Portable Electromechanical Braille Label Maker: From a 2.009 Prototype to a Product

By

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Submitted to the Department of Mechanical Engineering on May 8, 2009 in partial fulfillment of the requirements for the Degree of Bachelor of Science in Mechanical Engineering

Abstract

Most student projects never make the transition from a class prototype to a commercial product. This document is meant to be used as a guide by any student trying to turn an alpha prototype into a product on the market. The process is involved and there can be many challenges. There are also many approaches that might be adopted depending on the product and the goals of the inventor. This thesis begins with a discussion of technology transfer programs at three different universities and then looks into successful stories of student products. The focus then shifts to my own student product: a portable electromechanical Braille label maker that was developed in the MIT class 2.009, product engineering processes. The discussion focuses on the steps that have been taken thus far towards making the alpha prototype into a commercially available device, and discusses the steps that must be taken in the future.

Thesis Supervisor: David Wallace
Title: Professor of Mechanical Engineering

Acknowledgments

I would like to sincerely thank my thesis supervisor, Professor David Wallace, for all of his help and guidance this past year. Without the opportunity to enroll in his mechanical engineering design class, the Product Engineering Process, the Braille label maker project, called 6dot, would have never existed. I greatly appreciate his help in working with the team this semester during this thesis project; his assistance and supervision has been a valuable asset to the project and helped contribute to its success.

I would also like to thank the members of my family for all of their love and support these past four years of my undergraduate education.

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Introduction

With extensive academic and research opportunities at MIT, it is no surprise that the institute is a haven for innovative ideas. Each school year, several different projects are completed at MIT's college campus under the auspices of a variety of programs. Prospective engineers from various departments on campus join together to generate some groundbreaking ideas. Unfortunately, in the demanding college environment, many of these ideas and inventions do not make it past their initial stages.

This thesis document is written specifically for those students who want to take their class projects to a more meaningful level. My own experiences with product design in the fall semester of 2008 encouraged me to continue on with my project.

The project began in October of 2008 as part of a senior mechanical engineering design class: The Product Engineering Process[1]. Each team of 15-17 students was asked to design and create an alpha prototype of an object that could be used in the home. Our team shared an interest in developing a product that would aid the physically challenged, rather than creating a consumer product for the mass market. Therefore, after presenting six potential ideas to the rest of the class, our team was assigned the task of creating an assistive device for use in the home.

The ensuing investigation by members of our team helped us to narrow our focus to the challenges facing the blind community. We spent countless hours brainstorming a way we could best help this particular group of people. After speaking with members of the blind community at the Perkins School for the Blind[2] and attending meetings of the Visually Impaired and Blind User Group (VIBUG)[3], we quickly learned that the identification of objects is a formidable challenge that blind and visually impaired people face daily. In order to overcome this challenge, blind people label objects such as food cans, CDs, clothing, and other objects that are difficult to distinguish by touch. Although there are a few technologies used in labeling, they are outdated and have a low rate of user satisfaction.

In order to address this issue, our team decided to develop a Braille label maker that would make labeling easier and more effective for the blind. Together, we developed an alpha prototype of a device that solves many of the issues hindering other technologies. The prototype was displayed to the public on December 8, 2008.

While simultaneously developing the alpha prototype, we spent a considerable amount of time contacting potential customers looking for ideas and feedback. Through surveys, focus groups, and project celebration dinners, we received a great deal of positive reinforcement from blind people around the globe. Over the course of the semester, the contacts we made questioned us as

to whether or not the team would continue with the project after December. Interest among these potential customers was high. The team quickly realized that we needed to continue this project, moving it from prototype to production.

In this thesis document, I aim to explain the methods that were used to advance this project. Although the team had a working prototype, this alone was not enough to put the product on the market. There were and still are several steps that must be taken before the prototype can be transformed into a manufactured product that can be sold to the blind. By sharing my experiences in developing this product, I intend my thesis project to serve as a guide for other students who have created a prototype and would like to see it developed into an actual product that will reach the hands of consumers.

I start by examining the technology transfer programs of three different universities: Massachusetts Institute of Technology, California Institute of Technology, and the University of Michigan. After looking at these university programs, I then develop a case study of a start-up company run by former MIT students. Once I examine this student project, I look specifically at my own project: the Braille label maker. I explain in detail the steps the team took and the steps we will need to take in the future to turn our alpha prototype into a product on the market. Finally, I present a business model that explains the product and strategies we will implement to successfully bring it to the market. This model is useful when speaking with companies that can potentially manufacture the product. Also, the business model allows the team to stay on track with product development and clearly outlines the steps that must be taken for the product to reach the hands of consumers.

1. Technology Transfer at Universities

The Association of University Technology Managers (AUTM) describes university technology transfer as the act of disclosing product information to the university while protecting that technology with patents and licensing the intellectual property to someone in industry.[4] Technology transfer has become a vital component of many university resources. The Bayh-Dole Act, which was passed into law on December 12, 1980, allows places such as US universities, non-profits, and small businesses the right to the intellectual property, even if the money that funded the research came from the government.[5] There are currently several different programs at universities that are designed to help students with patent filing, product licensing, and starting a small business.

Below is a table that displays statistics for the technology transfer programs at three of America's best engineering schools: MIT, Caltech, and University of Michigan.

Table 1: Technology transfer statistics for top engineering universities

University	# Disclosures	# Patents Filed	# License Agreements	# Start Up Companies
MIT	522	282	68	20
Caltech	---	40 – 50	---	8
U of Michigan	306	132	91	13

Although each program is set up differently, they still have a similar fundamental organization. The tech transfer process for the three universities is described below.

Massachusetts Institute of Technology

MIT has a variety of resources and programs designed to help students take their projects and research to a more meaningful level. The MIT Technology Licensing Office (TLO) states that its mission is "to benefit the public by moving results of MIT research into societal use via technology licensing, through a process which is consistent with academic principles, demonstrates a concern for the welfare of students and faculty, and conforms to the highest ethical standards." [6]

The main service that the TLO provides is the ability to help the student license the product to a third party. As stated in the Inventor's Guide, "Licenses include terms that require the license to meet certain performance requirements and to make financial payments to MIT. These payments are shared with the inventors and also distributed to departments and research centers to provide support for further research, education, and participation in the technology transfer process." [7]

In order to commercialize a product with the MIT TLO, the inventor must go through a series of steps. The student begins with a pre-disclosure meeting with the TLO to briefly discuss the invention, and then files a disclosure agreement soon afterward that officially begins the technology transfer process. Once the disclosure is signed, the Technology Licensing Office goes through an assessment with the inventor and examines areas such as the market, other existing patents, and research regarding competitive products. Then patents are filed on the product in order to protect the ideas of the student. Once the patents are in place, the TLO begins to actively research potential companies that would be interested in the product, or potential ways to begin a start-up. The license agreement will be made once a third party is chosen.[8]

California Institute of Technology

The Office of Technology Transfer (OTT) at Caltech is another extremely successful technology licensing program designed for students. The office was created recently, in 1995, but has already successfully assisted with 40 - 50 patents per year and approximately 8 start-up companies per year[9] (Caltech OTT website). Caltech offers a variety of services to students, such as evaluating inventions for commercial appeal, securing patent rights, start-up company assistance, license agreement negotiation, and negotiating material transfer agreements and non-disclosure agreements.

If a student has a product or research that could be patentable, the OTT will ask for an invention disclosure form. With the information provided on the form, an experienced member of the OTT staff will complete the provisional patent application for this device. The OTT strongly encourages students not to publicly disclose any information before the provisional patent is filed. Although an inventor has a year to file an application after the invention is disclosed to the public in the United States, this is not always the case in other areas of the world.[10]

As stated on the website, Caltech is a major promoter of collaborating research information with the respective industry and expends a great deal of care negotiating technology license agreements between Caltech researchers and members of industry.

Caltech also offers a source of funding directly through the OTT. This program, known as the Grubstake Program, is a privately endowed funding program to help students with the costs associated with bringing an invention to production. In order to be considered for this funding, the inventor needs to fill out a proposal form. Funding awards total approximately $50,000 annually.[11]

University of Michigan

A successful technology transfer program also exists at the University of Michigan. According to the annual report, there were 306 disclosures, 91 license agreements, and 132 patents filed in the fiscal year of 2008. There were also 13 start up companies created through this program, and about $25 million in equity sales.[12]

The University of Michigan outlines the technology transfer process at the school. First, the student has a pre-disclosure meeting with the UM Tech Transfer staff to discuss the project or research. If the product is deemed viable, then invention disclosure will take place. After the disclosure, the tech transfer staff at UM goes through an assessment of the market and the competitors. The outcome of the assessment shows whether a start-up company or a license agreement would be a more appropriate option. Once the assessment takes place, the appropriate patents are filed. Finally, with proper protection, a license or start-up is created and commercialization begins.[13]

2. Successful Student Company: Atlas Devices

Despite the success that many of these programs claim, an ambitious student inventor can still develop the project to fruition without the direct aid of these programs. The following section discusses a start-up company that was created by recent MIT graduates in order to put their student project out on the market. These students undergo a relatively similar process to the ones outlined by the university technology transfer programs with a few slight variations.

Atlas Devices LLC is a company that was formed by MIT students in 2004 in order to successfully commercialize their device: The Atlas Powered Rope Ascender. The Atlas Powered Rope Ascender was initially designed to address a challenge for the 2005 MIT Soldier Design Competition. Competitors Nathan Ball, Tim Fofonoff, Bryan Schmid, and Dan Walker created a device designed for rapid vertical mobility. The product includes "a novel rope-handling mechanism that functions similarly to a capstan used to lower an anchor on a ship; each time a rope is wrapped around a cylinder a tighter grip is achieved. Thus the grip tightens as more weight is tied to the line." [14] The team won third prize in the competition and realized that the device they created had the potential to be an extremely useful product that could help members of the US Army, firefighters, and other workers who would have need for this rapid vertical mobility.

This group of students decided to begin the process by forming a company: Atlas Devices LLC. In an informational interview with Chief Technical Officer Nate Ball, he explains that even if the group is only looking to commercialize one product and even intending to license it to somebody else, forming a company is still a vital step in the process and should not be overlooked. Forming a company not only allows the group to establish more legitimacy, but allows the student team to direct everything to one single entity. For example, when filing for patents, the patents can be assigned directly to the company instead of to several individual inventors. This move is extremely beneficial for larger student teams that have unequal involvement in the development of the technology.[15]

After forming Atlas Devices LLC, the team immediately filed for provisional patents for the Powered Rope Ascender and were actively engaged in trying to sell the device to potential customers. The difficulty they first encountered was finding the money to produce the materials to make that first sale. Nate Ball explained in the interview that in order to create the first devices the company members had to pay for items with their own personal accounts. Reiterating the importance of establishing a company, Ball explained that the separate sources of payment by group members made the financial aspect more confusing, especially when

considering loan interest. Consolidating those separate sources of payment under the umbrella of one entity, the company, eliminated much of the financial confusion.[16]

Despite the initial difficulties that came with starting a company, Atlas Devices has filed several patents on the device, made improvements on the design, and negotiated contracts to sell the device. Although much of the company work was performed independent of MIT, there were a few institute resources that Atlas found to be helpful. MIT offers several different monetary awards to recognize projects of excellence. Nate Ball was the 2007 winner of the Lemelson-MIT student prize—a $30,000 award.

Another MIT resource Atlas found to be extremely beneficial to their company development was MIT's Venture Mentoring Service (VMS). As explained by L. Rafael Reif, "VMS's mission is uniquely inclusive, with its corps of experienced volunteer mentors offering services without charge to the entire MIT community, from students and stuff to faculty and alumni. By freely sharing their knowledge and insights, MIT Venture Mentoring Service mentors make a very important teaching contribution while helping start-up business ventures learn the roadmap to success." [17] Throughout their life as a company, the members of Atlas Devices have worked closely with the VMS staff and received helpful advice along the way.

3. 6dot: A Case Study

After carefully researching the procedures of technology transfer at other universities and examining other student projects that have been successfully introduced in the market, the focus of the paper now switches to my own student project: 6dot. After our final class presentation on December 8, 2008, members of the team knew that the project needed to continue further.

We began by assembling a new team of students that would be able and willing to commit themselves to the project. Four members of the original team stayed on board, and we also recruited two younger, outside members. Since all the members of the previous team were on track to graduate in June, we found students that would still be enrolled at MIT next year and committed to further developing the project. Also, the outside perspectives of the new members allowed the team to expand its pool of ideas.

Project Funding

The first step we took as a team of students was to secure funding from the Institute. The first generation alpha prototype was created with a budget of $6500. Although the product should eventually generate revenue, the team needs a certain amount of funding in order to develop the product to the point of production. A certain amount of money needs to be set aside for materials to build new generations of prototypes. Although most of the machine shops at MIT are free of cost to students, there are certain laboratories that charge for expensive machining jobs.

However, as the project continues, there are many other fees to consider besides prototyping fees. Intellectual property, for example, is crucial to the protection of the device. A great deal of money is spent on provisional and non provisional patents, as well as hiring patent attorneys.

Since the 6dot project has the power to impact the lives of many members of the blind community, we began by speaking with MIT's Public Service Center to explore our monetary options. After discussing with them the different sources of funding they offer for student projects, the team felt that entering the IDEAS competition[18] would be our best chance at obtaining substantial funding. A prerequisite objective of any competitor is to have a project that has a clear development and implementation plan. The judges evaluate each entry on innovation, feasibility, and community impact. This is an annual competition that is open to the general public with the rule that at least one third of each team must consist of MIT students. Each year, a small handful of winners is selected and given a certain amount of money. The winners are expected to use the awarded money over the next year to develop the project.

Our team submitted a detailed application that described the technical aspects of our prototype, our business model, our connection to the community, and the implementation plan. We also submitted a development grant in February; the grant is an opportunity for an IDEAS team to ask for immediate funds to work on the project before the judging session. Our development grant request was accepted and we were given about $700 to spend on further developing the prototype during the spring 2009 semester.

On Monday, May 4, 2009, the team was informed that we were one of the 8 IDEAS team winners of 2009. We received $7,500, which was a large percentage of the budget we had allocated for the upcoming year. To accompany this treasured prize, we will continue to apply for other awards that can aid us in funding the project.

Intellectual Property

Along with project funding, ensuring that the intellectual property was protected was another crucial step that needed to be taken care of immediately. According to the United States Patent and Trademark Office (USPTO), the inventors have exactly one year to file for a provisional patent after the information is disclosed to the public.[19] Since the final class presentation was open to the public, it was essential that we file patents to ensure that the invention was protected.

According to the USPTO, there are two different stages of filing a patent. A provisional patent is a temporary patent that allows the inventor to protect the invention for up to one year and allows more time for the non-provisional patent to be filed. The non-provisional patent is the official patent that must be filed a year after the provisional patent. The provisional patent is not as involved and can be submitted at a significantly lower cost.

The team began by filing a non-disclosure agreement with the MIT Technology Licensing Office. Unfortunately, the request was denied because the TLO was unsure that its investment on the patent would be returned by licensing the patent. Therefore, we worked on filing a provisional patent independent of the Institute. With the assistance of a voluntary patent lawyer, we submitted the provisional patent application on April 27, 2009. We will file the non-provisional patent throughout the upcoming year, using a great deal of the award money to pay for the associated legal fees.

Company Formation

Although the team will be working alongside another company to manufacture the product and bring it to market, we would also like to form our own separate entity to associate with our device. Forming an individual company is important because it allows us to operate any business directly through the company instead of ourselves. We aim to start our own company within the next few months, by August of 2009.

For our particular company situation, forming either an LLC or a non-profit organization would be appropriate. Since the company is not designed to be a monumental money making venture, it is not practical to form a corporation. Forming an LLC gives us a great deal of flexibility and lessens the liability issues we would have with a corporation.

Marketing

Since the blind community is small and focused, it is not difficult to get product information out to potential customers. We started developing our contact base at the start of the project by meeting with organizations designed specifically for the blind and visually impaired that were scattered around the Boston area. As we developed the initial design, we continually worked with people in meetings and focus groups to obtain personal feedback on the aspects of our device. We also sent a product survey to these nearby organizations, which was forwarded to various people worldwide. We currently have a website that explains important product information.

There are also several conferences in various locations that are designed to promote and display new products designed specifically for the blind and visually impaired community. These conferences are a valuable tool for people with emerging companies or products. The goals of attending these conferences are threefold. First, it gives inventors the opportunity to market their newly developed product to important organizations and to people that are active forces in the blind and visually impaired community. Second, it allows these inventors to show the product to potential customers, gain a sense of interest in the product, and gather feedback. Finally, it allows members of the community to take a look at other devices that are emerging on the market.

Over the past academic semester, our team visited two of these conferences. The first and most useful conference we attended was hosted by the California Transcribers and Educators for the Blind and Visually Impaired (CTEBVI). This conference recently underwent a name change and was formerly known as the California Transcribers and Educators for the Visually Handicapped (CTEVH). The conference takes place annually in California and features over 70 vendors from various parts of the country. It is also a place to meet some of the most influential members of the blind and visually impaired community.

Members of the team attended the CTEVH Conference from March 13-14, 2009. Displayed at the booth was the first generation alpha prototype, a second generation shell to demonstrate the size of the next prototype, and a video and flyers to provide additional information about the project. Attending the conference was extremely beneficial for the advancement of the project. First, we received a great deal of positive reinforcement from members of the blind community. Judy Dixon, author of a labeling guide called Label It, made herself a label with the device and

stated that the Braille created was "gorgeous." Several others, adults and children alike, were extremely impressed by the device.

Attending the conference also gave us an opportunity to meet with companies that could potentially manufacture the device. Similar to the blind and visually impaired people that stopped by the table, the manufacturers also appeared to be interested in the product and wanted to work with us on developing the device into an actual product.

There are a few other conferences the team can attend to get the word out about our product. We have already budgeted to attend the Getting In Touch With Literacy Conference from November 12-15, 2009. The aim of this conference is to address the urgency for literacy among the blind and visually impaired. Our product falls directly into this category because use of the product will allow blind or visually impaired users to expose themselves to Braille on a daily basis. Similar to the CTEVH conference, attending will allow our team to receive helpful feedback about the device and to spread the word about the product.

Manufacturing

In order to get 6dot out of the design phase and onto the market, the device needs to be manufactured on a production scale. Although the team will form our own company that can be associated with the device, as a student start-up company, we realize that we do not have the capability to internally manufacture the product and must look for an external resource. Therefore, the team feels that licensing the IP to a manufacturing company is the appropriate next step.

In the past month, the team has started meeting with potential interested candidates. There are several aspects that are being considered in recruiting a manufacturer. First, it is extremely important that the product goals of the manufacturer align with the team goals for 6dot. Our team is not interested in making a large profit from this device. Instead, we would like to form a sustainable business that allows the product to reach the hands of as many blind people as possible. Although the team understands that there must be a business aspect to the deal, it is important that it is not seen purely as a money-making venture.

Other important aspects of our license agreement are the terms and conditions of the license. Since the companies we have spoken with are only interested in an exclusive license agreement, our team cannot license the product to more than one manufacturer. However, it is crucial that we include a term in the license agreement that allows us to back out of the agreement if the company falls behind and manufacturing does not progress in the timely manner to which both parties agreed. It is extremely important to include this type of clause so that the production does not get delayed.

Continued involvement with the project is also something that the team highly values. If we license the IP to a manufacturer, we want to have the opportunity to work alongside them and offer our input on the development process. Since the company we would choose will have already brought products to industry, they will know what kind of changes will need to be made to the design. However, since the team members were the original designers of this product, it is crucial to maintain their involvement in the project and have them evaluate the necessary changes that are involved in developing the product for mass manufacturing.

4. 6dot Business Model

Executive Summary

6dot is a portable electromechanical Braille label maker consisting of a six-key plus spacebar user interface. The six keys represent the six dots in a typical Braille cell. The product is created specifically for blind people that are fluent in Braille, which accounts for 180,000 people in America.[20] Although this is a small market size, the demand for this product is extremely high so we envision being able to reach a large percentage of that market. The competing technologies are scarce and frustrating for users.

Assuming a positive response of our product by the American market, we would envision expanding to the international level. According to the World Health Organization, there are approximately 37 million people in the world who are also blind, and 124 million who have low vision.[21] Different forms of Braille exist for different languages, but our product, with its six-button interface, would be easily transferred to a new language with no need for modifications.

In the fall of 2008, as a team of 15 people in the MIT Mechanical Engineering course "The Product Engineering Process," we made our first alpha prototype of the device. This coming semester we have established a team of 7 people that is currently updating aspects of the design and forming a second prototype. During the next school year, we aim to develop our final prototype and determine the best manufacturing process. We aim to hand off our final design with the recommended manufacturing techniques by the spring of 2010. We intend to license the IP to the manufacturer. Provisional patent applications have already been filed, and we will file for the non-provisional patent within the following year.

This past fall, our team has already made contacts with potential customers. We have had various focus groups in the Boston area in order to gain feedback about our device, and we have sent out customer surveys that have travelled around the world. We have received a great deal of positive feedback from our potential customers and can already see that there is a high degree of interest in this product.

6Dot plans to sell approximately 1,000 products in the first year of production. We expect the amount of sales to increase each year as we establish the legitimacy of the product and people realize that the 6Dot is a better labeling method than the alternatives. We imagine that the product will reach a steady state in 4 to 5 years, selling approximately 5,000 devices each year.

Introduction to the Business

One of the greatest challenges for blind and visually impaired people around the world is the ability to correctly identify objects. The blind have several methods for identifying objects, one of them being labeling. Labeling objects is an extremely useful tool for blind people because there are numerous objects that are difficult to distinguish by touch, such as food cans, CDs and DVDs, clothing, and vitally important, and, if misidentified, potentially dangerous items, such as medication. Although labeling is a useful tool for blind and visually impaired people, the technologies that are currently used to label objects in Braille are outdated and frustrating to the user.

This presents an ideal opportunity for 6dot to enter the market. 6dot is a portable, electromechanical Braille label maker that has the same six-key plus spacebar interface that is seen in commonly used Braille typewriters. Each key corresponds to a specific dot configuration on the standard Braille cell. When the keys are pressed down and released, a mechanism within the device embosses the labeling tape with the respective dots.

6dot is a product created for blind or visually impaired people that are fluent in Braille. Although this is a small market, the demand for such a product is high. The labeling technologies that currently exist in this market are outdated and frustrating to use.

Market

Market Opportunity

According to the United States Census Bureau's report, "Americans with Disabilities: 2005," there are 7.8 million Americans who are visually impaired, where 1.8 million of these people are considered blind.[22] The American Federation of the Blind states that approximately 10% of this population can read Braille.[23] 6dot will begin by focusing mainly on this small market of legally blind Americans that are fluent in Braille. According to the Perkins School for the Blind, the number of Americans that are blind is expected to double in the next 15 years, mainly due to an increased aging population. Currently, around 5,000 people are estimated to go blind each year.[24] These numbers, however, only take into consideration the American market segment. The World Health Organization states that there are 37 million blind people in the world with 124 million having low vision.[25] Since most other countries use the six-key configuration that is seen in our device, it is simple to gradually expand the market to other areas of the world.

Customer Analysis

Potential customers have expressed a variety of wishes for what they would want and expect from a Braille label maker. For the most part, blind people are not particularly satisfied with the current technology that is used for labeling. I distributed a survey that reached 58 people from

around the world, with the hopes of gaining a better understanding of the labeling options currently on the market and to get an idea of the rate of satisfaction with these products. I began by distributing the survey to blind advocacy groups in the Boston area, and contacts there were able to pass the survey to blind and visually impaired people from other areas of the world.

One area of questions that the survey addressed involved the problems that exist in current labeling technologies. As survey responders expressed their difficulties with certain aspects of these devices, it provided the team with a good sense of what people were looking for in a labeling device. Most complained about the robustness of the existing technology. First and foremost, the product should work well, leaving on the tape clean Braille characters that are equally spaced from one another. Cutting and peeling the tape also came up in the survey responses as a huge issue that has been difficult to solve. Those surveyed also felt that it is important that the device cuts the tape close to the embossed character, so as not to waste tape.

Competitive Analysis

There are a few other technologies that exist that can be used to identify objects. Only one of these products, the 3M Braille Labeler, was specifically created to label objects.

Figure 1: Image of the 3M Braille Labeler:
http://www.magnifyingaids.com/index.php?page=products&subcategory_id=38

The 3M Labeler is a purely mechanical device. There is a dial at the top that turns to each letter. Once the letter desired lines up with the handle of the device, the user squeezes the handle to emboss the Braille character on the tape. Once the label is complete, the user squeezes the handle again to cut off the piece of tape.

At first glance, the 3M Labeler may seem like an ideal labeling tool, but after learning more about the product and hearing more feedback from our market, our engineering team has learned that it has several shortcomings. Since the device is purely mechanical, the depth of the Braille dots into the tape is a direct function of the strength a person uses when squeezing the handle. Therefore, sometimes some of the Braille characters are not deep enough to properly read. The 3M product also does a poor job in cutting the label. Since it cuts at a certain point within the

device, there is usually an extra amount of tape added to the label that the user must trim after cutting. This wastes tape each time a label is made.

One advantage that the 3M Labeler has is its low price. However, most blind people are extremely dissatisfied with the product and those that own it had to replace it several times. Therefore, it is safe to assume that most people would pay the extra money for a labeler that works well.

According to the survey data, the satisfaction for the 3M Labeler is quite low. Out of the 58 survey responders, 38 stated one or more difficulties they had with the device, while 13 of them could not respond to the question because they did not own one. Only 7 of the survey participants stated that they were satisfied with the device.

Most blind people opt to use a different technology to label their objects, but these technologies were not created specifically for labeling objects. The Perkins Brailler, for example, is a typewriter. Our own model was designed after the six-key interface of the Perkins Brailler.

Figure 2: Image of the Perkins Brailler: http://www.americanthermoform.com/perkins.htm

The Perkins Brailler is a reliable device that is extremely useful as a typewriter; however, it is not as useful as a labeler. Perkins makes an add-on module that can print on labeling tape, but the module fits awkwardly into the device and is difficult and cumbersome to install. Also, the Perkins Brailler does not cut or peel the labeling tape once the label is created. Finally, since it is a typewriter, and not a label maker, its size and weight does not allow the device to be portable in any way.

Another product that is sometimes used for labeling is a simple slate and stylus. As seen in the figure below, the slate and stylus allows people to write in Braille as if they were using a pencil and paper.

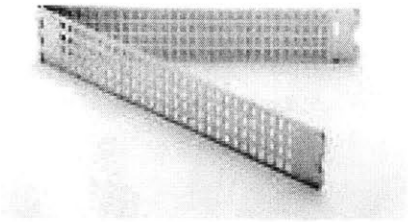

Figure 3: Slate and stylus: https://shop.aph.org

Although this device is inexpensive and portable, since each dot has to be embossed individually, making a label using a slate and stylus is extremely time-consuming and not efficient when making multiple labels. Also, since the user is manually embossing the dots, the Braille characters need to be embossed from right to left.

Compelling Attributes

Before developing the first prototype of 6dot, the team spent a great deal of time meeting with members of the blind community in order to get a good sense of customer preference. We learned many of the issues that are inherent with the current technologies and aimed to create a device that addresses each of these issues.

Our device, therefore, satisfies the following requirements:

- Intuitive user interface
- Ability to type quickly using no more than the force needed in using a computer keyboard
- Size and spacing of Braille is consistent throughout the life of the device
- Easy to cut and peel the labeling tape
- Small enough to be portable, but large enough to still type easily and comfortably

Sales and Marketing

Sales Plan

We anticipate selling 1,000 units of the 6dot in the first year of production. We expect the number of sales to increase each year as we establish the legitimacy of the product, as the 6dot product develops a reputation as a superior labeling tool and as operation profits can be reinvested in further improving the design. We imagine that in four to five years, sales will reach a steady state of about 4,000 per year. These sales projections are comparable to those of the Perkins Brailler.

Due to projected manufacturing costs, we envision initially selling the device for $200. Although the 3M Labeler is a much cheaper device, around the order of $30, it is such a poor

quality device that potential customers will be looking for something that works well and efficiently. Other typewriters and Braille devices created for the blind are typically priced over $500, so this is a reasonable price point for this particular product.

Marketing Plan

There are several avenues in which to market 6dot. Information about the product has already been passed along through support by some of the major organizations created for the blind and visually impaired. We will continue to reach out to these organizations that have been advocating for our project and keep them updated on recent developments.

Our team also put together a website: www.braillelabeler.net. The website gives up to date information about the product and is a useful guide for our base of potential customers.

Another great way to market product information to the blind and visually impaired community is to attend various conferences held for that specific purpose. On March 13-14, 2009, the team attended the annual CTEVH conference in California, which hosted over 70 vendors. The conference allowed us to meet several influential members of the blind community as well as potential manufacturers for the device. We also came in contact with several potential customers and received a great deal of helpful feedback regarding the device. We intend to continue to attend these conferences in order to further spread our name in the community.

Engineering and Product Development

Core Technologies

The Braille label maker consists of three innovative modules: the embossing module, which imprints the Braille character into the labeling tape, the advancing module, which moves the tape forward by a specified amount whenever a button is pressed, and the cutting module which cuts the tape and completes the label making process. In order to make a label, a roll of ½ inch width DYMO brand labeling tape is inserted into the device. Pressing the spacebar advances the tape into proper position. Then, the user presses any combination of the six keys. The keyboard electronics then activate the embosser, which makes a Braille imprint onto the tape. Finally, once the label is created, the user pushes the cutting button that cuts the label away from the rest of the tape roll, leaving the user with a Braille label.

The embossing module is the most complex module of the device. It consists of six embossing pins that are fitted through a stamp plate to make a 2x3 matrix. These embossing pins rest on cam shafts that connect to three servo motors that are programmed to move in a clockwise or counterclockwise direction. When a certain key is pressed and released, the electronics send a signal to the corresponding servo motor, which moves in the specified direction. When the servo

motor moves the corresponding embossing pin moves as well, making an imprinted dot into the labeling tape.

The advancing module is also electromechanical. The tape rests between an idler wheel and a friction wheel. The friction wheel moves the tape a certain amount due to a stepper motor. The stepper motor is activated whenever any of the six keys or the spacebar is pressed. Therefore, whenever the user types in a Braille character, the tape advances a specified amount.

Using electromechanical systems for embossing and advancing the tape greatly improves the quality of the device. The electronic system allows for the control of these modules. One particular concern with purely mechanical devices is their inconsistency in printing labels. With regards to embossing, if the mechanical device is not pressed with enough force, the Braille dot height is not tall enough to feel properly. However, with the 6dot, the height of every dot is always guaranteed to be the same, as well as the spacing between each character.

The cutting button has two main features: cutting the tape and scoring the end, giving it an easy-to-peel tab. The cutting button consists of two blades that are connected by a compliant material. One of these blades is directly connected to the button, which allows it to make a strong, clean cut. The other blade brushes lightly along the surface and leaves a scored slice in the tape.

As demonstrated by users, it is extremely difficult to peel the backing off the labeling tape after the label as been created, and it is even more difficult when the person is unable to see the backing. Therefore, the cutting and scoring mechanism that is built into this device alleviates a great deal of frustration for the users and saves them time when creating labels.

Current Development Status

Currently, two alpha prototypes of the device have been created. The second version of the device is smaller and more ergonomic and contains updated versions of the embossing mechanism, the electronic board, and the cutting and peeling button. The latest prototype also has side slots where a neck strap is attached. This allows the user to lean the device up against the body and make a label in a public place, resulting in a more portable, useful device.

Product Strategy for Future Products

There are several different ways to further advance this product. Before the device hits the market, it will need to go through 2 to 3 more design iterations based on the results of customer feedback as well as standards of manufacturing. Once the device hits stores, the future design can include a USB adaptor that allows users to type labels using a QWERTY keyboard. Therefore, all user preferences are taken into account. The device may also need to be lighter and more compact, depending on user preference.

Intellectual Property

Immediately after our first public display of the project on December 8, 2008, we began filing for a provisional utility patent on the entire device, the internal components, and the design concept. The filing of the provisional patent was completed on April 27, 2009. Over the next year, we will file the non-provisional patent.

Product Roadmap

Since the project began in October of 2008, two alpha prototypes have been developed of the device. The first prototype was displayed to the public in December of 2008 and the second displayed in April of 2009. Within the next year, we intend to develop two more updated prototypes of the device and then begin manufacturing the device to sell to the general public.

Manufacturing

Although 6dot has gone through design iterations at the MIT laboratories, the manufacturing of the product will take place through an external source. Our team plans to license the IP to a manufacturer that is willing to work alongside us and create 6dot in a way that it is prepared for manufacturing. Although we will be licensing the IP exclusively to our company of choice, it is crucial that we will be including a clause in the license agreement that allows us to take the device elsewhere if the company does not advance the project in a timely manner.

Conclusions and Recommendations

In summary, the document explains the basic technology transfer programs at universities. Then a real example of a student project is examined and compared to these technology models. Finally, I discuss my own student project, focusing on the progress the team has made and what the future holds in store for the label maker.

Our student team now follows a clear path on the road to production. We have already developed two generations of the alpha prototype and intend to create two others within the next year. We will modify these prototypes based on user feedback with using our device. We have already started the filing for a provisional patent and will continue to file until the device and its components are protected by a non-provisional patent. We have developed a business model that allows us to negotiate a license agreement with potential manufacturers of the device. We are in the process of meeting with these manufacturers and expect to choose one within the next month. One we work out the details of the license agreement, the schedule and timeline for this product will become even clearer. In the meantime, the team will continue to reach out to our contact base and attend conferences in order to keep up the momentum associated with this product.

Based on the information gathered from university programs and other student projects, the 6dot team has decided to follow this particular path on the road to production. Transforming an alpha prototype into an actual product is a daunting, complicated, and time consuming task. The information about 6dot and other student projects can hopefully be used as a guide for other students who are interested in taking their projects to new levels. The technology transfer processes has become important to universities because of the wealth of new ideas emerging from students. Therefore, these types of university programs can be extremely useful to student entrepreneurs. However, there are also a number of resources on and off campus that can help students advance their products from the prototype stage. In most of these situations, each project goes through similar steps as it makes its way through to production. With the tips and information presented in this thesis document, students looking to take their class projects and research to a more meaningful level will hopefully have the tools to do so.

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