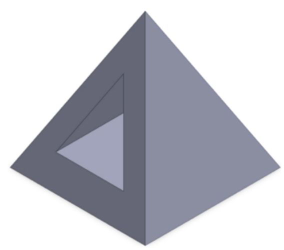
Northeastern University
College of Engineering

GE1110 Engineering Design

STEM Toy Project

Cubespective



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Report Submitted: **14 December 2021**

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14 December 2021
Dr. Leila Keyvani
368E Snell Engineering
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Dear Professor Keyvani,

Our group, Team Top Left, is proud to present the findings and process that led to the creation of our STEM toy, Cubespective. Cubespective is a game focused on geometry that teaches young children (5-6 y/o) about perspectives in a creative and engaging manner. Using simple yet interesting figures, our game allows for dynamic play with our target audience.

We performed research into what factors would be most important in the creation of our toy. We then brainstormed ideas for our final product, and after several rounds of ranking and consideration, we decided on our final idea. We would hone this idea through our design process, creating something different from what we anticipated in the form of Cubespective. After testing, our group found success with our target audience and are pleased with the feedback we have received on our final prototype.

Going through this process was a new challenge for most of us. While we had some slowdowns, it was an informative and interesting experience, culminating in our final product. Through Team Top Left's perseverance, we were able to realize Cubespective and present it to our target audience, and we look forward to seeing what we can do with this concept in the future.

Sincerely,

Max Correia

Benjamin Feng

Ben Feng

Susana J. Noto

Susana Noto

Niki Manolis

Niki Manolis

Paloma del Barrio Cabello

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Learning problem solving skills and creative thinking at a young age sparks an interest in STEM, and many modern products obstruct this stage of development. Currently available STEM-based designs have a heavy usage of digital components and mobile applications.

Our solution was a toy that built children's confidence in discovery with STEM. The users needed a design that involves hands-on learning without the need for a digital screen, and it would reach all users in our target audience. We decided to focus on the STEM topic geometry. Additionally, we had to remain within an $80 budget and the toy must be safe.

Our final solution was Cubespective: a hands-on geometry toy that practices spatial reasoning and problem-solving using shapes and perspectives. To get to this solution, we first brainstormed possible solutions and did market research to develop ideas. We then used various tables to compare our possible solutions based on if they met our objectives and constraints, as well as safety concerns. We found the most successful solution from these charts and then created drawings for the product using AutoCAD and SolidWorks. We finalized our designs and produced a prototype using cardboard and foam to replicate the size and function of our final product. We then produced the final toy using a laser cutter, wood, and hand-made the 3D shapes.

We can conclude that our toy was successful; through various evaluation and peer feedback, our toy reached user enjoyment, was noted as educationally stimulating, was functional as intended, safe, and inclusive to all. We managed to withhold these goals within our $80 budget as well.

1. INTRODUCTION

Before we began development, our group performed research on our target audience and the market of STEM toys. After compiling our research, we used both the information we found and the problem statements we had made to come up with a defined problem statement that would guide us going forward in the design process.

1.1 PROBLEM STATEMENTS

Our group aims to create a STEM toy that is both educational and naturally engaging while working around the constraints and objectives we have been given.

The STEM toy market has been inundated with too many products, giving consumers too many choices and often preventing them from receiving the best products they could possibly purchase. Despite this problem, there are many aspects of the STEM market that have been overlooked, and as such there is untapped potential in a market that appears to be oversaturated.

Our group will develop a STEM toy that targets one of these niche STEM topics to capitalize on this underutilized market.

Top Left aspires to create a toy that teaches STEM in children in an engaging way. While keeping a budget under $80, we want to create a toy that teaches geometry in a safe and open-ended way. With the market being oversaturated with purely building based toys, we want to create a toy that allows children to explore a different aspect of geometry while still working on their tactile motor skills.

Top Left intends to envision a toy that teaches geometry in a way that creates a learning environment with the children even realizing it.

STEM toys are heavily sought out by parents these days, with the growing job opportunities in the field. STEM can be a very intimidating field of study if not introduced to children at a young age. Our team intends to make STEM a less intimidating subject by making a toy that children will not realize is an educational tool. With fun colors and an entertaining concept, these children will be so entangled in the toy, they will not realize the vital information they are learning.

With the world three-dimensional world around us, we intend to teach children about three-dimensional geometry in an open-ended game. By using a three-dimensional design, the children will easily be able to compare the toy the world around them, and thus improving their skill of making connections.

In recent times, children play with toys that are meant to waste their time rather than enrich them.

Learning problem solving skills and creative thinking at a young age sparks an interest in STEM, and many modern products obstruct this stage of development. Currently available STEM-based designs use gender targeted marking and have a heavy usage of digital components and mobile applications.

Ideally, our solution will be a STEM toy that builds the child's confidence in discovery in STEM. The users need a design that involves hands=on learning without the need for a digital screen, and it will be made accessible for all users in our target audience. Our group discussed the STEM topics that our toy could target, and we decided to focus on geometry; it is a simple enough concept for our target, and we decided to focus on geometry; it is a simple enough concept for our target audience, children ages 5 or 6, to comprehend and the components of the toy will be sturdy and large enough for a child of that age not to choke on. Additionally, we must fulfill all these wants and needs with an $80 budget.

In summary, our design will encourage a hands-on experience in learning geometry without the use of electronics and will remain simple and cost-effective. The design will include attractive packaging to gain the attention of the buyers. Additionally, it will be built with the goal of replay value; the user should not get bored while playing with our product. This way, our target audience can be educationally entertained in a subject that is within their area of understanding while remaining fun; focusing on education should not come at the cost of a more uninteresting product.

1.2 BACKGROUND

1.2.1 Users

a. Our target audience is 5-6 years old. At this stage, these children can count 10 or more items at a time and can recognize simple geometric shapes (Centers for Disease Control and Prevention 2021). They are also able to distinguish between gender, and as such can distinguish masculine and feminine toys (Servin et al. 1999).
b. These children are likely to be playing with our toy in either a home or school environment, with varying amounts of floor and tablespace. There are likely to be other toys within their vicinity.

1.2.2 Need for STEM toys

Within our research, we found several studies regarding the development of geometric recognition in our target audience. Notably, most children have the potential to identify semi-complex shapes as early as 3 years of age, yet many are not taught to utilize these skills (Resnick et al. 2016). They also have the capability for spatial reasoning (Pritulsky et al. 2020), something that most toys do not appear to directly capitalize upon. Our market research indicated a boom in new robot-based toys, yet not much innovation has been made in geometry-based toys. We believe that if we create a toy that

1.2.3 Current solutions

During our market research, we found a plethora of STEM toys that taught both educational and tactical skills to children. For example, a popular geometry toy, Magnitiles, teaches geometry, motor skills, and building (Evans, 2021). Additionally, many toys we found that work with geometry focus on the building aspect of it: Velcro Brand Blocks Construction Set (*Velcro® brand FASTENING SOLUTIONS: Velcro Companies* 2021), Geometric Shapes Building Set (*Geometric shapes building set*), Equilibrio (Client, 2020), and Magna Qubix (*Landing Page – magna-qubix,* 2021). Because the market is heavily saturated with these building toys, as a team, we decided to steer clear of a geometry toy only based on building. We came across a toy called Colour Code (“Colour Code - SmartGames” n.d.). This toy uses perspective to teach young children about geometry and shapes. We were fascinated with the idea of teaching children perspective but in a 3D form, as the world we live in is three dimensional.

1.3 DEFINED PROBLEM STATEMENT

Our group aims to create a unique geometry-themed STEM toy that will adhere to the objectives and constraints we have been given.

Our research has shown us that there is a lack of new and innovative geometry-based STEM toys in today's market. We believe that this is an untapped market, and our toy aims to experiment with the possibilities that a new geometry-based STEM toy can bring to the current STEM toy market.

Regarding our client's outline, we will create an original product that is educational, safe, and age-appropriate while remaining attractive to our target audience. It will also be portable and constructed out of at least one laser-cut/3D printed part, and our budget will be $80 or less.

We will create a STEM toy that adheres to these ideals and restrictions and will work on-schedule to create an effective and engaging product.

2. METHODOLOGY

After compiling our research, our team moved on to the ideation and design phase of our project. We brainstormed several ideas under the umbrella of "STEM toy", and after collecting these ideas we organized and rated them based on our objectives, constraints, and desirables. We would then filter these ideas based on safety; if a product was deemed unsafe it would not be considered for our final product. After selecting our final idea, we created and worked upon an initial prototype of our design before reaching our final product, which had morphed into something different from our original concept as we went through our design process.

2.1 POSSIBLE SOLUTIONS

One possible solution we came up with was that of a Geometry Darts toy. A wall-mounted board with shape names would be set up, and there would be a bag full of shapes. First, the child chooses a shape from the bag. Then they must throw the suction dart so that it sticks on the part of the board with the name of the shape. One point is rewarded to knowing the shape and a second point is rewarded if you make it on the right part of the board. This game allows children to learn while playing, a trait of a successful STEM toy.

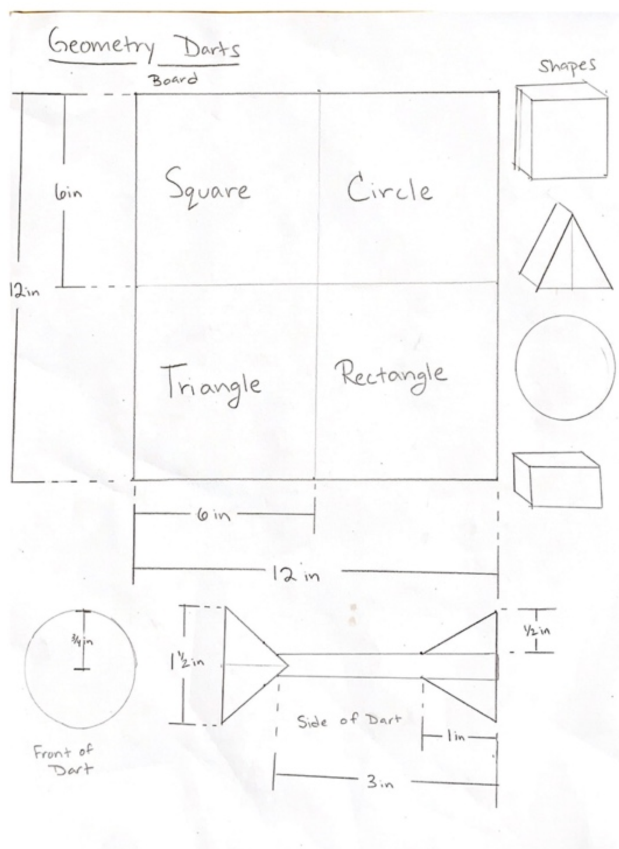

Figure 1: Geometry Darts sketch

Another solution we thought of was Color Code 3D. It would be an adaptation on the game Color Code (“Colour Code - SmartGames” n.d.) with transparent 3-dimensional figures in cubes as opposed to sheets. Users could manipulate the cubes to see different images, and they could be stacked to create different images; the same set of cubes could create multiple different pictures.

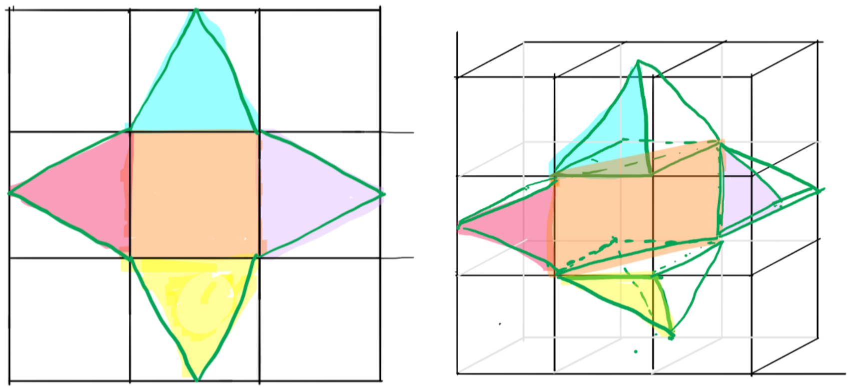

Figure 2: Color Code 3D sketch

A Velcro building toy was also suggested. Sheets of Velcro in various shapes could be used to create 3-dimensional figures, akin to how a soccer ball is stitched. The hooks of the toy would connect to the loops on the other side of the sheets, allowing one to construct figures by connecting pieces together.

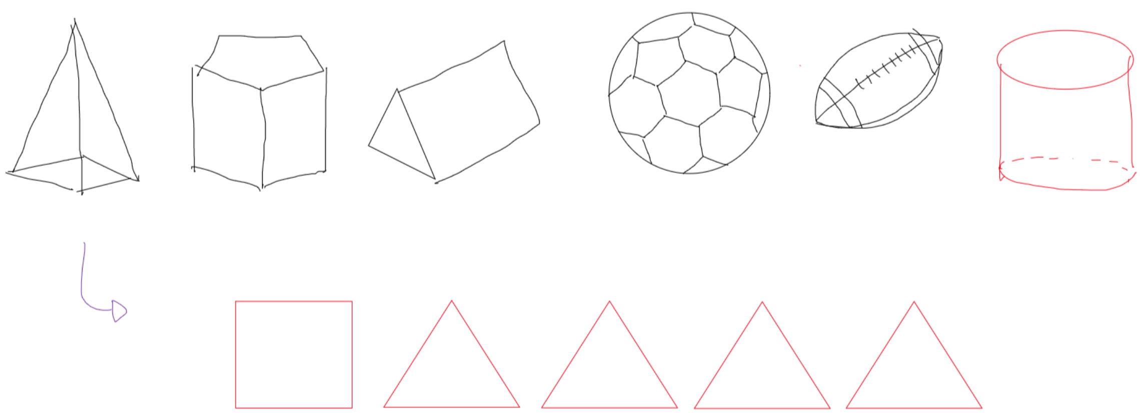

Figure 3: Velcro building toy sketch

We also ideated a figure-stacking game, named Geo Connect. It would be an adaptation of Connect 4 that involved the usage of shapes of all sorts as opposed to solely using disks. Each shape would have a counterpart, and to score, one would have to connect the correct shapes to their opposites.

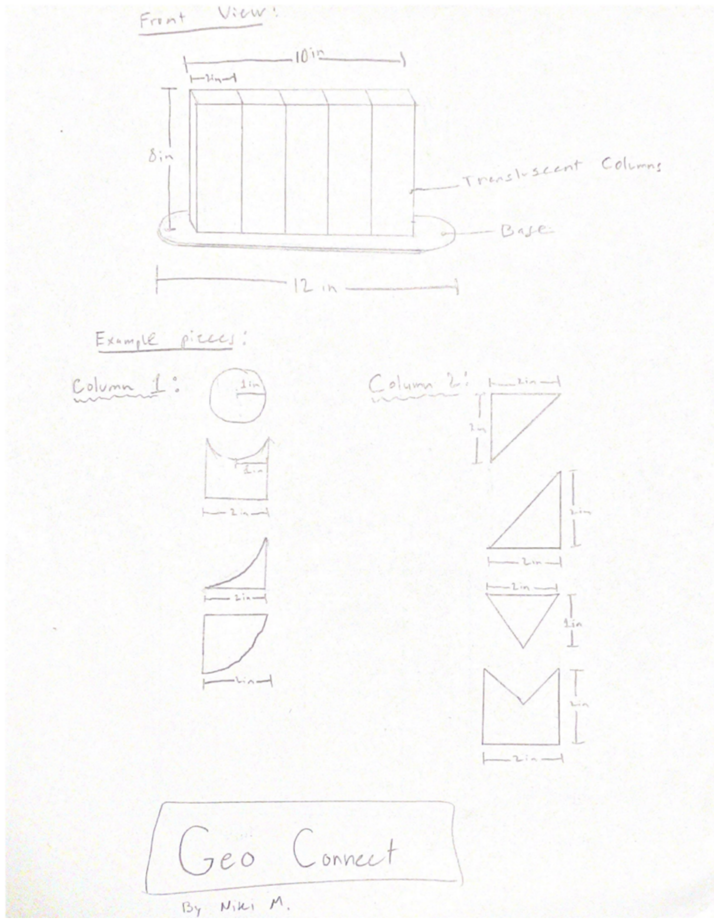

Figure 4: Geo Connect sketch

2.2 PROPOSED SOLUTION

Out of the many designs we made, we chose three of them for consideration for our final product, those being Geometry Darts (figure 1), Color Code 3D (figures 2 and 3), and Velcro Building (figure 4). We then compared each idea to our musts and wants based on our objectives and constraints. Out of the three, Color Code 3D scored the highest overall in our KTDA chart.

Alternative solutions/goals		Geometry Darts		Color Code 3D		Velcro Building	
Musts	Entertaining	Go		Go		Go	
	Safe	Go		Go		Go	
	Geometry-based	Go		Go		Go	
Wants	Weight (0-10)	Rating Scale 0-10	Score= W*R	Rating	Score	Rating	Score
inclusive	1	10	10	10	10	10	10
hands on	6	7	42	10	60	10	60
< $80	7	10	70	8	56	10	70
3D/laser part	6	10	60	5	30	8	48
open ended	7	0	0	8	56	9	63
originality	10	10	100	10	100	3	30
Total		282		312		281	

Figure 5: KTDA Chart

Afterwards, we compared these ideas based on safety using a KTPPA chart; if one toy was too unsafe, it would no longer be considered for our final product. Geometry Darts was deemed the most unsafe out of the three, and while Color Code 3D was not the safest based on the metrics we created, it was close behind Velcro Building, and combined with our previous considerations, we chose to proceed with Color Code 3D as our choice for our final product.

Table 1: KTPPA Chart

Adverse Consequences	Probability to Occur (P)	Seriousness Level (S)	Threat Value
Scale	0 -10	0 -10	P * S
Geometry Darts			
Throwing projectile	9	4	36
Choking Hazard	6	9	54
Suction cup failure	5	2	10
		Total:	100
Color Code 3D			
Sharp edges	5	4	20
Break ability	3	6	18
Too complicated	2	7	14
		Total:	52
Velcro Building			
Choking Hazard	3	9	27
Not Durable	2	8	16
Touch sensitivity	1	3	3
		Total:	46

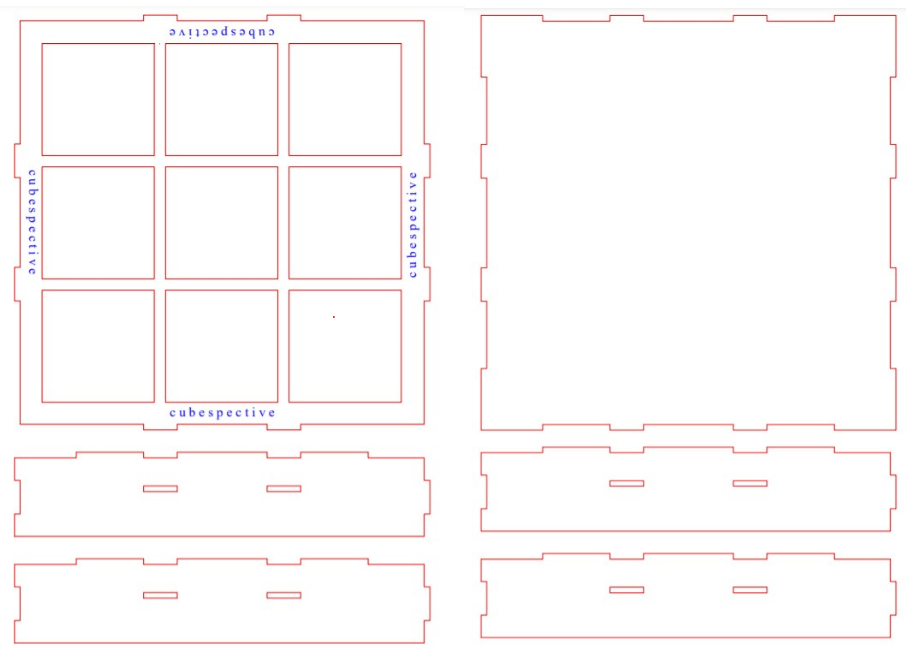

Figure 6: CAD drawing for the tray

Figure 7: Top, front, and side views of one shape

2.3 PRELIMINARY DESIGN

Our initial prototype was conceptualized as a 3-dimensional variation on Color Code, one of the market samples we found during our research phase. It would involve manipulating and stacking translucent figures in transparent blocks to create images by overlaying the blocks with one another. However, we realized early in development that we could work easier with the concept of perspective manipulation, as it would give us more flexibility regarding the materials that we could use for our geometric figures. This was the design that inspired our initial prototype, which we decided to use cardboard and paper to create. Each block was made of construction paper and colored to create the illusion of a 3-dimensional shape on the inside, which would be implemented into our final prototype. The tray was made of cardboard, with nine holes for each of the blocks to be stored in.

Figure 8: Our initial prototype. Each of the cubes are filled in to give the illusion of a 3D figure within each cube to emulate our final product.

2.4 EVOLUTION OF PROJECT

The project began with the idea that 3-dimensional figures would be overlayed to create shapes akin to Color Code, with each block's figure being made translucent to emulate the Color Code experience in a 3-dimensional environment (Figure 2). However, our group noted that even without using see-through materials, we could modify the figures to have different views depending on which window of the clear box we looked through. This shift marks the beginning of the concept that is Cubespective, which is shown in the design of our initial prototype. This version involved paper cubes which mimicked the appearance of a 3-dimensional figure on the inside, which would be fully implemented as transparent cubes in our final version (Figure 11). Apart from this change, no other major modifications were made to the design of the core of our product. The tray for our toy was present from the start of our design phase and was planned to be laser-cut due to its simple box-like structure (Figure 13). The booklet concept was added towards the end development after suggestions from our peer testing phase. It would feature puzzles akin to similar toys of its kind, with problems of varying difficulties (Figure 15).

3. PROJECT TIMELINE

Stem Toy Project Schedule

Top Left

Project Start Date: 9/23/2021 (Thursday) — Display Week: 1

Project Manager: Max (M5b)

Week 1 20 Sep 2021 | Week 2 27 Sep 2021 | Week 3 4 Oct 2021 | Week 4 11 Oct 2021 | Week 5 18 Oct 2021 | Week 6 25 Oct 2021 | Week 7 1 Nov 2021 | Week 8 8 Nov 2021

WBS	TASK	LEAD	START	END	DAYS	% DONE	WORK DAYS
1	**Milestone 1**			-			-
1.1	Planning	Everyone	Thu 9/23/21	Thu 9/23/21	1	100%	1
1.1.1	Three 3s	Everyone	Thu 9/23/21	Thu 9/23/21	1	100%	1
1.2	Emphasizing the User	Everyone	Thu 9/23/21	Sat 10/02/21	10	100%	7
1.2.1	Background Research	Everyone	Thu 9/23/21	Sun 9/26/21	4	100%	2
1.2.2	Writing for memo	Everyone	Tue 9/28/21	Sat 10/02/21	5	100%	4
1.2.3	Cite Sources	Everyone	Tue 9/28/21	Sat 10/02/21	5	100%	4
1.2.4	User Profile Canvas	Everyone	Sun 9/26/21	Sun 9/26/21	1	100%	0
1.3	Needs Assessment	Everyone	Tue 9/28/21	Sat 10/02/21	5	100%	4
1.3.1	Create a duncker diagram	Everyone	Tue 9/28/21	Tue 9/28/21	1	100%	1
1.3.2	Func, Obj, Con	Everyone	Sat 10/02/21	Sat 10/02/21	1	100%	0
1.4	Problem Statement	Everyone	Wed 9/29/21	Mon 10/04/21	6	100%	4
1.4.1	Creating it	Everyone	Wed 9/29/21	Thu 9/30/21	2	100%	2
1.4.2	Presentation	Susana	Fri 10/01/21	Mon 10/04/21	4	100%	2
2	**Milestone 2**			-			-
2.1	Current Market Solutions		Thu 10/14/21	Sun 10/17/21	4	100%	2
2.1.1	8-10 Current Solutions		Fri 10/15/21	Sat 10/16/21	2	100%	2
2.1.2	Fishbone diagram		Sun 10/17/21	Sun 10/17/21	1	100%	1
2.2	Original Solutions		Mon 10/18/21	Tue 10/19/21	2	100%	2
2.2.1	2 Ideation techniques		Mon 10/18/21	Tue 10/19/21	1	100%	1
2.2.2	Report these processes in the memo		Tue 10/19/21	Wed 10/20/21	1	100%	1
2.3	Resources		Wed 10/20/21	Wed 10/20/21	1	100%	1
2.3.1	Gather personal resources		Wed 10/20/21	Wed 10/20/21	1	100%	1
2.3.2	Summarize info in memo or in a table		Wed 10/20/21	Wed 10/20/21	1	100%	1
2.4	Updates		Thu 10/14/21	Wed 10/20/21	7	100%	7
2.4.1	Update problem statement		Thu 10/14/21	Fri 10/15/21	2	100%	2
2.4.1	Update Gantt Chart		Thu 10/14/21	Wed 10/20/21	7	100%	7
3	**Milestone 3**			-			-
3.1	Goals		Thu 10/28/21	Fri 10/29/21	2	100%	2
3.1.1	Rank-Order		Fri 10/29/21	Fri 10/29/21	1	100%	1
3.2	Solution and Problems		Sun 10/31/21	Tue 11/02/21	3	100%	2
3.2.1	KTDA		Mon 11/01/21	Tue 11/02/21	2	100%	2
3.3	Budget		Wed 11/03/21	Fri 11/05/21	3	100%	3
3.3.1	KTDA		Wed 11/03/21	Fri 11/05/21	3	100%	3
3.4	Visual Representations		Fri 11/05/21	Sun 11/07/21	3	100%	1
3.4.1	AutoCAD		Fri 11/05/21	Sun 11/07/21	3	100%	1
4	**Milestone 4**			-			-
4.1	Toy Details	Everyone	Mon 11/08/21	Tue 11/09/21	2	100%	2
4.1.1	Deciding on Name	Everyone	Mon 11/08/21	Tue 11/09/21	2	100%	
4.2	Implementation Documentation	Everyone	Tue 11/09/21	Fri 11/12/21	4	100%	4
4.2.1	Solid Work Drawings	Everyone	Tue 11/09/21	Fri 11/12/21	4	100%	4
4.3	Toy Model	Everyone	Wed 11/10/21	Sun 11/14/21	5	100%	3
4.4	Evaluation Planning	Everyone	Thu 11/11/21	Thu 11/11/21	1	100%	1
4.5	Updates	Everyone	Sat 11/13/21	Sun 11/14/21	2	100%	0

Stem Toy Project Schedule

Top Left

Project Start Date: 9/23/2021 (Thursday) — Display Week: 11

Project Manager: Max (M5b)

Week 11 29 Nov 2021

WBS	TASK	LEAD	START	END	DAYS	% DONE	WORK DAYS
5	**Milestone 5a**			-			-
5.1	Prototype	Everyone	Tue 11/30/21	Fri 12/03/21	4	100%	4
5.1.1	Laser cutting tray	Everyone	Fri 12/03/21	Fri 12/03/21	1	100%	
5.1.2	Refining cubes	Everyone	Tue 11/30/21	Sat 12/04/21	5	100%	
5.2	Evaluation and Feedback	Everyone	Fri 12/03/21	Sat 12/04/21	2	100%	1
5.3	Updates	Everyone	Sun 12/05/21	Sun 12/05/21	1	100%	0

Figure 9: Project Gantt Chart

During the time we were given, we worked on our project based on the deadlines we were given with each milestone. Milestone 1 is where we performed our background research and defined our problem statement. Milestone 2 is where we performed our market research and created a set of preliminary ideas to test in the next milestone. Milestone 3 is where we compared our ideas based on our client's outline and our own discretion to decide on which idea we would use in our final prototype. Milestone 4 saw us designing an initial prototype, as well as giving our final product the name "Cubespective". Milestone 5 involved us creating and refining our final prototype and receiving feedback from our peers on our design.

4. FINAL DESIGN

Our final design involves three main components; the blocks, the tray, and a booklet, in which the latter was introduced after our initial testing phase. The figures inside each block are made from foam due to limited resources, while the tray is made from laser-cut wood due to FYELIC's ease of access.

4.1 FINAL DESIGN DESCRIPTION

Each block is composed of a foam figure taking up no more than a 2x2x2 inch space enclosed in a plastic box of similar dimensions, sealed with all-purpose glue.

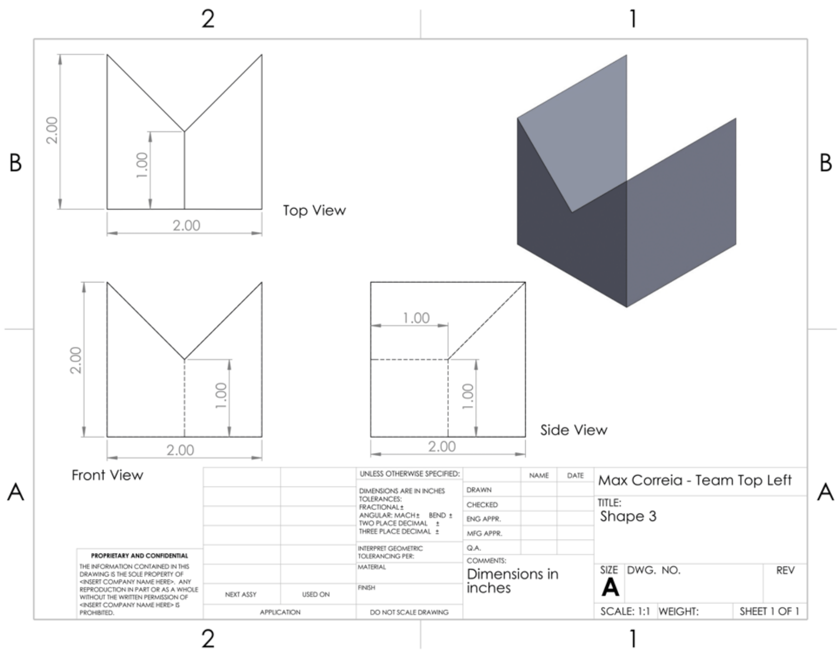

Figure 10: One shape that was built into our blocks

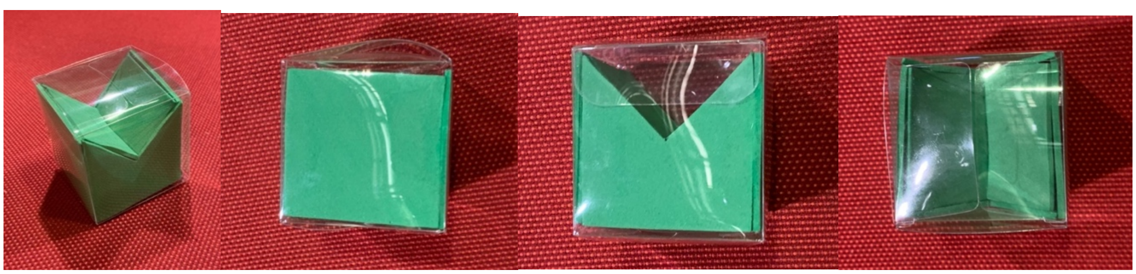

Figure 11: A multi-view of one block's perspectives

The tray has external dimensions of 1.875 in. x 9.25 in. x 9.25 in. and has an open top with nine 2.5 in. x 2.5 in. pockets to hold the blocks.

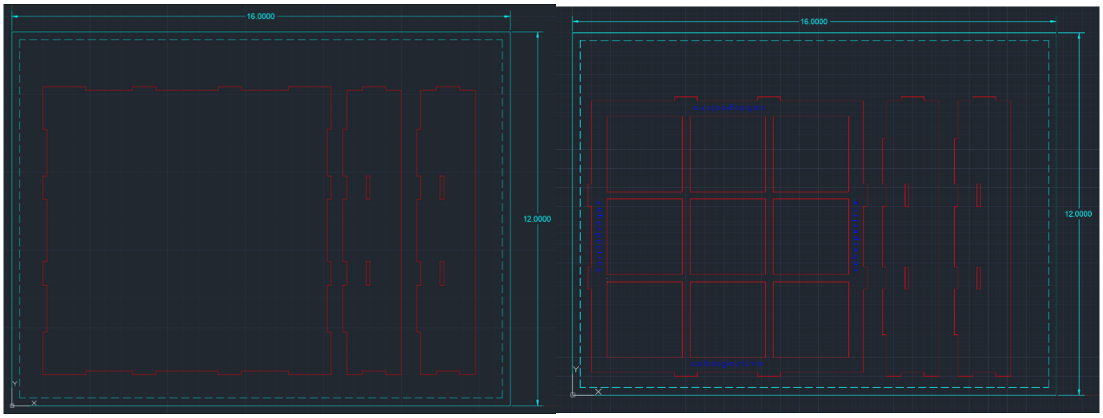

Figure 12: AutoCAD drawings of the tray

Figure 13: Pictures of our tray

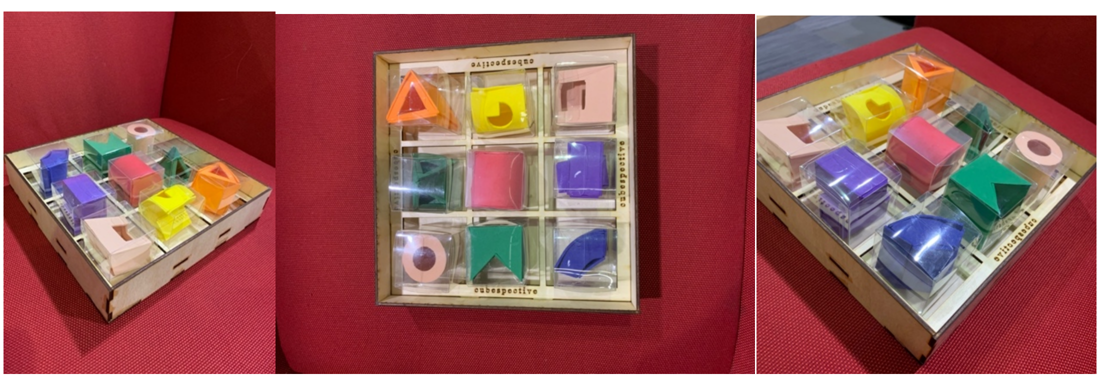

Figure 14: Pictures of our full assembly

The booklet is made of 6 sheets of printer paper cut in half and stapled on the shorter end of 8.5 in. x 5.5 in. pieces of paper.

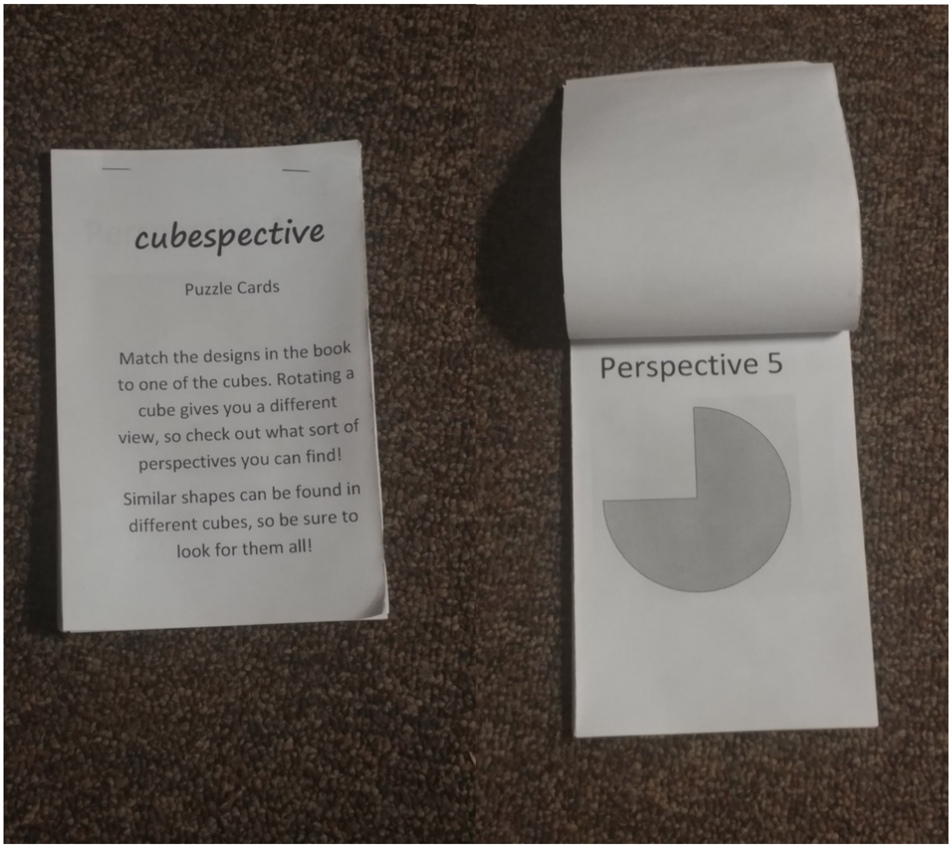

Figure 15: Pictures of our booklet and an example perspective

4.2 FINAL DESIGN COST ANALYSIS

In total, our group spent $38.60 of our allotted budget of $80. We spend less than half of our given budget, however this implies that there may have been some areas of our build that we could have afforded to spend more money on. Despite this, our build was stable and functional, and a low cost adds to the success of our final prototype.

Table 2: Summary of Project Costs for our final prototype for Cubespective

Item	Quantity needed	Total Cost to Purchase
Plastic Boxes	50	$15
1/8" Wood Slabs	2	$8
Printer Paper	6	$0.60
Foam	15	$15
Total		**$38.60**
Budget		**$80**

5. EVALUATION AND CONCLUSION

5.1 RESULTS AND DISCUSSIONS

When we tested our product at the children's center, we noticed differences with the children regarding how fast they were able to solve each puzzle. Even though we were never told this, we likely attribute these differences to age, seeing as how we also tested with users somewhat outside our target audience (including 3–4-year-old children). Our users were all satisfied with our product, as along with stating that they had fun, they were engaged and interested in playing with our toy. Regarding user experience, we have satisfied both our and our client's objectives in that we were able to create an engaging and educational STEM toy while following the safety and budgetary restrictions that were given to us.

5.2 EVALUATION

Our product had morphed significantly since its inception, up to the point that our initial idea and our final product are two completely different products. Because of this, we have exceeded ourselves in originality compared to the products found in our market research. When testing the toy on a group of preschoolers, over 50% of the participants responded with “yes” when prompted: “did you have fun playing with this toy?” We also noticed around 50% of participants identifying and naming a specific shape while playing with the toy. Our toy was also able to equally entertain boys and girls, a minor project goal that was initially overestimated yet proved to be successful during our testing phase. Our toy presents minimal safety issues due to the light materials that we made, and they withstood the endurance test of regular play.

5.3 CONCLUSION

By the end of the project, our team had created an original STEM toy that met the safety and budgetary constraints of our client while showing success with our target audience. From the research on our target audience and our competing market, we were able to formulate the core ideas that would be built upon to create our final design. This idea was then tweaked and modified until the final prototype was created, iterating what materials we would use and how our toy would play. The feedback we received from our peers has been positive, and we used our peer feedback to improve on our design before presenting it to our target audience. The improvements we made were substantial, and this was reflected in the positive reception to our product from our target audience when we tested our STEM toy with them.

6. FUTURE WORK AND RECOMMENDATIONS

The greatest challenge of implementing our design was the availability of materials for our toy. If we had more resources/skill, we would have likely used acrylic for the outsides of the boxes, as well as the figures on the inside. This would also allow us to implement our original idea of translucent figures in our boxes as opposed to opaque ones. Alternatively, we could use 3D printing for our figures; while this would mean that these shapes would remain opaque, the material would allow for more complex figures to be crafted with a more polished appearance. The tray would also be constructed more securely out of a stronger material of either acrylic or plastic to withstand repeated usage. If we had more time to research the children or had performed our research with more children, we would have likely received a wider scope of feedback from our target audience. Further research into childhood development and spatial recognition would likely help direct our product towards a more engaging and educational product by focusing on what these children need to learn while allowing them to play in an unrestrictive manner. Research into general toy development/psychology would also be beneficial in this regard. If we were to go forward with this product, we would focus on creating more interesting shapes and building on the concept of a game-based toy. The booklet was an idea implemented late into the creation of Cubespective, and it would have likely been expanded upon if it were considered earlier in the development cycle.

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8. AUTHOR BIOGRAPHIES

Niki Manolis was born in Park Ridge, Illinois in 2003. She is an undergraduate student at Northeastern University, currently with an undeclared major, and plans to graduate in 2025.

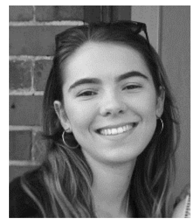
From 2019 to 2020, she worked with and coached 4th through 9th graders for a local AAU basketball program. From the beginning of 2021 to present, she has worked part time at a local café. She also worked as a peer tutor throughout the entirety of high school in mathematics topics such as algebra, geometry, and trigonometry, precalculus and more.

Ms. Manolis is currently a member of the Northeastern Women's Club Basketball team. In high school, Ms. Manolis was the Vice President of National Honors Society (2019-2021), a captain of the girls' basketball team (2019-2020 and 2020-2021), a captain of the softball team (2020-2021), and a member of the School-Wide Fundraising Club.

Max P. Correia was born in Winthrop, Massachusetts in 2003. He is pursuing a B.S. in computer science and mathematics from Northeastern University and plans to graduate in 2025.

From 2019 to 2021, he has worked in various contracting and childcare positions, including the 21st Century program in Winthrop, Massachusetts, in which he was the lead robotics counselor. He is interested in researching encryption, computer hardware, and cybersecurity.

Mr. Correia is a member of Northeastern University's Math Club and Game Development Club. In high school, he was the president of FIRST Robotics Team 7795 Norse Code (2020-2021) and was a member of the National Honors Society (2018-2021).



Paloma Del Barrio Cabello, born in Madrid, Spain 2001, is an undergraduate student pursuing a Bachelor of Engineering Physics in Carlos III University, Madrid, graduating in 2023. From 2021 to 2022, she is studying at Northeastern University, Boston, on a exchange program.

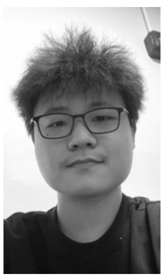
She graduated high school in 2019 with honors and received the Academic Excellence Scholarship, by the Ministry of Education of The Community of Madrid. The award recognizes the students graduating with the best academic performance.

Ms. Del Barrio has worked in Campus IFEMA Thinkids from 2017 to 2021, as a counselor and coordinator in summer camps, with kids of ages 6 to 16. In 2020 she participated in a startup hub bootcamp, Lanzadera, a Spanish startup accelerator established in 2013.

Susana Noto, born in Port Washington, New York 2003, is an undergraduate student at Northeastern University, Boston, Massachusetts, graduating in 2025 and is currently undeclared.

From 2017 to 2020, she worked as a volunteer in her hometown's children's library. Over the summer of 2021, she worked in a day camp for preschoolers. She also worked as a personal tutor throughout her high school career in mathematics, Latin, physics, and more.

Ms. Noto is currently the Technical Director for the Shakespeare Society at Northeastern University and was their assistant stage manager in their production of *Love's Labour's Lost* this semester. In high school, Ms. Noto was a member of National Honors Society, Tri-M Music Honors Society (President in 2020-2021), and Foreign Language Honors Society (secretary in 2019-2020 and Vice President in 2020-2021).



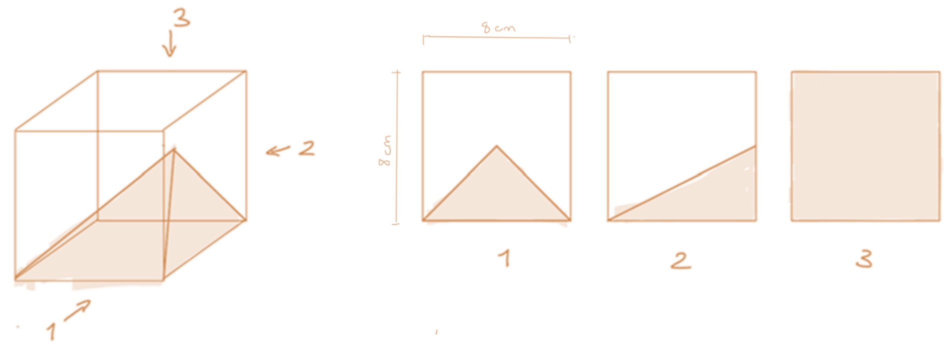
Ben Feng, born in Shanghai, China 2003, is an undergraduate student at Northeastern University and currently in the Explore program. He plans to graduate in 2025.

From 2018 to 2021, he volunteered to be the assistant in his junior high school music band, and leading children perform for some important events. In high school, he worked as an assistant in a special needs school in his community.

Mr. Feng has attended CTB (an innovation competition holding for high school students) and achieved a regional distinction. He also worked as a tutor in the Math class.

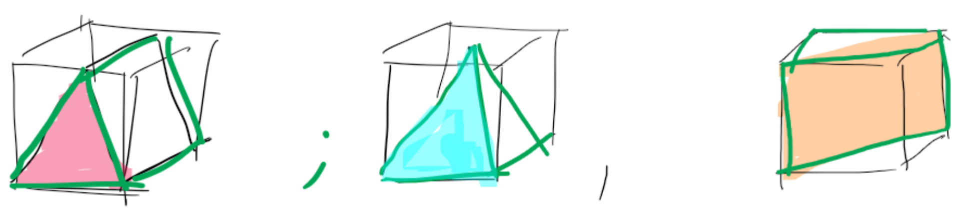
9. APPENDIX

9.1 APPENDIX A – DRAWINGS WITH TITLE BLOCKS



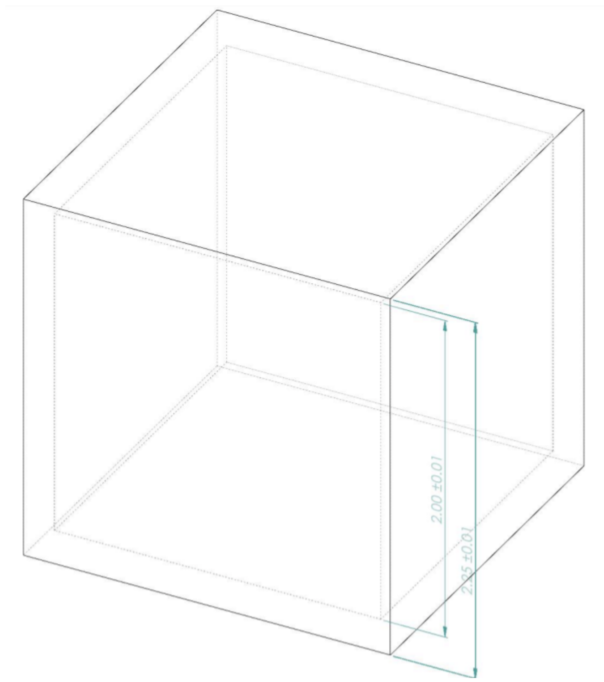
The initial sketch for a block in Cubespective, featuring multiple perspectives.

A-2



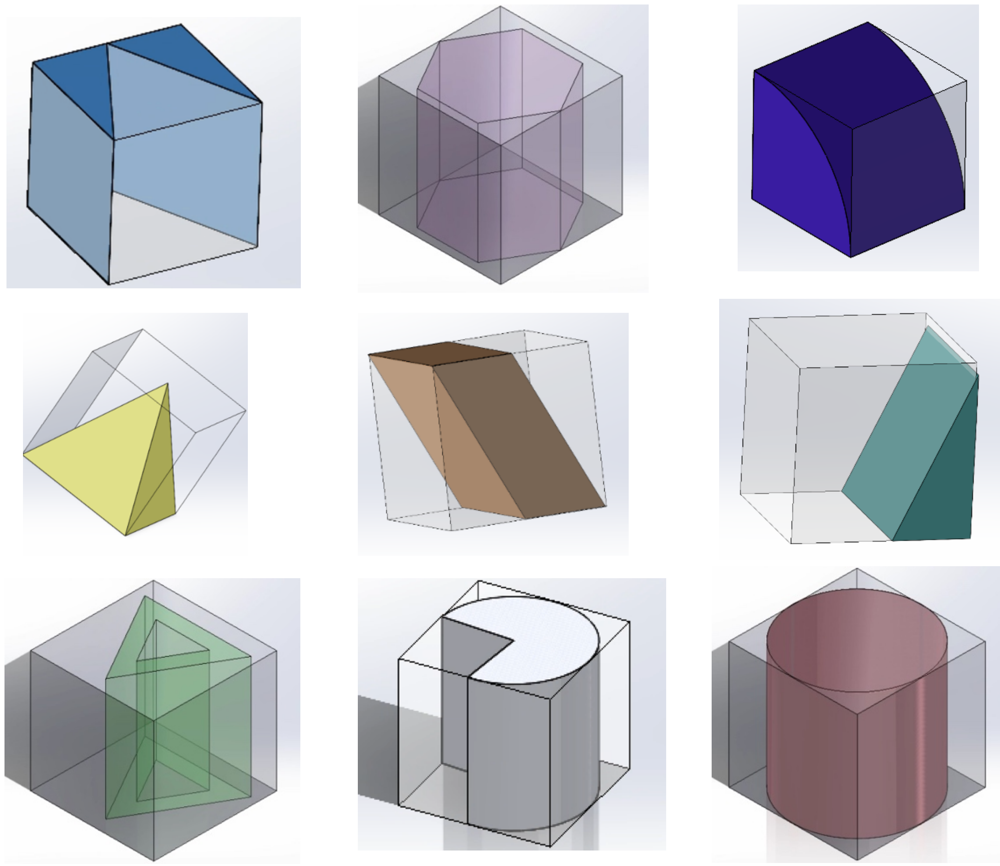
The initial sketches for various blocks found in Cubespective.

A-3



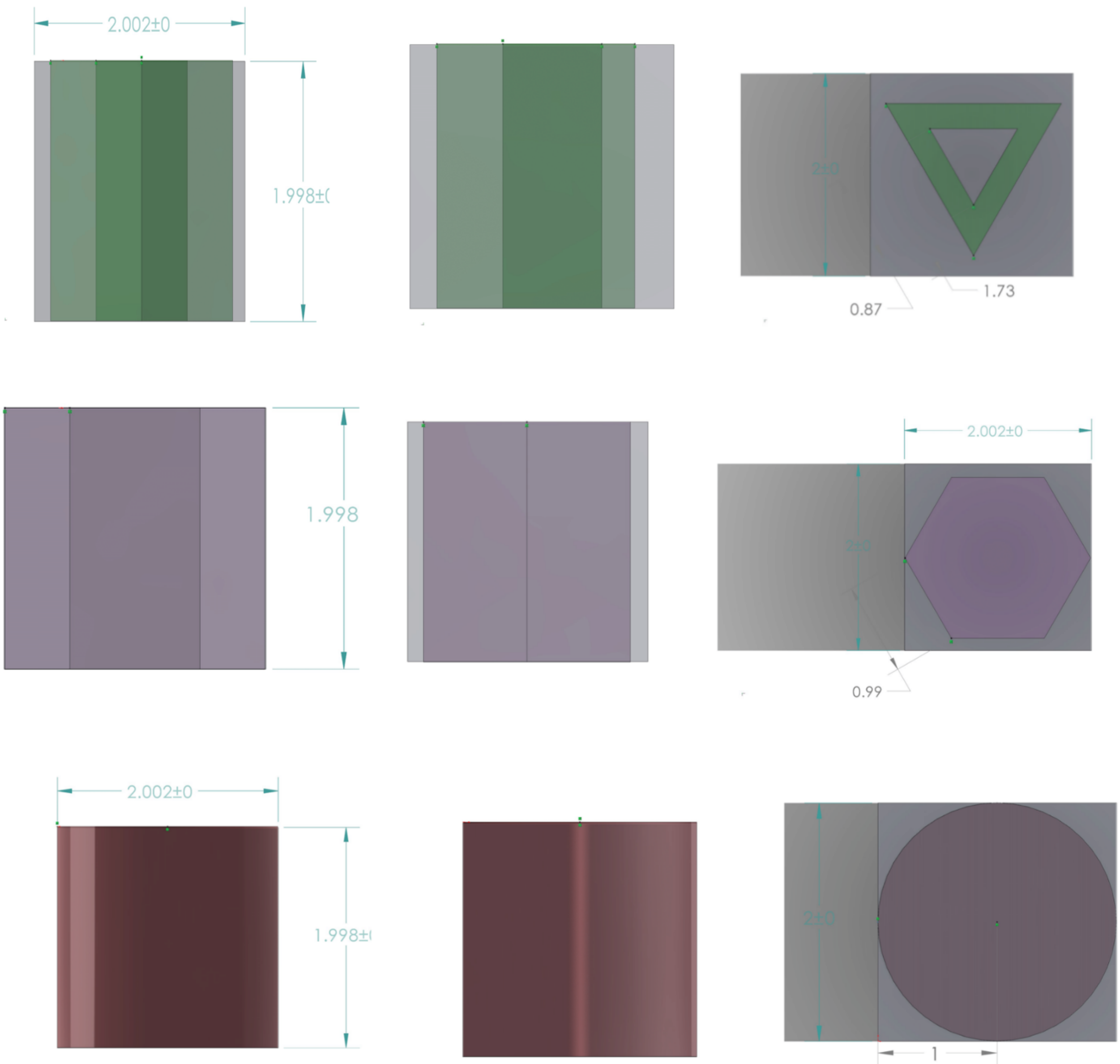
The drawing for the exterior block for the shapes to be put into.

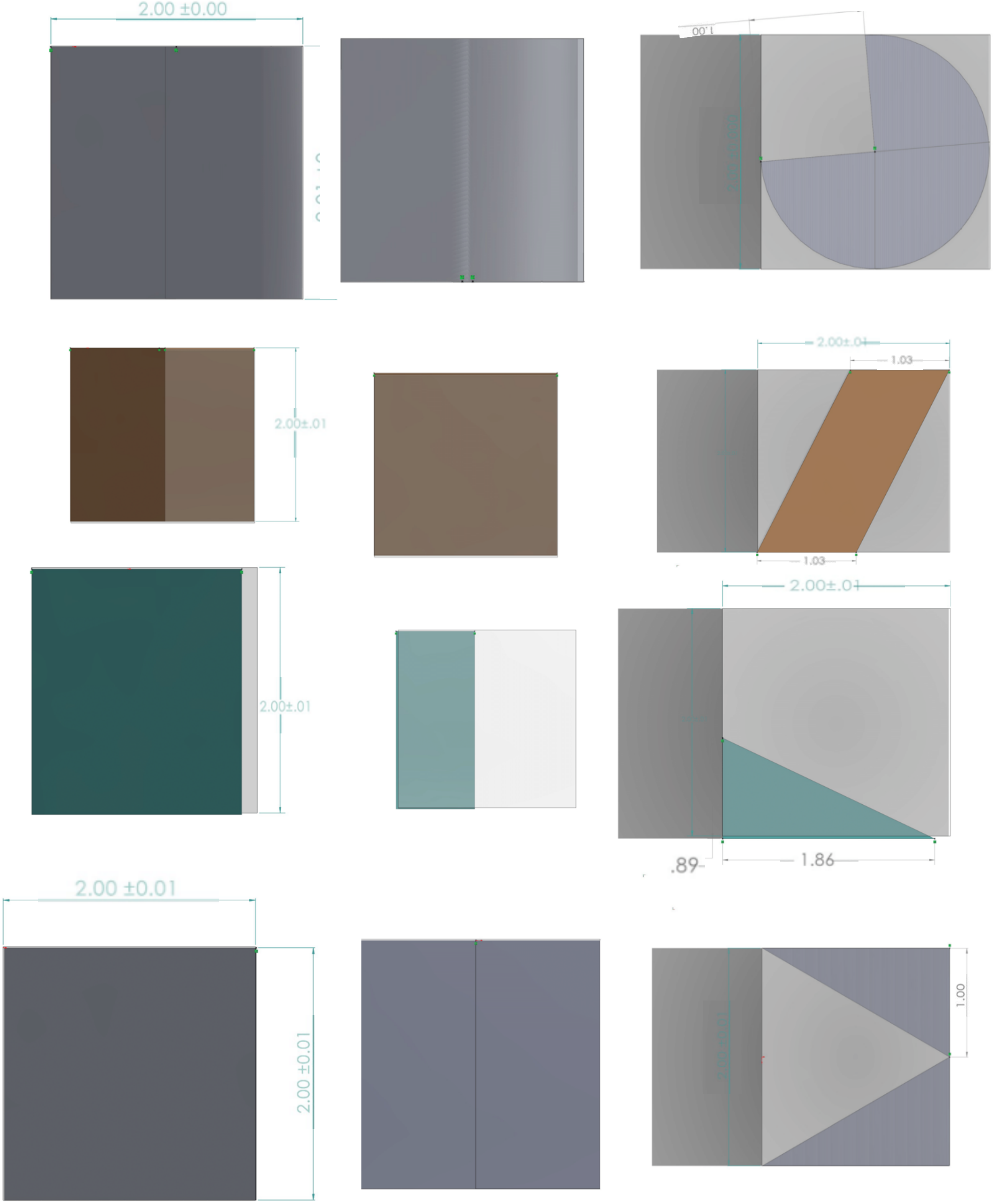
A-4



The initial designs for the nine blocks of Cubespective. While some of these designed stayed the same, the blocks mostly changed as we progressed through the process of making the toy.

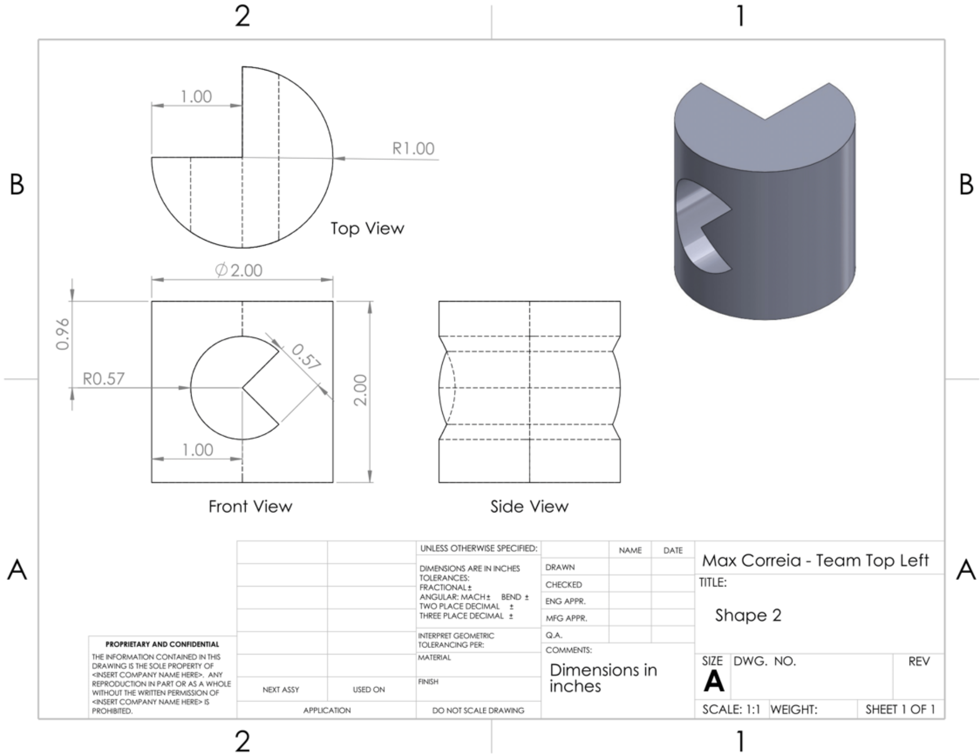
A-5



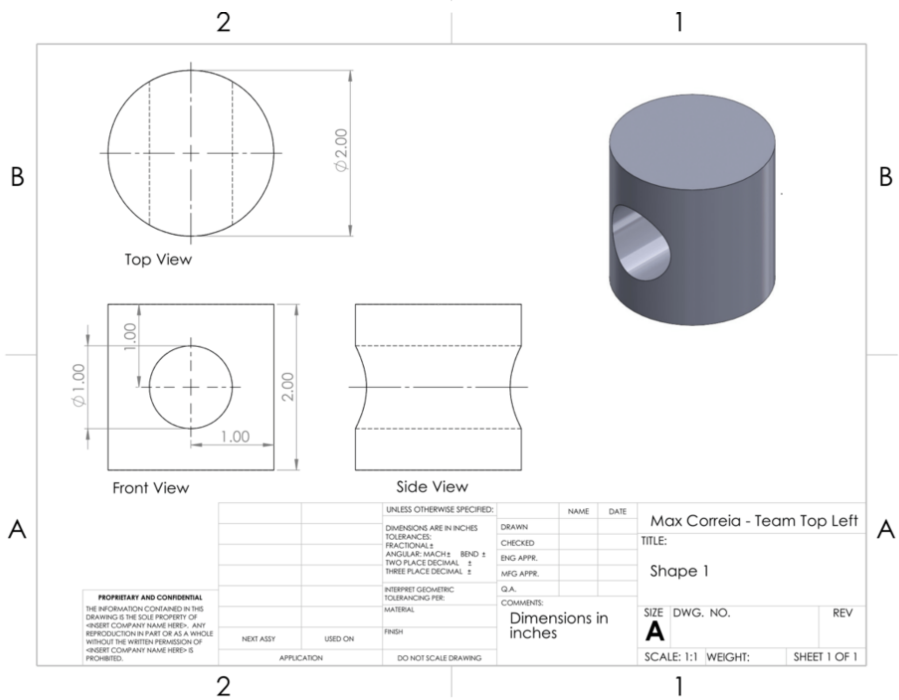


These drawings show the different perspectives and the measurements of seven out of the nine initial block designs.

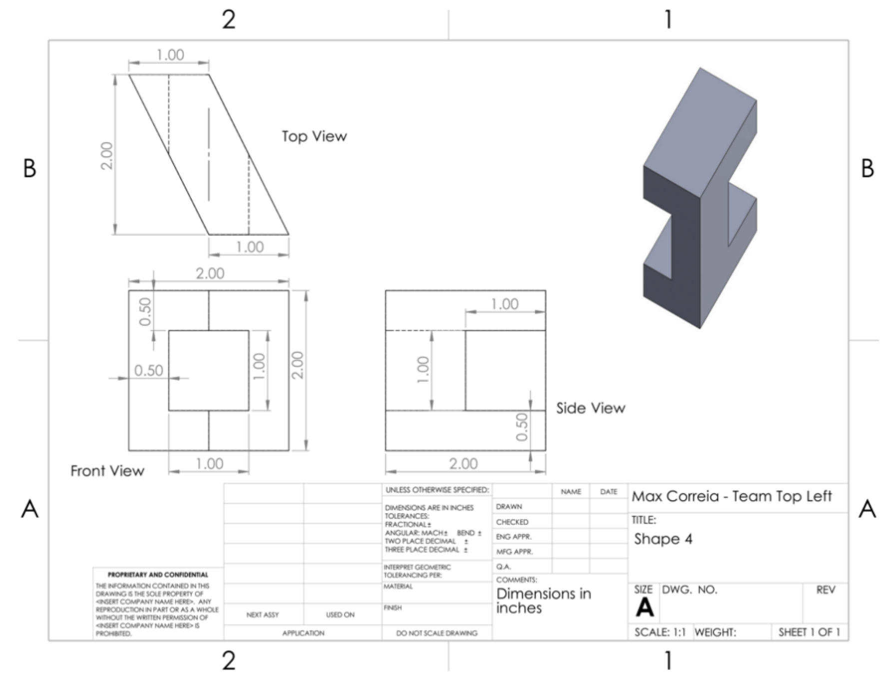
A-6

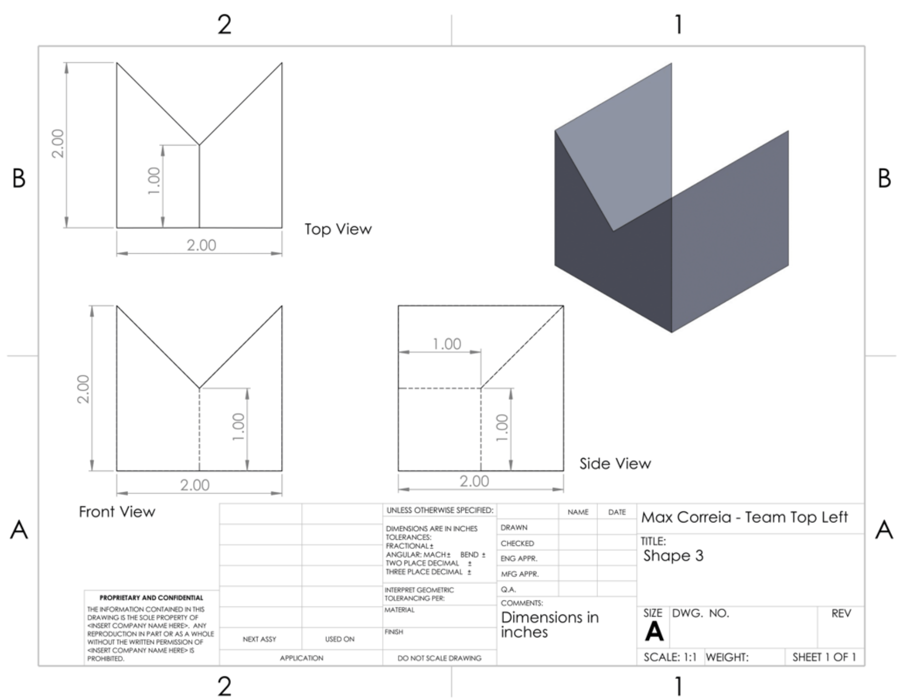


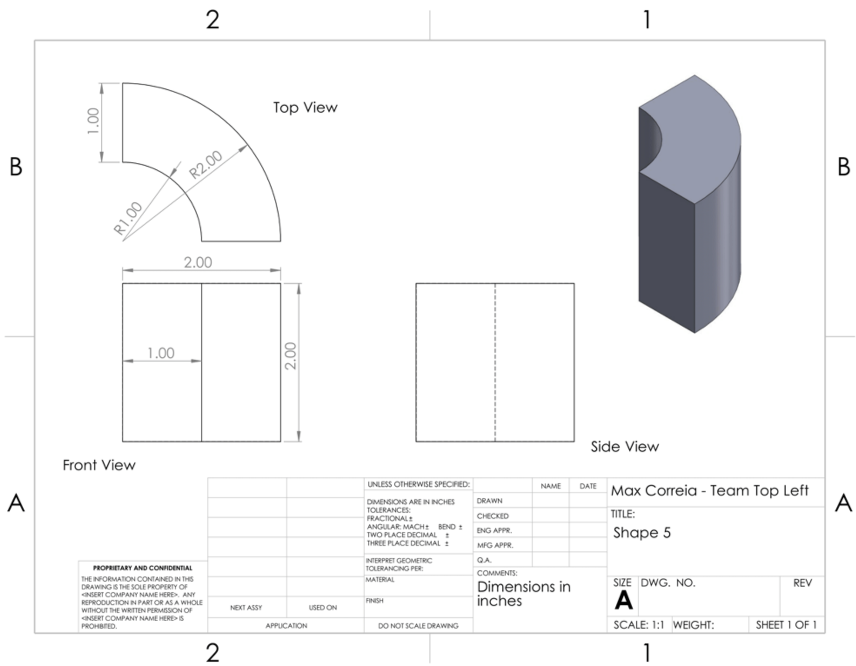
1.00
R1.00
Top View
⌀2.00
0.96
R0.57
0.57
2.00
1.00
Front View
Side View
Max Correia - Team Top Left
TITLE:
Shape 2
Dimensions in inches
SIZE A
DWG. NO.
REV
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1



⌀2.00
Top View
1.00
⌀1.00
2.00
1.00
Front View
Side View
Max Correia - Team Top Left
TITLE:
Shape 1
Dimensions in inches
SIZE A
DWG. NO.
REV
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1


Top View
Front View
Side View
1.00
2.00
0.50
Max Correia - Team Top Left
TITLE:
Shape 4
COMMENTS:
Dimensions in inches
SIZE A DWG. NO. REV
SCALE: 1:1 WEIGHT: SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL


Top View
Front View
Side View
1.00
2.00
Max Correia - Team Top Left
TITLE:
Shape 3
COMMENTS:
Dimensions in inches
SIZE A DWG. NO. REV
SCALE: 1:1 WEIGHT: SHEET 1 OF 1
PROPRIETARY AND CONFIDENTIAL


Top View
1.00
R2.00
R1.00
2.00
1.00
2.00
Front View
Side View
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
NAME
DATE
DRAWN
CHECKED
ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
Dimensions in inches
Max Correia - Team Top Left
TITLE:
Shape 5
SIZE
DWG. NO.
REV
A
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1
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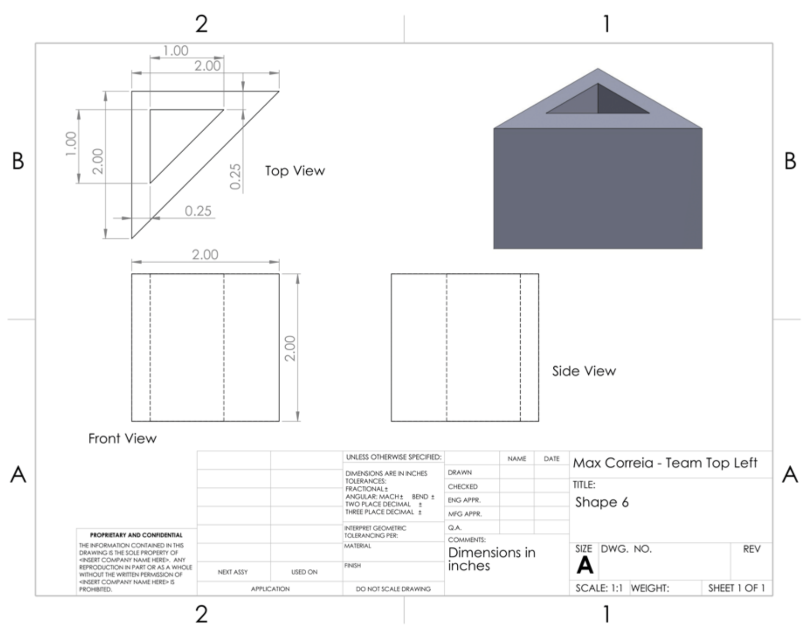
1.00
2.00
1.00
2.00
0.25
0.25
Top View
2.00
2.00
Front View
Side View
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
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DO NOT SCALE DRAWING
NAME
DATE
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ENG APPR.
MFG APPR.
Q.A.
COMMENTS:
Dimensions in inches
Max Correia - Team Top Left
TITLE:
Shape 6
SIZE
DWG. NO.
REV
A
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1
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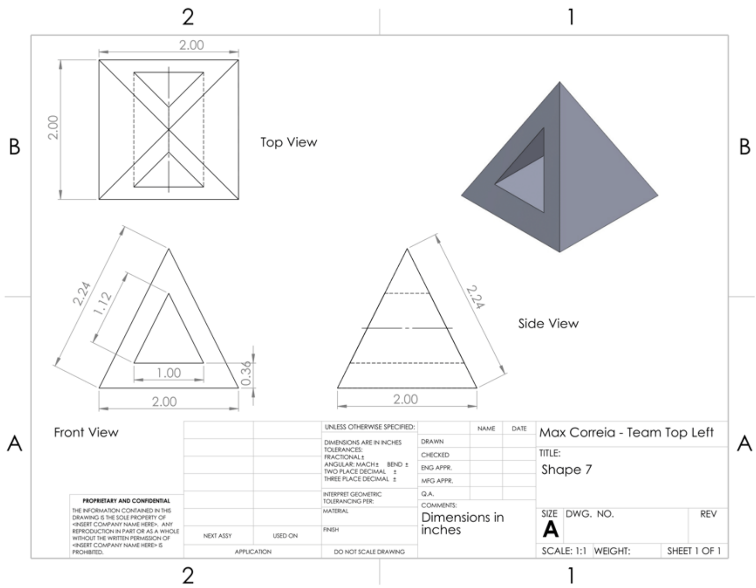
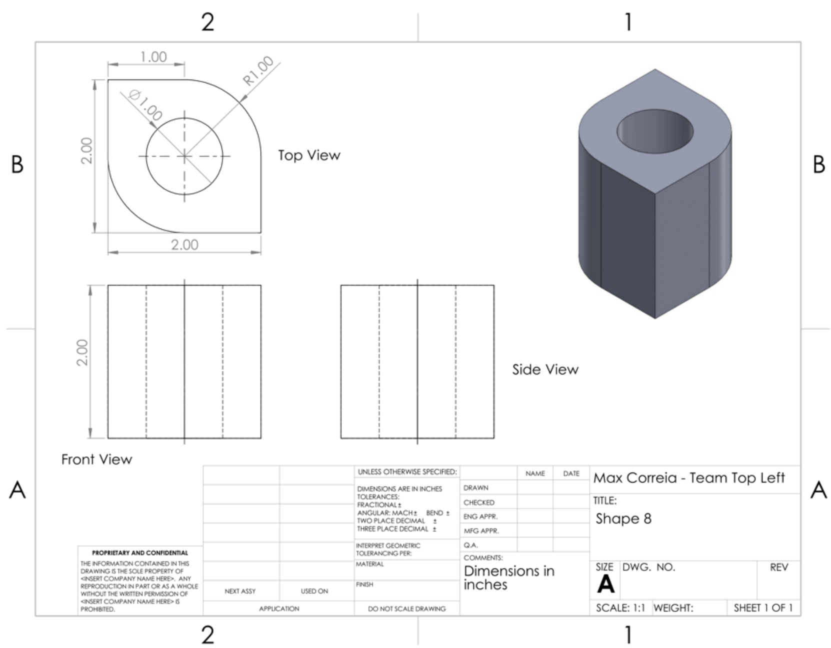
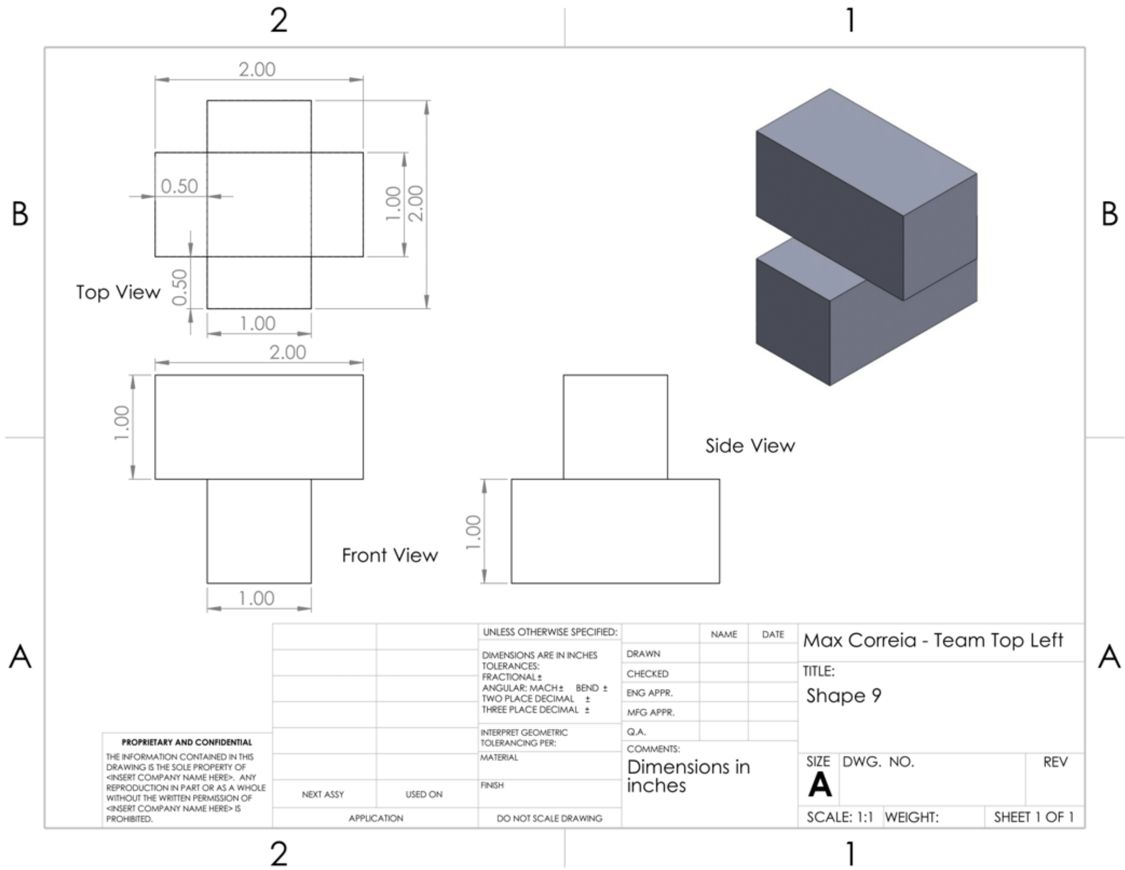

2.00
2.00
Top View
2.24
1.12
1.00
0.36
2.00
2.00
2.24
Side View
Front View
Max Correia - Team Top Left
TITLE:
Shape 7
Dimensions in inches
SIZE A DWG. NO. REV
SCALE: 1:1 WEIGHT: SHEET 1 OF 1


1.00
R1.00
Ø1.00
2.00
Top View
2.00
2.00
Side View
Front View
Max Correia - Team Top Left
TITLE:
Shape 8
Dimensions in inches
SIZE A DWG. NO. REV
SCALE: 1:1 WEIGHT: SHEET 1 OF 1



These are the documentations for each shape in Cubespective, modelled in SolidWorks. In our final product, a few of these designs were altered to make constructing each block easier.