To: McDonald's Corporation

From: Javier Franco, Thomas Howell, Thomas Owens

Subject: Captain America Shield Launcher Happy Meal Toy

Date: 22 March 2019

Executive Summary:

With the long anticipated Marvel movie *Avengers: Endgame* coming to theaters in April 2019, our team decided to design a Captain America shield launcher for McDonald's' next Happy Meal toy line. The toy is wrist-mounted and uses a spring-loaded lock and release mechanism to launch a Captain America themed shield. It comes in three parts: the wristband, launcher, and shield (Figure 1). The wristband is designed to fit the wrists of our young target demographic and is made with two rails on the top to hold the launcher in place. Inside of the launcher, there is a spring and a curved lip protruding from the top of the barrel which constitutes the locking mechanism. The shield itself is attached with an adhesive to a mount which interfaces with the launcher and spring pad. In terms of safety, the spring is securely held in place by an adhesive applied to the back spring pad and is completely covered by the barrel of the launcher. All edges of the toy are rounded and there are no choking hazards that could harm a child. In total, the cost of manufacturing the toy is $0.24 before labor and, with 3 tools running full-time for each part, nearly 100 million units could be manufactured in a year. However, with a projected runtime of only 2-3 weeks and a target distribution region limited to the United States, the team only plans on distributing 8-11 million toys.

Approach Description:

Ideation Techniques:

Before brainstorming, we decomposed our project design into two components: theme and primary function/gimmick. With a really broad scope of what both components could be, we decided to first research Happy Meal toys to get a basis for their design and then brainstorm individually as many ideas as we could. After we had jotted ideas down in our notebooks, we discussed what each of us had written down, keeping in mind potential sizes, functions, and

safety concerns. Brainstorming was an effective method of ideation because we needed to generate a lot of ideas across various relevant pop culture themes, something that would not be possible if we tried to think and talk through ideas as a group.

As a team, we decided that to effectively target today's children (audience) we wanted our toy to have a dynamic function. After consideration, we ultimately decided on a Captain America inspired projectile launcher, something that would be both relevant to many McDonald's customers and fun to play with. In terms of the design, we decomposed it further into three main components: the wristband, launcher, and shield projectile. We then discussed through the mechanics of the launching function as a team, calculating the approximate dimensions of each piece, as well as the necessary spring constant to launch a certain distance. This was an effective strategy as it allowed us to break down the larger problem into more approachable chunks while also allowing us to each provide input and share our questions/concerns.

Refinement Techniques:

After we had each designed prototypes component on Solidworks, we 3D-printed them to inspect any potential dimensional issues, compatibility between the parts, and relative durability. We then consulted with both each other and TAs about any difficult changes that needed to be made. This approach was effective because it allowed us to see the physical flaws in our design and adjust accordingly before the final design needed to be submitted.

Toy Description and Documentation:

As described before, this toy has three main components: wristband, launcher, and shield (with mount). The toys will be delivered separately in a happy meal and assembled by the user. During use, the launcher is snapped into place on the wristband and placed on the user's wrist. The user loads the shield into the launcher by sliding the shield mount into the barrel. The hook on the shield mount interfaces with the launching mechanism to lock the shield in place with the spring compressed. A specially shaped component attached to the end of the spring holds the mount

securely in place, ensuring that the shield is never accidentally fired. When the toy's button is pressed, the hook is released, the spring extends, and the shield is launched out of the toy. A string attached to the shield keeps it from firing too far and becoming dangerous. Technical drawings for each of these parts can be seen in Appendix 1. An exploded view of the assembly can be seen below, in Figure 1.

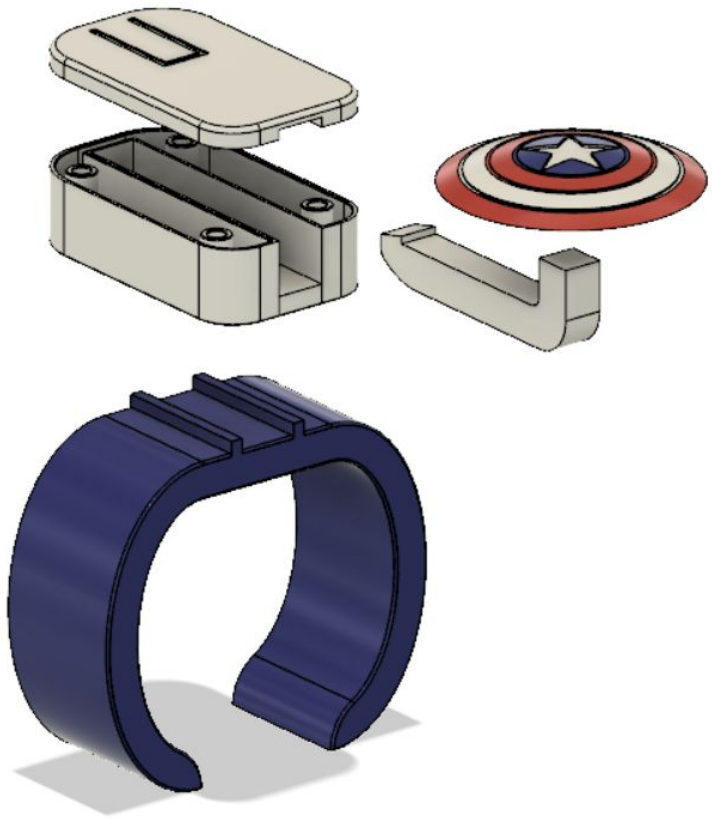

Figure 1: Exploded view detailing the assembly of the toy.

The critical-to-fit/function (CTF) dimensions identified in these drawings include the diameter of the pins and holes used to affix the top and bottom of the launcher, the size of the mount and the accompanying indent in the shield, and the size of the rails on the top of the wristband and bottom of the launcher. These dimensions are crucial to the function of the part: if one is too large or too small, the manufacturer or user will be unable to assemble the toy properly. For

example, if the rails on the wristband are too large, the user will be unable to fit the shield launcher onto the wristband. These dimensions can be identified in the technical drawings by their accompanying tolerance: 0.1 mm. To ensure a good fit for every manufactured part, worst-case tolerance analysis was employed. The maximum number of parts that fit together in this design is two, so each CTF dimension was increased or decreased, as appropriate, by 2 times the tolerance (0.1mm). For example, the rails on the wristband were narrowed by 0.2mm, and the corresponding rails on the launcher were widened by 0.2mm.

As seen in the drawings, these parts have two key design-for-manufacturability features. First, no overhangs are included in any part. Every part is injection-moldable using only a two-piece mold. No cam action or other additions are necessary to make each part. Second, every edge, with the exception of the outer edge of the launcher (where the two halves join), was filleted with a radius of at least 0.25mm. This helps facilitate the flow of plastic during molding, ensuring that no air bubbles or empty pockets are present in the final part.

The cost of manufacturing each toy is $0.24 before labor, for a total cost of roughly $0.30 to $0.35, including labor. A breakdown of this cost, including the cost of materials and injection molding for each part, can be seen in Table 1.

Part Name	Projected Area	Cavities per Tool	Molding Cost	Material	Part Volume	Part Material Cost	Total Part Cost
	in²	#	$		cc	$	$
Launcher Top	3.1	8	$ 0.024	ABS	4.80	$ 0.012	$ 0.04
Launcher Bottom	3.1	8	$ 0.024	ABS	11.50	$ 0.030	$ 0.05
Bracelet	2.1	8	$ 0.020	ABS	40.00	$ 0.103	$ 0.12
Shield	3.0	8	$ 0.024	ABS	3.15	$ 0.008	$ 0.03
Shield Mount	0.8	8	$ 0.018	ABS	3.90	$ 0.010	$ 0.03
Spring Pad, Front	0.1	8	$ 0.018	ABS	0.40	$ 0.001	$ 0.02
Spring Pad, Back	0.1	8	$ 0.018	ABS	0.30	$ 0.001	$ 0.02
							$ 0.31

Table 1: Breakdown of Total Parts Cost, showing the individual components and dimensions relevant to cost

This product will be part of a line of several other *Avengers: Endgame* inspired toys, including Thor's new axe and Iron Man's new suit of armor, among others. The line will launch on April 24th, concurrent with the release of the new movie, and will run for approximately 2-3 weeks. At 3.2 million Happy Meals sold every day in the US, this puts production targets for the line of toys at between 50-70 million units total, or about 8-11 million units per toy.

This production target can be met in time for the movie's release with 3 injection molding machines per part, each with 16 cavities. The molds for the launcher halves would require 250 tons of force; the bracelet 166 tons; the shield 240 tons; the shield mount 62 tons; and the spring pads 8 tons. All parts will be made out of ABS plastic. Post-injection molding, each toy will need to be painted: the wristband and shield mount blue; both halves of the launcher white; and the shield red white and blue, as Captain America's shield. Finally, the painted parts must be assembled using adhesive: the spring must be attached to the spring pad and the launcher; the two halves of the launcher must be assembled; and the shield must be attached to the shield mount. A rendering of the assembled, painted part can be seen below, in Figure 2.

Figure 2: Rendering showing the assembled, painted toy.

Marketing Analysis:

Although Captain America and the Marvel Universe have a global appeal, in the interest of streamlining manufacturing on a short timeline, we decided to restrict distribution to the United States. Our target demographic is fans of Marvel Studios' *Avengers: Endgame* and other related movies and comics in the franchise. The wristband, informed by anthropometric data, was designed to fit the wrist size of the average seven year old child in the US.

Overview:

Target Demographics:

- US-based fans of Marvel Studios' *Avengers: Endgame* and other related movies and characters.
- Intended for children aged seven years and older (wristband size designed based on anthropometric data of seven year-old US children).
- Marketed equally towards male and female children
- Not marketed towards any specific race, culture, or ethnicity.

Parent-friendly Features:

- String attached to minimize range of projectile to less than that from rear seating to the front seat of a car.
- Loose-fit wristband prevents the toy from getting stuck on the child's wrist.

Appendix 1: Documentation/Technical Drawings

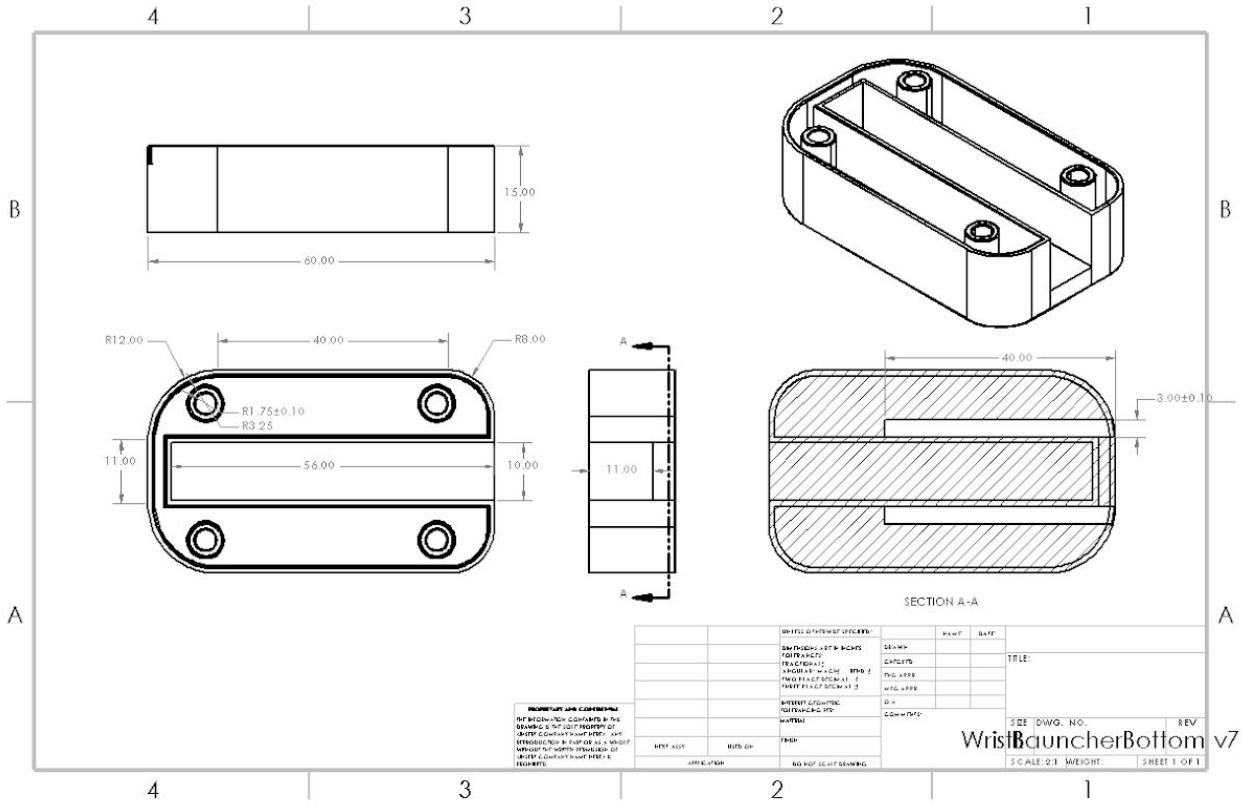

Figure 3: Technical drawing showing dimensioned launcher bottom.

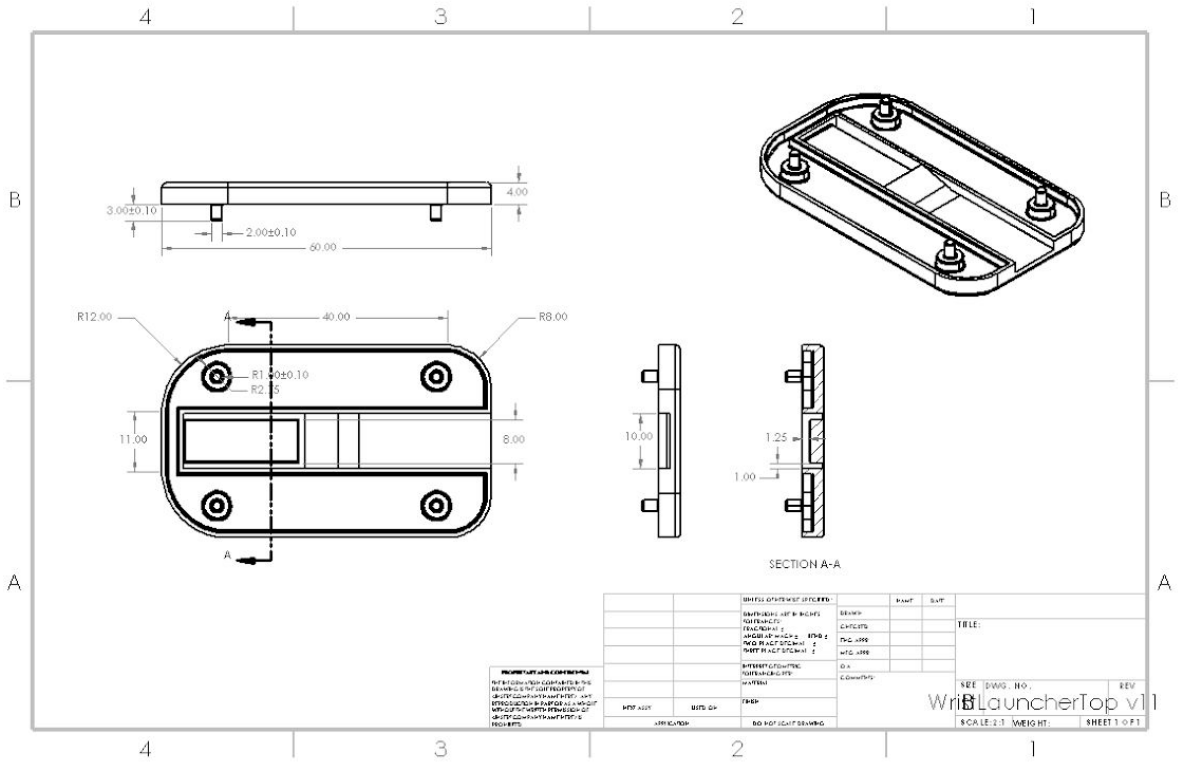

Figure 4: Technical drawing showing dimensioned launcher top.

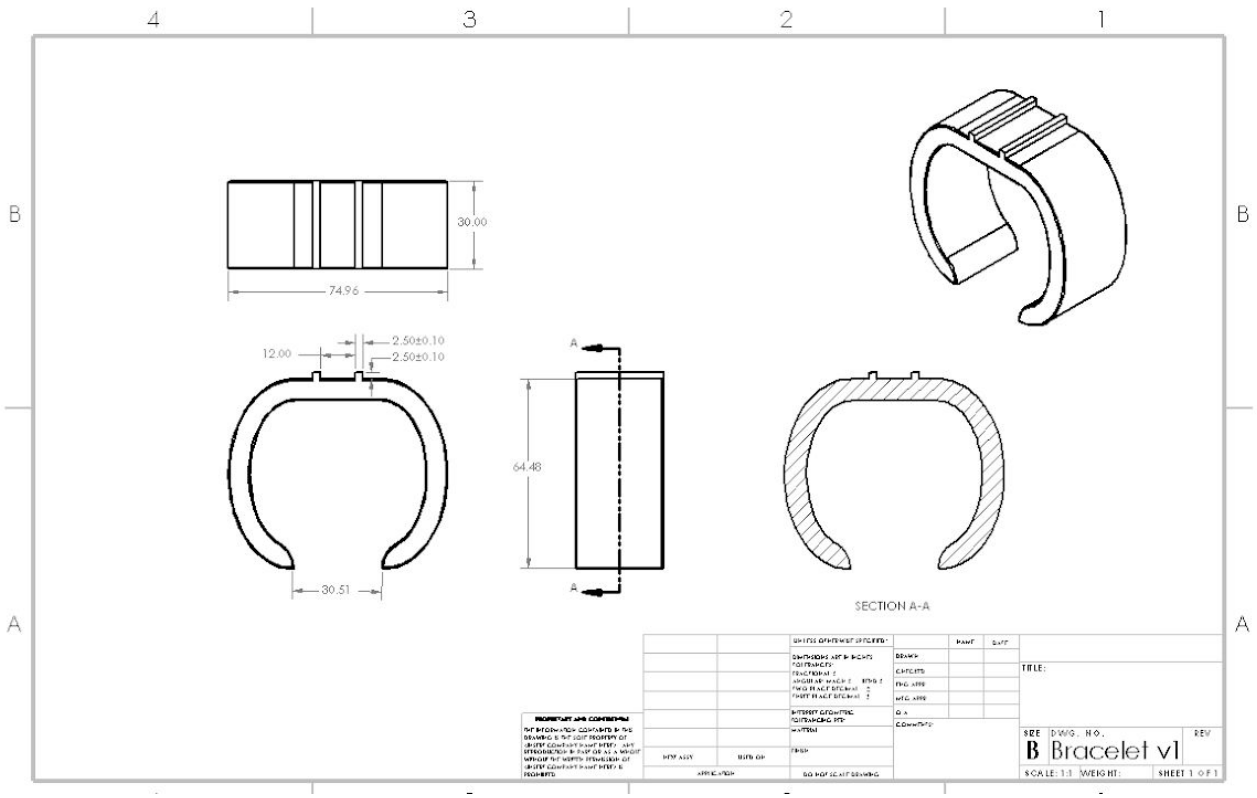

Figure 5: Technical drawing showing dimensioned wristband.

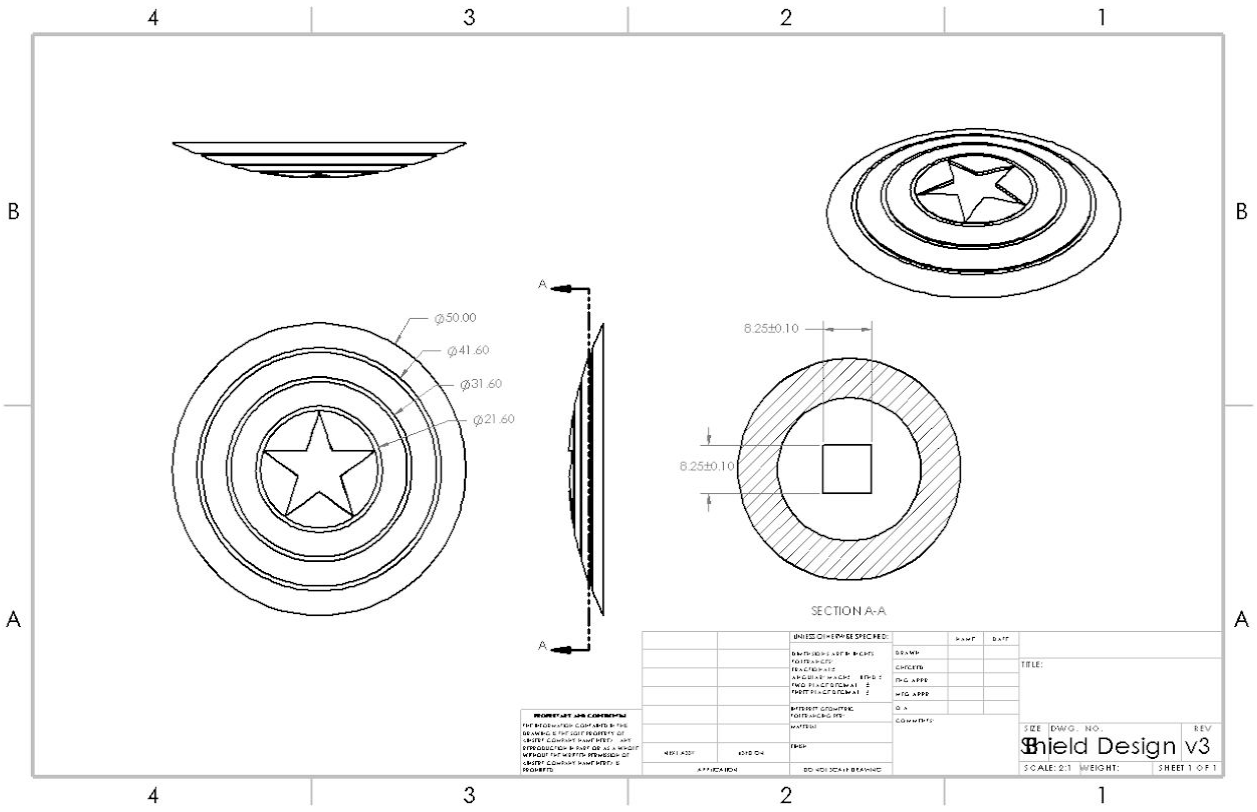

Figure 6: Technical drawing showing dimensioned shield.

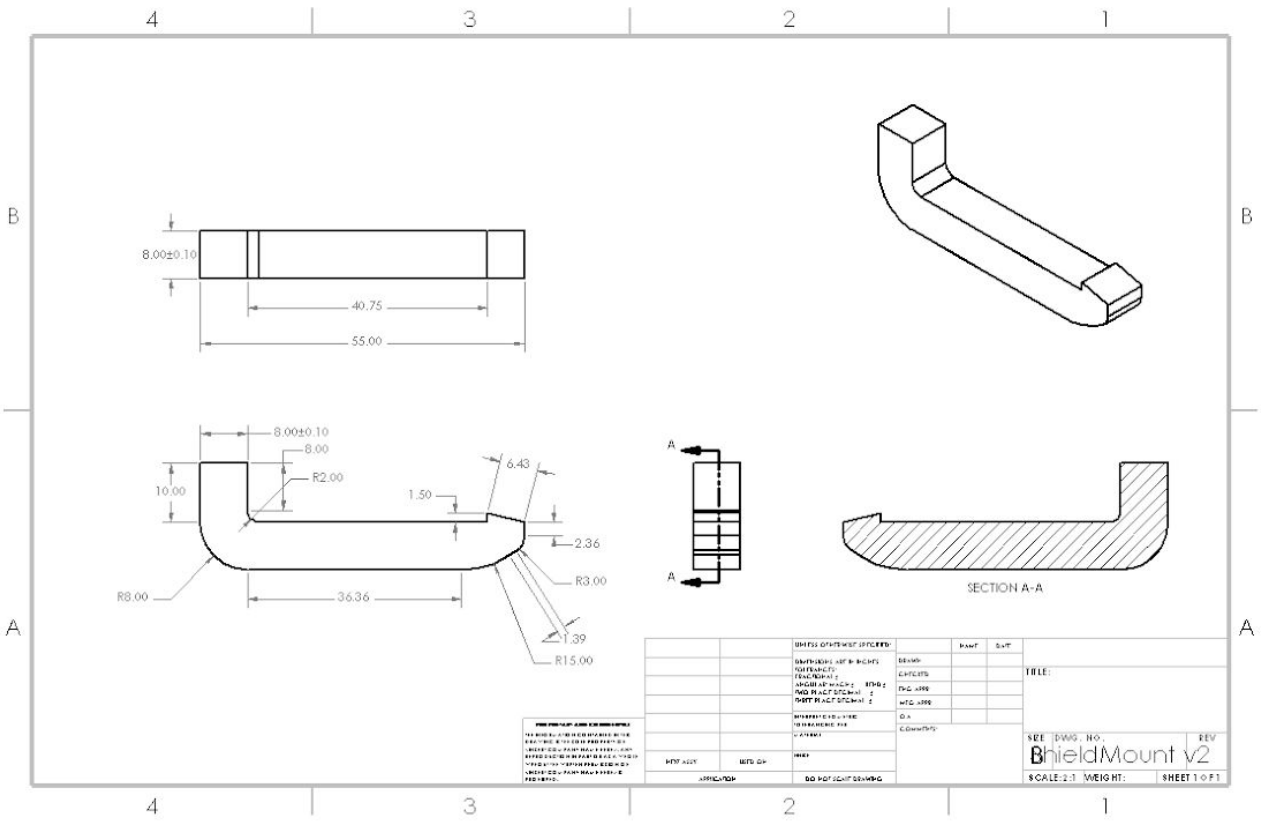

Figure 7: Technical drawing showing dimensioned shield mount.

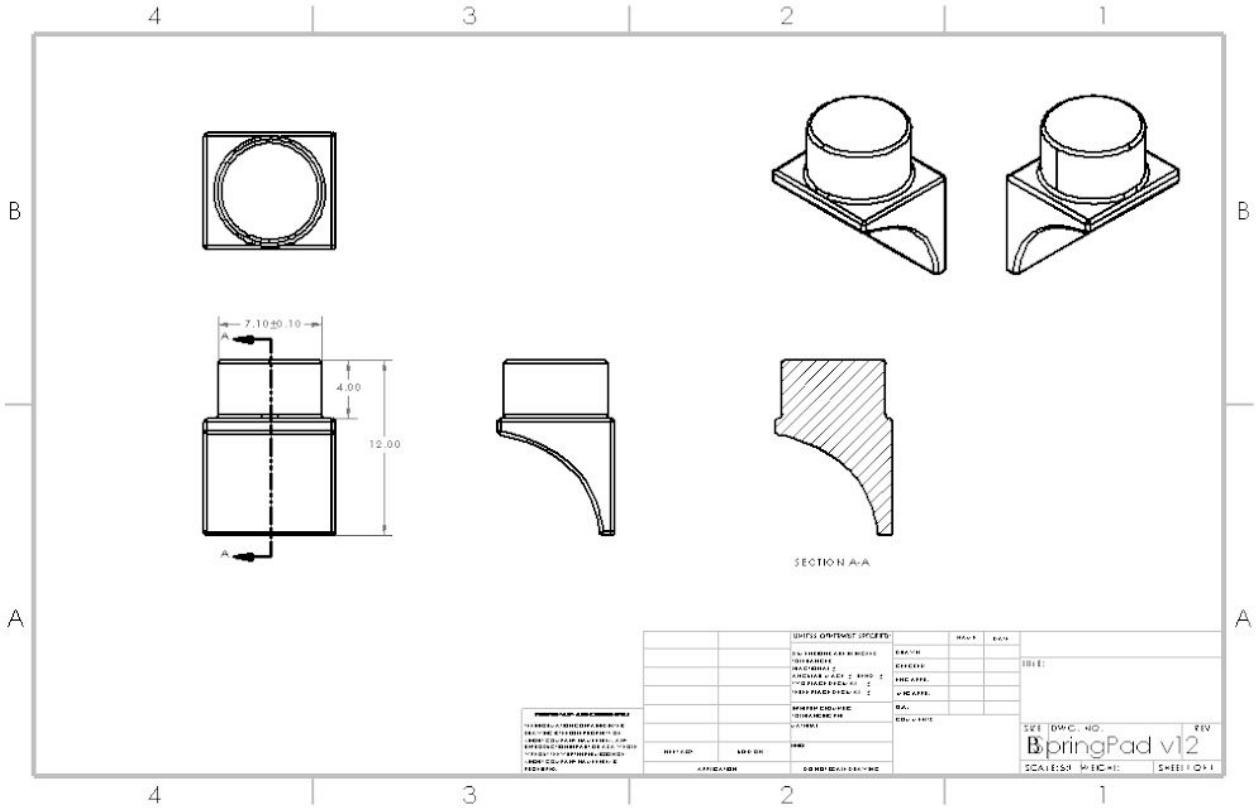

Figure 8: Technical drawing showing dimensioned front spring pad.

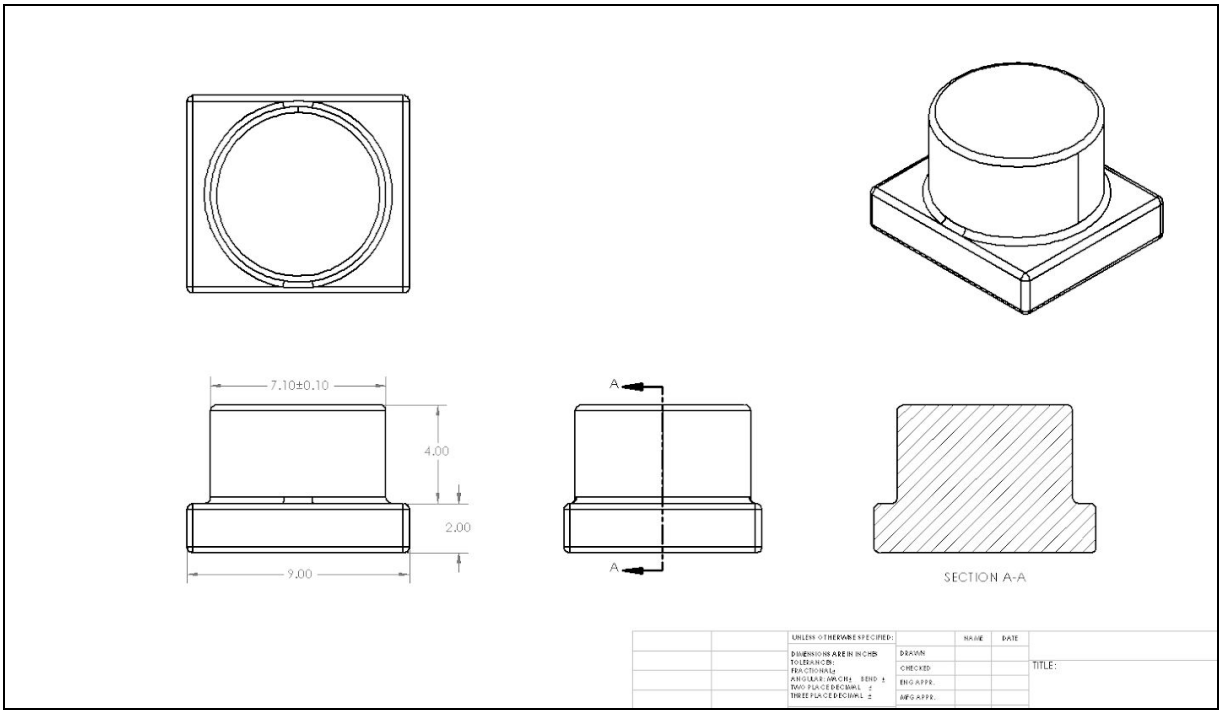

Figure 9: Technical drawing showing dimensioned back spring pad.

Figure 10: Marketing Sheet, highlighting final render, key features and overview on cost and manufacturing.