

The Blaze Buster Kinder Toy Concept Final Report

ENGG*2100

Group (4)

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Executive Summary

The purpose of this project was to design a Kinder™ Emergency Services toy that fits inside a 10 cm Kinder Surprise capsule, is safe for children aged five and older, and demonstrates a basic engineering concept. After brainstorming many ideas, our team developed the Blaze Buster, a small firefighting truck inspired by real situations where fires occur in remote areas and regular firetrucks cannot reach. The Blaze Buster teaches children about elastic potential energy. It uses a spring powered launcher that stores energy when compressed and releases it as kinetic energy to fire a small projectile. The toy contains seventeen total components with over 75% of the parts 3D printed in ABS, and all the pieces snap together without tools or adhesives, meeting the Kinder™ safety and manufacturing constraints. Three design concepts were considered, an Air Ambulance, a Police Car, and the Blaze Buster. Using a decision matrix, we selected the Blaze Buster based on safety, manufacturability, theme alignment, and how well it met with the project constraints. All parts were modeled in SolidWorks and designed so the full assembly can be taken apart and stored inside the Kinder Egg. A cost analysis was completed using the approved 3D printing rate of \$1.00 per cubic inch. Adding the volume of all printed parts gives a total material cost of \$5.16, which includes a \$1.67 metal spring for the launcher. Production labour was calculated at \$1.10 per toy, based on an assembly of about 1.5 minutes. Engineering labour totaled 57 hours, valued at \$946.20. Overall, the Blaze Buster meets all project requirements. It is safe, easy to assemble, fits inside the Kinder Egg when disassembled, and clearly demonstrates an engineering concept through play. Future improvements include reducing print material, improving snap-fit tolerances, and optimizing the launcher for more consistent performances.

Statement of Contributions

Required statement: Each of the students listed below has read and agrees with the contents of this report. Additionally, each student has made significant contributions (listed below) to the preparation of this report. *If you do not feel comfortable with this statement, please contact your instructor and explain the situation.*

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| | | Marketing Strategy |
| | | Executive Summary, 6, Appendix C |
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1 Introduction

1.1 Problem Definition

The toy industry continues to evolve rapidly, driven by the demand for innovative, safe, and engaging toys suitable for mass production. Kinder™ Surprise Eggs provide a unique opportunity to combine creativity with hands-on assembly, targeting children aged five and above [1]. Their global popularity is tied to compact, easy-to-assemble toys that balance entertainment value with manufacturability [1].

For this project, the BlazeForce™ design team aims to create an emergency-service-themed Kinder™ toy that meets child-safety standards, aligns with the Emergency Services theme, and satisfies the project constraints [2]. The toy is expected to include a motion mechanism that converts stored potential energy into kinetic energy, travels a minimum distance of 2.5 meters, or operate for at least five seconds depending on mechanism type [2]. All components must be produced using original student-created CAD files and assembled without adhesives, tools, or pre-made toy parts, ensuring safety and feasibility for the target age group [2]. The resulting design should be suitable for inclusion in a hypothetical BlazeForce™ product line in partnership with Kinder™.

1.2 Constraints & Criteria

When responsible for the design of a toy or product, constraints and criteria must be considered and met to ensure the process of manufacturing is smooth and that the product is deemed safe before it gets into the hands of a customer. A constraint is a restriction imposed on the design a product must follow, and a criterion is a standard by which a product or project can be judged [3]. In this case, the project goal is designing an emergency-service-themed Kinder™ Surprise toy targeted towards children aged five and above on behalf of BlazeForce™. Small parts will not be considered a choking hazard for this audience. Additionally, the toy will be modeled in SolidWorks™ and will be 3D printed. Below are some of the major constraints and criteria, as well as applicable group-determined criteria for the toy project and the BlazeForce™ brand.

Constraints and Criteria:

- **Trigger and motion mechanism:**
 - A key constraint for this project is that the toy must include a motion or trigger system that allows stored potential energy to be converted into kinetic energy once activated. The toy must move entirely on its own after being triggered, without any extra input from the user. Energy cannot be stored while the toy is disassembled inside the Kinder egg [2]. This encourages creative mechanical design and ensures that the toy runs safely and independently

- **Size and material requirements:**
 - All components of the toy must fit inside a 10-centimeter-tall kinder egg when taken apart, and the toy must be larger than the egg when assembled. At least 75% of the total toy must be made from 3D printed materials such as PLA, ABS, or PET [2]. These restrictions make sure to follow the packaging and manufacturing standards at Kinder™, while also challenging the team to efficiently use space and materials within the tight size limit.
- **Assembly and manufacturing restrictions:**
 - The toy must be designed so it can be assembled and disassembled without the use of adhesives, tape, or tools [2]. This means all components need to fit together securely using snap fits or other simple connections suitable for children. It ensures the design is safe, user friendly, and can be easily handled by the intended target group. Although this adds difficulty to the design process, it reinforces the need for precision and thoughtful mechanical design.
- **Safety and originality:**
 - For safety and ethical reasons, the design cannot use any pre-made toy components, such as Lego parts, gearboxes, or downloaded CAD files [2]. In addition, slingshot style launchers, weapons, or sharp edges are prohibited [2]. These constraints protect user safety, promote originality, and align the project with Kinders' commitment to child safe products. While less restrictive than the size and energy limits, they ensure that every design stays safe, unique, and compliant with course policies.
- **Thematic and Performance Constraints:**
 - The toy must reflect the “Emergency Services” theme and demonstrate a clear connection to that concept through form and function [2]. It must also meet performance targets based on its type: running, flying, or projectile toys must travel at least two and a half meters, and time-based toys must operate for at least five seconds [2]. These expectations set a measurable standard for success and ensure that the toy functions reliably while fitting within the creative theme of the project.

The most important criteria for this project are safety, energy performance, and ease of use, as these ensure the toy is safe for children, functions properly, and is enjoyable to use. The most restrictive constraints are the size limitations, 3D printing requirements, energy storage, and trigger rules, since they greatly affect how much space is available, what materials can be used, and how the mechanism can be designed. These factors shape nearly every major design decision and encourage creative problem solving to meet project goals.

The most restrictive constraints are the size limits, 3D printing requirements, energy storage rules, and trigger mechanism rules, as they heavily influence what can realistically be designed. These constraints determine how much space is available inside the Kinder™ capsule, what materials and part geometries can be manufactured, and which motion systems are allowed.

As a result, they shape nearly every design decision and guide the team toward mechanisms that are feasible, safe, and compliant with project expectations.

BlazeForce™ Determined Criteria:

Table 1: Additional Group Criteria.

| Group Criteria | Justification |
|---------------------------|---|
| Aesthetic Appeal | The toy design should be visually appealing and reflect the Emergency Services theme clearly. Strong visual design can enhance creativity, support storytelling, and increase the toy's entertainment value, making it more appealing and engaging for children. |
| Material/Cost | The toy should remain within the free 3D printing material allocation to minimize any cost. Limiting material use ensures affordable production, promotes efficient design, and mirrors real world engineering practices of working within a constrained budget. |
| Reliability | The toy must be able to operate consistently each time it is used, without breaking or malfunctioning. Ensuring reliability promotes user satisfaction, structural integrity, and long-term playability, while reinforcing the toy's educational and entertainment value. |
| Ease of Production | The toy should be simple to manufacture and assemble using 3D printing and basic connections. Minimizing complex parts reduces production time, prevents errors, and makes the toy easier to reproduce for testing or any other use. |

2 Design Process

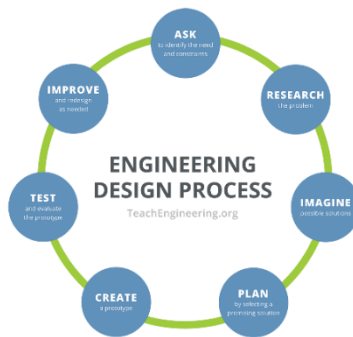


Figure 1: Diagram of an Engineering Design Process [4]. The key stages that were followed in developing the toy concept

The design process for this project followed the structured steps of the Engineering Design Process (Figure 1). This guided the BlazeForce™ team from defining the problem to selecting the final design. The process began with identifying the key project requirements and constraints such as toy size, safety, manufacturability, and the need for an exciting mechanism that can convert potential energy into kinetic energy (motion) within the project's limitations.

During the Ideation stage, the team applied multiple creativity-based strategies to generate and refine alternative toy concepts. Methods included: brainstorming sessions, individual sketching and the SCAMPER technique was used to generate numerous concepts [5]. Each member contributed unique ideas that aligned with the Emergency Services theme, resulting in three main concepts. The first was the Air Ambulance, a spring launched helicopter demonstrating vertical motion. The second was the Blaze Buster, a fire response monster truck with a spring powered projectile launcher. The last idea was the Police Car, a compact design with detachable wheels and wind-up sirens. These designs were developed through quick sketches and conceptual drawings to visualize mechanisms, toy assembly, and motion type.

In the Evaluation phase, the team used a decision matrix to compare each design against assigned and group-developed criteria including appearance, cost, ease of assembly and innovativeness. The Blaze Buster achieved the highest total score due to its energy conversion mechanism, strong connection to the Emergency Services theme and its visual appeal. The Air Ambulance and the Police Car were also creative but were ranked lower.

This structured approach ensured that the final BlazeForce™ concept was selected through evidence and criteria-based processes, leading to the selection of the Blaze Buster as the final concept for development and prototyping.

3 Design Alternatives & Evaluation

3.1 Conceptual Designs

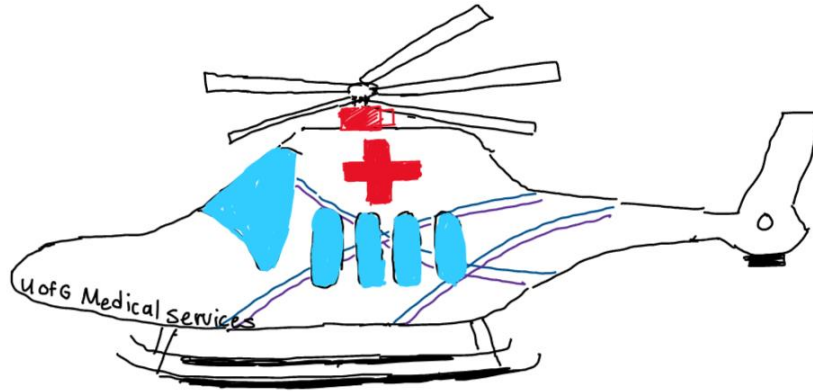


Figure 2: Concept Sketch 1- Time-Based Air Ambulance Toy. An air ambulance (helicopter ambulance), with a propellor that launches into the air for a certain amount of time using stored elastic potential energy from a spring mechanism.

The first concept sketch is a medical rescue helicopter toy that integrates a spring-propelled motion mechanism that turns the stored elastic potential energy into kinetic energy when triggered by a lever located at the bottom of the tail fin (Figure 2). It will then propel itself into the air for five seconds to meet the criterion for the mechanism type [2]. Merits include ease of assembly for the landing skid, the theme being represented through a first aid cross which adds imaginative value for children during play, and it showcases to children how elastic potential energy (spring) can be converted into kinetic energy in an entertaining way. Limitations include sizing issues, some of the parts might not be easy to collapse into smaller components to into an egg, the spring/lever mechanisms would most likely be prone to many failures and the design is not the most creative aesthetically. Full concept sketch can be viewed at Figure 5 in Appendix A.

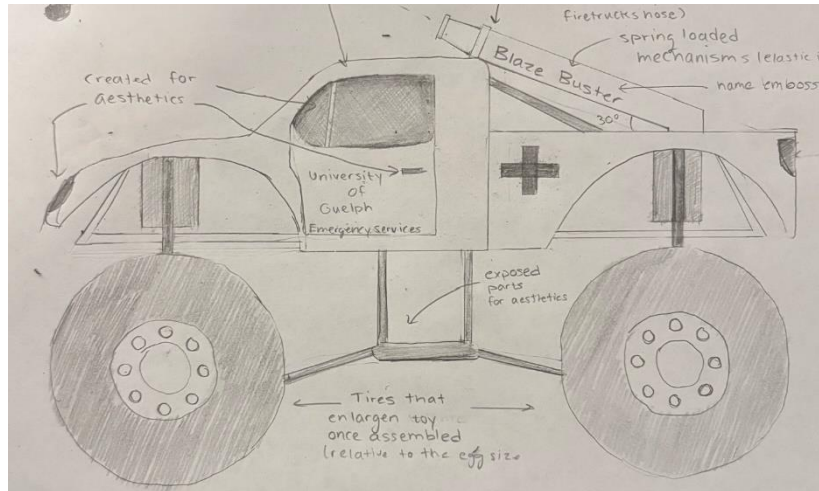


Figure 3: Concept Sketch 2 – Blaze Buster Projectile Toy. A monster truck with an attached projectile launcher in the form of a firetruck hose.

The second concept sketch is an emergency service truck toy, the “Blaze Buster,” that incorporates a spring-loaded mechanism to store elastic potential energy and release it as kinetic energy, shooting a projectile through the mounted hose (Figure 3). Once assembled, the truck expands in size with its detachable large wheels, giving the toy a bigger presence relative to the egg capsule. Merits include the fact that its larger scale makes it visually exciting for children, as bigger toys often increase play value. The addition of the spring-powered shooter introduces creativity to the monster-truck style design, while also tying it directly to the emergency services theme by functioning as a water hose for imaginative firefighting scenarios. Limitations include the potential difficulty of collapsing the oversized wheels to fit within the egg, as well as higher material usage, which may exceed the allowance for 3D printing within the given project constraints. The full concept sketch can be viewed at Figure 6 in Appendix A.

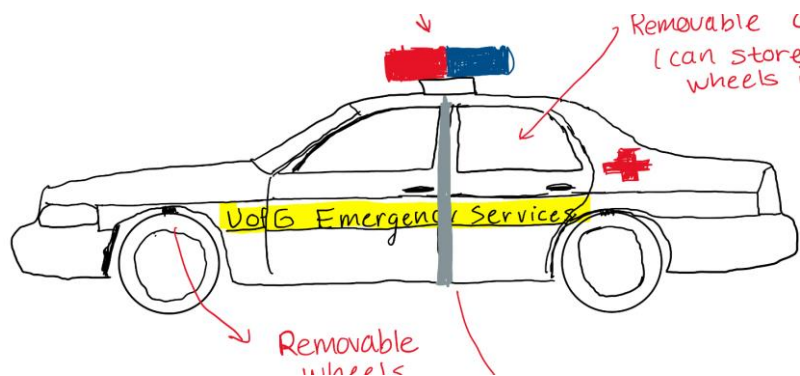


Figure 4: Concept Sketch 3 – Timed-Based Police Car Toy. A monster truck with an attached, with a propellor that launches into the air for a certain amount of time using stored elastic potential energy from a spring mechanism.

The third concept sketch is a police car toy that uses a body with a hinge and removable wheels to collapse into a compact form, allowing it to meet the egg size constraint when disassembled while expanding into a larger toy when assembled (Figure 4). A unique feature is the

siren, which spins for five seconds using a simple wind-up spring mechanism that stores elastic potential energy and converts it into rotational kinetic energy when released. This not only adds an interactive motion element but also enhances the Emergency Services theme by simulating a functional siren in a creative way. Merits include the compact design enabled by the hinge and detachable wheels, which satisfies project constraints and the spinning siren mechanism, which adds imaginative value beyond a typical police car toy. Limitations include the potential difficulty in designing a reliable hinge mechanism without contradicting aspects of the project description, as well as the possibility that the toy may appear less exciting compared to more dynamics alternatives since it resembles a standard police car. The full concept sketch is provided in Figure 7 of Appendix A.

3.2 Design Evaluation

Three toy concepts that satisfied the primary project requirements but varied in their ability to meet the criteria were selected for further comparison (Table 2). The team used both the necessary constraints and extra factors found during brainstorming to create a decision matrix so that the concepts could be fairly compared [5]. These included: the mechanism, size feasibility, cost, appearance and ease of production. In each category, each criterion received a score between one and five, where the higher score indicated better performance [5].

Table 2: Decision Matrix for Concept Selection.

| Criteria (/5) | Blaze Buster | Police Car | Air Ambulance |
|----------------------|---------------------|-------------------|----------------------|
| Mechanism | 4 | 4 | 3 |
| Size feasibility | 4 | 3 | 4 |
| Cost | 3 | 3 | 4 |
| Appearance | 5 | 3 | 3 |
| Ease of production | 4 | 3 | 4 |
| Total | 20 | 16 | 18 |

The Blaze Buster was the evaluation's best design overall, mostly because of its high ratings for originality and aesthetic appeal. Bigger, bolder toys tend to appeal to kids, and a spring-loaded firehose complements the emergency services theme while it supports imaginative play. Second place went to the Air Ambulance. The conversion of stored elastic potential energy to kinetic energy is demonstrated by its spring-propelled mechanism, and the medical theme adds interest. However, the spring mechanism's practicality was somewhat diminished by its size limitations and possible fragility. The Police Car received the lowest rating. It was regarded as less exciting than the other designs because it looked like a typical toy police car with little originality, even though

it performed well in terms of cost/resource efficiency and compactness (hinge and detachable wheels).

The Blaze Buster was chosen as BlazeForce™'s final concept because it provided the best mix of play value, theme relevance, and inventiveness. However, trade-offs were recognized, such as the possibility of increased material consumption because of its large wheels. The Police Car might have been a better option if factors like price and ease of use had been given more consideration. The BlazeForce™ team made sure the selection was objective, based on the criteria, and in line with the project's limitations by using this structured decision matrix. The team also identified areas where compromises between cost, appeal, and manufacturability had to be made.

4 Proposed Design

4.1 Design Description

The proposed design is a large-scale emergency vehicle toy named the BlazeForce™ Blaze Buster, which incorporates a spring-powered launcher integrated into a firehose style shooter. The design takes inspiration from emergency service vehicles, combining the recognizable form of a monster truck with imaginative fire-rescue features. When the spring is compressed and released, elastic potential energy is converted into kinetic energy, propelling a small projectile from the mounted hose. This motion provides children with an interactive and engaging way to explore energy transfer while the toy maintains the emergency service theme.

As shown earlier in Figure 3, features of the BlazeForce™ Blaze Buster include oversized detachable wheels that expand the toy's size once assembled, creating a strong visual presence that appeals to children. The modular components allow the toy to collapse into smaller parts that can be stored within the egg capsule. Aesthetic elements such as the embossed lettering and first aid symbols further emphasize its connection to emergency services. Overall, the design balances functionality, safety, and imaginative play.

4.2 Assembly Instructions

The BlazeForce™ Blaze Buster is designed using snap-fit, tool-free methods of connections to ensure that children aged five and older can assemble the toy safely and independently. All components were modelled in SolidWorks™ and manufactured with tolerances appropriate for repeated assembly and disassembly, aligning with Kinder™'s safety and usability requirements.

A complete set of visual assembly instructions is provided in Appendix A, where each major component is numbered and illustrated in sequential order. The appendix includes exploded views, part labels, connection interfaces, and final assembly configurations. These images guide the user through the three main stages of assembly:

1. **Launcher Mechanism Assembly**

Appendix A (Figure 4) shows the construction of the spring-powered launcher, including

the alignment of the chamber, spring housing, trigger unit, and support stand. The snap-fit geometry ensures proper alignment and safe operation of the mechanism.

2. Chassis and Wheel Assembly

Appendix A (Figure 4) illustrates the attachment of the chassis to the upper body, followed by the installation of the axle and oversized wheels. The axle slides through the chassis slot and locks into place, allowing smooth rotation while maintaining structural stability.

3. Launcher and Launcher Foundation

Appendix A (Figure 5) depict the connection between the foundation of the launcher and the chassis bed, as well as the launcher to the foundation at any desired angle (15°, 30°, 45°, 60°).

Placing the instructions in the appendix keeps the main report concise while still providing a complete, clearly illustrated, and easy-to-follow guide for users. This approach meets the project requirement for detailed assembly documentation and ensures that the Blaze Buster can be consistently assembled according to design intent.

4.3 Manufacturing and Cost Analysis

The Bill of Materials summarized by the BlazeForce™ team includes all the components required to produce one full Blaze Buster assembly (Table 3), including the material, quantity, volume, and printing cost of each part. Most components are made from ABS plastic and were manufactured using 3D printing. According to the 3D printing guidelines for this course [8], the expected cost of ABS material ranges from \$1 to \$5 per cubic inch. Based on this, the team selected the lowest printing cost of \$1.00/in³ for calculations. Since cost is directly proportional to part volume, larger components such as the chassis, bed, and launcher stand contribute most of the total cost, while smaller pieces such as the pin, mount, logos, and bullet add only a few cents each. The spring is a metal component purchased at a fixed cost. Summing all individual costs gives a total material cost of \$5.16 for one complete assembly. The volumes used in our cost calculations were obtained directly from the SolidWorks 2D engineering drawings for each component. These drawings, along with full dimensions for all parts of the Blaze Buster, are provided in Appendix C (Figures 1 - 21).

Table 3: Cost Analysis of the Blaze Buster Prototype.

| Item | Material | Qty | Volume (in ³) | Cost per in ³ | Total Cost |
|---------------|----------|-----|---------------------------|--------------------------|------------|
| Truck Chassis | ABS | 1 | 0.78 in ³ | 1.00 / in ³ | \$0.78 |
| Truck Bed | ABS | 1 | 0.53 in ³ | 1.00 / in ³ | \$0.53 |
| Chamber | ABS | 1 | 0.40 in ³ | 1.00 / in ³ | \$0.40 |
| Truck Wheels | ABS | 4 | 0.25in ³ | 1.00 / in ³ | \$1.00 |
| Trigger | ABS | 1 | 0.05 in ³ | 1.00 / in ³ | \$0.05 |

| | | | | | |
|------------------|-------|---|----------------------|------------------------|---------|
| | | | | | |
| Backplate | ABS | 1 | 0.01 in ³ | 1.00 / in ³ | \$0.014 |
| Launcher Stand | ABS | 1 | 0.39 in ³ | 1.00 / in ³ | \$0.39 |
| Spring | Metal | 1 | N/A | N/A | \$1.67 |
| Pin | ABS | 1 | 0.04 in ³ | 1.00 / in ³ | \$0.04 |
| Mount | ABS | 1 | 0.01 in ³ | 1.00 / in ³ | \$0.013 |
| Ladder | ABS | 1 | 0.02 in ³ | 1.00 / in ³ | \$0.02 |
| Bullet | ABS | 1 | 0.02 in ³ | 1.00 / in ³ | \$0.02 |
| Front Attachment | ABS | 1 | 0.17 in ³ | 1.00 / in ³ | \$0.17 |
| BB Logo | ABS | 2 | 0.01 in ³ | 1.00 / in ³ | \$0.03 |
| Bar | ABS | 1 | 0.02 in ³ | 1.00 / in ³ | \$0.02 |
| 34" Rod | ABS | 1 | 0.01 in ³ | 1.00 / in ³ | \$0.015 |
| | | | | Total Cost | \$5.16 |

For large-scale manufacturing, the Blaze Buster would be produced using injection molding rather than 3D printing. This method drastically reduces unit cost when producing high volumes, because the initial cost of the mold is distributed across all units. The estimated material used for mass production is polypropylene, which is commonly used in toys due to its toughness, low density, and excellent molding characteristics. Polypropylene also has a significantly lower cost than ABS, at approximately \$1.06 per kilogram [9], making it a more economical option for large batches. A rough estimate of the single-cavity aluminum mold cost is \$3,000, which is typical for mid-volume injection molding runs of 5,000 to 10,000 units [10]. Using the mass of each part and the cost per gram of polypropylene, the total material cost per unit was calculated (Table 4).

4.4 Life-Cycle Considerations

From a life-cycle perspective, a future redesign could incorporate recycled polypropylene, which would reduce material consumption, lower CO₂ emissions, and improve the toy's end-of-life recyclability. Polypropylene has a lower environmental footprint compared to ABS, particularly when recycled, due to its reduced embodied energy, lower manufacturing emissions, and higher compatibility with post-consumer recycling streams [11]. Research comparing the life-cycle impacts of ABS and PP shows that recycled PP typically produces fewer greenhouse gas emissions per kilogram and results in less energy use over its full material cycle [12]. Additionally, polypropylene is widely documented as one of the most easily recyclable

thermoplastics used in consumer products [13], making it a more sustainable option for mass-produced BlazeForce™ toys.

Despite these improvements, several constraints remain. The material must meet Kinder™ safety standards: it must be non-toxic, durable under repeated loading of the spring mechanism, and stiff enough to ensure that snap-fit joints do not wear out or deform permanently. The small internal volume of the Kinder Egg limits how much the geometry can be simplified or consolidated, since all components must remain collapsible and compact. Additionally, the spring and pin introduce mixed-material components, which are necessary for performance but complicate recycling at the end of the product's life [14]. From a manufacturing standpoint, injection-molded parts must incorporate proper draft angles, uniform wall thickness, and limited undercuts, which may require geometric modifications to certain 3D-printed shapes used in the prototype.

With a mass-produced Blaze Buster, injection molding significantly reduces the per-unit price, lowering the manufacturing cost to approximately \$2.02 per unit for a production run of 10,000 units (Table 4). Beyond this cost reduction, several opportunities exist to further improve the manufacturing process. One key improvement is material selection: although ABS was used for the prototype due to ENGG*2100 compatibility requirements, polypropylene would be the preferred resin for injection molding because of its lower cost, lighter weight, and better long-term durability [11], [12]. A future redesign could also incorporate recycled polypropylene to reduce environmental impact and improve the toy's end-of-life recyclability, as polypropylene produces lower CO₂ emissions compared to ABS [11], [13].

Table 4: Cost Analysis for Mass-Produced Blaze Buster Toy's (10,000 units).

| Item | Material | Qty | Volume (g) | Cost per g | Total Cost |
|--------------------|--------------------------------|-----|------------|------------|---|
| Single-Cavity Mold | Aluminum | 1 | N/A | N/A | \$3,000 (one time), \$0.30 per unit |
| Truck Chassis | Polypropylene, Metal spring | 1 | 13.3 g | \$0.00106 | \$0.0141 |
| Truck Bed | | 1 | 9.03g | | \$0.00958 |
| Chamber | | 1 | 6.82g | | \$0.00723 |
| Truck Wheels | | 4 | 4.26g | | \$0.00452 |
| Trigger Joystick | | 1 | 0.85g | | \$0.00090 |
| Top Cover | | 1 | 0.17g | | \$0.00018 |
| Launcher Stand | | 1 | 6.65g | | \$0.00705 |
| Spring | | 1 | N/A | N/A | \$1.67 |
| Pin | | 1 | 0.68g | \$0.00106 | \$0.00072 |
| Mount | | 1 | 0.17g | | \$0.00018 |
| Ladder | | 1 | 0.34g | | \$0.00036 |
| Bullet | | 1 | 0.34g | | \$0.00036 |
| Front Attachment | | 1 | 2.90g | | \$0.00307 |
| Logo Print | | 2 | 0.34g | | \$0.00036 |

| | | | | | |
|----------|--|---|-------|------------|-----------|
| Bar | | 1 | 0.17g | | \$0.00018 |
| 3/4" Rod | | 1 | 0.17g | | \$0.00018 |
| | | | | Total Cost | \$2.02 |

Despite these improvements, several constraints remain. The material must meet Kinder™ safety standards: it must be non-toxic, durable under repeated loading of the spring mechanism, and stiff enough to ensure that snap-fit joints do not wear out or deform permanently. The small internal volume of the Kinder Egg limits how much the geometry can be simplified or consolidated, since all components must remain collapsible and compact. Additionally, the spring and pin introduce “mixed-material” components, which are necessary for performance but complicate recycling [14]. From a manufacturing standpoint, injection-molded parts must incorporate proper draft angles, uniform wall thickness, and limited undercuts, which may require geometric modifications to certain 3D-printed shapes used in the prototype [12], [14].

5 Design Defense

The Blaze Buster truck was selected as the final design after a systematic evaluation of all proposed concepts against the established constraints and criteria. This design stood out because of its engaging spring-loaded interactive play value. By converting elastic potential energy into kinetic energy through the spring system, the toy not only meets the project requirement for a stored energy mechanism but also introduces an educational element by demonstrating energy transfer in an entertaining way. As a flagship concept for the BlazeForce™ Emergency Response line, it showcases how the company could blend learning with imaginative play.

One of the decisive factors in choosing this design was its strong visual impact and appeal to the target age group. The oversized tires and expandable structure create a large, impressive toy once assembled, which enhances excitement during play. Additionally, the modular design allows the wheels and body components to be removed and folded, ensuring that the toy can still fit within the egg capsule despite its larger assembled form. This balance between compacted disassembly and expanded play size directly addresses one of the most restrictive project constraints and aligns with BlazeForce™’s goal of delivering “big play in small packages.”

While the Air Ambulance concept was a strong contender, especially for its recognizable medical rescue theme, it was ultimately not chosen. The delicate rotor and tail components present challenges in terms of durability and compact storage, and the spring-propelled motion mechanism risked being more fragile in comparison to the Blaze Buster’s design.

Some trade-offs were acknowledged despite the robust design of the Blaze Buster. The enlarged wheels may increase material use during 3D printing, potentially exceeding the free filament allocation, the spring mechanism used for shooting projectiles may require some troubleshooting and parents/guardians might be concerned over the safety for children using a toy with a projectile launcher [7]. However, these limitations are outweighed by the design’s overall reliability, creativity, and ability to satisfy key criteria such as safety, assembly, and thematic relevance.

In the future stages of this project, planned validation activities would include CAD modeling in SolidWorks™, 3D printing of scaled prototypes, and basic spring mechanism tests to confirm that the hose shooter performs consistently and safely. These steps will provide further evidence that the Blaze Buster design is feasible for mass production and capable of delivering an enjoyable experience for children.

6 Marketing Strategy

BlazeForce™, Blaze Buster is positioned as an education toy for emergency services, enhancing ‘learning through play’ philosophy. The toy encourages hands-on assembly, demonstrates visible energy conversion, and promotes imaginative firefighting. Also, the objectives of the marketing strategy include the following:

- Establish BlazeForce™ as a Kinder™ partner brand aligned with STEM education.
- Target parents of children aged five and above who appreciate learning through play.
- Build long-term brand recognition for BlazeForce™, enabling future product line expansion within Kinder™ Surprise offerings.

6.1 Target Marketing and Positioning

Primary Target Market:

- Parents and guardians of children aged five and above who are interested in STEM-oriented toys and hands-on learning.
- Gift givers seeking an affordable, educational, and unique toy.

Secondary Target Market:

- Children who enjoy emergency vehicles, fire trucks, and monster-truck-style toys.
- Teachers and STEM clubs looking for simple examples of mechanics and elastic potential energy.

Brief Product Description:

“Blaze Buster is a Kinder™ Surprise BlazeForce™ emergency-response truck that lets kids build, assemble, and explore how stored elastic energy converts into motion as they ‘put out’ imaginary fires.”

Unlike typical standalone Kinder™ toys, the Blaze Buster is positioned as the first vehicle in the BlazeForce™ emergency-services fleet, giving Kinder™ the opportunity to introduce future coordinating toys.

6.2 Product Features

Marketing emphasizes several parent-friendly benefits:

- **Educational:**
The spring-loaded launcher demonstrates the conversion of elastic to kinetic energy, reinforcing STEM learning.
- **Safety:**
Designed for children above the age of 5, all components snap together without tools or adhesives. The projectile has a rounded tip to reduce risk.
- **Play Value:**
Oversized wheels, a monster-truck stance, and a fire hose-like launcher encourage imaginative rescue scenarios.
- **Collectability:**
Blaze Buster is marketed as the first vehicle in the BlazeForce™ fleet, with future additions such as an Air Ambulance and Police Pursuit vehicle.

6.3 Promotion and Social Media Campaign

To evaluate initial marketing effectiveness, the BlazeForce™ team created an Instagram page: @blazeforce.ltd, refer to Figure 6 in Appendix A. At the time of writing, the page includes 15 posts and 75 followers, demonstrating positive early engagement.

The social-media strategy includes:

- **Teaser Marketing:** Early previews of the Blaze Buster and launcher mechanism to build curiosity.
- **Engineering Showcases:** Behind-the-scenes CAD modeling, 3D-printing prototypes, and assembly footage.
- **Educational Posts:** Parent-focused explanations of elastic potential energy, design safety, and emergency-services themes.
- **Community Engagement:** Polls, follower questions, and suggestions for future BlazeForce™ vehicles.
- **Hashtags & Collaborations:** Use of tags such as #STEMtoys, #KinderSurprise, and #FireRescuePlay to expand organic reach.
Future campaigns would integrate Kinder's digital platforms, allowing BlazeForce™ to leverage Kinder™'s audience during collaborative promotions.

6.4 Distribution, Retailers, and Expanding Product Line.

As Kinder™ products are part of the Blaze Buster's design, existing retail channels will be convenient for the Blaze Buster; ideal retailers include Walmart, Toys R Us, Mastermind Toys, large grocery and pharmacy chains that stock Kinder™ Surprise eggs. In-store placement (visual merchandising), the BlazeForce™ Kinder eggs will be placed alongside Kinder product on the lower side of the shelf to attract kids aged five and above. However, they will be covered with emergency services graphics and BlazeForce™ branding so that the children can recognize BlazeForce™ products.

Interventions to sustain continued interest and simulate purchasing will be generated through planned extensions and add-ons like future BlazeForce™ vehicles including the Air Ambulance, Police Pursuit/Rescue and other seasonally themed rescue vehicles with similar branding and mechanics. We will also offer accessory packs featuring extra water-dart projectiles along with upgrades on aesthetics to personalize each Blaze Buster toy.

6.5 Intellectual Property and Brand Protection.

The BlazeForce™ initiative has developed several forms of intellectual property (IP) that demonstrate clear novelty and originality. These assets can be legally protected to establish BlazeForce™ as a defensible and competitive brand. The key IP components include:

Registered or Registerable IP Assets:

- **BlazeBuster™ Toy:**
The Blaze Buster is one of the core toys in the BlazeForce™ product line and can be trademarked as a distinct product name.
- **Logos and Visual Identity:**
The BlazeForce™ and BB logos, along with the emergency-services-inspired colour palette and design language used across the truck, marketing graphics, and social media branding, can be protected as trademarks and brand assets.
- **Marketing and Brand Visuals:**
This includes original photos, renders, illustrations, assembly diagrams, technical instructions, and written promotional content used on Instagram and in the instruction manuals.
- **Toy Design & Mechanical Features (Patent or Industrial Design):**
The 3D-modelled components—such as the chassis, bed, launcher, projectile, and snap-fit mechanisms—along with the unique geometric arrangement of the spring-powered fire-hose launcher, may qualify for patent or industrial design protection.

Leveraging Intellectual Property in Marketing:

- **Brand Recognition:**
BlazeForce™ and the Blaze Buster logos are strategically displayed on the toy, packaging concepts, social media posts, and presentation materials. This repetition builds strong brand recognition and reinforces the legitimacy of BlazeForce™ as an emerging toy company.
- **Brand Uniformity:**
Consistent use of logos, colours, naming, and visual style across the Blaze Buster and future planned vehicles creates cohesion within the BlazeForce™ product line. This consistency supports the rubric requirement that the toy be presented as part of a fully developed, authentic brand.

Plan for Protecting Intellectual Property

If BlazeForce™ were commercialized, the following actions would be taken to secure and defend its IP:

1. **Trademark Registration:**
Protect the names BlazeForce™, Blaze Buster™, and all associated logos.
2. **Patent / Industrial Design Filing:**
Apply for protection of the unique launcher mechanism, monster-truck geometry, snap-fit system, and other original mechanical features.
3. **Copyright Registration:**
Protect all written content, illustrations, graphical assets, assembly instructions, and marketing materials.
4. **Non-Disclosure Agreements (NDAs):**
When engaging with manufacturers or design contractors, NDAs would prevent third parties from replicating or registering BlazeForce™ IP before it is officially protected.

The marketing plan clearly differentiates and describes how, with the protection of defensible IP, Blaze Buster will be able to operate as a professional toy product and BlazeForce™ brand will be able to compete with the toy companies and operate with a defensible brand and a unique product line.

7 Project Management

7.1 Budget

The estimated budget for the Emergency Services toy design is \$42 CAD, which is within the project constraints and leaves room for unexpected costs. Most of the expenses come from the filament used to 3D print, while the spring and finishing details account for smaller costs. This

ensures the design remains affordable while still achieving the required functionality and appearance.

Table 5: Budgeting Table.

| <i>ITEM</i> | <i>ESTIMATED COST (CAD)</i> | <i>NOTES</i> |
|--------------------------------|------------------------------------|---|
| 3D Printing Filament | \$15 | Enough material for body, wheels, and smaller parts. |
| Springs | \$8 | Used for launcher mechanism |
| Paint/Decals | \$6 | Logos and colours that match the Emergency Services theme |
| Fasteners/Snap-fit Pieces | \$8 | Pins, hinges, or clips for easy assembly/disassembly |
| Prototyping/Testing Allowances | \$5 | Cover extra filament or small replacement parts. |

As seen from the chart, the toy design emphasizes cost efficiency, which is a crucial part to mass produce the Blaze Buster as a toy.

7.2 Project Schedule

To estimate the time, it will take to create the Blaze Buster, a Critical Path Method (CPM) was created. The CPM provides a clear overview of the task, the dependencies, and estimate duration of each task. With the help of CPM, the team can identify what tasks are most crucial to meet the final deadline of the project.

Table 6: The Critical Path Method.

| <i>TASK</i> | <i>PREDECESSOR</i> | <i>DURATION</i> |
|--------------------------------|---------------------------|------------------------|
| A - Concept Sketches | None | 5 Days |
| B - Finalization of final idea | A | 2 Days |
| C - Proposal Report | B | 5 Days |
| D - SolidWorks Modelling | B, C | 10 Days |
| E – 3D Printing | D | 3 Days |
| F – Aesthetic Finishes | E | 3 Days |
| G - Presentation | E, F | 1 Day |
| H - Final Report | G | 7 Days |

As seen from the CPM chart, to successfully complete the project, the team needs approximately 36 days to meet all deliverables.

Anticipated Challenges:

While the team was brainstorming, several challenges were identified that could arise during the duration of the project. One main concern is due to the printing and tolerance. As the team goal is to create a snap-fit design allowing the toy to be easily assembled, the tolerance values and dimensions must be very accurate. To address this, early test prints will be conducted for

critical components to ensure proper tolerance values and dimensions. Another challenge that may arise is regarding the projectile launcher. As the projectile must travel 2.5 meters, the spring mechanism must be correctly calibrated [2]. This challenge will be addressed by conducting vigorous testing and adjusting the spring to achieve the required results. Additionally, a major challenge the team will face is time constraints. With academic deadlines, work of other courses and exams it will be challenging to manage the project at hand. Precautionary steps will be taken, such as implementing deadlines within the group, communicating, and finishing all tasks one week prior of the official deadline. By identifying the anticipated challenges early on during the design process, the team is prepared to address them. With advanced planning, testing and effective time management, the team can successfully complete the Blaze Buster.

Unanticipated Challenges:

While the team has developed solutions to anticipated challenges, it is known that unanticipated challenges always emerge during a design project. In the event of any unforeseen challenges whether during the design phase, build process, 3D printing, or issues amongst the team, everything will be addressed through open communication between group members, as it is essential to overcome these challenges. Additionally, weekly meetings are held to find and resolve issues early on, ensuring the project remains on track. By doing so, the team is well prepared to overcome unexpected challenges.

8 Conclusion & Recommendations

The evaluation of the three proposed concepts showed that the Blaze Buster best satisfied the overall goals of the project. Using the established criteria such as mechanism effectiveness, size feasibility, appearance, safety, and ease of production the Blaze Buster consistently achieved the highest performance because it balanced strong visual appeal, a clear connection to the Emergency Services theme, and a reliable spring-based mechanism. While the Air Ambulance and Police Car concepts also met several project requirements, their limitations in appearance, practicality, or long-term durability made them less suitable compared to the Blaze Buster.

Looking ahead, the recommended next steps focus on refining the chosen concept to improve manufacturability, playability, and user experience. This includes simplifying tire assembly for easier capsule storage, ensuring the design remains within printing and safety constraints, and completing additional prototyping to verify consistent launcher performance. Addressing these refinements will allow the design to better meet the criteria outlined in Section 1.2 while maintaining strong engagement for the target users.

Overall, the Blaze Buster's alignment with the project's goals, constraints, and user needs makes it the most suitable concept to advance into further development. Its combination of educational value, safe operation, and imaginative play demonstrates a well-rounded solution that fulfills the objectives of the ENGG*2100 design project.

9 References

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Appendix A

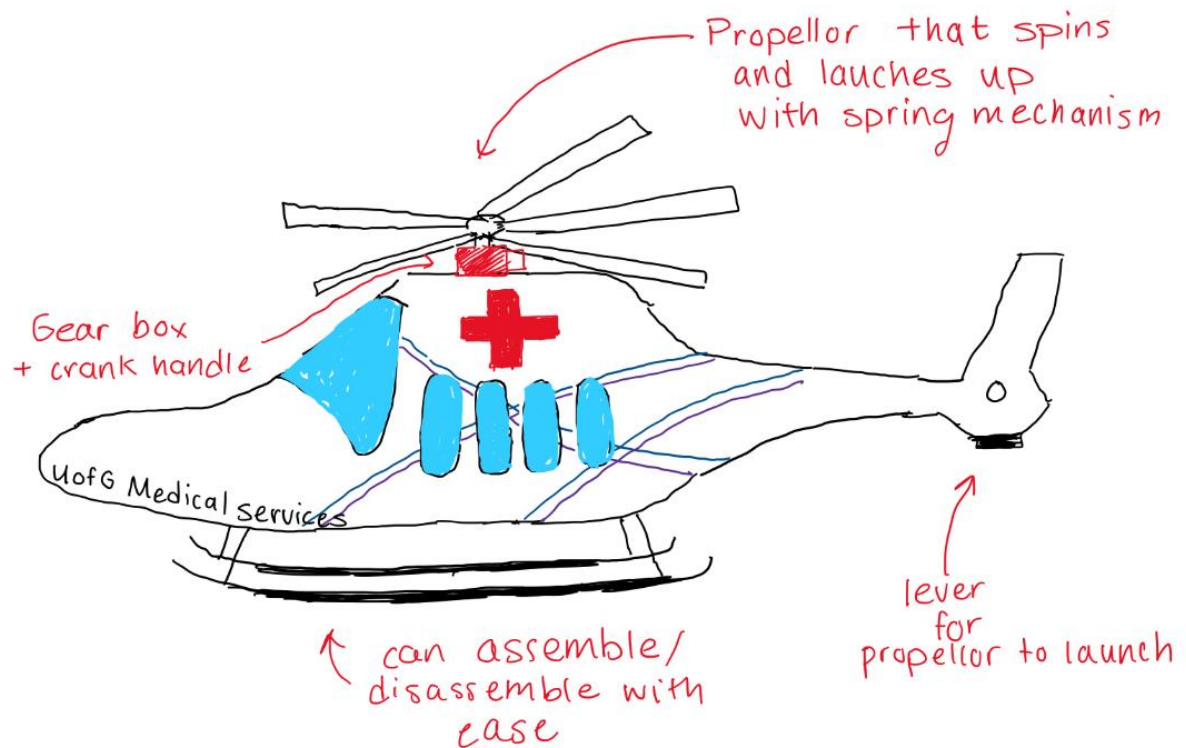


Figure 1: Full Concept Sketch of the Air Ambulance

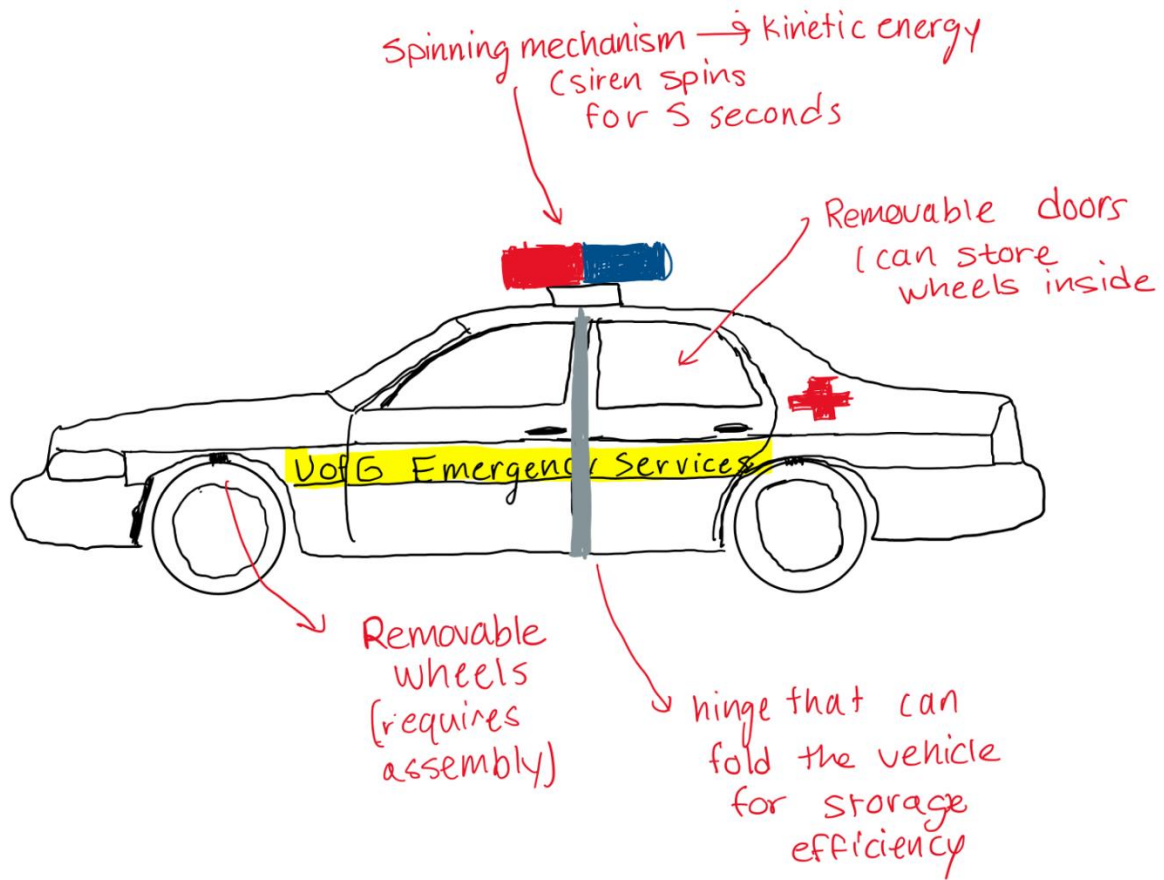


Figure 2: Full Concept Sketch of the Police Car

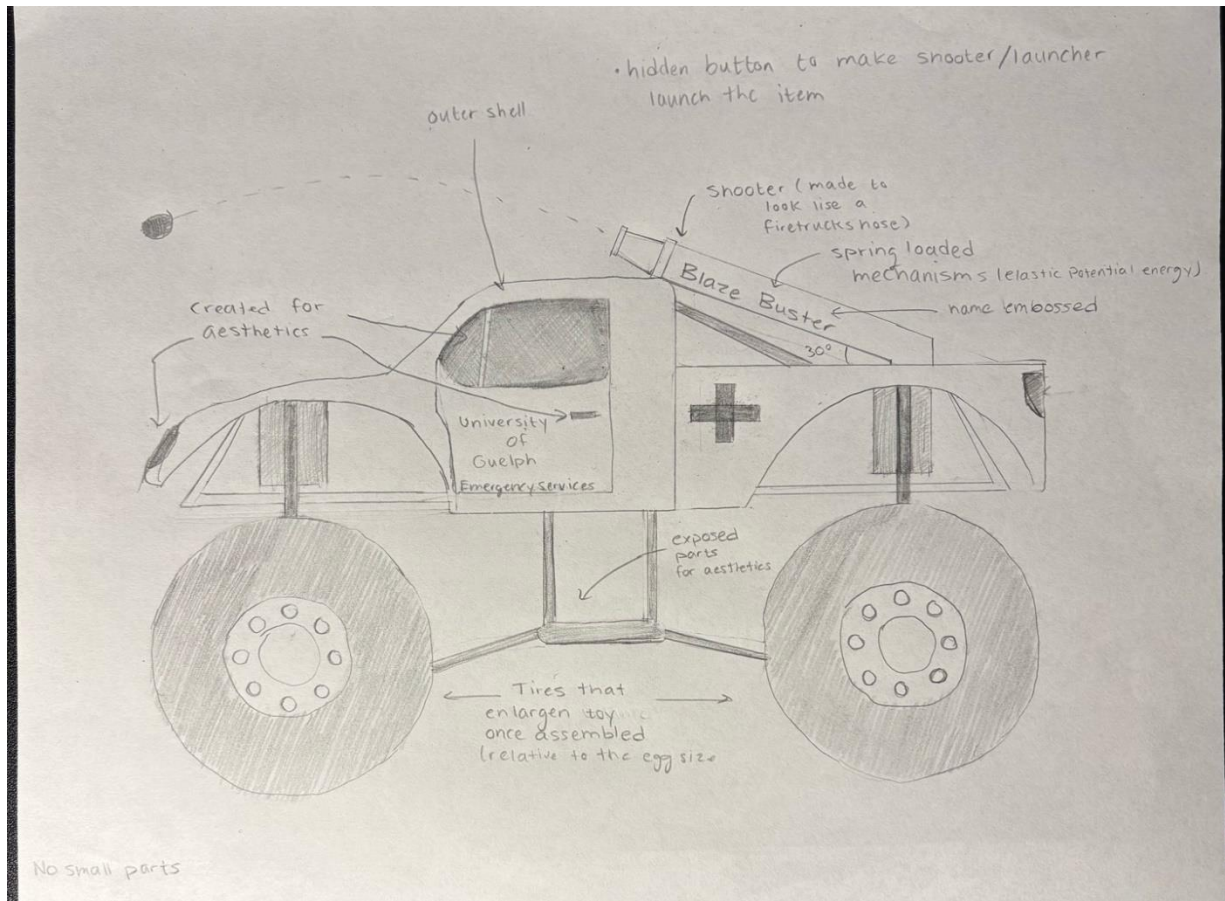


Figure 3: Full Concept Sketch of the Blazer Buster

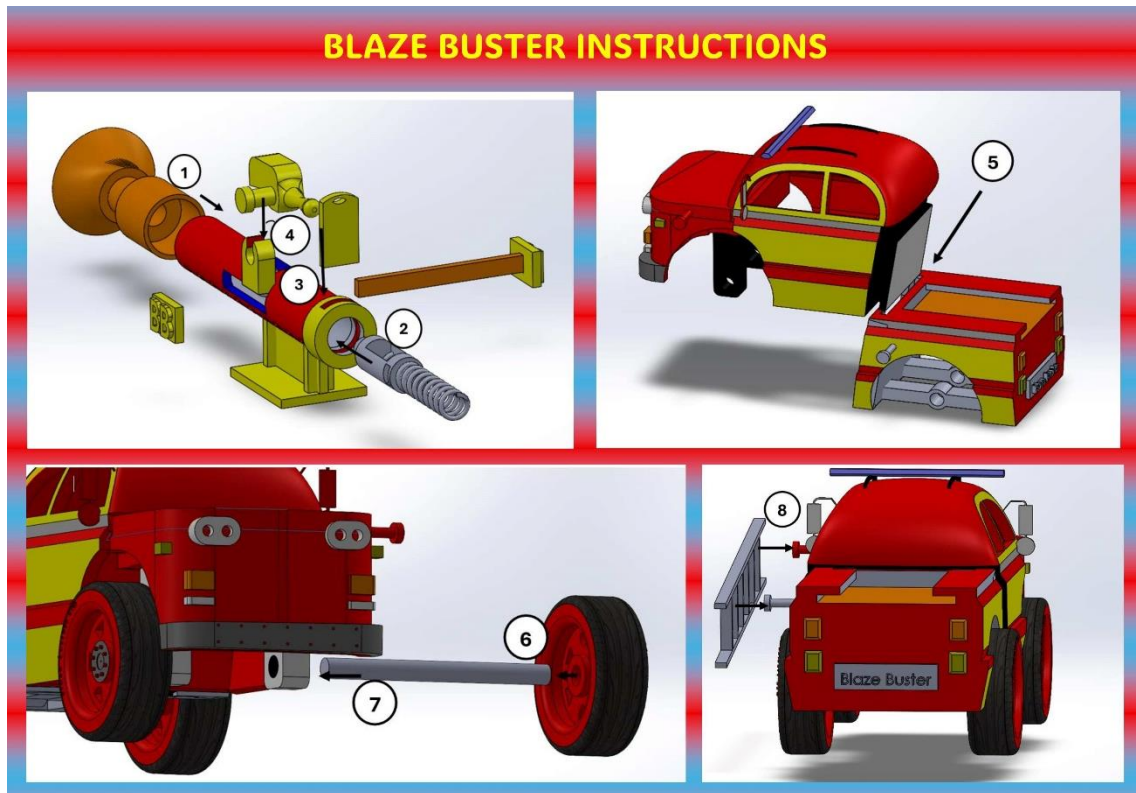


Figure 4: Part 1 of assembly instructions

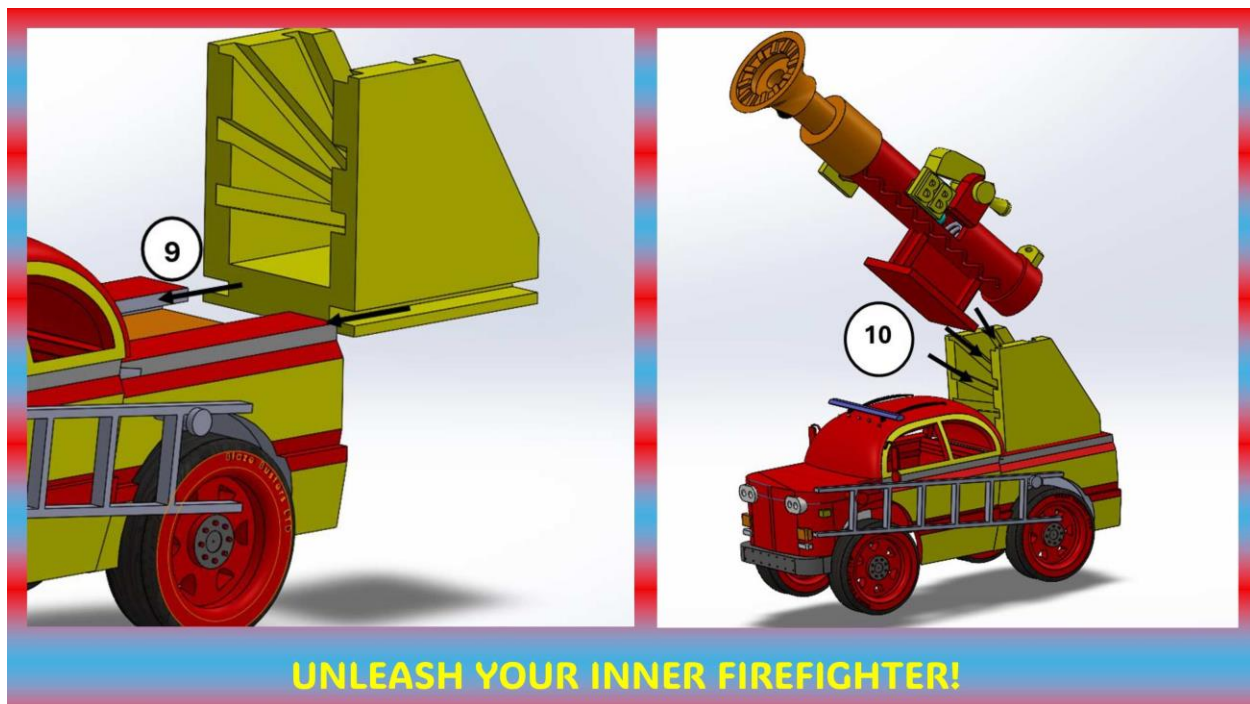


Figure 5: Part 2 of assembly instructions

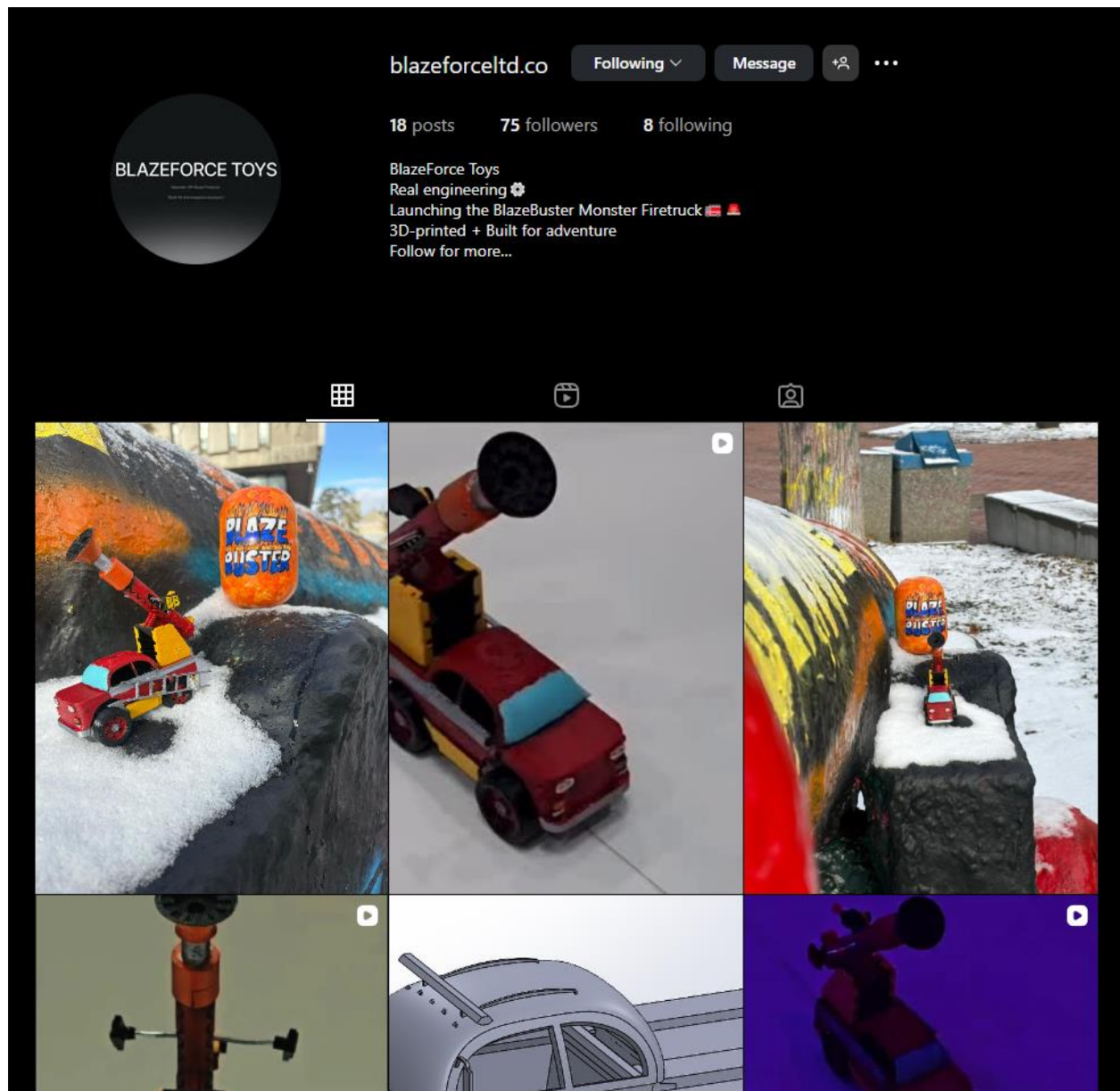


Figure 6: The BlazeForce™ Instagram page

Appendix B

Table 1: Additional Group Criteria.

| Group Criteria | Justification |
|---------------------------|---|
| Aesthetic Appeal | The toy design should be visually appealing and reflect the Emergency Services theme clearly. Strong visual design can enhance creativity, support storytelling, and increase the toy's entertainment value, making it more appealing and engaging for children. |
| Material/Cost | The toy should remain within the free 3D printing material allocation to minimize any cost. Limiting material use ensures affordable production, promotes efficient design, and mirrors real world engineering practices of working within a constrained budget. |
| Reliability | The toy must be able to operate consistently each time it is used, without breaking or malfunctioning. Ensuring reliability promotes user satisfaction, structural integrity, and long-term playability, while reinforcing the toy's educational and entertainment value. |
| Ease of Production | The toy should be simple to manufacture and assemble using 3D printing and basic connections. Minimizing complex parts reduces production time, prevents errors, and makes the toy easier to reproduce for testing or any other use. |

Table 2: Decision Matrix for Concept Selection.

| Criteria (/5) | Blaze Buster | Police Car | Air Ambulance |
|--------------------|--------------|------------|---------------|
| Mechanism | 4 | 4 | 3 |
| Size feasibility | 4 | 3 | 4 |
| Cost | 3 | 3 | 4 |
| Appearance | 5 | 3 | 3 |
| Ease of production | 4 | 3 | 4 |
| Total | 20 | 16 | 18 |

Table 3: Cost Analysis of the Blaze Buster Prototype.

| Item | Qty | Volume (in ³) | Cost per in ³ | Total Cost |
|------------------|-----|---------------------------|--------------------------|---------------|
| Truck Chassis | 1 | 0.78 in ³ | 1.00 / in ³ | \$0.78 |
| Truck Bed | 1 | 0.53 in ³ | 1.00 / in ³ | \$0.53 |
| Chamber | 1 | 0.40 in ³ | 1.00 / in ³ | \$0.40 |
| Truck Wheels | 4 | 0.25in ³ | 1.00 / in ³ | \$1.00 |
| Trigger | 1 | 0.05 in ³ | 1.00 / in ³ | \$0.05 |
| Backplate | 1 | 0.01 in ³ | 1.00 / in ³ | \$0.014 |
| Launcher Stand | 1 | 0.39 in ³ | 1.00 / in ³ | \$0.39 |
| Spring | 1 | N/A | N/A | \$1.67 |
| Plunger | 1 | 0.04 in ³ | 1.00 / in ³ | \$0.04 |
| Mount | 1 | 0.01 in ³ | 1.00/ in ³ | \$0.013 |
| Ladder | 1 | 0.02 in ³ | 1.00 / in ³ | \$0.02 |
| Bullet | 1 | 0.02 in ³ | 1.00 / in ³ | \$0.02 |
| Front Attachment | 1 | 0.17 in ³ | 1.00 / in ³ | \$0.17 |
| Logo Print | 2 | 0.01 in ³ | 1.00 / in ³ | \$0.03 |
| Bar | 1 | 0.02 in ³ | 1.00 / in ³ | \$0.02 |
| 34" Rod | 1 | 0.01 in ³ | 1.00 / in ³ | \$0.015 |
| | | | Total Cost | \$5.16 |

Table 4: Cost Analysis for Mass-Produced Blaze Buster Toy's (10,000 units).

| Item | Material | Qty | Volume (g) | Cost per g | Total Cost |
|--------------------|----------|-----|------------|------------|---|
| Single-Cavity Mold | Aluminum | 1 | N/A | N/A | \$3,000 (one time), \$0.30 per unit |
| Truck Chassis | | 1 | 13.3 g | \$0.00106 | \$0.0141 |
| Truck Bed | | 1 | 9.03g | | \$0.00958 |
| Chamber | | 1 | 6.82g | | \$0.00723 |
| Truck Wheels | | 4 | 4.26g | | \$0.00452 |
| Trigger Joystick | | 1 | 0.85g | | \$0.00090 |
| Top Cover | | 1 | 0.17g | | \$0.00018 |

| | | | | | |
|------------------|--------------------------------|---|-------|-----------|------------|
| Launcher Stand | Polypropylene, Metal spring | 1 | 6.65g | | \$0.00705 |
| Spring | | 1 | N/A | N/A | \$1.67 |
| Pin | | 1 | 0.68g | \$0.00106 | \$0.00072 |
| Mount | | 1 | 0.17g | | \$0.00018 |
| Ladder | | 1 | 0.34g | | \$0.00036 |
| Bullet | | 1 | 0.34g | | \$0.00036 |
| Front Attachment | | 1 | 2.90g | | \$0.00307 |
| Logo Print | | 2 | 0.34g | | \$0.00036 |
| Bar | | 1 | 0.17g | | \$0.00018 |
| 34" Rod | | 1 | 0.17g | | \$0.00018 |
| | | | | | Total Cost |

Table 5: Budgeting Table.

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| B - Finalization of final idea | A | 2 Days |
| C - Proposal Report | B | 5 Days |
| D - SolidWorks Modelling | B, C | 10 Days |
| E – 3D Printing | D | 3 Days |
| F – Aesthetic Finishes | E | 3 Days |
| G - Presentation | E, F | 1 Day |
| H - Final Report | G | 7 Days |

Appendix C

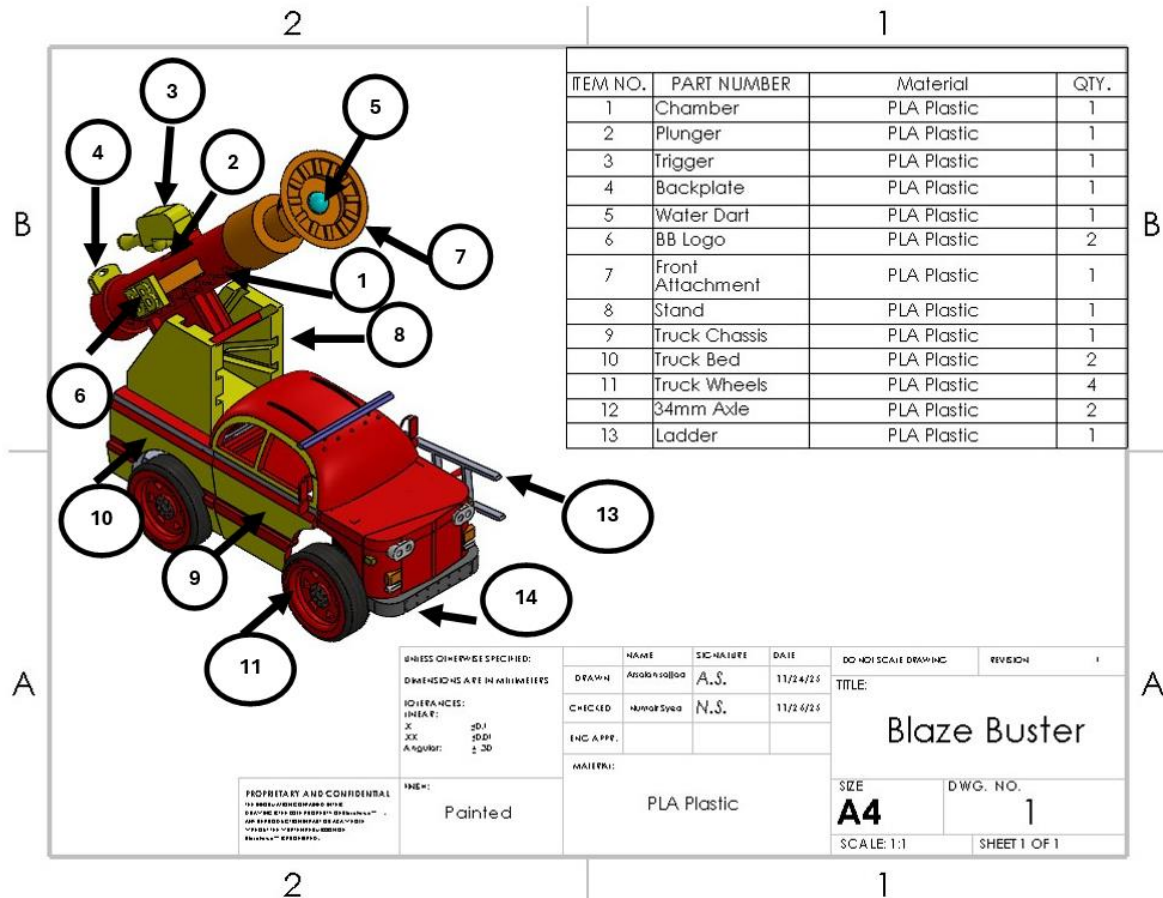


Figure 1: Chamber (Part 1)

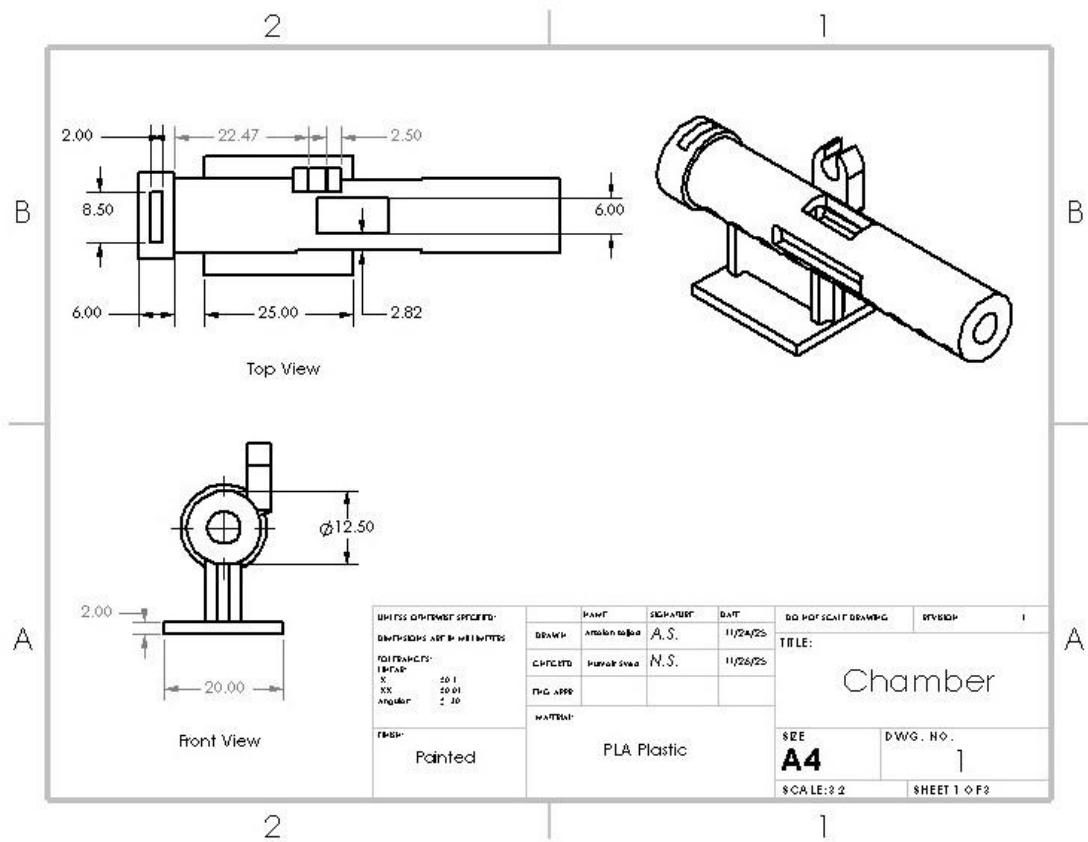


Figure 2: Chamber (Part 1)

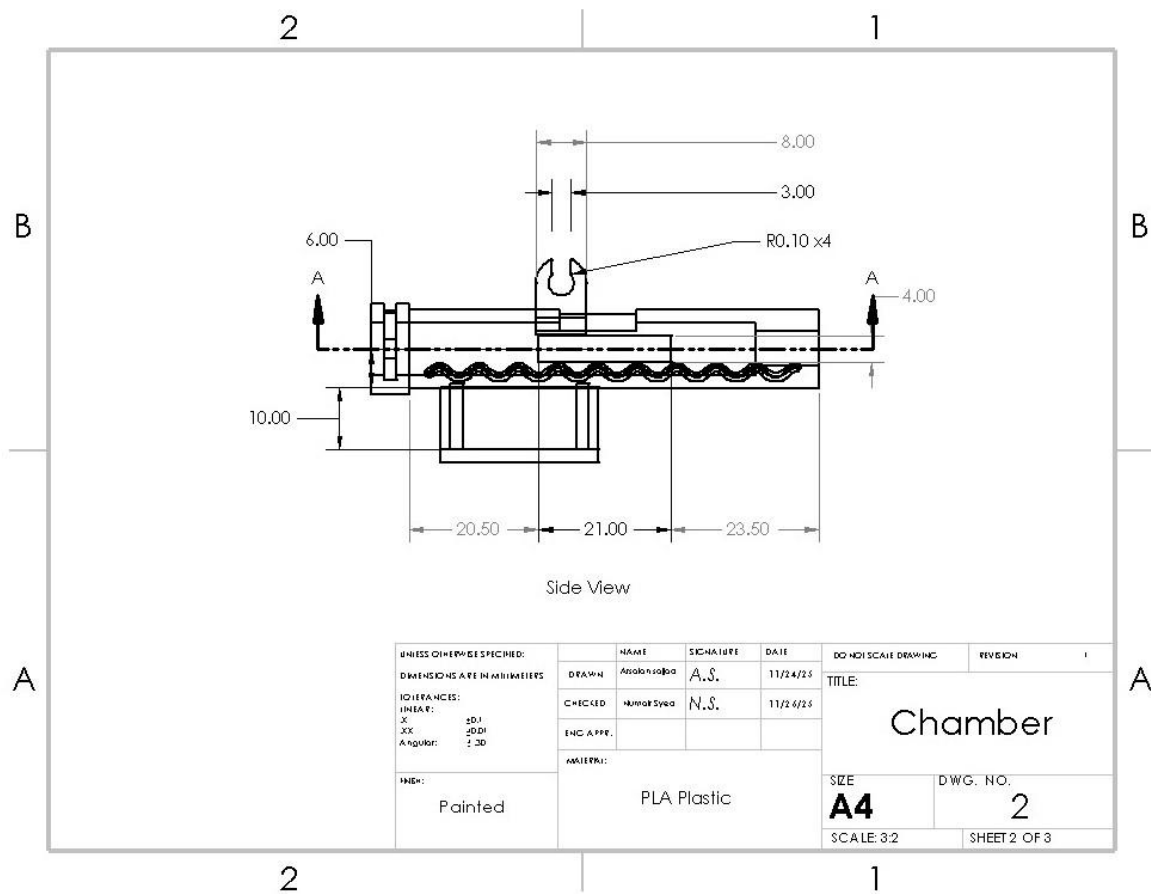


Figure 3: Chamber (Part 2)

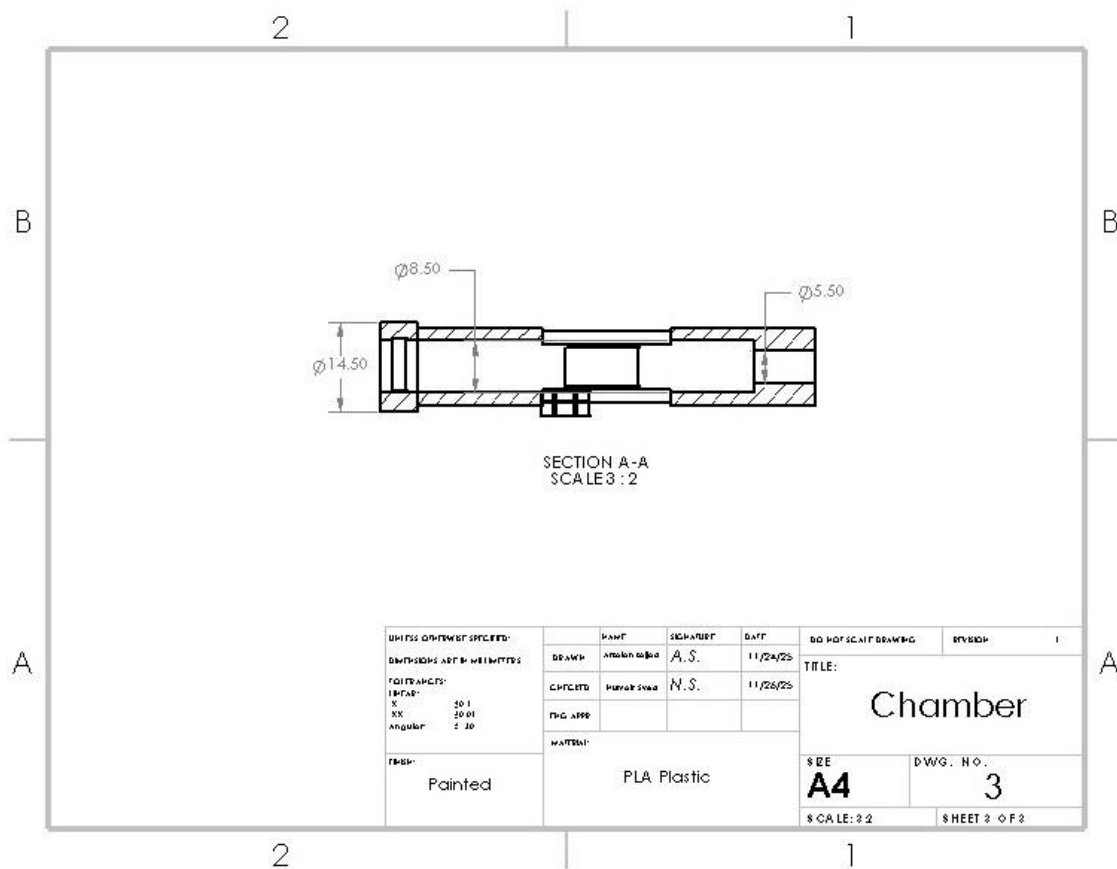


Figure 4: Chamber (Part 3)

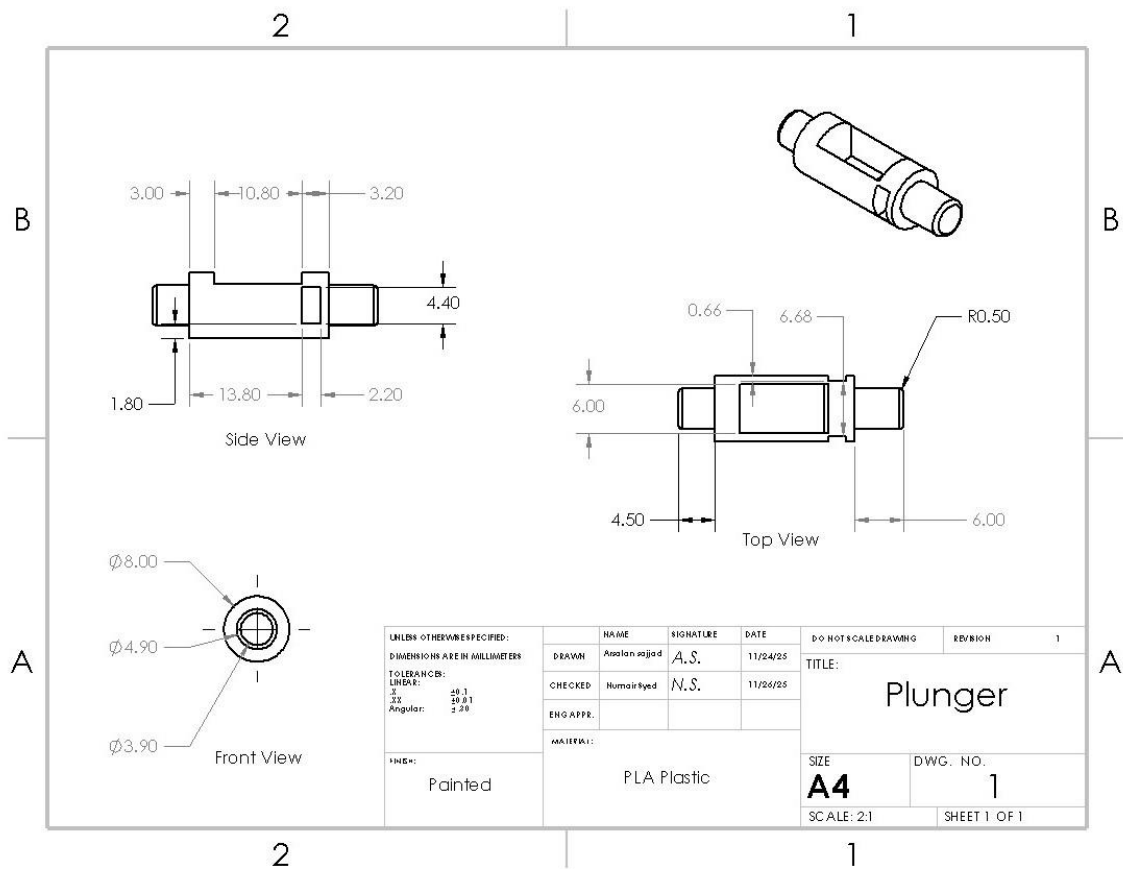


Figure 5: Plunger

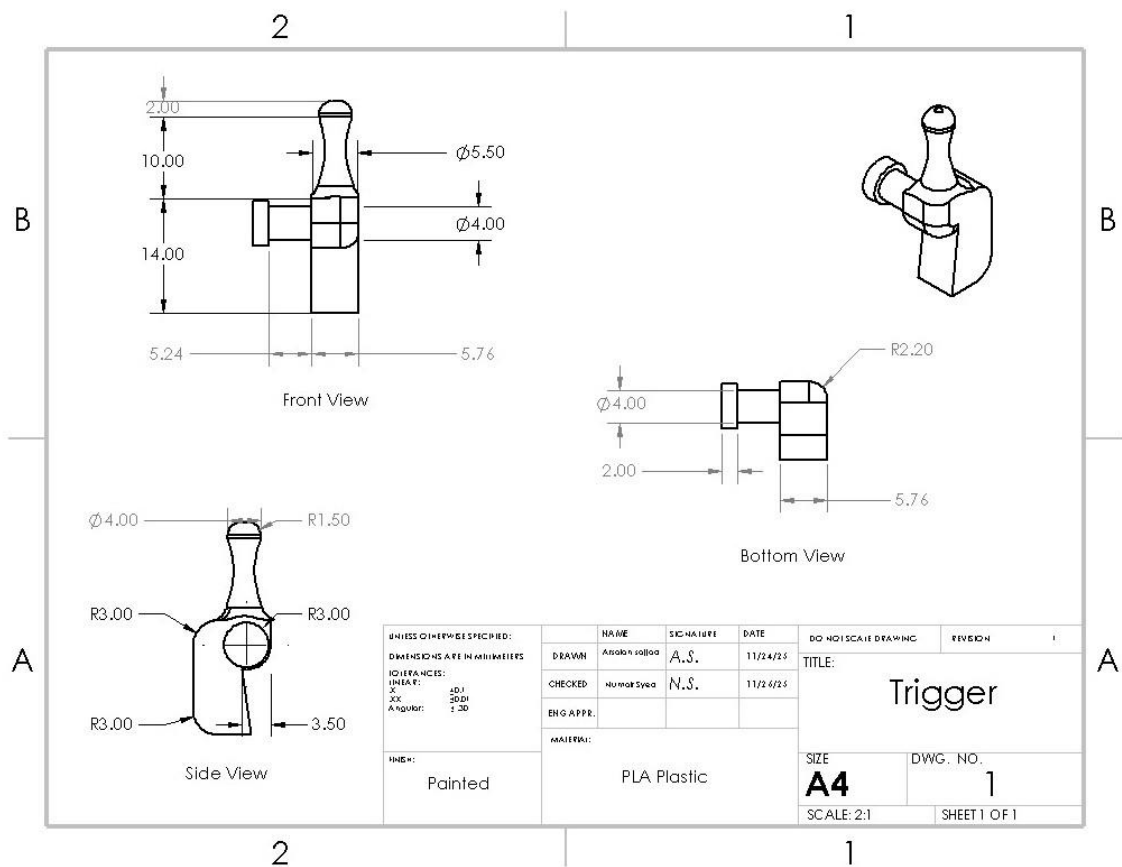


Figure 6: Trigger

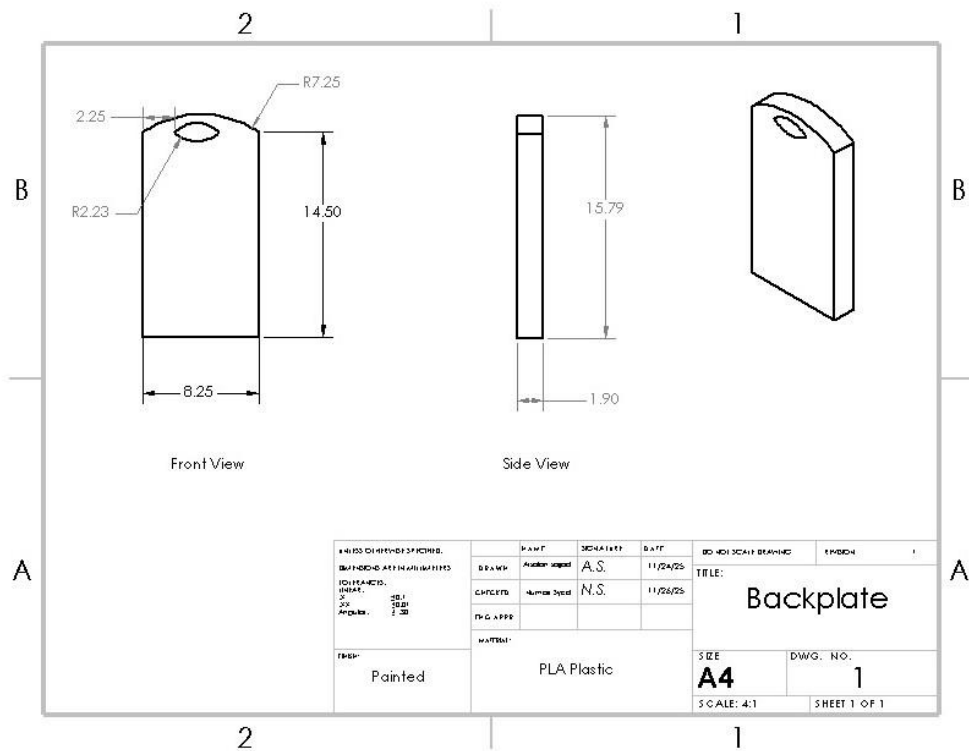


Figure 7: Backplate

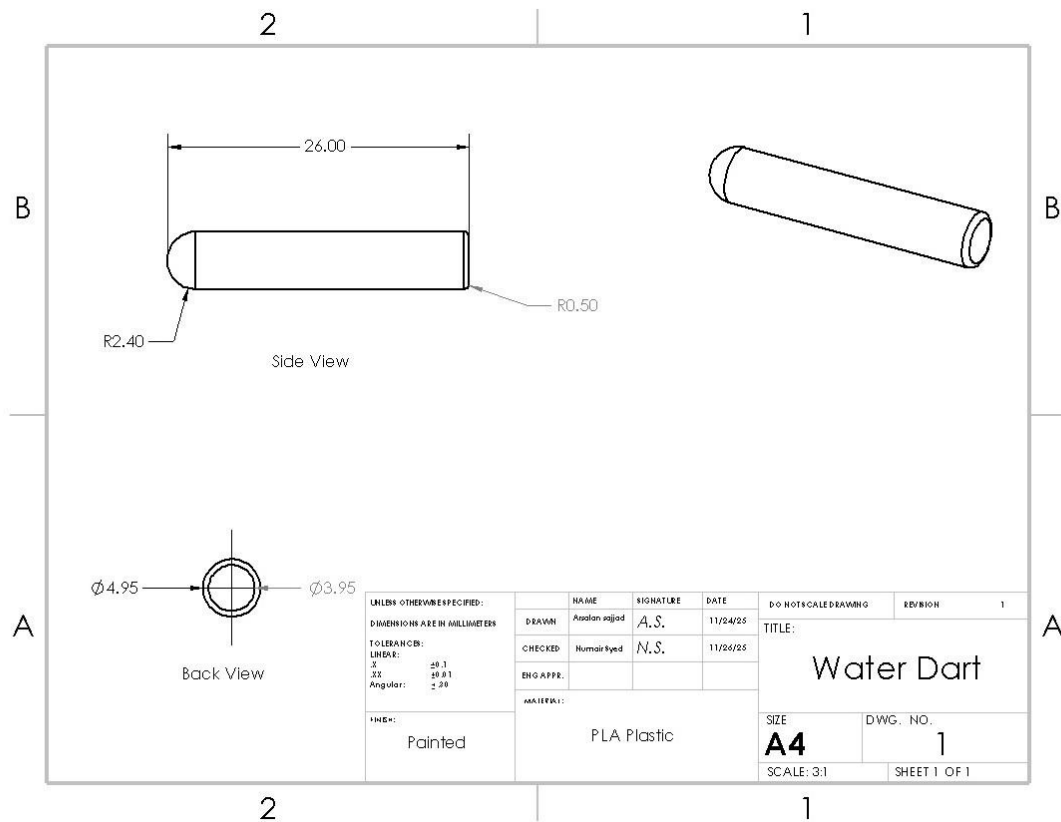


Figure 8: Water Dart

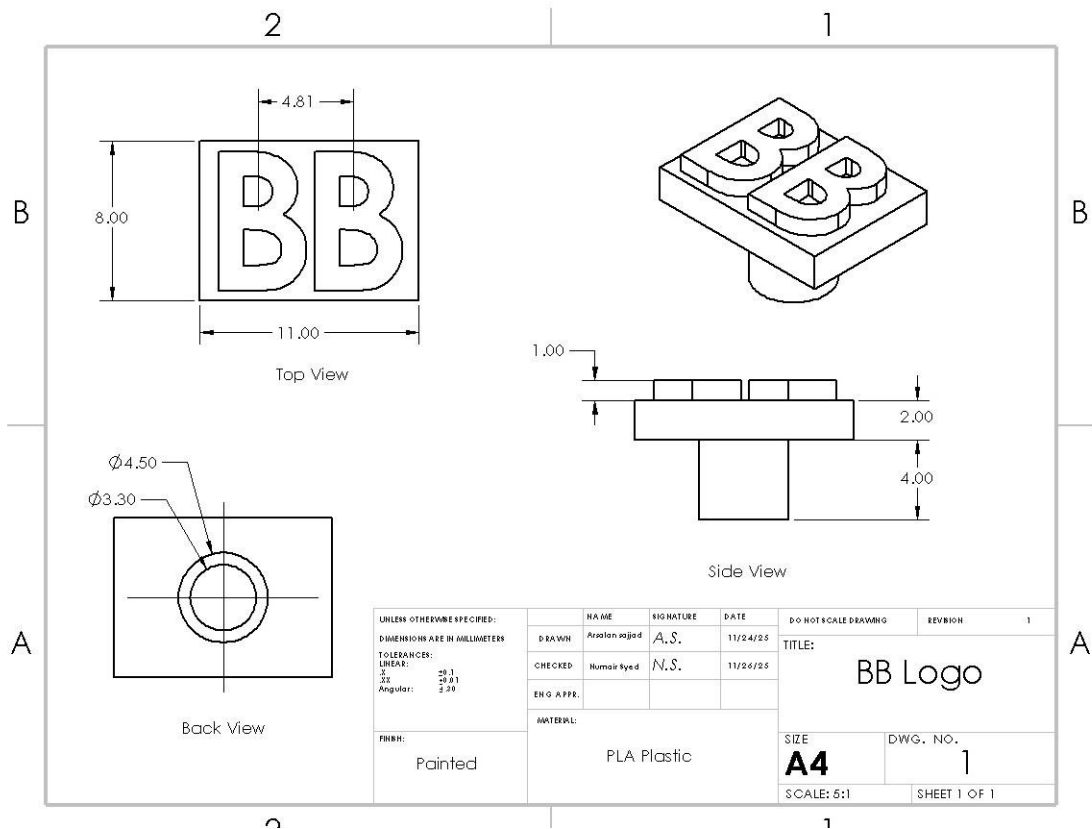


Figure 9: BB (Blaze Buster) Logo

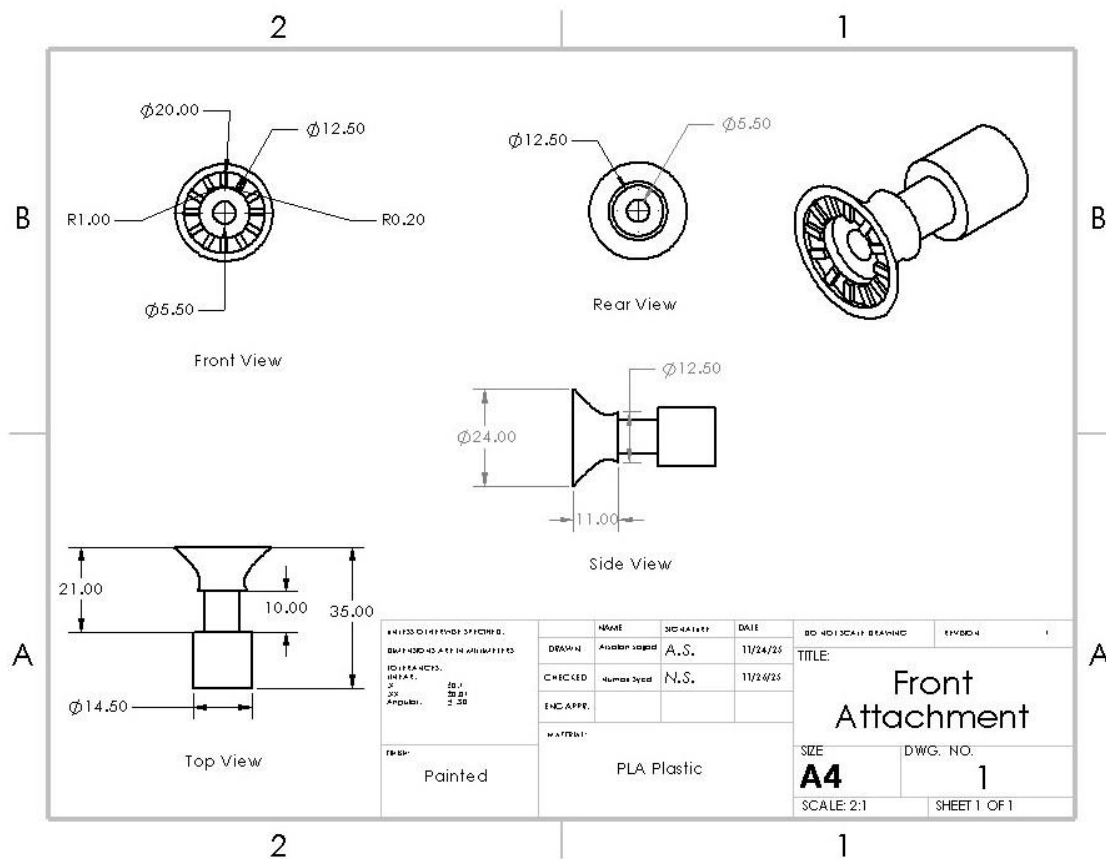


Figure 10: Front Attachment

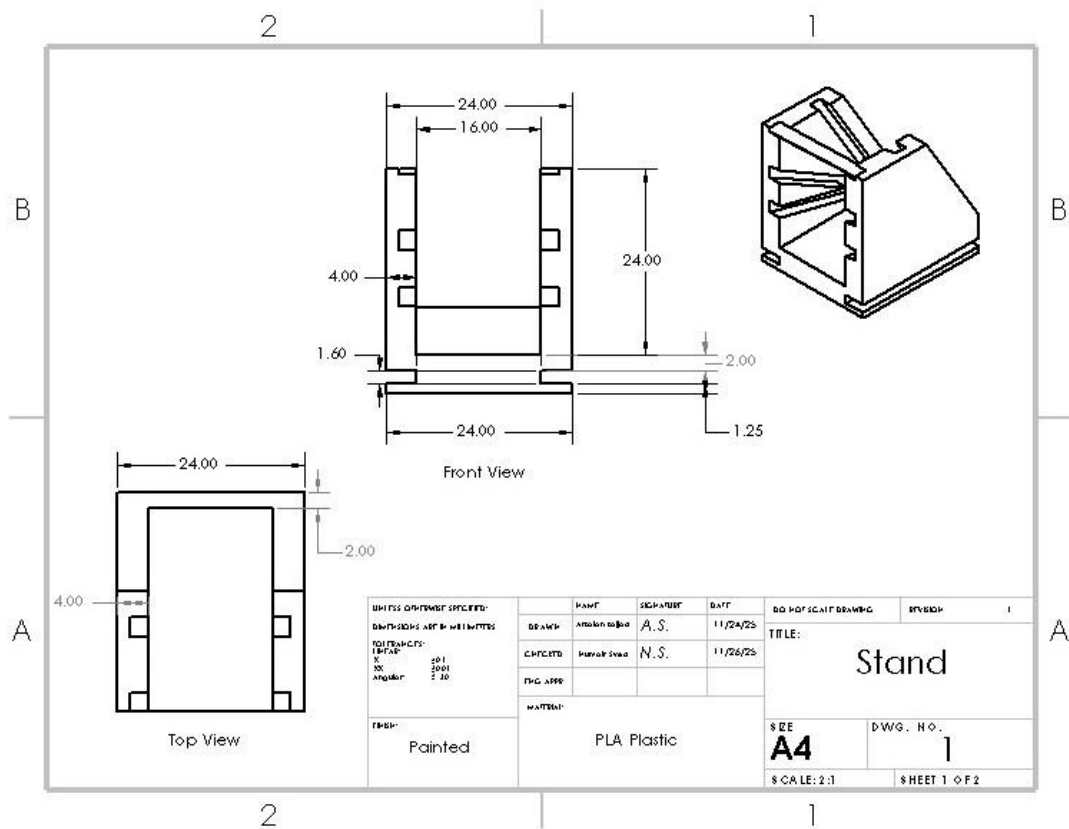


Figure 11: Stand (Part 1)

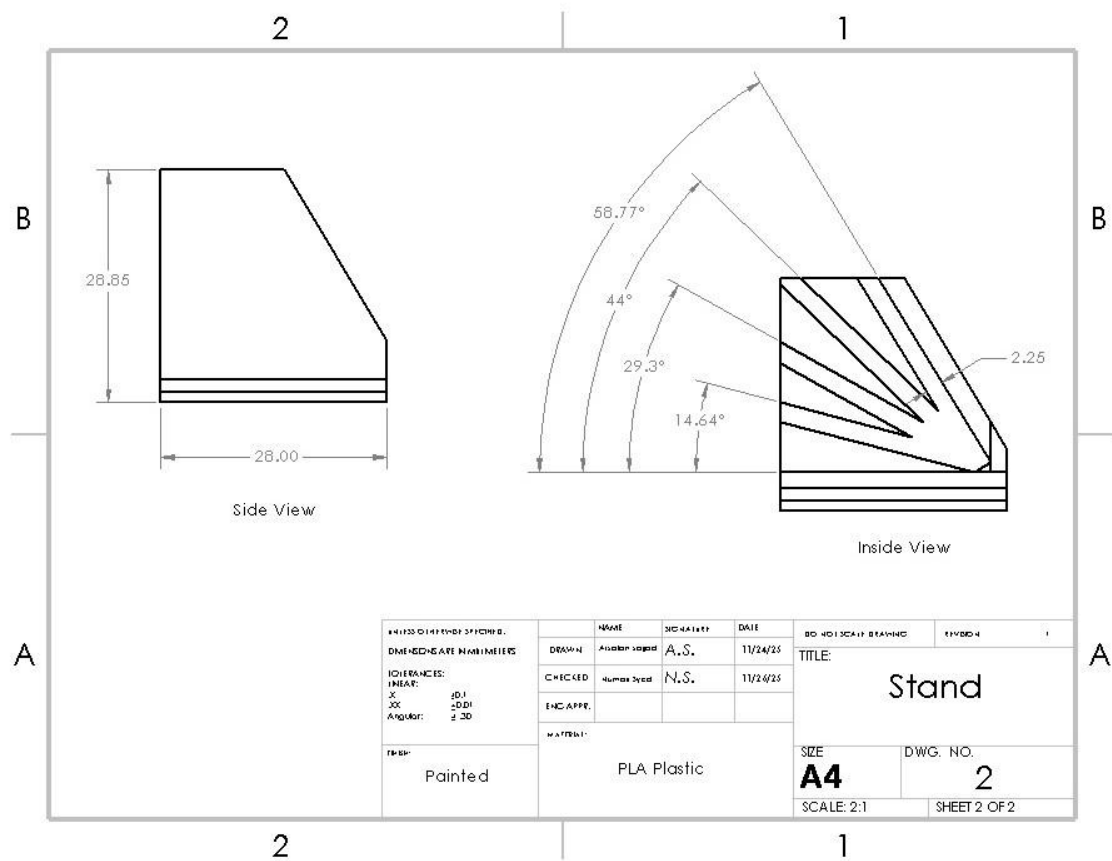


Figure 12: Stand (Part 2)

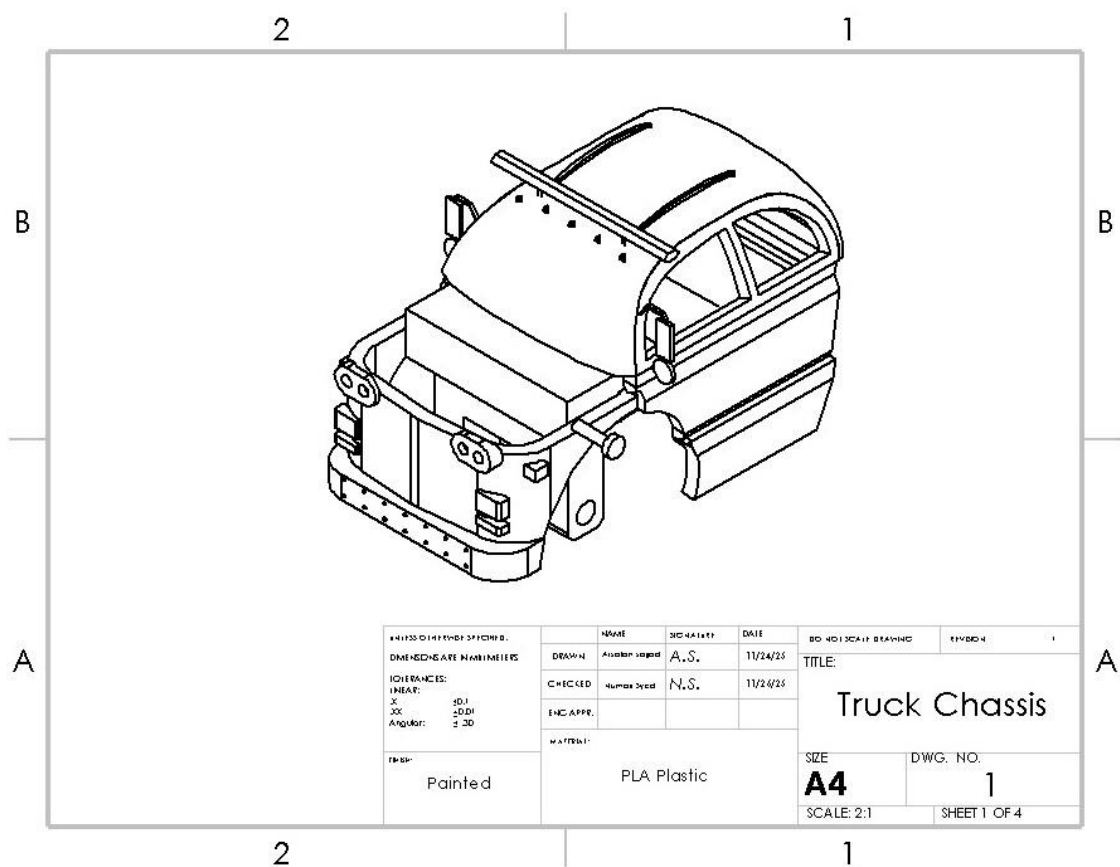


Figure 13: Truck Chassis (Part 1)

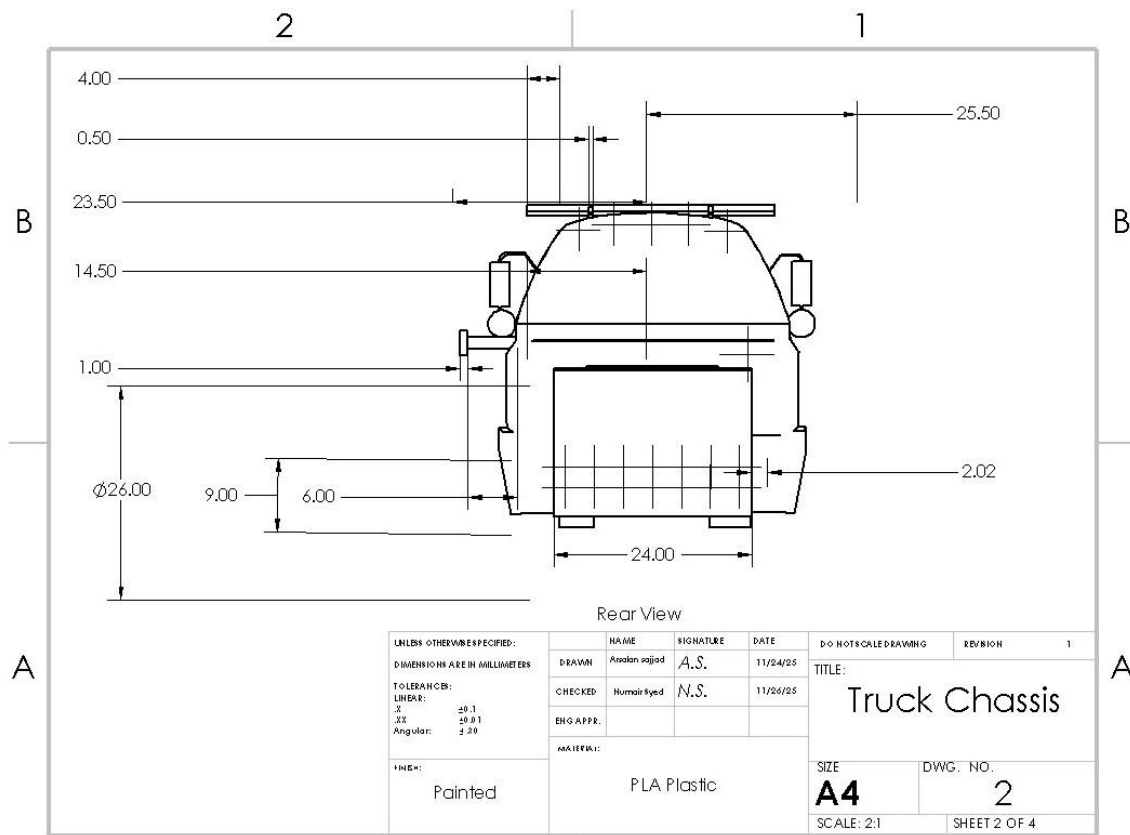


Figure 14: Truck Chassis (Part 2)

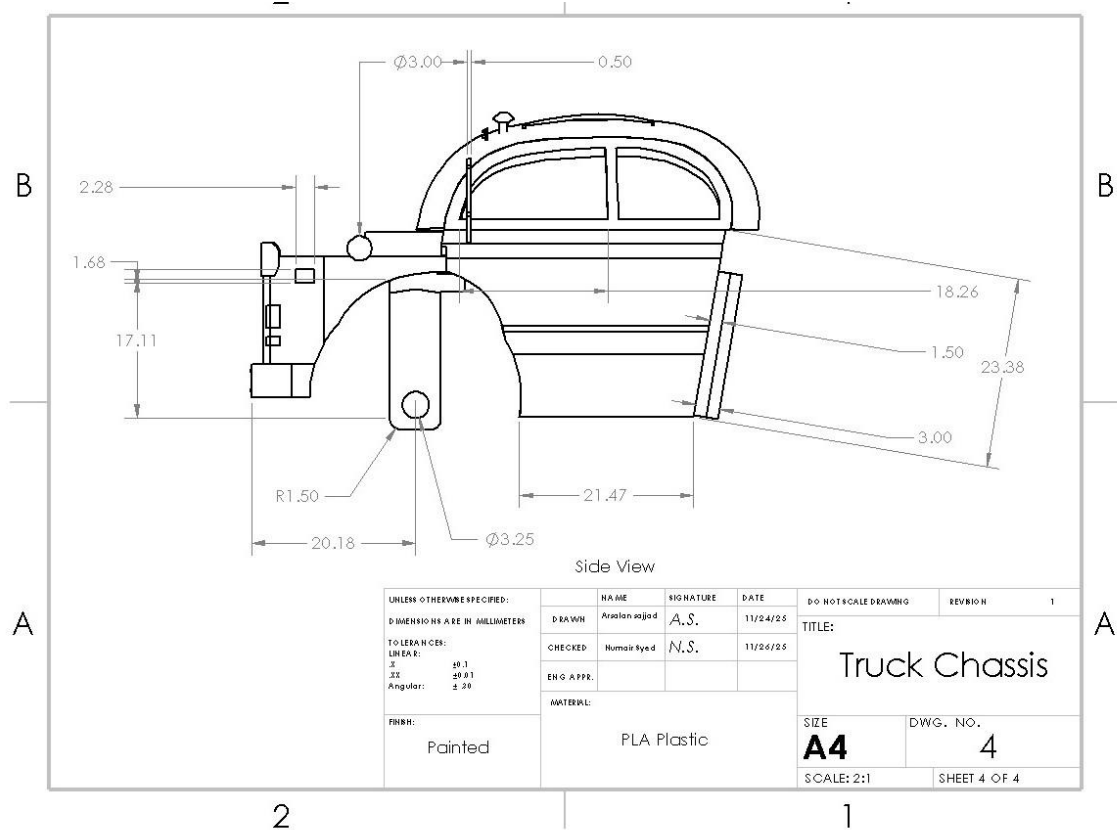


Figure 16: Truck Chassis (Part 4)

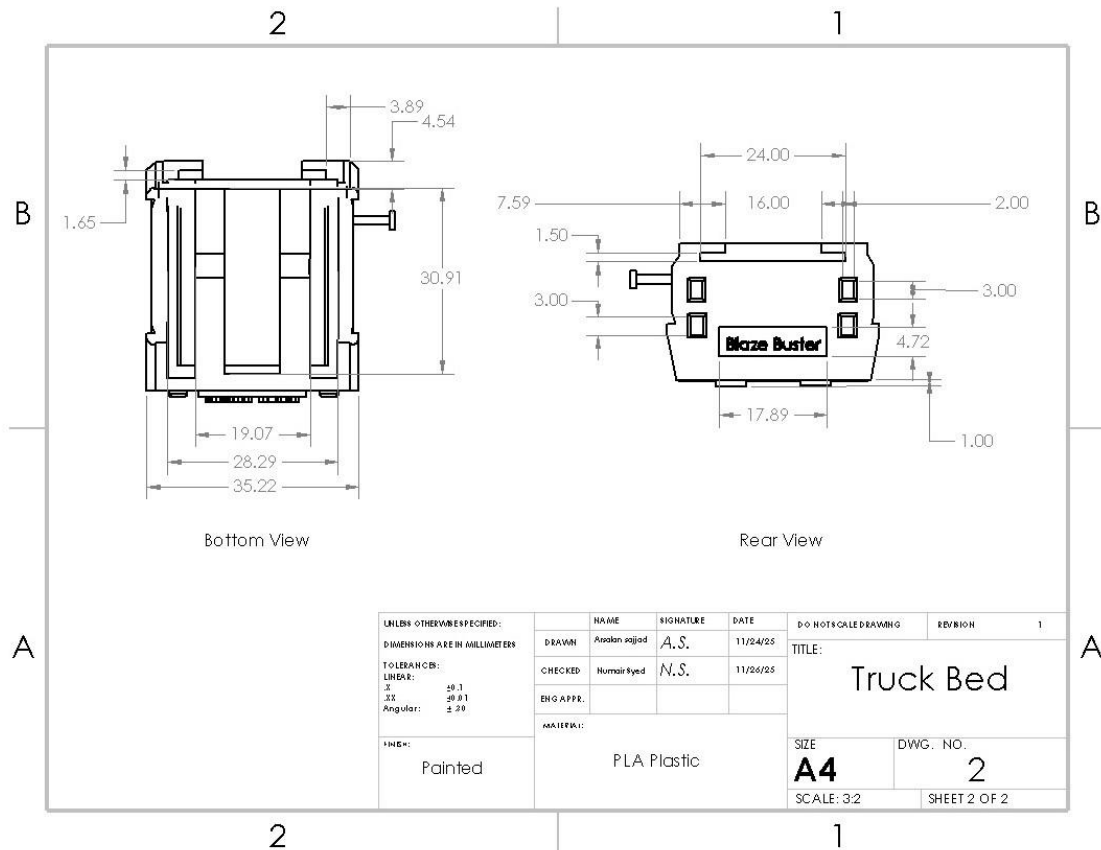


Figure 18: Truck Bed (Part 2)

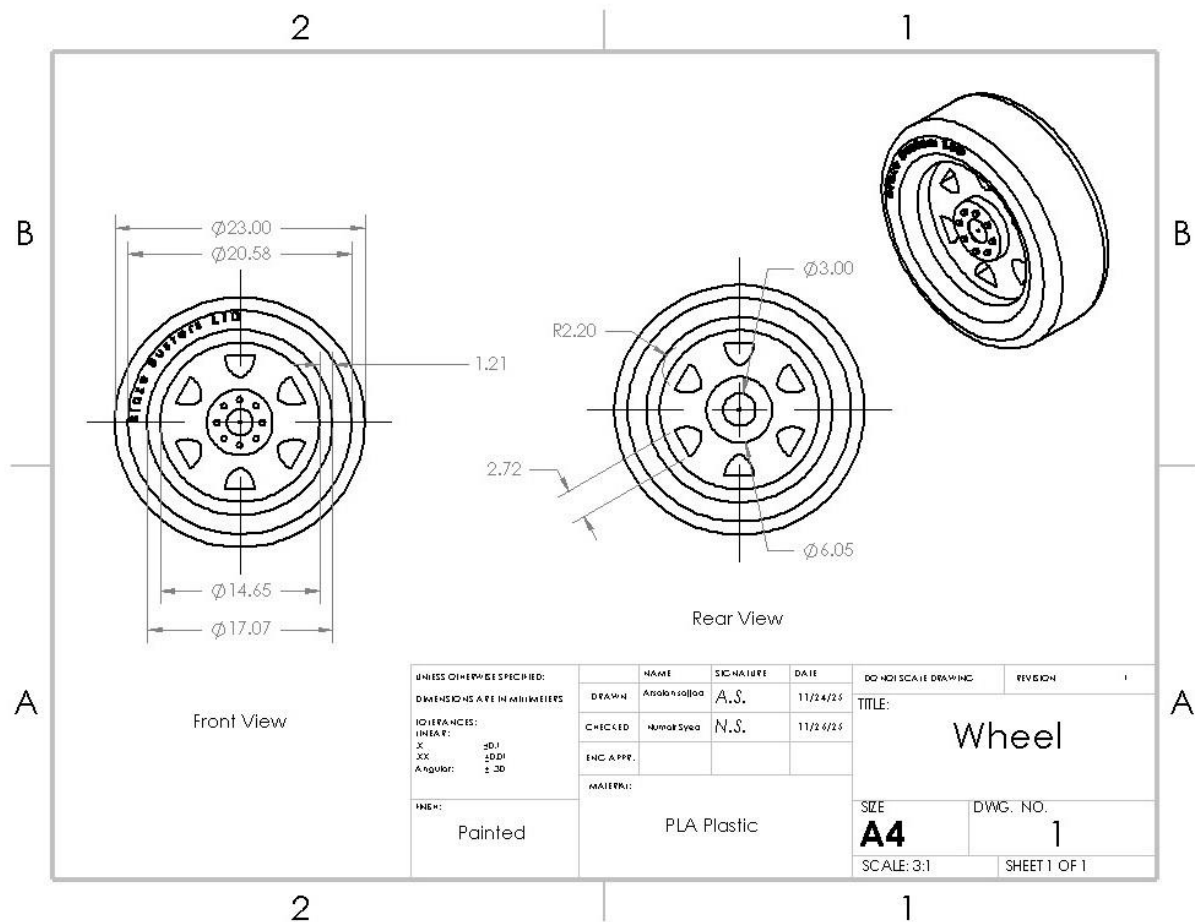


Figure 19: Wheel

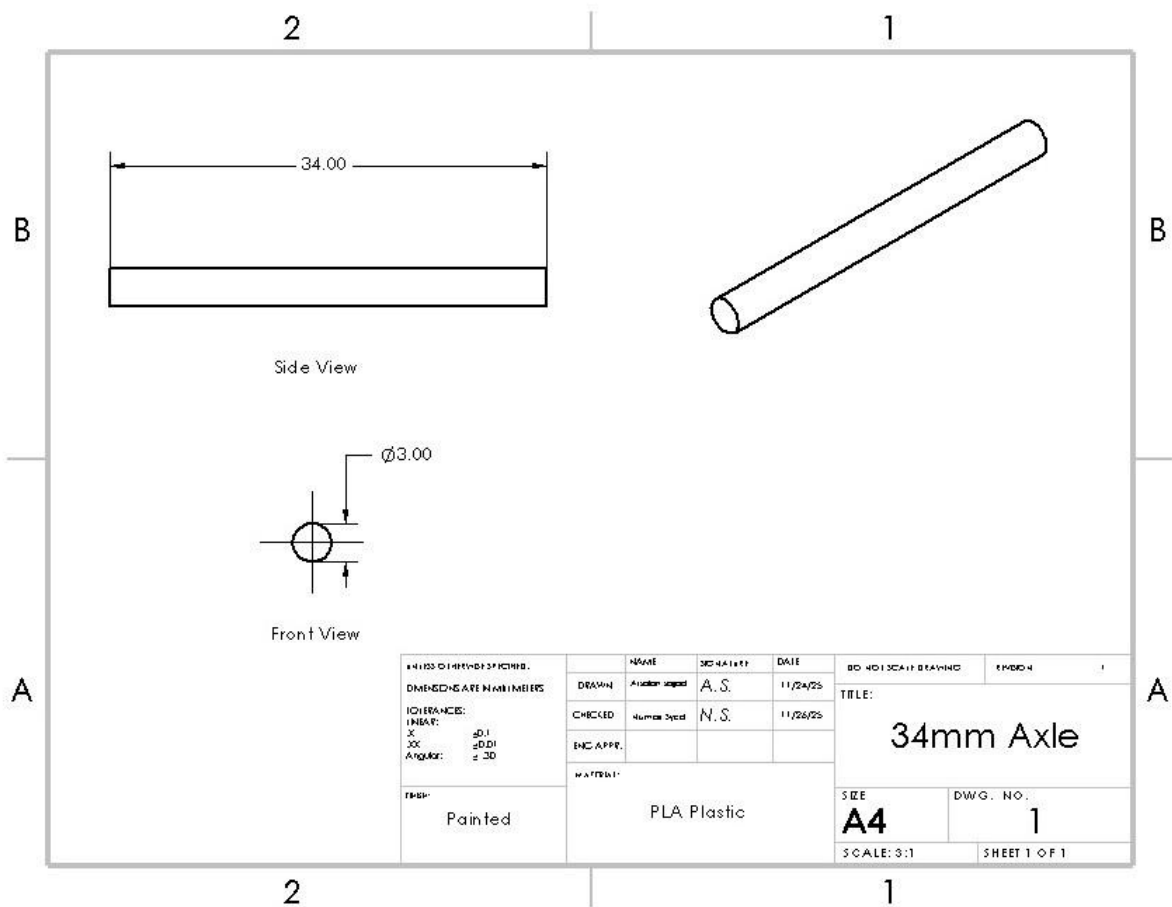


Figure 20: 34mm Axle

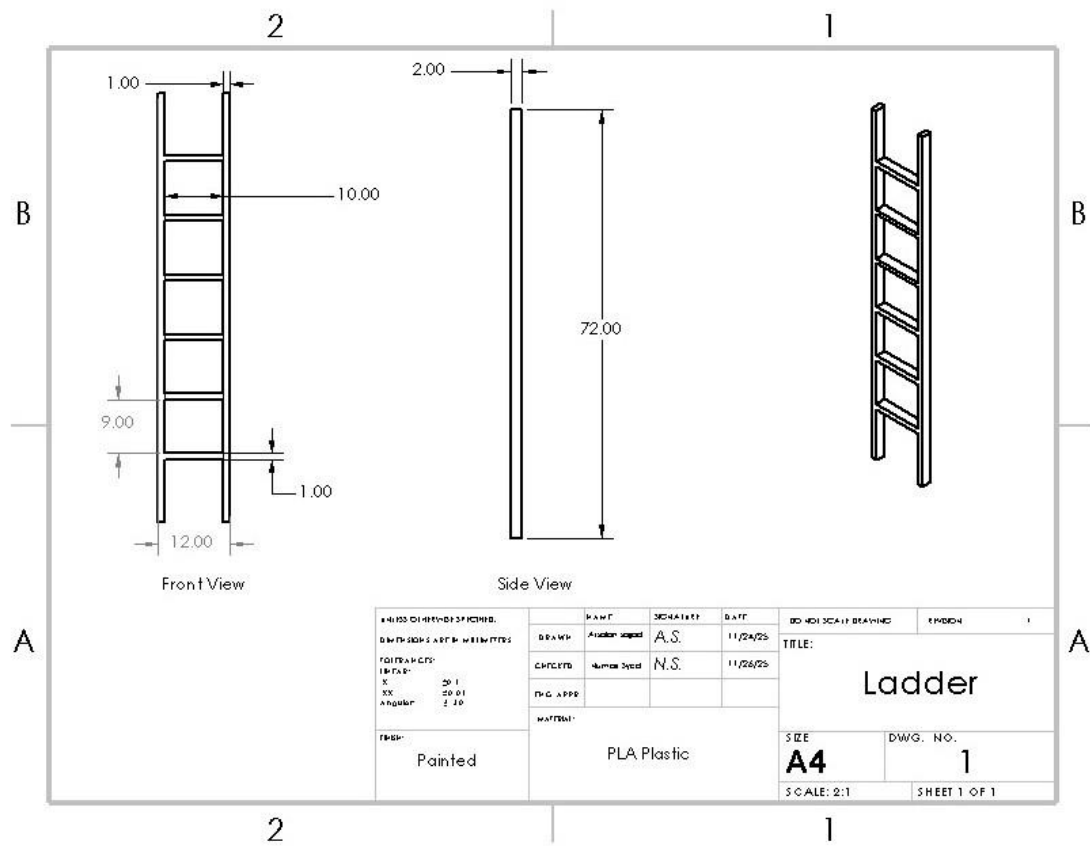


Figure 21: Ladder