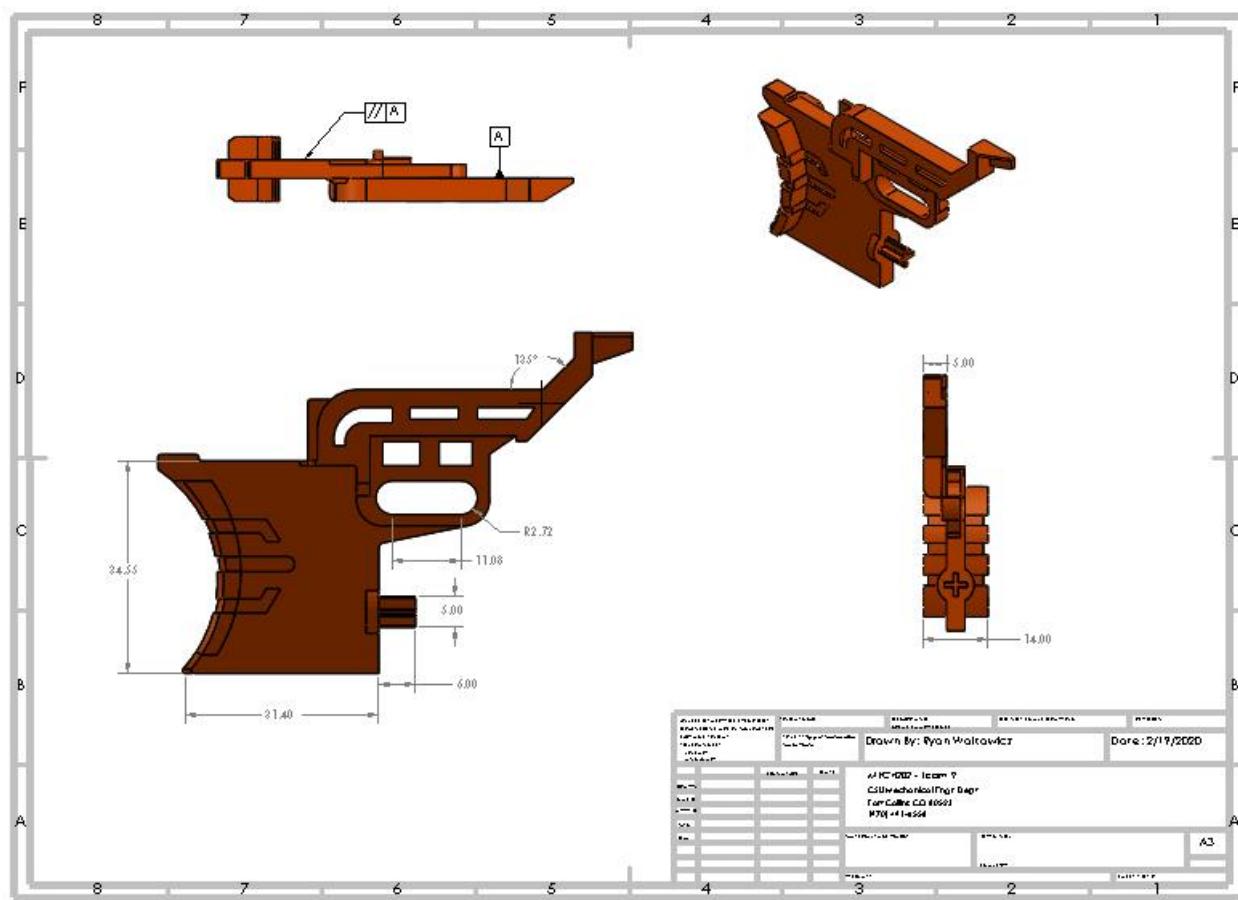


Figure #16: Engineering drawing of part (25)

The trigger mechanism's two main purposes are to release the mechanism that will fire the air-plunger and to interact with another part to rotate the cylinder. It has direct interactions with part (24) and part (26). Part (24) is the part that is directly responsible for translating the pulling of the trigger into the cylinder's rotation. Part (26) is the part that activates the mechanism to release the air-plunger, which fires the dart.



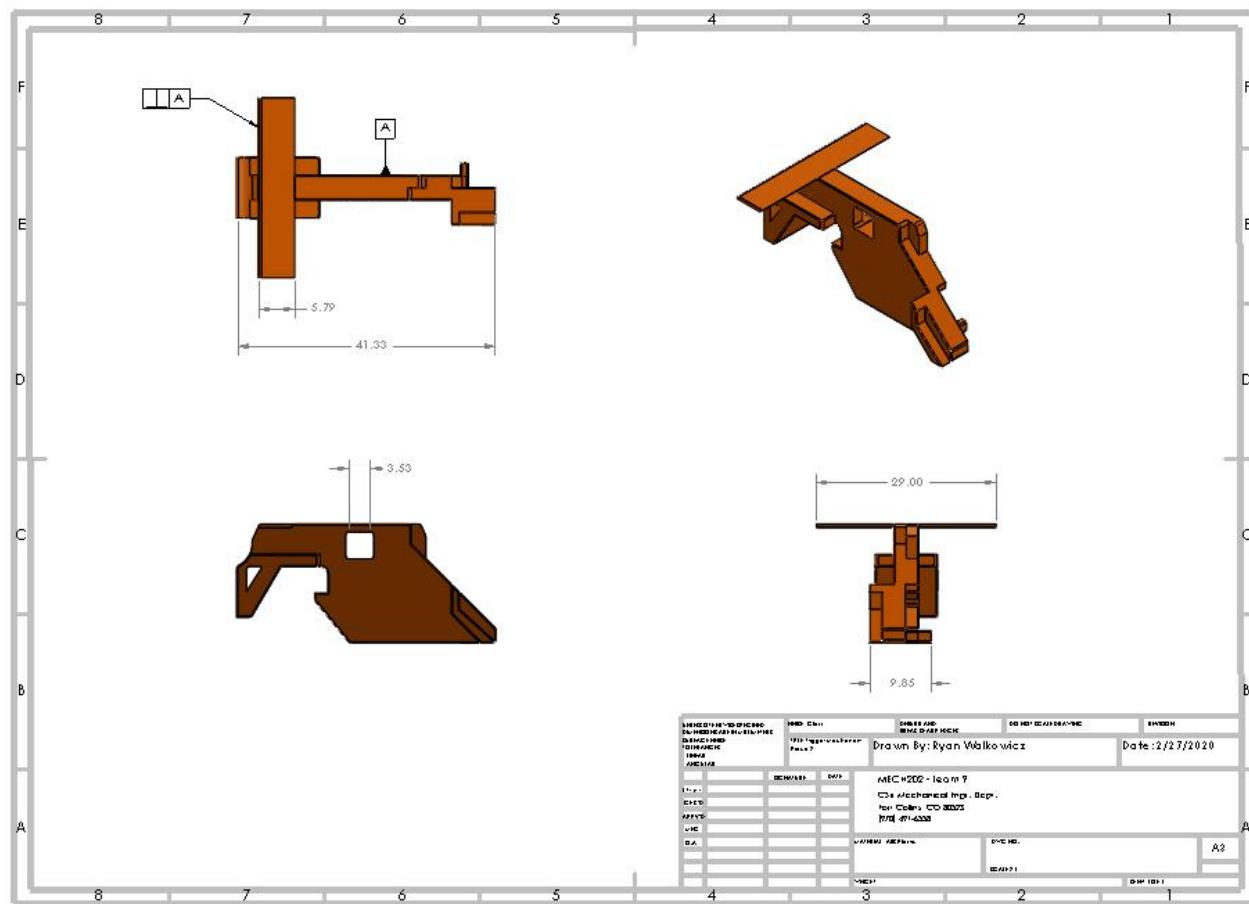
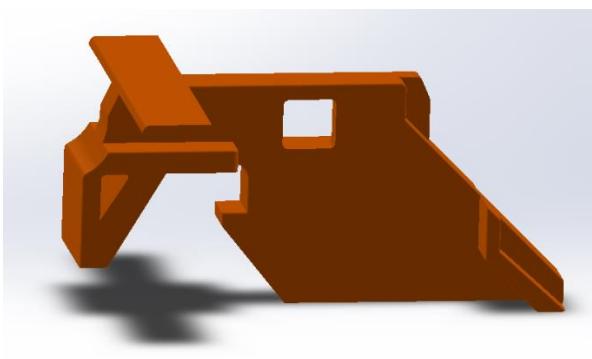


Figure #17: Engineering drawing of part (26)

This component of the trigger mechanism's purpose is to lock the air plunger in place, making the spring tense, allowing it to be ready to fire when the trigger is pulled. It has direct interactions with part (15) and part (25). Part (15) is the air-plunger, which gets locked into place with the small hook-like shape of the part. Part (25) is the trigger, which it interacts with when the trigger is pulled to release the air-plunger and fire the dart.



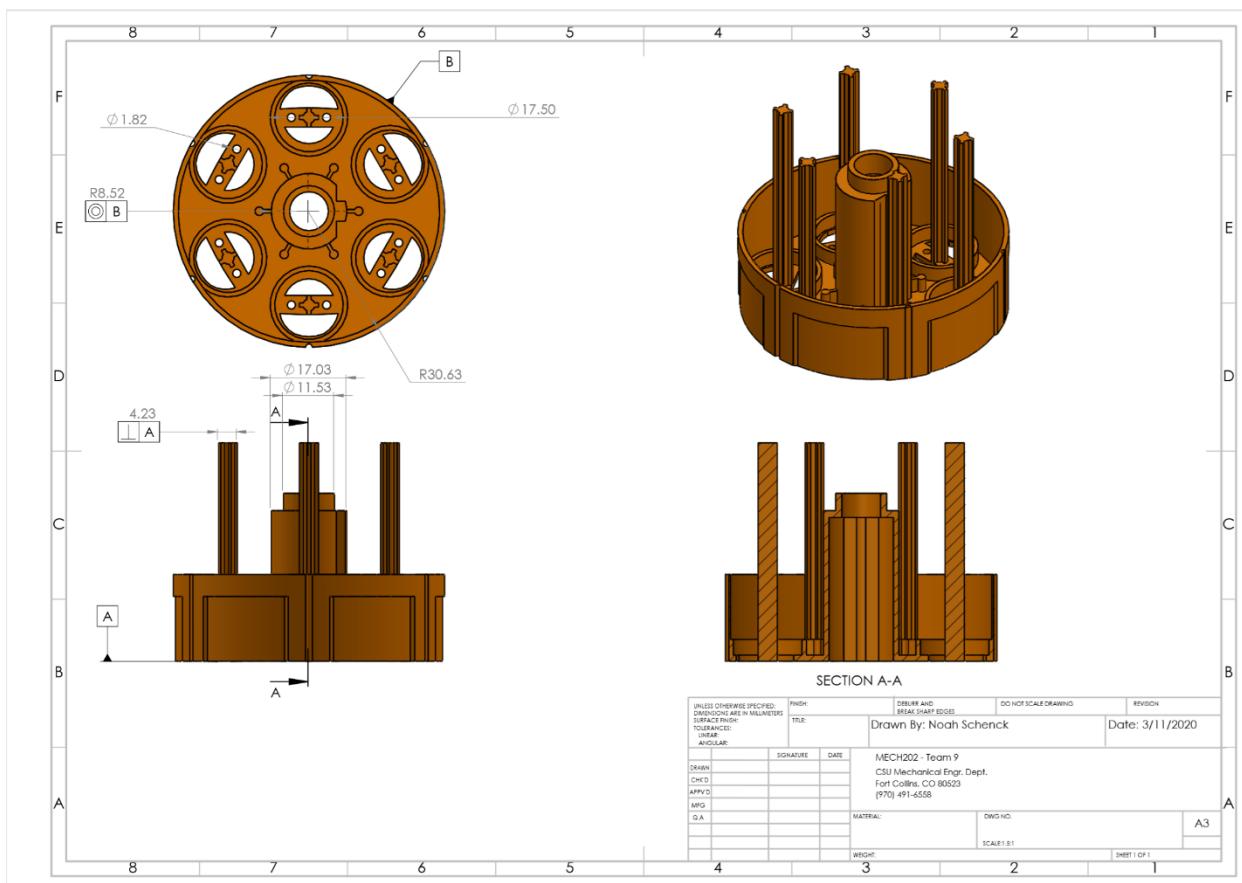


Figure #18: Engineering drawing of part (13)

The bottom half of the cylinder mechanism's main purpose is to house the darts so that they are ready to fire. It has direct interaction with part (4), part (12), and part (14). Part (4) is one of the Nerf darts that loads onto the cross-shaped extrusions, which holds them in place. Part (12) is the upper half of the cylinder, which it directly locks into via the extruded rings around the dart-holders. Part (14) is a small 'key' that locks into the bottom center hole which allows the cylinder to rotate into place to fire the next dart after the trigger has been pulled.



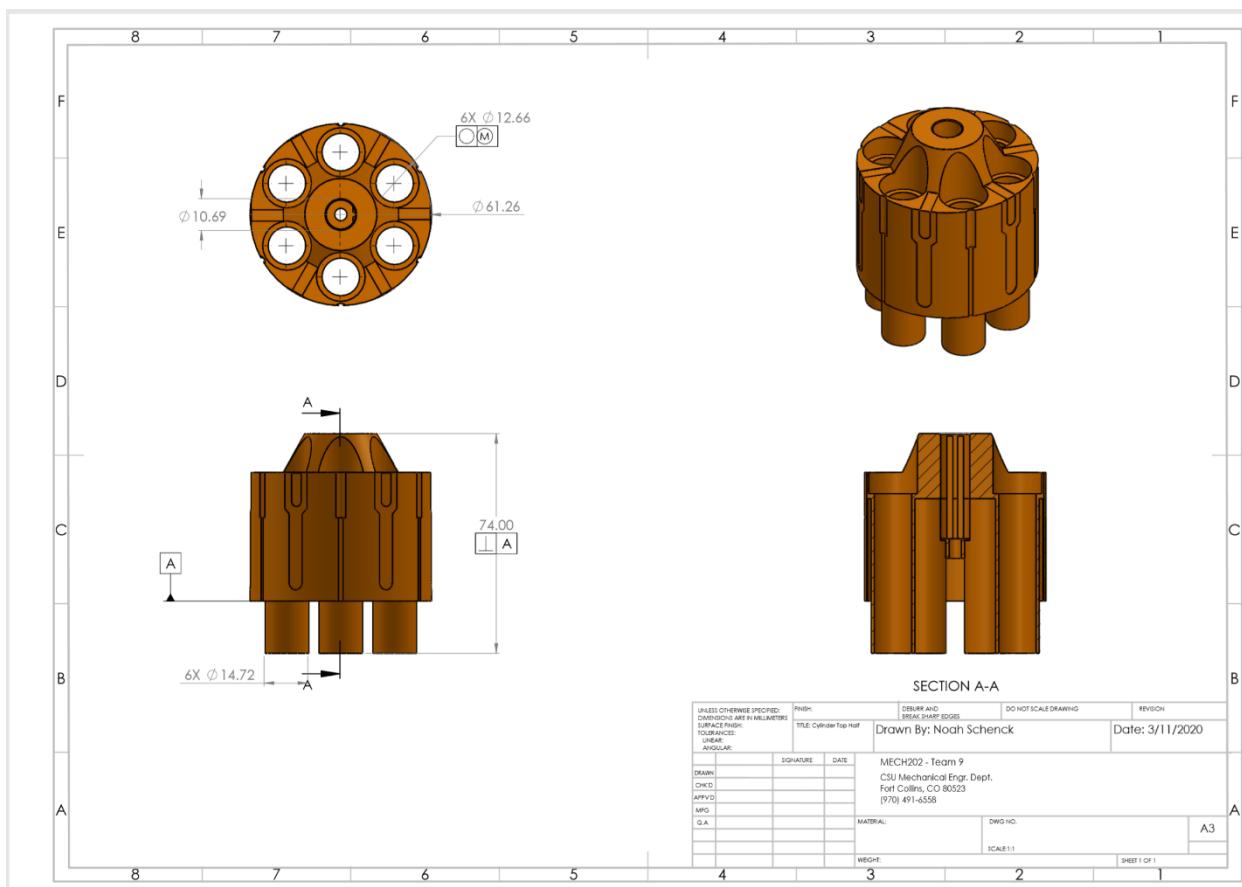
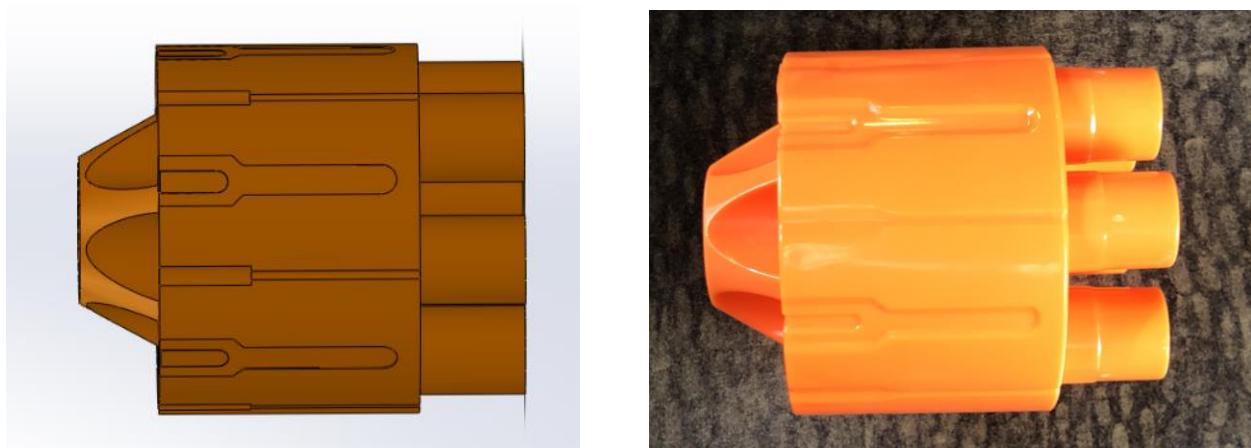


Figure #19: Engineering drawing of part (12)

The top half of the cylinder's main purpose is to assist the darts by holding them in place as well as guiding them for the first part of flight once the air pushes them. It has direct interactions with part (11) and part (13). Part (11) is the small 'key' that inserts into the top hole which helps the cylinder rotate into position to fire the next dart after the trigger has been pulled. Part (13) is the bottom half of the cylinder, which it directly locks into via the cylindrical extrusions for dart guidance.



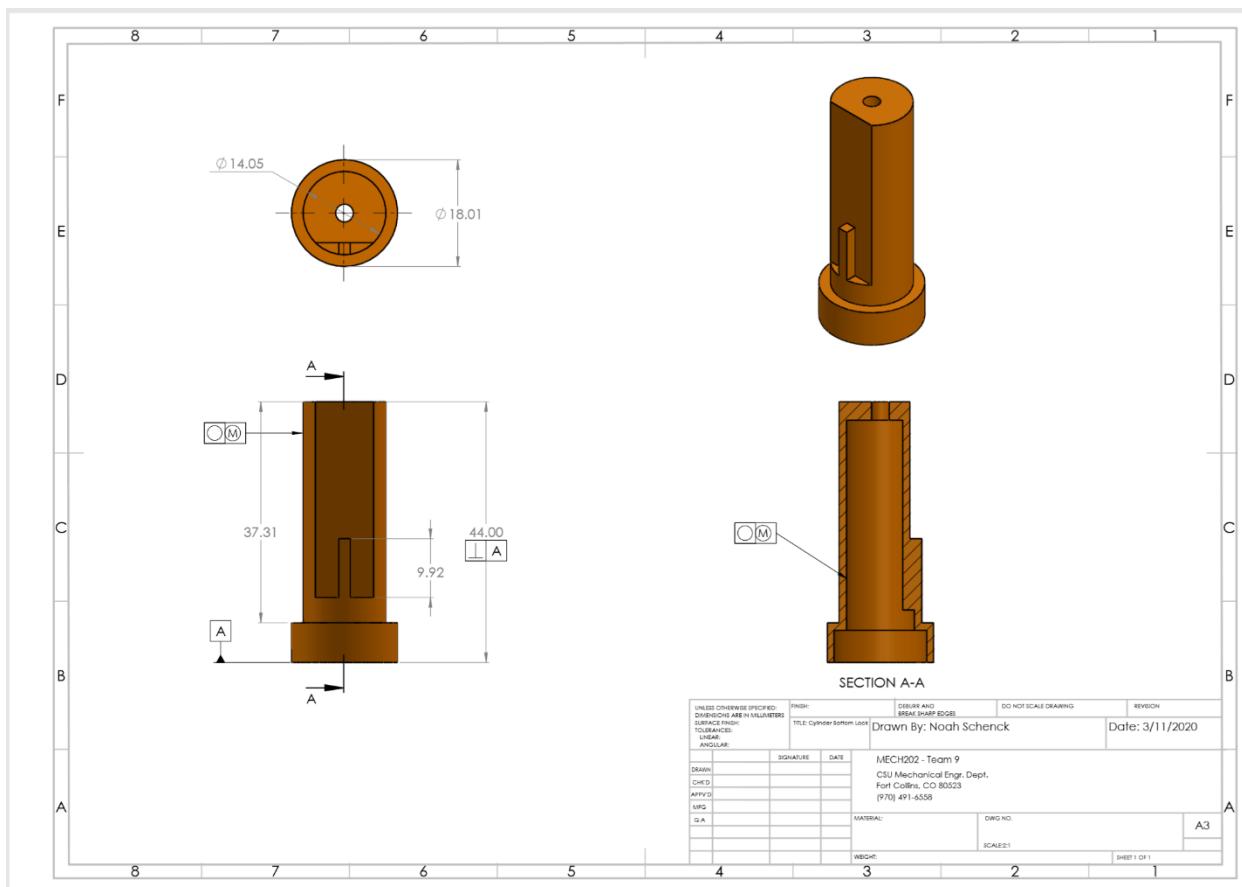
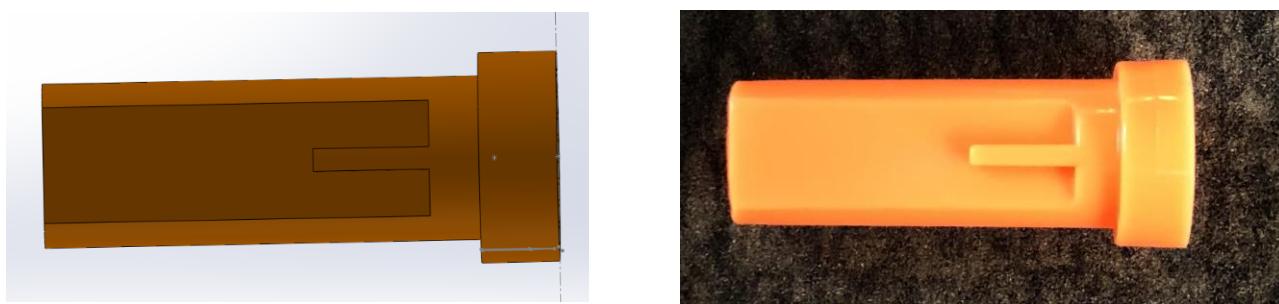


Figure #20: Engineering drawing of part (14)

The bottom ‘key’ that inserts into the bottom half of the cylinder’s main purpose is to lock the cylinder into place as well as assist the cylinder to rotate via its interaction with other parts. It has direct interactions with part (13) and part (18). Part (13) is the bottom half of the cylinder which it is inserted into and locked into place by the small rectangular cutout. Part (18) is a component of the cylinder rotating mechanism that inserts into the bottom of it, rotating it when activated by the trigger mechanism.



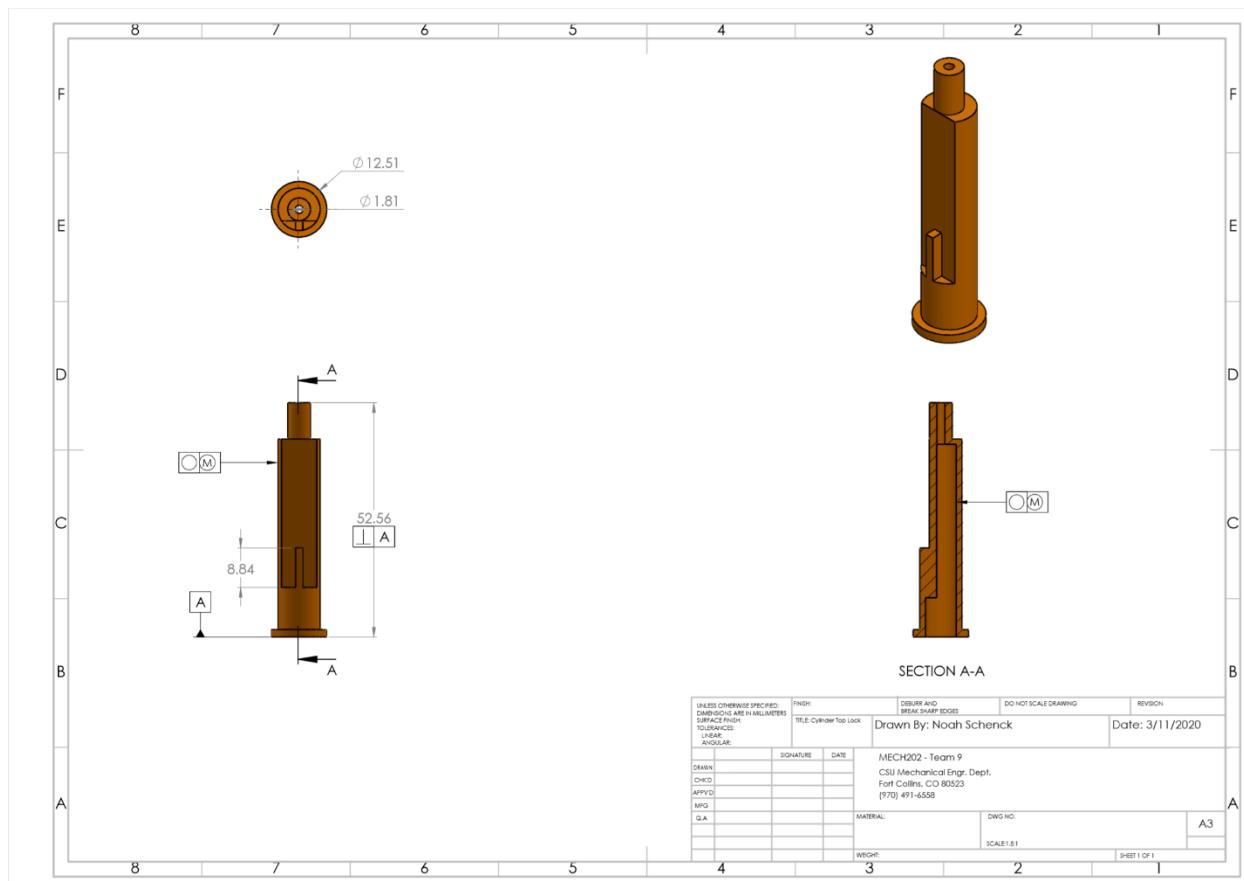
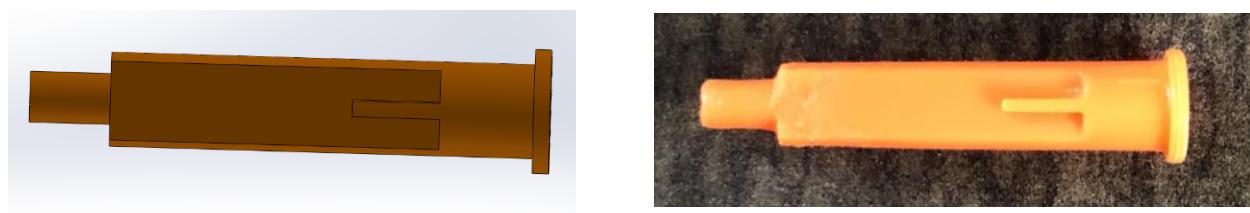


Figure #21: Engineering drawing of part (11)

The top ‘key’ that inserts into the top of the cylinder’s main purpose is to lock the cylinder into place, while still allowing it to rotate. It has direct interactions with part (1) and part (12). Part (1) is the tip of the barrel which it inserts into to lock the cylinder’ translational motion, while still allowing rotational motion. Part (12) is the top half of the cylinder which it is inserted into and locked into place via the small rectangular cutout.



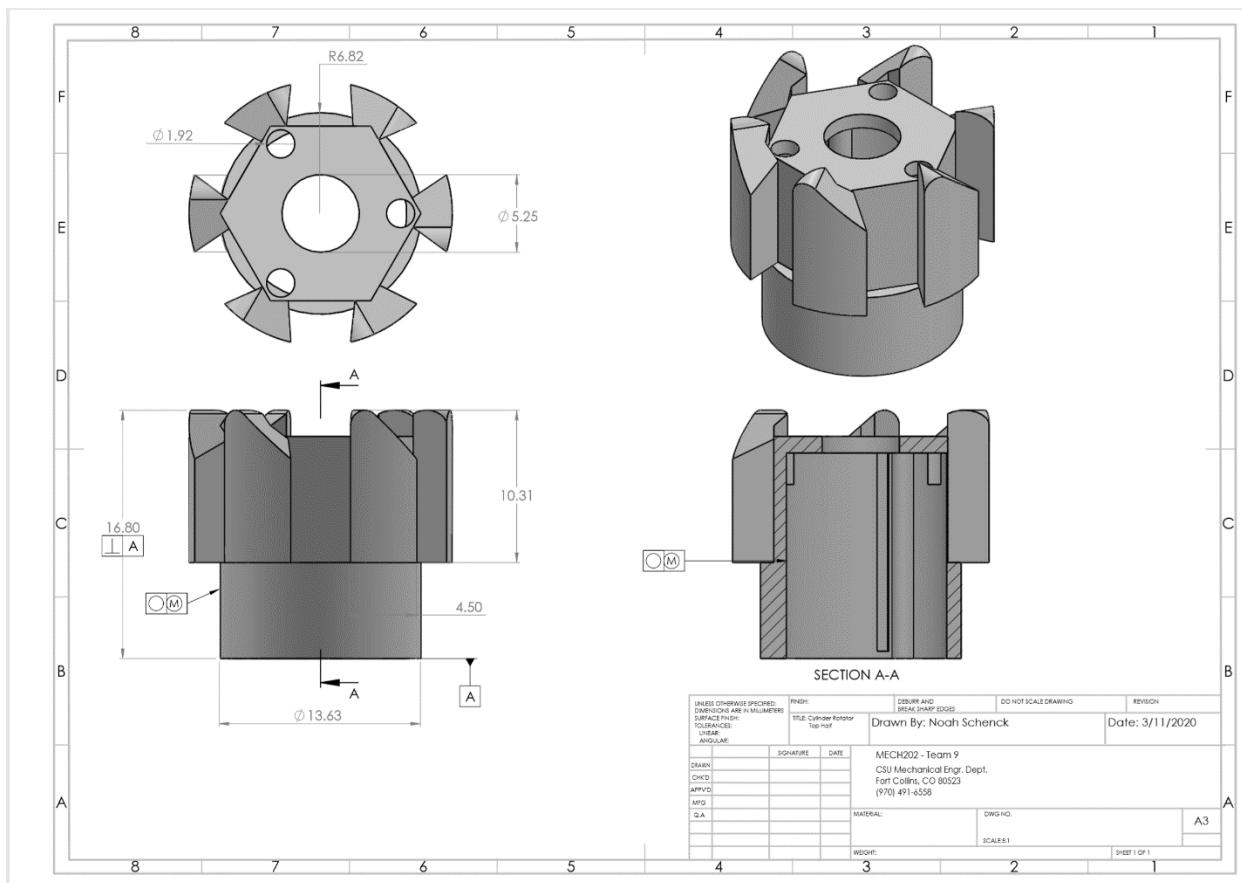
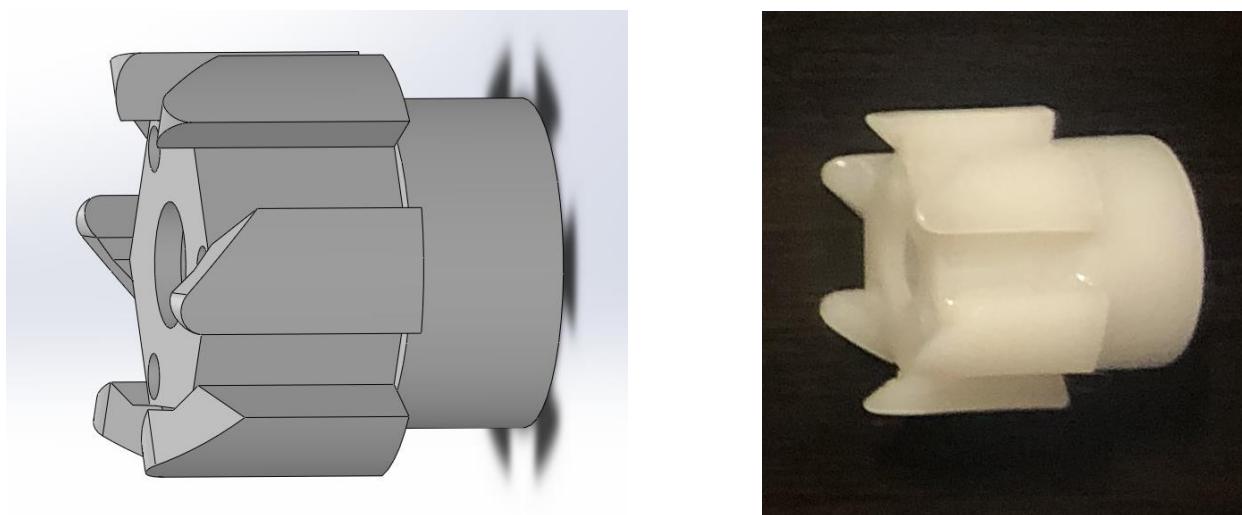


Figure #22: Engineering drawing of part (22)

The top half of the cylinder rotator's main purpose is to directly interact with the trigger mechanism, rotating the cylinder when pulled. It has direct interactions with part (21). Part (21) is the bottom half of the rotating mechanism, which it is locked to by the extrusions of that part directly inserting into the three holes on top. The main, larger hole in the middle is where a screw is inserted, which locks it into part (18).



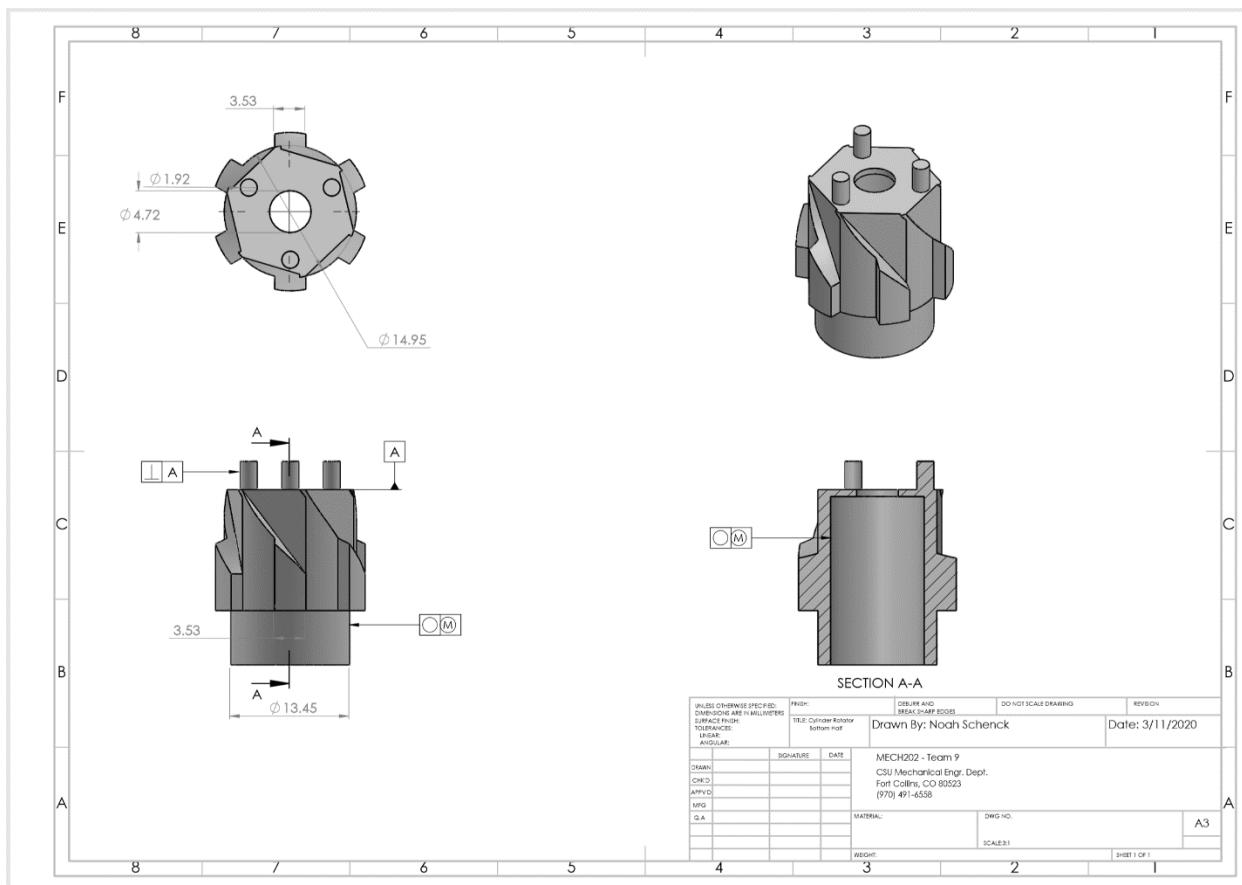
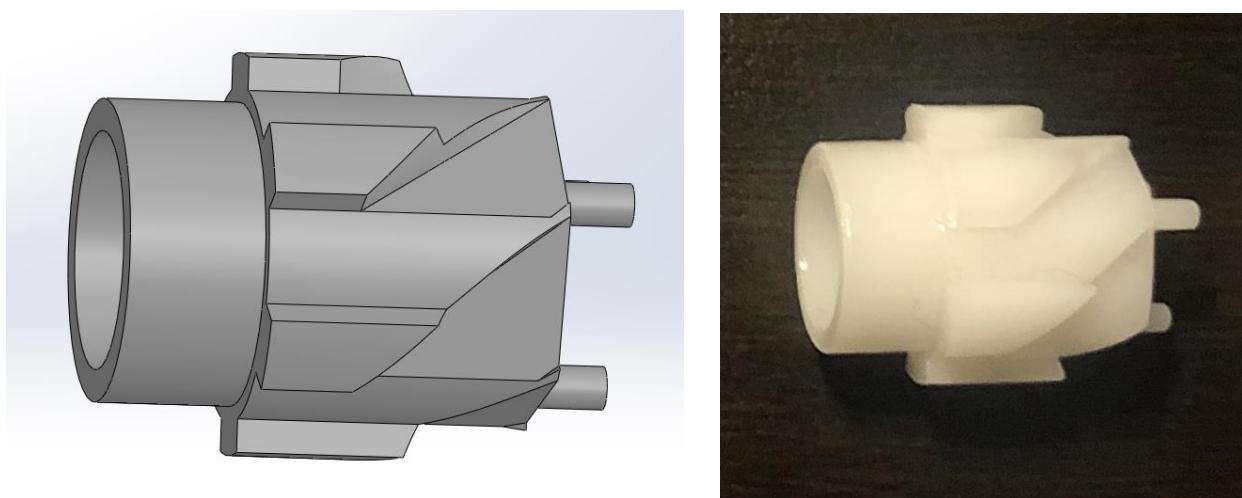


Figure #23: Engineering drawing of part (21)

The bottom half of the cylinder rotator's main purpose is to directly interact with the trigger mechanism, rotating the cylinder when pulled. It has direct interactions with part (20) and part (22). Part (20) is a small piece that interlocks with this part to directly translate the interaction with the trigger mechanism into the cylinder rotation. Part (22) is the top half of the cylinder rotator, which locks into via the three extrudes on its top surface.



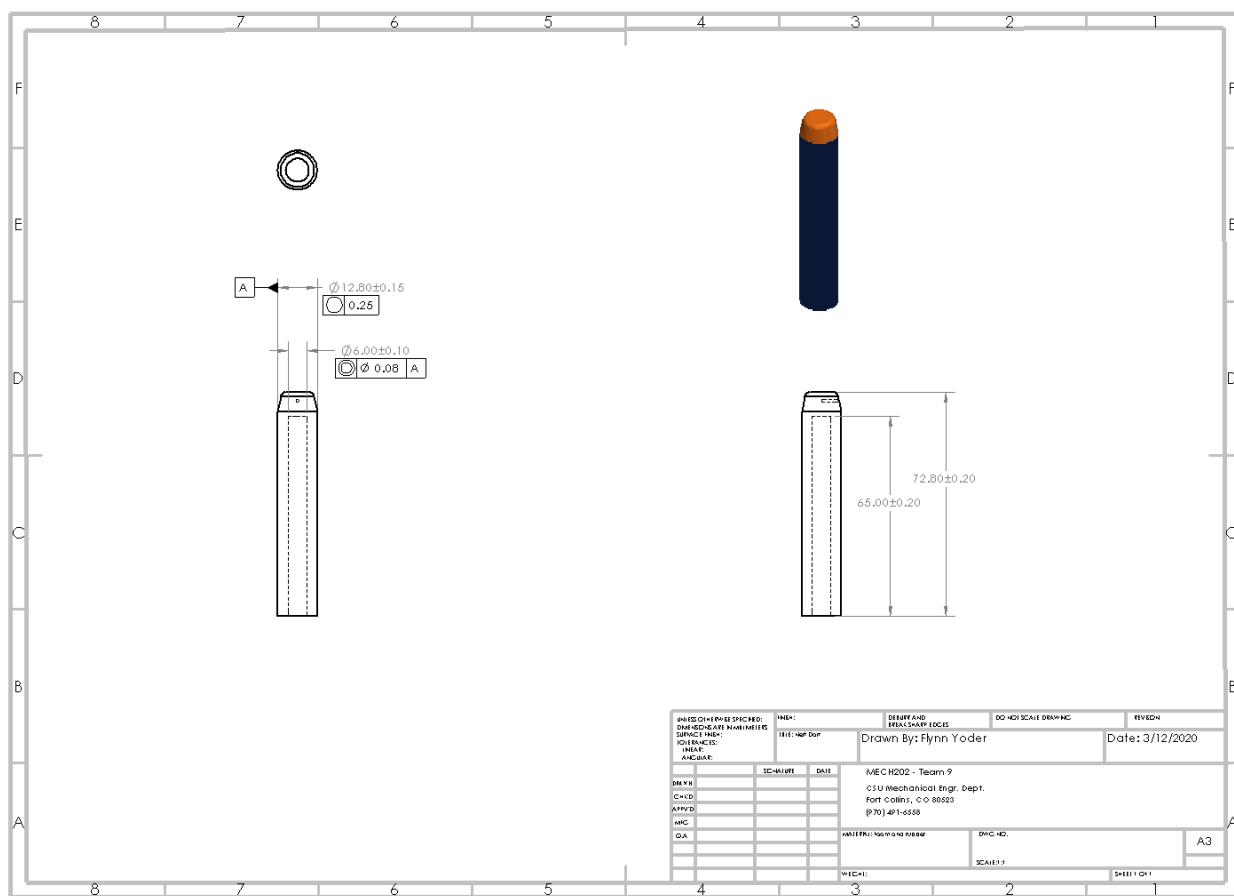


Figure #24: Engineering drawing of part (4)

This part functions as the projectile that shoots from the Nerf gun. There are six of these parts in the Nerf gun assembly. Each part is made of orange rubber and blue foam. This part directly interacts with parts (12) and (13), and indirectly interacts with parts (15) and (17). Part (12) is the revolver cartridge that holds the darts in place from the outside. Part (13) goes through the middle blind hole of the darts and holds them in place from the inside. Parts (15) and (17) comprise the spring and plunger that provide the air that propels the darts out of the Nerf gun.



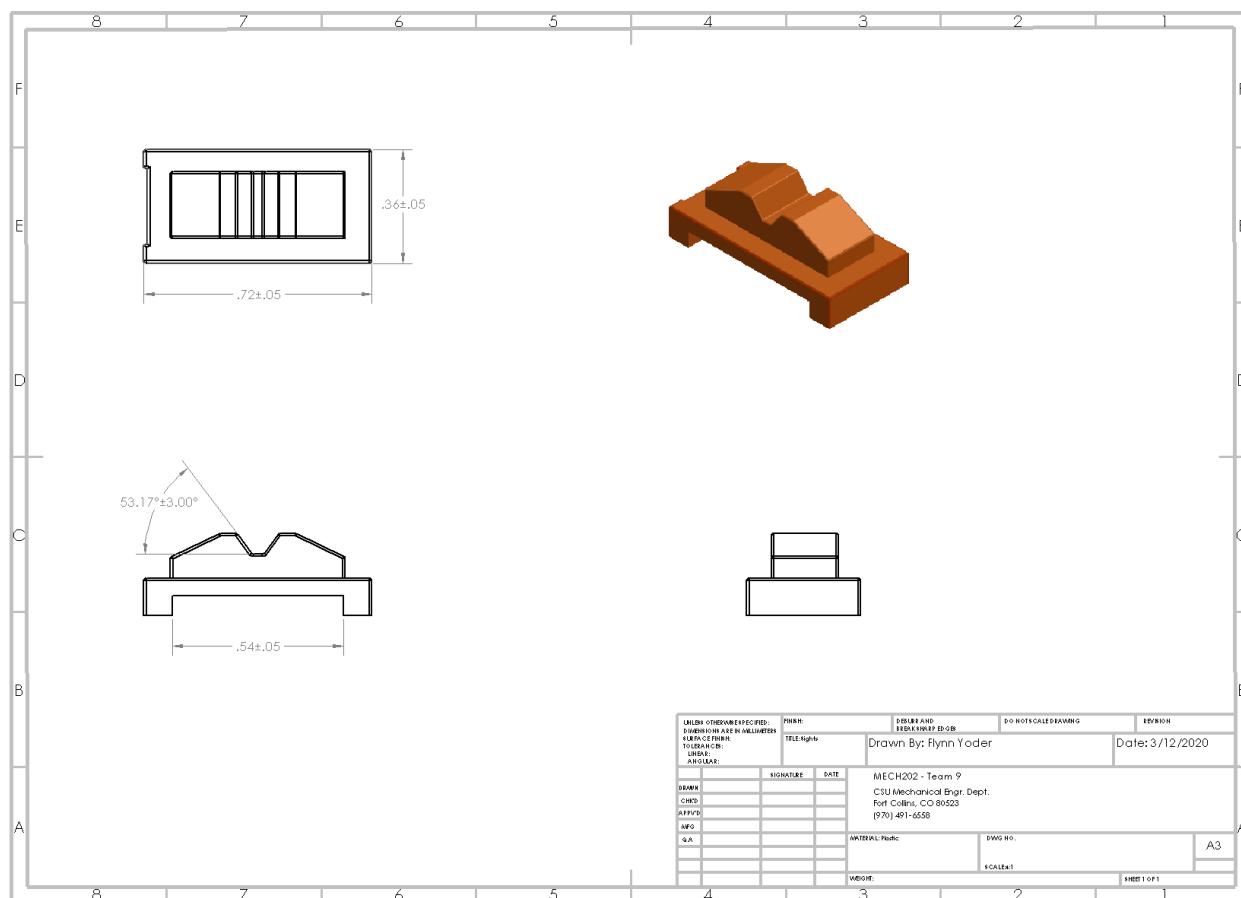
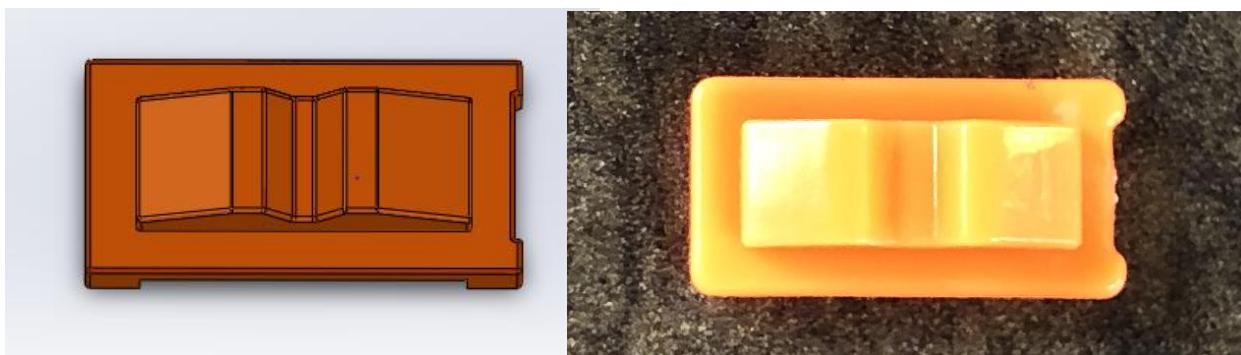


Figure #25: Engineering drawing of part (27)

The main function of this part is to assist in securing any attachments onto the top rail of the Nerf gun. This piece directly interacts with part (2). Part (2) is the exterior shell of the Nerf gun. It holds this piece in place on the top part of the assembly. This part and part (2) combine to make the rail of the gun, which has the ability to hold any attachments such as a scope or a laser sight. These attachments would be sold separately from the Nerf gun.



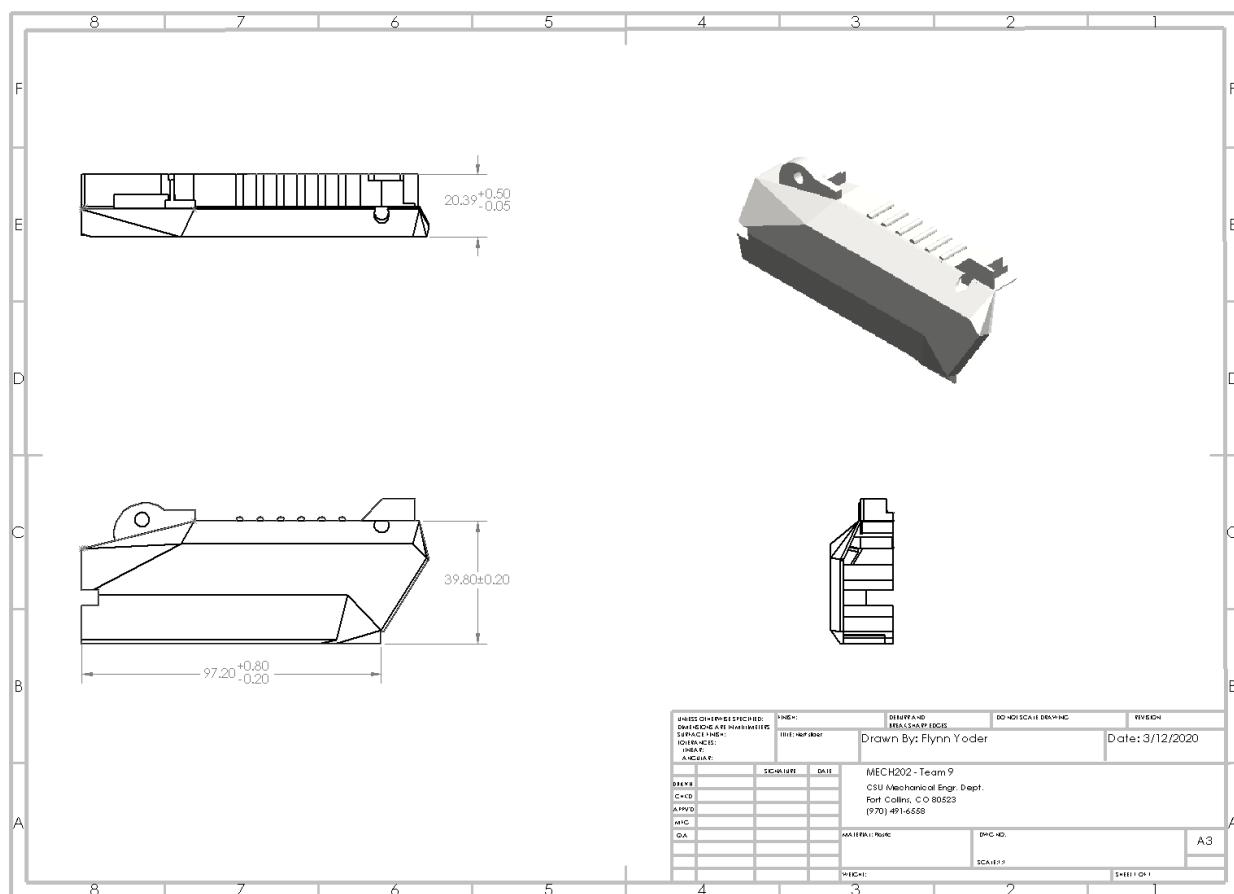
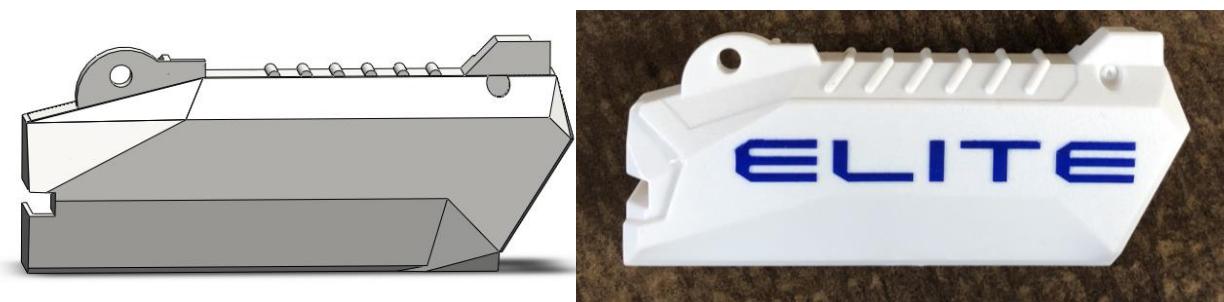


Figure #26: Engineering drawing of part (9/10)

This piece is used to cock the gun prior to shooting it. The part is mirrored to form a solid rectangular shape. It is pulled back with enough force to shoot the projectile after release. This part directly interacts with parts (2) and (15). Part (2) is the outer shell of the Nerf gun. The shell holds this slider piece in position while allowing it to be pulled back and forth. Part (15) is a part of the plunger device that propels air to the dart, firing the dart from the Nerf gun. Part (15) uses a spring to take the energy from the gun being cocked and release it quickly. The plunger then moves enough air to shoot the dart out of the Nerf gun.



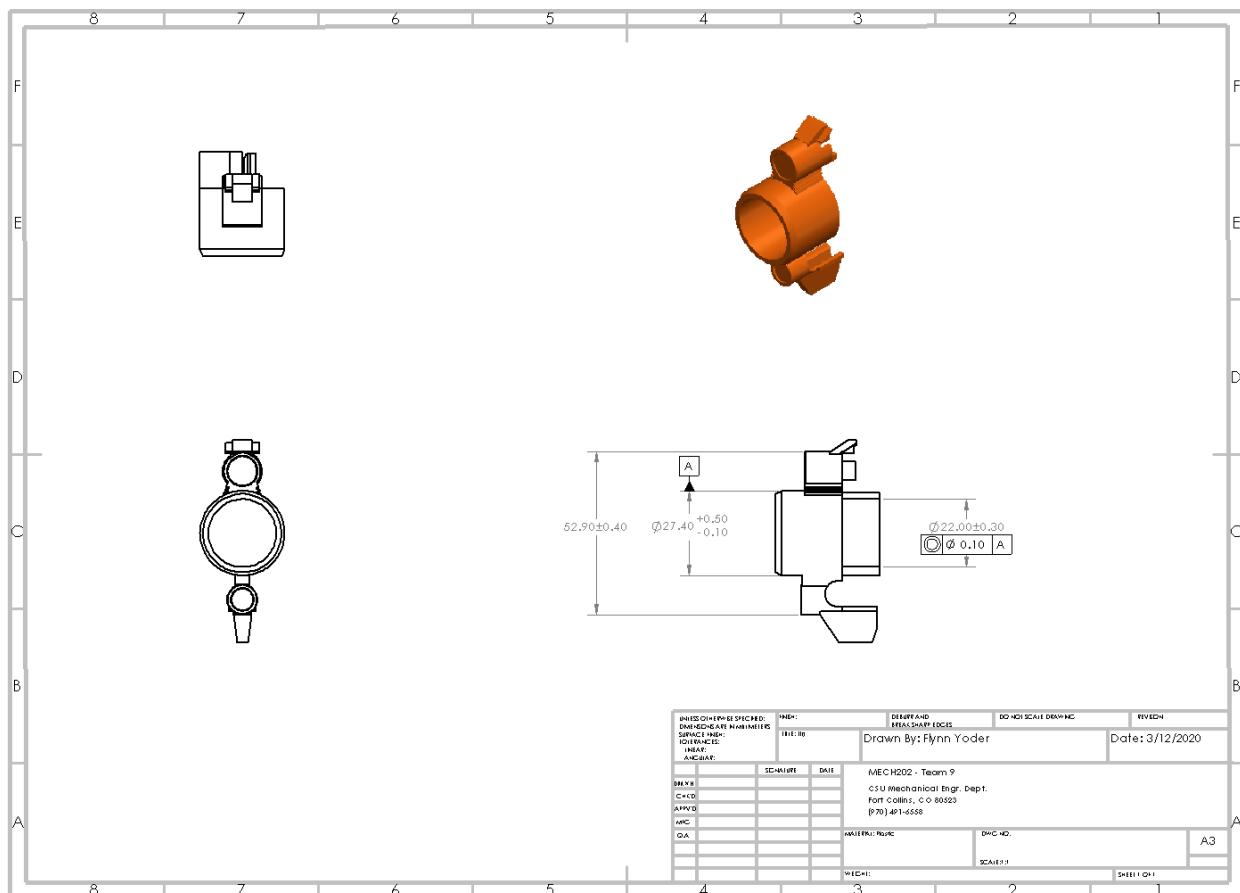
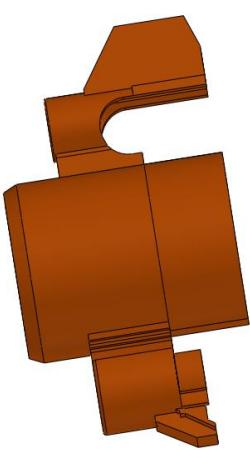


Figure #27: Engineering drawing of part (1)

This piece comprises of the tip of the Nerf gun. It is responsible for guiding the Nerf darts out of the gun. It also is used as the front sights to look down when aiming. This piece directly interacts with parts (2) and (11). Part (2) is the exterior shell of the Nerf gun. The shell holds this part (part (1)) in place. Part (11) secures the cylinder of the gun in place while still allowing it to rotate. Part (11) and this piece touch but do not interact. They might hold each other in position slightly, but they do not fix to one another, so they don't do much to hold each other in place.



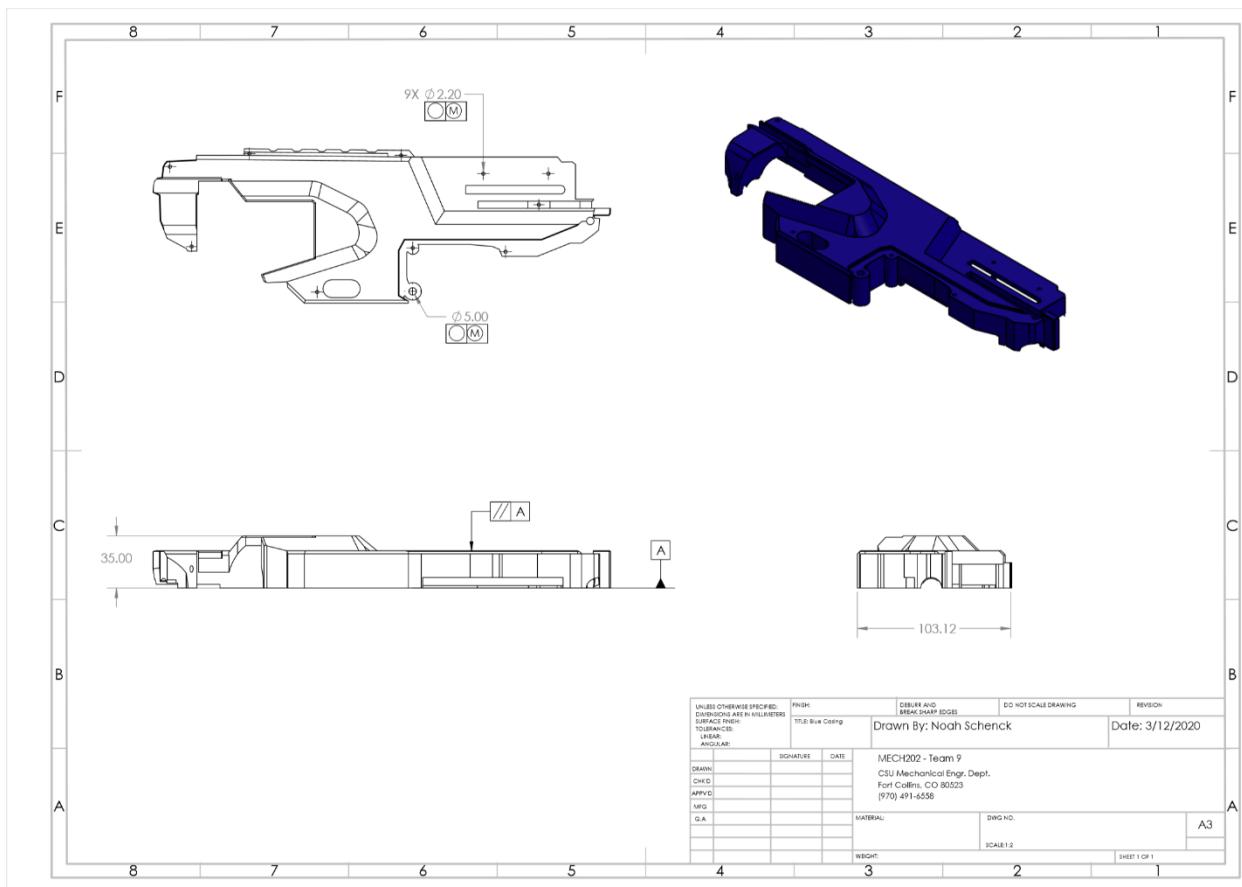
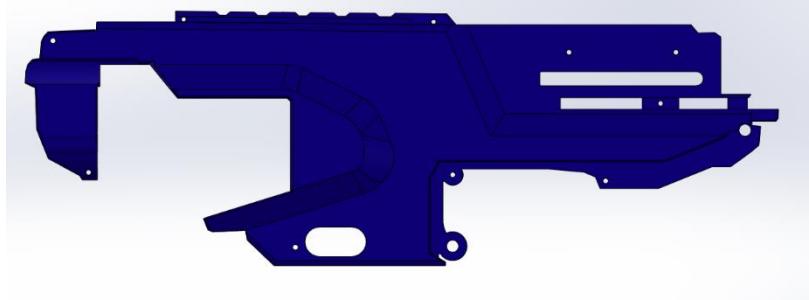


Figure #28: Engineering drawing of part (2/3)

The outside shell's main function is to give the gun its aesthetic flair as well as hide all the inner components for safety. Its primary interactions are with the opposite side of the blue shell in addition to part (5/6), part (7/8), and part (9/10). Its secondary interactions are with all of the internals, as it keeps them in place, but does not directly affect the movement or interaction of any of the internal pieces, it is just a housing.



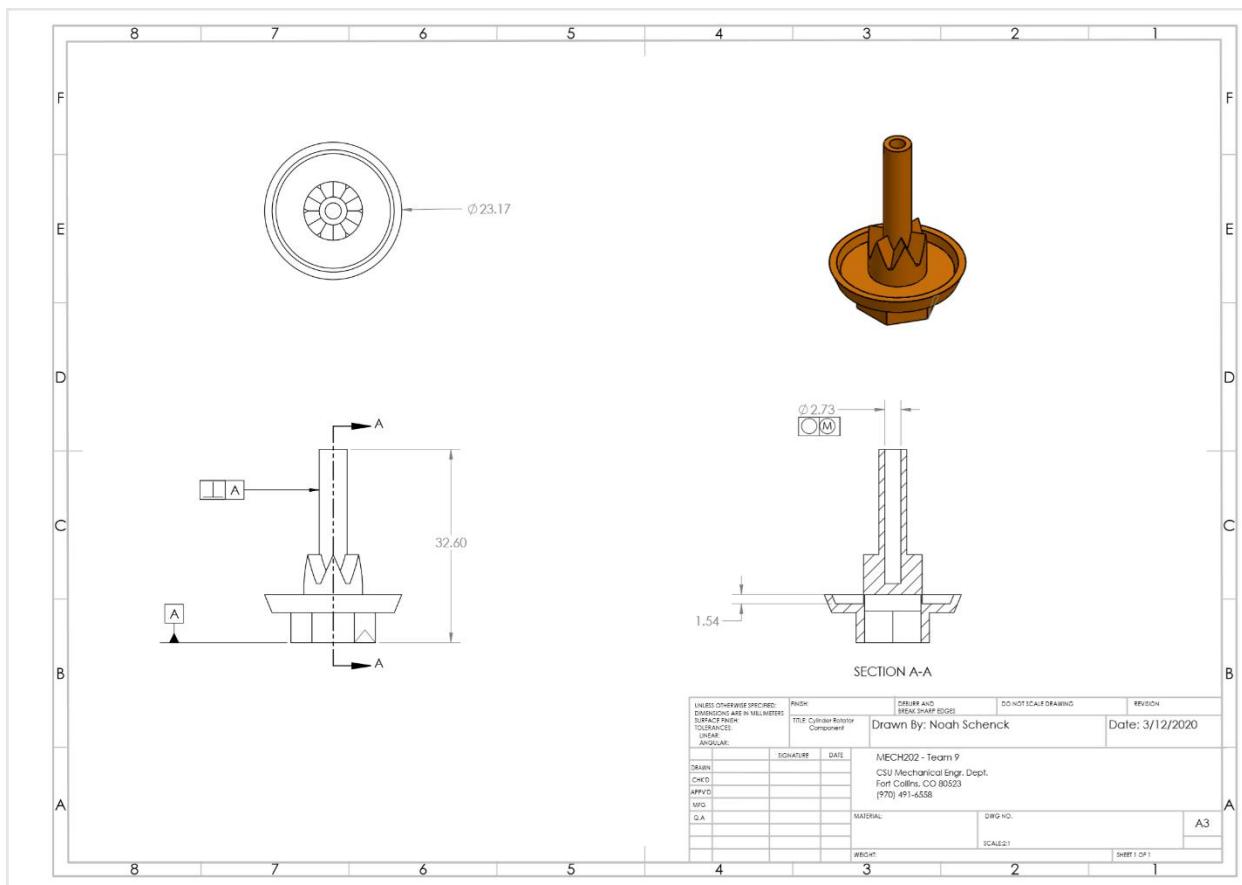
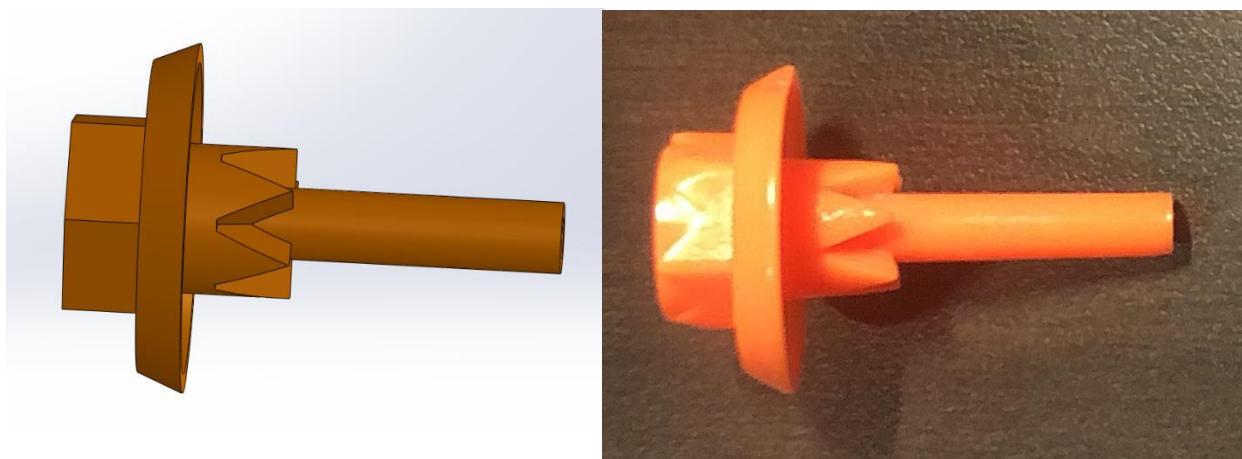


Figure #29: Engineering drawing of part (18)

This component of the cylinder rotator's main purpose is to be the first piece that translates the trigger pull into the rotation of the cylinder. It has direct interactions with part (14), part (20), and part (21). Part (14) is the bottom 'key' that inserts into the cylinder, that when rotated, will rotate the whole cylinder, readying up the next dart. Part (20) is a small part that interlocks with the teeth of this part that allows part (21) to be attached to it, translating the rotation.



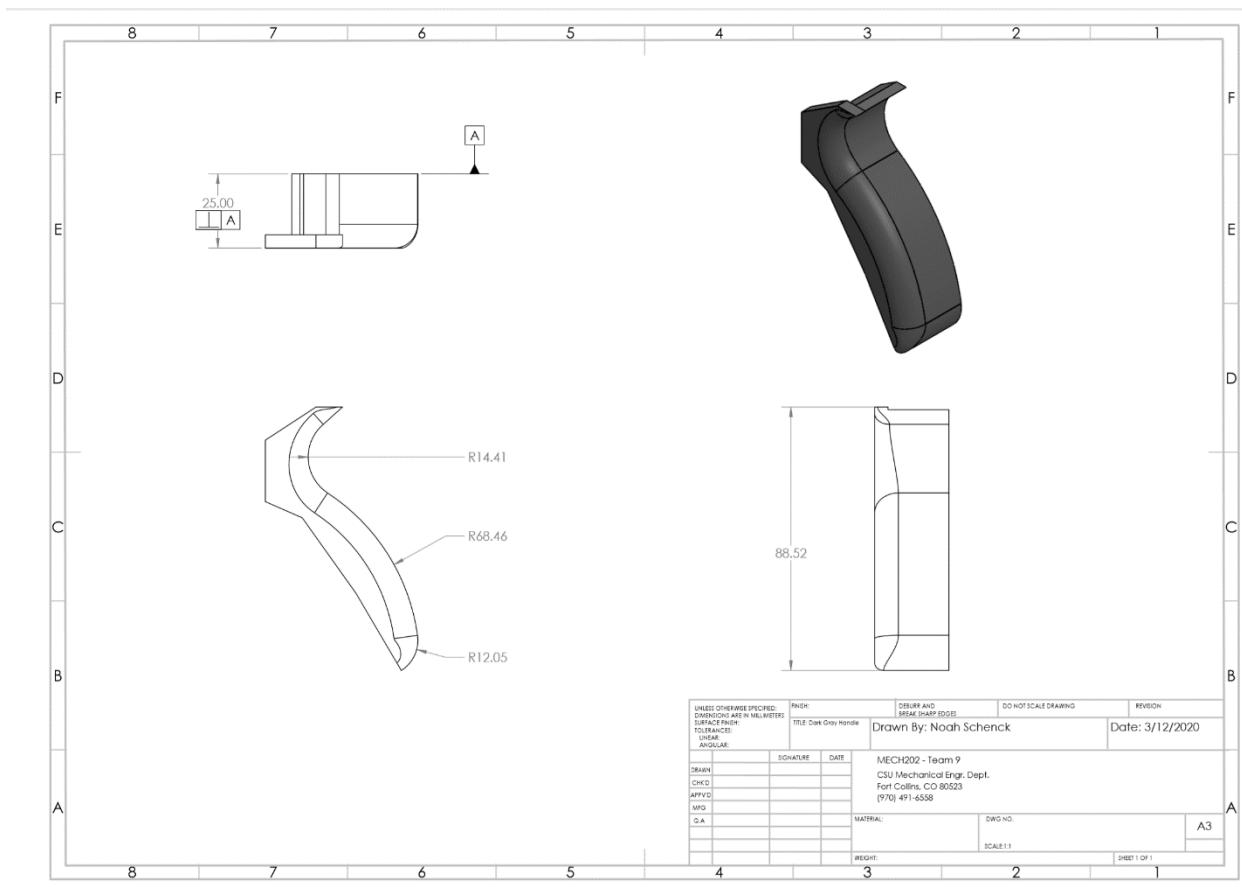


Figure #30: Engineering drawing of part (7/8)

This component of the handle's main purpose is to allow the user to have a better grip on the gun by having a very ergonomic shape. It has direct interactions with part (5/6) by interlocking into the other part of the handle.



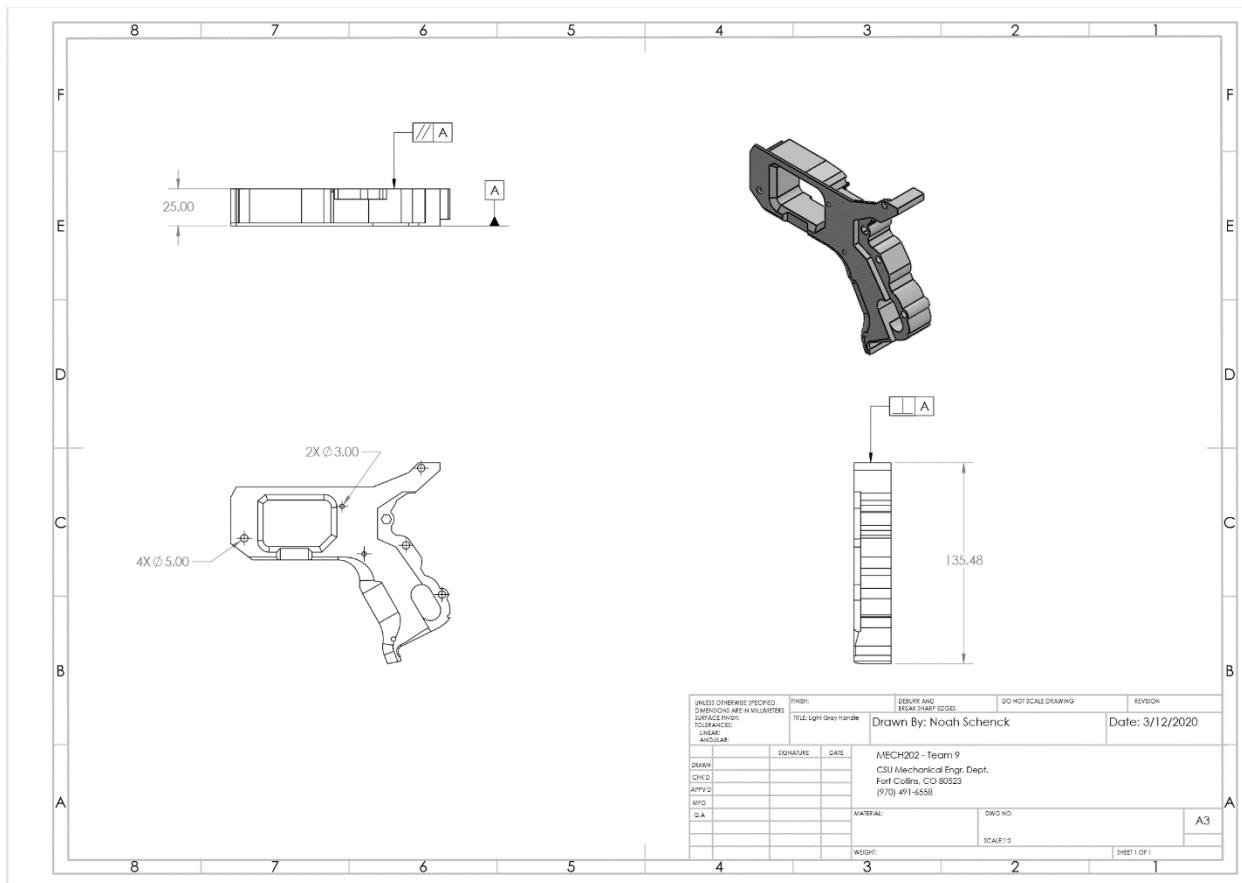
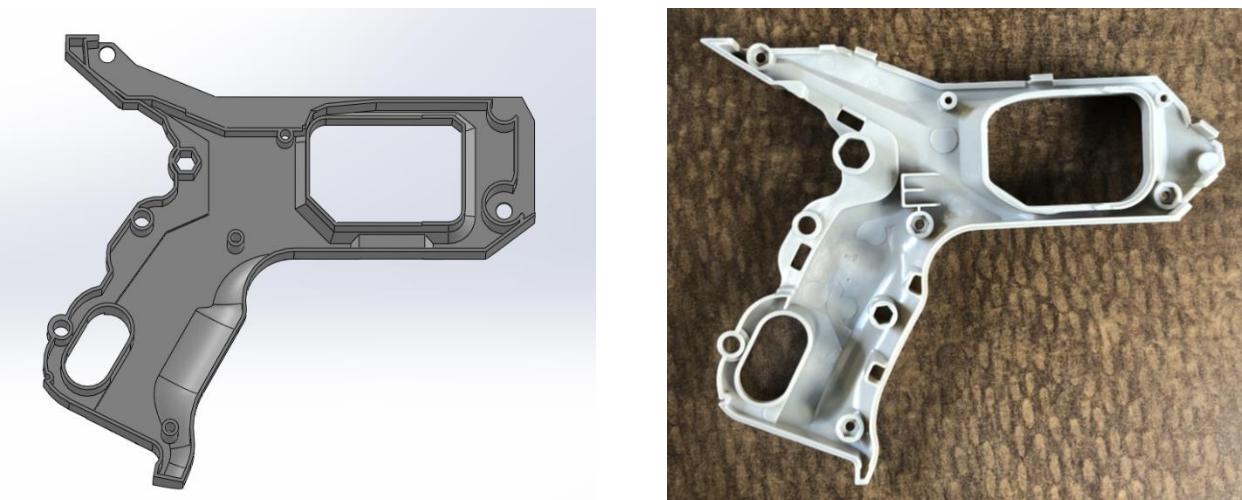


Figure #31: Engineering drawing of part (5/6)

This component of the handle's main purpose is to give an ergonomic grip to the user's fingers, as well as house the trigger. It directly interacts with the mirror opposite of the handle as well as part (25). Part (25) is the trigger, and it seats in the rectangular gap in the handle, allowing the user to easily pull the trigger.



Competitive Analysis

Nerf is a very well-known brand in the toy industry, and a leader in the foam-dart gun/blaster field. To compare the Nerf N-Strike Elite Disruptor (The model that was reverse-engineered), competitors had to be identified. Nerf manufactures a range of different blasters, however each gun in Nerf's range will be designed to slightly different customer requirements (or else that device has no use in their product line-up), so these alternative Nerf Products will be disregarded as "competitors". Three other brands were found who manufacture a single-shot, 6 dart capacity, rotating cylinder dart guns. These products are listed below:

- Dart Zone BlitzFire
- Zuru X-Shot Excel
- Adventure Force Destroyer

Dart Zone BlitzFire



Figure #32: The Dart Zone Blitzfire as shown on the Walmart website

Waste of time

Would not recommend

Montessori Mom - 10 months ago

Very hard for child to pull back. Only fires randomly and bullets get stuck often. We've spent more time frustrated trying to get it to work properly than enjoying it. Reluctant even to donate it.

Broad age appeal out of 5

Length of play out of 5

Quality out of 5

Value out of 5

2 guests found this review helpful. Did you?

[Report review](#)

Disappointed

Would not recommend

Julie - 1 year ago, Verified purchaser

My boys bought this less than an hour ago with their own money. I FINALLY let them buy toy guns. It's so tight, it's hard for them to reload, and they've already broken 2 bullets because it was caught and was too tight for them to get them out. Very disappointed. What I thought would be hours of fun on a day off from school ended up being about 3 minutes of excitement followed by frustration and giving up altogether. Perhaps older, stronger kids can handle it better.

Quality out of 5

Broad age appeal out of 5

Length of play out of 5

Did you find this review helpful?

[Report review](#)

Figure #33: Scathing customer reviews of the Blitzfire toy gun

About the company

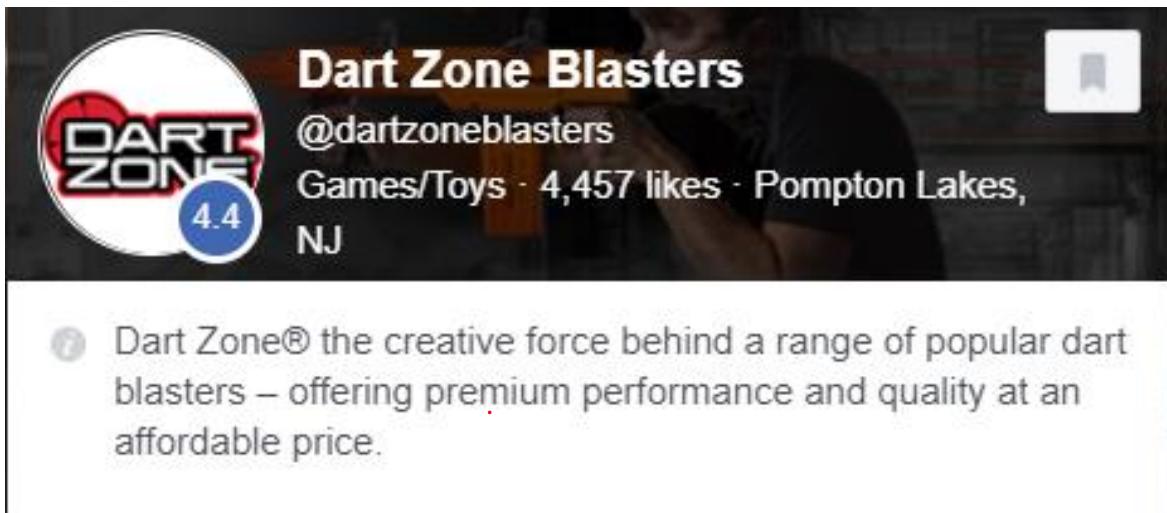


Figure #34: The brief description of the Dart Zone company provided by Dart Zone's Facebook page

Dart Zone's website consists mostly of selling their products. They do not have any clear mission statement or description of their company as a whole [6], [7]. This company focuses mostly on advertising and selling their products.

Zuru X-shot Excel



Roll over image to zoom in

Extremely satisfied

★★★★★ | Would recommend

Krista - 1 year ago, Verified purchaser

Bought online for my son for Christmas. Was pleased with the price. Had free shipping too so that was nice. Got here the next day if I'm not mistaken. And the guns were bigger than they had appeared online which totally made me that much more excited. Going to have one happy boy Tuesday morning!

5.0 Broad age appeal
out of 5

5.0 Length of play
out of 5

5.0 Quality
out of 5

3 guests found this review helpful. Did you?

Helpful

Not helpful

Report review

★★★★★ | Would recommend

Graysonsmom - 1 year ago, Verified purchaser

Great fun and got at a great deal for Black Friday

5.0 Quality
out of 5

5.0 Broad age appeal
out of 5

5.0 Length of play
out of 5

Did you find this review helpful?

Figure #35: Zuru's X-shot Excel and customer reviews as seen on the Amazon website.

About the company



LET'S REIMAGINE

ZURU is a disruptive and award-winning company that designs, manufactures and markets innovative toys and consumer products. Inspired by kids and imaginative play, ZURU is one of the fastest growing toy companies in the world and is known for their agility, creativity and new-age manufacturing techniques. The company that started in New Zealand and is now headquartered in Hong Kong, now directly or indirectly employs more than 5,000 staff across 10 countries and distributes to most major retailers in over 120 countries. ZURU has delighted millions of families all over the world with brands such as Bunch O Balloons™, X-Shot™, Rainbocorns™, Robo Alive™, Smashers™, 5 Surprise™, Pets Alive™ and Metal Machines™ as well as through partnerships with entertainment properties, including Nickelodeon, Disney, Universal Studios and DreamWorks. With a strong commitment to the community, ZURU supports Captivating International, local China orphanages and also student development programs in Asia and in New Zealand. ZURU will continue to pave new ways for kids to play and focuses on reimagining what this looks like everyday.

Figure #36: Zuru's company logo and mission statement

Zuru makes it clear that they want to become a major company in the toy industry, and that they are growing into that role [5]. They cite growth numbers, a large product range, and partnerships that support their claim and their goal. Additionally, Zuru brands itself as an innovative company, using “new age manufacturing techniques” and “disruptive” designs [5]. The company website makes it clear that they look to directly compete with Nerf.

Adventure Force Destroyer

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⊕



★★★★★ [9 reviews](#)

We aim to show you accurate product information. Manufacturers, suppliers and others provide what you see here, and we have not verified it. [See our disclaimer](#)

Treat your kid to an Adventure Force Destroyer foam dart blaster and watch them wage a dart war with friends. Designed for use by ages 8 and up, the Destroyer dart blaster is a super-fun addition to any toy collection, and is sure to provide countless hours of battle. This 25-piece set has everything you need to practice your aim and perfect your battle skills. With a 6-dart capacity, 90-ft range, and a vibrant, eye-catching design, the Destroyer is sure to be a hit with kids of all ages. The set includes 24 reusable foam darts that are compatible with all Adventure Force dart blasters and most standard NERF blasters. For some active and dynamic fun, pick up the Adventure Force Destroyer blaster today and see how much fun shooting darts can be!

- Treat your little one to a fun and dynamic playset to enjoy at home
- Complete set is vibrantly colored and eye-catching with a colorful design
- 25-piece set includes Destroyer Foam Dart Blaster and 24 darts
- Darts can fly up to 90 feet in distance for far-shooting fun
- All darts are compatible with all Adventure Force Blasters and most standard NERF blasters
- Ideal addition to any home's playroom, kid's bedroom or elsewhere
- Designed for use by children ages 8 and up

★★★★★

Great Blaster

I spent 30 minutes in the dart gun aisle pulling back every blaster to hopefully find one that my kiddos could pull back on their own. These had the lightest pull, and were priced right. We bought 6 and 400 extra darts for an upcoming "Nerf war" at a family Christmas party. While the Christmas party has not yet happened, we had to thoroughly test out our gear before we threw it into the stress of battle. The verdict is that these are a great buy. My 5 y/o (our youngest combatant) can pull back the blaster all by herself, without strain. They all shoot fairly accurately and have plenty of zip. I would definitely recommend eye protection for all and maybe an extra layer for more sensitive players. Overall, you can't go wrong with these blasters, especially for the price.

Figure #37: Adventure Force Destroyer and customer reviews

Adventure Force: About the company

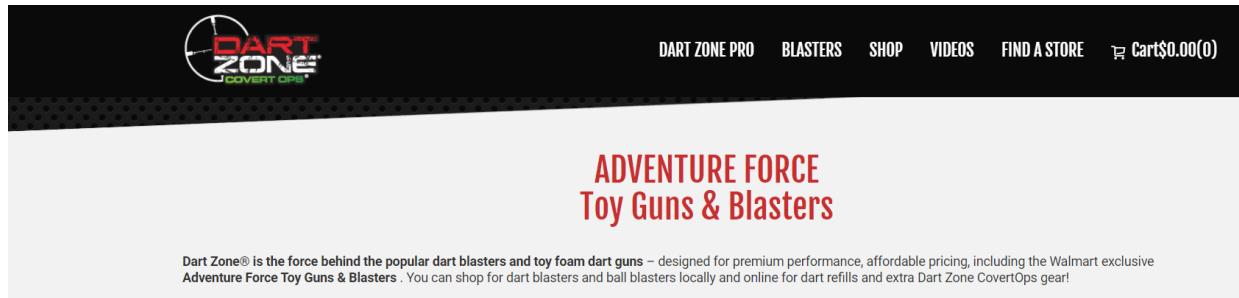


Figure #38: A brief description of the Adventure Force brand provided by Dart Zone.

Adventure Force is a line of dart guns made under the company Dart Zone, who manufactures the BlitzFire as well, one of the other competitors identified [7]. As is the case with the BlitzFire, very little is known about the mission or values of the Dart Zone company, and it is apparent that a majority of the effort goes into advertising and marketing.

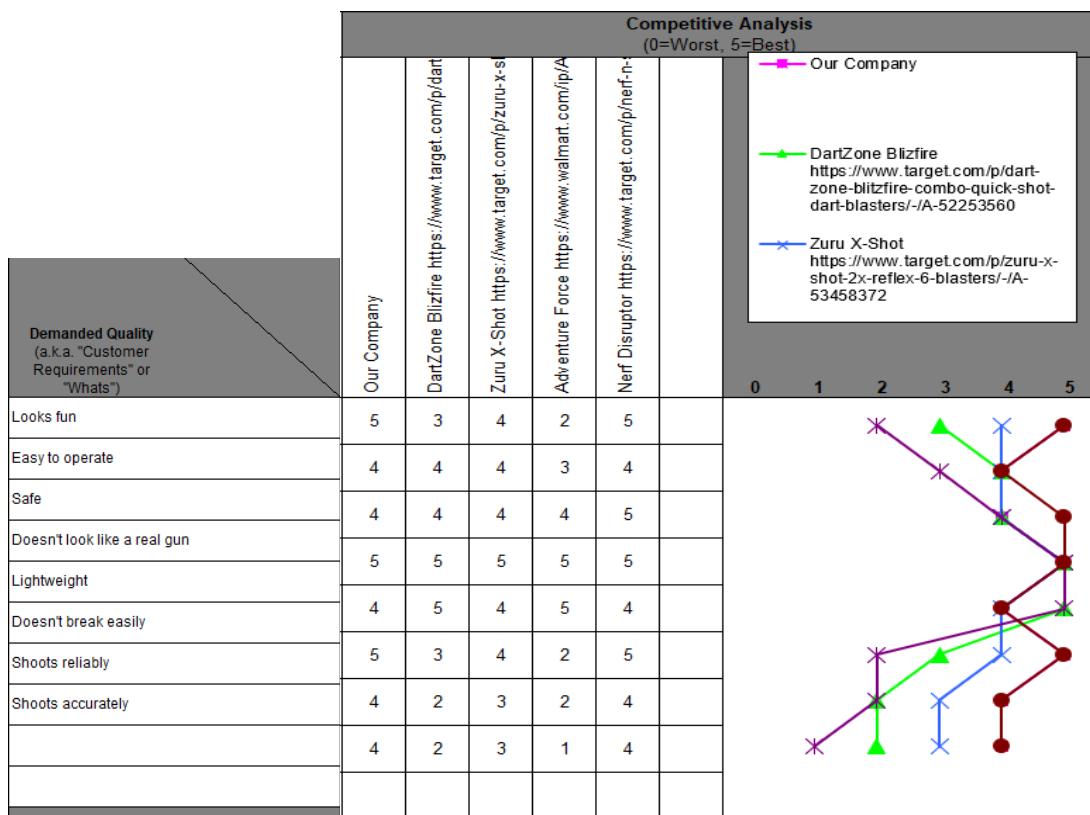


Figure #39: Competing products and how they rank with each demanded customer quality.

A way effectively to analyze the competitiveness of the Nerf Product is to use the matrix pictured above. These are elements taken from a larger Quality Function Development (QFD) matrix, that is further utilized in the Product Improvement section. The rows on the left identify the requirements of the customer, and each column on the right represents each competitor and how well the requirements were fulfilled, ranked on a scale from 1-5 (5 being perfect). When comparing the Nerf to other brand competition, our product has a higher average score across the board for the customer needs, which shows why the Nerf brand has become synonymous with dart guns. To further compare the Nerf blaster to its competitors, each customer requirement can be looked at closer:

Looks fun – The competition fulfills this quality but not as well as our product. Each competitor's product has multiple colors and contours to make the toy appealing, but the colors are not as vivid and the shapes do not resemble otherworldly or futuristic weapons as well as our product does [2], [3], [4].

Easy to operate – The competition is at the same level with this quality. From the toy's descriptions, each competitive produce requires less than 10 pounds of force to operate, and has simple mechanisms to load and cock the toy guns.

Safe – The competition is at the same level with this quality. Each competitor's toy shoots soft foam and rubber projectiles at a speed that could not injure anybody unless they were hit directly in the eye.

Does not look like a real gun – The competition is at the same level with this quality. Each competing product has enough color combinations and has a strange enough shape to make sure that they are not mistaken for real weapons [2], [3], [4].

Lightweight – The competition is at the same level with this quality. Each competitor's product is made of plastic and weighs less than 2 pounds, which is the same as our product [1], [2], [3], [4].

Does not break easily – The competition does not fulfill this quality as well as our product does. Our product can be dropped repeatedly from a height of 4 feet, while customer reviews reveal that the Adventure Force Destroyer and the Dart Zone BlitzFire are made of cheap thin plastic and sometimes break when dropped from around 4 feet [2], [3].

Shoots reliably – The competition is at the same level with this quality. Reviews of the competing toys reveal that each toy gun loads and shoots reliably when the foam darts are inserted correctly and are not bent out of shape [2], [3], [4].

Shoots accurately – The competition does not fulfill this quality as well as our product does. Customer reviews reveal that the competition's products do not shoot as far and as accurately as our product [2], [3], [4].

Alternatively, a decision matrix can be made to provide another tool for analyzing competitors.

Alternatives		Nerf Gun	Zuru X Shot	Dartzone Blitzzfire	Adventure force (range destroyer)		
Criteria	Wt.						
Accuracy	5.0	4	4	4	3		
Range	5.0	5	5	4	4		
Reliability	4.0	5	5	5	5		
Ease of use	3.0	5	5	3	2		
Safety	2.0	3	3	2	2		
Dart capacity	4.0	2	2	2	2		
Looks appealing	3.0	5	4	3	2		
Ease of transport	2.0	5	5	5	5		
Cost	2.0	3	4	4	5		
Weighted Scores		125	124	108	99		

Which Dart gun is the best?
There are many different types of dart guns, all have their strengths and weaknesses but the goal for this team is to find the best one, respectively, and to quantify the abilities of each device.

Criteria	Definition
Accuracy	The dart gun is able to land shots in a 1ft x 1ft square from 25ft away, 1 point for each shot made out of 5.
Range	The total range output of the gun, averaged from 5 shots. 1 point for every 5 feet above 50
Reliability	The gun functions as expected without jams or misfires, -1 for every jam/ misfire out of 10 shots
Ease of use	The cocking mechanism is easy to pull back, and the gun is easy to load. Time is measured for loading and relative force for slide.
Safety	The gun doesn't have any pinch points, or sharp edges if fallen on or thrown. Minus 1 point for each issue.
Dart capacity	The dart gun can hold a reasonable amount of ammunition without reloading. +1 point for every 5 darts above 1.
Looks appealing	The dart gun looks "cool", with colors that don't look too childish and has a realistic design. Ranked according to the opinion of a child
Ease of transport	The ability to bring the gun with the user easily, without disassembly. 5 for extremely easy, 1 for extremely difficult.
Cost	The gun is affordable for all users, -1 point for every 5 dollars that each gun costs.

Note on calculation
The formula for weighted scores uses a Sumproduct formula and has conditional formatting applied. Please check that the formula and conditional formatting includes the correct cell ranges if you add or remove any rows or columns.

Figure #40: A decision matrix used to analyze our competitors.

The decision matrix is similar to the matrix taken from the QFD, however it weights the importance of each customer requirement to transform them into a quantifiable item. From there, the weight can be multiplied by the effectiveness to generate an overall score for each product, that can then be ranked. According to the decision matrix above, the Nerf gun is the best choice for consumers, although it was closely followed by the Zuru X shot. All 4 guns were very close in most categories, but according to customer reviews there were a few flaws with some of the lower rated ones. These flaws included the products jamming easily, being difficult to load, and shooting inaccurately [2], [3], [4].

The two matrices included above present customer needs in a quantifiable way, and online reviews and user experience allows us to measure the effectiveness of each rival product. In both the QFD matrix and decision matrix, the Nerf Blaster was found to be the best product. Nerf could be considered a household name, so it makes sense that the quantified data presents Nerf as the top choice.

Product Improvement

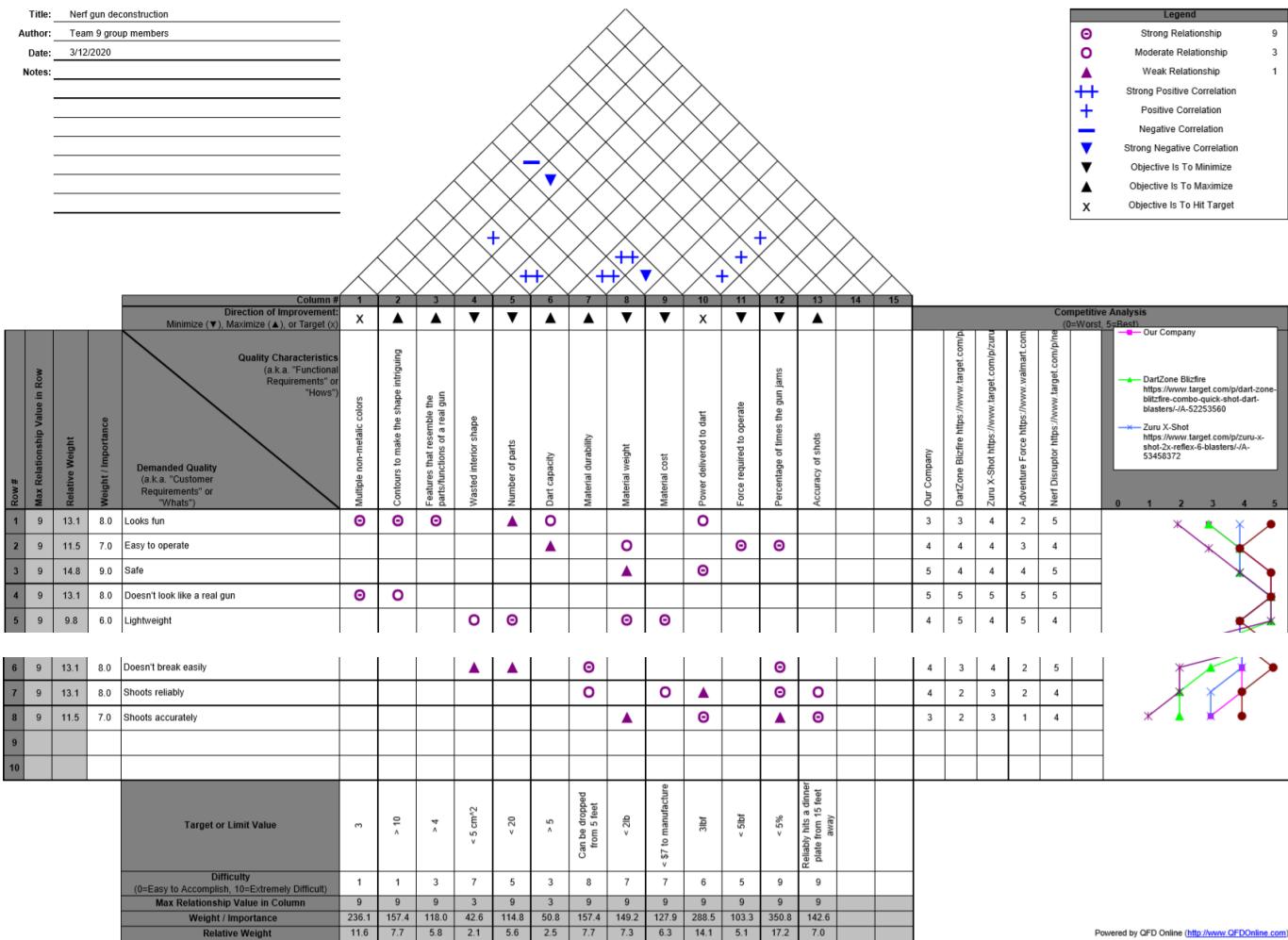


Figure #41: The QFD chart used by our group.

Customers & Their Needs

	Parents	Kids
Looks fun (Second most important because it will help sell them)	Want their kids to be excited to get a new toy	Needs it to look fun to make them choose to play with it over their other toys
Easy to operate (Third most important because the kid will be more likely to continue playing with it)	Parents need to be able to figure out the complicated new toys so they can play with their kids and teach them how to use it.	Makes it easier to play with, making them more likely to use it more often & possibly want more Nerf guns
Safe (Most importance because kids getting hurt could lead to lawsuits)	Do not want their kid to hurt themselves or others when playing with it	Kids do not like getting hurt either; Nerf guns are designed to be toys and not torture devices.
Does not look like a real gun (Second most important because it should be easily distinguishable as a toy)	Do not want the kid to associate Nerf violence with real violence & do not want to scare other parents or law enforcement	Looks "cool" and has futuristic elements that make the gun look better than real guns in the eye of a child.
Lightweight (Least importance because minor changes in weight will not affect the overall 'playability' of the toy)	Parent's want the gun to be lightweight so that the kids cannot hurt themselves or other objects as much.	Makes it more accessible to play with at any age. Also increases the duration that kids can play with the product
Does not break easily (Second most important because it will build customer brand loyalty)	Do not want to have to buy another one soon after purchasing the first one	Do not want it to break so they can keep playing with it
Shoots reliably (Second most important because the kids will enjoy it and ask their parents for more)	When a kid shoots a parent, parents want to be able to shoot them back reliably. It also prevents kids from bugging parents with guns needing to be fixed every 3 minutes	Increases enjoyment factor, and decreases the time needed to fix the gun, the kid does not want to be in a nerf battle with a jammed gun
Shoots accurately (Third most important because it will increase the kids' enjoyment if they can shoot their friends with it, but it is not as important as reliable shooting)	Parents want the gun to shoot accurately so that the gun can be used to shoot cats or dogs when they misbehave	Increases enjoyment factor, a kid wants to hit what they are aiming at and not their dad standing behind their sister

Who

Kids age 5-15, parents of these kids, grandparents and other extended family who might purchase Nerf guns as gifts for children. Teenagers and adults can also use Nerf products, but the vast majority of Nerf customers are children. For this reason, we chose to focus on designing these products to fit the needs of children.

Customer requirements

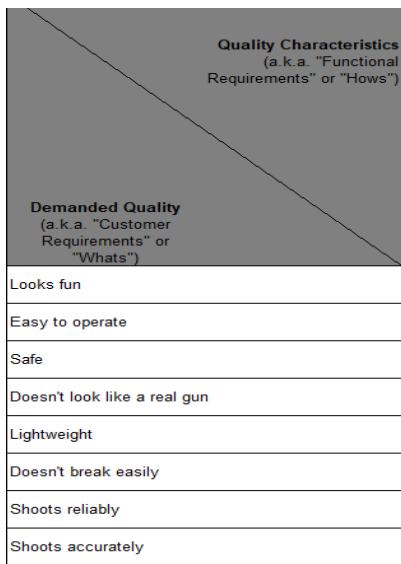


Figure #42: The customers demanded qualities.

The customer requirements comprise of, but are not limited to the following:

- Looking fun
- Easy to operate
- Safe
- Doesn't look like a real gun
- Lightweight
- Doesn't break easily
- Shoots reliably
- Shoots accurately

Most of these requirements are stemmed from children's needs, but some, such as being safe and durable pertain to the children as well as their parents or supervisors.

How vs. How

Nerf has used many different design aspects that also influence other desires, as shown by many strong correlations in the top of the QFD. This shows that they are efficiently designing their product and are accomplishing all the desired goals.

What vs. How

	X	▲	▼	▲	▼	▲	▲	▼	▼	X	▼	▼	▲
Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Multiple non-metallic colors	Contours to make the shape intriguing	Features that resemble the parts/functions of a real gun	Wasted interior shape	Number of parts	Dart capacity	Material durability	Material weight	Material cost	Power delivered to dart	Force required to operate	Percentage of times the gun jams	Accuracy of shots
Looks fun	○	○	○	▲	○				○				
Easy to operate				▲		○				○	○		
Safe						▲							
Doesn't look like a real gun	○	○			○	○							
Lightweight			○	○			○	○					
Doesn't break easily		▲	▲		○							○	
Shoots reliably					○		○	▲			○	○	
Shoots accurately					▲		○	▲			○	○	

Figure #43: Demanded qualities versus quality characteristics, and how each characteristic affects the demanded qualities.

Nerf has done a great job at designing their product to meet all the needs required by their customers, this is seen by the fact that all the categories have multiple relationships, and most have multiple strong relationships, which mean each goal is covered by multiple tasks.

How Much

	1	2	3	4	5	6	7	8	9	10	11	12	13
Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Multiple non-metallic colors	Contours to make the shape intriguing	Features that resemble the parts/functions of a real gun	Wasted interior shape	Number of parts	Dart capacity	Material durability	Material weight	Material cost	Power delivered to dart	Force required to operate	Percentage of times the gun jams	Accuracy of shots
Looks fun	○	○	○	▲	○				○				
Easy to operate				▲		○				○	○		
Safe						▲							
Doesn't look like a real gun	○	○			○	○							
Lightweight		○	○			○	○						
Doesn't break easily	▲	▲		○								○	
Shoots reliably				○		○	▲		○		○	○	
Shoots accurately					▲		○		▲		○	○	
Target or Limit Value	3		> 10	> 4	< 5 mm ²	< 20	> 5	Can be stored from < 20°	< \$7 to manufacture	380F	< 10J	< 5%	Reaches the greatest distance from 15 feet away
Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	1	1	3	7	5	3	8	7	7	6	5	9	9
Max Relationship Value in Column	9	9	9	3	9	3	9	9	9	9	9	9	9
Weight / Importance	236.1	157.4	118.0	42.6	114.8	50.8	157.4	149.2	127.9	289.5	103.3	350.8	142.6
Relative Weight	11.6	7.7	5.8	2.1	5.6	2.5	7.7	7.3	6.3	14.1	5.1	17.2	7.0

Figure #44: The target or limit values for each characteristic.

The numerical analysis of the relative weights of each task is evaluated to conclude that the most important item is the number of times the gun jams. If the nerf gun jams frequently, it is rendered nearly useless, unless the user decides to throw the entire gun at their enemies. This result doesn't leave anyone happy, and would result in many unsatisfied customers.

The next most important task is increasing the power delivered to the dart. We aim to deliver 3 pounds force to the darts and have them shoot at least 80 feet consistently. A more powerful toy gun makes playing with it more fun as kids can shoot targets or their friends from farther away, thus making larger scale games with more children possible.

The third most important task is incorporating multiple non-metallic colors into the exterior of the toy gun. We shoot for at least three, as multiple bright colors draw attention to the product and make sure that it is recognized as a toy and not a dangerous weapon.

Numerical analysis showed that the next most important task is having exterior contours on the toy to make the shape intriguing. We aim for at least 10. These contours can make the toy gun look futuristic, or similar to what kids see in action movies or videogames. A simple shape will not inspire any awe or creativity in the children using the gun.

Material durability was the next most important category. We strive to make our product able to be dropped from 5 feet and not break. A toy that breaks easily is no fun as the games have to halt to repair the gun or go buy a new one.

The sixth most important quality of the toy is material weight. We have attempted to make the gun weigh less than two pounds. A lightweight gun will increase the length of time children can play with the gun before becoming fatigued.

The next most important category is the accuracy of the shots. An accurate shot from a toy gun is fun because kids can set up targets to hit, and when they hit the targets they feel a sense of accomplishment. We aim to make our product be able to consistently hit a target the size of a dinner plate from 15 feet away.

Next comes the cost to manufacture each toy. We want the cost of manufacturing to be less than \$7 for each product. This way we can make a profit by selling these guns, and fund research and development that will go towards creating new and improved products.

The tenth most important quality is having features that resemble the parts and functions of a real gun. We want our product to have at least 4 features that replicate the functions of a real gun, while still appearing to be a toy. Shooting guns is exciting, and while it is dangerous for children to do this, our product gives them a safe way to feel this same excitement.

The number of parts is the next most important category. We want to limit the number of parts to 20, since having more parts makes the gun more expensive to manufacture and increases the chance that one of the parts will malfunction or break.

The second to least most important category is the dart capacity of our product. We want the toy gun to hold at least 5 darts. A higher dart capacity will result in less time needed to stop and reload the toy gun. We want to reduce any time that kids need to stop playing, so reducing the time needed to reload the toy will help us achieve this goal.

Numerical analysis determined that the least important category out of the ones we have chosen is wasted interior space. We strive to minimize this quality, and at least have the wasted interior space be less than 5 cubic centimeters. Less wasted space on the interior of the gun means that the toys can be made more compact, therefore using less material and making it cheaper to manufacture. Having the parts close together will also decrease the chance that parts can bend or break when the toy gun is dropped, since there is less space for the parts to move during any impact.

Who vs. What

Looks fun – Important to the children or anyone who uses the Nerf gun for fun

Easy to operate – Important to the user of the Nerf gun as continued use with difficult operation would get frustrating

Safe – Important to the kids using the Nerf guns, but more important to their parents or anyone who is supervising the children

Does not look like a real gun – Important to those around the children so that they don't get scared. Also important to the children so that they don't mistakenly get in trouble for using real guns

Lightweight – Important to the user as continued use of a heavy Nerf gun would become tiring

Does not break easily – Important to the kids using the Nerf gun as they wouldn't want the gun to break if it was dropped. Also important to the parents as they would not want to buy new Nerf guns if the original ones break often.

Shoots reliably – Important to the kids using the Nerf gun as an unreliable gun momentarily stops the fun when it jams or doesn't perform as expected.

Shoots accurately – Important to the children using the Nerf gun as it is more fun to play with a toy that functions as it is supposed to, and a gun is supposed to shoot where you point it.

Ranking importance

1. Safety is most important because children and their parents or any guardians are very negatively affected if the toy gun harms people. Also, our company could be sued if it seriously injures anybody.
2. The durability of the gun is second most important as nobody wants a toy to break when dropped. It immediately stops the kids from having fun, and costs the parents money as they have to go out and buy a new product.
3. The fact that the toy does not look like a real gun is very important, as the consequences for the toy being mistaken for a real weapon could threaten human life, and could cause an immense amount of grief if children are harmed for mistakenly using a real weapon.
4. Shooting reliably. This is important as a jammed gun cannot be played with. Requiring constant maintenance to keep the toy functioning is too much effort for children to give while still having fun playing with our product.
5. Looking fun is fifth most important as catching the attention of kids or parents who want to buy the gun for their children is necessary in order to sell our product.
6. The ease of operation is important as the target user of our product is children, and they lack hand eye coordination and the focus necessary to operate something that is difficult to use.
7. The weight of our product is important as a lightweight toy can be used for a long period of time without causing the user to become fatigued and need a break from playing with the toy gun
8. The accuracy of the shots is the least important requirement of the ones we have selected. An accurate gun is more fun as one can aim and hit targets accurately, but kids can still have fun shooting our toy gun without hitting anything. Less accuracy may increase the amount of time that kids play with our product, as they will spend more time trying to hit a target instead of hitting it the first time and being done with that goal or situation.

Customer Requirements	
Design Organization: Winning Team	Date: 3/12/2020
Product: Nerf Gun	
Who: Children and parents or extended family of children	
<p>1. Who are the primary users of the product? The Primary users of this product are children, ages 8 and up for the basic products and 14 and up for the more high-powered toys.</p> <p>2. What skills or education will the primary users have? The primary users possess the ability to load the toy gun, pull back the slide action of the device, aim at desired target, and pull the trigger to hit such item. They also generally require the ability to avoid getting hit by other darts and building forts or bases that give allow for safe play. No education is required to use this product, however basic components of safety are necessary to understand so that nobody is injured by the product.</p> <p>3. Describe any primary user physical conditions that affect the design of the product. The product must be designed with a relatively simple design, since most the users will be children. Any jams caused in the firing action must be easy to clear, and the device itself must be easy to load, cock, and fire. This ease can be quantified by the number of steps required.</p> <p>4. Who will purchase the product? Parents or extended family will purchase this product for their children to use, as well as the occasional use by the parent or other adults when involved in a nerf gun war. Children will also purchase this product for their own use.</p> <p>5. Who else is a stakeholder in the design of the product? The other stakeholders for the design in this product are parents; since they want the toy to remain safe and still be fun, as well as children; since they want the toy to be the most powerful, accurate, and easy to use as possible.</p> <p>6. Describe any cultural practices or customs related to the product. For this product to be the most fun, the typical practice for children and adults alike is to have a dart gun war, also simply called a Nerf war. This practice involves getting into teams and having a goal such as shooting the other players with your darts and capturing the opposing team's flag. The dart gun war can be whatever the creator wants it to be, and this allows for lots of creativity with children to have the most fun possible.</p>	

7. How much is the purchaser willing to pay for the product?

The customer is generally willing to pay anywhere from \$5 to \$20 for this product, however there are other types of Nerf brand guns that can cost over \$100 depending on their features.

8. How much is the user willing to pay to operate the product?

This product is initially free to operate, however as time goes on it is inevitable that the user will lose darts, which generally cost about \$10 for 30, so this is the minimum cost to operate it.

9. How much is the user willing to pay to maintain the product?

The user will not want to maintain this product. If it stops working properly, it is not designed to be serviceable so the cost of maintenance is \$0.

How:**1. For what specific purposes will the product be used?**

The product will be used to entertain children and adults, to give them something fun to do during their free time.

2. What is the current process used?

The current process of using the product is to load it with darts and shoot at whatever the customers desires.

3. How often will it be used?

The product will typically be used one to two times a week.

4. How long will it be used each time?

The product will be used for an average of about an hour each use.

5. Describe the quality expected by the user.

The user expects the device to work as intended, without jams or misfires, due to the nature of the game. Any issues with the gun itself will cause a negative opinion to be had.

6. How far, how often and in what way will product be transported?

The product typically isn't transported far by the customer, although during transport no additional padding or packing can be expected. The typical mode of transport is to throw the gun in a backpack or similar carrying device, where it gets taken with the user to wherever the dart gun war will take place.

Where:

1. Describe the surroundings for normal use.

The nerf gun is typically used indoors, in homes or apartments wherever there is room to make multiple bases to conduct a dart gun war. The product can also be used outside, in a large open outdoor space or in forested areas, where cover can be found to avoid the shots of your enemy players.

2. Describe the noise, weather, temperature or other environmental factors that may affect the design of the product.

The device should be able to withstand variable temperatures, from the typical coldest of 0 degrees C or the hottest of 50 degrees C.

3. Describe any size or weight limitations.

The device should be easily wielded by a child, but still needs to be able to fit in the hand of an adult as well, so that all ages can use the product. The nerf gun should also be able to be easily transported, so that the user can bring it to a friends house or other area to use the device.

4. Describe the aesthetics of the use surroundings.

The use surroundings are typically indoors, where forts can be built, in concrete basements or attics at the most extreme.

5. Describe the energy available when the product is in use.

The product only requires the energy to pull the slide back, and outputs an energy similar to this with the velocity of the dart that is propelled by the air cylinder on the inside of the gun.

Customer Requirements (include how well the product fulfills each requirement):

1. Looking fun (5/5)
2. Easy to operate (4/5)
3. Safe (4/5)
4. Doesn't look like a real gun (4/5)
5. Lightweight (4/5)
6. Doesn't break easily (5/5)
7. Shoots reliably (4/5)
8. Shoots accurately (4/5)

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

1. Dartzone Blitzfire
2. Adventure force range destroyer
3. Zuru X-Shot

Team member: Nolan	Team member: Trevor
Team member: Noah	Prepared by: Nolan
Team member: Ryan	Checked by: Noah
Team member: Flynn	Approved by: Trevor

Proposed Improvements for the Nerf Disruptor Toy:

1. Stiffer Spring

This modification involves stiffening the spring that powers the inner piston which compresses the air and propels the dart. This would allow for a faster initial speed and therefore a longer range and better accuracy. The only major trade off of this component is that the slide would be harder to pull back, since the spring would be more powerful.

2. Longer Barrel with Rifling

This modification involves a longer front barrel, with rifling added to the inside. This would keep the dart straight and would also induce a spin to the projectile, allowing for a more stable flight path. This would result in a longer range and better accuracy, as well as making the gun look better since it would have a longer, “cooler” looking barrel.

3. Bigger Dart Drum

A bigger dart drum would allow for more than 6 darts to be held by the device, reducing reload time and therefore making the device easier to load. The most likely number of darts held would be 8, since this would keep the compact size and simplicity of the current model.

4. Folding Stock

A folding stock would allow for the nerf gun to be held more securely, keeping the device more stable when shooting. This would increase the accuracy, make the gun easier to use, and it would make the device look more appealing since a folding stock always looks sweet.

Drawings of Improvements:

8 Dart Drum

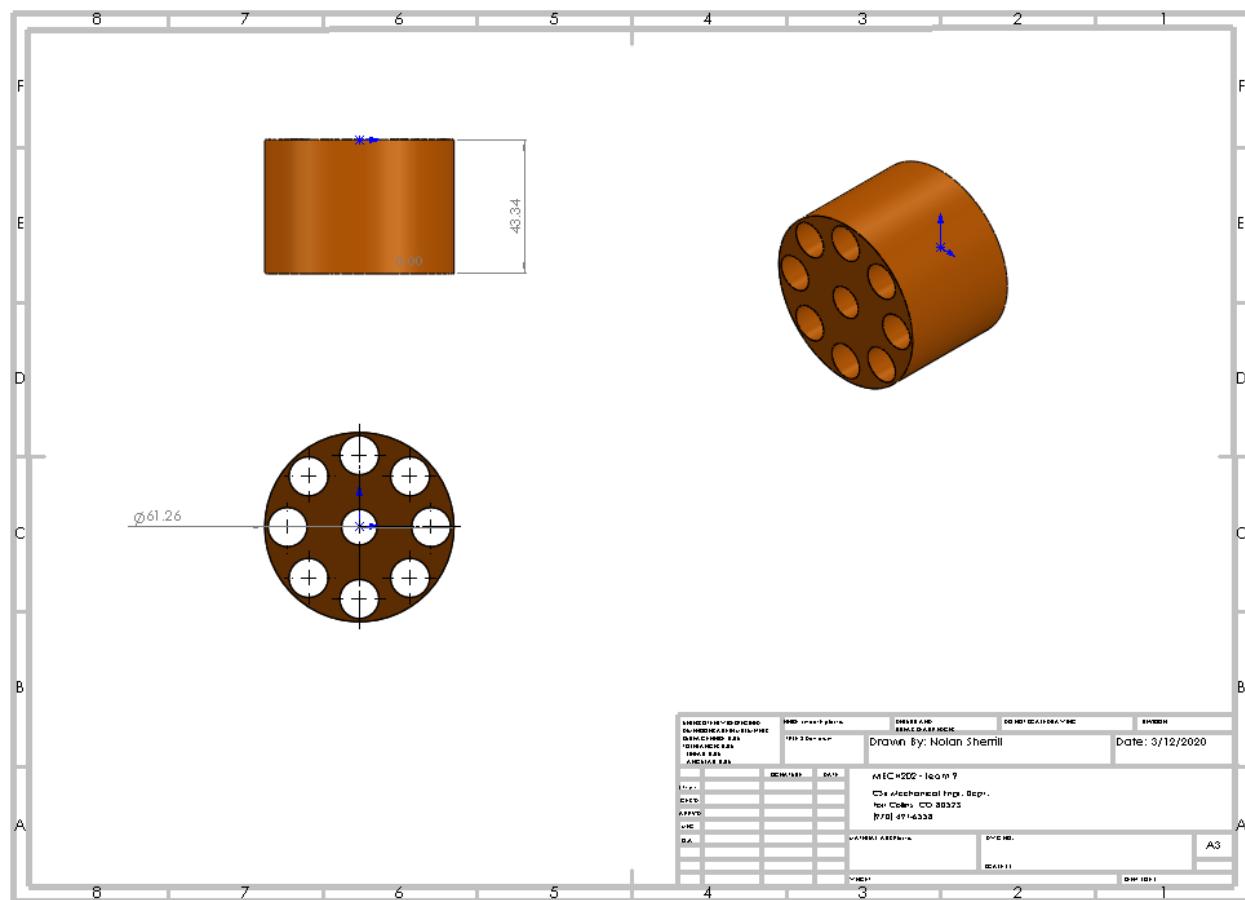


Figure #45: A proposed cylinder that would increase the dart capacity of the Nerf gun.

Extended Barrel

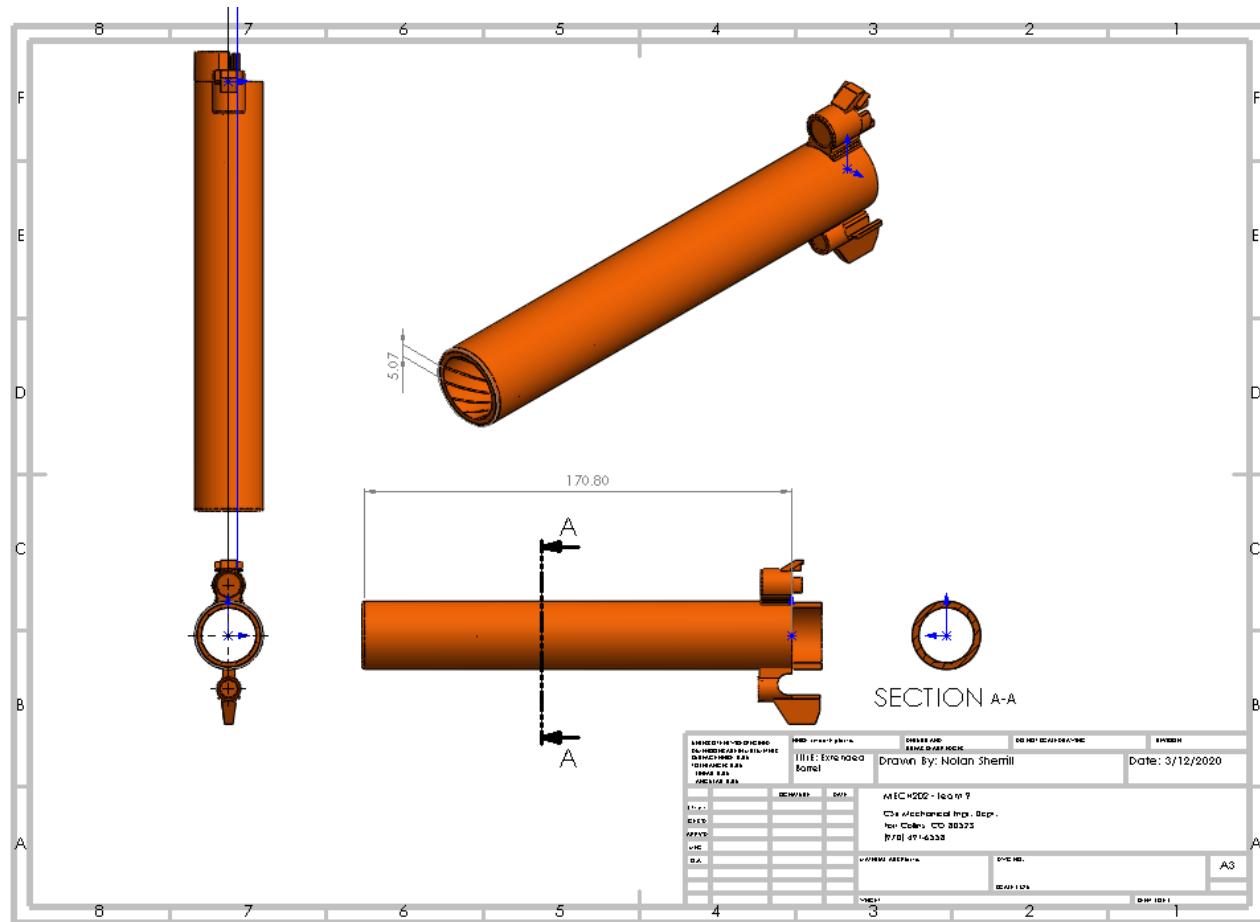


Figure #46: A proposed barrel that would increase the accuracy of the darts shot from the gun.

Stiffer Spring:

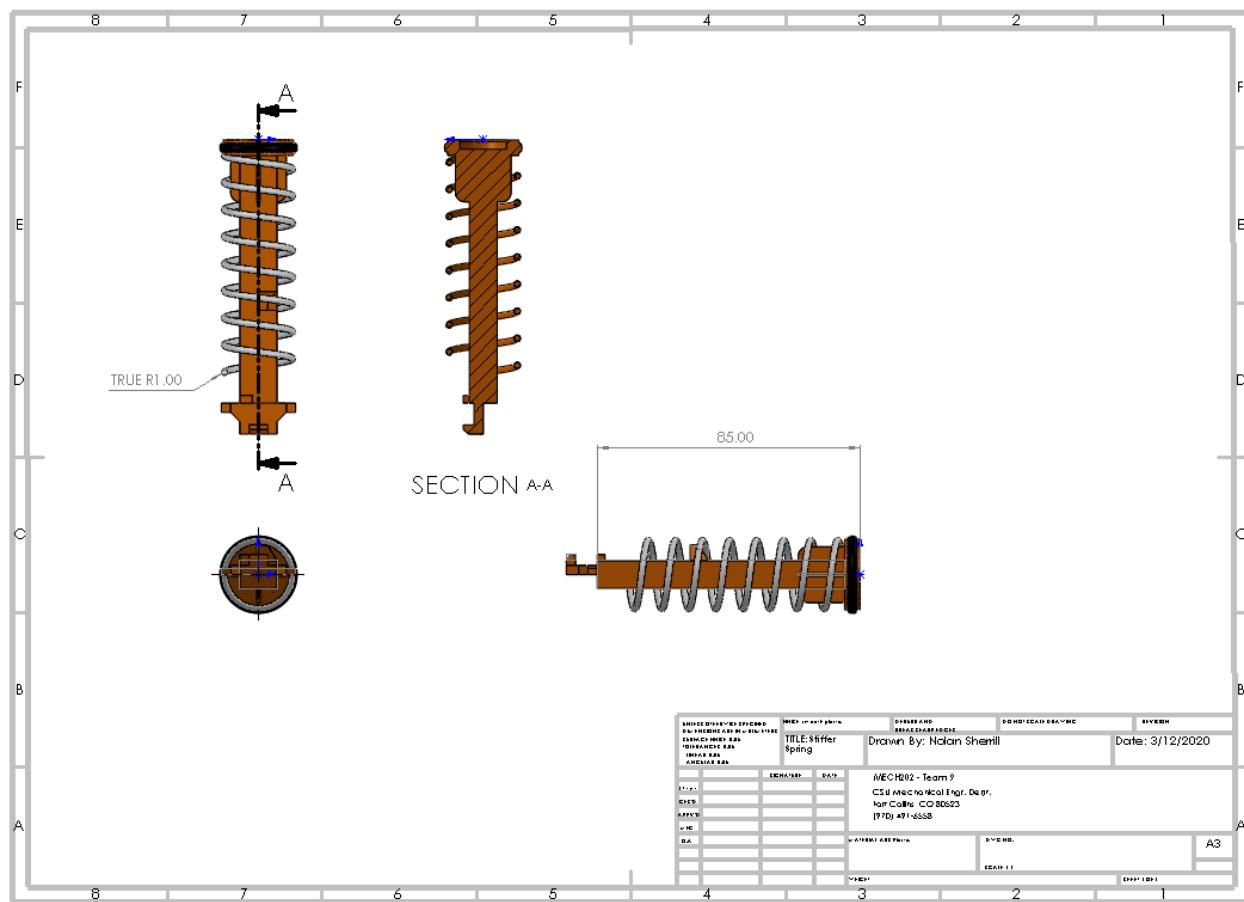


Figure #47: A proposed spring that would deliver more power to the darts being fired.

Folding Stock:

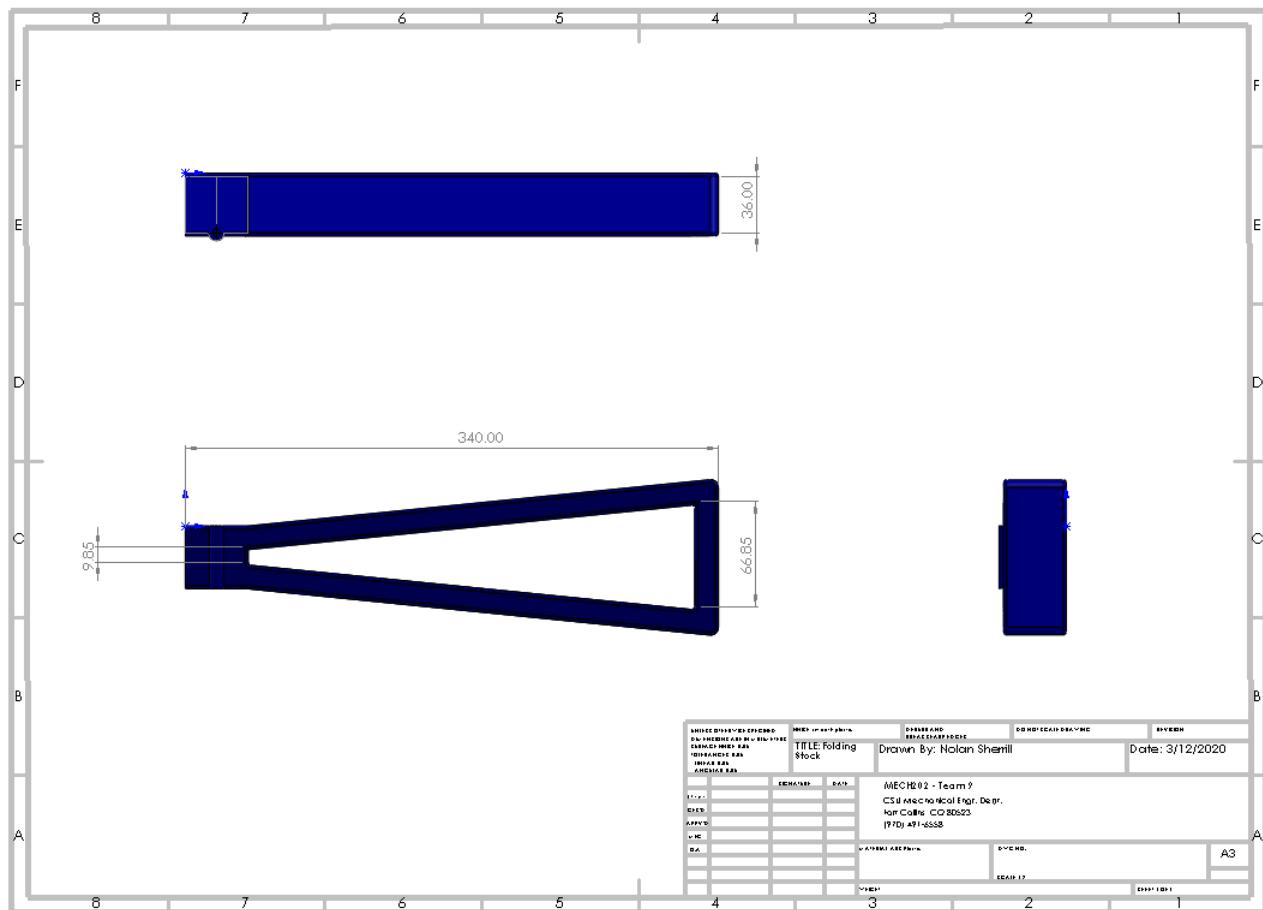


Figure #10: A proposed stock that would fold for convenience and unfold to improve the stability of the Nerf gun.

Decision Matrix for Proposed Improvements

Alternatives		Stiffer Spring	Longer barrel with rifling	Bigger dart drum	Folding stock	
Criteria	Wt.	1	2	3	4	
Accuracy	5.0	1	1	0	1	
Range	5.0	1	1	0	0	
Reliability	4.0	0	-1	0	0	
Ease of use	3.0	-1	0	1	1	
Safety	2.0	-1	0	0	-1	
Dart capacity	4.0	0	0	1	0	
Looks appealing	3.0	0	1	1	1	
Ease of transport	2.0	0	-1	-1	0	
Cost	2.0	0	-1	-1	-1	
Weighted Scores		5	5	6	7	

Which improvement should Nerd pursue with their Disruptor gun?
While the Disruptor is a great toy already, there are a few improvements that could make the gun even better, however most have trade offs. This document analyzes the strengths and weaknesses of each proposed change, using Pugh's method of +1, +0, and -1.

Criteria	Definition
Accuracy	The dart gun is able to land shots in a 1ft x 1ft square from 25ft away, 1 point for each shot made out of 5.
Range	The total range of the gun, averaged from 5 shots. 1 point for every 5 feet above 50
Reliability	The gun functions as expected without jams or misfires, -1 for every jam/ misfire out of 10 shots
Ease of use	The cocking mechanism is easy to pull back, and the gun is easy to load.
Safety	The gun doesn't have any pinch points, or sharp edges if fallen on or thrown.
Dart capacity	The dart gun can hold a resonable amount of ammunition without reloading. +1 point for every 5 darts above 1.
Looks appealing	The dart gun looks "cool", with colors that don't look too childish and has a realistic design. Ranked according to the opinion of a child
Ease of transport	The ability to bring the gun with the user easily, without dissasembly. 5 for extremely easy, 1 for extremely difficult.
Cost	The gun is affordable for all users, -1 point for every 5 dollars that each gun costs.

Note on calculation
The formula for weighted scores uses a Sumproduct formula and has conditional formatting applied. Please check that the formula and conditional formatting includes the correct cell ranges if you add or remove any rows or columns.

Figure #48: A decision matrix used to come up with improvements to the existing product.

Analysis:

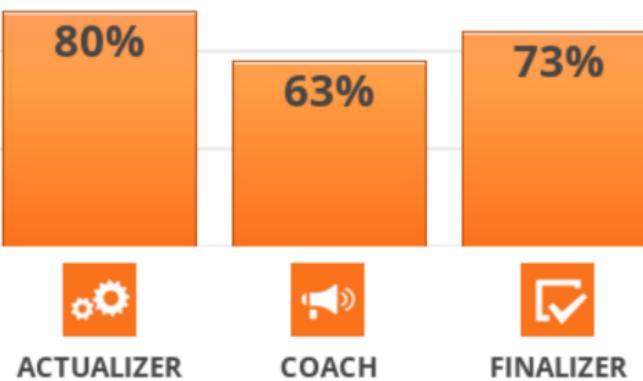
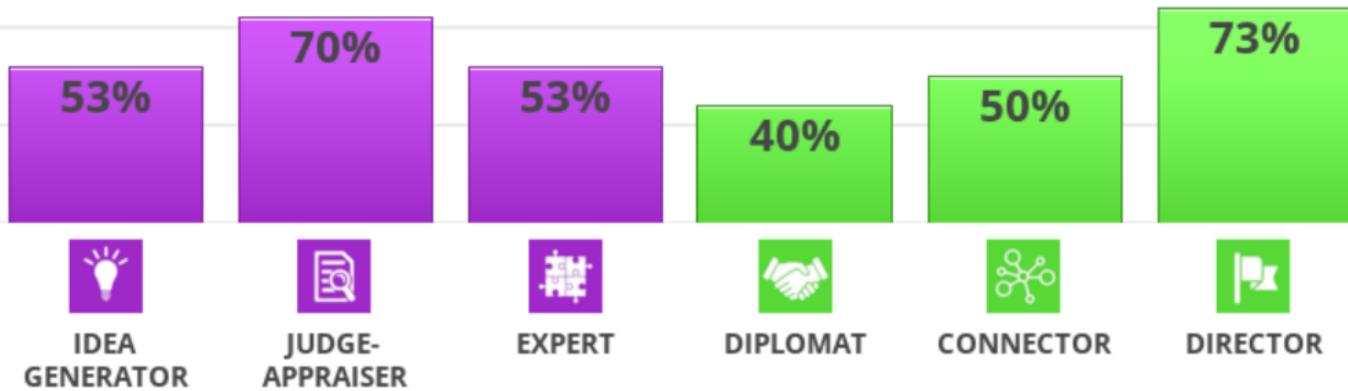
According to the decision matrix, using Pugh's method, the modification that would improve the device the most without having as many tradeoffs is a folding stock. This would allow for greater accuracy, an easier to use product, and a more appealing look. The trade-offs for this modification are a decrease in safety, since there would be an added pinch point at the hinge for the stock, and an increased cost, since more plastic would be used to make the product. All the proposed modifications are positive in result, so they are all better than the original Nerf Disruptor when combined with the weighted categories. This means that all 4 improvements would improve the gun in total and could be applied together or independently by Nerf to improve the disruptor itself or make an entirely new model of gun. The new models could advertise that they have more darts, power, accuracy, and range than their competitors, as all the competitors ranked similar to the original Nerf blaster.

Team Assessment

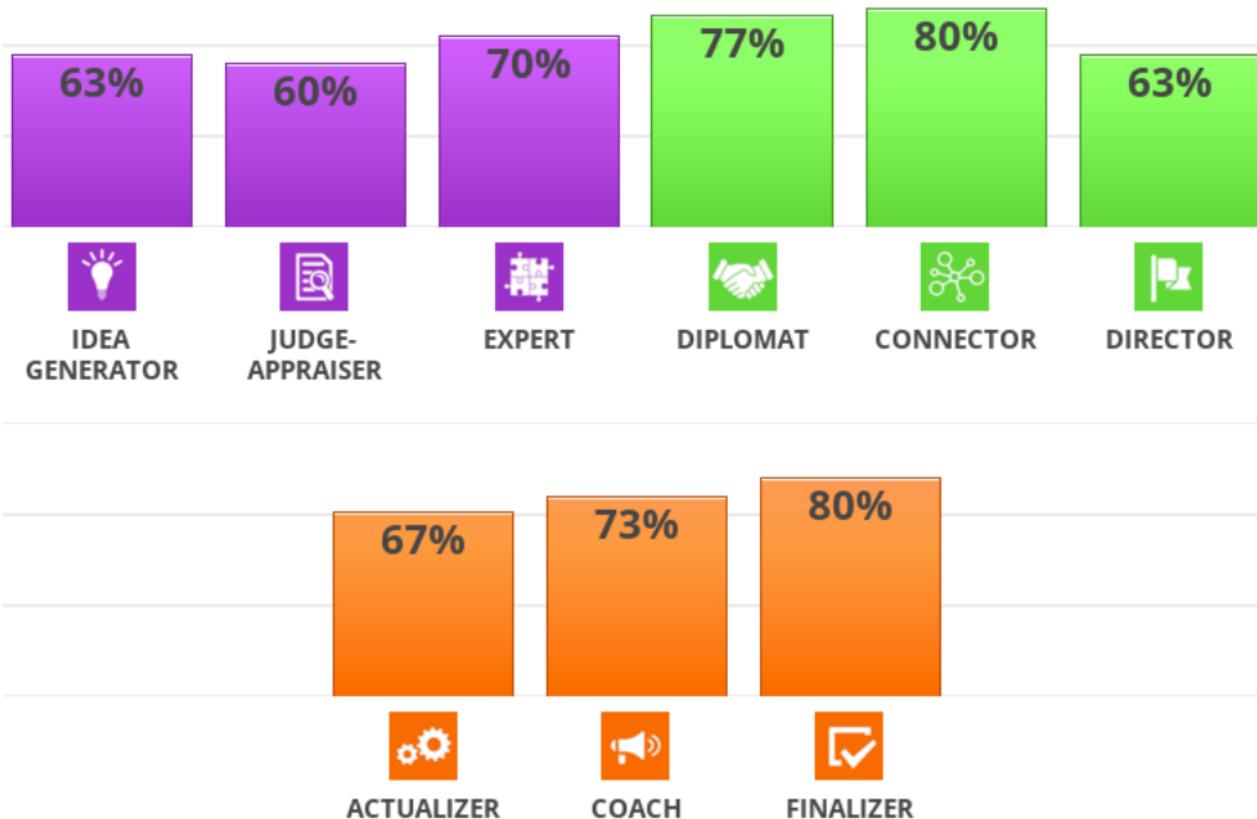
Team Contract																																															
Design Organization: Mech 202 Winning Team		Date: 2/3/2020																																													
Team Member	Roles	Signature																																													
Trevor Long	Idea Generator																																														
Nolan Sherrill	Finalizer																																														
Noah	Actualizer	Noah Schenck																																													
Flynn Yoder	Actualizer	Flynn Yoder																																													
Ryan	Diplomat	Ryan Walkowicz																																													
Team Goals		Responsible Member																																													
1. Disassemble the Nerf gun		All members																																													
2. Take Pictures of each part		All members																																													
3. Put the pictures onto a document		All members																																													
4. Describe the disassembling process on the document		All members																																													
5. Create a model of the nerf gun that could be assembled		All members																																													
6. Communicate well as a team		All members																																													
7. Develop skills in engineering design using concepts from class		All members																																													
8. Effectively delegate tasks to members in based on strengths to complete the project efficiently		All members																																													
Team Performance Expectations		<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="5" style="text-align: center;">Initial</th> </tr> <tr> <th>FY</th><th>NS</th><th>TL</th><th>RW</th><th>NS</th></tr> </thead> <tbody> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>	Initial					FY	NS	TL	RW	NS																																			
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Strategies for Conflict Resolution:																																															
<ul style="list-style-type: none"> • Talk it out • Conflict resolution center 																																															
<i>The Mechanical Design Process</i>		Copyright 2018, David G. Ullman																																													

Team Role Test

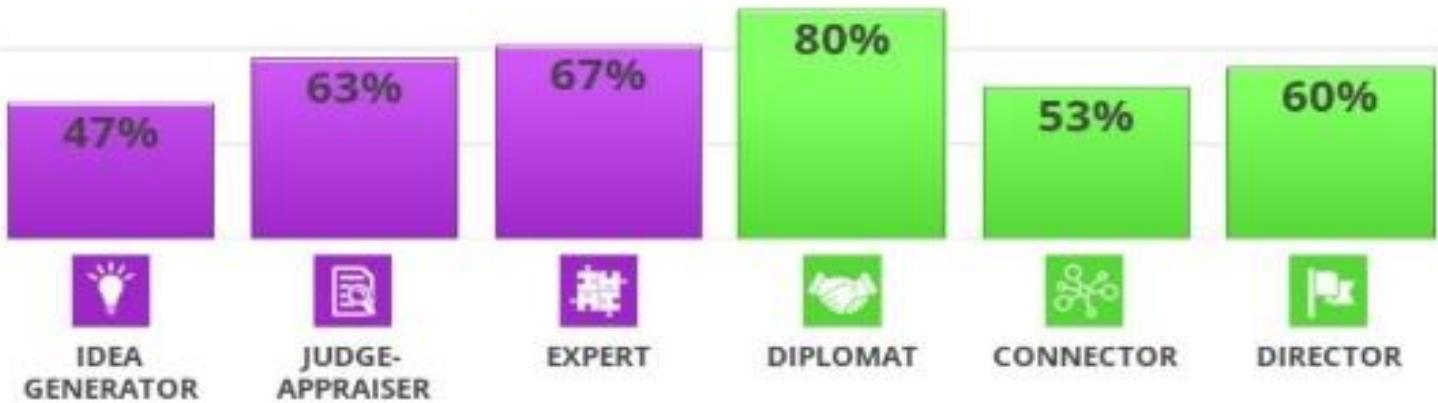
1) Nolan Sherrill:



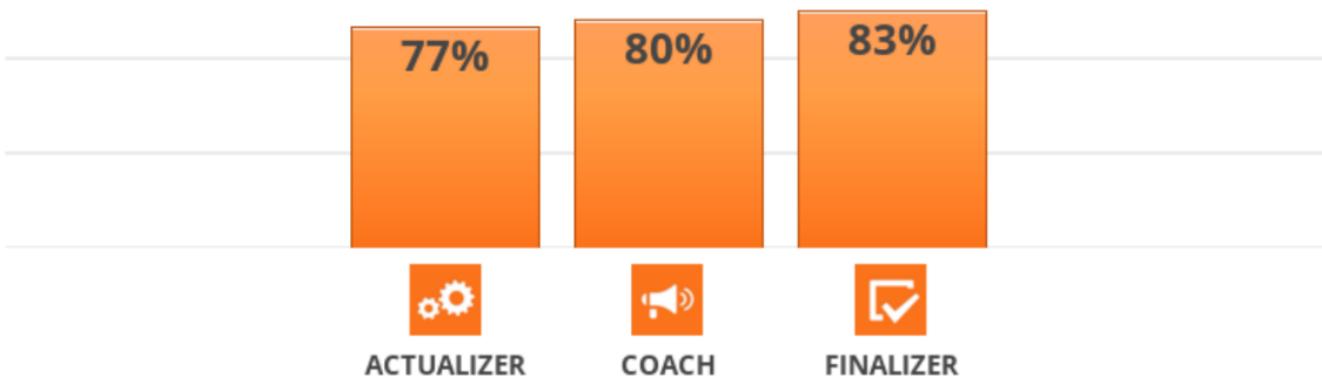
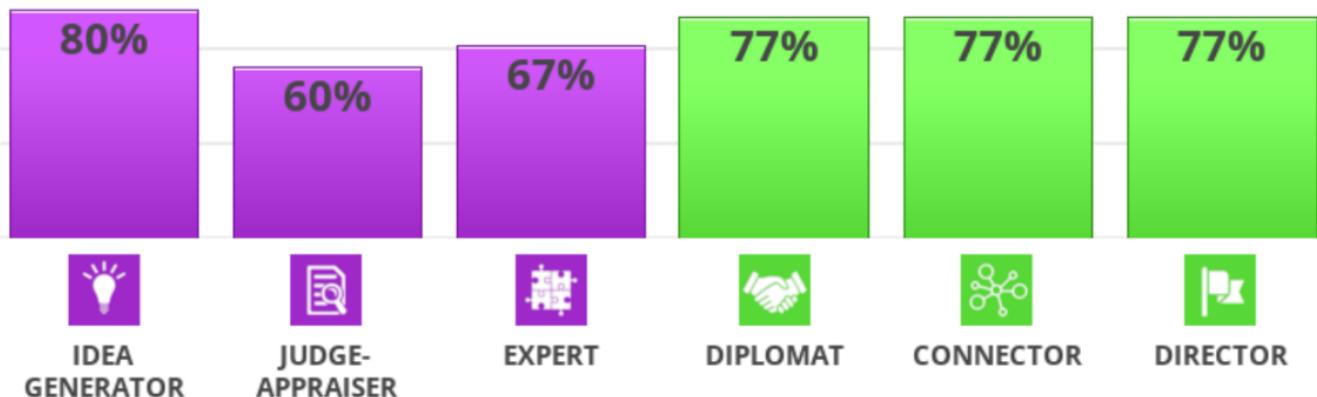
- These traits show that I work best as a connector and a finalizer. This means I am good at managing the group, getting ideas to work together and to run smoothly, and putting finishing touches on the outcome of the project; making sure everything is done right.

2) Noah Schenck:

- My results show that I am best at finalizing as well as team connections, with strong percentages in both the diplomat and connector categories. This means that throughout the project, I will ensure the team operates smoothly with minimal conflict and that agreements on issues are arrived at relatively quickly. Then, once the project wraps up, I will finalize the details, ensuring completion to the standard that we will be holding the team to as well as to the standards of the rubric to ensure the best outcome.

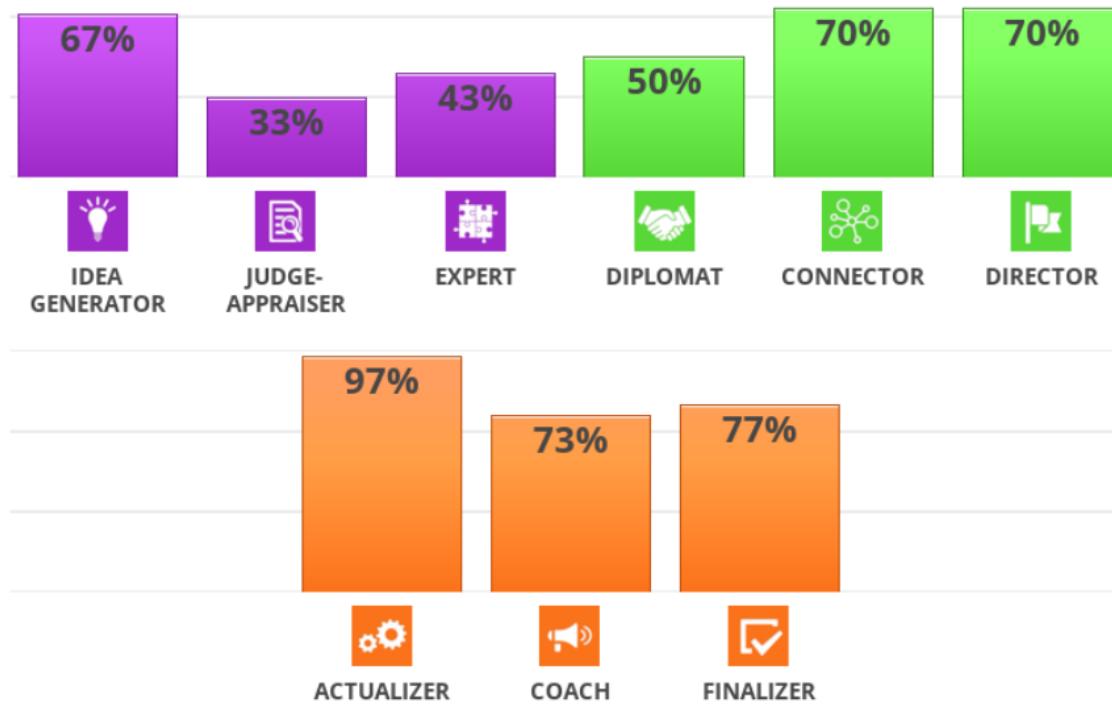
3) Ryan Walkowicz

- These results show that I am good at facilitating and contributing to discussions when problem solving. I will ensure the team is able to exchange ideas freely to make sure we are successful as possible.

4) Trevor Long:

- My top 3 roles are finalizer, coach, and idea generator. This means that I am good at coming up with ideas to solve the problem, and that when the project is getting near the end, I will be good at putting the finishing touches on it. During the project I will also excel at helping other people with difficulties and planning so that we all succeed.

5) Flynn Yoder



- My top three categories are Actualizer, Finalizer, and Coach. I should excel at instructing the group on what needs to be completed. I will also succeed in completing a lot of the work, especially with a fast approaching deadline that needs to be met. I will do well at reading over everyone's work and making any adjustments that need re-working. This will come in handy when submitting assignments. I might catch those errors that my other team members missed.

Team Health Assessment

Team Assessed: Mech 202 Winning Team

Date: 3/1/2020

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree, NA = Not Applicable

	Measure	SA	A	N	D	SD	NA
1	Team mission and purpose are clear, consistent and attainable.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	I feel that I am part of a team.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	I feel good about the team's progress	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Respect has been built within the team for diverse points of view.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Team environment is characterized by honesty, trust, mutual respect, and team work	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	The roles and work assignments are clear	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Team treats every member's ideas as having potential value	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Team encourages individual differences.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Conflicts within the team are aired and worked to resolution.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	Decisions are made with input from all in a collaborative environment.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	The environment encourages communication and does not "kill the messenger" when the news is bad.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	When one team member has a problem others jump in to help	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	Dysfunctional behavior is dealt with in an appropriate manner	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15	When someone on the team says they are going to do something, the team can count on it being done.	<input checked="" type="checkbox"/>	<input type="checkbox"/>					
16	There is no "them and us" on the team	<input checked="" type="checkbox"/>	<input type="checkbox"/>					
17	Our team cultivates a "what we can learn" attitude when things do not go as expected.	<input checked="" type="checkbox"/>	<input type="checkbox"/>					

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

Though there were no categories with Neutral (N), Disagree (D), and Strongly Disagree (SD) responses, there are a few minor improvements that could really help with our team's cohesion. The two main improvements would be to meet more in person to work on 'All Team Member' tasks as well as more clear division between tasks in the team. Our team almost never met in person due to conflicting school and work schedules, which was remedied through primary communication being diverted to our groups group-chat, but that made it a little more difficult to get a team consensus. Another improvement for our teamwork would be to divide sub-tasks on assignments prior to beginning them so that all team members have even work loads and to ensure everything is completed on time.

Assessor: Noah Schenck

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Team Health Assessment

Team Assessed: Mech 202 Winning Team

Date: 3/12/2020

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree, NA = Not Applicable

	Measure	SA	A	N	D	SD	NA
1	Team mission and purpose are clear, consistent and attainable.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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	respect, and team work						
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Remedies for improving the Neutral (N), Disagree (D) and Strongly Disagree (SD) responses:

We could meet more in person. This would cut out any errors in communication, or misinterpretations due to texting instead of speaking face to face. This would also provide a quick way for each team members input to be heard and considered. Additionally, this would make it easier for all team members to voice their opinions on how to complete each team task.

An increased sense of team roles would benefit our team. We could assign specific tasks for each team member regarding what needs to be done for each assignment. This would make sure that work is evenly distributed.

Assessor: Flynn Yoder

Team Health Assessment

Team Assessed: Mech 202 Winning Team

Date: 3/12/2020

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

No category was marked neutral or lower, however it was a little difficult to arrange in person meetings. A lot of the discussion between teammates was done online which was effective but sometimes inefficient, having to wait for responses that would have come immediately in person. Overall the team worked together well and each person was able to communicate their ideas or concerns.

Assessor: Ryan Walkowicz

The Mechanical Design Process

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Team Health Assessment

Team Assessed: Mech 202 Winning Team

Date: 3/12/2020

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	respect, and team work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Remedies for improving the Neutral (N), Disagree (D) and Strongly Disagree (SD) responses:

Assessor: Nolan Sherrill

Team Health Assessment

Team Assessed: Mech 202 Winning Team

Date: 3/12/2020

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5	Team environment is characterized by honesty, trust, mutual respect, and team work	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	The roles and work assignments are clear	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Team treats every member's ideas as having potential value	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Team encourages individual differences.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Conflicts within the team are aired and worked to resolution.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	Team takes time to develop consensus by discussing the concerns of all members to arrive at an acceptable solution	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11	Decisions are made with input from all in a collaborative environment.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12	The environment encourages communication and does not "kill the messenger" when the news is bad.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	When one team member has a problem others jump in to help	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	Dysfunctional behavior is dealt with in an appropriate manner	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15	When someone on the team says they are going to do something, the team can count on it being done.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16	There is no "them and us" on the team	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	Our team cultivates a "what we can learn" attitude when things do not go as expected.	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>				

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

Assessor: Trevor Long

The Mechanical Design Process

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Teamwork Plan

The plan to work together involves delegating tasks based on both the team member's strengths as well as the task they want to do. Balancing those two things will ensure each individually completed task will be done well. The team members not involved in the individual tasks will oversee them to make sure the time schedule is followed and will assist people working as needed. The plan for the 'All Team Member' tasks is to schedule meeting times that all members can attend where work on that individual task will be completed.

References

- [1] Amazon, Amazon, 2020. Accessed on: Mar 12, 2020. [Website]. Available: <https://www.amazon.com/NERF-B9837-N-Strike-Elite-Disruptor/dp/B01JJ5KFMY?th=1>
- [2] Target, Target Brands Inc, 2020. Accessed on: Mar 12, 2020. [Website]. Available: <https://www.target.com/p/dart-zone-blitzfire-combo-quick-shot-dart-blasters/-/A-52253560>
- [3] Walmart, Walmart, 2020. Accessed on: Mar 12, 2020. [Website]. Available: <https://www.target.com/p/zuru-x-shot-2x-reflex-6-blasters/-/A-53458372>
- [4] Target, Target Brands Inc, 2020. Accessed on: Mar 12, 2020. [Website]. Available: <https://www.walmart.com/ip/Adventure-Force-25-Piece-90-Range-Destroyer-Foam-Dart-Blaster/234335099>
- [5] Zuru, Zuru Inc, 2020. Accessed on: Mar 12, 2020. [Website]. Available: <https://zuru.com/about-us/>
- [6] Facebook, Facebook, 2020. Accessed on: Mar 12, 2020. [Website (social media)]. Available: <https://www.facebook.com/dartzoneblasters/>
- [7] Dart Zone Covert Ops. Accessed on: Mar 12, 2020. [Website]. Available: <https://dartzoneblasters.com/adventure-force-toy-guns-blasters/>