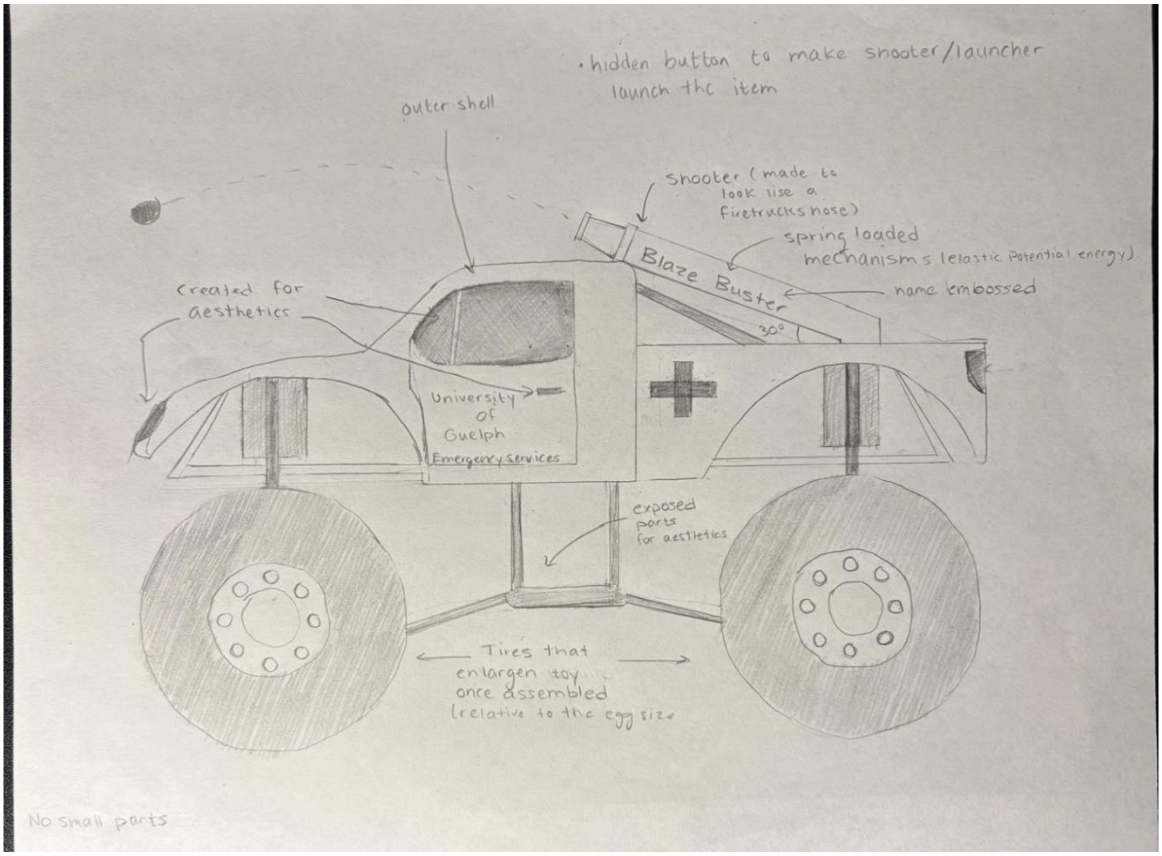

The Blaze Buster Kinder Toy Concept

ENGG*2100

Group (4)

Numair Syed

Executive Summary

This report introduces the proposed design of the group, Blaze Buster. The Blaze Buster is a monster fire truck developed for Kinder™ as part of the Emergency Services theme collection. It combines the thrill of a monster truck with the functionality of a fire truck. This offers children a fun and imaginative firefighter experience. With the spring launcher firehose, children can extinguish fires by shooting a water ball more than 2.5 meters away. The Blaze Buster transforms stored elastic potential energy with the help of a spring-loaded mechanism into kinetic energy to launch a projectile. The toy is kid-friendly and does not require any parental supervision, tools, adhesives, or power. Approximately 75% of the toy parts will be 3D printed in PLA. The goal is to reduce production cost and increase durability, while making the toy lightweight. All parts fit inside the 10-centimeter-diameter Kinder™ egg when disassembled. When constructed, the Blazer Buster is to be bigger than the egg and to be aesthetically pleasing. The Blaze Buster is both entertaining and educational. It teaches children concepts such as energy conservation (potential energy to kinetic energy and projectile motion as they play imaginatively. The Blaze Buster prioritizes safety and user-friendliness, aligning with Kinder™'s goal to create toys that teach through enjoyment and innovation.

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.*

Name (Printed)	Signature	Design Contributions & Sections Written or Edited
		Constraints & Criteria, Design process
		Executive Summary, Project Management
Numair Syed	Numair	Problem Definition, Constraints & Criteria, Design Process, Conceptual Designs, Design Evaluation, Proposed Design, Design Description, Design Defense, Project Management, Conclusion & Recommendations, References

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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].

This project aims to design 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, travel 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].

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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 for which a product/project can be judged by [3]. In this case, the project goal is designing an emergency service-themed Kinder™ Surprise toy targeted towards children aged five and above. 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.

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 an 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, energystorage 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.

<u>Group-Determined Criteria:</u>

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

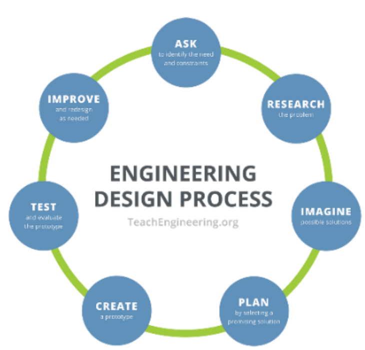

Figure 1: Diagram of an Engineering Design Process [4]. The key stages that were followed in developing the toy concept

The design process for this project followed the structured steps of the Engineering Design Process (Figure 1). This guided the 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 group 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 design 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

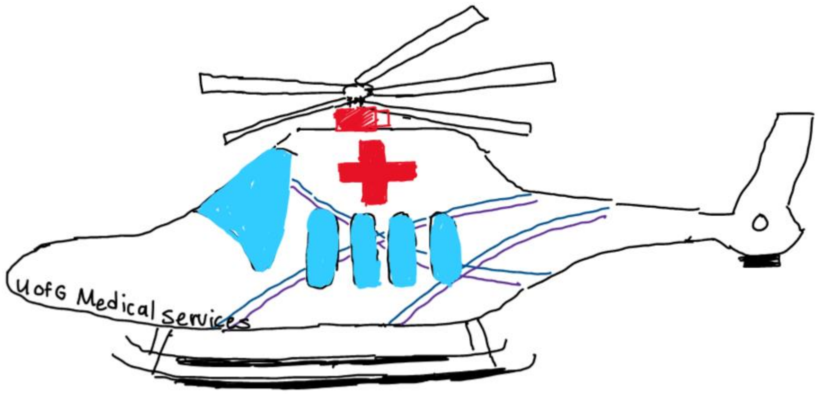

Figure 2: Concept Sketch 1- Time-Based Air Ambulance Toy. An air ambulance (helicopter ambulance), with a propellor that launches into the air for a certain amount of time using stored elastic potential energy from a spring mechanism.

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.

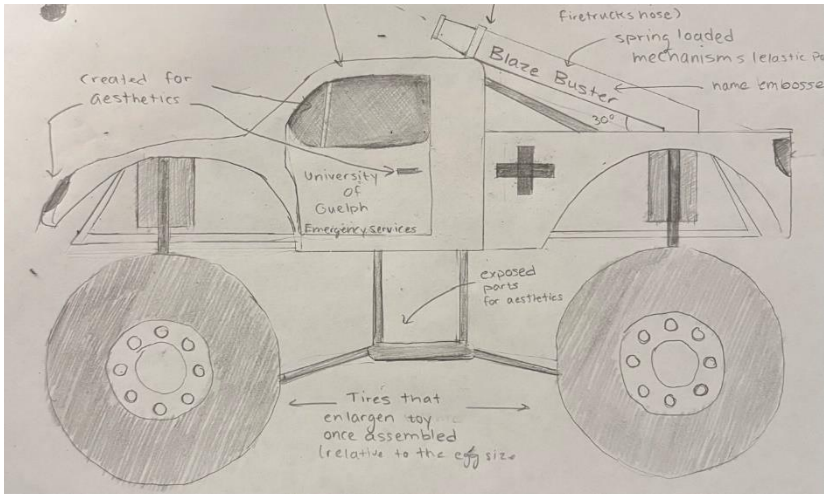

Figure 3: Concept Sketch 2 – Blaze Buster Projectile Toy. A monster truck with an attached projectile launcher in the form of a firetruck hose.

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.

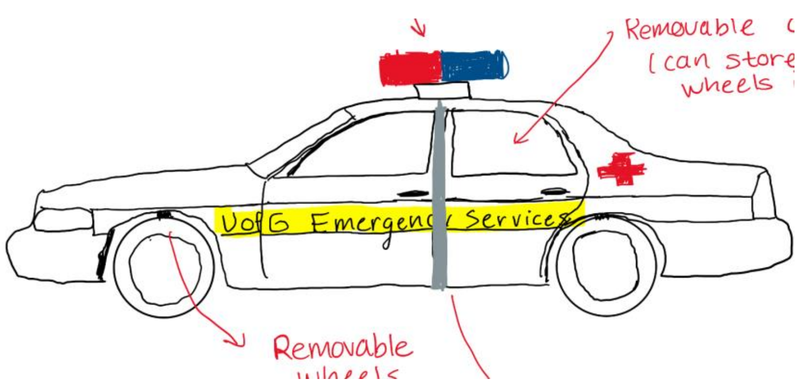

Figure 4: Concept Sketch 3 – Timed-Based Police Car Toy. A monster truck with an attached, with a propellor that launches into the air for a certain amount of time using stored elastic potential energy from a spring mechanism.

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	Air Ambulance	Police Car
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 the group'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 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 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.

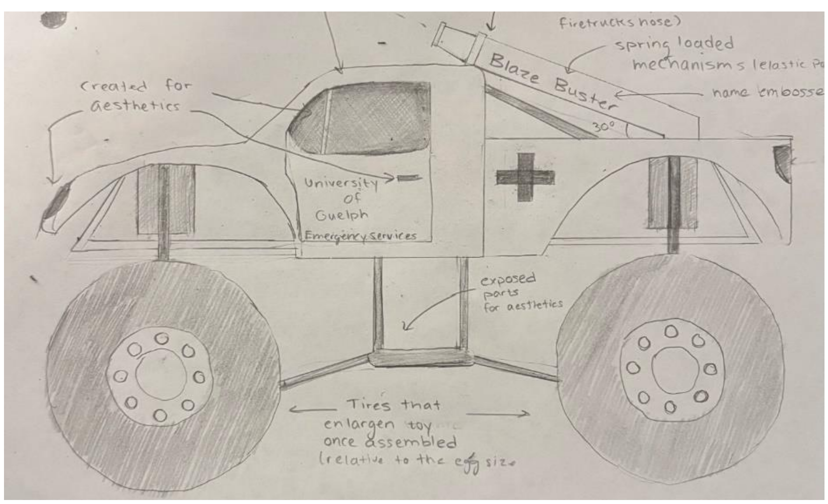

Figure 3 (repeated): Concept Sketch 2 – Blaze Buster Projectile Toy. The chosen design toy.

Key features of the 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.

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.

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.

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 Project Management

6.1 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 3: Budgeting Table.

ITEM	*ESTIMATED COST (CAD)*	*NOTES*
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.

6.2 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 4: the Critical Path Method.

TASK	*PREDECESSOR*	*DURATION*
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, in order 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. 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.

7 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, 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 an effective spring-based mechanism. While the Air Ambulance and Police Car also met several project requirements, their performance in key areas such as appearance, mechanism practicality, or long-term durability made them less compelling compared to the Blaze Buster.

Looking ahead, the recommended next steps focus on refining the chosen concept to improve manufacturability and user experience. This includes simplifying tire assembly for easier capsule storage, ensuring the design stays within printing constraints, and conducting additional prototyping to verify the launcher's reliability. By addressing these refinements, the design will better meet the criteria outlined in Section 1.2 while maintaining a high level of engagement for the target users. Overall, the Blaze Buster's strong alignment with the project's goals and constraints makes it the most suitable concept to advance into further development.

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Appendix A

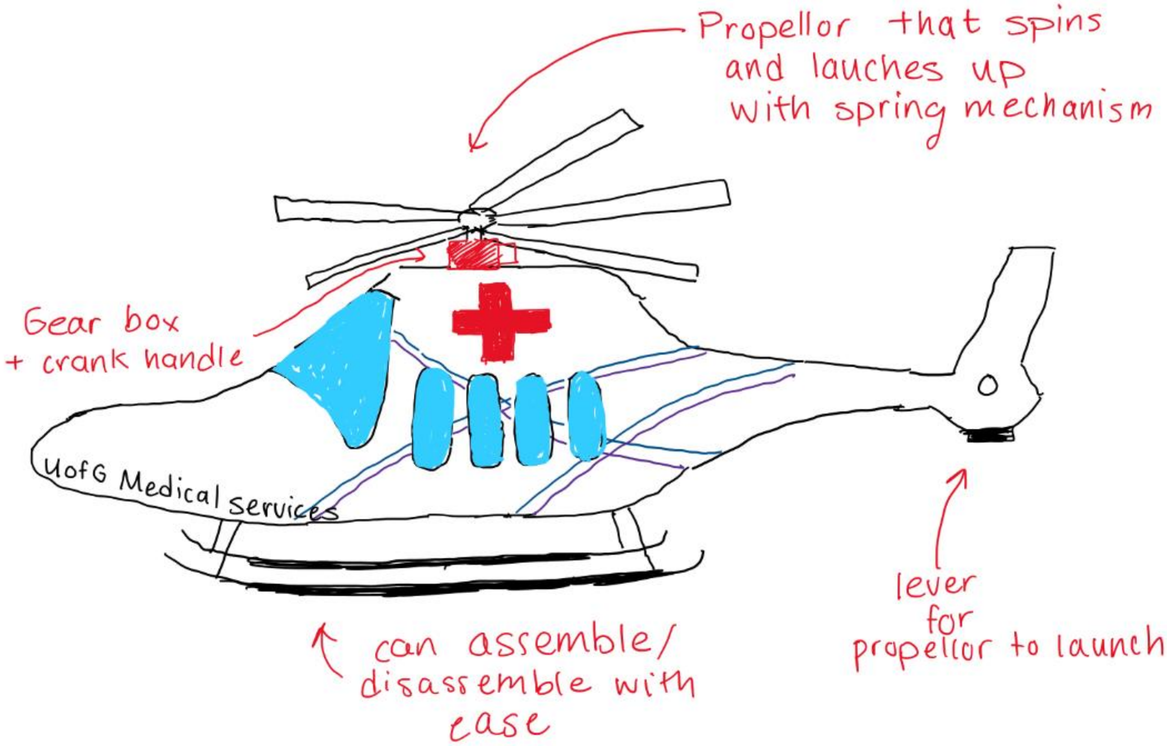

Figure 1: Full Concept Sketch of the Air Ambulance

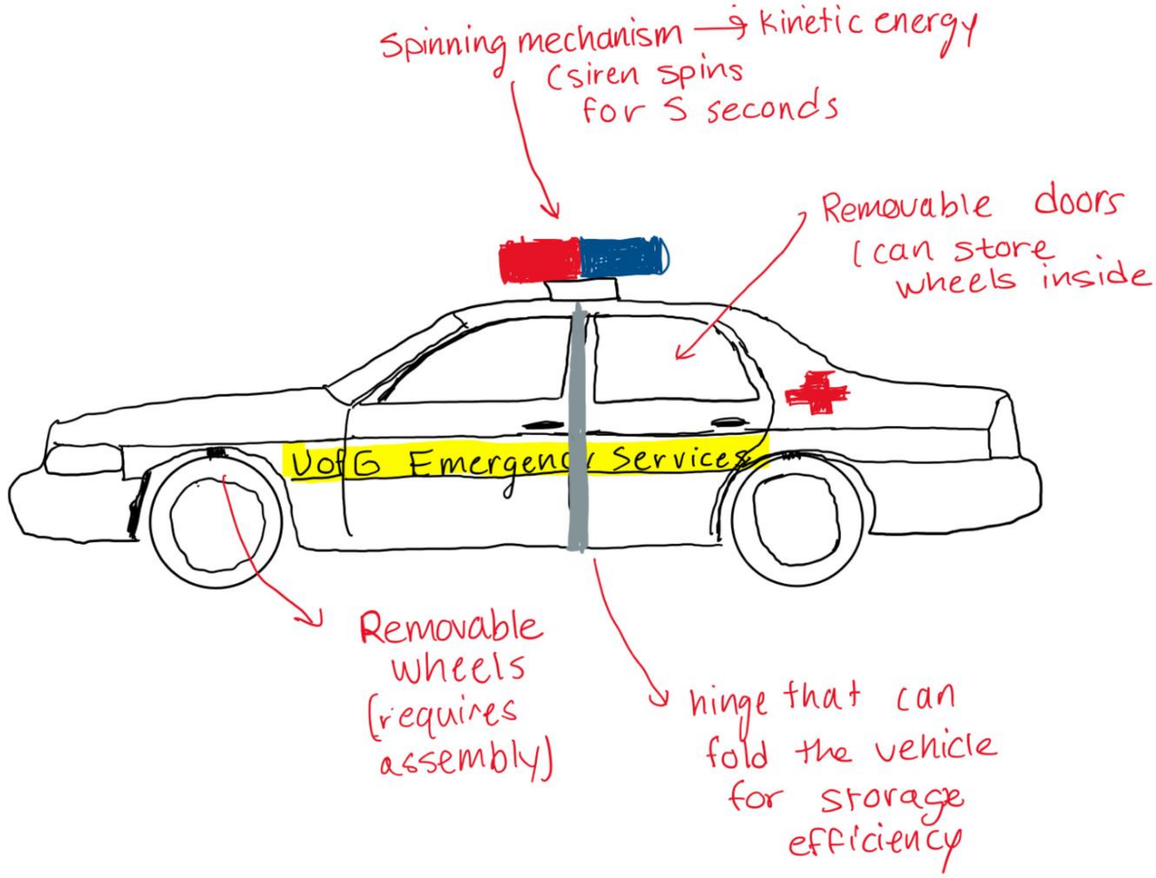

Figure 2: Full Concept Sketch of the Police Car

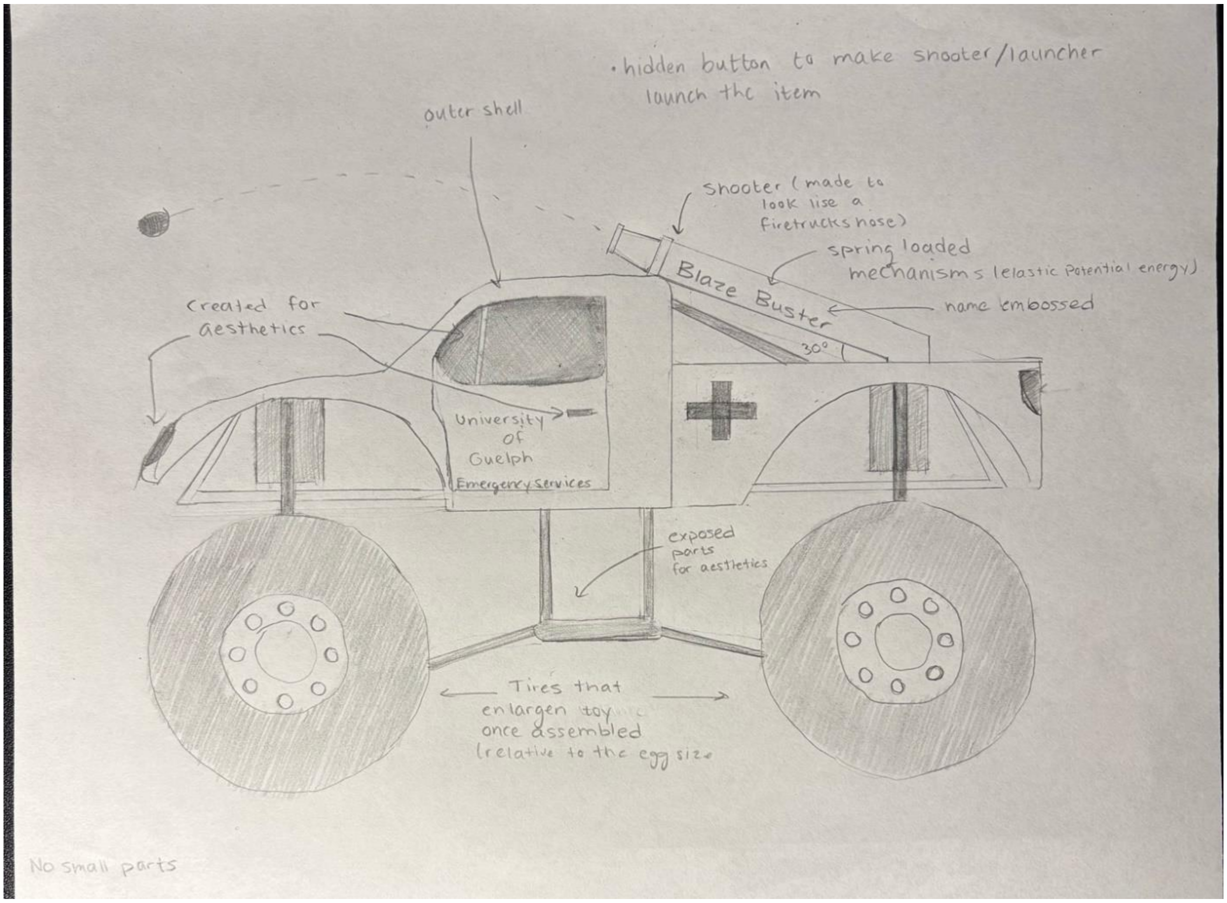

Figure 3: Full Concept Sketch of the Blazer Buster