Stimmy Socks

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Executive Summary

Professional athletes often have access to incredible health resources. These resources are necessary as athletes push their bodies through strenuous regiments that are foreign to the average person. Unlike typical professional athletes, student athletes face additional pressure as they are expected to learn as a typical student despite their extraordinary circumstances. This causes them to miss out on key therapeutic treatments that allow for a healthy recovery. In many cases, student athletes are forced to make a decision between class and recovery.

The team aims to improve the recovery process by making pain relief more accessible. Stimmy Socks are a product designed to give relief to individuals experiencing foot pain in an easy and affordable way. This product was developed by considering the story of a single individual; David (Appendix B). David is a quarterback on the University of Maryland football team who consistently has pain in both his shoulder and feet. When interviewed, David described how he was unable to find time within his busy schedule to receive therapy for his pain. The Stimmy Socks were not just developed to solve a problem of pain relief itself, rather, they were created to aid in time management. Meeting David's needs meant developing a product that would not interfere with his current lifestyle and routine. The Stimmy Socks are designed to fit within David’s busy schedule, during settings in which conventional pain relief methods are not an option.

Treatments such as Tylenol or Ibuprofen that are commonly used to relieve body pain will typically carry side effects, are wasteful, and are only usable at specific times. Due to this, the team opted to use TENS therapy, a method of pain relief that is reusable and noninvasive. Many TENS therapy units exist on the market today, however, Stimmy Socks are the only solution that is specifically designed to take into consideration the user’s busy lifestyle. This method allows for a reusable and user focused structure that ensures a seamless introduction into one's daily life.

The Stimmy Socks team will initially operate by selling directly to student athletes. Focusing on this market allows the product to gain traction among an audience that has a high need for easy foot pain remedies. This market is also far more accessible to the team which is currently based at the University of Maryland. After reaching into this market, the team aims to move towards bringing the product to a broad audience. Ideally, Stimmy Socks will improve the life of student athletes and ultimately any individuals that experience consistent foot pain.

Introduction to Problem/Opportunity

Team Revenge is a Dish QUEST Served Cold (RIDQSC) interviewed a handful of possible clients. A student-athlete–more specifically a Division 1 Football Quarterback– expressed his concern about having no time to recover from his workouts. Student-athletes must balance their intense workout and training regimen with their coursework. With buildings being so spread out on campus and their schedules being overbooked, student-athletes are not allotted the proper time to recover. A lack of recovery can lead to an increased risk of injury, and for athletes at the very beginning of their careers, this can hinder their chances of going professional [Fetters, 2022].

Considering these circumstances, a handful of possible solutions were brainstormed to account for the lost time that the client deals with. There was no one specific solution that could be considered at the time, since there wasn't a specific type of recovery that was needed the most. That is when the same client was interviewed for a second time and got more insight as to what kind of recovery methods he wished were portable. If the team was to develop a product specifically for student-athletes, their recovery issues had to be understood better through additional interviews. The team then interviewed a Division 1 track star, who expressed her concern regarding foot strains she suffers from. Because most sports have to do with some sort of footwork activity, the primary focus for the product solution became foot recovery.

Foot pain affects many demographics outside of student-athletes. Those who use walking as their primary form of transportation, those who are required to be on their feet for work, and many others experience prolonged foot strain. While the original problem is centered around student-athletes and the problems regarding their specialized schedules, it is applicable to many more beyond this market.

Detailed Description of Solution

To tackle the problem of foot pain that was identified by the interviewed student athletes, the team aimed to create a solution that can also account for the limitations to existing solutions identified by the interviewed football quarterback, which include a lack of time to recover and the status of being a student with limited financial resources. It was determined that the solution would have to be portable to allow for recovery in different locations and contexts while being cheap enough to be accessible for a college student. The team's final solution, the Stimmy Sock, was designed to have these qualities while being an effective form of recovery.

The Stimmy Sock uses transcutaneous electrical nerve stimulation (TENS) therapy in order to provide a noninvasive way for athletes and individuals to reduce pain [Cleveland Clinic, n.d.]. TENS therapy involves sending small electrical pulses through the skin via electrodes - electrically conducting adhesive pads - to reduce the intensity of pain signals sent by nerves to the central nervous system [Enriched Health Care, 2020].

Stimmy Socks integrate these electrodes into the inside of a sock, forming a wearable tech combination designed to alleviate foot pain experienced by its users. Wearable tech allows for convenient access to TENS therapy that can be used on the go. The initial concept of the solution involved placing electrodes on a removable shoe insert. This idea was introduced to different college students who pointed out that socks would be an insulating layer between the electrodes on the shoe insert and the foot itself, preventing electrostimulation from working.

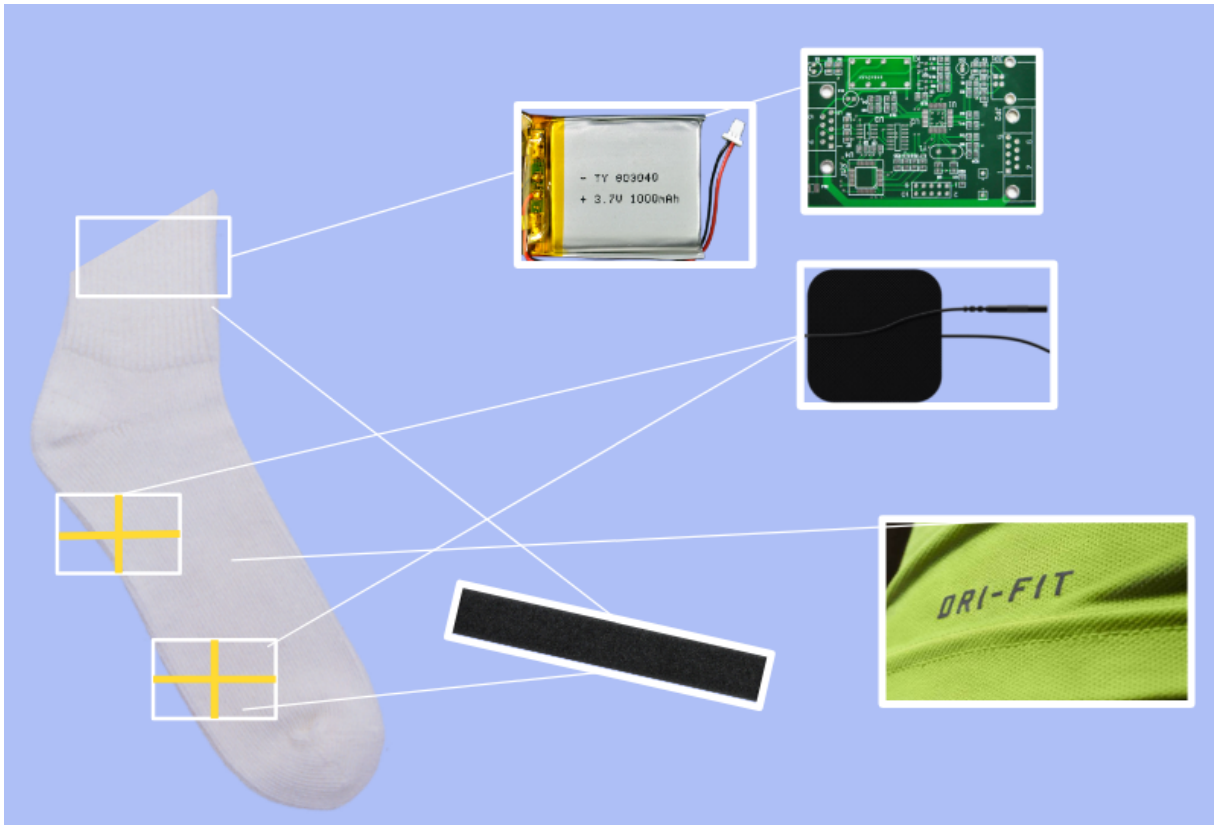


Figure 1. Stimmy Socks Component Diagram

The device comprises three main components: the sock, the control system, and the electrodes. The sock is a portable method for the electrodes to interface with the user's foot, the control system provides and modulates power to the electrodes, while the electrodes interface with the bottom of the user's foot to deliver electrical pulses. The control system will be wired to the electrodes via detachable wires that feed through the interior of the sock.

The sock is made of a high-quality cotton and polyester blend that will wick sweat off of the foot, preventing damage to the electrical components while being comfortable enough to wear throughout the day. This material was chosen to accommodate a college student's schedule in which they may not have a convenient time to change socks during the day, allowing Stimmy Socks to be worn at different locations, while walking, and for long periods of time. The sock is a low-cut sock to minimize the length of the wiring connecting the electrodes to the control system device since the control system is attached to the cuff, or top, of the sock. The control system is placed at the cuff so the Stimmy Sock can be compatible with a variety of shoes; a lower placement for the control system would mean that the device would be obstructed by the collar of shoes such as boots or high-top shoes.

Control System

The control system is responsible for outputting electrical pulses to the electrodes, adjusting the power output according to feedback, and adjusting the power output according to user instructions. The chips that control electrical output are on a printed circuit board (PCB). The battery and PCB of the control system are contained within ABS plastic housing and wired to the electrodes.

The control system of the product is subdivided into the device power supply, the power modulation system, the microcontroller, and the control system housing.

The device's primary power supply is a 3.7V, 1000 mAh lithium ion battery. This type of battery was selected because its low discharge rate and high efficiency means that it can be a long battery-life, long lifetime, rechargeable power supply for the product while also being small and light enough to wear on a sock conveniently [Tennant Blog, n.d.]. The power supply will be wired to a PCB containing the various chips required for the product to function.

Figure 2. Battery [Appendix H]

Figure 3. Atmel ATtiny85Microcontroller [Quasar Electronics]

The power outputted by the battery into the electrode has to be modified to conform to what the user specifies as well as according to feedback from the electrodes in order to maintain a safe power output. Necessary voltage levels for TENS devices are around 100V, while the battery voltage is only 3.7V [Quell Relief, 2020]. A MOSFET will be used to adjust the voltage while capacitors will be used to accumulate the electric charge necessary to reach voltage levels appropriate for TENS treatment.

A microcontroller will take pre-coded instructions to execute the product's core electrical functionality. It will be responsible for communicating with other PCB chips that will measure and determine output needed for individual electrode systems. Due to the space requirements as well as the simple nature of processing needed, we have opted to use an Atmel ATtiny85 microcontroller. This device is one of the cheapest and most lightweight microcontrollers on the market and is commonly used for power regulation systems [Circuit Basics, 2021]. The battery and chip are routed to electrodes to provide power and power modulation respectively.

The Stimmy Sock has three separate intensities that correspond to three different pulse frequencies, each suited for a different level of pain [Enriched Health Care, 2020]. To switch between these intensities, a button placed on the electronics housing can be pressed, increasing the intensity by one increment. When the button is pressed at maximum intensity, the intensity resets to the lowest intensity. The intensity is indicated by white LEDs within the plastic housing - the light closest to the button indicates that the device is turned on, then the other three lights indicate what intensity level the device is at. Holding the button down when the device is off turns it on, and the opposite occurs when the device is already on.

Stimmy Sock Frequencies:	Type of Pain:
2 - 10 Hz	Chronic Pain
35 - 50 Hz	Muscle Stimulation
80 - 120 Hz	Acute Pain

To maintain the appropriate electric current on the skin and to ensure that the current does not reach unsafe levels, the microcontroller uses voltage feedback from sensors within the electrode to modulate the voltage. Voltage values from each of the electrodes is returned to the microcontroller - power is supplied to the electrodes via current source, so the electrical impedance of skin is calculated using Ohm's Law, $V = IR$. When impedance values get higher than 1 MΩ/cm^2, a reasonable upper limit for the electrical impedance of human skin, the microcontroller assumes that the skin-electrode interface is broken and the power is cut off until impedance levels are lowered below that threshold [Webster, 2014]. This is to ensure the user's safety and to conserve battery life.

Electrodes

The figure to the left displays the general positioning of the wires, the battery, and the electrodes within the sock. The electrode units will be attached to the sock via velcro straps to allow for detachment while the battery band will be velcroed to the side of the sock so that the entire TENS unit can be removed for electrode maintenance and sock washing. After the unit is removed, it can still function as a sock with a velcro inline. To affect the different portions of the foot that commonly experience foot pain, one electrode is placed at the intersection of the heel and arch of the foot and at the intersection of the ball and arch of the foot [Laura Inverarity, n.d.].

The design of Stimmy Socks primarily focuses on two dimensions of quality: performance and features. The Stimmy Sock uses a common method of administering TENS therapy and has different settings to accommodate different levels of pain. It also has easy-to-use one button interface and the use of velcro to attach the different electronics to the sock allow for easy maintenance for the different components; electrodes can easily be switched out when they reach the end of their lifetime and the socks can be washed as needed. However, both of those dimensions of quality are not maximized to allow the device to be cheaper and more portable. Compromises include a comparatively lower battery life than other TENS devices due to the smaller, more portable battery, and less settings and modes are available to increase simplicity, ease-of-use, and size since there would be no need for a display screen. Stimmy Socks still provide an effective form of foot pain treatment while addressing the primary objectives of creating a solution that is portable and low-cost.

Market Considerations

Competitor analysis

			Values			
		Portability	Targets a Body Area	Affordability	Ease of Use	User Control
Product	Company					
Bulky machine	**Richmar**	☐	☐	☐	☑	☑
Stim patches	**Auvon**	☑	☐	☑	☑	☑
Foot stim machine	**Osito**	☐	☑	☐	☑	☑
Stimmy socks	**Our product**	☑	☑	☑	☑	☑

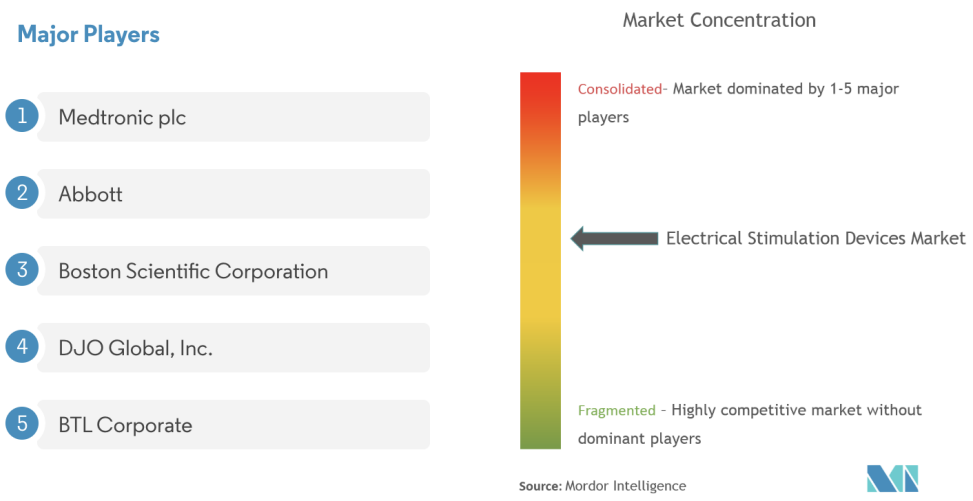
Differentiation

The team's product differentiates from competitors as none of them include every aspect of the customer's needs. Unlike a bulky machine or a foot stim machine, this design allows the individual to recover on demand, wherever and whenever.. The user will not have to worry about setting aside an allotted time to stand still on a machine, tiring themselves out and wasting their time. This product allows one to walk, sit, or even jog while allowing the foot to receive the electronic stimulations from the patches.

Although there are shoes that provide those stimulations, the differentiation occurs because this particular design allows the user's foot to be in constant contact with the patches. A person's foot is constantly moving in a shoe, so the patches also get moved and they aren't able to perform as efficiently. Additionally, if a user wanted to wear sandals instead of a closed toed shoe given by the company, they would not be able to because the patches aren't portable. Because the technology used in this model is integrated with a sock by a velcro, it is easily removable and users are able to wear whatever sorts of shoes they'd like (any that can be worn with a sock).

Market share

Stimmy Socks meet a niche market as they are designed to specifically target foot pain in an effective and portable manner. Despite this, there are a variety of related markets such as the e-stim and muscle stimulator market that focus on a broader application of electrostimulation. Through studying these markets, the team finds that there is a potentially large market for a portable foot based pain solution.



[Mordor Intelligence, 2022]

The graph above displays the concentration of products fitting the general market of electrostimulation. As estimated, the market has a variety of players and is fairly large with it set to reach $6.7 billion by 2026 (Prnewswire, 2021). This combination of competitiveness and market size will allow Stimmy Socks to more easily reach its potential audience given its specialized offerings.

Financial Considerations

<u>Revenue</u>

Our main source of revenue will come from sales. The total addressable market is approximately 8 million users in the US as the NCAA estimates nearly 8 million students in high school athletics in the U.S. and nearly 500,000 NCAA athletes [NCAA, n.d.]. With a big TAM of 8 million, the team is targeting the University of Maryland student athletes. According to College Factual, there are 583 student athletes at UMD [College Factual, 2022]. The team believes they can capture 50% of the segmented market in their first year of operations due to Stimmy Socks addressing a major problem that many student athletes face, hence a strong conviction that they will be able to sell about 291 units in year 1.

To forecast sales, the team forecasted units sold and its unit price. The team believes the units sold will first increase exponentially for the first 2 years since we just started. After 3 years, units sold should increase 100% year over year with an increase of 200bps. Given its unit costs, the team chose a markup of 50% since the average markup is roughly 50% for many industries. This 50% markup allows them to maintain a slim margin on each unit while still allowing the product to remain affordable.

Expenses

Advertising

The team believes advertising costs will increase as they sell more units to be able to capture more market share. As a result, advertising costs are projected by using a percentage of revenue as advertising efforts should have a direct impact on the units sold. According to Spendesk, they recommend startups who are younger than 5 years to spend 12-20% of revenue on marketing [Whatman, n.d.]. The team starts with a $50 marketing expense in year 0 as their startup cost to get the word out about their company. Starting in year 1, advertising costs will be 12% of their respective revenue for the year.

Rent

For office rent, the cheapest office space in DC is $31/sq foot with small office space taking up about 30 sq ft and costing $930/month, therefore $11,160 a year. However, the average cost per storage unit in DC is $190/month [Manwaring, 2022]. With that being said, the team chose storage costs as it is significantly cheaper than office rent which they do not need now since they have not employed outside founding members yet.

Employee Salary

The team will employ 5 initial employees for the first 5 years of inception. These employees include the founding teammates and will each be paid an annual salary of $5,000. The average salary of startup employees is about $50,000 [Founders Network, n.d.]. Because the team does not need to earn a living off of this wage, it is reasonable to give 10% of the average salary to its employees for the first 5 years of inception. Afterwards, the team can plan accordingly to increase the employee's wages periodically.

Miscellaneous

Delivery: In the first year of inception, the team will target UMD student athletes. Since the management team are all UMD students, they can hand deliver the socks without the need for delivery services. In the near future, when the team opens their website to welcome online sales, delivery expenses will still be insignificant because customers will have to pay for the delivery fee through USPS. As a result it will not be counted as revenue. It is not included in the income statement because although they receive the delivery fee from the customers when they order from our website, the team will pay that to USPS immediately, so it is regarded as a pass-through expense. Therefore the team will not include delivery expenses in the income statement.

Impact and Next Steps

In the future, RIDQSC plans on making quality of life improvements to the Stimmy Sock, increasing customization options, and creating a website for easy access to replacement components. Improvements include adding vibration feedback on the electronics housing to indicate a disconnect of the skin-electrode interface, and vibrations to indicate changes in intensity and power status. Customization options include different sock color and sock length options.

After establishing a user base among UMD student athletes, RIDQSC plans on marketing Stimmy Socks to student athletes and physically active students through Maryland high schools and colleges. Expansion will progress to schools along the east coast and eventually to other portions of the United States, starting at universities and colleges and expanding outwards.

Eventually, RIDQSC plans on expanding the target market to lay people and non-professional/non-student athletes by reaching out to athletic product retailers, especially those closely associated with school sports teams. The team believes that there is also a market for the Stimmy Sock among people who experience foot pain in general, especially middle-aged and working adults. For example, up to 25% of people have frequent foot pains by middle-age [Thomas, 2011]. Working adults with busy schedules would also find the Stimmy Sock appealing for similar reasons that student athletes would, those being cheap cost and portability. However, we recognize that the market for the Stimmy Sock in particular would still mostly appeal to athletes in general due to non-athletes having less of a need for immediate recovery options and a lower chance for acute foot pain than athletes that run at high intensity for long periods of time.

The overarching objective is that Stimmy Socks will provide a means of reducing either chronic or acute pain in the feet of its users. By upholding industry standards for TENS devices, the Stimmy Sock can address foot pain effectively. By integrating TENS therapy into wearable technology, the Stimmy Sock can suit the specific need - a convenient and portable solution to foot pain - of student athletes or busy people with foot pain in general.

References

1. *Default manufacturer*. Location. (n.d.). Retrieved March 17, 2022, from https://quasarelectronics.co.uk/Item/microchip-pic-atmel-microcontrollers
2. *Electrical stimulation devices market: 2022 - 27: Industry share, size, growth - mordor intelligence*. Electrical Stimulation Devices Market | 2022 - 27 | Industry Share, Size, Growth - Mordor Intelligence. (n.d.). Retrieved March 17, 2022, from https://www.mordorintelligence.com/industry-reports/electrical-stimulation-devices-market
3. *Estimated probability of competing in college athletics*. NCAA.org. (n.d.). Retrieved March 17, 2022, from https://www.ncaa.org/sports/2015/3/2/estimated-probability-of-competing-in-college-athletics.aspx#:~:text=Nearly%20eight%20million%20students%20currently,the%20professional%20or%20Olympic%20level.
4. Fetters, K. A., Rapaport, L., Jesner, L., Migala, J., Robinson, K., Bedosky, L., & Byrne, C. (n.d.). *Rest and recovery: How to let sore muscles heal*. EverydayHealth.com. Retrieved March 17, 2022, from https://www.everydayhealth.com/fitness/post-workout-muscle-recovery-how-why-let-your-muscles-heal/
5. *A guide to startup salaries & compensation- the founders ...* (n.d.). Retrieved March 17, 2022, from https://foundersnetwork.com/blog/guide-to-startup-salary/
6. *How the current in tens compares to your house current*. TMJ Therapy And Sleep Center of Colorado. (2022, March 11). Retrieved March 17, 2022, from https://www.tmjtherapyandsleepcenter.com/blog/current-tens-compares-house-current/
7. *Introduction to microcontrollers*. Circuit Basics. (2021, December 9). Retrieved March 17, 2022, from https://www.circuitbasics.com/introduction-to-microcontrolleres/
8. Laura Inverarity, D. O. (n.d.). *Why do your feet hurt?* Verywell Health. Retrieved March 17, 2022, from https://www.verywellhealth.com/common-causes-of-foot-pain-2696405
9. Manwaring, K. (2022, March 10). *How much does the average storage unit cost?* Move.org. Retrieved March 17, 2022, from https://www.move.org/storage-units-cost/
10. *Onsemi Products*. MOSFETs. (n.d.). Retrieved March 17, 2022, from https://www.onsemi.com/products/discrete-power-modules/mosfets#products=fjI1MDIzMzd+dmFsdWV+Mn4yMjB+NTAwfjI1MDIzMzl+dmFsdWV+M34xMS41fjEyfjEzfg==
11. *Quell technical specs*. Quell Relief. (2020, July 11). Retrieved March 17, 2022, from https://www.quellrelief.com/the-quell-system/tech-specs/
12. Roland, J. (2019, July 29). *E-stim: What it is, how it works, and why it may help you*. Healthline. Retrieved March 17, 2022, from https://www.healthline.com/health/pain-relief/e-stim#types
13. *Tens under the hood: Maximum voltage - quell blog*. Quell Relief. (2020, August 26). Retrieved March 17, 2022, from https://www.quellrelief.com/blog/tens-under-the-hood-maximum-voltage/#:~:text=Basic%20TENS%20devices%20have%20simple,than%20most%20OTC%20TENS%20devices
14. Teschler, L., says, J. D., D., J., & Teardown: Dr. Pocket TENS therapy pain relief kit | Electrical Engineering News and Products says: (n.d.). *Teardown: Inside the neurometrix quell tens device*. Microcontroller Tips. Retrieved March 17, 2022, from https://www.microcontrollertips.com/teardown-inside-the-neurometrix-quell-tens-device/

15. Thomas, M. J., Roddy, E., Zhang, W., Menz, H. B., Hannan, M. T., & Peat, G. M. (2011). The population prevalence of foot and ankle pain in middle and old age: a systematic review. Pain, 152(12), 2870–2880. https://doi.org/10.1016/j.pain.2011.09.019
16. *Transcutaneous electrical nerve stimulation (TENS)*. Cleveland Clinic. (n.d.). Retrieved March 17, 2022, from https://my.clevelandclinic.org/health/treatments/15840-transcutaneous-electrical-nerve-stimulation-tens
17. *University of Maryland - College Park Athletics Programs*. University of Maryland - College Park Athletics Programs - College Factual. (2022, February 2). Retrieved March 17, 2022, from https://www.collegefactual.com/colleges/university-of-maryland-college-park/student-life/sports/#:~:text=University%20of%20Maryland%20%2D%20College%20Park%20Sports%2DRelated%20Financial%20Aid,male%20and%20268%20are%20female
18. *Use of TENS guidelines*. Enriched Health Care. (2020, April 24). Retrieved March 17, 2022, from https://enrichedhealthcare.com/library/resources/tens/
19. Webster, J. G. (2014). Skin impedance. *Journal of Electrical Bioimpedance*, *5*(1), 1–1. https://doi.org/10.5617/jeb.857
20. *What are the benefits of lithium-ion batteries?* Benefits of Lithium-Ion Batteries | Tennant Blog. (n.d.). Retrieved March 17, 2022, from https://www.tennantco.com/en_ca/blog/2019/11/lithium-ion-battery-benefits.html
21. Whatman, P. (n.d.). *Startup Marketing Budget: How to allocate and manage your expenses*. Spend Journal. Retrieved March 17, 2022, from https://blog.spendesk.com/en/startup-marketing-budget
22. Wikimedia Foundation. (2022, March 17). *Lithium-Ion Battery*. Wikipedia. Retrieved March 17, 2022, from https://en.wikipedia.org/wiki/Lithium-ion_battery
23. *With market size valued at $6.7 billion by 2026, it`s a healthy outlook for the global electrical stimulation devices market*. With Market Size Valued at $6.7 Billion by 2026, it`s a Healthy Outlook for the Global Electrical Stimulation Devices Market. (2021, October 7). Retrieved March 17, 2022, from https://www.prnewswire.com/news-releases/with-market-size-valued-at-6-7-billion-by-2026--its-a-healthy-outlook-for-the-global-electrical-stimulation-devices-market-301395393.html
24. *"world's smallest" Ble module emerges from Toshiba and Nordic semi team-up - news*. All About Circuits. (n.d.). Retrieved March 17, 2022, from https://www.allaboutcircuits.com/news/worlds-smallest-ble-module-emerges-from-toshiba-and-nordic-semiconductor-team-up/

Images

1. thesportspulse.com
2. pcbway.com
3. tinycircuits.com
4. iReliev.com
5. Sewingiscool.com
6. Vhr.rv
7. pngkit.com

Appendices

APPENDIX A, Data Analysis

Questions used

How much of an issue is foot pain/strain for you?
How familiar with electrostimulation technology (TENS, E-stim) are you?
How comfortable are you with using wearable technology products? (Apple Watch, Fitbit, etc.)
How comfortable would you be with wearing a device that emits small electrical currents to your body for aiding in recovery efforts?
To what extent did you engage in physical activity last week?
What foot treatments do you currently use for recovery?
The following couple of questions refer to the diagram above. What about this product concerns you?
Where might you see yourself using this product (if at all)?
In your opinion, what is an acceptable noise level for a product like this?
How comfortable do you feel with wires near or around your foot?
How much do you care about the aesthetics of a wearable tech product for your feet?
Given that you do not currently use foot treatments, what is the main factor influencing this decision?
If you currently play for a sports team, what sport do you play and at what level (i.e. D1, D2, intramural, etc)

Data collection/preparation

Questions for this product were compiled into a Google Sheets survey. This survey was distributed to athletes and trainers with a particular focus on student athletes that are currently playing at a collegiate level. The goal of this survey was to ensure that there is a clear need for this product as well as to understand design changes that need to occur for it to be viable.

While preparing the data, collections would be focused around a series of response types: free response, numerical rating, and multiple choice.

Analysis

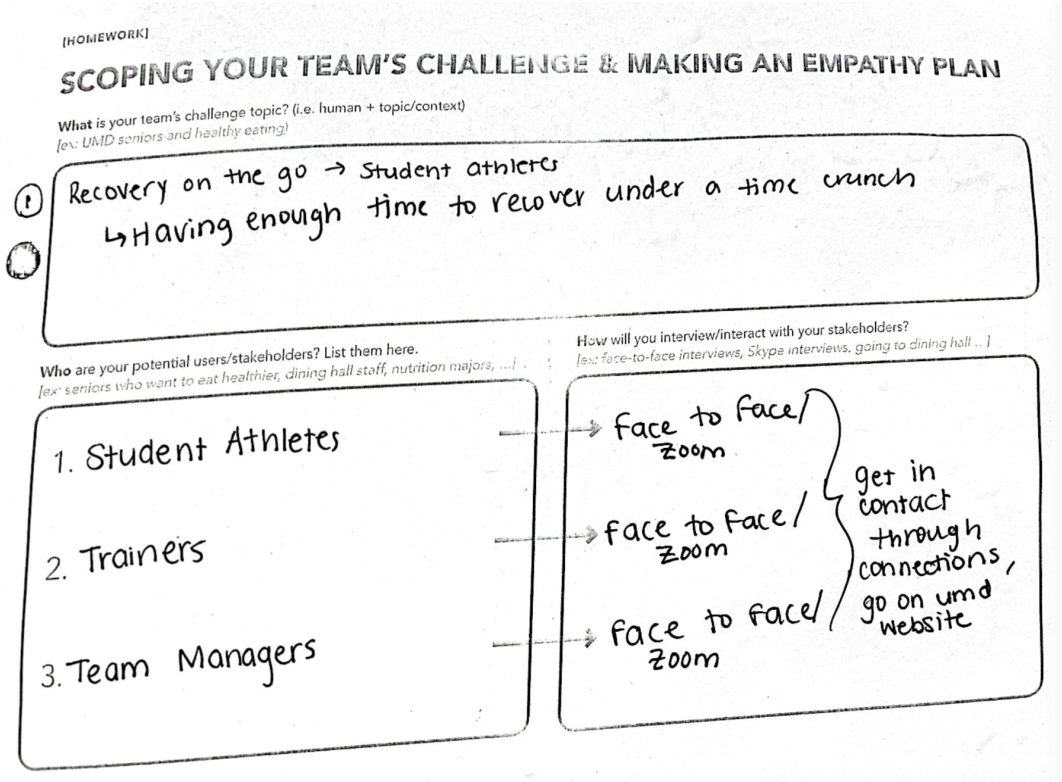
Based on the demographic information, our survey managed to reach a large number of student athletes at the D1 level. This did however bring some bias to our results as a significant number came from the Track and Field team which can be expected to have a greater amount of foot strain. The benefit of this is that the team gained insight into a user base that may benefit more from our product.

How it impacted our product

A question about the noise level of our product gave us insight into a possible issue with our device. Users stated that this product should have a very low amount of noise while being used. To address this, the team opted for smaller electrical components that will considerably reduce noise levels at the expense of cost.

Respondents also consistently brought up concerns about the durability of the product. A large part of this was the production of moisture that could prove problematic to the electrical components at the base of the foot. This was a particular concern for athletes who said that they might consider using the product while training in their respective sport.

APPENDIX B, Identifying the Problem (Interview Guide, POV Statement)


[HOMEWORK]

SCOPING YOUR TEAM'S CHALLENGE & MAKING AN EMPATHY PLAN

What is your team's challenge topic? (i.e. human + topic/context)
[ex: UMD seniors and healthy eating]

Recovery on the go → Student athletes
↳ Having enough time to recover under a time crunch

Who are your potential users/stakeholders? List them here.
[ex: seniors who want to eat healthier, dining hall staff, nutrition majors, ...]

How will you interview/interact with your stakeholders?
[ex: face-to-face interviews, Skype interviews, going to dining hall ...]

1. Student Athletes → Face to Face/ Zoom
2. Trainers → Face to Face/ Zoom
3. Team Managers → Face to Face/ Zoom

get in contact through connections, go on umd website

Rethink

Original POV

- We met David, a UMD football player, and learned that not having enough time to recover leaves his muscles (especially his feet) feeling sore. We want to focus our efforts on creating ways to help him recover that doesn't take too much time out of his schedule.

New solution

- Our new solution involves attaching the electrostim technology to a sock, so that it is both portable and efficient. Having the technology on a sock rather than an insole allows the electrodes to be closer to the skin and provide better pain relief. The technology will be attached using velcro so that it is removable for when the user needs to wash the socks.

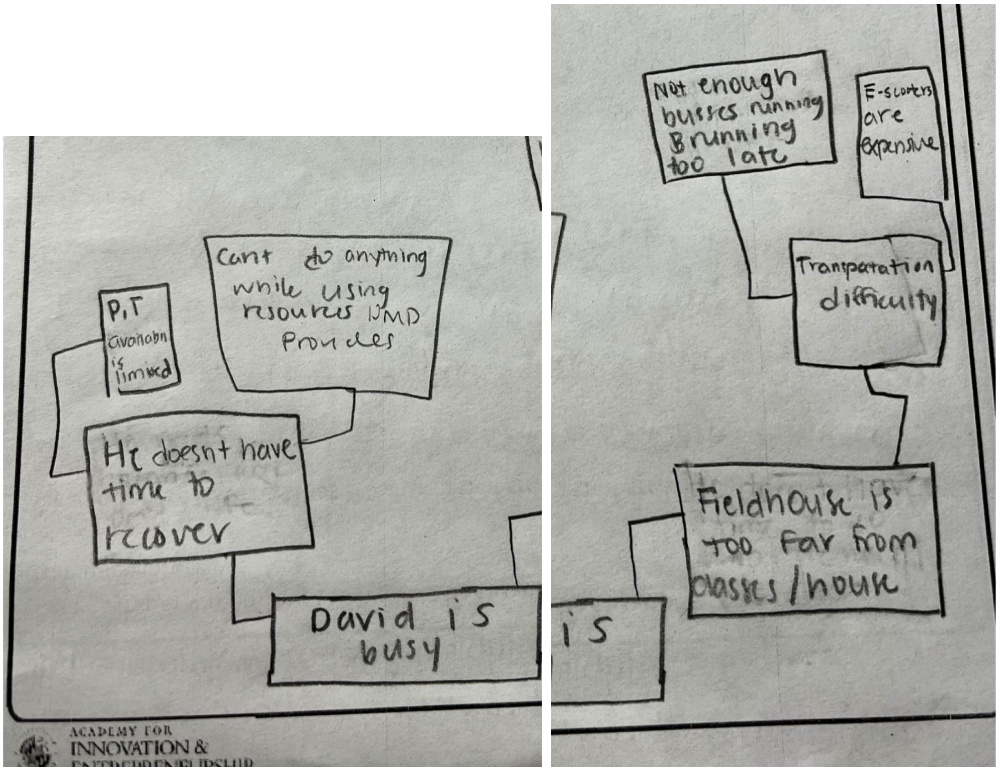
Unique value proposition

- Portability and versatility when it comes to addressing foot pain with stim tech. Our product allows users to put on any footwear while undergoing recovery stim.

Shape Shift insights

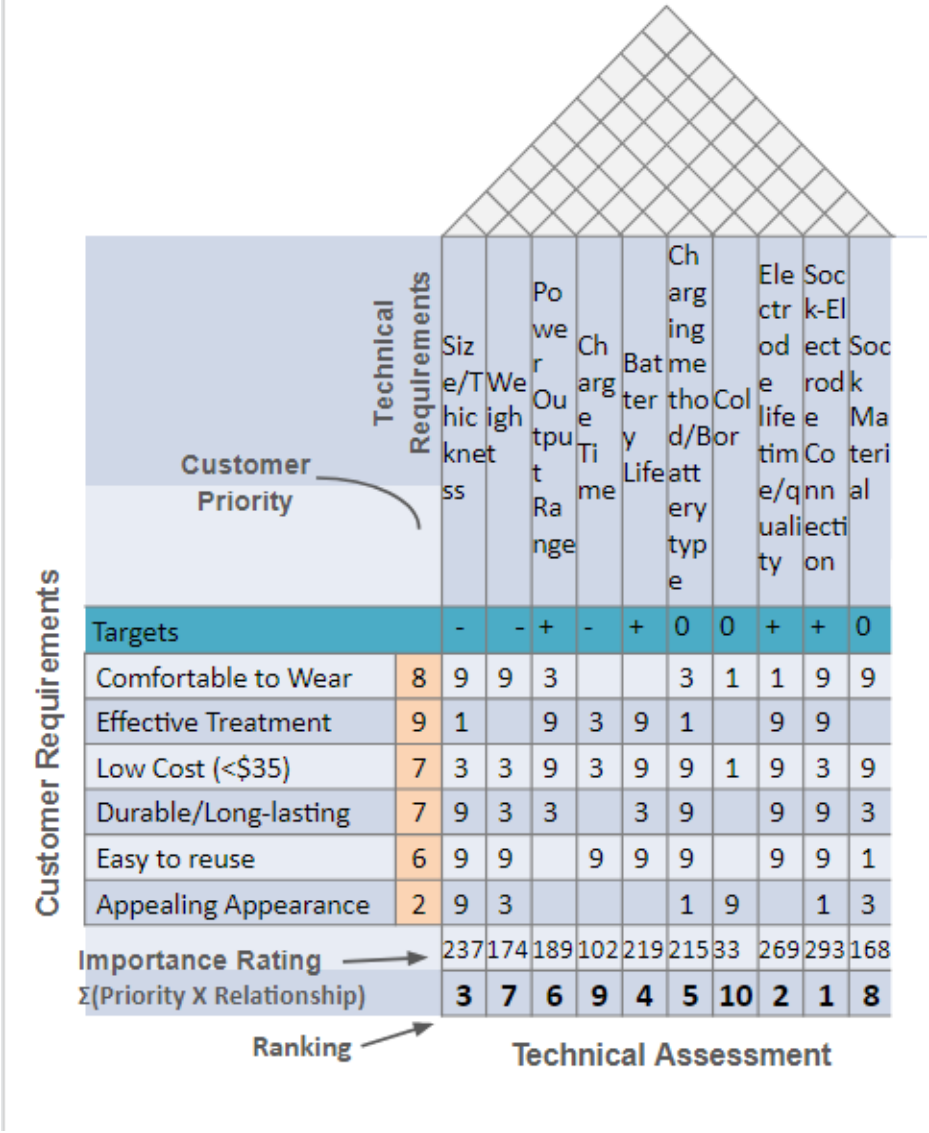
- Allowing more freedom and flexibility for users to use the technology as they see fit - maybe alternative locations, control over intensity all the way down to the voltage and current levels using an application.

APPENDIX C, Process to a Solution (Why Ladder, Decision Matrix)



Weights:	4	3	2	2	
	portability	quality compared to trainer	versatility	time	Sum * Weight
Working With Trainer	0	0	0	0	0
Roller Wrap	"++"	"-"	"+"	"+"	9
Suction Temperature Patch	"++"	"-"	"-"	0	3
Portable Stim	"++"	0	"-"	"++"	10
Hot/Cold Sleeve	"++"	"-"	"+"	0	7

APPENDIX D, House of Quality



Customer Requirements	Customer Priority	Size/Thickness	Weight	Power Output Range	Charge Time	Battery Life	Charging method/Battery type	Color	Electrode life time/quality	Sock-Electrode Connection	Sock Material
Targets		-	-	+	-	+	0	0	+	+	0
Comfortable to Wear	8	9	9	3			3	1	1	9	9
Effective Treatment	9	1		9	3	9	1		9	9	
Low Cost (<$35)	7	3	3	9	3	9	9	1	9	3	9
Durable/Long-lasting	7	9	3	3		3	9		9	9	3
Easy to reuse	6	9	9		9	9	9		9	9	1
Appealing Appearance	2	9	3				1	9		1	3
Importance Rating		237	174	189	102	219	215	33	269	293	168
Σ(Priority X Relationship)		**3**	**7**	**6**	**9**	**4**	**5**	**10**	**2**	**1**	**8**

Technical Requirements

Ranking

Technical Assessment

APPENDIX E, Prototyping Guide

[HOMEWORK]

3. BUILD TO TEST

With your team, generate a list of questions you aim to answer by building your prototype(s). If it helps, refer back to your storyboard and assumptions to get inspiration about where your idea could fail.

Example Questions:

- Does [feature x] successfully do [function x] for our user?
- What's more important to our user: x, y, or z?
- How does our user intuitively use our product?
- Does our user care about [function x] of our innovation?

Write your questions and how you might test them in the box on the right.

1 · What is the optimal place to put the components
↳ Can the device be wireless? If not, where do wires go?
2a · What kind of power source will the insert use?
b ↳ What power output and frequency is required for the product to be effective
c ↳ How would the device be charged?
3 · How comfortable would wearing an electronic insert be?
4a · Should the inserts be removable or only fit one shoe?
b ↳ What does replacement/maintenance entail?
5 · Does our user prefer modularity (e.g. different power levels) at the cost of size/comfortability?
6 · Do insoles slip? Would specific sizes be needed? How do we secure them in place?

[HOMEWORK]

PROTOTYPING GUIDE: CRAFTING LITTLE EXPERIMENTS

1. Identify your user *(think back to your empathy work!)*

David, a quarterback on UMD's football team who experiences muscle soreness

2. Form your questions *(mindsets: learn as much as you can from user feedback)*

What are the ASSUMPTIONS you have about your idea?
List them and circle the most critical ones (if those turned out to not be true, your idea as it exists right now would not work)

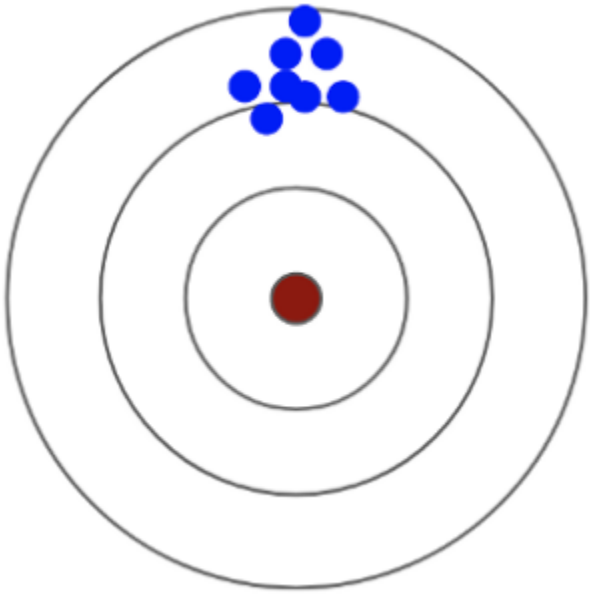
- The user experiences foot soreness/pain to the extent that he needs an alternative method of dealing with it
- Stim is an effective way of mitigating foot soreness/pain, especially on the go
  ↳ - Stim treatment is comparably effective to treatment from a physical therapist or athletic trainer
- Stim technology exists that is small enough to fit in a shoe but can withstand the weight of a human being

What are the VARIABLES your might experiment with?
[ex. time, roles, features, colors, materials...]

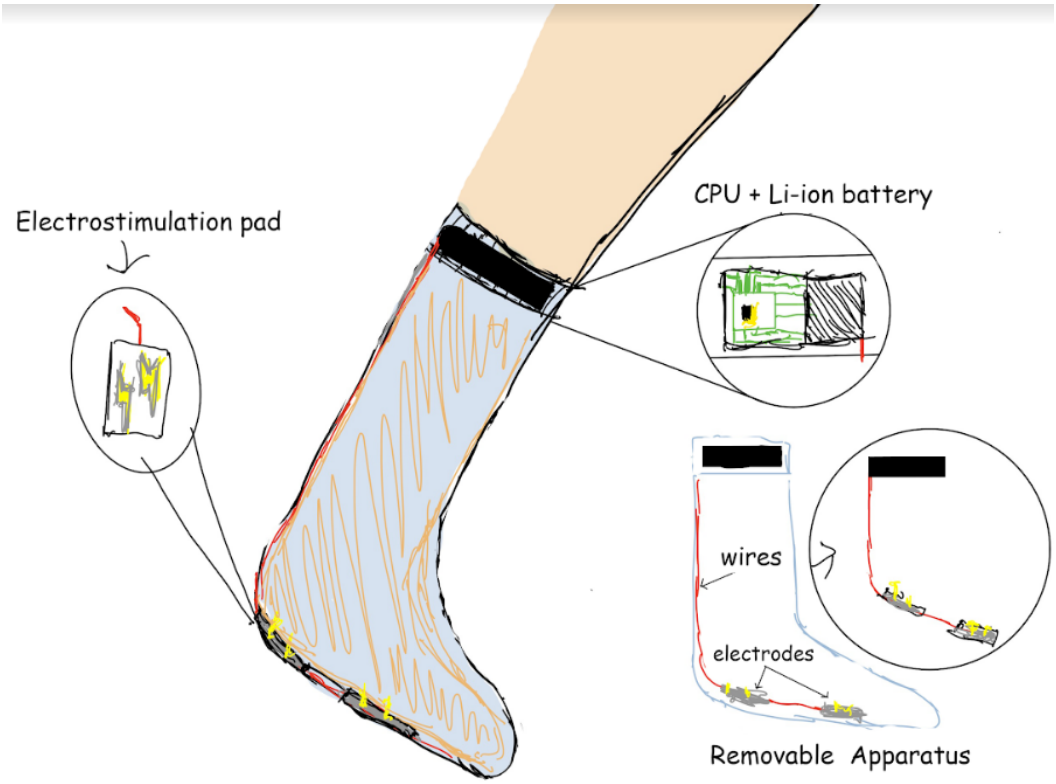
- Material → comfort level, water-proofing
- Size → width, thickness
- Power input/output
- Power capacity
- Control mechanism (microcontroller)

ACADEMY FOR INNOVATION &

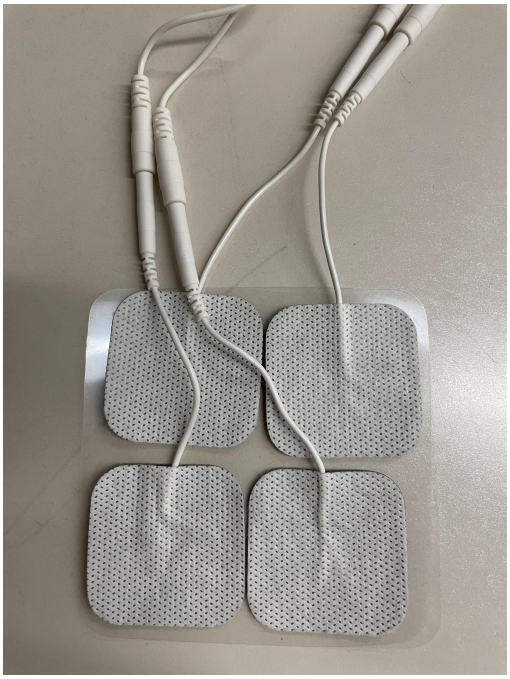
APPENDIX F, Bulls-eye diagram



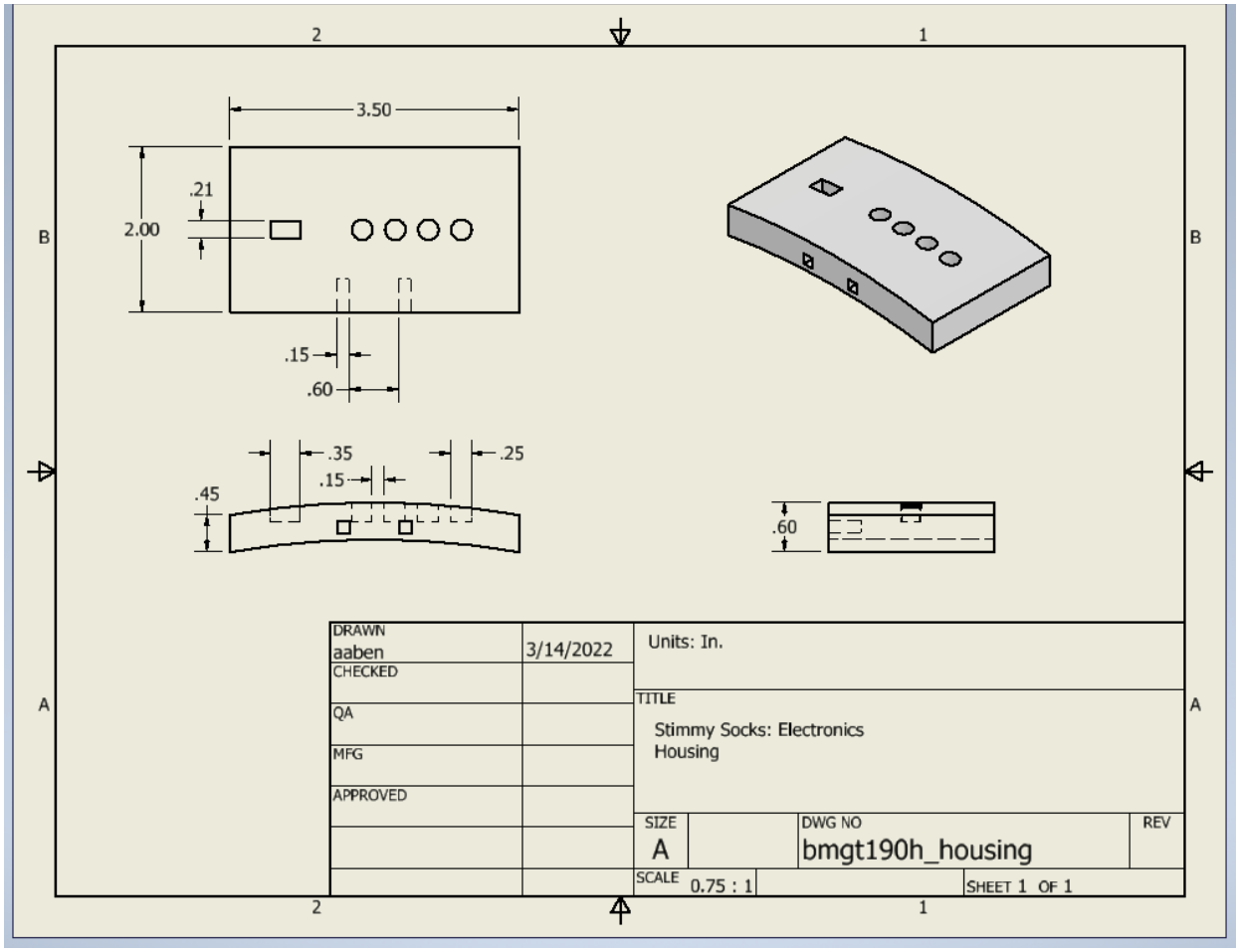
APPENDIX G, Drawing of Final Prototype



APPENDIX H, Photos of Final Prototype



APPENDIX I, Engineering Drawing of Electronics Housing



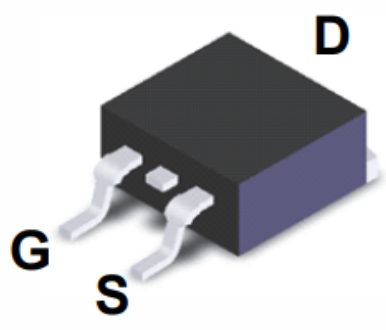
APPENDIX J, Control System Component Technical Specifications

*Data sheets for each component are on each website

Battery

Voltage	3.7 V	
Battery Life	1000 mAh	
Unit price	$3.00 /unit (50 unit purchase)	
Reference	https://www.alibaba.com/product-detail/Li-ion-Battery-3-7v-3_62424376932.html?spm=a2700.7724857.normal_offer.d_title.10ee4d7alsfATW&s=p	

MOSFET

Voltage (Drain to Source)	500 V	
Current	11.5 A	
Unit price	~$0.70 /unit	
Reference	https://www.onsemi.com/products/discrete-power-modules/mosfets/fdb12n50tm	

Capacitor

Voltage rating	100 V
Unit price	$0.034 /unit
Reference	https://www.digikey.com/en/products/detail/venkel/C0805X7R101-103KNE-CT/14652249?utm_adgroup=Capacitors&utm_source=google&utm_medium=cpc&utm_campaign=

	Shopping_DK_Supplier_Venkel%20LTD&utm_term=&utm_content=Capacitors&gclid=CjwKCAiAyPyQBhB6EiwAFUuakjboBMUU14daMSnbUFEw2IBo6QSvF0s6LSjQs3FWfHfZQqnsUqd1ExoCmcYQAvD_BwE Data Sheet

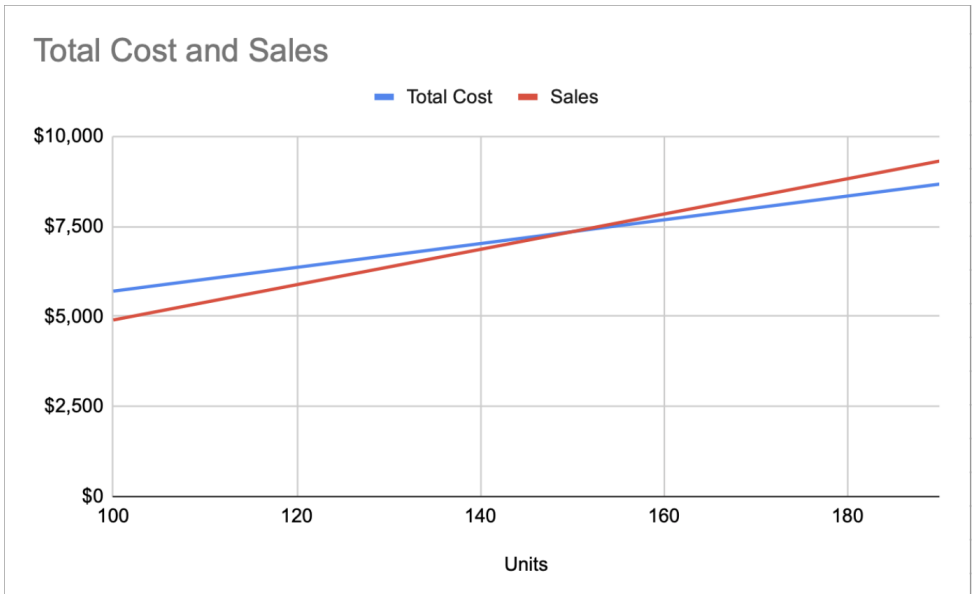
APPENDIX K, Five Year Income Statement

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue						
Sales Revenue	0	14352	31,893	70,178	155,978	350,142
Total Revenue	0	14352	31,893	70,178	155,978	350,142
Growth			*122.22%*	*120.04%*	*122.26%*	*124.48%*
Cost of Goods Sold	0	9,568	21,262	46,785	103,985	233,428
Gross Profit	**0**	**4,784**	**10,631**	**23,393**	**51,993**	**116,714**
Expenses						
Advertising	50	1,722	3,827	8,421	18,717	42,017
Rent (storage unit)	0	2,280	2,280	2,280	2,280	2,280
Employee Salary	0	25,000	25,000	25,000	25,000	25,000
Total Expenses	50	29,002	31,107	35,701	45,997	69,297
Income before Taxes	**-50**	**-24,218**	**-20,476**	**-12,309**	**5,995**	**47,417**
Tax Expense	-12	-5,570	-4,710	-2,831	1,379	10,906
Net Income	**-39**	**-18,648**	**-15,767**	**-9,478**	**4,616**	**36,511**

APPENDIX J, Break Even Analysis

Units	100	110	120	130	140	150	160	170	180	190
Total Cost	$5,700	$6,030	$6,360	$6,690	$7,020	$7,350	$7,680	$8,010	$8,340	$8,670
Sales	$4,900	$5,390	$5,880	$6,370	$6,860	$7,350	$7,840	$8,330	$8,820	$9,310

Unit price	$49
Unit cost	$33
Discount rate	15%
Demand Growth Rate	50%
Fixed costs (overhead, e	$45,997
Breakeven at 150 units and we estimate we would reach this point between years 4 and 5	



APPENDIX L, Revenue Build

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue						
Sales Revenue	0	14352	31,893	70,178	155,978	350,142
Total Revenue	0	14352	31,893	70,178	155,978	350,142
Growth			*122.22%*	*120.04%*	*122.26%*	*124.48%*
Cost of Goods Sold	0	9,568	21,262	46,785	103,985	233,428
Gross Profit	**0**	**4,784**	**10,631**	**23,393**	**51,993**	**116,714**
Expenses						
Advertising	50	1,722	3,827	8,421	18,717	42,017
Rent (storage unit)	0	2,280	2,280	2,280	2,280	2,280
Employee Salary	0	25,000	25,000	25,000	25,000	25,000
Total Expenses	50	29,002	31,107	35,701	45,997	69,297
Income before Taxes	**-50**	**-24,218**	**-20,476**	**-12,309**	**5,995**	**47,417**
Tax Expense	-12	-5,570	-4,710	-2,831	1,379	10,906
Net Income	**-39**	**-18,648**	**-15,767**	**-9,478**	**4,616**	**36,511**

APPENDIX M, Expense Build

	Actual		Projected					
	0	1	2	3	4	5		
COGS per unit	0.00	32.88	36.17	39.80	43.79	48.18		Step up:
Growth		*10.00%*	*10.01%*	*10.02%*	*10.03%*	*10.04%*		0.01%
Quantity sold	0	291	588	1176	2375	4845		
COGS	**0.00**	**9,568.08**	**21,262.21**	**46,785.36**	**103,985.42**	**233,428.13**		
Expenses Build								
Advertising	50	1,722.25	3,827.20	8,421.36	18,717.38	42,017.06		12.00%
Rent	0	2,280	2,280	2,280	2,280	2,280		
Employee Salary	0	25,000	25,000	25,000	25,000	25,000		

	Cost per unit	Cost per pair
COGS		
Sock (moisture wick)	$1.25	$2.50
Wires	$0.82	$1.64
Battery	$2.75	$5.50
E-stim pad	$0.34	$0.68
Velcro	$1.28	$2.56
PCB	$10.00	$20.00
COGS per unit	**$16.44**	**$32.88**