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11th Grade

The Transformable Tent: A Novel Design to Aid Humanitarian Relief Efforts

STEM Business Plan

Elevator Pitch:

There is a lack of portable, practical, and cost-effective shelters for victims of natural disasters and refugees. The transformable tent is a multipurpose garment that can transform into a tent, a rain jacket, or a backpack for humanitarian relief efforts. My company plans to sell this product to large humanitarian organizations who are able to efficiently distribute them to refugees and disaster relief victims around the world.

Part 2. Executive Summary:

The amount of natural disasters and refugee movement has increased in the last 20 years [1], leading to a new set of challenges for humanitarian organizations worldwide. The lack of portable, practical, and cost-effective shelters and clothing for victims of these dual challenges are not addressed thoroughly by nonprofits and humanitarian organizations today. My B2B organization, Metamorphosis Tents, is creating transformable garments that can be a tent, a rain jacket, or a backpack to assist humanitarian organizations from around the globe. My design has the potential to compete in a \$10 billion market due to its mountaineering-based tent design, ventilation features, easy to fold corners, and a lower sales price compared to competitors, such as Adiff Tents. This similar brand is currently on the market.

Part 3. Problem Summary and Proposed Solution:

In the past 20 years, there has been a definitive rise in the level of refugee-based movement and natural disasters [1]. Climate change and a constantly changing geopolitical atmosphere have made many areas of the world more prone to these two problems, and one of the primary challenges that this has brought about for major humanitarian organizations are the lack of practical, portable, and cost-effective shelters and clothing for victims of these dual challenges. This need has arisen from the mobile nature of disaster relief and refugee life, and I feel that it has not been fully and comprehensively addressed by the major humanitarian organizations worldwide because of their focus on stationary shelters over portable shelters.

To combat this problem, my company creates multipurpose garments that can transform into a rain jacket, a tent, or a backpack. The dimensions of the tent floor are around 3x8 ft, with a height of around 3 feet along with a 1 ft long vestibule that stretches across the 8 ft length of the tent. The tent has 5 tent stakes that are used to help hold down the tent, along with a ykk zipper opening and fiberglass tent poles that form crossing x to make the tent dome-shaped. The rain jacket has a single zipper on the front that extends down the body, along with two arms and a hood, but it also has the potential for pockets and other customizations to be added onto it. The backpack utilizes the two jacket arm sleeves as straps and provides additional support with the tent poles to provide a storage environment that utilizes the hood of the tent as the top backpack cover. The sketches below, labeled in the format Figure 3.X (Where x is the prototype number): Type Design, show some of the progression of my design (Zoom in for details). One key feature that is missing from these sketches is the backpack function, which was recently added due to a customer interview, but these are otherwise a complete story of my prototyping process.

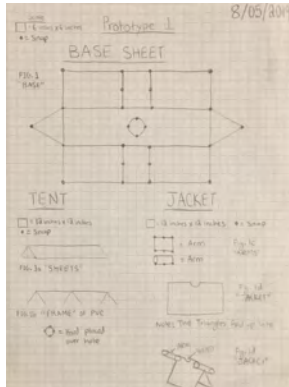


Figure 3.1: Homeless-Centered Design

Major Flaws of Design: Did not have a bathtub floor so it was inadequate for preventing leaks. Was not tall enough or wide enough to comfortably support a person. The weight due to the PVC Pipes and the heavy white tarp made it almost unusable. The snap buttons were extremely hard to work with and did not offer complete protection.

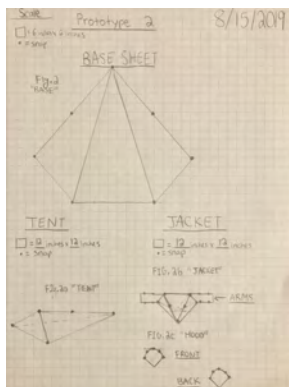


Figure 3.2: Triangular-Based Design

What was done to fix the flaws of the previous design: Is now tall enough and wide enough at the end of the tent in order to properly contain a person. This design utilizes less white tarp and pvc pipe than the previous design, so it weighs less. **Main Flaws of Design:** Still does not have a bathtub floor. The snap buttons were still utilized.

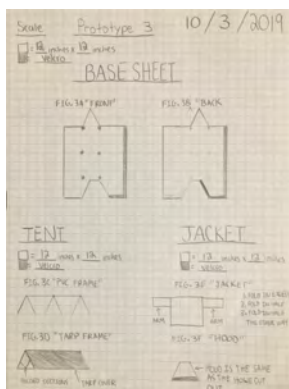


Figure 3.3: A-Frame Design

What was done to fix the flaws of the previous design: PVC Pliers were used instead of the saw for faster cutting of the PVC Pipe. Velcro was utilized instead of snaps because the material was cheaper, more workable, and offered better protection for the design over the snaps. **Main Flaws of Design:** The PVC pipe is still very cumbersome. No efficient way to carry PVC Pipe. The folding of the back did not provide proper coverage and allowed water in through the seams.



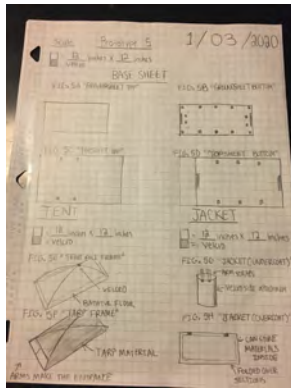
Figure 3.4: Thin Parallelogram-Based Design

What was done to fix the flaws of the previous design: A lighter green sheet was used instead of the heavy white sheet in order to reduce bulkiness and to reduce weight. A bathtub floor was implemented to prevent excess leakage of water into the tent. White Velcro tape was used instead of black velcro tape due to saving \$1/roll. **Main Flaws of Design:** Was wide enough at the middle but was too thin at the edges to properly support a person. The jacket design had too many velcro straps and was too hot in order to be properly used. The PVC pipe used was very heavy and hard to break up into lightweight pieces. There was no well-defined entrance or exit for the tent. The jacket was very hard to move with, not due to bulkiness, but due to the excessive amount of loose straps and folds

that kept falling down, made this very impractical.

Figure 3.5: Direct Relief Prototype Design

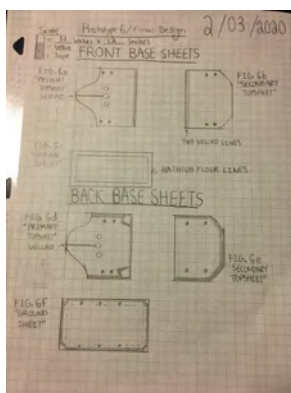
What was done to fix the flaws of the previous design: The base was now rectangular in shape so it could be wide enough to properly contain a user comfortably. Tent poles were used instead of PVC Pipe because it reduced weight and complexity and made it easier to store in the prototype. The amount of velcro was reduced in order to reduce manufacturing complexity and to increase the ease of the experience for first-time users. **Main Flaws of Design:** The arm system of loops and straps was incredibly complicated and was also extremely inefficient as it would continually fall off. There was no vestibule for putting shoes or other items that could be wet. The overcoat and the undercoat were both



very confusing in the amount of time that it took to transform them. The entrance to the tent was very small and is difficult to set up and take down.

Figure 3.6: Changes after Direct Relief Prototype

What was done to fix the flaws of the previous design: The arm system was changed from overalls and attachments to being built into the jacket. A vestibule was added to the tent design in order to store shoes or other wet items. The overcoat and the undercoat were combined into one coat to cut down on the number of steps that the coat would have to undergo. The tent entrance was moved so that it was big enough for a person to comfortably move through and could be easily set up just by pressing against the velcro loops and by inserting a tent stake. The outside of the hood and the arms were taped to prevent leakage of water into the tent. The connecting fold of the tent was twice folded over to prevent leakage along the sides of the tent. **Main Flaws of Design:** The long velcro straps would get tangled and the arms were coarse at the entrance.



Part 4. Summarize the STEM Concepts and Principles Underlying the Overall Plan:

The engineering concepts that I am identifying are the need for ventilation, storage space, and added protection from the elements. I choose to implement a vestibule (as shown in figure 4.1 (note: not my actual design, just an online example that I found), an overhang in the tent that can cover shoes or other items, because it increases the floor space of my design and increases the air ventilation as well. The inclusion of a vestibule in many mountaineering tent designs provides a feasible basis for my project. I choose to implement a bathtub floor (as shown in figure 4.2), an elevated ring around the tent floor, because it helps to keep out precipitation, snow, and dew. The inclusion of a bathtub floor in many leading brands for backpacking tents provides a feasible basis for my project.



A technology concept that I am identifying is the need to seal my prototype from the outside while also being easy to utilize by customers.

I choose to implement YKK™® zippers (as shown in figure 4.3), a high quality, weather-resistant Japanese brand zipper, because it can help to seal the three functions of my design, provides easy transformability, and is weather and temperature resistant. The inclusion of YKK zippers in many search and rescue shelters provides a feasible basis for my project.

Mathematical considerations for my design included adequate space for a person and that person's storage needs, which involved me having to calculate how the placing and angle of my tent poles would affect these two considerations.

A materials science part of the *Transformable Tent* is the material that I choose to construct my design out of, because it had to be durable, lightweight, water-resistant, and low-cost.

In order to fully bring my idea to fruition, I plan to test my device frequently with target users in order to get precise feedback before moving to a production phase. I would require funding to create multiple versions of my current prototype in order for the testing to be completed in parallel, which is covered in a later section of this report.

Figure 4.1



Figure 4.2



Figure 4.3



Part 5. Commercialization Assessment of the Overall Plan:

In the past 20 years, there has been a definitive rise in the level of refugee-based movement and natural disasters. This rise can be attributed to climate change, but the changing geopolitical factors in the middle east and sub-Saharan Africa are also a cause for this rise. [2] One of the primary challenges that this has brought about for major humanitarian organizations attempting to combat these problems is the lack of practical, portable, and cost-effective shelter and clothing for victims of these dual challenges. Traditional humanitarian organizations, such as the Red Cross and Direct Relief, do not address this specific niche, as they focus more on stationary structures. In contrast, other organizations with similar products do not fulfill all three requirements of a practical, portable, and cost-effective solution.

Spending on supplies in the disaster relief industry totals around **\$10 billion annually** and is expected to grow at around 0.7%. There is a growing amount of initiatives, such as the Red Cross's Corporate Diversity movement, that are pushing for smaller suppliers that could better serve the needs of my target market, which could provide more opportunities for my company to become a vendor.

My company creates multipurpose garments that can transform into a rain jacket, a tent, or a backpack to combat this problem. The tent is based on mountaineering tent designs, both strong and weather-resistant as well as relatively lightweight. In contrast, the rain jacket and backpack are based on a poncho and a lighter weight design, respectively. The rain jacket will allow the user to remain dry in wet and windy environments, while the backpack could be more useful for hot and humid climates where the user may be overheated while wearing a full jacket. YKK zippers, 3M tape and a minimal amount of velcro were used during the construction of this project due to the weather resistance, durability, and low cost of the three options, relative to snap buttons or sewing, which can be difficult for users and time-intensive for manufacturing.

My target markets are the large humanitarian organizations that help both victims of natural disasters and refugees, such as Direct Relief and Doctors Without Borders. I choose this group as my primary target customer because of their established connections to at-risk areas and their large distribution and storage networks, which would outperform my smaller business. Despite this, the intended users would be the victims of natural disasters and refugees because they are the ones who require practical, portable, and cost-effective shelter and clothing. I have

verified this through multiple in-depth market analysis interviews that I conducted during the fall. Some of the interviewees included the CEO of Direct Relief, the CEO of Team Rubicon Global, and the Emergencies and Humanitarian Action Unit director at the International Rescue Committee.

I chose to look at three separate competitors: ShelterBox, Zelter Shelter, and Adiff, each representing a different competitor type. I acknowledge that there are more than three competitors in my industry and my niche, but I chose to focus on these three competitors for the essence of time.

Status Quo (ShelterBox) [11]



Cost: \$500.00 (For tent only), Materials: Does not specify exact material on website, but UV-resistant and 3000mm Hydrostatic Head (Essentially waterproof), Weight: 110-130 lbs for a full ShelterBox (Tent and other items included), Intended Market: Disaster Relief Victims, Bathtub Floor (Tent Only): No, Floor Size (Tent Only): 255 ft² space and 7'4" height, Vestibule (Tent Only): No, but vents are included, Arms (Jacket Only): N/A, Tent Stakes Included (Tent Only): Yes and guy lines are provided as well

Overall Review: The high durability standards of the tent and the large amount of floor space are strong design characteristics that should be incorporated into a future design. The lack of a bathtub floor is concerning, especially due to precipitation that could leak in through the floor, but it could be avoidable if the zippers that are used are watertight. In an interview with Alex Y. Miller, the Shelter and Settlements Acting Team Lead for the USAID Bureau for Humanitarian Assistance, mentioned that some issues that might arise from this product is that it creates an unhealthy dependency that could be potentially detrimental for economic recovery in an area hit by natural disasters. Overall, while the disaster relief market is being served by this product, it is much more qualified as a stationary tent rather than a more portable design, which is indicative of a different niche.

Similar Product, Different Market (Zelter Shelter) [13]



Cost: \$163.03, Materials: 75D Nylon with Waterproof Ventilation, Weight: 2.6 lbs, Intended Market: Consumer, Rescue, Military (Coast Guard), Bathtub Floor (Tent Only): No, Floor Size (Tent Only): 90.5”x 43”x 39.5” (LWH) (Large triangular design that connects to 1 point), Vestibule (Tent Only): No, Arms (Jacket Only): Yes, Tent Stakes Included (Tent Only): Yes

Overall Review: The Zelter Shelter combines simple design with quality materials and an average cost while also having durability and breathability in its tent. The lack of a bathtub floor and the complexity of the straps involved in the jacket form are concerning issues, along with no vestibules, but the low weight and inflatability are very positive attributes that must be considered further.

Similar Product, Similar Market (Adiff) [12]



Cost:\$350 (Total) [\$300 (Jacket) +50\$ (Tent Base and Poles)], Materials: Nylon+Polyester (Jacket), Aluminum (Tent Poles), Weight: 3-4 lbs, Intended Market: Refugee and Consumer, Bathtub Floor (Tent Only): No, Floor Size (Tent Only): 58”x58”x37” (LWH) (Dome-Shape), Vestibule (Tent Only): No, Arms (Jacket Only): Yes, Tent Stakes Included (Tent Only): No

Overall Review: Seemed like it was more of a fashion brand that was targeting consumers more than a humanitarian-based brand. The tent would be ineffective in any wet conditions and the extremely high price is non-conducive to proper distribution. The emphasis on recyclability, providing jobs for workers and high quality materials are all appealing, but were not enough to save the brand.

We're the only startup that truly fulfills the need for practical, portable, and cost-effective shelter and clothing. Our mountaineering-based tent designs, our easy fold corners, and our low estimated sales price per unit, which I am predicting to be up to 50% lower than the leading brands for transformable jackets, such as Zelter Shelter, make us a strong potential competitor in the disaster relief and refugee industries. During my interview with the Red Cross, they mentioned that price was an essential factor for making a deal, so my lowered sales price is an advantage in this industry. Although single units are available, we expect that most of our customers will place bulk orders of 10 or more units at a time. When sold in bulk, each unit will retail for around \$90, while single units will retail for a slightly higher price. The large humanitarian organizations will make up the bulk of our revenue. Still, I can see smaller buyers and the occasional individual customer as a portion of our revenue that could keep our cash flow at a more consistent level. Despite the occasional single person customer, the vast majority of our revenue will be from businesses, organizations, and nonprofits due to our B2B model.

The startup and operating costs that I would expect to be incurred fall into five separate categories: Legal Fees, Manufacturing Fees, Production Fees, Testing Fees, and Marketing Fees. The legal fees consist of four main subjects: A provisional patent, a final patent, insurance, and the registration of my business. A provisional patent for a small business costs around \$140 for micro-entities, but I might also have to pay legal fees for a proper search and drafting. A full patent costs around \$3,000 to \$5,000 to file, so I want to wait on that until I get a second round of investment or more sales. General liability for a business in Ohio is around \$300 to \$5000, so I'll try to see if I can pay \$300 to minimize costs. Still, I would be willing to pay more if it prevented any large losses that might cause bankruptcy. It costs around **\$125** to register my business in Ohio, so that is an automatic expense that I will try to pay as soon as possible.

The manufacturing fees consist of a potential upfront payment of initial order size for batch manufacturing, typical in contract manufacturing. Due to the variability of factory prices, the upfront payment for the initial order size is difficult to appraise, but I am estimating that this would not be greater than \$5,000 for the size of my venture.

The production fees consist of four main subjects: Materials, Labor, Overhead, and Shipping/Packaging. If they are purchased in bulk, the materials should cost around **\$45 per unit of my product**, which should mainly consist of tent poles, tarp, and tape/YKK zippers. The labor cost is more variable due to different factories having different standards, but the majority of factories have around a \$20/hour wage, and if 45 minutes of work was utilized, then that would be \$15 of pure human labor. The overhead cost for many places is also around 2.5 x human labor, which would cost approximately \$32.50 of human work once the overhead is accounted for. If I use the ULINE packages and their provided tape, then it should only cost \$5/unit to package at most.

The testing fees consist of two main subjects: The money to build more copies of my prototype for testing and any shipping fees if the testing is to take place out of personal driving distance for me. I am planning on creating a maximum of 10 copies of my prototype in order to test, and if the cost of materials for each prototype is around \$50, then I would estimate that the maximum amount of money that I would spend for testing prototypes is \$500. The UPS flat rate shipping cost for my product, since it is under 5 lbs, would cost around \$15, so if I sent out ten prototypes, then I would have to pay \$150 in shipping there. Ideally, if the customer liked the product, then they would purchase it, and the profit from that purchase would pay off the cost of the shipping.

The marketing fees consist of two main subjects: Website operation and a B2B email finder website subscription. I already have the domain name for my website from GoDaddy. While there is technically a free option on Wix.com for my website, I think that investing in the \$18/month entrepreneurship plan on Wix.com would help me to have a high-quality website that could become a part of my assets if my company were ever sold or acquired. A B2B email finder, such as hunter.io or rocket reach, is free for a limited amount of uses but costs **\$49/month** for their basic plan that dramatically expands the searching capability. A \$49/month expense would not be something I would concern myself with during my business's early stages, but I can see it being invaluable in a later stage of my business.

Part 6. Business and Financial Proof of Concept: For a B2B-style business, like Metamorphosis Tents, the best way for us to reach our market initially is through personal connections. I plan to build on my interviews and testings to form these personal relationships, which are crucial for deals. As my company grows, email campaigns and social media will also be effective for reaching new customers. The sales process for a B2B compared to a more traditional B2C is longer and has fewer individual buyers, but the size of the sale is considerably larger. Many of the deals will be reached due to multiple discussions and interviews, which I expected will be grown by leads created by LinkedIn, email finding websites, and social media/email campaigns. I am also considering an E-store if more traditional B2C customers are intrigued, but that would be a secondary concern. Although single units are available, we expect that most of our customers will place bulk orders of 10 or more units at a time. When sold in bulk, each individual unit will retail for around \$90, while single units will retail for a slightly higher price. This would give us a profit margin of around 15%, but it should be noted that there is a high materials cost that goes into each individual unit, even if buying in bulk is more feasible. Since one of the lowest similar products that I could find, the Zelter Shelter, has a sales price of more than \$150, I could potentially sell my product at a 50% lower rate than one of the most competitive options on the market if my manufacturing and price calculations are correct.

I plan on developing my product and producing it in Cleveland in a textile factory due to the issues with shipping and developing overseas due to coronavirus. In addition, this will allow me to better supervise and personally know the facility plant manager or the factory general manager, which is essential for great deals and a positive relationship. The cost of developing my product would consist mostly of creating current versions of my prototype to test, along with the securing of a provisional patent, so it would cost no more than \$640 combined for that, but the uncertain part of cost would be whether or not the factory requires a minimum order to start production. My back up would be to look at Toledo, Columbus, or Sandusky-based factories, as they are within driving distance while being in-state, which is important for me due to my constricted student schedule. Distribution would be primarily handled by the large humanitarian organizations due to their connections with shipping companies and established stations in multiple nations. The bulk of the storage would also be handled by the large humanitarian organizations, but they would be initially stored in our factory

While there are certainly an endless amount of uncertainties and potential risks associated with being an entrepreneur, there are three that are present in my STEM business plan: Accidental Injury, Failure to gain traction, and a lack of a diversified customer base. An Accidental Injury could occur to my business because my product has the potential to be used in dangerous areas,

such as those that are war-stricken or destroyed by natural disasters , but I believe that I could mitigate the chances of this negatively affecting my business by purchasing insurance to make sure that I wouldn't lose everything in case of a lawsuit or by having the proper safety regulations printed on my tent in order to help prevent injuries through education. The failure to gain traction could occur to my business because my business is B2B, so not having many deals could be a possibility at the beginning of my business, or due to a lack of marketing and/or market fit, but I believe that I could mitigate the chances of this negatively affecting my business by reaching out to a large base of customers via social media and email campaigns for marketing or by conducting more market validation interviews to ensure that my product is a fit for my niche. Finally, the lack of a diversified customer base could occur with my business because I will inherently have less customers than a more traditional B2C business due to primarily selling to organizations, but I believe that I could mitigate the chances of this negatively affecting my business by reaching out to very small organizations that might be more willing to accept my product in order to not solely rely on major humanitarian organizations or by increasing the amount of marketing that I would conduct in order to grow my customer base.

I believe that my idea would require one round of funding to bring to market, but a second round of funding in order to truly expand and gain the reach necessary to begin impacting global humanitarian relief operations. The first round of funding would be a mixture of science fair awards that I had won from the State Science Day Competition in May 2020 along with the Core City Jumpstart Pitch Competition that was held on 12/8/2020, where I was the sole high school-aged finalist in an adult crowd of 10. The combined funds of these two sources would be around \$1000, due to around \$500 coming from the State Science Day Competition and a minimum of \$500 coming from the Core City Jumpstart Pitch Competition. While there are multiple smaller uses that I plan to use my funds for, the two primary purposes for my funds are the acquisition of a provisional patent, and the creation of more copies of my current prototype. The provisional patent allows my business to be seen as reputable to these larger humanitarian organizations, and it offers a higher level of legal protection. Creating more copies of my current prototype will allow me to complete more testing, which will help me to go into production. The second round of funding would be based off of either a university investment fund, an angel investor, or a much higher profile pitch competition, due to the size of the funding being estimated to be around \$25,000. This level of funding would be preferably in a non-equity fashion, but I also understand that as the level of funding increases, the payoff of equity to investors becomes more commonplace. The two primary purposes of this secondary round of funding would be to increase the production capacity of the Transformable Tent and to fully obtain a full legal design patent for the Transformable Tent. Increasing the production capacity of my product will help to grow my business by allowing me to take larger orders from more customers, which will allow for my business to be able to create a return on this investment at a faster pace. Obtaining a full legal design patent for my product will solidify the transformable tent as my company's intellectual property, which will help when dealing with potential larger organizations for customers and in the event of an acquisition or business sale.

My 3 year financial projection as an excel sheet is shown below, and here is a brief explanation for some of my reasoning:

I am projecting that my first quarter will be spent developing my prototype, testing, and ensuring the legality of my business, so I did not enter any sales for that quarter.

The majority of my selling, marketing, and advertising costs are to be spent on a website and a rocketreach account, since the majority of my sales are Business to Business rather than Business to Customer.

My Management and Administrative costs include the creation of a gmail suite account in order to organize and further legitimize my business.

Development costs are related to constructing more prototypes and less for paying design engineers, even though I am open to working with them through either Jumpstart or MAGNET.

A provisional patent has an estimated cost of around \$100 for a filing fee, but I am planning on using the IP Venture Clinic at Case Western Reserve [16] in order to assist me with the actual filing of the provisional patent. I plan on receiving an actual design patent, which can cost between \$3,000 and \$5,500 [15], which I am estimating to be \$4,000, with the help of a traditional patent lawyer. I am looking into receiving a grant from the Small Business Innovation Research (SBIR) government fund [14], which helps with development, startup, and organization funding for organizations that have fewer than 500 people and are 51% or more based in the US.

My Testing costs primarily come from creating more prototypes, and less from any equipment to test, since the majority of the testing will involve user feedback.

I got the \$600 value for general insurance from Progressive's rating in Ohio, where the median insurance cost was around \$47/month while the mean cost was around \$53/month, so I used \$50/month as a round number that would provide a stable estimate. [17]

Metamorphosis Tents Business Plan (2021 Believe in Ohio)							Updated December 2020						
Financial Projections													
For the First Four Quarters and First Three Years													
							Totals For						
							Year 1	Year 2	Year 3				
							Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year 1	Year 2	Year 3
Sales and revenues							\$0	\$2,000	\$4,000	\$8,000	\$14,000	\$30,000	\$60,000
Costs and expenses:							Quarter 1	Quarter 2	Quarter 3	Quarter 4	Year 1	Year 2	Year 3
Cost of sales							\$0	\$1,600	\$3,200	\$6,400	\$11,200	\$24,000	\$48,000
Selling, marketing and advertising costs							\$100	\$100	\$100	\$100	\$400	\$400	\$400
Space and occupancy costs							\$0	\$0	\$0	\$0	\$0	\$0	\$0
Management and administrative costs							\$100	\$100	\$100	\$100	\$400	\$400	\$400
Total costs and expenses							\$200	\$1,800	\$3,400	\$6,600	\$12,000	\$24,800	\$48,800
Pre-tax cash profit (loss)							(\$200)	\$200	\$600	\$1,400	\$2,000	\$5,200	\$11,200
Investment required to start your business:													
Cost of developing prototype products							\$300	\$0	\$0	\$0	\$300	\$0	\$0
Legal, patent or other organizational costs							\$200	\$0	\$0	\$2,000	\$2,200	\$4,000	\$100
Product Testing Costs							\$200	\$0	\$0	\$0	\$200	\$200	\$200
General Liability Insurance											\$600	600	600
Other investment costs											\$0		
Projected Investment (Yearly)											\$3,300	\$4,800	\$900
Projected Investment (Total, as of X Year)											\$3,300	\$8,100	\$9,000
Projected return on investment (Profit/Investment)											60.6%	64.2%	124.4%

Part 7. Acknowledgements: I would like to thank Amy Klencz, my AP Lit teacher at Westlake High School and Laurie Godfrey, my STEM advocate, for the guidance that both of you have provided for my project, as well as the Believe in Ohio program for providing an incredible opportunity to showcase how STEM and entrepreneurship can be combined.

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