The Custom 3D Printed Earbud Cover

Major Qualifying Project completed in partial fulfillment of the Bachelor of Science degree at Worcester Polytechnic Institute, Worcester, MA

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Abstract

Due to the recent explosion of mobile multimedia devices, the headphone industry has become exceedingly large and diverse worldwide. The most popular style of headphones are in-ear "earbuds." Despite their extreme popularity, there is a common consumer complaint in that earbuds tend to fall out or become uncomfortable with use, causing an interrupted listening experience. EarThotix solves this problem with the custom 3D Printed Earbud Cover. Using a blend of high-end technologies, EarThotix delivers a custom product with a streamlined production process that delivers an earbud that fits our customer's ears only.

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Table of Contents

Table of Figures

Authorship

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Executive Summary

Modern earbud users expect to be able to listen to their music regardless of situation or activity. As earbuds popularity increases, the environment in which they are utilized grows more diverse. More active earbud users share a common complaint that their earbuds do not fit satisfactorily and frequently fall out during use. Interruption of music can tarnish the user experience, and lead to physical discomfort after repeatedly jamming the earbud back where it belongs. This combination of pains creates an opportunity for improvement of customer satisfaction with earbud use.

Our proposed solution is to introduce a custom manufactured earbud cover that can attach onto a user's current pair of earbuds. This add-on will significantly increase the comfort of the user, by simultaneously improving fit and minimizing how often earbuds fall out. The 3D scanning and printing combination will deliver the custom solution to the customer faster and cheaper than any current comparable market offering.

The purpose for the report was to investigate and validate the consumer pain, identify the appropriate technologies to deliver the solution, and perform a market analysis to determine its feasibility. We compiled these findings to formulate a business plan based on our solution. Using this business plan, we hope to enter start-up competitions such as MassChallenge and eventually launch our venture. We gained the information through market research, survey, and general conversations with professionals in related fields. This information helped us conclude that we have a feasible solution to the market need, and our business plan has prepared us to enter the market.

1.0 Introduction

Fulfilling the requirements for management engineering with biomedical and mechanical engineering concentrations, this project developed an organic idea into a comprehensive business plan using concepts and tools learned from various WPI business and entrepreneurial courses. The criteria for the capstone project includes an incorporation of everything students have gathered from course work and apply it to solve real world problems. According to the WPI Projects Program Website, "an MQP is a senior year capstone setting the stage for your career launch...students are expected to deliver genuine and measurable value" (WPI, 2014). The business plan written for this project is in itself a collection of values learned from Marketing, Finance, Business Development, and Management courses we have taken through the Business School at WPI. Our business plan interrelates various concepts learned from these courses and is the ultimate representation of what a senior year capstone project should be. This project exceeds the criteria for a completed MQP, as we were able to generate substantial information required for filing of a provisional patent, as well as networking with extremely influential entrepreneurial advisors. We believe upon completion of the MQP, we are ready to transform this project into a company.

3D Printing is a rapidly expanding technology which has potential to reinvent the manufacturing industry. It is currently being used in a variety of applications, yet it is in a very early stage of market penetration. At the same time, the headphone market has grown to become an extremely large industry worldwide, and the most popular style of headphone is the in-ear bud, or earbuds. While earbuds are extremely popular, we have found that there are a few common consumer complaints. Consumers have found that most earbuds do not fit their ears

well with extended use, which leads to them falling out during exercise, discomfort, and ultimately n discontinuous and dissatisfying listening experience.

The solution to the pain of ill-fitting earbuds is the EarThotix custom earbud cover, which is 3D printed based on a high resolution in ear scan of the customer's ear canal. Able to fit on any existing earbud, the EarThotix cover will improve the listening experience of the user by eliminating the need to constantly adjust or reinsert one's earbud. The cover is created with a medically approved biocompatible photopolymer, quite similar to what is used modern hearing aid manufacture. By combining a brand new device for rapid in ear scanning and the precision of a 3D printer, EarThotix will be able to deliver an unrivaled custom product in significantly less time than any current market competitor.

The market is ready for our product. Consumer reports, blogs, conversations, and the results of our survey show that there is a need for our product due to customer dissatisfaction with current earbud fit. Consumers are using more personalized audio than ever before. Industry reports show that the headphone market is currently a 1.5 billion dollar industry with 54% of the market composed of earbuds. Our product serves as an add-on feature to currently existing earbud brands. As a result, we do not pose as a direct threat to popular earbud competitors. We use a unique manufacturing process that is currently unmatched in the industry, involving 3D printing technology. As a result of the size of the market, our minimal threat to already existing competitors and our use of 3D printing which is a rapidly expanding technology, we have determined that our company is feasible as well as highly profitable.

2.0 Background

Our project goal is to propose a solution to the overall fit and comfort of the modern earbud, developing an earbud that is uniquely custom fit to each individual's ear canal. In order to create such a product, we researched the information necessary to start our own company, EarThotix. In this chapter, we will discuss the current devices and methods of 3D printing, the major areas in biomedicine where 3D printing is currently used, and background on the headphone market.

2.1 3D Printing Devices and Methods

3D printing is a technology which utilizes methods of additive manufacturing to produce a part or product. Additive manufacturing (AM) is a term used interchangeably with 3D printing, and is defined as "the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies" (Wohler). Additive processes are able to produce products which minimize waste in the form of both materials and time. 3D printing is possible with several unique approaches, though they all share the common thread of building up the part one layer at a time. The materials commonly used include filaments, liquids, or powders which are heated or chemically treated in order to fuse together. Mainstream 3D printing technologies include fused deposition modeling, stereo-lithography, laser sintering, and polyjet 3D printing. It should be noted that there a numerous methods of 3D printing, which utilize countless devices and material combinations. Explaining each of these slightly differentiated technologies is unnecessary as they do not directly relate to our product. All of these technologies rely on an accurate digital 3D model in the form of a CAD file, which can be generated using a modeling program, or a 3D scanning technology (PC Mag, 2013).

The earliest form of 3D printing is the extrusion method utilized by fused deposition modeling (FDM). In this method, strands of plastic referred to as filament are heated and extruded to form the individual layers of the 3d printed object. Each strand of filament is known as a road once it has been extruded and laid down in parallel with the existing roads. These structural units allow for variation in the pattern of roads, and affect the final texture, shape, strength, and volume of filament needed to complete the object. FDM is utilized primarily on a smaller scale, as larger prints are very time consuming, and the size of the object depends on the size of the printer itself. For this reason, FDM is favored for rapid prototyping and construction of functional models (PC Mag, 2013).

Stereo-lithography (SLA) relies on a liquid polymer which is photo-reactive, meaning it hardens when exposed to the correct wavelength of light. The first layer of polymer which is solidified will be the bottom of the object, and the structure is built up as the platform lowers into a vat of liquid polymer. The second layer will be hardened directly on top of the first, and then descend under the surface of the liquid so the next layer may be built upon the last. Hardening of the polymer is normally achieved by laser, with a mounting and track similar in structure to a modern desktop printer. The track allows the laser to trace the 2d shape into the polymer and harden it before the platform automatically lowers. A slightly varied method of stereo-lithography utilizes a digital light projection system rather than a laser for the curing of the liquid polymer. This alternative can harden an entire 2d layer of resin at a time, directing light to the correct areas and deflecting light away from areas which must remain liquid. This method is used in similar situations as the FDM approach like rapid prototyping and scale model creation. SLA provides a higher degree of detail and allows for a more professional final product, so it may be utilized for a more customer facing product, or a more complex model than can be created by

FDM. It is rare for an object created by FDM or SLA to be utilized as a functional component (PC Mag, 2013).

Selective Laser Sintering (SLS) utilizes powdered materials including polymers, metals, and composites as a structural unit, binding together the individual grains with the heat of a laser. The object is built from the bottom up, with each individual layer of powder applied after binding has taken place. Many different materials may be utilized, requiring a tuned laser for the correct amount of heat and energy to ensure proper melting and bonding of the individual particles. Subdivisions of SLS printing include solid state sintering, chemically induced binding, and liquid phase sintering. The lasers employed in most SLS systems must be considerably more powerful than any other lasers used in 3d printing, as the process requires full melting rather than activation of a reaction. SLA is very effective for creating functional components, but it is not scalable for large scale production. It is more likely that a small and specific unit be created for a special order by SLA than for generic and mass-produced items (PC Mag, 2013).

Polyjet™ technology is similar in concept to modern inkjet printing of text, images, and documents. Rather than printing words or diagrams onto paper, the Polyjet™ printers "jet layers of liquid photopolymer onto a build tray and cure them with UV light" (Stratasys, 2013). Stratasys Polyjet™ 3D printers are capable of blending polymers during production resulting in an unrivaled control of final product properties. Polyjet™ technology supports one of the most diverse selections of materials for model creation, organized into 9 families and containing over 90 unique materials. Properties such as opacity, density, durometer, and flexibility may all be fine-tuned through unique combination of digital polymers to create the desired physical and mechanical makeup required. For prototyping, this is an advantageous trait, and for end product development, it serves as a viable option for specific applications. Polyjet™ technology represents

a cutting edge process which is proven effective for complex prototyping and due to its wide range of possible materials it is capable of producing products for end use roles (Stratasys, 2013).

The Lantos Technologies 3D ear canal scanner represents an extremely viable tool for accelerating and simplifying the ear molding process. An accurate impression of the ear is essential in order to produce a properly fitting in-ear device of any sort. The current method of imprinting the ear is somewhat archaic, involving injection of a liquid resin based material into the ear and allowing for a curing time of up to 10 minutes per ear. In order to have these impressions made, either an audiologist or a home kit is required. The Lantos 3D scanner uses a "conforming membrane" which is gradually filled with an "absorbing medium" which swells to make contact with the ear canal (Lantos, 2013). Once the membrane is in contact with the full ear canal, a sensor inside retracts and records hundreds of two dimensional readings. These individual images are constructed based on the distance of the membrane from the sensing rod, creating a very accurate 3D image. The process requires a mere 60 seconds, and automatically generates the proper file type for manufacture of a custom in ear device (Lantos 2013).

The current state of 3D printing technology and applications has been described as the peak of the inflated expectations curve of technology adoption. There is an abundance of media coverage and so called "hype" about the technology, and stories of 3D printing success stories are very hopeful in their reporting. A positive indicator of 3D printing industry growth was highlighted in a scienceprogress.org article in the "new pilot program to create an institute for public-private collaboration and innovation in additive manufacturing" which the Obama administration has publicly backed. Federal investment in applied research through collaboration among industry professionals, research universities, and nonprofit organizations will

undoubtedly lead the market in a positive direction and spur acceptance of the relatively

underutilized technology. Aside from massive research initiatives, the 3D printing market has

given birth to an online community which hosts files, shares experiences, and promotes

innovation, both through at home tinkering and numerous sponsored innovation and business

plan competitions. Practical 3D printing applications which are employed today are primarily

focused in the rapid prototyping industry, where objects which are printed are used for

demonstration or modeling more than becoming an end use item.

This trend is beginning to change as at home 3D printer kits become more inexpensive,

and group funded initiatives like Kickstarter begin to offer an ever more diverse range of

hardware for the at home segment. Successfully funded 3D printing projects from Kickstarter

include the Formlabs Form1, funded almost $3 million after setting a fundraising goal of only

$100,000 , the Cartesian EX[1] , and the Pirate3D Buccaneer, all marketed as affordable desktop

3D printers designed for the end user. This overwhelming crowd funding demonstrates how

ready consumers are to consider 3D printed products as unique and desirable. The continued

development of 3D printing applications and market readiness point to growth and innovation

opportunity within the market (Formlabs, 2012).

2.2 3D Printing in Biomedical Engineering

Currently, 3D printing is used in a variety of different fields, ranging from medical and

manufacturing to fashion, sports and even food. As technology progresses and the demand for

custom products increases, experts continue their research concerning the capabilities of this

device. Their advancements and discoveries about this science reveal more and more the

limitless possibilities of 3D printing. This is particularly true in the biomedical industry where

3D printing is being utilized to create custom parts for the individual such as bones, dental

toothbrushes and crowns, prosthetics, casts, hearing aids and living tissues to name a few. Biomedicine holds vast potential for the growth of 3D printing as it can offer a way to heal the human body faster and more effectively.

2.2.1 Bones

"3D printing has grown from a niche manufacturing process to a $2.7 billion industry" in just 20 years… (Doyle, 2013). Scientists are working towards 3D printing live cells, which have proven to be possible with certain advanced printers. Bones comprised of a patient's own cells can be 3D printed. An image of a defect in the bone structure of a patient can be fed into a computer which then 3D prints a replacement that fills the defect. MIT researchers are also working towards discovering ways in which "durable, lightweight, and environmentally sustainable" artificial bones can be 3D printed. Bones which are broken can also be repaired using a specific 3D printing and x-ray scanning method, which creates a breathable and ultra-lightweight nylon exoskeleton-type sleeve that functions to protect the broken bone with a custom fit and superior support (Doyle, 2013).

2.2.2 Dental

3D printing is also used in the dental industry, for teeth replacements, crowns, bridges, fillings as well as toothbrushes. Priced around $75-$200, the Blizzident is a 3D printed toothbrush, custom fit to a person's mouth that can clean teeth in less than 7 seconds. A person simply bites down on a 3D mold of their mouth, similar to a mouth guard, and grinds on the 600 bristles that line the toothbrush. The process behind this device is that the dentist first takes an impression of the person's teeth which is then next sent to a laboratory that scans the impression and creates a digital 3D model, ready for the patient to use (Blizzident, 2012).

2.2.3 Prosthetics

3D printing can also be used to create prosthetics and parts of the human face. For around $2439-$5000, there is currently a process in London where a patient's face is 3D scanned and "specific contours then are added to a digital model of the new prosthetic part to create a perfect fit" (Wainwright, O, 2013). The parts are printed in starch powder and full color and then vacuum-infiltrated with medical grade silicone. This technology allows a person to scan any part of their face, whether a nose, forehead or ear for example and replicate it for facial prostheses.

Artificial limbs can be created through consumer-grade 3D plastic printers in approximately 6 hours and for less than $100. These limbs are created using low-cost in order to be available at an affordable price to people who are suffering from missing limbs. The downside to these limbs however are that they have limited flexibility, control, strength and need certain attachments in order to carry-out ordinary tasks such as eating, and thus do not provide the perfect solution to the patient (McCracken, H, 2014).

2.2.4 Casts

Customizable casts are now possible with the help of 3D printing. The prototype Cortex cast is an example of this technology. Very similar in structure to bone tissue, the Cortex is light, comfortable, inexpensive, waterproof and has a personalized tailored honeycomb foundation. The cast is custom made to each patient and according to the area of their injury in order to offer them the greatest support and most comfort during healing. The method behind the cast is as follows: first an x-ray is taken of the patient's bone in order to identify the area of the break. Next, a 3D scan is taken of the patient for customized dimension. And last, the dimensions and data from the x-ray and scan are sent over to a computer program where the cast is then created for the patient (Gologowski, N, 2013).

2.2.5 Hearing Aids

3D printing is also now commonly utilized in the hearing aid market to create customizable, fitted hearing aids. Business Insider claimed that "more than 90% of all hearing aid shells today are produced through the process [of 3D printing]" (Wile, R, 2013). There are numerous companies using 3D printing to create customizable hearing aids. As an example, one Danish Company, Widex, has created a certain method, CAMISHA that creates the world's smallest hearing aids. This process is used "throughout the hearing aid industry for 95% of all custom hearing aids" (3Ders, 2013). For around $1000-$3000 CAMISHA inserts liquid silicone into the ear of the patient, creating an impression of the ear canal which can then be scanned into a computer program, converting the scan into a 3D image. After this process, a fitted plastic ear shell is then created out of acrylic from the scan where the micro-circuitry of the hearing aid is then inserted into the product and given to the customer (3Ders, 2013).

2.2.6 Tissue

The ability to print living human tissue and organs is also being heavily researched by scientists. These machines have already successfully experimented with making bioartificial cartilage in cow tissue. In order to create and print living tissue, the 3D bio-printers would print cells in either a liquid or a gel. The possibility of being able to 'print on demand' a live organ, such as a heart, is something scientists and researchers have been striving towards for the future. Laboratories in Germany have been experimenting printing sheets of heart cells and skin cells that could potentially be used to repair damage caused by a heart attack (Fountain, 2013).

Research is also underway to create a synthetic 3D printed skin that "can be matched to a patient based on his or her age, gender and ethnicity…custom tailored skin that would mirror the bumps, crinkles , veins and tones found elsewhere on a patient's body" (Maxey, 2013). This

research is based on a 3D imaging and skin modeling program that essentially would scan a person's skin, creating an image that could be embedded into a 3D skin profile where the custom skin would be accurately printed. Eye tissue is also being heavily researched as scientists for the first time ever have 3D printed living central nervous system retina cells using lab rats and an inkjet printer. This invention could revolutionize biomedicine as it holds a potential cure for blindness and can be used for other eye surgical purposes. The researchers behind this study believe that "this process will be capable of 3D printing retinal grafts tailored for individual patients… [As well as] leading to other neural repair surgeries, possibly even including damaged nerve cells and spinal cord injuries." (Druce-McFadden, 2013). With these breakthrough advancements in 3D bioprinting, it will not be long before perfect individualized bones, tissues and organs are available to every patient. Much more research has to be done in the field of 3D printing living tissue and skin, but this technology is evolving and growing fast, presenting endless and exciting possibilities in not only biomedicine but any other field imaginable.

2.3 Headphone Market

2.3.1 Problem in the Market

The worldwide headphone market is now a 1.5 billion dollar industry, and is growing at an annual rate of 7.0%. There is a variety of different style of headphones available in the marketplace today, and the most popular of all headphone styles is ear buds, which are designed to fit inside the consumers' ears to provide superior audio quality, as well as convenience. While this style of headphone is extremely popular, it does not come without major flaws. Consumers have long griped about finding the perfect fit for in-ear buds, as even the most popular of ear buds have trouble staying comfortably in consumers' ears. This is especially true with active consumers such as athletes, who use headphones while training or performing in athletic events.

With this added movement, traditional ear buds tend to fall out of the consumers' ears, and do not provide the consumer with an interruption-free listening experience. With research compiled from various sources, it has been confirmed that consumers are still facing this issue, even with more and more new ear buds being released by major companies every quarter. This leaves the door open for a different solution to meet the needs of headphone consumers (Lerman, 2014).

2.3.2 Overview of the Headphone Market

The worldwide headphone market is now a 1.5 Billion dollar industry. From 2008- 2013, there was an annual growth rate of 7.0% in this market. The projected growth for 2013-2018 is 1.1%. As the headphone market currently stands, there are 78, 072 enterprises in the business of manufacturing and/or selling headphones, but there are no major players in this industry with a significant portion of the market share. The headphone life cycle stage is mature according to, which contributes to why the growth is expected to slow within the next five years. In terms of methods of sale, e-commerce is huge for this market. Because people buy headphones generally to use with consumer electronic devices, the e-commerce sales for this market are vital. In 2013, around 50% of sales were through e-commerce retailers for headphones. Headphone purchases are also considered to be discretionary spending because they are not vital items. Over the next five years, consumers are expected to be purchasing more expensive, high-end headphones, as consumer per capita disposable income is expected to increase. (Lerman, 2014).

This leads into an emerging segment of the headphone market, the high-end or luxury headphone market. As the NPD research group notes, the premium headphone market is defined as the market segment that includes headphones with a price of $100 or more. This market segment has grown substantially in 2012-2013, and currently makes up 43% of all headphone sales (NPD). The premium headphone market was always in existence, however it was a niche

market that only appealed to consumers who were musicians, music producers, and "audiophiles," people who need the highest quality audio output. As the overall headphone market matures, this premium headphone market has grown. More and more consumers are valuing sound quality when shopping for headphones, with 73% of consumers stating the greatest determining factor was sound quality. The leaders in this market segment are Beats by Dre and Skullcandy, who largely offer over the ear headphones that are marketed as having superior audio quality and superior style as their main points of their value proposition. There are many different types of headphones available on the market today. In-ear "buds", over the ear, behind the neck, wireless, and gaming headphones make up what is available to consumers today. The largest two in terms of market share of these different types of headphones are in-ear buds (54%) and over the ear headphones (24%). With all types of headphones, the market is largely e-commerce driven. Sales from electronic retailers are critical to this market, largely due to the fact that most consumers are purchasing headphones for their internet-connected personal electronic devices, such as their personal computers, smartphones, and tablets. E-commerce sales represent about 50% of all headphone sales in 2013. The number of overall retailers in the market is expected to grow 6.5% annually, as smartphone, tablet, and computer sales continue to rise, driving the demand for headphones higher (Lerman, 2013), (O'Connor, 2012).

In terms of target demographics, 39.5% of headphone consumers are of age 35-54, 17.3% are of age 25-34, and 13.2% are under the age of 24. Headphone consumers can be further classified into different behavioral segments. Lead users for headphones are generally classified as "audiophiles," meaning any person who values audio quality above all other features, and is willing to pay upwards of $100. These are the consumers who are driving the premium

headphone market. Other significant segments are athletes, who tend to purchase headphones based on their design, as they require well-designed headphones that allow the user to move about without interruption. Another significant segment is gamers, who use headphones with their video game systems or personal computers.

2.3.3 Basic Info on How Headphones are Traditionally Made

There are a few different industry-wide methods for making headphones, as well as a wide array of choices for manufacturers when it comes to materials. The choice of materials largely depends on the target market, as higher quality materials are generally required to satisfy the needs of the premium headphone market. For in-ear buds, the typical materials list consists of pre-molded plastic, carbon polymers, gel cups, and metal components for the sound system. In higher-quality headphones, manufacturers may turn to thicker wiring systems, gold-plated components for a more secure fit, and noise cancelling electronics. The sound producing system traditionally consists of a small dynamic driver and magnets (Lacoma, 2012).

2.3.4 Example of 3D Printing in the Current Market

The headphone industry is slowly starting to adopt 3D printing. A direct competitor to our proposed solution is "Accord Ear Buds" by Julian Goulding (3D Printing Industry). These ear buds are the same basic concept as our solution, offering 3D printed ear buds that are designed to fit perfectly in the consumer's ear. A significant detail about Julian Goulding's ear buds is the process in which the consumer is fitted and receives his/her ear buds. The consumer is faced with the choice to buy a molding kit, mold their ear, and send the kit to the company, or they can have their ears molded professionally by an audiologist. It is worth noting that as of December, 2013, the product is not in production, and Julian Goulding plans to start producing these headphones in early 2014 (Accord, 2013).

2.3.5 Why We Chose the Headphone Market

We chose to bring 3D printing into the headphone market for a variety of reasons. We believe there is a significant market need, as established through researching competition as well as consumer opinions throughout the whole headphone market. It has been established that many consumers feel as though their in-ear buds do not fit them properly, and it causes discomfort as well as having a significant negative impact on their listening experience. In thinking of a solution to this problem, we believe using a combination of 3D scanning and 3D printing to create custom covers for consumers' favorite headphones would solve this market need in a feasible manner. The headphone market is also conducive to e-commerce companies, with roughly half of all headphone sales in 2013 coming from online retailers. We also believe the headphone market would be a smart market to dip into because of the solution at hand. With manufacturing customized covers for current earbuds, we have created a solution that is feasible and within reach for our project timeline.

3.0 Methodology

The main research goals of the project were to, first, determine the best 3D printer technology and material suited for our company's purpose; second, conduct market research in order to define our market niche and the distinctiveness of our product; third, attain expert advice regarding 3D printing and intellectual property; and fourth, develop a business plan proposal in order to estimate the profitability and success of our company. In order to accomplish these goals, we identified the following methodology objectives to serve as a basis for our research.

1. Investigate the current devices, processes, and materials of 3D printing

2. Research current and developing competition and target market

3. Conduct Interviews

4. Compose a Business Plan

To help us achieve these objectives and gain the information needed, we employed a variety of research methods such as interviews, public surveys, online research, and literature review of relevant and professional sources. This chapter explains our methodology in detail and is organized according to each objective.

3.1 Investigate the Current Devices, Processes, and Materials of 3D Printing

Our goal is to identify and classify the modern leading 3D printer types by their market presence, their method of printing, and the range of materials available as the structural component of the final product. Discovery of devices with greater flexibility in terms of process and materials is a priority, as the selection of a proper device for our business should be made from the most complete range of competent devices possible.

3.1.1 Scholarly Reports on 3D Printing Methods

Major categories of 3D printers unrelated to brand and material must be acquired first from various scholarly sources used to educate students about 3D printing. This research will define the primary categories of 3D printers based on the technology which is utilized and the process which is carried out. Next, the useable materials for each 3D printing technology will be defined, as the final product's physical and chemical properties will determine the behavior of the final product.

3.1.2 Technology and Business News Articles

Breaking articles published on various technology oriented news sites will illuminate the new and popular 3D devices which are either being released or are being utilized successfully. These news sites may lack hard data and specifications, but they will give an idea of which industries are taking advantage of which processes and materials for their production. These articles on news sites are a great resource for identification of market trends, technology acceptance, successful implementation, as well as which 3D companies are rising and gaining recognition. The companies identified in this article will become a resource for the more in depth data necessary for making educated decisions about the proper device for our project.

3.1.3 Market Leaders' Websites and Personnel

Once viable brands have been identified utilizing news articles and tech columns, their company website will become a valuable resource for more technical information. Data on specific models of 3D printer will be collected in order to determine the best speed, size, process, and material needed to accomplish our product plan. This data can be found using buyer guides, specification sheets for devices, or technical material guides. Other information will be collected

from company websites and personnel though a Q&A or information request process, and will include pricing information as well as details not available on the website.

3.2 Research Current and Developing Competition and Target Market

Our objective was to perform research on two fronts of the headphone market. First to research the industry as a whole, and then to research specific companies and/or products. This will help us find the market need, and in turn, help us eventually result in us finding the market solution. We used models and methods recommended by both Professor Hoy and Professor Mendoza.

3.2.1 Industry Research

To find information about the headphone industry as a whole, we will use library databases to discover key statistics about the headphone market. These statistics will include but not be limited to: market share by company, industry-wide revenues, growth trends, and sales methods. A specific finding will be to discover who the industry leaders are, what sort of products they offer, and how they are perceived by their customers.

3.2.2 Market Research

Market research will be conducted using the "Market Segmentation Worksheet" provided by Professor Mendoza. This worksheet will allow us to narrow our focus on exactly what kind of headphone consumer we will be appealing to and targeting. We will find out what percentage of headphones sold are "ear bud" style, what types of people buy headphones, how much they are willing to spend. We will also survey WPI athletes to learn more about their views on using ear buds in an active setting, and we will be asking them how well their current headphones fit during athletic activity.

3.2.3 Consumer Reports

After finding the industry leaders, we will research exactly how their customers feel about their products, by using tools such as Consumer Reports and Amazon Reviews, as well as blogs and social media trends. Ideally this will lead us to confirm our hypothesis that there is a significant need in the headphone market for ear buds that fit consumers' ears perfectly. If proved correct, we will find how large the problem is, and whether our target market is closer to being everyone with ear bud headphones, or more of a niche market, such as athletes who use ear bud headphones.

3.2.4 Initiate an On-Campus Survey

We plan to develop and implement an on-campus survey that will be sent out to both faculty and undergraduate students at WPI. When developing the types of questions, we want to ask survey responders about their current pair of headphones, with questions about brand, headphone style, and their satisfaction with their current set of headphones in terms of audio quality, fit, and design, and how much they paid. We also want to know about how and when they use their headphones, as well as how much they would pay to improve the fit of their current set of ear buds. This information will help us determine the market need further, as well as give us key information regarding how people use their headphones, and what features they value most.

3.2.5 Potential Customer Conversation

Identifying the specific needs of our potential customers may be deduced from our survey, but the most reliable way to gauge the customer's emotion and acceptance of the product is through face to face discussion. Each of the group members will share the EarThotix solution with friends, classmates, colleagues, or anyone they believe could benefit from a custom earbud

cover. Our goal is to gather first hand recommendations and feedback from a diverse and honest group of individuals.

3.2.6 Determine how research results will be incorporated into business plan.

These research results will likely have major impacts on our business plan. The size of our business will depend on the size of both the headphone industry as well as the percentage of ear bud consumers who are dissatisfied with the fit of their current headphones. This market research will also help us confirm or pivot on which type of headphone we will be targeting first. We believe there to be significant problems with Apple earbuds, and if our market research supports this, we will move forward targeting these types of headphones.

3.3 Conduct Interviews

Throughout our research process, we want to pair all the above research with interviews with professionals in the field who can give us useful tips and information. We will reach out to professionals with backgrounds in Intellectual Property and 3D Printing.

3.3.1 Intellectual Property Professional Interview

We plan on asking which processes in our business plan would be eligible for some form of Intellectual Property protection. We would also like to know things such as cost and process involved in order to protect our eligible assets. Another question we will ask is if it is a viable option or necessity for start-ups to hire a lawyer who specializes in intellectual property, and if that would be a better decision than attempting to undertake the process ourselves.

3.3.2 3D Printing Expert Interview

When interviewing a 3D Printing expert, we first want to ask general questions based on cost. This includes an estimate for the cost of the Stratasys Printer itself, material cost, and

maintenance. Expanding further, we would like to know what sort of packages and/or warranties Stratasys offers and how potential problems with the printer will be handled. Determining these costs will help us better understand our financial situation, and learning how the maintenance is handled will help us better understand how our business will be able to handle these problems down the road, should they appear. Another challenge which we wish to address is the overall feasibility of printing the earbuds from both a mechanical and operational standpoint.

3.4 Compose a Business Plan

Our objective was to create a practical and well-thought out business plan that was best suited towards our company, our mission and our goals. In order to gain the information necessary for our plan, we utilized various business models and tools, studied several business plan templates and thoroughly researched different business strategies after investigating our target market, potential customers and current competitors. The deliverable of this research will ultimately help us determine whether our company will prove to be both feasible and profitable.

3.4.1 Business Model Canvas and SWOT

The first step to composing the business plan was to gain a general and visual understanding of some of the specifics of our business itself, such as market, customers, products and competitors. In order to accomplish this, we completed a Business Model Canvas and the SWOT analysis. Developing these models enabled us to clearly list the specifics of our business and recognize all opportunities and challenges that our company could potentially face. The information in these models acted as the foundation and starting point for our business plan.

3.4.2 Plan Template Research

The team was assisted by Professor Hoy and Professor Mendoza who provided us with a variety of professional business plan templates. We thoroughly reviewed all of the business plan examples, and were able to formulate criteria to incorporate in our plan that would correspond with our overall company structure and vision. The team then began in-depth research of the market, possible business strategies, operational structures and financial analysis tools.

3.4.3 Determining Business Strategies

In order to determine the best suitable business strategies for our company, we utilized several resource methods. First, we used the book *Case in Point*, by Marc P. Cosentino, which presented us with valuable information in regards to different companies pricing, growth, financial, industry and competitive strategies. This provided us with a solid foundation for selecting the different strategy paths we were looking to take as a startup company. We also utilized the WPI library database to find articles in the business databases (Business Insights: Essentials; Business Source Premier) relating to different marketing, distribution and pricing strategies new companies undertook. We then analyzed the benefits and costs of seeking assistance from online marketing software company, such as Hub Spot, to help our idea reach our target market. We investigated possible methods using social media, newspapers, and local gyms to advertise our products. We also explored the pros and cons of different investor groups, to help kick-start our idea and provide early financial help and funding for our company. And finally, we also strategically priced our products and located our stores based on the research we had completed in our target market sector.

4.0 Findings and Analysis

4.1 Devices, Processes, and Material

After thorough exploration into the viable options for 3D printing devices, processes, and materials, a specific system and combination of resources has been determined which will maximize our potential for creating the best end user product. The 3D printing technology which suits our requirements best is the Polyjet technology offered by Stratasys. There are several devices which are able to utilize the Polyjet technology, ranging in size of print area, quality/speed of print, and the availability of compatible materials. Generally, the larger and the higher resolution a 3D printer from Stratasys is, the more expensive it is. Our team decided to utilize the smallest possible printer in the class of devices which may utilize Polyjet technology in order to minimize costs.

For our purposes, we have determine the Stratasys Objet Eden 260V from their design series. This printer offers the optimal combination of size, print quality, and most importantly, it supports printing with the specific biocompatible material which must be utilized for a product which is in constant contact with the customer's skin. The material which we have chosen based on 3D printing expert opinion as well as thorough headphone and 3D printer market research is the Stratasys Bio-compatible Polyjet photopolymer (MED610). This is a rigid opaque material which is rated for prolonged skin contact. MED610 has passed five different medical requirements or biocompatible materials, including "cytotoxicity, genotoxicity, delayed type hypersensitivity, irritation and USP plastic class VI" which ensure that the final product will not be cause to irritation or toxicity to the customer. This material is exclusively created and sold by Stratasys for the Objet Eden and Objet Connex Polyjet 3D printers. Our research has led us to

discover the price point of $1,260 for 3.6 Kg, or $3,630 for 10.8 Kg of MED610 Bio-Compatible Polyjet photopolymer.

In our search for a viable in-ear scanning device to match the speed and modernism of our 3D printer, our team discovered the AURA 3D Ear Scanning System by Lantos. It is a brand new technology which has only become commercially available in the past few weeks. This device offers unrivaled speed and ease of use for the operator, as well as maximizes comfort for the customer. This device is capable of taking a full deep-canal scan of the customer in less than 1 minute per ear. Without the need for any putties or polymers to be inserted in the ear and allowed to cure for model creation, the AURA is a much faster and more convenient process compared with current practices. Once the canal has been scanned, the AURA sends a full 3D image in the form of a CAD file to whichever computer it is connected to via USB cable. This file type is compatible with the Objet Eden, and will minimize the amount of processing and preparation needed for the development from scan to print.

The overall process from customer acquisition to product delivery should be as seamless and painless as possible. Based on our selection of technologies and determination of operational requirements, we believe this requirement to be met. First, the customer will receive a free in-ear scan, and be explained how their ear canals measure up to our Degree of Fit Index. After the sale has been finalized, the 3D scans of the customer's canal will be forwarded to the 3D printer. Once a sufficient number of orders are met to fill the base of the printing tray, the additive process will begin. After printing has been completed, the customer may elect to pick up their earbud cover in store, or utilize a free 2 day shipping service to their residence.

4.2 Market Need

4.2.1 Survey Results

In C-Term, we conducted a survey that was sent to all undergraduates at WPI, as well as faculty and close friends of the project group. This survey was designed to serve the purpose of market research, and what we learned from it greatly impacted the business plan for EarThotix. Our survey was focused on gaining information about headphone use. Our questions covered basic demographics, questions about users' current pair of headphones, and questions on how people use their headphones.

Basic Demographic Questions:

What is Your Age?

#	Answer		Response	%
1	17 or under		3	0%
2	18-24		617	93%
3	25-39		21	3%
4	40+		22	3%
	Total		663	100%

Figure 1: Age Survey Question

What is your WPI Affiliation?

#	Answer		Response	%
1	Undergraduate Student		602	91%
2	Graduate Student		10	2%
3	Faculty		26	4%
4	Employee		8	1%
5	Other		17	3%
	Total		663	100%
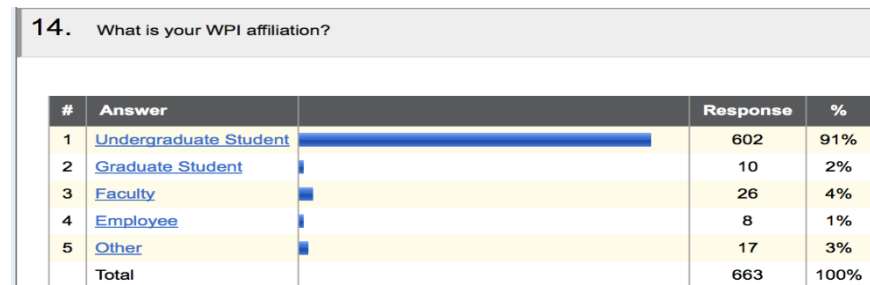
Figure 2: WPI Affiliation Survey Question

These questions were designed as a benchmark for us to understand basic information about who answered our survey. From the responses, 93% of responders were between the ages of 18-24, and 91% were undergraduate students at WPI. With this information, we were able to understand our target market moving forward, and it put the rest of the responses in perspective. Gaining insights on the target demographic of 18-24 year olds is vital for our business, as we are positioning our product at "first-mover" innovative types, who are typically in college or have recently graduated.

Product Questions:

What Style of Headphones Do you Currently Use the Most?

#	Answer		Response	%
1	Over the ear		207	29%
2	In ear		463	64%
3	ear hook		38	5%
4	Other		13	2%
	Total		721	100%
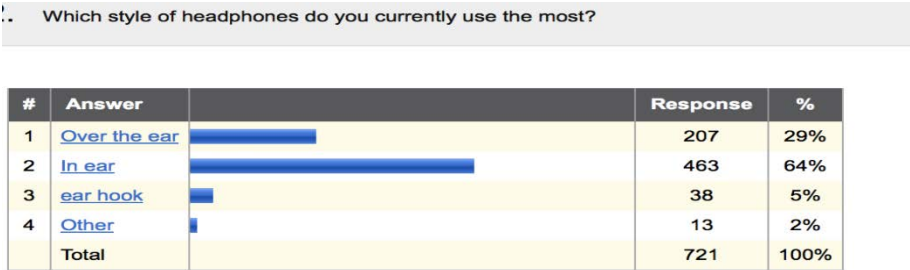
Figure 3: Headphone Style Survey Question

From the survey data, we found that 64% of people said they use in-ear headphone buds the most. Over the ear headphones was the second most popular style, with 29% of people. This was valuable information for us because it shows that in-ear headphones are still the majority ruler in the headphone market. Even with the recent surge of over the ear, premium headphones, in-ear buds are still the most popular by a fairly wide margin in our survey. We saw that these numbers were very similar to the industry averages seen below for the headphone market in America in 2013 according to IBISWorld. This validated our product as being a solution for the most popular headphone style.
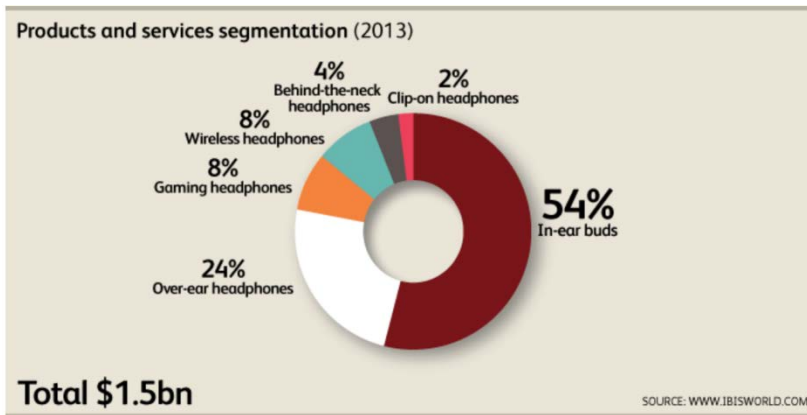
Figure 4: Industry Averages for Styles of Headphones Sold in 2013 (IBISWorld, 2013)

What Feature do you Value the Most in Shopping for Headphones?

7.   What feature do you value the most in shopping for headphones?

#	Answer	1	2	3	4	Total Responses
1	Audio Quality	400	230	42	6	678
2	Design/ look	25	131	446	76	678
3	Fit	245	304	113	16	678
4	Brand	8	13	77	580	678
	Total	678	678	678	678	–

Statistic	Audio Quality	Design/ look	Fit	Brand
Min Value	1	1	1	1
Max Value	4	4	4	4
Mean	1.49	2.85	1.85	3.81
Variance	0.43	0.43	0.60	0.26
Standard Deviation	0.65	0.66	0.78	0.51
Total Responses	678	678	678	678

Figure 5: Highest Feature Value Survey Question

Here, we learned how consumer's value different headphone features while shopping and comparing brands. From the data, we saw that the second most important factor was headphone fit, with an average score of 1.85 on a scale from 1-4, with "1" meaning it was the most important factor, and "4" meaning it was the least important factor. Overall, the most important quality on average was audio quality. This told us that in our targeted survey, our responders put headphone fit extremely high on their list of product features that they look for. Next, we wanted to ask how satisfied consumers were with their current pair of headphones.

How Satisfied are you With the Comfort and Fit of your Current Headphones?

#	Question	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	Total Responses	Mean
1	Comfort	11	44	106	319	185	665	3.94
2	Fit	12	48	105	293	207	665	3.95

Figure 6: Comfort and Fit Survey Question

Here, we wanted to understand how consumers feel about the fit and comfort of their headphones that they currently own. From the data, the average response on a scale from 1-5, with "1" being very dissatisfied, "2" being dissatisfied, "3" being neutral, "4" being satisfied, and "5" being very satisfied, the average responses for comfort and fit were 3.94 and 3.95, respectively. This equates to most people saying they were "satisfied" with the current comfort and fit of their headphones. We want to target everyone who responded with "very dissatisfied" to "satisfied" with their current fit of their headphones, because our product is designed to make everybody move into the "very satisfied" category. This equates to 458 responders out of 665 for the question of fit, telling us we have a market large enough to target and to become a successful business.

Use Questions:

We also wanted to gain insight on how people use their headphones. This information would allow us to better tailor our product to fit their needs and to fit into their lifestyles.

When Are You Most Likely to Use Your Headphones? Select All That Apply
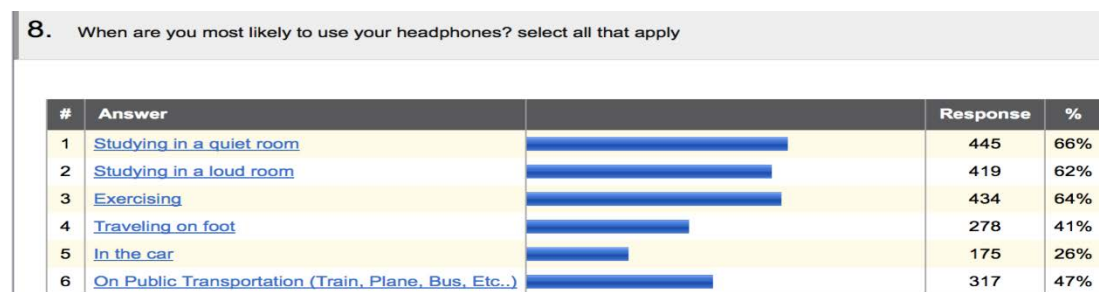
Figure 7: Headphone Use Survey Question

Here, we wanted to know when people were most likely to use their headphones. From the data, we can conclude that most people in our survey use headphones while studying in a quiet room and while exercising. This was extremely important data for us, as we believe our product will fit the needs of the athlete market segment extremely well. In ear buds are more likely to fall out while exercising simply because the user is moving around more than if they are studying sitting down in a quiet room. This allows EarThotix to become the solution for athletes who enjoy using in-ear buds. This information allows us to move forward targeting athletes in our marketing and in our product positioning.

How Often Do Your Earbuds Fall Off During Use?

Figure 8: Earbuds Falling Out During Use Survey Question

In this question, we wanted to understand how often people's current pair of in-ear buds fall out of their ears during use. From the data, we see that 351 responders out of 665, or about 53%, stated their pair of in-ear buds fall out sometimes, often, or all the time. This is roughly half of the headphone market we want to target, and it validated for us that headphone users

experience the problem of in-ear buds falling out during use, and interrupting both their musical experience as well as their activity.

How Much Would You Be Willing to Pay to Improve the Fit of Your Current Headphones?

11. How much would you be willing to pay to improve the fit of your current headphones?

#	Answer		Response	%
1	$0		243	37%
2	Less than $50		384	58%
3	$50-$100		32	5%
4	More than $100		6	1%
	Total		665	100%

Figure 9: Price Willing to Pay to Improve Headphone Fit Survey Question

The final question we asked about headphone use was a straightforward question that asked how much people would be willing to pay to improve the fit of their current pair of headphones. We were encouraged to see that the majority of people would pay less than $50. This was encouraging because the survey responders did not have any inclination as to our product or the value our product can provide them, so having a baseline understanding that the consumer would in fact be willing to pay to improve the fit of their headphones is encouraging. This impacted our business plan greatly, as we set a price point for our base model Midas at $50.00, and the price of our higher-end model, Apollo, at $75.00 per set in year one. We believe that once the consumer understands our value proposition of our product, they will see the value and be willing to pay the respective prices. This means that it is up to our marketing to communicate this value proposition to our consumers.

Overall, our survey and survey results were a valuable asset in allowing us to form our business plan. We gained knowledge and understanding of WPI students and faculty as to their preferences on different aspects of buying and using headphones.

4.3 Current and Developing Competition in our Target Market

As previously stated, the headphone market does not have any major players who hold significantly more market share than other competitors. The biggest companies in the headphone market by market share are Skullcandy, Bose, Sony, Harman International, and Beats by Dre. For direct competitor analysis, we chose Skullcandy, due to their customizable offerings and similar focus on ear buds (Lerman, 2014).

One of Skullcandy's biggest value propositions for their headphones is customizability. They offer a wide variety of ear buds, ranging from different sizes, color themes, and quality levels. They also offer a wide range of products from low end (~$10), to high end, dipping into the premium headphone market. Skullcandy enjoyed very strong growth in 2012, with their revenue growing at an annual rate of 28.05% during that year, compared to the industry median of 6.36% (Hoover's, 2013). In terms of market segmentation, Skullcandy appeals to a wide range of consumers. They have gaming headphones for gamers, over the ear "hook" style headphones designed for athletes, and everyday ear buds for the regular electronics user. What greatly contributed to their growth in 2012, however, was their emergence in the premium headphone market. In the headphone market, the most extreme users are typically classified as "audiophiles," who value audio quality higher than any other attribute of a set of headphones, and they have shown they are willing to pay upwards of $100 for their headphones. In 2012, Skullcandy released several new lines of over the ear headphones to compete with the market leader in the premium headphone space, Beats by Dre, LLC (Hoover's, 2013).

One of Skullcandy's bestselling in-ear bud-style headphones is the S2IKDY (Amazon.com, 2014). While this product is reviewed highly and is highly popular, we were still able to find consumers who complained that the ear buds were not fitting their ears properly, and

this caused them to fall out. One reviewer said the ear buds felt heavy and this caused them to fall out quite frequently, and another stated that the quality of the headphones met their expectations, but they did not fit well in their ears (Amazon.com, 2014). This gave us confirmation that even with one of the market leaders in in-ear headphones, consumers are still finding issues with finding the perfect fit for their ears. And since the average Skullcandy consumer also values customizability, we feel like designing and manufacturing 3D-printed headphone covers for these ear buds would be a sound business decision.

4.4 Interview Results

4.4.1 3D Printing Expert Interview

In B-Term, Matthew Mulvey interviewed Erica Stults, who is the WPI 3D printing expert. She manages several 3D printers on campus, and facilitates student and faculty utilization of 3D printing services. The first set of questions asked pertained to costs of the Stratasys Objet printer which is owned and operated by WPI. Erica estimated the cost to be between $150k and $200k, but also noted that WPI bought the device when it was not commercially introduced, so they may have paid a premium to receive the product earlier than the market. Next I inquired about the costs of material which is used by the 3D printer to create the objects. Erica provided me with an official Stratasys order form, listing out all available materials, and their costs in both individual and bulk orders. This bit of information allowed us to much more accurately evaluate our potential for profit and our true COGS. Erica then informed me about the maintenance and care program offered by Stratasys, which included long term maintenance and repair that may be too technical for a non Stratasys-employee to carry out. This program is estimated to cost around $15k by Erica. Next, she led me through the process of adding filed, preparing the printing tray, and finishing a 3D printed object. This gave me a much better idea of the logistical aspect of

printing, and shed light onto the requirements for our operations. The most promising part of the interview was Erica's reaction to the EarThotix pitch, and her endorsement that the product was feasible to print using Polyjet technology.

4.4.2 Intellectual Property Interview

In C-Term, David Boroyan interviewed Natasha Aljalian, who is a patent lawyer, currently working for a software company. The conversation started with David giving a brief overview of EarThotix, and Ms. Aljalian was asked what sort of general things she thought would be eligible for any sort of intellectual property. We learned that first off, our logo and name should be trademarked. After that, our "degree of fit" index has the potential to be eligible for some sort of utility patent. The 3D printing industry in general has hazy at best intellectual property laws, so we learned that nothing is guaranteed, but it would be best to apply for trademarks and/or patents as early as possible. We next moved into cost and process, which Ms. Aljalian said we would definitely need to hire a patent lawyer to either aid us in the process part-time, or who can take care of the entire process of applying for intellectual property rights.

4.5 The Business

After much research, we have created a detailed Business Plan for our company. Within the plan, we have developed our business concept, value propositions, goals and milestones. We described the current and potential market and competition as well as the business strategies we will be implementing. We further discussed the operational structure of our company and then performed detailed financial calculations in order to make forecasted projections for our business. From this, we determined that our company would not only be feasible but profitable as well. The full Business Plan can be found in Appendix A of this report.

4.5.1 Business Model Canvas and SWOT analysis

Below is the completed Business Model Canvas for our company and a SWOT analysis. These two models act as a graphical snapshot of our company and the industry and were crucial for the formation of our overall business plan.

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
▪ Potential Investors ▪ Earbud Manufacturing Leader(s) ▪ Lantos Technologies ▪ Stratasys Professional 3D Printing	▪ Expand Network ▪ Enter start-up competitions ▪ Research and Development of products ▪ Marketing/Advertising ▪ Purchase of Equipment ▪ Hire Employees ▪ Develop Website	▪ Custom fit ▪ Product specifically designed to the exact shape of the customer's ear canal ▪ Continuous listening experience ▪ Reduces the chance of earbuds falling out ▪ Trendy alternative designed with cutting-edge technologies ▪ Add-on feature to current headphones.	▪ Personal ▪ Free first ear scan ▪ Fast creation process ▪ Customer can watch earbuds being made in the store on the 3D printer ▪ Maintain customer records of ear scan for potential future replacement	▪ Anyone who owns a set of earbuds ▪ Unsatisfied earbud users ▪ Athletes ▪ Tech Savvy/ first movers
	Key Resources ▪ Existing network ▪ Equipment ▪ Material ▪ Store location ▪ Database management ▪ IP		**Channels** ▪ Storefront ▪ Online advertising ▪ Information can be found on website	

Cost Structure	Revenue Streams
▪ Advertising ▪ Research and Development ▪ Renting space in mall ▪ Salaries ▪ Equipment ▪ Material ▪ Outside Services	▪ Our two earbud products

Figure 10: Business Model Canvas

STRENGTHS	OPPORTUNITIES
• Custom products • Trendy alternatives • Utilizes 3D printing, an exciting emerging technology • Unique manufacturing processes and creation is unmatched in industry • Low substitute products available in the market • Current demand and need for our product • No manufacturing middleman company • Entering a pre-existing market and billion dollar industry with a large user base • Customization is low for top headphone retailers in target market • Team is motivated, eager and committed to our idea and company	• Creating customizable products using 3D printing that have not been made using that technology before • Continued research, advancements, development and innovation in 3D printing technology • The trend of customizable products continues to grow • An increase in active lifestyles • Continued increase of interest in 3D printed products • Headphone market continues to grow • Competitors vulnerabilities • Unfulfilled customer needs • Potential partners
WEAKNESSES	THREATS
• Inexperience • Lack of capital • Low recourses • Small staff • New startup business with no market presence and no reputation. Need to heavily focus on advertising and marketing to gain recognition	• Pre-existing companies with more resources to do so adapt our technology and enter our target market • Buyers become suppliers • Emergence of substitute products or substitute technologies • Potential shifts in consumer tastes resulting in lower market demand • Competitors implement new strategies, innovations and products that compete with ours • More established and larger competitors react to us taking away market share and alter their attention, destroying our attained market position.

Figure 11: SWOT

4.5.2 Start-Up Competitions

Our group entered the MassChallenge Start-Up Competition after encouragement from our advisor and attendance of a MassChallenge information session held at WPI. This will ultimately provide us with the connections, networking, and mentorship that will help us jump-start our company. Our group sees MassChallenge as the "start-up catalyst central," and we could leave the competition with a solid marketing strategy and a refined goal of our company, as well as invaluable public exposure. We look forward to hearing from the panel of judges regarding our application by the end of the month.

5.0 Conclusion

In conclusion, the EarThotix MQP incorporated concepts, tools, and strategies learned throughout the Undergraduate WPI Management Engineering Program. Our initial research regarding current technologies and biomaterials allowed us to formulate our idea into an applicable solution. Through in-depth investigation, including collection and analysis of potential customer and market expert opinion, we were able to determine the feasibility of our product. Market feasibility was determined through analysis of market environment, competitor trends, and identification of cutting edge technology which could add value to our process. We compiled findings using tools introduced to during the WPI Management Engineering Program, such as the Business Model Canvas, SWOT Analysis, and Porter's Five Forces. We evaluated various business plan templates and then composed a comprehensive business plan based on observed strengths and weaknesses. Our next steps will be to pitch our project at a number of start-up competitions with the goal of being accepted to an accelerator program or securing outside investment.

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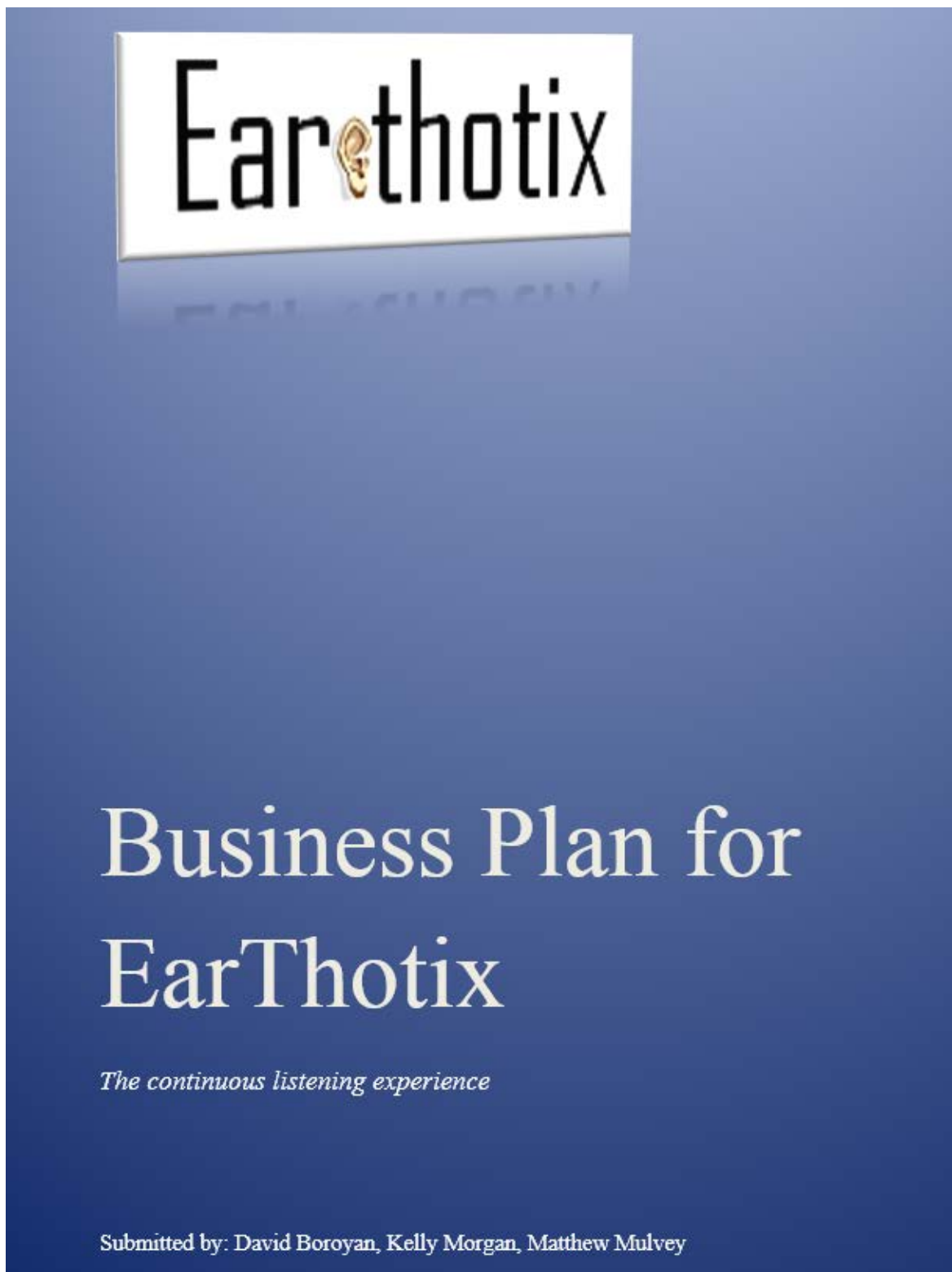
Appendix A: Business Plan

Business Plan for EarThotix

The continuous listening experience

Submitted by: David Boroyan, Kelly Morgan, Matthew Mulvey

Table of Contents

1.0 Executive Summary

Business Concept

The modern earbud user is unsatisfied with the current product offering on the market. The frequency with which earbuds become dislodged or fall out during use is a universal pain which consumers are unhappy with. People now have access to music at any time, and they wish to enjoy their music in any situation. EarThotix is attempting to make this wish into a reality by eliminating the chance of your earbud improperly fitting your ear, causing it to fall out.

Current Situation

Consumers need an earbud which will not slow them down and fall out even during rigorous activity. The primary target market for EarThotix is athletes, who complain about earbuds falling out but also desire to use them during workouts. The current industry does have offerings which are aimed at fitting the consumer's ear more effectively, but none of these solutions are truly custom fit.

Key success Factors

EarThotix offers an innovative product which is not accessible through any other means. Our unique customer identification and product creation system allows for the only truly customized solution for an earbud augmentation. Our "wow" factor lies in our unique utilization of 3D polyjet technology to quickly and inexpensively create a reliable custom product.

Financial Situation/Needs

EarThotix will need funding to purchase two 3D printers, one in ear scanner, and various other startup essentials such as staff, R&D, and a venue for customer interaction. We are currently looking to acquire at least $500,000 in funding.

Vision Statement

EarThotix seeks to add value to even the most generic earbud and create an unprecedented custom continuous listening experience.

Milestones

After research and analysis of the market, we have determined that reaching the following milestones is necessary to successfully launch EarThotix from concept to reality:

1. Test process and product
2. Trademark name EarThotix, purchase online domain
3. Acquire investors and obtain needed amount of initial funding
4. Purchase equipment, material and hire necessary personnel
5. Rent desired store location
6. Launch advertising and marketing campaign

2.0 The Concept

EarThotix has developed an attachable cover using 3D printing and rapid in-ear scanning that can be fitted over a consumer's existing in-ear headphones, or "earbuds." On one end, it fits perfectly over a user's earbuds, and the other end is a 3D printed model of the consumer's ear canal. Our solution is specifically made for each customer and provides a superior fit that reduces the risk of falling out during use and ultimately improves the overall listening experience.

EarThotix will have a space located in a mall with high consumer traffic, allowing for optimal exposure. Ideally a kiosk or smaller store front will be utilized, as minimizing rent costs will contribute to our profit margin. The company will sell two primary ear covers; Midas and Apollo. The difference between the two products is that Apollo will be more expensive as it will consist of a smoother material and take longer to make.

Once at the store, an EarThotix production process consists of a technician scanning the customer's ear, sending that 3D computer-generated image to the 3D printer, and printing out the custom earbud covers in-store. This process should take no longer than two hours. For convenience, the ear scan of the customer will be saved in a secure company database for potential returning customers.

2.1 Value Proposition

EarThotix's mission is to deliver an earbud cover that offers an elusive perfect fit to the end user. Every EarThotix product will be created using 3D printing technology and will be specifically customized solely to the unique ear canal of the customer. The process behind creating an EarThotix earbud cover is unparalleled in the headphone market today.

Continuous Listening Experience
EarThotix realizes that not every ear is the same. We know that the headphone listening experience can be ruined, frustrating and even distracting if earbuds frequently fall out during use. EarThotix products solve this universal problem. Every single earbud cover is specifically designed to fit the exact ear canal of the user. This custom fit will reduce the chances of the earbud falling out, increasing user comfort and ultimately improving the listening experience.

Reusable
As a result of the attachable feature on one end the earbud covers, EarThotix products can be easily transferred and used on a new pair of similar earbuds. This add-on feature offers the customer flexibility and insurance that they will still be able to detach and reuse their custom

earbud covers, regardless of the condition of their actual headphone piece. Approximately 40% of all headphone purchases in 2013 were replacement purchases (Lerman, 2014). Our consumer will not be forced to replace their set of EarThotix if they need to replace their headphones with the same model.

Customized Service

EarThotix collects and stores the ear-canal scan of every customer in a private, secure system database. In the event that a revisiting customer wishes to purchase a new earbud cover, the customer will not have to sit through the process of a rapid in-ear scan again. Their previous ear-canal scan information will be retrieved from their existing file in the database and the 3D printing process will be started immediately on their new earbud cover.

A Trendy Alternative

In a world where technology is constantly evolving, people are excited with new technological alternatives and methods that attempt to solve a common issue. 3D printing is currently one of the most up-and coming technologies out on the market. Not only does our product fulfill the *need* for the customer to have an earbud that does not fall out during use, but it also fulfills the customers *want* to have the most innovative and "coolest" product available.

2.2 Market Need: Why The Time is Right

- Since the explosion of smartphones and mobile devices in general, headphones have become a necessity in today's market
- Earbuds are extremely popular, but consumers have proven that there is a serious design flaw
- Customers of the most popular earbuds made by companies such as Apple and Skullcandy agree that the earbuds simply do not fit their ears properly, especially with intensive use, such as during working out or running
- At the same time, the 3D printing market is just beginning to develop, allowing us to do all the manufacturing in-house and create an all-in-one solution for this problem

2.3 Goals

We have developed specific short term and long term goals that will allow EarThotix to be a successful company for years down the road. This will require us to focus on Product Development, especially during the first three years of operation, in order to be able to cover a wide range of headphone brands, as well as other consumer goods.

Short Term Goals

- Successfully introduce our solution into the market and generate interest among a specific market segment
- Establish our niche market with the first-movers
- Further research and development efforts following initial customer feedback in order to find the best design fit
- Establish and implement a degree of fit index that we can apply to every pair of EarThotix we manufacture

Long Term Goals

- Develop the widest possible array of compatible headphones
- Open multiple locations in upscale malls
- Seek possible partnership with Stratasys™ as well as other headphone companies
- Develop more customizable consumer goods
- Branch out into earbud technology development

2.4 Additional Future Products and Services

In our first year of business, we hope to expand our product line to cover all the major earbud brands. This includes brands such as Skullcandy, Bose, Beats by Dre, and Sony models, among others. This will expand our offerings and allow us to reach more consumers. In year 2 and 3, we plan on opening a second store in a different area selling the same products; however we will undergo intensive research and development of new, customizable products that we can create using 3D printing. In the following future years, we plan on developing a full line of customizable mobile accessories, making us a mobile device owner's one-stop shop for everything they could possibly need for their mobile device.

3.0 The Market

The main industry EarThotix will be entering is the headphone market, an extremely large and mature market that has grown steadily since 2008. Since we will be creating a product that is designed to fit as an add-on feature to the most popular brands of earbuds, we need to establish the landscape of the market itself and the major players. We also need to determine what types of consumers buy headphones, what they look for in terms of benefits, and how much they are willing to pay for certain features or for certain standards of quality.

3.1 Market Potential for EarThotix

Headphone Industry Overview

The headphone market is a mature market that has experienced tremendous growth since 2008, largely due to the popularity of personal electronic devices. Headphones are seen as a companion product to devices such as smartphones, tablets, and laptops, as well as personal music players. While growth is expected to slow over the next three to four years, there is a luxury headphone market that is relatively new and is expected to continue to grow.

There are many different types of headphones that are offered. EarThotix products are compatible with the most popular headphone style; earbuds.

The Numbers
- $1.5 Billion in revenue
- 7% annual growth from 2008-2013, projected 1.1% in 2013-2018
- E-commerce sales critical, account for more than 50% of sales in 2013
- 78,072 firms offering headphones
- Number of retailers expected to grow 6.5% annually

Luxury Market
- Classified as headphones with a price tag of $100 or more
- Currently makes up 43% of all headphone sales
- Fastest growing segment of the headphone market

Types of headphones
- Earbuds account for 54% of headphone sales in 2013

(Lerman, 2014)
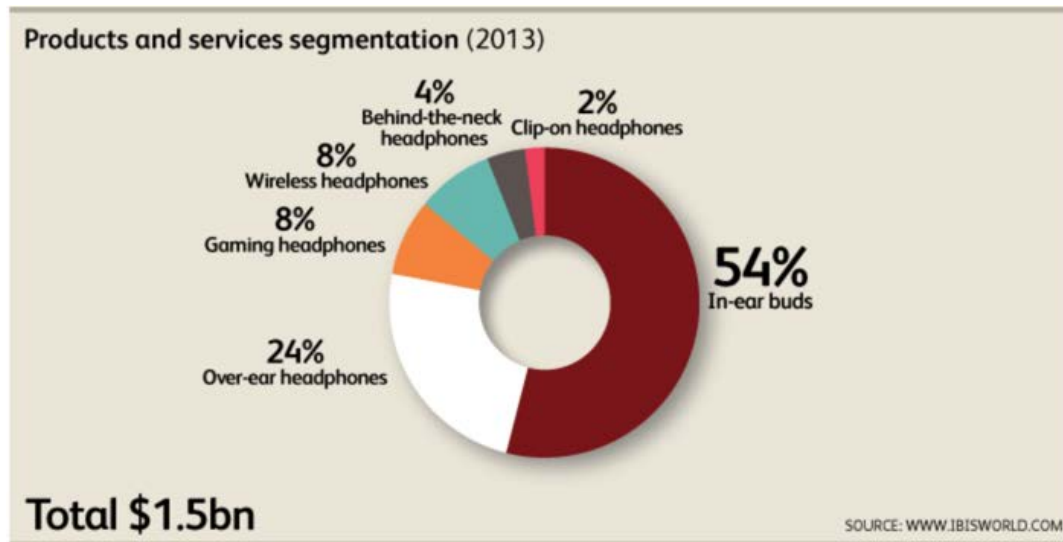
Source: (Lerman, 2014)

Market Demographics
- 39.5% of consumers are aged 35-54, 16.3% aged 25-34
- 60% of sales are new purchase, 40% replacement

Changes in the market
- Moving towards more e-commerce sales
- Premium headphone market is rapidly expanding

(Lerman, 2014)

3.2 Specific Market Segmentations

We were able to find three specific types of consumers who purchase headphones. The lead users, or "audiophiles," only want to buy headphones with the highest quality audio and design. Athletes want headphones that have good enough fit to keep up with their lifestyles, and the casual consumer uses headphones for various activities throughout the day.

Audiophiles:
- Lead users, desire extremely high audio quality and design, seem to prefer over the ear headphones instead of earbuds
  - Use headphones for things such as music development and gaming

Athletes:
- Need fit and comfort that can keep up with their active lifestyle
  - Primarily use sleek, lightweight headphones

Casual: everyday electronics users

- Want earbuds to use with their phone for music, generally frustrated by fit and comfort of some earbuds such as Apple and Skullcandy

3.3 Market Needs

Audio quality, design and fit quality

We will be focusing on the need for a pair of earbuds that fit reliably. The audio quality and design depends on what earbuds the consumer already has, and our add-on cover can only increase the quality of fit and comfort.

In our survey conducted on campus at WPI and elsewhere, we found that headphone users highly value the fit of their headphones. We asked "What Feature do you Value the Most When Shopping For Headphones," and gave the options of "audio quality," "design/look," "fit," and "brand." "Fit" was second only to audio quality, coming back with an average response of 1.85, with 1 being the most important and 4 being the least important feature they value when shopping for headphones.

7. What feature do you value the most in shopping for headphones?

#	Answer	1	2	3	4	Total Responses
1	Audio Quality	400	230	42	6	678
2	Design/ look	25	131	446	76	678
3	Fit	245	304	113	16	678
4	Brand	8	13	77	580	678
	Total	678	678	678	678	–

Statistic	Audio Quality	Design/ look	Fit	Brand
Min Value	1	1	1	1
Max Value	4	4	4	4
Mean	1.49	2.85	1.85	3.81
Variance	0.43	0.43	0.60	0.26
Standard Deviation	0.65	0.66	0.78	0.51
Total Responses	678	678	678	678

Market Trends/ Market Growth

The headphone industry is in a mature stage, and the growth is tied to the growth of smartphone sales and mobile device sales. The market is expected to grow at a rate of 1.1% annually after 2014 as the mobile device market slowly begins to saturate (Lerman, 2014). It is also expected that brands will begin to consolidate slowly as competition rises.

Target market and customers

Our initial target markets will be to appeal to athletes and audiophiles. The athlete will want a superior fit over what their current earbuds deliver for their active lifestyle. We can provide that perfect fit as well as a unique and effective method of delivery. This will be our first established niche market. We will also focus on appealing to the audiophile segment of the headphone market. These users are typically well-versed in technology and value audio quality and fit. We can appeal to this segment by emphasizing the technology behind our product.

From our survey, we can confirm that athletic activities lead people to use headphones at a very high rate. We asked when they were most likely to use their headphones, and the second most common response was "exercising", with 64% of the vote. We can attract this market with EarThotix with the promise of fixing the problem of earbuds falling out.

8. When are you most likely to use your headphones? select all that apply

#	Answer		Response	%
1	Studying in a quiet room		445	66%
2	Studying in a loud room		419	62%
3	Exercising		434	64%
4	Traveling on foot		278	41%
5	In the car		175	26%
6	On Public Transportation (Train, Plane, Bus, Etc..)		317	47%
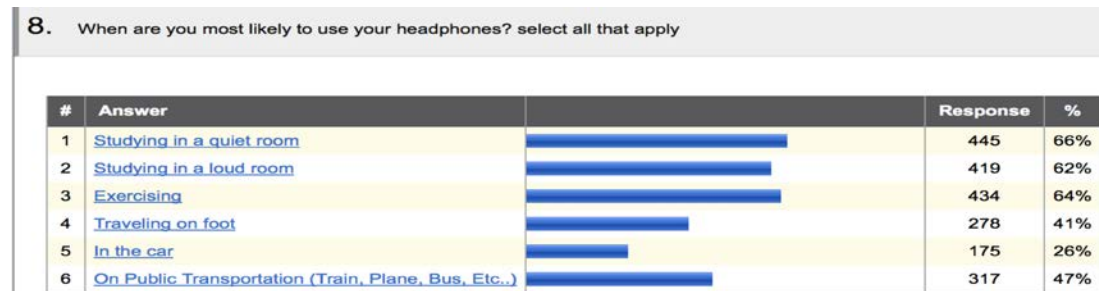
4.0 The Competition

EarThotix will be competing with numerous other companies who offer 'one size fits all' headphones for the consumer. The most direct competition to our company would be ACS, Inc. who also makes customizable in-ear headphone covers but using a different process.

4.1 Indirect Competition: Major Players in the Headphone Industry

The major players in the headphone industry are Skullcandy, Harman International, Bose, Sony, and Beats by Dre, who all create earbud style headphones along with other products. Our main competition of these headphone companies would be Skullcandy, whose value propositions of customizability put them in direct competition with EarThotix. Even though they are a smaller company than Bose and Sony, their profit margins are high for the industry (Hoover's, 2013).
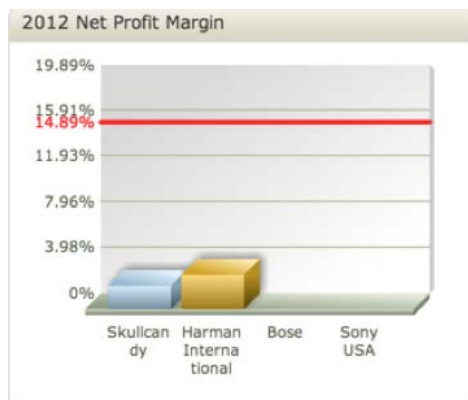
(Hoover's, 2013)

Indirect Competition: Skullcandy, Inc.
Skullcandy offers custom colors and logos on their different earbud offerings. Their customers enjoy their headphones' mix of audio quality, design, and customizability. We believe they are our direct competition because EarThotix will offer custom fit, whereas Skullcandy offers a wide range of earbud colors and logos. Skullcandy enjoyed very strong growth in 2012, with 28.05% revenue growth compared to the industry median of 6.37%. This is largely due to Skullcandy entering into the gaming market in 2012 and focusing on introducing new headphones designed for video game use. Based on new product introductions in the last two years, it appears as though Skullcandy is focusing more on entering the luxury headphone market and establishing a presence.
(Hoover's, 2013)

4.2 Direct Competition: Headphone Cover Companies

The most direct competition that EarThotix will face are companies such as ACS Custom, who create covers designed to be placed over existing pairs of headphones to better fit the consumers' ears. Our key differentiating factor is our method of ear canal molding and cover manufacturing, as companies such as ACS Inc. use traditional ear molding methods, which can range anywhere form several days to weeks until the final product is in the customer's hands.

ACS Custom Fit Earphone Sleeves
- Company which focuses on very high end professional models of earbuds
- Process for ACS Custom includes getting in-ear mold at audiologist, then shipping molds to ACS lab for creation of sleeve
- Cost for sleeves only: $150 (does not include audiologist)
- Cost for Audiologist ear mold procedure: $40-$100
- Time needed: ~1 week for audiologist appointment, ~10 days for sleeve creation in ACS lab, ~5 days for shipping

(ACS, 2013)

4.3 Changes in the Industry

- Headphone companies are starting to move towards the luxury market, releasing high-end products that emphasize design and audio quality
- Following the lead set by Beats by Dre which have become the dominant player in the luxury market
- Moving more and more towards e-commerce sales, with more than 50% in 2013 (Lerman, 2014)

Opportunities:
- Our main opportunity is to inject new technology into an existing, mature, and large market
- Our production method will allow us to create more value for consumers as well as allowing us to quickly produce custom-made ear bud covers

Threats
- Main threat is competition from established headphone brands creating custom earbuds that better fit the consumers' ear canal

4.4 3D Printer Industry Overview

- Stratasys™ is by far the largest and most reputable seller of 3D printing devices
- Major part of industry growth takes place in virtual crowd-sourced projects such as Kickstarter

- Extremely basic FDM or SLA printers can be purchased for in home use, extremely complex SLS and Polyjet printers can be purchased for business use
- Overall cost of 3D printing technology is being driven down by at home tinkering segment

(Stratasys, 2013)

3D Printed Objects Industry Overview
- Industry growth is constant, with expected growth highly anticipated
- 3D printing is described as the top of the inflated expectations section of the hype cycle for emerging technologies
- Most 3D printed products are not sold to a customer, but produced within a company to aid in research and development

Current Popular 3D Applications
- Rapid prototyping for manufacturing industry
- Modeling for scale size in manufacturing industry
- At-home hobbyists and tinkerers
- Innovation planning and testing
- Very limited end-user products produced by 3D printers of any kind

Direct Competition
- Companies who 3D print end-user products

Indirect Competition
- Companies who specialize in custom products produced by methods other than 3D printing

5.0 Marketing and Sales Strategy

Where does our company fit in the world? We fit into the need that almost everyone discovers when using earbuds: the elusive perfect fit. Specifically, we can alleviate the pain of having earbuds fall out for athletes who are frustrated with re-adjusting their headphones after every move they make. We will also be able to fill the need for the average person who has an extremely difficult time finding earbuds that fit.

EarThotix's overall marketing strategy is to appeal to the athletic first mover market. Our utilization of 3D printing will be a major point when positioning the product, as it enables true customization. Involving a real time display of the 3D printer in the customer experience is a priority, as the novelty of the new technology will fascinate potential customers. Our product will be available brick and mortar in a mall such as a kiosk or store front, where we will have two varieties of product for purchase, the Midas and the Apollo.

Key competitive capabilities
In contrast to the main competition, EarThotix offers a customizable product with a unique manufacturing process and a prompt delivery time. Conducted research and collected data prove that there is a strong need and want for our product in the marketplace. EarThotix will not make a user replace a product they already own, but rather offer a customizable, add-on attachment to a frequently used commodity.

Key competitive weaknesses
Completing a thorough analysis on competitors currently in the market, we have identified a few potential weaknesses. Lack of experience will be a major factor for our business as this is our first attempt at a startup company. Also, money will play a significant role in the forming of our company as we will have to find the necessary resources, other than our own personal savings, to allocate funds for our ventures. Another challenge we expect to face is discovering how many units we can produce at first to keep up with demand.

Becoming aware of our weaknesses is the first step in forming solutions to transform them into our strengths down the road. Although we lack experience, we are proactive and always striving to continue researching our target market, competitors, and the voice of our potential consumers in order to continue gathering information for our business to grant us the competitive edge. We utilize the knowledgeable advice of our college business professors and our connections with current business owners and 3D printing employees. We are exploring ways in which to promote our company and partner with investors, which will help pay for our expenses and the needed resources to keep up with the demand of our product.

5.1 Implementing Strategy

In order for EarThotix to excel, we need to focus on our competitive advantages when determining strategies to pursue. We are looking to capitalize on our unique source of manufacturing, 3D printing, and its distinctive ability to construct a completely custom unit, different for each user, with an unmatchable fit. We plan on playing to our strengths, especially our early establishment in the brand and our timely speed of delivery of our product to the customer. We also will be closely monitoring the price of maintaining printers, materials and resources within our company in order to adjust our prices and costs if necessary.

Marketing strategy

The proper positioning of our unique earbud solution is essential to establishing EarThotix as an innovative solution and a desirable high-tech product. By developing our marketing strategy based around EarThotix key differentiating factors, and targeting the groups most likely to value those differentiating factors, we ensure that the value will be recognized by potential consumers.

- Target tech savvy and athletic groups equally
- Position EarThotix as a futuristic solution to attract first movers
  ○ show the process of 3D printing
- Going for an athletic endorsement from a major athlete
- Keeping customer ear canal scans to encourage repeat visits

Sales Tactics

Even if the consumer likes the idea of owning a 3D printed solution, they will need to have value demonstrated to them in other ways than product value. In order to convince potential customers that EarThotix are valuable and worth purchasing, a few subtle sales tactics will guide the customer experience and maximize purchases.

- Free in-ear scan for first time customers
- Develop a degree of fit index which can clearly quantify and demonstrate to potential customers the benefit EarThotix may provide over traditional earbuds

Customer Relationship

As a strategy to minimize customer difficulty in acquiring our product, each free in-ear scan may be saved in a secure database of customers. Subsequent visits would not require the in-ear scan, and potentially will not require any physical visit to the retail location.

It is important to EarThotix as a brand and the industry of 3D printing that customer creativity and input be encouraged and rewarded. Our interactive customer experience offers ample opportunity for survey and feedback functions, to be completed concurrently with the sign in and ordering process.

Advertising

As a new company entering into an established market, EarThotix must employ a gripping ad campaign which will intrigue and excite the potential customer. Our goals are to eventually be associated with all major earbud brands, and to be recognized as the most innovative approach to solving the problem of ill-fitting earbuds.

- The "Every Ear Is Different" campaign will draw attention to how varied ear canal shape is among individuals, and even between your right ear and left ear, emphasizing the value of a customized solution
- The Athletic campaign will emphasize the way that interruptions in an athletic routine or regimen of any kind are inconvenient and potentially "throw you off your game"
    - We want to stress our benefit of the continuous experience of music
- Work with Hub Spot for inexpensive internet exposure and inbound marketing
- Will do own self advertising via social media such as Facebook and Twitter. We will also create our own website.

Publicity

Trade shows represent an opportunity for us to demonstrate how quick and painless our process is. EarThotix could successfully participate in both consumer audio and 3D printing trade shows to maximize exposure and networking potential.

Location

In year 1, our first store will be located in the Natick mall where we will rent out a space roughly 500 sq. ft. This is an area with high consumer traffic which allows our products to gain maximum exposure. In year 2, we hope to open a second store in the Northeast US, exact location to be determined, but still within a mall.

Product Development

In year 1, we plan on selling two products, both earbud covers; Midas and Apollo. In the following years we will still be selling these two original products. However, we plan on investing more money in Research and Development costs for creating new accessories and products, desired and thought of by our customers, with 3D printing.

Pricing

EarThotix products will be positioned at the high end of the market as a result of their unique 3D printed manufacturing process and optimal customization. For the prices of both our Midas and Apollo products, we implemented an image/prestige pricing strategy. As a result of the smoother surface finish and extended time to print, the Apollo is priced more expensive than the Midas

- Midas is priced at $50.00 per set
- Apollo is priced at $75.00 per set

6.0 Operations

Choice of Store Venue

There were three main possible venue options for opening our store. The first was purchasing our own building, the second was renting out a small space in a mall, and the third was buying a truck and having a mobile operation. After an analysis of our business, strategies, products, equipment we will be using, costs and current cash, we concluded that we would not require a large space for our operation. Also, the mobile business truck idea would not be ideal since the 3D printers themselves need to be on a solid, steady surface in order to avoid damage. Renting a small space in a mall was the most practical for our business as it met our needs as a company, while also providing a source of advertising for our business as a result of the natural flow of people traveling through the mall to different stores.

Product Service and Delivery

We plan to position our traditional storefronts in kiosks in upscale malls, preferably locating ourselves right outside of stores where high-end electronics are sold. Our customers will start by receiving an ear scan from an EarThotix employee. In the time it takes for us to print out their custom EarThotix earbud covers, the customer will be able to go about their shopping at the mall, and come back at a specified time before they leave to pick up their product. We will print out three batches of EarThotix earbud covers per day, at 10 AM, 1 PM, and 4 PM. The customer will be able to come back at the closest available time slot to pick up their product.

To emphasize our commitment to high tech solutions, an integrated iPad ordering and survey system will be utilized in the store. This will allow customers to self-educate and submit themselves for the scanning and ordering process. Another benefit of operating this system is the opportunity for customers to provide real time instantaneous feedback about their experience, and make suggestions about improving the process. Survey and customer idea generation is a priority for EarThotix, and allowing customers to submit their own ideas in contests will serve as a huge opportunity for product diversification efforts.

Store layout

For our mall store, we plan on having a 500 sq. ft. space. There will be two distinct stations within the floor layout; the rapid ear-scan station and the 3D printing station. We also plan on having an open floor plan layout, with everything visible to the customer, for the purpose of enhancing the customer experience by allowing them to see the 3D printer in action, creating their product. This process will also intrigue passers-by into the store and spark their interest in EarThotix products, potentially becoming future customers or spreading the word about our store.

Equipment and Suppliers

For each of our stores, we will have two 3D printers and one rapid ear-scanner. Two printers are necessary as we will need one for or Midas product and the other for our Apollo product. This will enable a better flow of operations as it eliminates us having to change the material in the printer for every different order and it allows us to print multiple units at once. We will purchase our printers and the materials we will need from the company, Stratasys™, and our rapid ear-scan from Lantos Technologies™.

Organizational Structure and Key Personnel

Outside of the EarThotix founders who will be responsible for the overall management and financials of the business, our company structure will consist of two key employees. First, we will have one employee who will be responsible for operating the rapid ear-canal scanner device and responsible for customer service and sales on the floor. He will also be responsible for recording and organizing the transactions of all customers in a database. Our store space is small so this job is manageable and ideal, as it reduces the risk of idle time by the employee when customers are few, thus increasing company efficiency. Our second employee will operate the 3D printer and be responsible for both the printing of the Midas and Apollo products once the scan has been completed and delivered. Below is a visual representation of our company personnel and chain of command.

7.0 Financials

7.1 Financial Projections

OPENING DAY BALANCE SHEET	
ASSETS	
Current Assets	
Cash	$ 500.00
Inventory and Supplies	$ 3,630.00
Pre-paid Expenses	$ -
Other	$ -
Total	**$4,130.00**
Fixed Assets	
Machinery & Equipment	$ 202,500.00
Furniture and Fixtures	$ 1,600.00
Lease	$ -
Real Estate/Building	$ -
Other	$ -
Total	**$204,100**
Total Assets	**$208,230.00**
LIABLITIES	
Current Liabilities	
Accounts Payable	$ -
Taxes	$ -
Salaries	$ 352.00
Notes Payable	$ -
Interest Payable	$ -
Insurance	$ -
Current Portion of Long Term Debt	$ -
Other	$ -
Total	**$ 352.00**
Assets minus Current Liabilities	**$207,878.00**
Long Term Liabilities	
Bank Loans	0
Notes Payable to Stockholders	0
Other	0
Total	**$0**
Owners' Networth	
Invested	$207,878.00
Retained Earnings	0
Total	**$207,878.00**
Total Liabilities and Networth	**$208,230.00**

Income Statement

EarThotix
First Year Operation
Financial Statements in U.S. Dollars

Revenue

Gross Sales		$ 678,986.00	
Less: Sales Returns and Allowances		$ -	
Net Sales			$ 678,986.00

Cost of Goods Sold

Beginning Inventory		$ -	
Add:	Purchases	$ 71,698.00	
	Freight-in	$ -	
	Direct Labor	$ 87,996.00	
	Indirect Expenses	$ -	
Inventory Available		$ 159,694.00	
Less: Ending Inventory		$ -	
Cost of Goods Sold			$ 159,694.00
Gross Profit (Loss)			$ 519,292.00

Expenses

Advertising and Marketing	$ 13,320.00	
Contingency Fund	$ 10,000.00	
Depreciation	$ 11,617.00	
Hotels and Entertainment	$ 5,000.00	
Legal and Professional Fees	$ 8,156.00	
Office Expense	$ 1,600.00	
Payroll Taxes	$ 4,840.00	
Postage	$ 500.00	
R&D	$ 67,800.00	
Rent	$ 8,520.00	
Repairs and Maintenance	$ 1,500.00	
Telephone	$ 60.00	
Transportation	$ 2,000.00	
Wages	$ 88,000.00	
Total Expenses		$ 222,913.00
Net Operating Income		$ 296,379.00

Other Income

Gain (Loss) on Sale of Assets	$ -	
Interest Income	$ -	
Total Other Income		$ -
Net Income (Loss)		**$ 296,379.00**

Twelve-month profit and loss projection

	Jan-15	% B/A	Feb-15	%	Mar-15	%	Apr-15	%	May-15	%	Jun-15
Revenue (Sales)											
Midas	25,000	66.2	27,500	66.2	30,250	66.2	33,275	66.2	34,939	66.2	36,686
Apollo	12,750	33.8	14,025	33.8	15,428	33.8	16,970	33.8	17,819	33.8	18,710
Total Revenue (Sales)	37,750	100.0	41,525	100.0	45,678	100.0	50,245	100.0	52,758	100.0	55,396
Cost of Sales											
Midas	2,975	11.9	3,272	11.9	3,600	11.9	3,960	11.9	4,158	11.9	4,365
Apollo	1,011	7.9	1,112	7.9	1,224	7.9	1,346	7.9	1,413	7.9	1,484
Total Cost of Sales	3,986	10.6	4,384	10.6	4,824	10.6	5,306	10.6	5,571	10.6	5,849
Gross Profit	33,764	89.4	37,141	89.4	40,854	89.4	44,939	89.4	47,187	89.4	49,547
Expenses											
Salary expenses	7,333	19.4	7,333	17.7	7,333	16.1	7,333	14.6	7,333	13.9	7,333
Outside services	1,250	3.3	1,250	3.0	1,250	2.7	1,250	2.5	1,250	2.4	1,250
Supplies (office and operating)	1,600	4.2	0	0.0	0	0.0	0	0.0	0	0.0	0
Boston Globe Advertisement	610	1.6	610	1.5	610	1.3	610	1.2	610	1.2	610
HubSpot Advertisement	200	0.5	200	0.5	200	0.4	200	0.4	200	0.4	200
Gold's Gym ADvantage Advertisement	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Facebook Advertisement	300	0.8	300	0.7	300	0.7	300	0.6	300	0.6	300
Rent	710	1.9	710	1.7	710	1.6	710	1.4	710	1.3	710
Telephone	30	0.1	30	0.1	30	0.1	30	0.1	30	0.1	30

3D Printer Depreciation	938	2.5	938	2.3	938	2.1	938	1.9	938	1.8	938	
3D Scanner Depreciation	31		31		31		31		31		31	
R&D	5,658	15.0	5,658	13.6	5,658	12.4	5,658	11.3	5,658	10.7	5,658	
Contingency Fund	2,263	6.0	2,263	5.4	2,263	5.0	2,263	4.5	2,263	4.3	2,263	
Total Expenses	20,923	55.4	19,323	46.5	19,323	42.3	19,323	38.5	19,323	36.6	19,323	

Net Profit	12,841	34.0	17,818	42.9	21,531	47.1	25,616	51.0	27,864	52.8	30,224	

Revenue (Sales)	Jul-15	%	Aug-15	%	Sep-15	%	Oct-15	%	Nov-15	%	Dec-15	%	YEARLY	%
Midas														
Apollo	38,520	66.2	40,446	66.2	42,468	66.2	44,592	66.2	46,821	66.2	49,162	66.2	449,659	66.2
Total Revenue (Sales)	19,645	33.8	20,627	33.8	21,659	33.8	22,742	33.8	23,879	33.8	25,073	33.8	229,327	33.8
	58,165	100.0	61,073	100.0	64,127	100.0	67,334	100.0	70,700	100.0	74,235	100.0	678,986	100.0
Cost of Sales														
Midas														
Apollo	4,584	11.9	4,813	11.9	5,054	11.9	5,306	11.9	5,572	11.9	5,850	11.9	53,509	11.9
Total Cost of Sales	1,558	7.9	1,636	7.9	1,718	7.9	1,804	7.9	1,894	7.9	1,989	7.9	18,189	7.9
	6,142	10.6	6,449	10.6	6,772	10.6	7,110	10.6	7,466	10.6	7,839	10.6	71,698	10.6
Gross Profit														
	52,023	89.4	54,624	89.4	57,355	89.4	60,224	89.4	63,234	89.4	66,396	89.4	607,288	89.4
Expenses														
Salary expenses														
Outside services	7,333	12.6	7,333	12.0	7,333	11.4	7,333	10.9	7,333	10.4	7,333	9.9	88,000	13.0
Supplies (office and operating)	1,250	2.1	1,250	2.0	1,250	1.9	1,250	1.9	1,250	1.8	1,250	1.7	15,000	2.2

Boston Globe Advertisement	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1,600	0.2
HubSpot Advertisement	610	1.0	610	1.0	610	1.0	610	0.9	610	0.9	610	0.8	7,320	1.1
Gold's Gym ADvantage Advertisement	200	0.3	200	0.3	200	0.3	200	0.3	200	0.3	200	0.3	2,400	0.4
Facebook Advertisement	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Rent	300	0.5	300	0.5	300	0.5	300	0.4	300	0.4	300	0.4	3,600	0.5
Telephone	710	1.2	710	1.2	710	1.1	710	1.1	710	1.0	710	1.0	8,520	1.3
3D Printer Depreciation	30	0.1	30	0.0	30	0.0	30	0.0	30	0.0	30	0.0	360	0.1
3D Scanner Depreciation	938	1.6	938	1.5	938	1.5	938	1.4	938	1.3	938	1.3	11,250	1.7
R&D	31		31		31		31		31	0.0	31	0.0	367	
Contingency Fund	5,658	9.7	5,658	9.3	5,658	8.8	5,658	8.4	5,658	8.0	5,658	7.6	67,896	10.0
Total Expenses	2,263	3.9	2,263	3.7	2,263	3.5	2,263	3.4	2,263	3.2	2,263	3.0	27,156	4.0
	19,323	33.2	19,323	31.6	19,323	30.1	19,323	28.7	19,323	27.3	19,323	26.0	233,469	34.4
Net Profit														
	32,700	56.2	35,301	57.8	38,032	59.3	40,901	60.7	43,911	62.1	47,073	63.4	373,819	55.1

7.2 Financial Projection Assumptions

Below is the breakdown of our financial assumptions for our first year of business:

Setup Review for year 1
- Open one store in mall
- Selling two products: Midas and Apollo
- Two employees

Growth Projections
- A top headphone competitor's growth in their first year was approximately 28% (Hoover's, 2013). Since we are a company that offers a unique manufacturing process and 3D printing technology along with custom products, we used this percentage as a base but increased our overall growth percentage.
- We formed the following growth projections in year 1 for our first store: (1) For the first three months, growth would be approximately 10% per month for all products. (2) After the first three months and for the remaining of the year, growth would be 5% per month for all products.

Cost of Goods
- Our Cost of Goods is calculated under the following assumptions: (1) Two grams of the material that we will be using costs $5.95. (2) It takes two grams of the material to make one set of EarThotix earbuds. (3) In year 1, we would be selling approximately 3,058 units of Apollo earbuds and 8,993 units of Midas earbuds.

Equipment
- <u>3D printers</u>: We would purchase two 3D printers from Stratasys™ in year 1 for our first store. Information on the costs of their 3D printers is scarce, so we are setting aside $200,000 for purchase.
- <u>In-ear scanner</u>: We would purchase one in-ear scanner from Lantos Technologies™ in year 1 for our first store. Information on their scanners is scarce, so we are setting aside $2,500 for purchase.

Advertising Expenses
- Newspaper advertisements in the Boston Globe cost approximately $610 for six advertisements a month (Boston Globe, 2014).
- The basic package for Hub Spot advertisements cost approximately $200 a month (HubSpot, 2014).
- Business advertisement costs at Gold's Gym in their ADvantage program are free of cost (Gold's Gym, 2014).
- Facebook website advertisements cost approximately $300 a month (Facebook, 2014).

Research and Development Expenses
- We chose to allot 10% of our estimate total gross revenue towards R&D. The standard in the headphone market is 8.7% (Lerman, 2014). We decided to increase this base percentage for our company since we are using 3D printing manufacturing and want to heavily research other products we could develop using this technology in the following years.

Salary Expenses
- We chose to pay our scanner/customer service employee an annual salary of $40,000 and our 3D printer employee an annual salary of $48,000. There was either limited or no information on the annual salaries for both these exact positions due to their rarity. We could not find information on the annual salary for an in-ear scanner technician to model our number after, but the rough average annual salary for a customer service representative is $39,500 (Glassdoor, 2014). In choosing this salary, we took into consideration that the technician's job would not require a college degree but only training seminars for the in-ear scanner and his/her job would not entail extensive work with customers, mainly just answering questions in-store. Similarly, it was also very difficult to find information on the annual salary of a 3D printing employee. In choosing this salary number, we took into consideration that this was mainly a manual job that required training but no necessity for a college degree

Outside Services Expense
- Our company's outside service costs for year 1 consist of the $15,000 maintenance package Stratasys™ provides with the purchase of their 3D printers.

Telephone Services Expense
- A typical business telephone package plan is approximately $30 a month (Comcast, 2014).

Rent
- We based our rent price on the average rental price in Massachusetts. The average rental price in Massachusetts is $1.42/sq. foot per month. Our space would be approximately 500 sq. ft. that we would be renting for a total of 12 months in year 1. Thus, the approximate total amount our company would be spending in year 1 for rent would be $8,520.00

3D Printer Depreciation

- In year 1, our total asset value for the 3D printers is $200,000. We have determined that the machine's approximate useful life is 10 years and their salvage value after this time span is $50,000.

Year	Book Value Year Start	Depreciation Expense	Accumulated Depreciation	Book Value Year End
2014	$200,000	$11,250.00	$11,250	$188,750
2015	$188,750	$15,000.00	$26,250	$173,750
2016	$173,750	$15,000.00	$41,250	$158,750
2017	$158,750	$15,000.00	$56,250	$143,750
2018	$143,750	$15,000.00	$71,250	$128,750
2019	$128,750	$15,000.00	$86,250	$113,750
2020	$113,750	$15,000.00	$101,250	$98,750
2021	$98,750	$15,000.00	$116,250	$83,750
2022	$83,750	$15,000.00	$131,250	$68,750
2023	$68,750	$15,000.00	$146,250	$53,750
2024	$53,750	$3,750.00	$150,000	$50,000

In-ear Scanner Depreciation

- In year 1, our total asset value for the in-ear scanners is $2500. We have determined that the scanners approximate useful life is 5 years and its salvage value after this time span is $50.

Year	Book Value Year Start	Depreciation Expense	Accumulated Depreciation	Book Value Year End
2014	$2,500	$367.50	$368	$2,133
2015	$2,133	$490.00	$858	$1,643
2016	$1,643	$490.00	$1,348	$1,153
2017	$1,153	$490.00	$1,838	$663
2018	$663	$490.00	$2,328	$173
2019	$173	$122.50	$2,450	$50

Contingency Fund

- We chose to allot 4% of our estimate total gross revenue towards other expenses and adjustments as a safety net for unforeseen expenses by the company.

Funding

- We hope to acquire approximately $500,000 in funds for our first year.

7.3 Company Key Milestones

After research and analysis of the market and our company vision, we have determined the following key milestones to be reached in order to successfully launch EarThotix from concept to reality:

1. Test process and product
2. Trademark name EarThotix, purchase online domain
3. Acquire investors and obtain needed amount of initial funding
4. Purchase equipment, material and hire necessary personnel
5. Rent desired store location
6. Launch advertising and marketing campaign

7.4 Risks

There are certain events that, if occur, could have negative effects on the performance and success of EarThotix. These include the following:

- Initial financial assumptions and estimates are substantially inaccurate and below the actual numbers
- Do not receive the necessary amount of funding
- Competition intensifies in our particular target market
- Lack of resources necessary to stop a larger more established company from taking our idea and expanding on it quicker than us
- Cannot obtain the desired store location
- Problems with the technology working as planned

Should these risks occur, EarThotix will take the necessary steps and respond immediately.

8.0 Feasibility

In determining whether or not EarThotix would be feasible, we considered numerous factors:

1. The current situation of our targeted industry and market
2. Demand and need for our product
3. Current competitors and possible threat of new competition or product substitutions
4. Competitive advantage of our idea and product. What differentiates our product from our competitors and why will customers choose our product over theirs.
5. Financial forecasts and potential profitability
6. Ability and resources to supply our product to meet demand
7. Current personal circumstances such as knowledge and experience in industry, skill set and commitment to our idea and venture
8. Do benefits outweigh drawbacks and potential risks for our idea

After researching and analyzing these factors, we came to the following conclusions:

Factor	Analysis	Feasible? Yes/No/Maybe
1.	The headphone market is a very large and mature industry that could use a new product to start reversing the product life cycle. It is a $1.5B industry, with 54% of all headphones sold in 2013 being earbuds. This means our product will have an extremely large built-in user base.	Yes
2.	Based on the results of our public survey and based on various conversations, blogs and consumer reports, there is an easily identifiable need by the majority for a product such as ours that can offer a solution to the problem of falling out earbuds.	Yes
3.	There is currently heavy competition in the headphone market with numerous big name companies. There is always a threat of a new competitor or a new substitute product, such as ours, in a technological market. However, since we offer our product as an add-on feature to many of these current competitors' products, and do not pose as a direct threat to their business, we firmly believe that our company will find success and thrive.	Yes
4.	Our product serves as an add-on feature to already currently existing in-ear headphones. We use a unique manufacturing process that is currently unmatched in the industry, involving 3D printing technology. Customers are offered an entirely customizable product, perfectly fit to the exact structure of their	Yes

	ear canal.	
5.	Our financial forecasts and analyses show a high potential profitability for our company. However, that it is based on our assumptions of cost and demand.	**Maybe**
6.	We have suppliers for our scanners, 3D printers and material. All we would need to do is hire the necessary employees and rent the optimal location for our store. Once we accomplish this, we should have no problem meeting demand.	**Yes**
7.	Currently, we have no experience in this industry. We are undergraduate students at Worcester Polytechnic Institute finishing our senior years in the school of business with concentrations in Biomedical Engineering and Mechanical Engineering. We will be relying on the advice and guidance of our WPI advisor who is a business professor and an experienced entrepreneur specialist. Since we are learning as we go, we will also be relying on the skill set and knowledge of our connections with personnel experienced with in ear scanners and 3D printers. We have a strong commitment to our idea and are proactively pursuing this venture and further valuable connections.	**Maybe**
8.	We have determined that the benefits and potential profitability of this company outweigh the potential risks we could face.	**Yes**

As can be seen by the analysis above, we conclude that the launching of our business, EarThotix, is feasible and will prove to be a profitable and successful venture.