**LaserCane**

**(Formerly SmartCane)**

**Term Project Report**

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# Introduction

## Brief Description of the White Cane

The white cane is the mobility aid most frequently used by visually impaired (VI) people. Invented in the early 20th century, it granted its users increased independence[[1]](#footnote-0). It functions as an important signifier of visual impairment and allows users to detect obstacles in their path and changes in elevation. Although the white cane is extremely useful, the current model is in dire need of improvement as it presents many issues for its users.

## Who We Are

At LaserCane, we strive to create a revolutionary and technologically advanced SmartCane to alleviate the shortcomings of the white cane. We stay true to this mission by offering our product, LaserCane, which is intended to improve the quality of life for white cane users by introducing laser sensors and ultrasonic technology.

# Market Fit

## Product

The Current white cane design presents many issues. To alleviate these issues, we created an innovative, new design. The LaserCane is a white cane for the 21st century, combining the underlying principles of the white cane with the design concepts of a laser pointer.

Since learning how to use a cane is a taxing process, we decided not to alter the cane too radically. Learning how to use a new product presents a switching cost, and requiring the user to learn a new technique would exacerbate this. The user of a LaserCane still uses the same constant contact technique they would on a traditional cane. The body of the cane is supplanted by Light Detection and Ranging (LIDAR) technology, leaving only the handle.



LIDAR uses a laser to detect the distance between the sensor and an object based on how the light bounces off of the object.

| **Situation** | **Response from White Cane** | **Response from LaserCane** |
| --- | --- | --- |
| The cane signifies visual impairment | The red and white cane is a universal sign of blindness. | The highly visible red laser alerts other people. |
| The cane is in use, but not detecting anything. | Constant contact technique means that the cane is always providing audio and haptic feedback. | The white cane emits a weak, constant vibration when the sensor is within an acceptable distance from the ground. |
| The cane detects an obstacle in the user’s path. | The cane bumps into the object.  The cane user probes around the base of the object so they can navigate around it. | The object intersects the laser, and the sensor detects that there is an object too close to it. The cane emits a rhythmic pulse. Each pulse consists of a single vibration followed by a pause. The gaps between the pulses decrease as the cane sensor gets closer to the object. |
| The cane detects a descent in elevation, | The tip of the cane drops until it touches the ground. | The LIDAR sensor emits a laser that measures the distance from the sensor to ground. |
| The cane detects an ascent in elevation. | The cane runs into the ground and the user must lift it to detect the level of the higher ground. | The LIDAR sensor detects an obstruction in the user’s path, and they must angle the sensor to determine the height of the obstruction. |
| The user approaches an obstruction that is above waist level. | Nothing happens. | The ultrasonic sensor detects the obstruction. The cane emits a rhythmic pulse, and where the cane vibrates twice followed by a pause. The gaps between the pulses decrease as the cane sensor gets closer to the object. |

## Target Market Demographic

Learning how to use a white cane is a serious commitment. It requires that visually impaired people undergo Orientation and Mobility Training (O&M), a process that can take 1-2 weeks of continuous, immersive training. Since our product is based on the white cane, our target demographic only includes visually impaired users who are already trained to use the original white cane.

Visual impairment is a growing issue in the United States. In 2012, it was reported that 4.2 million Americans were living with uncorrectable visual impairment[[2]](#footnote-1). This number is expected to increase by 2050 to 8.96 million Americans2. This is caused by a number of factors, such as population growth, ageing, and urbanization[[3]](#footnote-2). In addition, various health conditions (including: cataracts, macular degeneration, diabetes, and glaucoma) can also cause blindness2. Since health and access to adequate healthcare is a causal factor, vision impairment tends to affect people of lower socioeconomic statuses, people with other disabilities, and people who live in rural areas3.

According to our interview with Jerry Chiarelli from the Carroll Center for the Blind, white canes are the primary assistive device used by visually impaired people. Additionally, the American Academy of Ophthalmology reports that there is a lack of current and reliable statistics on cane usage among visually impaired people[[4]](#footnote-3). The Perkins School for the Blind estimates that only 2% to 8% of all visually impaired people use a white cane[[5]](#footnote-4). These remaining people rely on their existing vision, assistance from sighted people, or guide dogs5.

## Customer Pains

Regardless of the user’s skill level, the white cane cannot detect obstacles above waist height. This presents safety issues and navigation limitations for the users. If an object were suspended in midair, with no structural support below waist level, a visually impaired person risks collision because they would be unable to detect it with the white cane. Therefore, it is recommended that users wear protective eyewear; however, users can still collide with low hanging obstacles.

Portability for the white cane is also an issue. Some canes, such those made of fiber-glass are not portable because they do not collapse or downsize for more convenient carrying. Other canes also come with drawbacks despite potability. These canes may use elastic, aluminum or graphite to allow folding into smaller sections. However, these materials, especially the elastic, can snap under prolonged stress, rendering the cane unusable due to lack of sturdiness. Canes that telescope into smaller sizes can collapse while in use for this reason. Also, these canes are not very durable, as graphite canes are prone to cracking and can inflict splinters on the user.

The white cane’s sensory tip present uses with other challenges. Currently, there are several designs in the current market. Although thinner designs tend to be lighter and more sensitive to terrain, they can still get stuck in cracks. On the other hand, thicker designs, despite increased durability, are heavier and offer weaker sensory feedback.

In addition, white canes need to be replaced if they are outgrown, so children with visual impairment need to replace their canes more often than adults. The white cane is replaced when the cane no longer reaches the user’s underarm as the cane is standing straight up.

## Customer Gains

The LaserCane is an advancement of the white cane. Below is a chart that highlights many ways that LaserCane directly relieves the pains of the white cane customers. Additional, it highlights some additional benefits for users of using LaserCane.

| **Customer Pains** | **LaserCane's solution** | **Additional Customer Gains** |
| --- | --- | --- |
| White canes have a high learning curve. | LaserCane, which uses the constant contact technique, is offered to current white cane users. Therefore, it has a low learning curve. | LaserCane is very high-tech. It incorporates LIDAR and ultrasonic sensor technology and is compatible |
| White are neither portable or durable, so it can present user with many safety risks and limitations. | LaserCane eliminates all of the problems associated with the lower half of the white cane's design by replacing it with LIDAR technology and only leaving the handle. | Increased independence and mobility |
| White canes only detect ground level obstacles. Therefore, they have to wear protective eyewear. | LaserCanes can detect both low-hanging and ground-level obstacles. | Users are able to pay for LaserCane by breaking payments into monthly installments |
| The white cane was invented in the 20th century. To many users, the design needs to be improved. | LaserCane has a new, innovative, and creative design and is technologically advanced. | Offered in many different colors to give users a variety of options to choose from |
| Users have to spend a lot of money on replacement canes. | LaserCanes requires only a one time purchase because it adjusts to users of all heights. | LaserCane offers customers with outstanding support, so any problems that they have can be resolved promptly and personally. |

# Hypotheses

In the table below we describe some of our key hypotheses and how we validated them using our various MVPs (described in MVP section). Additional hypotheses and details in Appendix.

| **Hypothesis** | **MVP/Research** | **Validated** |
| --- | --- | --- |
| People think our design is creative and innovative | We interviewed 20 people who participated in the concierge MVP and asked them what they thought about the design. 20/20 people thought that the design was innovative and creative. The only suggestions was for a strap to be added to the design to prevent users from misplacing their LaserCane. | Yes |
| Current white cane users are dissatisfied with current white cane products | From the interview with Jerry Chiarelli, he shared several limitations of white canes and issue with its design that prevent the user from having a pleasant experience | Yes |
| Some people do not use white canes due to stigma | Stigma is mainly an issue for the younger clients. They tend not to like white canes because of the aesthetics of the design. | Yes |
| Making the cane less visible could eliminate some stigma | In the interview with Jerry Chiarelli, we learned that the stigma mainly involves with the design of the cane, not its visibility. | No |
| The white cane is useful because it acts as a signifier of visual impairment. | During the interview with Jerry Chiarelli, he shared that it is necessary for the cane to be visible, so onlookers will be notified of visual impairment. | Yes |
| White canes are inconvenient to carry because the users only have 1 free hand. | Jerry Chiarelli said that this was more of a circumstantial issue. | No |
| When an individual begins to experience visual impairment affects how they will adjust to using a cane. | Jerry Chiarelli stated that typically younger children are able to adapt faster to using the white cane while the elder usually take longer to learn how to use the white cane. | Yes |
| Vibration is a more useful signifier than sound. | The anonymous student shared that he had a SmartCane, but he prefers to use the white cane because he experiences many technical issues. He is not able to hear the tones that indicate obstacles. | Yes |
| It is possible for the LaserCane to detect obstacles using a sensor | Confirmed by Charlie Squires, a roboticist. | Yes |
| It is possible for the LaserCane to detect obstacles above waist-level | Confirmed by Charlie Squires, a roboticist | Yes |
| There are other mobility aids for blind people, but they are not as widespread as the white cane | Confirmed by Jerry Chiarelli, who said that many other assistive devices are intended to supplement the white cane. | Yes |
| The aesthetic of the design will not be very important to our customers because they will not be able to see it very well | Refuted by Jerry Chiarelli, who indicated that some younger cane users are very self conscious about the cane’s design and appearance. | No |
| Since people can outgrow canes, they need to buy different sizes and adjusting to the new size is annoying | Confirmed by Jerry Chiarelli. | Yes |

# MVPs

We present a table summary of the MVPs conducted during the course of the term project, including those before and after our pivots. These include product prototypes, product testing, interviews, site visits, and virtual interviews.

| MVP | MVP Type | Brief Description |
| --- | --- | --- |
| **Jerry Chiarelli** | **Interview** | **Interview with Store Operations Coordinator at the Carroll Center for the Blind concerning the use, limitations, and design of white canes** |
| **Anonymous Carroll Student** | **Interview** | **Interview with a Low Vision student at the Carroll Center for the Blind concerning previous experience using a competitor smart cane** |
| **Charlie Squires** | **Interview** | **Communication with an engineer and roboticist on the feasibility of our laser design and other hardware components for the LaserCane** |
| **3D Printed Model** | **Prototype** | **3D printed model of the LaserCane constructed with help from the MakerLab at Brandeis University** |
| **Vibration/Obstacle Test** | **Concierge** | **Concierge MVP involving a simulated scenario testing user reaction times in an obstacle course** |
| **Landing Page** | **Digital** | **Landing page tests for user/web metrics** |
| **Prototype Usability Test** | **Prototype** | **Concierge MVP concerning our 3D printed prototype on user experience whilst handling the model** |
| **Michael Li** | **Interview** | **Interview with a President of a Manufacturing companies concerning the shipping and distribution of specialty products** |
| **Kenneth Lin** | **Interview** | **Interview with an SDE II at Amazon FBA concerning the use of FBA versus MFN for shipping and distribution** |

## MVPs In-Depth (More in Appendix)

Interview with Jerry Chiarelli

We interviewed Jerry Chiarelli, store operations coordinator at the Carroll Center for the Blind. He was very knowledgeable about the use, limitations, and design of white cane. We hypothesized that there is a stigma that comes along with using a white cane. This hypothesis was proven slightly true because the stigma exists in small children because they do not like the color of canes. Also, we learned there has to be a visual aspect to the cane because the onlooker needs to know that the cane user is blind. We hypothesized that having to use one hand to operate the white makes it difficult to use. However, this was disproven because this more of a situational issue. We hypothesized that the time in which an individual starts experiencing blindness does have an impact on how quickly they adapt to using the white cane. This was proven true because younger cane users adapt to the cane easier. This also implies that younger people are more likely to use our product. We hypothesized that the white cane is 100% safe for users. However, this is not true because white canes sometimes cause splintering or explode completely (due to the loose elastic that holds the cane together.). We hypothesized that there were features cane users wanted that the white cane lacked. He verified this hypothesis by mentioning that some people put LED strips on their canes so sighted people could see them in the dark. There are many types of cane tips, so we hypothesized that each type had tradeoffs. He confirmed this. Thinner tips are more sensitive, fragile, and prone to getting stuck in cracks on the ground. Thicker tips are less sensitive, but less fragile and not as prone to getting stuck in cracks on the ground. Not many alternatives for mobility aids, white cane is the first go-to. When there are other assistive devices, they usually supplement the white cane instead of replacing it.

Interview with Carroll Center student

We interviewed a Carroll Center student who had experience using a SmartCane. We hypothesized that individuals would prefer to use a SmartCane over using a white cane. However, this was disproven because the student said that he did not like to use his SmartCane since it had a lot of technical difficulties. For example, he could not hear the sound that indicates obstacles. This also reflects that tech support and accessible help lines could be beneficial.

Communication with Charlie Squires

We contacted Charlie Squires, an engineer and roboticist, for the feasibility of our SmartCane design. We could use a laser beam and sensors to detect obstacles. This was partially disproved because lasers are used to detect distance. However, we could rotate the laser to detect obstacles on a plane. We hypothesized that it would be possible to use the cane to detect obstacles above waist-level. He confirmed that it was feasible. We hypothesized that BlueTooth integration was feasible. He confirmed this. We suggested that cane users might find value in a button that would contact emergency services, but he disagreed. We later disproved the hypothesis by confirming that virtual assistants could contact emergency services by voice command.

3D Print Prototype & Usability Test

We 3D printed a model to show people our design. We asked people if our design was aesthetically pleasing. People responded that they thought our design looked cool, but they wished it included a strap that would prevent them from accidentally dropping it.We also surveyed people with different hand sizes to ask them if they could comfortably hold our cane. No one indicated discomfort, so we believe our design is within acceptable parameters. We hypothesized that people would like our design and they would think it is simple to use. We hypothesized that people would personally like that the trigger is on the top so that they do not accidentally hit it. This was proven true because these people thought they would accidently turn the laser off/on if the trigger was placed in another location on the handle.

Vibration/Obstacle Concierge MVP

Concierge MVP- We simulated the use of our SmartCane by having people go through an obstacle course; we texted them when they approached an obstacle. When they felt a vibration, they would stop until told to continue. (Test 1: Individual does the course without their glasses (simulate having low vision) Test 2: An individual does the obstacle course blindfolded (simulated being blind). We hypothesized that delaying the vibrations would impact the user’s reaction time. This was proven true because the test subjects needed to be warned ahead of time of the obstacles in front of them. If they were warned too late, they ran straight into the obstacles. We hypothesized that the pace in which an individual walks affected their ability to use our cane. This was proven true because the individuals needed time to react to the vibration. When they went too fast, they were more likely to run into obstacles.

Landing Page Tests

Hypothesis: if we offered a 30 day trial of our LaserCane, individuals would be more likely to take the survey and subscribe for future information about our SmartCane. This was proven true.

Interview with Michael Li

We interviewed Michael Li, Founder of Tyflong International Inc. a chemical manufacturing company on shipping & logistics. Due to our low volume (20 packages a day according to our projected distribution numbers), Michael recommended we either hande our own packaging/shipping or we contract our distribution to a third party. He discussed several options between FedEx, UPS Ground, DHL, and Amazon, and recommended we look into Amazon Fulfillment. From our interview, we found out that the gross margin we had given him was unusually low for a specialty hardware/electronics company, which highlighted some our financial concerns. In terms of pricing, Michael stated that we are unlikely to get significant discounts on distribution costs due to two reasons. Domestically, the state of distribution is that UPS and FedEx have a duopoly and are not likely to budge on their quotas past 10 or 20%. In addition, any decrease is due to economies of scale and volume and thus it is unlikely with our small volume to get a significant decrease.

Interview with Kenneth Lin

We interviewed Kenneth Lin, an SDE II at Amazon FBA (partial conversation and LinkedIn link provided in Appendix). Per our conversation with Michael Li, we decided to interview someone familiar with the Amazon Fulfillment process to give us some insight on distribution for a small electronics startup. Kenneth talked about the choices between MFN and FBA, where under MFN or Merchant Fulfillment Network the company retains the responsibility of storage and packaging with shipping being outsourced. Whilst under FBA, although Amazon takes a small cut of the margins (less than 10%), Amazon will do the distribution, storage, packaging, customer support, and order tracking. Kenneth was also able to direct us to the specific rates for the distribution as well as give some recommendations on whether or not FBA might be appropriate (if we have a fast moving product etc).

# Business Model

**Costs:**

Below is a partial from our financial analysis workbook. In this section we describe the annual wage expense concerning the startup as well as a description of the unit costs. We also include some revenue projections given some of the units sold annually. We derive our unit costs given components necessary for an individual LaserCane. These components include grip, vibration, ultrasonic components as well as distribution costs (analyzed below in the table Amazon Fulfillment).

From our discussions and research into wage expense, we decided upon hiring an embedded software engineer, two hardware technicians, and either a single part-time customer support agent (or outsourcing customer support to working hours 52 work weeks a year through a call center in India).

|  | **Type** |  |  | **Amount** |  |  | **Annual Cost** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Wage Expense | Embedded Software Engineers |  |  | 1 |  |  | $176,524 |
| Wage Expense | Hardware Technician |  |  | 2 |  |  | 86600 |
| Wage Expense | IT/Customer Support |  |  | 1 |  |  | 24960 |
| Self Salary | CEO/CTO/COO |  |  | 3 |  |  | 135000 |
| **Total wage expenses** |  |  |  |  |  |  | $423,084 |
|  |  |  |  |  |  |  |  |
| **Component** | **Component Type** |  |  | **Unit Cost** | **Units Sold** | | |
|  |  |  |  |  | 350 | 450 | 550 |
| LIDAR Device | [Benewake Tfmini Micro Lidar](https://www.robotshop.com/en/benewake-tfmini-micro-lidar-module-12-m.html) |  |  | $39 | $13,650.00 | $17,550.00 | $21,450.00 |
| Cane Handle | [Black Gel Handle Grip](https://www.grainger.com/product/24JN14?gclid=CjwKCAiAlajvBRB_EiwA4vAqiJ8CwNC6NDtdXeKokhKt7skBfZ2lj55Oe4_b16QkcIaqlAk9g5FuuxoC77MQAvD_BwE&cm_mmc=PPC:+Google+PLA&ef_id=CjwKCAiAlajvBRB_EiwA4vAqiJ8CwNC6NDtdXeKokhKt7skBfZ2lj55Oe4_b16QkcIaqlAk9g5FuuxoC77MQAvD_BwE:G:s&s_kwcid=AL!2966!3!50916704997!!!g!71842759159!) |  |  | 9.73 | $3,405.50 | $4,378.50 | $5,351.50 |
| Vibration Devices | [Mini Bluetooth Vibration Device](https://www.amazon.com/DZS-Elec-Button-type-Electronics-Appliances/dp/B07PHPK6SC/ref=asc_df_B07PHPK6SC/?tag=hyprod-20&linkCode=df0&hvadid=309803885710&hvpos=1o1&hvnetw=g&hvrand=16627809869631616738&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9002071&hvtargid=pla-675863995091&psc=1) |  |  | 8.99 | $3,146.50 | $4,045.50 | $4,944.50 |
| Ultrasonic Module | [Ultrasonic distance sensor module](https://americas.rsdelivers.com/product/parallax-inc/28015/parallax-inc-28015-ping-ultrasonic-distance/7813020?cm_mmc=US-PLA-DS3A-_-google-_-PLA_US_EN_CatchAll_New-_-Catch+All-_-PRODUCT_GROUP&matchtype=&pla-827276542976&gclid=CjwKCAiAob3vBRAUEiwAIbs5TgL1mimSTmfuF4a2QwtM1_w6WmMpYsTR830XFYR0h6MGC_8sj2Y29BoCo2UQAvD_BwE&gclsrc=aw.ds) |  |  | 30.63 | $10,720.50 | $13,783.50 | $16,846.50 |
| Distribution Costs | Amazon Fulfillment |  |  | 18.67 | $6,534.50 | $8,401.50 | $10,268.50 |
| **Total** |  |  |  | **$107** | **$460,541.00** | **$471,243.00** | **$481,945.00** |

Below is the Monthly, Annual, and Per Unit distribution costs via Fulfillment by Amazon. As directed by our interview with Amazon employee in FBA, we referred to Amazon’s quotes and rates to determine our distribution costs given our projected quantity sold per year and per month. We decided on Fulfillment by Amazon, as it allows us to outsource the shipping, order tracking, customer service, and storage of our product before we get them to the customers.

| [**Fulfillment by Amazon**](https://services.amazon.com/fulfillment-by-amazon/pricing.html) | | | | |
| --- | --- | --- | --- | --- |
| **Cost Type** | **Distribution Prices** | **Costs by Quantity** | **Quantity Sold** | |
| Unit Distribution (2-3lbs) | 5.26 | 2498 | **Year** | 5700 |
| Jan-Sept Storage | 6.21 | 2949 | **Month** | 475 |
| Oct-Dec Storage | 7.2 | 3420 |  |  |
|  | **Monthly** | 8868 |  |  |
|  | **Annually** | 106419 |  |  |
|  | **Per Unit** | 18.67 |  |  |

**Pricing:**

Since health and access to adequate healthcare is a causal factor of vision impairment, vision impairment tends to affect people of lower socioeconomic statuses. We decided on an installment pricing plan to alleviate the burden of a substantial payment of $450 lump sum.

| **Pricing** | **Annual Interest Rate** | **Interest Amt** | | **Monthly Installment Periods** | |
| --- | --- | --- | --- | --- | --- |
|  |  | **Annual** | **Monthly** | **12-month** | **6-month** |
| $450 | 3.75% | $17 | $1 | $39 | $76 |

In addition, below is a partial table from our analysis on the potential revenue scheme given our research into possible annual quantities sold of our LaserCanes. These numbers (such as COGS and other expenses) are derived from other sections of our financial analysis workbook.

| **Price** | **450** |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
| **Quantity** | **Cost of Goods** | **Other Expenses** | **Total Expenses** | **Revenue** | **Profit** | **Profit Margin** |
| 5700 | $610,014.00 | $423,084 | $1,033,098.00 | $2,565,000.00 | $1,531,902.00 | 0.5972327485 |
| 2850 | $305,007.00 | 669644 | $974,651.00 | $1,282,500.00 | $307,849.00 | 0.2400382066 |
| 1425 | $152,503.50 | 558084 | $710,587.50 | $641,250.00 | -$69,337.50 | -0.108128655 |
| 712.5 | $76,251.75 | $423,084 | $499,335.75 | $320,625.00 | -$178,710.75 | -0.5573824561 |

**Engine of Growth:**

The growth of our company, LaserCane, depends heavily upon the viral engine of growth, in particular word of mouth. One of our main objectives is to retain customers by providing them with outstanding service. We will also partner with centers such as the Carroll Center for the Blind, Therefore, our team goes above and beyond to solve all our customer’s problems promptly and personally. We employ embedded Software Engineers and IT Service Technicians who provide round-the-clock support to users of our LaserCane. If there is an issue with a user’s LaserCane, we will fix the repair the cane free of charge, so our users do not have to constantly repurchase our LaserCane.

In addition, our LaserCane is unlike any other assistive cane on the market. Since our canes have a numerous number of features that improve the quality of life of the visually impaired (see customer gains), our SmartCane will appeal to many people. We are confident that our quality product combined with our stellar service will ensure that our consumers have the best experience possible. This is important to us because we want our customers to want to encourage their friends and family members to purchase our LaserCane as well. For this reason, we give our customers many opportunities to recommend others to our services. Consequently, our customers are encouraged to engage the forum on our landing page to share their experiences with other cane users. Additionally, these customers have the option of submitting feedback to us via email and completing an online survey. We want our customers to give their honest feedback on our services to serve as a testimonial of our outstanding customer service and be the basis for the company’s future improvements. Also, prior to purchasing the SmartCane, customers are able to recommend five other people for a 30% off coupon code for our product.

We also intend to grow through our partnerships with different hospitals and schools/center for the blind. Since they have access to our market, they could direct their customers to us. This is essential to our growth because their customers become our customers, and they will share their satisfaction with other potential customers. As a consequence, our business will continue to grow larger.

**Competitors**

Below is a table comparing key features of LaserCane and our competitors, Ultracane, WeWalk, Sunu Band, and the standard White Cane. Price is an important factor because health problems associated with lower socioeconomic status can cause vision loss, indicating that vision impairment disproportionately affects people with less disposable income. Resize capability ensures that the cane user does not need to adjust to a new cane when they outgrow their old one. Above the waist detection is a safety issue. Detection range is more complicated, because the cane will provide too much information if the range is too large and too little information if it is too small. This is why we believe a range that closely matches the white cane is easier to adjust to. Ease of use, durability, and battery life are all important factors, as the user relies on this device on a regular basis.

| **Features** | **LaserCane** | **Ultracane** | **WeWalk** | **Sunu Band** | **White Cane** |
| --- | --- | --- | --- | --- | --- |
| **Price** | **450 USD** | **850 USD** | **500 USD** | **470 USD** | **~30 USD** |
| **Resize Capability** | **Y** | **N** | **N** | **N** | **N** |
| **Above Waist Detection** | **Y** | **N** | **N** | **Y** | **N** |
| **Range Detection** | **1.5 m** | **2 m** | **1 m** | **5.5 m** | **1.2 m** |
| **Easy to Use** | **Y** | **Y** | **N** | **N** | **N** |
| **Durable** | **Y** | **Y** | **N** | **N** | **N** |
| **Battery Life** | **12 Hrs** | **N/A** | **5 Hrs** | **24 Hrs** | **N/A** |

# Conclusions

Using the lean startup process, we were able to pivot several times until we decided definitively on the details of our product. Through the testing of our multiple MVPs, we were able to validate our each of our leap of faith hypotheses and choose the best features for our LaserCane. We also consulted experts in white canes, embedded software engineers, schools for the blind, and centers for the blind to get knowledge on the feasibility of our white cane.

When we started this project, none of us were knowledgeable about visual impairment, white canes, or hardware. This meant that the project required a lot of research into visual impairment and white canes before we could proceed. Even with our background knowledge, we needed to pivot several times. We initially believed that many visually impaired people used white canes, but found that this was not the case. We hypothesized that this was because they felt concerned about stigma, and we believed we could alleviate this stigma and increase cane use by making a less visible cane. However, once we found out that the white cane acts as an important signifier of blindness, we pivoted away from making less visible canes. Since many of the white cane’s shortcomings were related to the part of the cane below the handle, we believed we could eliminate some of these problems by replacing everything below the handle. After verifying that this was possible, we researched specific hardware.

Now, we are confident that our product is of value to our demographic. We are ready to begin testing out our engine of growth and measuring its performance in yielding consumers to our company. We understand that our progress may be slow initially, but it will gradually increase over time as our reputation increases. Although this business is profitable, our team is pleased that we are able to make a difference in the world by satisfying all of our customer’s needs.

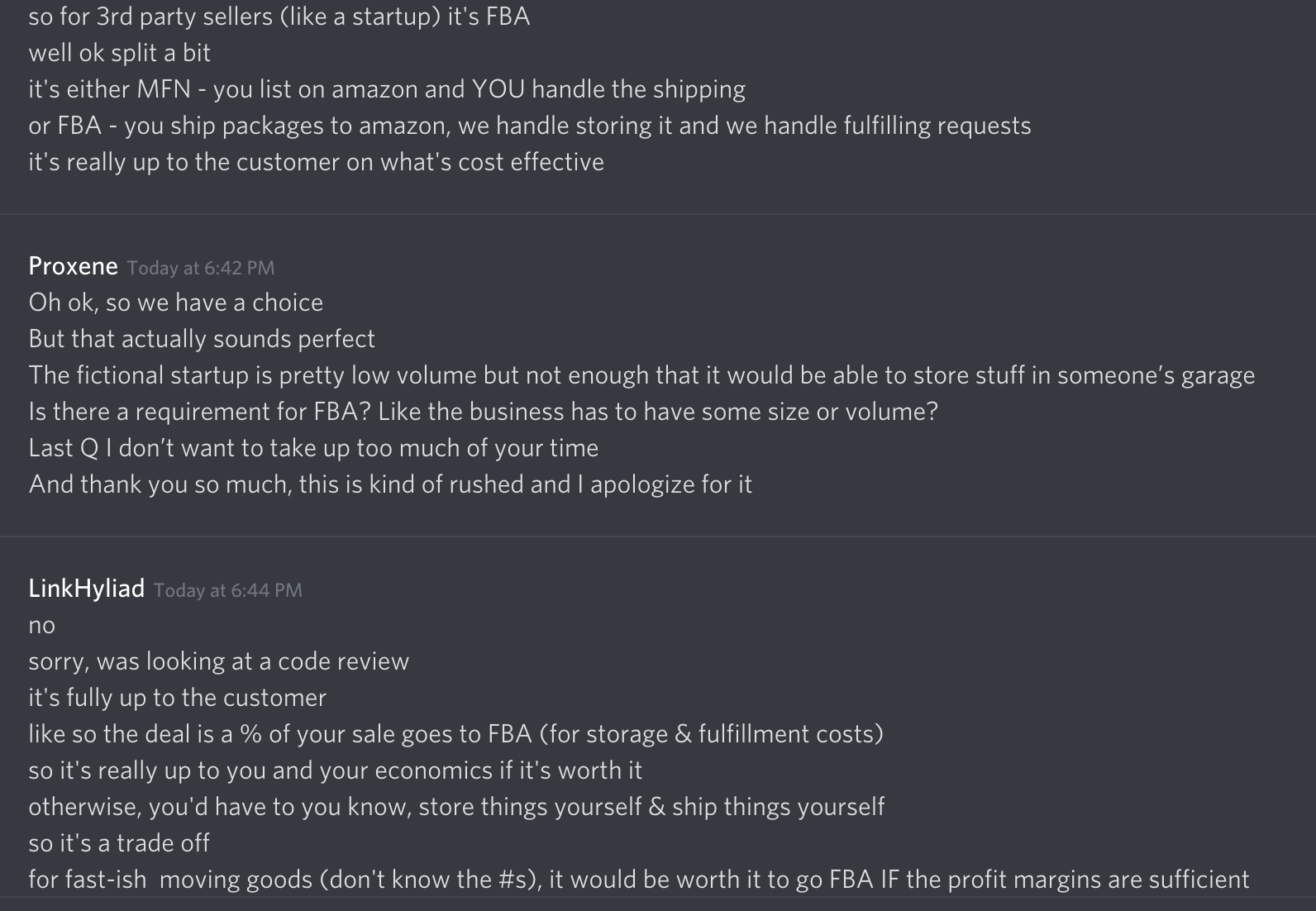
# Appendix

## Background on Cane Techniques

Using a cane technique, called constant contact, a cane user touches the ground with a cane’s tip and uses “sweeping motion”. When the cane touches the ground, it provides haptic feedback by jolting and audio feedback by creating a rhythmic ticking noise. If the cane’s tip drops suddenly, the user knows that a change in elevation has occurred. If the rhythm of the bumping changes, this signals a change in terrain surface type. The cane’s tip and body, the fiberglass or aluminum “stick” part below the handle, can also detect obstacles by touching them.

## MVP Extras

Screenshots of Interview with Kenneth Lin, SDE II at Amazon FBA ([Linkedin](https://www.linkedin.com/in/kenneth-lin-3b548872)):



## MVP Extras (Untested MVPs)

We intended to interview Ed Christopher, an Orientation and Mobility instructor at the Carroll Center for the Blind. Even though we emailed him in early November, and sent follow up emails throughout the month, he never responded.

* 1. We wanted to test his openness to the idea of adopting a LaserCane. Did he have objections to the concept of a smart cane? Did he have any experiences with them in the past? Would he be open to testing a free LaserCane in his classes?
  2. We wanted to ask him for insights into his students’ willingness to adopt a smart cane. Would openness differ between adolescent and elderly users? Have any students tried using a smart cane in the past?
  3. We based our design on the traditional white cane. How would people need to adjust from using a traditional white cane to using our cane? Would these changes completely deter them from trying our cane?

In November, we contacted an embedded software engineer with specific questions about the feasibility of our design, but he did not respond.

* 1. Specifically, we wanted to know his opinions on which sensors would best fit the needs of our product.

Talk to parents of visually impaired children to see how much money they spent on replacement canes.

* 1. We hypothesize that parents have to spend a lot of money on canes for the children because they are constantly outgrowing their whites canes.
  2. We hypothesized that there we other unique challenges faced by adolescent cane users.

We contacted Brandeis Accessibility for a meeting, but they denied our request. They also would not ask visually impaired students to speak with us.

**Concierge MVP Results**

Blind Individuals(blindfolded)

|  | Trial One | Trial Two | Trial Three | Average reaction Time |
| --- | --- | --- | --- | --- |
| 1 | Reaction time: 2.18 seconds distance: 6ft | Reaction time: 2.14 seconds distance: 4ft | Reaction time: 1.03 distance:3ft | Reaction time: 1.78 seconds |
| 2 | Reaction time: 1.10 seconds distance: 6ft | Reaction time: 2.33 distance:6.5ft | Reaction time: 1.22 distance:4ft | Reaction time: 1.55 seconds |
| 3 | Reaction time: 1.06 seconds distance: 6.5 ft | Reaction time: 1.02 seconds distance: 6.5 ft | Reaction time: 1.19 seconds distance: 6.5 ft | Reaction time: 1. 09 seconds |
| 4 | Reaction time: 1.63 seconds distance: 6 ft | Reaction time: 1.08 seconds distance: 4 ft | Reaction time: 2.18 seconds distance: 3ft | Reaction time: 1. 63 seconds |
| 5 | Reaction time: 1.47 seconds distance:3ft | Reaction time: 1.32 seconds distance: 4ft | Reaction time: 1.21 seconds distance: 4ft | Reaction time: 1.33 seconds |
| 6 | Reaction time: 1.62 seconds distance: 6 ft | Reaction time: 1.22 seconds distance: 6ft | Reaction time: 1.02 seconds distance: 3.5 ft | Reaction time: 1.29 seconds |
| 7 | Reaction time: 1 second distance: 3ft | Reaction time: 1.73 seconds distance: 4ft | Reaction time: 1.33 seconds distance: 9ft | Reaction time: 1.35 seconds |
| 8 | Reaction time: distance: | Reaction time: distance: | Reaction time: distance: | Reaction time: 1.78 seconds |
| 9 | Reaction time: 1.78 seconds distance: 3ft | Reaction time: 2.18 seconds distance: 3ft | Reaction time: 2.83 seconds distance:3ft | Reaction time: 2.26 seconds |
| 10 | Reaction time:1.67 seconds distance: 3.5ft | Reaction time: 1.39 seconds distance: 6ft | Reaction time: 2.38 seconds distance: 4ft | Reaction time: 1.81 seconds |

Low Vision Individuals (No glasses)

|  | Trial One | Trial Two | Trial Three | Average reaction Time |
| --- | --- | --- | --- | --- |
| 1 | Reaction time: 1.33 seconds distance: 4ft | Reaction time: 1.23 seconds distance: 4ft | Reaction time: 1.36 distance:4ft | Reaction time: 1.30 seconds |
| 2 | Reaction time: 1.30 seconds distance: 6ft | Reaction time: 1.56 seconds distance:6.ft | Reaction time: 2.13 seconds distance:6ft | Reaction time: 1.83 seconds |
| 3 | Reaction time: 1.71 seconds distance: 3.5 ft | Reaction time: 1.62 seconds distance: 3.5 ft | Reaction time: 1.12 seconds distance: 3 ft | Reaction time: 1. 48 seconds |
| 4 | Reaction time: 1.35 seconds distance: 3 ft | Reaction time: 1.58 seconds distance: 3 ft | Reaction time: 1.83 seconds distance: 3.5ft | Reaction time: 1. 59 seconds |
| 5 | Reaction time: 1.40 seconds distance:3ft | Reaction time: 2.35 seconds distance: 3.5ft | Reaction time: 2.08 seconds distance: 4.5ft | Reaction time: 1.94 seconds |
| 6 | Reaction time: 2.23 seconds distance: 3 ft | Reaction time: 2.46 seconds distance: 6ft | Reaction time: 2.51 seconds distance: 3.5 ft | Reaction time: 2.4 seconds |
| 7 | Reaction time: 2.21 seconds distance: 3ft | Reaction time: 1.80 seconds distance: 3ft | Reaction time: 1.85 seconds distance: 3ft | Reaction time: 1.95 seconds |
| 8 | Reaction time: 1.92 seconds distance:3ft | Reaction time: 2.13 seconds distance:3.5ft | Reaction time: distance: | Reaction time: 2.07 seconds |
| 9 | Reaction time: 1.76 seconds distance: 3ft | Reaction time: 1.72 seconds distance: 3ft | Reaction time: 2.20 seconds distance:3.5ft | Reaction time: 1.89 seconds |
| 10 | Reaction time:1.59 seconds distance: 3ft | Reaction time: 1.52 seconds distance: 3.5ft | Reaction time: 1.77 seconds distance: 4ft | Reaction time: 1.63 seconds |

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4. Vasconcelos, Galton, and Luciene Fernandes. “Low Vision: Orientation and Mobility.” American Academy of Ophthalmology, 2016, <https://www.aao.org/disease-review/low-vision-orientation-mobility>. [↑](#footnote-ref-3)
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