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January 21, 2008

Patrick Leung, P.Eng
School of Engineering Science
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RE: ENSC 440 Project Proposal for Portable Braille Display

Dear Mr. Leung,

As per the requirements laid out for our ENSC 305/440 project, what follows is our proposal for a small, cost-effective, portable device for storing and displaying Braille. The end objective of this project is a unit which will give individuals with visual impairments the ability to read material in a portable manner. Furthermore, the compact style of design will allow it to be used everywhere, and its ability to refresh will allow individuals to take large amounts of reading material where ever they go without considerable bulk or stacks of papers. That is, one may think of this as an eBook reader for the blind.

This document aims to outline our ideas, taking time to focus on the technical side, as well as the marketing and financial sides. As such, we will include our tentative funding, budgeting, work allocation, and scheduling plans.

The BDot team is comprised of five innovative and passionate engineering students who see the technology as an opportunity to make manifest a future where technology allows our society to reach its full potential. As engineers, it is our professional and ethical obligation to contribute not only in technical ways, but to apply our knowledge to alleviate the problems in our society as well. We are Jill Steele (CMO), Joan Thomas (CFO), Mei Young (COO), Dave MacLeod (CTO), and myself, Jessica Tang (CEO). If any questions, concerns, or problems should arise, please feel free to contact us at ensc440-braille@sfu.ca.

Sincerely,

Jessica Tang
BDot, Chief Executive Officer

Enclosure: *Proposal for a Portable Braille Display*
cc: Steve Whitmore, Bradley Oldham, Jason Lee

Tiresias

Portable Braille Display

Management Team:	Dave MacLeod Jill Steele Jessica Tang Joan Thomas Mei Young
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Submitted To:	Patrick Leung Steve Whitmore Bradley Oldham Jason Lee

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Executive Summary

Close your eyes for just one moment and imagine what life would be like if you were unable to read this report. Imagine life as it would be, devoid of the sense of sight and all the knowledge there imbibed. Close your eyes and imagine, just what life would be like if when you opened them, your sight was gone.

With the introduction of Braille, blind people were given back one small joy: the ability to read. The pervasiveness of the computer, coupled with declining costs of scanners and Internet access, the prevalence of digital content has increased significantly. Despite this, a cheap way of displaying this information in a Braille format remains elusive. That is, how does one take text on a computer (or on paper which can be scanned into a computer) and transform it into Braille?

The absence of an affordable, light, and portable Braille display is of prime importance, and this is what BDot aims to rectify with *Tiresias*. The current market offerings have missed a very important sector – the common person. Existing displays are cumbersome and unwieldy, and do not allow for the amount of freedom *Tiresias* can provide. Computers have been mobile for years and thus, the visually impaired are in need of a truly mobile display.

BDot does not see the world as it is, but what it could be, imagining a world where blind people can be a part of the global workforce of the new millennium. It has the power to change the face of assistive technology in a groundbreaking way.

BDot is small, agile, efficient, and has the drive to bring *Tiresias* to fruition in the global market. It consists of five engineering students of various backgrounds, yielding experience in biomedical, computer, mechanical and electrical systems.

The engineering cycle for this project is scheduled to take 13 weeks from January 7, 2008 to April 14, 2008, and will include research, design, and quality analysis. Several working prototypes of the *Tiresias* system will be created, with a fully functional prototype complete by the end of the cycle. The projected cost of this system is $710.00, which is expected to come from an abundance of sources.

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1.0 Introduction

There are over 600 000 blind people in Canada [1], and an astonishing 1.3 million legally blind people in the United States [2]. Of these populations, only 25% and 8% respectively, are in the workforce at the moment [3-4].

In 1829, Louis Braille introduced a revolutionary system that gave the visually impaired the ability to read. In the wake of environmental responsibility, much public content has been reduced to digital form. As such, the visually impaired currently have no affordable method of absorbing this information.

Now, in 2008, BDot is introducing its own revolutionary system, *Tiresias*, a portable, cost-effective Braille display for the visually impaired. With advances in the mobility of technology, it's no wonder that assistive devices also need to be more portable. While there are many models currently available, large, extensive displays are not affordable for everyone. *Tiresias* will prove to be a viable solution for any visually impaired person.

A compact Braille display system will ensure easier integration of the visually impaired within society, allowing them to contribute as much, if not more, than any able-bodied Canadian. However, to ensure maximum effectiveness, it is the intention of this company to create a refreshable Braille display. By using compressible pins (in sets of six), ASCII characters will be read in, and translated into a corresponding Braille character. By using an innovative rotating system, these characters can be reset, to allow for continuous and seamless translation of digital information for the visually impaired.

A system like *Tiresias* is more effective than other refreshable displays currently on the market, because of the target towards everyday use. Small and lightweight, it can be used everywhere, giving the visually impaired the freedom every Canadian deserves.

This document is a proposal providing an overview of the technology, design considerations, sources of funding and other resources, and project scheduling. Furthermore, different solutions and current models of this technology are explained and analyzed. The financial obligations for this product are also included, as well as other relevant timeline information.

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2.0 System Overview

Tiresias can be used in two different ways. Firstly, it can interface directly with a PC, via a USB or serial cable. From this point, digital text can be translated into ASCII characters by way of a customized software program installed on the PC. The microcontroller on board *Tiresias* will then convert the ASCII characters to Braille, for output to the refreshable display. To make it more portable, the ASCII characters can also be written to a removable memory card (Secure Digital technology), and then read directly by *Tiresias* for output. In this manner, users have the option of using *Tiresias* in either mode. The graphical overview can be seen in Figure 1 below.

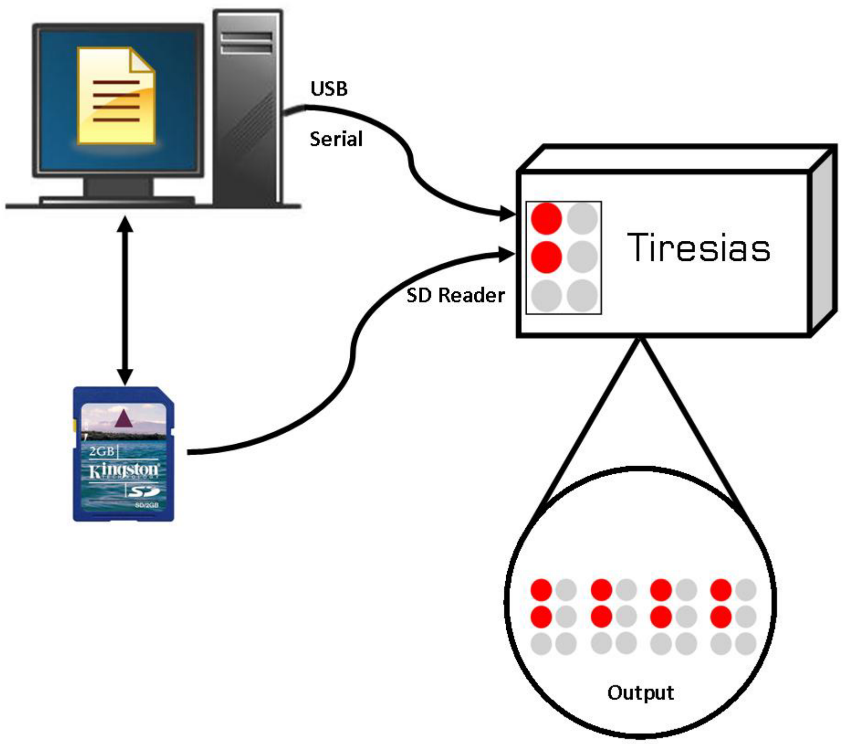

Figure 1: Overview of *Tiresias* system

3.0 Possible Design Solutions

In each design solution, we investigate several methods of placing dots representing Braille on a surface so that the user is able to read it by running their fingers along a section of the unit.

3.1 Ink Jet Printer

In the Ink Jet Printer design, a small printer is located on the right side of the device and prints dots with a thick ink onto a thin strip of plastic. The ink is thick enough that it can be felt with the tip of a finger. The ink dries quickly and as the plastic moves out of the printer, the user can feel the protruding ink dots. The plastic will move across a small conveyor belt where the user can feel the dots. The dots are then scraped off and discarded and the plastic moves under the conveyor belt to return to the printer and be re-used. This design was not chosen because of its wasteful nature (discarded ink) and requires a printer that would make the device larger.

3.2 Dot-Matrix Printer

In the Dot-Matrix Printer design, a small printer is located on the right side of the device and prints onto a thin strip of heat-moldable polymer. The printer would be modified to punch an imprint onto the polymer plastic. As the plastic moves out of the printer, the user can feel the embossed dots with their fingers. The plastic will once again move across a conveyor where the user can read the characters. The plastic is then re-heated to smooth out the formerly protruding dots, and moves under the conveyor belt to be re-used by the printer. The Dot-Matrix design was not chosen because it required major modifications to existing technology, and also would incur great cost by using a heat-moldable polymer. Not only would the material be costly, the lifetime of the material would surely be short.

3.3 Conveyor Belt with Pins

In the Pins design, pins would be placed in moving plates on a conveyor belt. The pins would sit below the surface of the plate. As pins pass a set of actuators, certain pins will be raised to move up onto a ramp that keeps the pins position protruding above the moving plates. This means the pins would not require a constant power source to keep them above the surface. The pins will be kept in position for the length of the conveyor belt so the user can feel the protruding pins with their fingers. The pins are then released from the ramp and thus fall below the surface of the belt. The pins will then move around the conveyor belt to again pass the set of actuators. This method was not used because the conveyor belt design would add unnecessary size to the product, and would also prove to be prone to mechanical errors. A motor would likely be required to power the conveyor belt, adding more cost to the product.

4.0 Proposed Design Solution

Our actual design is based on the belt-driven design, in that it still uses mechanical pins. It was determined that although the belt design reduced power requirements by eliminating constant actuation of each raised pin, the belt itself became the restriction on design. The space requirements for a belt became a limiting factor on the size of the unit.

Looking at pin actuation in a simple fashion, we can identify some defining characteristics. Firstly, we need a way to support the pins in a raised state. Secondly, we need a way to transition this back to a lowered state (refreshable). Thirdly, we require that each pin can be locked in this state, once lowered. Finally, we require an easy method of resetting the pins to the raised state.

If we state that the first mechanism can be accomplished by supporting the pin on a spring, this allows us to simply pull the pin down to accomplish the second requirement. We are planning to use muscle wire to produce this effect. Once the pin is lowered to an acceptable depth below the surface of the display, as stated above, a locking mechanism is required to keep the pin in place. This can be accomplished in a number of ways. Several designs will be tested, including sears (locking plastic catches) and magnetism. In either case, we plan to use a single motion of actuation to reset each character (or line, depending on final design).

This design relies on the fact that actuating single pins (or a low number of pins) at once will not require a substantial current draw. Initial calculations suggest this will be the case, but more tests will be required to determine the actual behaviour of these systems in reality. In any case, we imagine the display resetting in a ‘waterfall like’ manner; after the pins are reset, each character is set in a linear order, producing a fluidic display response.

5.0 Sources of Information

BDot will be gathering information from as many sources as possible to be able to acquire the necessary knowledge to develop a marketable Braille display.

For the technical design aspect, SFU professors such as Andrew Rawicz have expressed interest in sharing their ideas and technical knowledge. Further, graduate students such as Eli Gibson have researched extensively on this topic and have brainstormed with us on possible improvements and new design ideas. We will also need the expertise of Patrick Leung, P.Eng, Dr. Ash Parameswaran and Bradley Oldham for the design and development of the microcontroller.

For the user interface aspect, we will be interviewing a number of people from rehabilitation centres such as GF Strong Rehabilitation Centre to gain a better knowledge on how visually impaired patients read Braille as well as what configuration of controllers they would prefer. In doing this, we can determine what obstacles we can help them overcome, and provide the best solution for the demographic that matters most.

Along with the aforementioned sources, expertise from industry, the Internet, engineering texts, journals and papers will also be valuable sources of information for product research, development and distribution.

6.0 Budgeting and Funding

6.1 Budget

Table 1 below is a tentative price list of the various components required for the system. All costs have been determined via considerable research and have been over-estimated by 15% for contingency. Additionally, we have factored miscellaneous costs into our budget, to accommodate for any additional components we may require once testing occurs. Estimated total also take into account shipping charges and taxes [5-6].

Table 1: Budget for Tiresias Prototype

Equipment		Estimated Cost (CAD)
Mechanical Components	Muscle Wire	$12
	Dynalloy Flexinol Sample Kit	$38
	Springs	$65
	Plastic	
	Casing	$15
	Pins/Miscellaneous	$10
	Buttons/Mini Joystick	$12
	Metal Sheeting	$40
	Magnets	$10
Electronic Components	Memory Card (1GB) & Reader	$25
	Microcontroller / FPGA board	
	AVR Controller	$20
	Programmer	$40
	Demo Kit	$120
	Batteries and Holder	$30
	Proto Boards	$35
	Board Components	$15
	Miscellaneous	$60
	Shipping Costs	$70
	Sub-Total	$617
	Tax (15%)	$93
	TOTAL	**$710**

6.2 Sources of Funding

One of the major goals for this product is for it to be very low cost such that it can easily be purchased by anyone who needs it. However, the initial prototype is expected to cost much more than the final manufactured version of the product, and thus sources of funding are required before investment opportunities arise.

In order to finance this venture, BDot is actively pursuing funding from both the Engineering Science Student Endowment Fund (ESSEF), as well as the Wighton Engineering Development Fund. We believe we are very likely to obtain funding from the Wighton Fund as "[p]rojects benefiting society, (for example, biomedical developments or aids for the elderly and physically or mentally disadvantaged) [are] treated preferentially." [7] By creating a direct aid for the visually impaired, the goal of Tiresias is directly parallel to the goal of the Wighton Fund.

We also intend to use resources like the ESSEF Equipment Loan Program as well as contacting professors who may be able to lend us equipment (such as FPGA boards) that we may use for our prototype.

7.0 Schedule

In Figure 2 below, the proposed schedule and timeline is presented by way of a Gantt chart.

	Tasks	Task Lead	Start	End	Duration (days)
1	Documentation	Jessica	1/07/08	4/15/08	99
1.1	Project Proposal		1/10/08	1/21/08	11
1.2	Functional Specification		1/22/08	2/18/08	27
1.3	Design Specification		2/19/08	3/03/08	13
1.4	Group Presentation		3/03/08	4/02/08	30
1.5	Post Mortem		4/02/08	4/09/08	7
1.6	Lab Notes		1/07/08	4/15/08	99
2	Mechanical Design	Dave	1/21/08	2/20/08	30
2.1	Muscle wire with spring system		1/21/08	1/27/08	7
2.2	Locking system		1/28/08	2/01/08	5
2.3	Moving pins		2/04/08	2/11/08	8
2.4	Mechanical design integration		2/11/08	2/20/08	10
3	Software Design	Joan and Mei	1/21/08	1/27/08	7
3.1	Serial porting		1/21/08	1/27/08	7
4	Microcontroller Design	Joan and Mei	1/28/08	2/20/08	20
4.1	Ascii to Braille		1/28/08	2/04/08	5
4.2	User control functions		2/05/08	2/09/08	5
4.3	Memory card reader		2/10/08	2/14/08	5
4.4	Voice control		2/15/08	2/20/08	5
5	System Integration and	Jill	2/20/08	3/27/08	37
5.1	Microcontroller and Software		2/20/08	2/26/08	7
5.2	5.1 and Mechanical		2/27/08	3/07/08	10
5.3	Debugging		3/08/08	3/27/08	20
5.4	Modifications		3/15/08	3/27/08	13

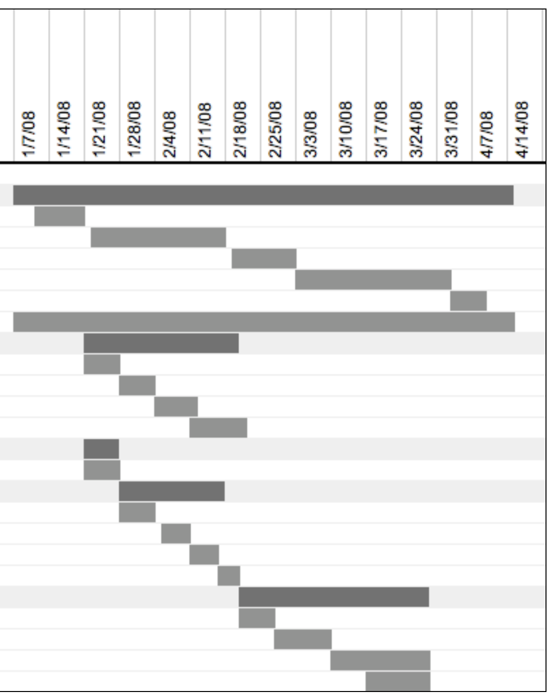

Figure 2: Gantt Chart

7.1 Milestones

Below in Figure 3, the major milestones and documentation submissions for this project are highlighted. Adhering to these milestones will ensure a timely completion of the product.

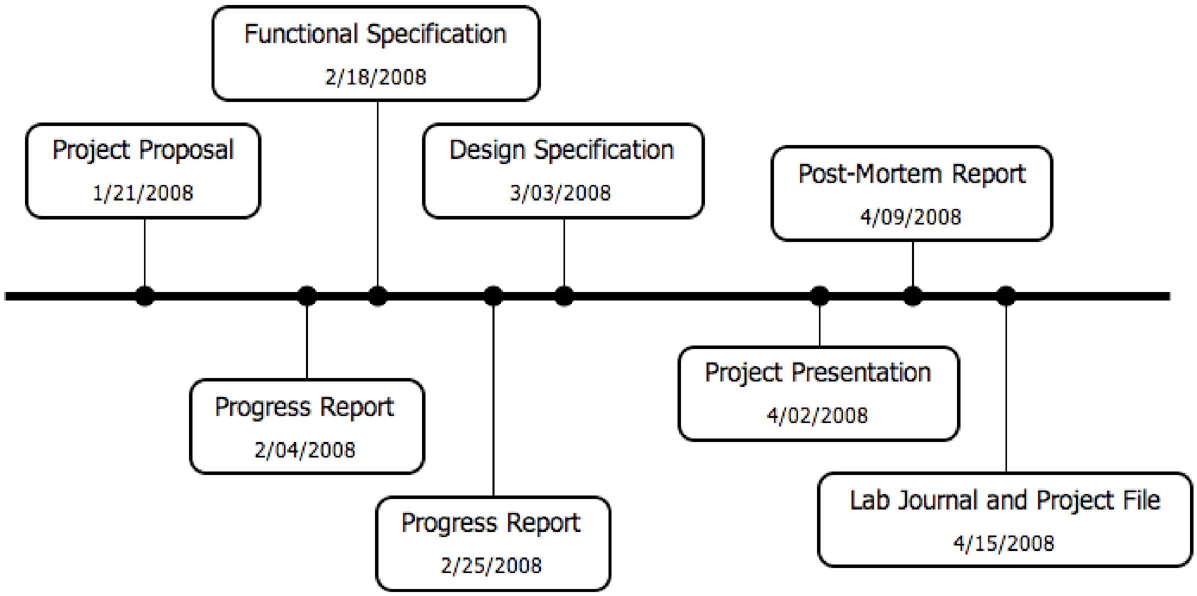

Figure 3: Major Milestone Continuum

8.0 Team Organization

The BDot team consists of five enthusiastic and talented engineering students from Simon Fraser University. As the success of our project is highly dependent on the skill set and organization of team members, each member has been assigned to overlook different aspects of the project based on his/her own interests and skills. The interests and skills of our team members vary from biomechanics and biomedical applications, to programming, electronics and mechanical systems.

Jessica Tang, a biomedical engineering student, is the Chief Executive Officer charged with overseeing the project. Mei Young, also a biomedical engineering student, is the Chief Operations Officer charged with overseeing the daily operations from conception to completion. Dave MacLeod, a systems engineering student, is the Chief Technical Officer charged with overseeing the technical specifications and implementations. Joan Thomas, a systems engineering student, is the Chief Financial Officer charged with overseeing the budget and funding for the project. Jill Steele, a systems engineering student, is the Chief Marketing Officer charged with surveying the current market and ensuring the product meets a specific social need.

Currently, the team meets regularly once a week to ensure ongoing communication between group members. Each member provides an update of his/her current activities and presents any problems or ideas. The team members discuss issues such as current design and development difficulties, and come to an agreement on how to proceed with the product development. An agenda is provided before each meeting, and minutes are kept to ensure the team's discussion is accurately recorded. Any information such as minutes and documentation is shared among team members using Google Docs and team deadlines and activities are recorded using Google Calendar. Our organization method ensures input from all members and allows our team to shift tasks according to a team member's ability, interests, and availability so that product development can move forward efficiently. The online availability of this information also makes it easily accessible for all group members.

Our team structure offers a combination of both ownership of responsibilities and flexibility. By assigning tasks, each member can work on aspects of the project in which he/she is more skilled or interested. By allowing for flexibility, our team is able to handle any unexpected problems that may arise during product development, and can also ensure proper application of specific experience when required.

9.0 Company Profile

Jessica Tang | Chief Executive Officer (CEO)

As a fifth year Biomedical Engineering student with a minor in Kinesiology, I have the technical background and experience to oversee this company. My interests revolve around rehabilitative and assistive devices, which align perfectly with the focus of BDot. As a Hardware Engineer with Circon Systems, I gained extensive experience in hardware troubleshooting, PCB design, microcontroller design and applications, as well as testing and quality analysis. Further, my lab experience in the neurokinesiology and biomechanics labs have furthered my understanding of the physiological aspects of assistive technology. My experience within my student society has required me to delegate tasks to committee members to ensure maximum efficiency. I have led many projects, both academically and occupationally, and my leadership skills will ensure the success of BDot in the global market.

Mei Young | Chief Operations Officer (COO)

I am a fourth year Biomedical Engineering student with interests in medical imaging as well as rehabilitative devices. I worked at Business Objects as a Programmer Writer. My task was to do documentation and create web application tutorials. While continuing my studies, I have volunteered in various labs which expanded my knowledge on image acquisition, signal processing, sensor evaluation and basic hardware skills. Aside from academic work, I have co-chaired a one week conference as well as held the position of VP Internal in the Engineering Science Student Society which provided me with the skills to manage day-to-day operations.

Dave MacLeod | Chief Technical Officer (CTO)

Originally from Halifax, I received a Bachelor's of Computer Science at Dalhousie University in 2005, specializing in computer graphics and programming language theory. Afterwards, I worked in bioinformatics, publishing several papers on genetics, genomics, and phylogeny before moving to Vancouver to pursue Systems Engineering at SFU. My most recent work term was an electrical engineering co-op at Pacbrake in Surrey, BC, where I designed brake controllers for exhaust brakes. I am now entering my last year of study at SFU, and have current interests in analog circuits and mechanical design. I also have an ongoing interest in human/machine interfacing and human/computer interaction. As Chief Technical Officer, it is my aim to facilitate a succinct and elegant design and play an active role in major aspects of production.

Joan Thomas | Chief Finance Officer (CFO)

I am a Systems Engineering student, with a minor in Computer Science, entering my fourth year at Simon Fraser University. My work experience includes two engineering co-op positions at BC Hydro and the BC Cancer Agency. I have extensive programming background in C and assembly language as well as a keen interest in electronic design and digital signal processing. In addition to my knowledge base, my experience with organizing career fairs, fundraising for conferences and several years as an executive with the SFU tennis club have given me the skills to effectively handle the finances of BDot.

Jill Steele | Chief Marketing Officer (CMO)

I am a fifth year Systems Engineering student at Simon Fraser University. Previously, I worked for Safeway Information Technology where I managed computer updates made to the Safeway store servers. I gained experience working in a project-driven development environment where customer satisfaction was of prime importance. I enjoy working with people and am well in-touch with the demands of today's market. I have the skills to effectively handle my responsibilities as Chief Marketing Officer and bring our product to center stage.

10.0 Conclusion

BDot is certain that *Tiresias* can bring to the market what no other Braille display has brought before. With its simplistic yet effective design, *Tiresias* has the power to bring freedom and mobility to the visually impaired, improving productivity and allowing further access to the digital era.

This proposal shows the focus that is required to take this product to the market. The budget and timeline constraints demonstrate the processes that are necessary for success. Furthermore, the vast number of proposed design solutions will help focus the development of our chosen implementation, ensuring a well-defined design process.

Similar to what Louis Braille did over 100 years ago, BDot is creating revolutionary Braille technology for the world. By bringing a cost-effective Braille display method forward, we are forging through past hurdles, giving society a solution that will address an identified and unmet adversity. Productivity will not only increase in the workplace, but in the educational system as well. Visual impairment will no longer be an impairment, nor will it be a barrier to success in the years to come.

BDot strives to bring innovative technology to the world, seeing the world as it could be, not as it is.

11.0 References

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