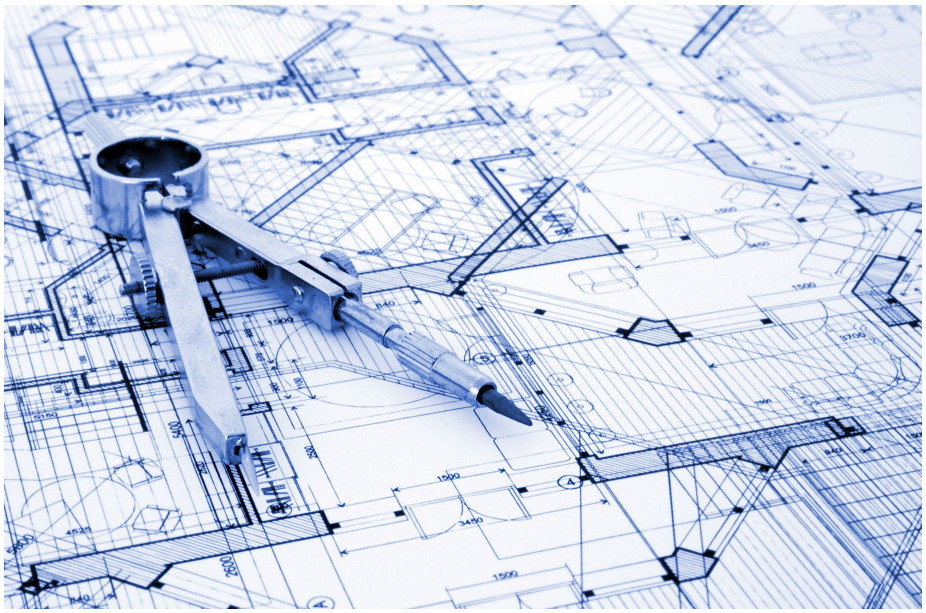

Engineering Desgin Notebook

Elizabeth Herrejon

09/10/2021 — 12/03/2021

Contents

1 Pre-Project Forms & Documentation

1.1 Proposed Project Form

Form for Proposing Student Projects Today, it is normal for women to be hyperaware of their surrounding areas as they navigate through a mundane and unassuming life. It is also the norm for women to buy pepper spray, pocketknife, brass knuckles, etc. to keep themselves safe. However, all of these products are hard to use at the same time and sometimes are clanky and obvious to a potential attacker. If there was a situation where a women has been overtaken and is at a last resort, that is where our product will come in. We hope to make a product for women that is concealable but powerful enough to shock the attacker and provide another level of comfort for people using the product.
We plan to use our Electrical Engineering skills to build either a circuit similar to the shocking gum or a circuit that is implemented in tasers. At the same time, using embedded design systems, IC fabrication, intro to nanotechnology, computer communications, and cryptography, we will fabricate a piece of jewelry that will be used as both a brass knuckle and a taser all in one.

SIGNATURE: *Elizabeth Herrejon* DATE: 9/10/2021

ECE 4871 -- Form for Proposing Student Projects

ECE 4871 students may propose their own projects for consideration by filling out the form below and submitting it via Canvas and email to Bruno.Frazier@ece.gatech.edu .

Please follow the instructions contained in the form below and properly name your file prior to submission.

Basic Information

Student Name: Elizabeth Herrejon **Major:** EE **GTID Number:** 903284817

Email address: eherrejon3@gatech.edu

ECE 4871 Term: Fall 2021 **ECE 4872 or ECE 4873 Term:** Spring 2022

Note: ECE4872 and ECE4873 are taught only in Spring and Fall terms.

☐ Check if this project is proposed for ECE 4873 (multidisciplinary design teams only) instead of ECE 4872.

Project Title and Team Name

Team Name:

Project Title: Self Defense Weapons

Proposed Advisor

If a faculty member has already agreed to supervise proposed project, list his/her name below. If not, list the ECE project advisor you believe is most appropriate for the proposed topic.

Project Advisor:

☐ Check if the advisor has already agreed to supervise this project

Team Information

Please list the proposed size of your team, the composition of the team members, and other students in ECE4871 that have expressed interest in this project.

Number of EE members: 4 **Number of CmpE members:**

Other ECE4871 students interested in this project:

2

If it is anticipated that this project will be multidisciplinary, then please list other schools within the College of Engineering at Georgia Tech from which students might be drawn. Note that multidisciplinary teams from ECE will be expected to take ECE4873 for their 2nd semester instead of ECE4872.

Other disciplines anticipated from GT-COE:

Number of non-ECE team members:

SIGNATURE: *Elizabeth Herrejon* DATE: 9/10/2021

ECE 4871 -- Form for Proposing Student Projects

Explain how the proposed project relates to your major(s) and background

The overall project topic must constitute a significant culminating design experience appropriate to the major(s), experience, background, and advanced courses (e.g., electives) of the participating students.

This project will relate to our major(s) and background as some teammates will be taking IC Fabrication and others are taking robotics classes. So far, all of the teammates are electrical engineering but with all different focuses. This relates to the teammates major as we are mostly all EE majors. Using the skills we have acquired, we will be able to accomplish the building of the project. The only thing we lack is a bit of experience in mechanical aspects when it comes to drafting and designing a mechanical body, but we have the drive to learn more about it.

List advanced courses (ECE electives plus other relevant courses) that are directly related to the proposed project.

- Computer Communications – project will have GPS signals transmitting to another server, as well has transfer files to another source when given the command.
- Cryptography - project will consist of trustworthy circuit designs which includes protection of the hardware platform against tampering and the unauthorized extraction of information.
- Intro to Robotics - project will have feedback control laws for devices accurate tracking and algorithms to process sensor data collected by device.
- Embedded Systems - project will be using processors, chipsets, buses, and I/O devices.
- CS Computer Vision - will use methods for tracking, boundary detection of the device.
- Integrated Circuit Fabrication – device will utilize an integrated circuit.
- Intro to Nanotechnology – device will consist of microelectronics and nanotechnology in wearable technology.
- Design Fundamentals – project overview will follow the same design processes and major deliverables.

CmpE Majors: Additional Information (REQUIRED)

If the proposed project will include CmpE majors, both the overall project topic and their individual contribution must involve both hardware and software elements, including interactions and/or trade-offs. If some student(s) effort will be primarily focused on only one of these, that effort must involve close interaction with and dependence on design decisions in the other aspect.

Briefly describe how the proposed project satisfies these requirements (200 - 500 characters):

SIGNATURE: *Elizabeth Herrejon* DATE: 9/10/2021

ECE 4871 -- Form for Proposing Student Projects

Brief Project Description

The overall project topic must constitute a significant culminating design experience appropriate to the major(s), experience, background, and advanced courses (e.g., electives) of the participating students.

Today, it is normal for women to be hyperaware of their surrounding areas as they navigate through a mundane and unpresuming life. It is also the norm for women to buy pepper spray, pocketknife, brass knuckles, etc. to keep themselves safe. However, all of these products are hard to use at the same time and sometimes are clanky and obvious to a potential attacker. If there was a situation where a women has been overtaken and is at a last resort, that is where our product will come in. We hope to make a product for women that is concealable but powerful enough to shock the attacker and provide another level of comfort for people using the product.

We plan to use our Electrical Engineering skills to build either a circuit similar to the shocking gum or a circuit that is implemented in tasers. At the same time, using embedded design systems, IC fabrication, intro to nanotechnology, computer communications, and cryptography, we will fabricate a piece of jewelry that will be used as both a brass knuckle and a taser all in one.

Using computer communications, we will be able to hopefully implement a GPS tracker that will monitor the user's movement and provide that location to the 5 emergency contacts and if they are in danger, send that location and description of the victim to the police. We want to provide a secure network that won't be tampered into and provide GPS tracking for the user even if wifi or data is lost. Also using cryptography, we plan to secure our device so that way it cannot be reversed engineered. For IC fabrication, we can use that to build some parts in the device that require it and nanotechnology will help us with the smaller scaled items that will need to be inside the small jewelry case.

SIGNATURE: *Elizabeth Herrejon* DATE: 9/10/2021

ECE 4871 -- Form for Proposing Student Projects

Additional Comments (OPTIONAL)
Provide any additional information that you think will be helpful to your ECE 4871 faculty instructors about this project (600 characters max):

Save this Form, and Email Your Files
Save this form as a Microsoft Word document so that you can edit it, if needed. When you are ready to submit your file, save a copy of the form as a **pdf** file using the "Save As" function. Name it as specified below. Name the file as follows: **LastName_FirstName_Proposed_Project.pdf** For example, George P. Burdell would name his proposed project file as: Burdell_George_Proposed_Project.pdf Lastly, submit your file via Canvas and email to: Bruno.Frazier@ece.gatech.edu

SIGNATURE: *Elizabeth Herrejon* DATE: 9/10/2021

1.2 Project Preference Forms and Resume

Project Preference Forms Before assembling the final team together, it is important to submit a team preferences form in the events my top choice team is full. Listed in the forms are some of the other teams proposed ideas that I am interested.

Resume My resume lists and summarizes my skills and work experience to introduce my qualifications and skills to potential teammates.

ECE Culminating Design Project Preference Submission Form

Each ECE4871 student must complete ALL pages of this form. The form must be submitted to the ECE4871 Canvas website. You can use this copy as a working draft before submission.

BASIC INFORMATION

Student Name: Elizabeth Herrejon **Major:** EE **GTID Number:** 903284817

Email address: eherrejon3@gatech.edu

ECE4871 Term: Fall 2021 **ECE4872 or ECE4873 Term:** Spring 2022

Note: ECE4872 & ECE4873 are taught only in Spring and Fall terms.

☐ Check if you are planning to complete ECE4873 (primarily for multidisciplinary design teams) instead of ECE4872

☐ Check if you are participating in the **International Plan** and using ECE4872 or 4873 as your culminating IP course

PROJECT PREFERENCE

Complete as described in the detailed instructions for each option.

Option A: Student or Teams needing to be assigned a Project and Advisor

*Using the list of project advisors and their potential project ideas or topic areas, choose your **top 3** choices in ranked order. You **MUST** list projects from **at least two** different advisors and include **at least one** industry-sponsored project.*

Team Name (if applicable): Self Defense Weapons (Not Final Name)

Project Choices	Project Title	Advisor Name
Choice #1:	Self Defense Weapons	
Choice #2:	Bionic Crab	Patricio A.Vela
Choice #3:	Solar Powered Drone	James Hamblen, David Taylor, Samuel Coogan

***Proposed or preferred team members (max 5):**

***Individuals (max 3) with whom you would prefer not to be teamed:**

**Optional information that will be used by the instructors in forming teams; this will not be shared with the other students and will be kept confidential to the extent possible.*

Option B: Student-Proposed Project and Team

Fill out this section for student formed teams. If already agreed to, then list the advisor. All students / teams filling out Option B must fill out Option A as well using the student proposed project as Choice #1.

Team Name: Self Defense Weapons

Project Title: Self Defense Weapons

Project Advisor:

Other team members: Katherine Roberts, Katherine Weatherwax, Radha Changela, Christine Saw

Option C: Using your VIP project (see detailed instruction for eligibility requirements)

VIP section code and title (e.g., VP7 - eCampus):

VIP team advisor:

VIP credit hours completed (including ECE4871 term):

SIGNATURE: *Elizabeth Herrejon* DATE: 9/14/2021

ECE4871 Project Preference Submission

Proposed Project (or Topic Area) and Your Planned Contribution

Briefly describe the project topic (Choice #1 topic area if you don't have a specific project) and your planned technical contribution to the overall effort (400 - 1000 characters):

I plan to contribute by helping to develop the logistics and embedded systems required for the project. Using my Embedded Systems class and intro to computer vision, I am hoping to use these skills when working with the project as a whole. I also plan on working with the networking aspect of the project, and using, Computer Communications, I hope to learn more and contribute on that aspect. Lastly, working with tools is something I am good with as my job requires me to working with electrical wires and fibers.

How Proposed Project Relates to Your Major and Background

The overall project topic must constitute a significant culminating design experience appropriate to your major. Additionally, your individual contribution must draw upon your experience and background, including advanced courses (e.g., electives) taken in your major field.

Briefly describe how the project (or Choice #1 topic area) and your proposed individual contribution satisfy these requirements (200 - 800 characters):

This project will relate to our major(s) and background as some teammates will be taking IC Fabrication and others are taking robotics classes. So far, all of the teammates are electrical engineering but with all different focuses. This relates to the teammates major as we are mostly all EE majors. Using the skills we have acquired, we will be able to accomplish the building of the project. The only thing we lack is a bit of experience in mechanical aspects when it comes to drafting and designing a mechanical body, but we have the drive to learn more about it.

List all ECE electives (plus other relevant electives) that you have completed or are currently taking. (800 characters max):

- Computer Communications – project will have GPS signals transmitting to another server, as well has transfer files to another source when given the command.
- Cryptography - project will consist of trustworthy circuit designs which includes protection of the hardware platform against tampering and the unauthorized extraction of information.
- Intro to Robotics - project will have feedback control laws for devices accurate tracking and algorithms to process sensor data collected by device.
- Embedded Systems - project will be using processors, chipsets, buses, and I/O devices.
- CS Computer Vision - will use methods for tracking, boundary detection of the device.
- Integrated Circuit Fabrication – device will utilize an integrated circuit.
- Intro to Nanotechnology – device will consist of microelectronics and nanotechnology in wearable technology.
- Design Fundamentals – project overview will follow the same design processes and major deliverables.

SIGNATURE: *Elizabeth Herrejon* DATE: 9/14/2021

ECE4871 Project Preference Submission

CmpE Majors: Additional Information (REQUIRED)

For CmpE majors, both the overall project topic and your individual contribution must involve both hardware and software elements, including interactions and/or trade-offs. If your part of the project will be primarily focused on only one of these, that effort must involve close interaction with and dependence on design decisions in the other aspect.

Briefly describe how your Choice #1 project and your proposed individual contribution satisfy these requirements (200 - 800 characters):

Additional Comments (OPTIONAL)

Provide any additional information that you think will be helpful to the instructors in assigning students to teams and projects (600 characters max):

Team is filled up. Not looking for new members.

Save this Word Form, Save the Excel Form, Prepare Your Resume, and Upload Your Files

1. Save this form as a Microsoft Word document so that you can edit it as needed. When you are ready to submit your files, save a copy of the form as a **pdf** file using the "Save As" function. The pdf file MUST be uploaded to Canvas along with the Excel file and your resume. Name the file as specified below.

2. Fill out the Excel file using **Row 2** of the file. Name the file as specified below.

3. Prepare your resume as a separate document using any software you choose. When you are ready to submit it, save it as a pdf file. Name the file as specified below.

Submit your two files as an Assignment on the course website. You must upload your deliverables as three separate files: (1) the completed WORD Project Preference form, (2) the completed abbreviated EXCEL Project Preference form and (3) your resume. Name the files as follows:

LastName_FirstName_form.pdf
LastName_FirstName_form.xls
LastName_FirstName_resume.pdf

For example, George P. Burdell would name his resume: Burdell_George_resume.pdf

SIGNATURE: *Elizabeth Herrejon* DATE: 9/14/2021

Elizabeth M. Herrejon

1428 Churchill Way, Marietta, GA 30062 | 404-984-3026 | eherrejon3@gatech.edu | US Citizen | Secret Security Clearance

Objective

Award-winning, multi-lingual electrical engineer with 1+ years of experience in research and development for defense and military companies. Strength focuses on troubleshooting, designing circuits, and applying fundamental electrical principles learned in class to the research completed at work. Addition experience generating technical diagrams and building cable assemblies with expertise in developing Labview GUI, VISIO, and hardware maintenance.

Education

Electrical Engineering Major & Physics Minor, Georgia Tech, Atlanta, GA — 1-2019 onward
GPA: 3.11
Coursework: Fundamentals of Digital Design and lab, Signal Processing (Continuous and Discrete), Circuit Analysis, Microelectronics and lab

Math Major, Georgia State University, Atlanta, GA — 7-2018 to 12-2019
GPA: 3.66

Skills

NI Labview: Able to create user interfaces, code hardware components, design station setups using DAQs
Microsoft Office: Proficient in Excel, Word, Powerpoint, Visio, Publisher, etc.
Editing Software: Sony Vegas Pro, Adobe Platforms (Photoshop, After Effects, Audition, Premiere, etc.), Logic Pro, AutoDesk software (Revit, AutoCad, Inventor), Google SketchUp, Final Cut Pro
Languages/Scripts: Experience in C++, Java, Arduino, Labview
Operating Systems: Windows (v.7 and up) and iOS (Mac v.10 and up)
Other: Great communication and presentation skills, work well under pressure, team player

Activities

HSF Scholar Recipient	12-2020
Recipient of OMED Gold Academic Transfer Award	9-2020
GSU Hackathon: Honorary Mention (Cryptology)	10-2018, 3-2019
Founder of MESS: Universal Dysgraphia Pen (STEM Capstone Project)	6-2017 to Present
Georgia Tech Music Technology Earsketch Competition	12-2017
Purdue STEP Summer Program	7-2017
Georgia Tech Music Technology Summer Program	6-2017
Co-Founder & Vice President, Society of Women Engineers NEXT	8-2016 to 5-2018
Participant Inventure Challenge at Walton, Georgia Tech	2015-2016

Work Experience

Electrical Engineering Research Assistant Spring 2020 - ATAS — 1-2020 to Present
Worked with the System Design Division to support various engineers in SSD to troubleshoot circuits, create circuit diagrams, build cable assemblies, and generate technical diagrams. Received Secret Security Clearance and worked on various projects assisting engineers by checking, building, and creating systems to practice and expand on fundamental electrical principles learned in class.

Admin Support Student Assistant - Support Services Department (SSD) — 5-2019 to 12-2019
Worked under the guidance of an administrative manager to perform different business administrative duties such as creating manuals and spreadsheets, organizing and distributing keys to new employees at 762-B11, create name tags, assign keys in TMA, look over different architectural drawings to assign positions for moving employees, and manage project schedules and office coordination.

Covenant House, Atlanta — 7-2018
Worked with homeless teens, wrote three grant summaries, and managed the office phone.

GT CODA-Portman Project, Atlanta — 6-2017
Worked on site at the headquarters of the CODA project where construction plans were reviewed and modified daily to incorporate the needs of engineers. Some of the duties performed included calculating the volume for the basement support columns and organized project files.

Integral Construction Inc., Atlanta — 6-2017 to 7-2017
Reviewed plumbing, electrical, landscape, and mechanical architectural drawings for different engineers while directly editing the files to upload to the company shared drive. Used both AutoCad and Revit to complete the edits.

SIGNATURE: *Elizabeth Herrejon* DATE: 9/14/2021

2 Team Skills Matrix

2.1 General Completion

Analyzing the Team Skills Matrix, overall, the team is the strongest when it comes to the Technical Writing and the Digital Design aspects of the project. Having all members with EE, analyzing our greatest weaknesses and strengths helped us to prioritize the coding and mechanical designs of the project, as outlined in Figure 1 and Figure 2.

Project Skills Matrix

ECE4871 rev. 1/18/2018

Directions: Please rate yourself in each of the skillsets according the the scale:
0=No relevant experience, **1**=exposed to but limited proficiency, **2**=applicable coursework and/or work experience, **3**=2+ years academic or professional experience

Team Member	Analog Design	Digital Design	Real-Time Software Coding	Mechanical Design	PCB, Mechanical Design, Assembly	Project Management	Team Leadership	Technical Writing	Avg	StDev
Radha Changela	1.0	2.0	0.0	2.0	1.0	2.0	2.0	2.0	1.5	0.8
Katie Roberts	2.0	3.0	1.0	0.0	2.0	3.0	2.0	2.0	1.9	1.0
Hubert Elly	2.0	1.0	2.0	0.0	1.0	1.0	2.0	2.0	1.4	0.7
Christine Saw	2.0	1.0	1.0	0.0	1.0	1.0	2.0	2.0	1.3	0.7
Lara Kassabian	1.0	1.0	0.0	3.0	2.0	3.0	3.0	0.0	1.6	1.3
Katie Weatherwax	1.0	2.0	0.0	1.0	2.0	3.0	3.0	3.0	1.9	1.1
Elizabeth Herrejon	1.0	1.0	2.0	3.0	2.0	3.0	3.0	3.0	2.3	0.9
Member X (Advisor)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Avg:	1.3	1.4	0.8	1.1	1.4	2.0	2.1	1.8		
StDev:	0.7	0.9	0.9	1.4	0.7	1.2	1.0	1.2		

Figure 1: Generic Team Skills Matrix: Project Skills Matrix

Skill Levels Normalized to μ=0 σ=1 for each member with avg team skill added

Team Member	Analog Design	Digital Design	Real-Time Software Coding	Mechanical Design	PCB, Mechanical Design, Assembly	Project Management	Team Leadership	Technical Writing	
Radha Changela	0.6	2.0	-1.2	1.8	0.7	2.7	2.8	2.4	
Katie Roberts	1.9	3.4	0.1	-0.9	2.0	4.0	2.8	2.4	
Hubert Elly	1.9	0.7	1.4	-0.9	0.7	1.3	2.8	2.4	
Christine Saw	1.9	0.7	0.1	-0.9	0.7	1.3	2.8	2.4	
Lara Kassabian	0.6	0.7	-1.2	3.1	2.0	4.0	4.1	-0.2	
Katie Weatherwax	0.6	2.0	-1.2	0.5	2.0	4.0	4.1	3.7	
Elizabeth Herrejon	0.6	0.7	1.4	3.1	2.0	4.0	4.1	3.7	
Average Skill Level	1.2	1.5	-0.1	0.8	1.5	3.0	3.4	2.4	
Specialist Rating	0.7	1.0	1.2	1.8	0.7	1.3	0.7	1.3	Avg(StDev)= 1.09
Analysis of Team Skills	Average	Average with Specialists	Weak with Specialist	Average with Specialists	Average	Strong with Several Specialists	Strong with Several Specialists	Strong with Several Specialists	

Figure 2: Generic Team Skills Matrix: Guitar Tablature Project Skills Matrix

Suggestions for Team Assignments	
Analog Design	Katie R, Hubert, Christine
Digital Design	Katie R, Radha, Katie W.
Real-Time Software Coding	Christine, Hubert, Elizabeth
Mechanical Design	Radha, Lara, Elizabeth
PCB or Mechanical Design	Katie R. Katie W, Lara
Project Management	Katie R. Katie W
Team Leadership	Elizabeth, Lara
Technical Writing	Katie W. Elizabeth, Christine, Radha

Table 1: Generic Team Skills Matrix - Team Assignments

Based on the filled out Teams Matrix Table 1, we were able to get a better grasp of what positions that people in the team wanted to fulfill all this semester and next semester.

3 Project Quality Function Deployment Chart

3.1 QFD Chart

The QFD chart's methodology is created in response to a problem: It's focused on providing a clear framework for addressing customer needs, beginning with a matrix called the House of Quality.
Some aspects we deem important for the Customers include:

- GPS Tracking
- Concealability
- Low cost
- Long battery life
- Comfortability
- Aesthetically pleasing
- Shocking power
- Durability
- Intuitive App Interface
- Size Adjustability

While identifying important factors consumers, for our prototype production, some Quality Characteristics include:

- Low Power consumption
- Lightweight
- Insulated from user
- Affordability
- Emergency contact time
- GPS Location accuracy
- Current Discharge
- Coverage of Stun Gun
- Product dimensions
- Long Shock range*

*: no longer a requirement (11/23/2021).

As shown in Figure 3, our team identifies some relationships between the two factors. Also, we were able to analyze some our competitors when it came to those same facotrs.

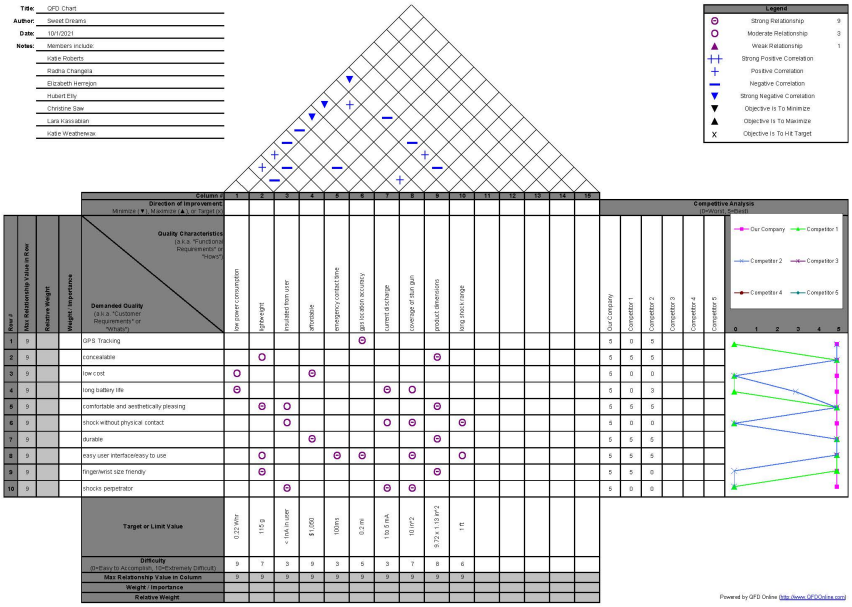

Figure 3: Quality Function Deployment Chart

SIGNATURE: *Elizabeth Herrejon* DATE: 10/1/2021

4 Technical Review Paper

4.1 Section Assignments

For this assignment, when it came to splitting research, I chose to research more about material selection for the ring and bracelet. I was really intrigued with this subject as the material needed to be conductive in order to hold the charge but also pliable enough to work with at a small scale. Another factor I wanted to consider was rust and longevity. With this ring, hopefully, always on the hand, knowing of the materials expected lifetime is important as that affects the way we design the ring.

A Look Into the Material World With Self Defense Weapons

Elizabeth Herrejon

College of Electrical Engineering
Georgia Institute of Technology

1. Introduction

Compared to many areas of the world, North America is considered a place where women have equal rights and status. There are no formal prohibitions against women's autonomous functioning or restrictions on access to jobs or education. Despite this, violence against women is epidemic in North America, including homicide, assault, domestic violence, incest and child abuse, rape, and elder abuse [1]. In most cases, the violence goes undetected and gets dismissed when brought to the police or the court. In North America, the concept of violence has expanded to include categories such as sexual harassment, breaches of fiduciary trust, and stalking. It is impossible to end all forms of violence, but it is possible to help prevent more attacks from occurring.

2. Existing Products

With all the violence against women going unchecked, it is apparent that it is up to each woman to equip herself with tools and weapons to guard off these possibilities. As such, the weapon has to fit specific criteria to be helpful against such attacks.

2.1. Material Breakdown

Mechanical properties (elasticity, hardness, ductility, viscosity, etc.) characterize the ability of a material to resist deformation and fracture. Surface hardening of steel is essential for various fields of application. To test the steel's mechanical properties, an approach would be to "modify the surface or near-surface layer of the steel itself without special building up or enlarging the size of a workpiece" [2]. This method allows a more selective and localized hardening (heating and quenching, selective nitriding, titanium-carbon diffusion, ion implantation, laser hardening, etc.) [2], [3]. When choosing a material, it is imperative to know what materials to allocate to different applications. For jewelry, there are many metals but the most common is 316L Stainless Steel

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(SS). 316L SS is very durable, corrosion-resistant, and effortlessly polished. The maintenance and long-wear certainly attract many jewelers to this metal. While a great choice, it is also relevant that the composition of the 316L SS must not have too much Nickel in it. According to Catlogix, more nickel can sometimes cause irritation and an allergic reaction on human skin. Stainless steel 316 contains 10-13% nickel and according to the EU directives on Nickel ion migration, 316L SS has to leach less than 0.2 µg/cm2/week for post assemblies. This could still be too much for people with nickel allergies or who are hypersensitive [4].

After having picked the metal, calculations of its quasistatic hardness is measured by using Vickers and Berkovich indenters, respectively, as the arithmetic mean by following formulas:

$$H_{miV} = 2P/d^2 \tag{1}$$

$$H_{miB} = 1.74P/l^2 \tag{2}$$

where P is the load on the indenter, d is the diagonal of the Vickers imprint, l is the triangle height of the Berkovich indentation projection [2].

With the formulas and experiments set up, it shows that a decrease in hardness accompanies an increase in the indenter load. The formation of a fine-grained structure was detected both in the indentation and in the scratch methods. This indicates that at low loads (P =10, 20 mN) on the metal, deformation around the load impact zone propagates around a small area. Higher loads (P = 20-2000mN) can cause a strain on the metal, leading to microscopic scratches and a more significant impact area.

Grabco found that the steps inside the scratches represent the traces of the indenter edges and serve as proof of the jump-like (stick-slip) nature of the scratch formation [2], [3]. . As a result, while under a concentrated load, the 316L SS performed well and showed it could withstand several types of concentrated loads.

The data obtained in this work expand the understanding of the deformation mechanisms of the austenitic steel AISI 316L, which can be useful for its practical application.

2.2. Competitors

Knowing more about the common and specific features of 316L SS, it is evident that using such metal will not only withstand rusting and long wear, but maintain its hardness and overall condition. The company Defender Rings [5], has already taken advantage of such metal. Defender Rings has produced a wearable ring with a blade underneath a protection bead. The band and blade weapon are made of 316L Stainless Steel, again known for its strength, durability, corrosion resistance, and hypoallergenic properties while the ring tops are made of different materials including 925

Sterling Silver, 316L Stainless Steel, 14K Gold, Rose Gold, and Colored Enamels. While the design provides for a use for strength and durability, the ring top is still mechanical and requires the user to manually remove it for use.

Another competitor, invisaWear [6], has a different functionality than from Defender Rings. invisaWear acts as a bracelet that when pressed a certain number of times, contacts the authorities and notifies 5 of the pre-defined emergency contacts. The invisaWear charm is made out of brass. The gold charms are plated in 14k gold and the silver invisaWears are plated in Rhodium. The backside of the invisaWear charm is plastic so that it can be easily pressed. While convenient, it not made out of a material that is durable enough to withstand an impact.

3. Electrical Properties

As it is impertinent to have a material that conducts electricity well, 316SS has an Electrical Resistivity 7.4e-005 ohm-cm at 20ºC [7]. The best metal conductor, such as hard-drawn copper, has an Electrical Resistivity of 1.77e-06 ohm-cm. The 316SS has relatively high conductivities and low resistivities which makes it a conductor.

On the market, ADVANCED TASERS currently are made up of the following:

- Recycled plastic grocery bags.
- Sonic welded, molded, high impact polymer.
- Machined alloy.
- Lightweight metal.[8]

For the product, it is imperative to continue to gather more research on the best conductive materials for the casing and the inside of the ring. Able to conduct and withstand most impacts, 316L SS is the best option.

4. Conclusions

Studies have shown that various testing methods (submicro-, microindentation and micro-scratching) create similar patterns of plastic deformation in thin surface layers 316SS material. With the inherent stick-slip nature of the scratching process, it is found that load growth leads to a decrease in hardness under submicro-, microindentation and microscratching for all applied methods [2]. This method affects the mechanical characteristics that should be taken into account when considering the practical purpose of the AISI 316L austenitic steel products in self defense weapons. Considering a combative, long use, and resistant application of the product, 316SS is not only a decent conductor, able to carry the charge of the stun gun, it is able to withstand a hard impact by a possible physical altercation.

5 Project Gantt and PERT Analysis

5.1 Gantt Chart

Purpose The purpose of a gantt chart 4 is to equip the team with the tools you need to oversee every aspect of the project by scheduling, assigning, and tracking project tasks from kickoff to completion.
The Gantt chart is important in our project management because it puts the plan at the center of our project. And when its at the forefront, it was easier for everyone to know what to expect and what it will take to deliver the project on time and budget.

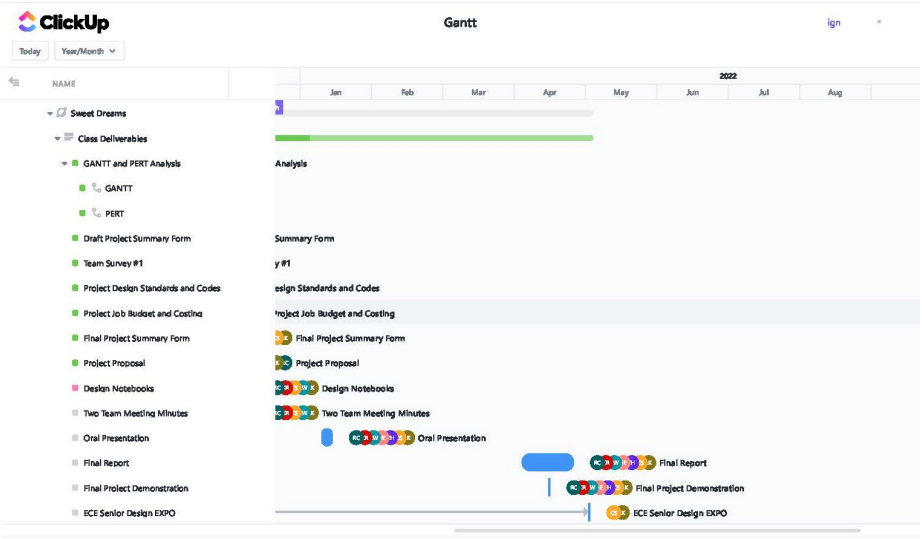

Figure 4: GANTT Chart ClickUP

Another option to view the Complete Gantt Chart is located here at ClickUP Gantt Chart.

5.2 PERT Analysis

Reflection While visualizing the Gantt Chart at a horizontal scale, I ended up finding it easier to follow the trajectory-like path of the PERT chart 5. With task orientated features in mind, it was useful to view the project's tasks on one page with a flowchart. We were able to narrow down what exactly we wanted the product to complete by the end of next semester.
For our Analysis, it was required that we answer a questionnaire sheet to complete the task of our understanding.

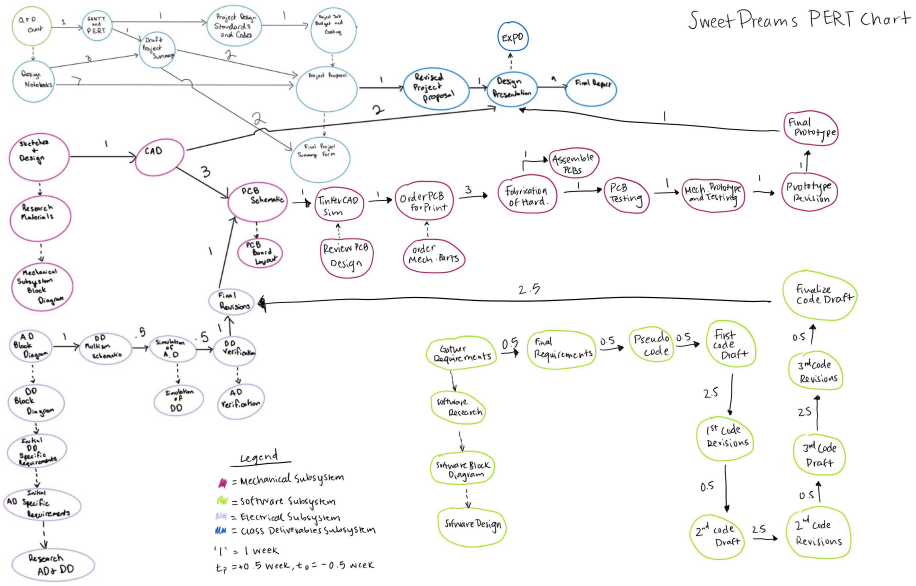

Figure 5: PERT Chart Analysis

Sweet Dreams Answers

Using a PERT analysis, did the critical path(s) change?

1. No, it did not. We designed the GANTT with the critical path in mind. Therefore, through using PERT analysis, our critical paths did not change.

What is the expected duration of your project?

2. 30 weeks and/or 210 days is the expected duration of the project.

What is the expected standard deviation for the critical path?

3. $\sigma = \left[\frac{t_p - t_o}{6}\right] = \frac{30}{6} = 5$

What is the probability of finishing the project one week prior to the Design Expo?

4. The probability of the finishing project will be as follows,

$$z_s = \frac{(T_s - T_e)}{\sigma_T}$$

$$z_s = \frac{(31 - 30)}{5}$$

$$z_s = 0.20$$

$$0.4013 = 0.20$$

$$\rightarrow 40.13\%$$

6 Draft Project Summary Form

6.1 Purpose

The project summary is one of the most important parts of the proposal. It is our first form that a potential reviewer will read, and its our best chance to grab their interest, and convince them of the importance, and quality, of the research before they even read the proposal.

ECE4011/ECE 4012 Project Summary

Project Title	Sweet Dreams
Team Members (Names and majors)	Katie Weatherwax (EE) Katie Roberts (EE) Elizabeth H (EE) Christine Saw (EE) Radha Changela (EE) Lara Kassabian (EE) Hubert Elly (EE)
Advisor / Section	Dr. Hasler
Semester	2021/Fall Circle: Either Intermediate (ECE4011) or Final (ECE4012)
Project Abstract (250-300 words)	(10-point font, single spaced) This project will produce a prototype of a wearable self-defense weapon. The main components of this device will be: ability to shock perpetrator, track GPS location of device, identify if user is unconscious, and monitor other health stats possible via the developed app. In addition to these technical requirements, the final product will be concealable, affordable, durable, easy to use, and adjustable for each wearer. Currently there is not one product that fits all of the requirements listed above. This product will consist of a conductive nanocircuit with bluetooth, network, and power usage and consumption capabilities. There will an external USB-C port for recharging. The subject will be able to monitor and record their personal information on the companion app that will be able to show location and notify designated emergency contacts in case of emergency. The programming language used will depend on external app building and the hardware utilized in the actual product. The subject will be able to trigger the device via an external gem, acting as a switch. The device tracks the acceleration and pressure so when either has been changed by defined criteria, the device will emit a charge that is insulated by the gem and release that charge in order to shock the perpetrator. The general circuitry will be a hybrid of a typical stun gun and taser, where the electrodes are not necessarily linearly travel the length of the taser but more disperse in a certain area. When the user triggers the stun gun feature, the app will notify the emergency contacts with the time and the location of use.

SIGNATURE: *Elizabeth Herrejon* DATE: 10/22/2021

Project Title	Sweet Dreams
List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	(10-point font, single spaced) IEEE (Institute of Electrical and Electronics Engineers) P360 standards for wearable consumer electronic devices will significantly affect the design of our project. As it will be wearable electronic device, there are many codes that would limit the current and voltage that can be used to protect the safety of the user. IEC 60479 Effects of current on human beings and livestock will also affect the design as the taser will be used on a human. Understanding the effects of current used on a human will affect the amount of current we are allowed to use in the device.
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	(10-point font, single spaced) Design constraints that apply to the project are the size and weight of a piece of jewelry that could be. The bracelet will be the main source of power and electronic storage which means the electronics will have to be small and light for the user to want to be able to use. Another constraint is the size of the stun gun circuitry. Since we are looking to fit the circuit on the ring (~inch wide in diameter), we must look for ways to miniaturize the transformer, battery, and other electronic components.
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	(10-point font, single spaced) Due to the size of the design, there will be limitations on the output voltage of the stun gun. Thus, we may consider making a flash gun instead of a stun gun. The power could also be a tradeoff, lower voltage for a smaller battery.
Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions. *Complete if applicable; required if team includes CMPE majors.*	(10-point font, single spaced) The computing aspects of the project will be focused on the GPS tracking and heart rate detection for the device. The heart rate detection will be a hardware-software interface that will allow the hardware to detect the microscopic pulsations on the surface of the skin with the software to calculate the heart rate. The GPS will also be another software and hardware interface as we will need a GPS hardware component to calculate position and acceleration. Something that will be purely software is the triggering of the taser, contraction pre-chosen contacts, and interacting with an app/phone.

SIGNATURE: *Elizabeth Herrejon* DATE: 10/22/2021

Project Title	Sweet Dreams
Leadership Roles (ECE4011 & forecasted for ECE4012) (NOTE: ECE4012 requires definition of additional leadership roles including: 1.Webmaster 2. Expo coordinator 3. Documentation	Webmaster: Hubert Elly Expo Coordinator: Katie Weatherwax Documentation: Radha Changela Electrical Lead: Katie Roberts Mechanical Lead: Lara Kassabian Software Lead: Christine Saw Leadership Coordinator: Elizabeth Herrejon
International Program: Global Issues (Less than one page) (Only teams with one or more International Program participants need to complete this section)	(10-point font, single spaced) No team members are a part of the international program.

SIGNATURE: *Elizabeth Herrejon* DATE: 10/22/2021

7 Assignment Project Design Standards Codes

7.1 Purpose

The Project codes are used to distinguish requisitions and related documentation and shipments, and to accumulate Service/Agency (S/A) performance and cost data related to exercises, maneuvers, and other distinct programs, projects, and operations.
Finding the codes were able to open many questions about our previous idea of how we wanted to design the product. With the research done on each standard, we came to the conlcusion that the former "taser" gun would be difficult to implement in all 50 states due to legality. We therefore focused on completing the build using a stun gun circuitry.

Project Design:
Standards and Codes

Sweet Dreams

October 29, 2021

IEEE P360 - IEEE Draft Standard for Wearable Consumer Electronic Devices - Overview and Architecture

The IEEE Standard for Wearable Consumer Electronic Devices is significant to our project as it outlines the specific technological requirements to make wearable devices secure and suitable for wear. The code affects our design as it defines technical requirements and testing methods that we will have to follow to make the device safe [1].

IEC 60601-1 Medical Design Standards for Power Supplies

IEC 60601-1 is a series of technical standards for the safety and effectiveness of medical electrical equipment [2]. It is significant to our project as it addresses the basic safety and essential performance requirements of medical electrical equipment. Our project revolves around a self-defense wearable that may collect heart rate data. The standards give us guidance on the product requirements such as isolation, creepage and insulation clearance to ensure the device is safe for the user. However, not all countries do not comply with the same requirements. For example, China and Taiwan have only adopted the 2nd edition of the standard but the United States, Canada, and Europe have already fully adopted the 4th edition requirements [2]. Therefore, when making design decisions, we must take additional consideration into our market to ease the compliance process.

IEC 60335-2-76 Ed 2.1 Household and similar electrical appliances – Safety

The International Electrotechnical Commission (IEC) household and similar electrical appliances standard is important to our project as it sets the safety requirements for electroshock devices. This standard affects our design as it sets a limitation on the maximum rated voltage of our stun gun [3].

UL 69 Standard for Electric-Fence Controllers

The UL 69 standard may be meant for electric-fence controllers used only for the control of animals but is still used to verify the safety for Conducted Electrical Weapons (CEW) [4]. During two IEEE conferences, papers were released detailing how the safety of certain CEWs

relates to relevant standards, “Electrical safety of conducted electrical weapons relative to requirements of relevant electrical standards” [5] and “New conducted electrical weapons: Electrical safety relative to relevant standards” [6]. Both papers consider the UL 69 standard as it covers portable electric-fence controllers with peak-discharge or sinusoidal-discharge output for battery circuits of 42.4 V or less. Our team is creating a non-lethal weapon; therefore, this standard should be used to verify the safety of our device. These standard details load requirements and a Current vs. impulse duration graph [4]; too high of a current or a long impulse can have fatal or harmful effects. This will affect our circuit design for the CEW portion of our final product so that the final device is safe to use.

IEC 60479-1 2 Effects of Current on Human Beings and Livestock

The International Electrotechnical Commission (IEC) Effects of Current on Human Beings and Livestock is significant to our project as it explains the thresholds and limits of current that can pass through the human body. With these standards, it explores the safety concerns with each range of current and consequences with as mild as a tingling sensation and as severe as death. Since our jewelry has a taser, we will be passing a current and a large voltage into a human being and thus our electrical components must be fine-tuned in order to meet the standards and not cause unnecessary harm. These standards will affect our decisions in purchasing components such as capacitors as they must have the correct voltage rating in order to produce the correct range of current. Measurements that will affect these decisions will be the average resistance of the human body (provided within the standards documentation) and the current range the device will operate at [7].

References

[1] “IEEE p360 - IEEE Draft Standard for Wearable Consumer Electronic Devices - overview and Architecture,” IEEE SA - The IEEE Standards Association - Home. [Online]. Available: https://standards.ieee.org/project/360.html. [Accessed: 29-Oct-2021].

[2] “IEC 60601-1 Medical Design Standards for Power Supplies,” CUI Inc, 22-Jul-2020. [Online]. Available: https://www.cui.com/catalog/resource/iec-60601-1-medical-design-standards. [Accessed: 29-Oct-2021].

[3] “IEC 60335-2-76:2018, Household and similar electrical appliances - Safety - Part 2-76: Particular requirements for electric fence energizers,” IEC Webstore, 29-Jun-2018. [Online]. Available: https://webstore.iec.ch/publication/60232 [Accessed: 29-Oct-2021].

[4] Underwriters Laboratories, UL Standard for Electric-Fence Controllers, UL 69 10th Ed, 2009, Northbrook, IL: UL Laboratories.

[5] D. Panescu, M. Nerheim and M. Kroll, "Electrical safety of conducted electrical weapons relative to requirements of relevant electrical standards," 2013 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2013, pp. 5342-5347, doi: 10.1109/EMBC.2013.6610756.

[6] D. Panescu, M. Nerheim, M. W. Kroll and M. A. Brave, "New conducted electrical weapons: Electrical safety relative to relevant standards," 2017 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2017, pp. 2185-2190, doi: 10.1109/EMBC.2017.8037288.

[7] “Effects of current on human beings and livestock - Part 1: General aspects,” IEC 60479-1:2018 | IEC Webstore, 13-Dec-2018. [Online]. Available: https://webstore.iec.ch/publication/62980. [Accessed: 29-Oct-2021]

SIGNATURE: *Elizabeth Herrejon* DATE: 10/29/2021

8 Project Job Budget & Costing

8.1 Cost Anaylsis

The cost of engineers (the biggest cost) was estimated using a recent offer letter granted to one of our group members for an entry level position. We also assumed that the engineers will be working 3 months full time in order to get this porotype prepared for market/demonstration. We also assume one month is needed for marketing. The price of parts was estimated from the following article, Teardown: Inside the fitbit charge [1]. In the article an engineer strips down the parts of a Fitbit and calculates how much each component costs and the production cost. The total cost of production for the Fitbit is $17.36 we then added another $10 for parts and PCB design to account for the additional ring and taser circuitry needed. We determined the price for each unit to be $100. We thought this was a fair price as most Fitbits (which we are using as a model) cost at least a $100 and our product also has the added feature of a ring with a taser component for self-defense. This will make our product very marketable especially with the competitive price. For future changes, we can reevaluate the price of the unit and increase it depending on first year sales.

[1] L. Teschler, C. Says, Clayton, L. T. says, M. says, Marty, and Getting your Steps In!Doggone Healthy Choices says: "Teardown: Inside the fitbit charge," Microcontroller Tips, 27-Sep-2016. [Online]. Available: https://www.microcontrollertips.com/inside-fitbit-charge/. [Accessed: 12-Nov-2021].

9 Project Proposal

9.1 Contribution

From the last cost analysis, I elaborated more on the concept of what parts needed to be acquired, specifically, for the Fitbit adapted wristband. Listing and sourcing all the components that are used in the Fitbit will help in the long run when it is necessary to reverse engeineer and hack the bracelet to our needs for this project. Also, I was able to comment and see the overall flow of the project proposal.

Stun Gun Self Defense Ring and Bracelet

ECE4871 Senior Design Project

Section L01, Team Sweet Dreams

Project Advisor, Dr. Jennifer Hasler

Radha Changela, EE, rchangela3@gatech.edu

Hubert Elly, EE, helly3@gatech.edu

Elizabeth Herrejon, EE, eherrejon3@gatech.edu

Lara Kassabian, EE, lkassabian6@gatech.edu

Katie Roberts, EE, kroberts73@gatech.edu

Christine Saw, EE, csaw3@gatech.edu

Katie Weatherwax, EE, kweatherwax3@gatech.edu

Submitted

November 22, 2021

SIGNATURE: *Elizabeth Herrejon* DATE: 11/22/2021

Table of Contents

Executive Summary

The world is a dangerous place, especially for women, as one in five women are sexually assaulted during their time at college [1]. This is a major problem that Sweet Dreams has decided to find a solution to. Sweet Dreams' Self Defense Jewelry is a bracelet and ring combo made to protect the user while looking fashionable and unassuming. The main goal of this product is to protect the user from a variety of dangerous situations. With that goal in mind, Sweet Dream strived to find a solution that no one would suspect to be a weapon, would be hard for the user to lose, and be effective in defense. In the end, it was agreed upon to create the jewelry set.

The bracelet component holds a majority of the electronic components such as the battery, GPS, Bluetooth, heart rate monitor, and circuitry for a stun gun. All of these would be assembled using integrated circuits on a PCB inside the bracelet. The bracelet then connects to the ring through an optic cable. The ring contains electrodes, so when the user punches an attacker, it triggers the stun gun circuit in the bracelet, which sends the charge through the cable out the electrodes and shocks the attacker on contact. The design will cost $47 to produce.

The design works such that when the user feels unsafe, she can press a button on the side of the bracelet, which would charge the stun gun circuit and notify her five prechosen contacts that she feels unsafe. Then when she punches an attacker, this will cause the stun gun circuit to discharge, shocking the attacker and notifying the police. Also, if the user's heart rate drops below a given threshold (i.e., she has been knocked out), the product will notify her contacts as well. The design stands apart from competitors as other products only focus on one feature or the other, those features being defense or notifying loved ones, while Sweet Dreams' product does both. The product is set to be sold for $100, but the lives it will save are priceless.

1. Introduction

Sweet Dreams is a team requesting $301,000 in funding to develop a self-defense ring and bracelet set. Today, it is normal for women to be hyperaware of their surroundings as they navigate unpresuming lives. It has also become customary for women to buy pepper spray, pocketknife, brass knuckles, and more to keep themselves safe. However, all these products are hard to use, clanky and evident to the attacker, and are often not allowed into public events, a place where tools like this would be important. Our product is designed to shock the attacker while being discrete and stylish for the user. The bracelet ring combo will have the main components of the ability to shock the perpetrator, track the location of the user and device through GPS, and monitor the user's heart rate to identify if the user is alive. In addition to the technical requirements, the final product will be discrete, affordable, durable, easy to use, and adjustable for users. The product will consist of a conductive nanocircuit with a Bluetooth network and power usage and consumption capabilities. There will be an external USB-C port for recharging. The technical challenges that will be faced are the small size that the electronics will have to be lightweight for the customer, wearable electronics codes and standards [2], and weapons regulations at events.

The primary desired solution is the one described with the bracelet and ring combo acting as a stun gun. The successful completion of this design will be demonstrated by a successful current discharge from the ring's electrocution after meeting all the right conditions/triggers. This will be measured by either having a multimeter measure the current discharge or asking for a volunteer to pretend to be the attacker. However, there are many technical obstacles between now and the successful completion of the product; therefore, a backup solution would be to make the ring into a flashlight instead of a stun gun. Therefore, the ring will emit a bright light blinding the attacker.

This will be easier to implement as concerns about insulation will become obsolete, and no physical contact between the user and attacker will be needed.

The rest of the document will go into more detail about the specific design and goals. Then it will become more technical as the technical specifications are explained and how they fit in the design. The design description will explore the justification, engineering analysis, and codes and standards affecting the project. Then the document takes another shift by focusing more on the logistics such as scheduling, marketing, and cost analysis. The document then wraps up with a brief description of the project's status and the delegated leadership roles.

2. Project Description, Customer Requirements, and Goals

The user will be able to monitor their heart rate and GPS location in an accompanying app that can hold emergency contacts to contact in case of use of the weapon.

The requirements for the customers are that the product has/is:

- concealable,
- GPS tracking,
- long battery life.
- low cost,
- comfortable while aesthetically pleasing,
- durable,
- user friendly,
- and, shocks the perpetrator.

All the requirements for the customers align with the hopes of the company and steps will be taken to ensure that all the requirements are met.

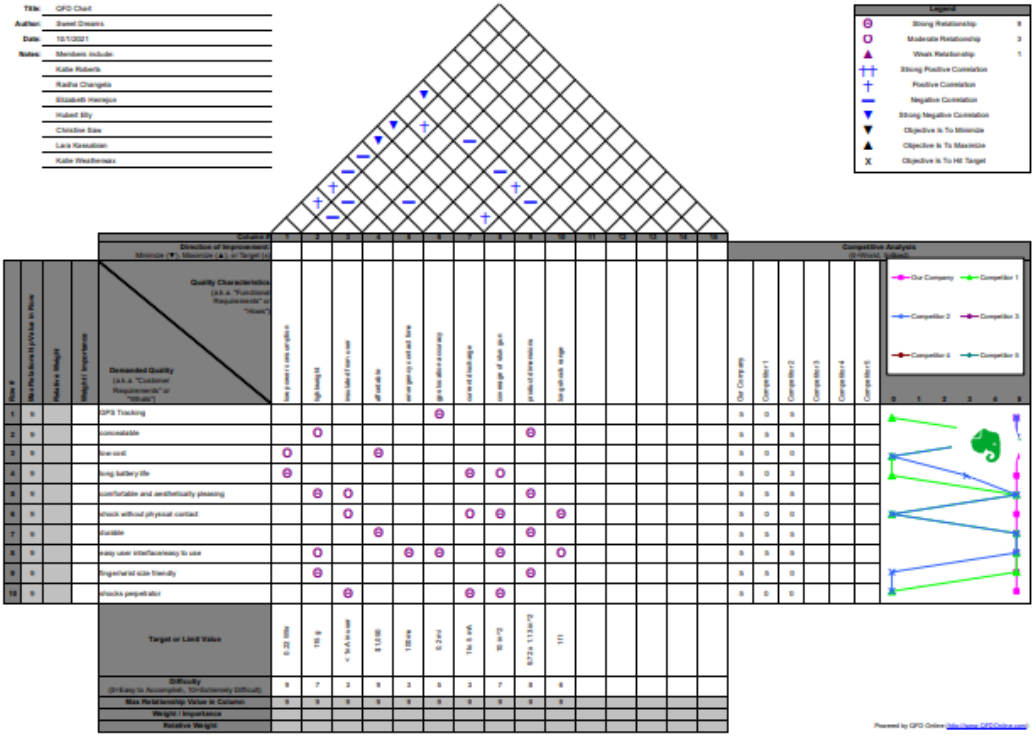

Figure 1. A QFD aligning customer requirements, design elements, and competitor analysis.

3. Technical Specifications

Table 1 contains the specific engineering requirement that will be used to determine the final product design.

Table 1. Engineering Requirements

Technical Requirement	Target/Limits	Reasoning
Low Power Consumption	0.22 Watt-hours	Longer lasting battery life so that users are protected for an extended period of time.
Lightweight	115 g	Not cumbersome for the user to wear so they are more likely to wear it for protection.

Insulated from User	<1 nA in user	Insulation is important to protect the user from accidental electrocution or shocking.
Affordable	<$1050 production costs	To expand product outreach, the product should be reasonably priced so that more women can afford it as a self defense object.
Emergency Contact Time	100 ms	Contacts should be notified as soon as possible so that help can reach the user quickly.
GPS Location Accuracy	0.2 mi	A higher location accuracy can guarantee higher chances of the user's emergency contacts and the police locating them.
Current Discharge	1 mA - 3 mA	The higher the current discharge, the more damage the attacker receives. However, current cannot be too high to cause permanent damage to the attacker.
Coverage of Stun Gun	10 in^2	The wider the coverage of the stun gun, the more pain the attacker will feel, which should reduce chances of the attacker attacking a second time.
Product Dimension	9.72 x 1.13 in^2	The product dimension needs to be small and compact so that it is not bulky for the user to wear. Also, the smaller it is the less likely the attacker will identify it as a weapon.

4. Design Approach

4.1 Design Concept Ideation, Constraints, Alternatives, and Tradeoffs

There are two main components to the device: the ring and the bracelet. The bracelet, inspired by Fitbit, will draw upon many open-source circuits and software. The primary purpose of the bracelet is to hold most of the electrical components such as the power supply, GPS, Bluetooth, heart rate monitor, and the stun gun circuitry. The bracelet will have most of the

components since it will have the most space to work with. It will be modeled after a Fitbit with added circuitry for the stun gun.

The stun gun/shocking circuit's main component is a high voltage capacitor. The circuit has a switch in it that remains open for regular operation. However, there is a button on the side of the bracelet that the user can press when feeling unsafe. This causes the switch to close, and the capacitor begins charging. The pressing of the button also triggers the software to notify the five prechosen emergency contacts that the user feels unsafe. The bracelet connects to the ring through a PTFE dielectric coaxial cable. The ring acts as the shocking device, having the main "gemstone" area being the contact point between the circuit and the attacker. As soon as the user punches the attacker applying force to the "gemstone" area of the ring, another switch activates in the stun gun circuitry. This causes the switch to open, allowing the capacitor to discharge and carry the current through a cable to the ring. The current then exits from the electrodes on the ring, shocking the attacker.

The idea of stun gun jewelry has many constraints in the form of predefined codes and standards. For example, great care must be taken into setting the output current as it must remain between one to three milliamps. Also, the design must implement specific insulation guidelines to protect the user from getting shocked when punching the attacker.

Due to these constraints and many technical concerns, the team has decided on a backup plan. The alternative solution is to implement a bright "flash" device to blind the attacker temporarily instead of shocking them. This design would have fewer standards and safety concerns to deal with and would not require as much insulation. However, the jewelry becomes less focused on self-defense and more focused on prevention. Through plenty of research, it was determined that the shocking device would be the most lightweight and affordable solution.

4.2 Preliminary Concept Selection and Justification

At the beginning of the semester, many ideas were discussed on the topic of self-defense jewelry. For example, the first design solution was to have the ring acting as a chainsaw to help women break out if they were tied up. However, the technical obstacles (and the unrealistic design) were soon scrapped. The next idea explored was of a taser ring with electrodes shooting out of the ring allowing the user to attack from a distance. This idea was favored for a while, but after research, it was discovered that there were too many complicated laws and policies regarding tasers. This, along with the technical obstacle of having electrodes shoot out of the ring, made the group reject the idea.

It was then decided to take the taser idea and simplify it to a stun gun as stun guns had fewer legal concerns, more straightforward technical requirements, and would ultimately work out for the user better. The idea of a stun-gun ring with a GPS tracker bracelet worked well for our customer requirements listed in the table below.

Table 2 contains the demanded quality or customer requirements that will be implemented into the final design of the product.

Table 2. Customer Requirements

Customer Requirements	Reasoning
GPS Tracking	Allow users to get help when in emergency situations. This feature is currently present in similar products.
Concealable	Product should not look like a weapon so that users can wear it all day without perpetrators identifying it as a weapon.
Low Cost	The goal is to equip as many women as possible so that they can be safer; therefore, it needs to be reasonably priced to expand product outreach.

Long Battery Life	Allows users to use the product in emergency situations for an extended period of time without worrying about product running out of battery.
Comfortable and Aesthetically Pleasing	Product is meant to be worn and seen all day.
Durable	Allows users to use product for a long time.
Easy User Interface/ Easy to Use	Allows users of any technical background to use the product in emergency situations without confusion.
Finger/ Wrist Size Friendly	Allows all users to use and wear the product comfortably.
Shocks Perpetrator	Allows users to fight off perpetrator when being attacked.

After discussing and researching stun guns and wearable jewelry, the solution of a stun gun self-defense ring and bracelet set was the best course of action. This solution not only defends the customer and meets all customer requirements but also has obtainable technical specifications that would be easier to implement.

4.3 Engineering Analyses and Experiment

Research on modern technologies such as heart-rate monitors and prank gum proves that functional heart rate circuits and shock circuits are entirely possible. The heart rate circuit exists in Fitbits and open-source forums, while the shock circuit exists in prank gum and stun guns. No experiments have been completed at the time of this proposal to determine the reliability of these circuits. However, due to the popularity and reviews of Fitbits, it is predicted that using a similar heart rate monitor circuit will function as well. Similarly, with the shock circuit, stun guns and prank gum are widely used and functional. Applying the shock circuit technology of these modern contraptions into the stun gun jewelry device is possible. Other parts of the device like the GPS tracker will also be based on currently available products.

To ensure the prototype meets specifications and functions as designed, the following tests will be conducted:

1. Testing the shock circuit:
    a. The voltage and current will be measured across the electrodes when a button is pressed to close the circuit.
2. Testing the heart rate monitor:
    a. Person A will wear the device prototype while Person B counts Person A's heart rate using their fingers and a stopwatch. The prototype's display should match up to the calculated heart rate. Another method includes Person A wearing the device prototype while staying connected to a heart rate monitor and comparing both devices' final heart rate values, checking if they match.
3. Testing the GPS:
    a. Person A will move the prototype to various locations and ask Person B if the GPS display shows the correct locations. Another method includes Person A comparing their location displayed from the prototype with another smartphone's GPS map tracking their location.
4. Testing the alert system:
    a. Person B will enter their phone number into the software. Person A will press the alert button on the prototype circuit and Person B will verify that they received an alert message.

As of this proposal, no tests have been conducted as there are no prototypes. Tests will be conducted as soon as the prototypes have been created.

4.4 Codes and Standards

IEEE P360 - IEEE Draft Standard for Wearable Consumer Electronic Devices - Overview and Architecture

The IEEE Standard for Wearable Consumer Electronic Devices is significant to our project as it outlines the specific technological requirements to make wearable devices secure and suitable for wear. The code affects our design as it defines technical requirements and testing methods that we will have to follow to make the device safe [3].

IEC 60335-2-76 Ed 2.1 Household and similar electrical appliances – Safety

The International Electrotechnical Commission (IEC) household and similar electrical appliances standard is important to our project as it sets the safety requirements for electroshock devices. This standard affects our design as it sets a limitation on the maximum rated voltage of our stun gun [4].

IEC 60479-1 & 2 Effects of current on human beings and livestock

The International Electrotechnical Commission (IEC) Effects of Current on Human Beings and Livestock is significant to our project as it explains the thresholds and limits of current that can pass through the human body. With these standards, it explores the safety concerns with each range of current and consequences with as mild as a tingling sensation and as severe as death [5]. Since our jewelry has a stun gun, we will be passing a current and a large voltage into a human being and thus our electrical components must be fine-tuned to meet the standards and not cause unnecessary harm. These standards will affect our decisions in purchasing components such as capacitors as they must have the correct voltage rating to produce the correct range of current. Measurements that will affect these decisions will be the average resistance of the

human body (provided within the standards documentation) and the current range the device will operate at.

IEC 60601-1 Medical Design Standards for Power Supplies

IEC 60601-1 is a series of technical standards for the safety and effectiveness of medical electrical equipment [6]. It is significant to our project as it addresses the basic safety and essential performance requirements of medical electrical equipment. Our project revolves around a self-defense wearable that may collect heart rate data. The standards give us guidance on the product requirements such as isolation, creepage and insulation clearance to ensure the device is safe for the user. However, not all countries comply with the same requirements. For example, China and Taiwan have only adopted the 2nd edition of the standard but the United States, Canada, and Europe have already fully adopted the 4th edition requirements [6]. Therefore, when making design decisions, we must take additional consideration into our market to ease the compliance process.

UL 69 Standard for Electric-Fence Controllers

The UL 69 standard may be meant for electric-fence controllers used only for the control of animals but is still used to verify the safety for Conducted Electrical Weapons (CEW) [7]. During two IEEE conferences, papers were released detailing how the safety of certain CEWs relates to relevant standards, “Electrical safety of conducted electrical weapons relative to requirements of relevant electrical standards” [8] and “New conducted electrical weapons: Electrical safety relative to relevant standards” [9]. Both papers consider the UL 69 standard as it covers portable electric-fence controllers with peak-discharge or sinusoidal-discharge output for battery circuits of 42.4 V or less. Our team is creating a non-lethal weapon; therefore, this standard should be used to verify the safety of our device. These standards detail load

requirements and a current vs. impulse duration graph [7]; too high of a current or a long impulse can have fatal or harmful effects. This will affect our circuit design for the CEW portion of our final product; it is needed to ensure that the final device is safe to use.

5. Project Demonstration

5.1 Stun Gun Demonstration

To demonstrate the stun gun wearable jewelry, two tests will be conducted. The first test will not involve any person to test the technical requirements. The stun gun jewelry will be placed on a lab bench with the ring's electrodes connected to a digital multimeter. We will then go through the correct sequence of events to trigger the stun gun circuit as follows:

1. Press the safety button. This button triggers the software to start charging the stun gun circuit and notify the emergency contacts the user is feeling unsafe.
    a. During the demonstration, we will show the notifications sent to the emergency contacts.
2. Apply pressure to the ring (substitute to actual event of the user punching the attacker).
    b. This will trigger the stun gun circuitry and release the charge.

With the multimeter attached to the electrodes the current/ discharge will be measured and shown to be in the determined range of 1 to 3 mA. For the next test, two people will demonstrate the stun gun with the following procedure:

1. Person A will equip the device securing the bracelet around the wrist and the ring on any finger of their choosing. After adjusting the fit securely, the user will press the safety button triggering the above sequence of events.

   a. The first step is to demonstrate the wearable as a lightweight, easy to use device with a comfortable fit, as noted under the customer requirements.
   b. The notification of emergency contacts will be redemonstrated again.

2. Person B will wear rubber, non-conducting gloves. Person A will then punch Person B on the gloves.
   a. The second test will be a real-life demonstration of the product working in an attack while also showing its ease of use. This test will also demonstrate successful insulation when Person A does not feel pain or tingling.

5.2 GPS and Alert System Demonstration

Two people will demonstrate the GPS and alert system with the following procedure:

1. Person A will equip the device in their hand and press the safety button.
2. Person B will hold a phone with the GPS application installed.
3. Person B will enter their phone number into the emergency contacts list.
4. Person A will press the ring onto a hard surface to activate the device.

To verify that the GPS is functioning correctly, Person B will check that their device map shows the user's location within 20 feet of them. To verify the alert system, Person B will receive a text message alert to their phone number.

6. Schedule, Tasks, and Milestones

The Gantt chart in **Appendix A** displays the tasks that must be finalized to complete the device. Each task has an allotted time that is estimated for completion to stay on track. Each sub-team has broken down the necessary steps to complete their portion of the project.

7. Marketing and Cost Analysis

7.1 Marketing Analysis

In the United States, 50% of women feel unsafe walking alone at night, and as a result, 34% and 12% of women carry pepper spray and an alarm, respectively [10]. Wearable and concealable self-defense devices and weapons are not a new concept in the current market for this reason. However, each option typically focuses on one distinct feature. The two current products on the market with the same deliverable feature as the proposed are invisaWear and Defender Ring. InvisaWear is designed as a necklace or bracelet with a button that sends the user's location to emergency dispatchers and their friends and family during an emergency [11]. Defender Ring is a ring with a small hidden blade that can be used during an emergency [12]. These products lack the ability to fight off a perpetrator while notifying emergency dispatchers, including friends and family.

7.2 Cost Analysis

The total development cost for a prototype of the Stun Gun Ring is approximately $100.00. **Tables 3** [13] and **4** [14] below shows a breakdown of the material costs of different components of the prototype. The costliest equipment is the wristband material and custom design built PCB board, intended to minimize cost and optimize functionality at such a small scale.

Table 3. Parts for Teardown: Fitbit Flex

Item	Manufacturer	Quantity	Cost
2-Shot Injection Molded Polycarbonate & Silicone Rubber	Healthy Metrics Research Inc.	1	$20.00
MCU, 32-Bit, ARM Cortex-M3, 32 MHz, 128KB Flash, 16KB SRAM, 24 Channel x 12-Bit ADC	ST MICROELECTRONICS	1	$6.44
Bluetooth, Single-Chip, V4.0LE	NORDIC SEMICONDUCTOR ASA	1	$5.61
Bluetooth USB Dongle	RoHS - TP link	1	$9.99
USB Cables / IEEE 1394 Cables USB Cable, Type A Plug to Type C Plug, USB 2.0, 28 AWG	CUI Devices	1	$5.82
Accelerometer, 3-Axis, ±2g/±4g/±8g/±16g, I2C/SPI digital output interface	ST MICROELECTRONICS	1	$9.97
Lithium Ion Polymer Battery Ideal For Feathers - 3.7V 400mAh	Adafruit Industries LLC	1	$6.95
Vibration Motor, Coin Type, w/ 2 Discrete Insulated Wires	Adafruit Industries LLC	1	$1.95
			$66.73

Table 4. Parts for Stun Gun Circuit on PCB

Item	Price	Quantity	Cost
2SD965 NPN Transistor	0.34	1	$0.34
Fly back Transformer	3.81	1	$3.81
Push button	0.47	1	$0.47
LED	0.61	2	$0.61
PCB	4.00	1	$4.00
Terminal Block 2 pin	1.14	3	$3.42
Resistor 150k	0.15	1	$0.15
Resistor 1k	0.31	3	$0.93
Capacitor 1nF/3KV	0.90	2	$1.80
Capacitor 1000uF	0.99	1	$0.99
Capacitor 470nF/400V	1.68	1	$1.68
Capacitor 105/3KV	0.56	1	$0.56
Power Supply 3v-12v - Battery	1.32	1	$1.32
1N4007 Diode	0.22	7	$1.54
Zenner diode 5.1v	0.22	1	$0.22
On/off switch	0.95	1	$0.95
			$22.79

The development costs shown in **Table 5** were determined with an assumed production cost of $46,000. Overhead costs were factored into the higher costs, specifically with Total Cost/Year, and thus, would affect the Total Cost of Year 1 Adjusted Cost and the Cost/Unit. With a total of $-20,312.50 in Total Profit/Year, it is not until more years go by that we see a steady decrease in Cost/Unit and an increase in Total Profit/Year. The most laborious process will be the assembly of the product as it is predicted to cost $10,000 in its first year.

Table 5. Development Costs

Project Component	Base Cost Year 1 (USD)	Total Cost Year 1 (USD)
Production		
Parts	17.00	$17,000.00
PC Board	8.00	$8,000.00
Assembly	10.00	$10,000.00
Packaging	1.00	$1,000.00
Testing	10.00	$10,000.00
Packaging		
Per/Unit	1.00	$10,000.00
Marketing		
Non-Engineering	30,000.00	$2,500.00
Sales		
Non-Engineering	30,000.00	2,500.00
Distribution		
Shipping Per/Unit	1.50	$1,500.00
Shipping		
Non-Engineering	30,000.00	$2,500.00

Using the overheard as 150% of material and labor, the total development cost for the ring stun gun product is $300,781.25, as shown below in **Table 6**.

Table 6. Total Development Costs

	Base Cost Year 1 (USD)	Total Cost Year 1 (USD)
Parts	$89.52	$120,312.50
Overhead	$47.00	$180,468.75
Adjusted Cost		$300,781.25
Cost/Unit		$120.31
Total Profit/Year		$-20,312.50
Total Profit		$373,137.50

The production run will consist of 1000 units sold over a 5-year period at a price of $100.00 per unit. A group of seven engineers will be employed to work a total of $65,000.00 in the first base year. Sales expense, or marketing and advertising, will make up 6% of the final selling price. With the current prediction of the unit price, the expected revenue is $373,137.50.

8. Current Status

The major features and technical specifications of the device have been determined. Research into the stun gun circuitry and the GPS has already begun. Research so far has mainly been focused on miniaturizing the stun gun circuitry. The electrical components have mostly been decided on for the bracelet, but the stun gun electrical components can still change. Also, research on assembly and how the software and hardware interact still needs to be conducted.

9. Leadership Roles

To better organize the project, each member of the team has been assigned a leadership role. While all members will collaborate to accomplish the tasks of each role, the leader of each role will be held accountable should the tasks assigned to their role fail to be accomplished on time. The current leadership roles and the corresponding tasks are assigned as follows:

- Webmaster (Hubert Elly): creating and designing the product and contact information website
- Expo Coordinator (Katie Weatherwax): organizing and coordinating the end-of-term exposition
- Documentation (Radha Changela): documenting project progress and results
- Electrical Lead (Katie Roberts): designing circuits and assembling electrical components
- Mechanical Lead (Lara Kassabian): device packaging design
- Software Lead (Christine Saw): GPS software design
- Leadership Coordinator (Elizabeth Herrejon): keeping track of the project deadlines and making sure all team members are doing their job

10. References

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Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2013, pp. 5342-5347, doi: 10.1109/EMBC.2013.6610756.

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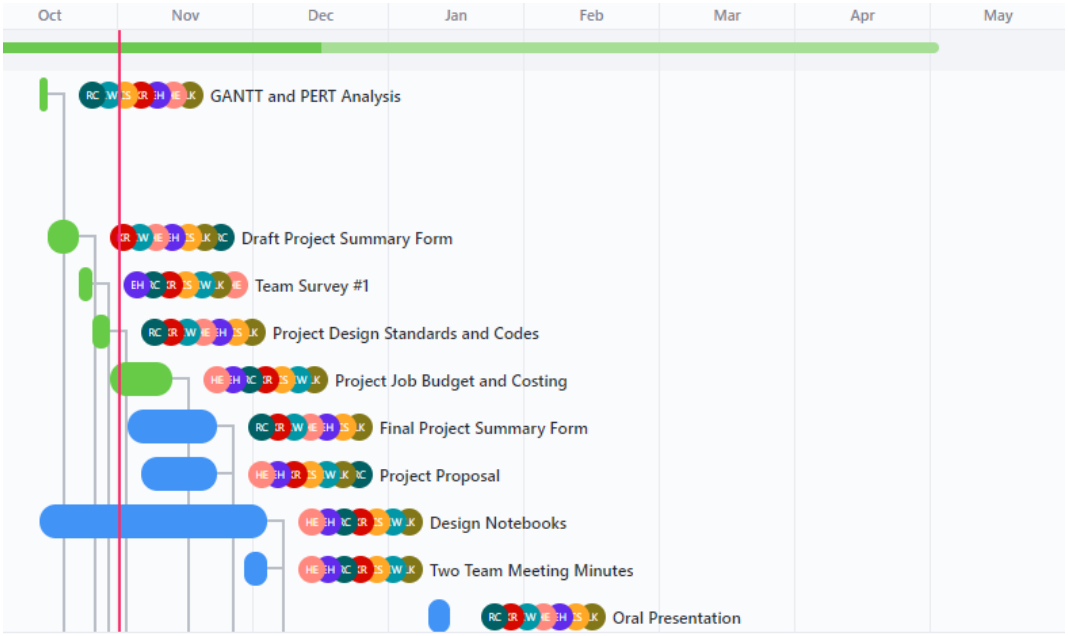
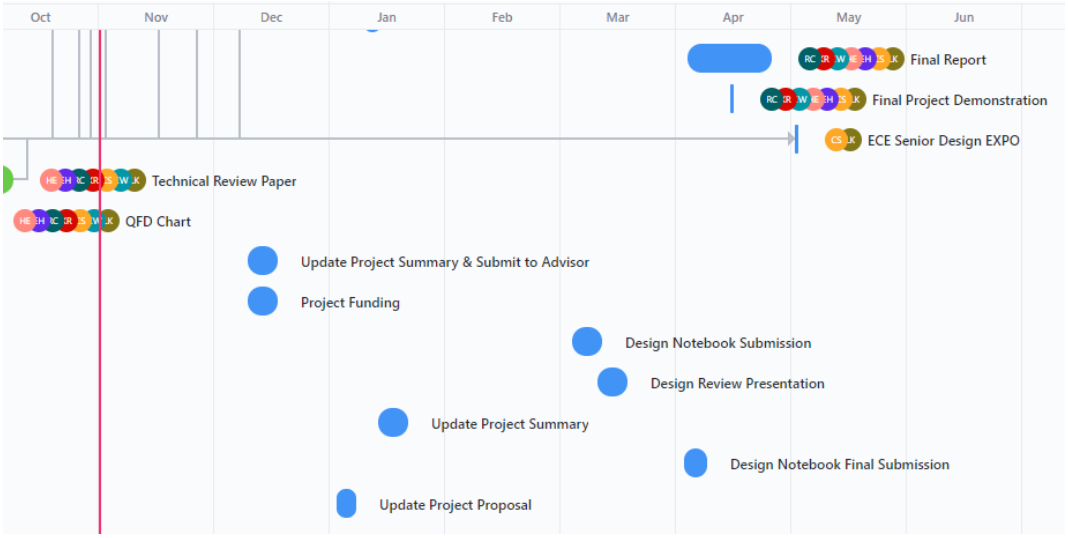
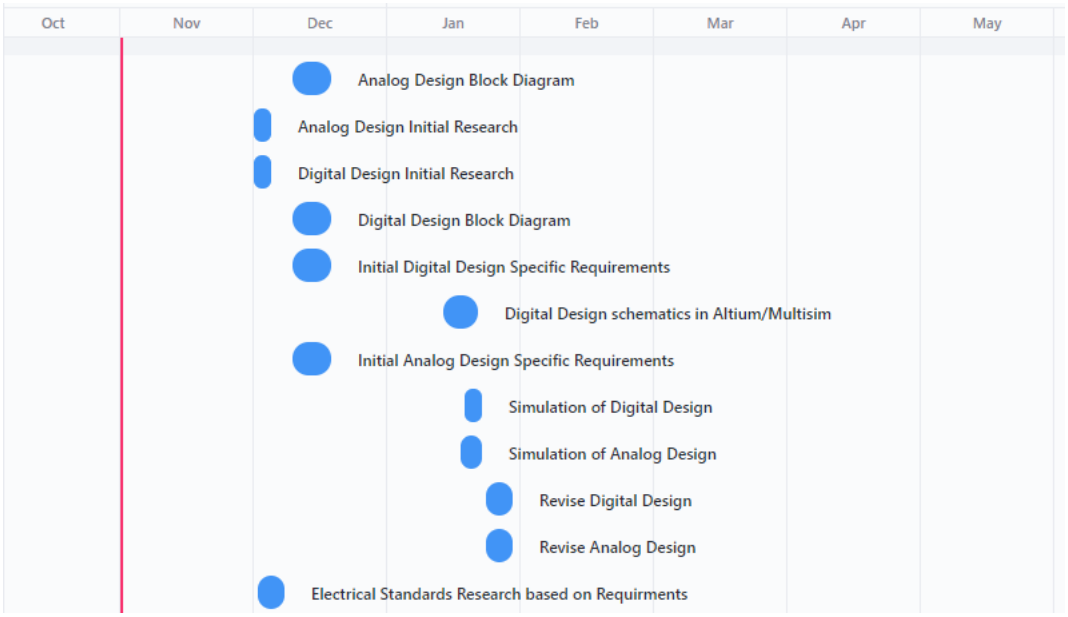
[14] Saddam. DIY Stun Gun Circuit on PCB. [Online]. Available: https://circuitdigest.com/electronic-circuits/diy-stun-gun-circuit [Accessed: 18-Nov-2021]

Appendix A: Gantt Chart



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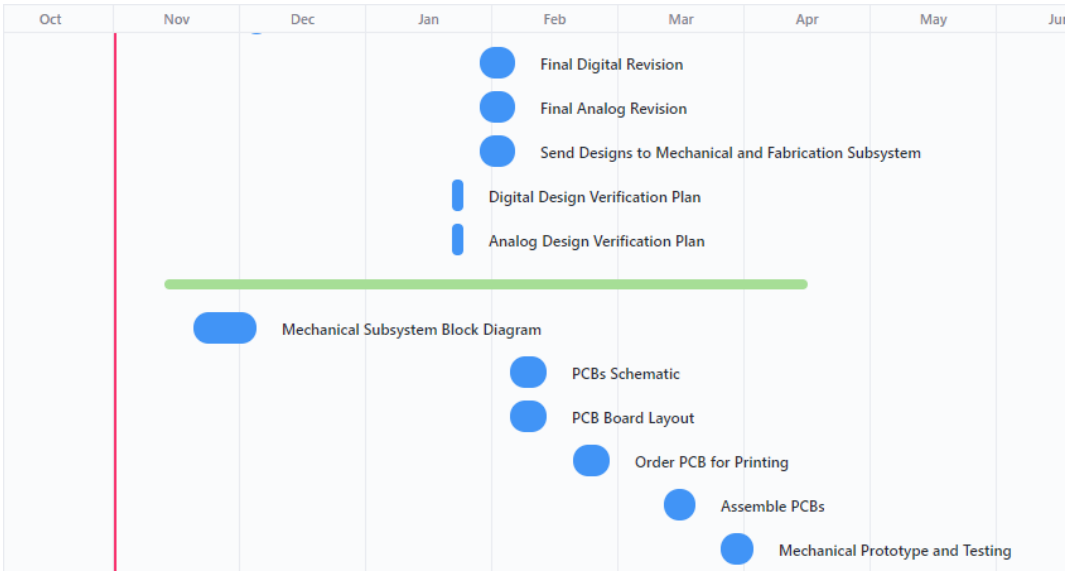
May
Analog Design Block Diagram
Analog Design Initial Research
Digital Design Initial Research
Digital Design Block Diagram
Initial Digital Design Specific Requirements
Digital Design schematics in Altium/Multisim
Initial Analog Design Specific Requirements
Simulation of Digital Design
Simulation of Analog Design
Revise Digital Design
Revise Analog Design
Electrical Standards Research based on Requirments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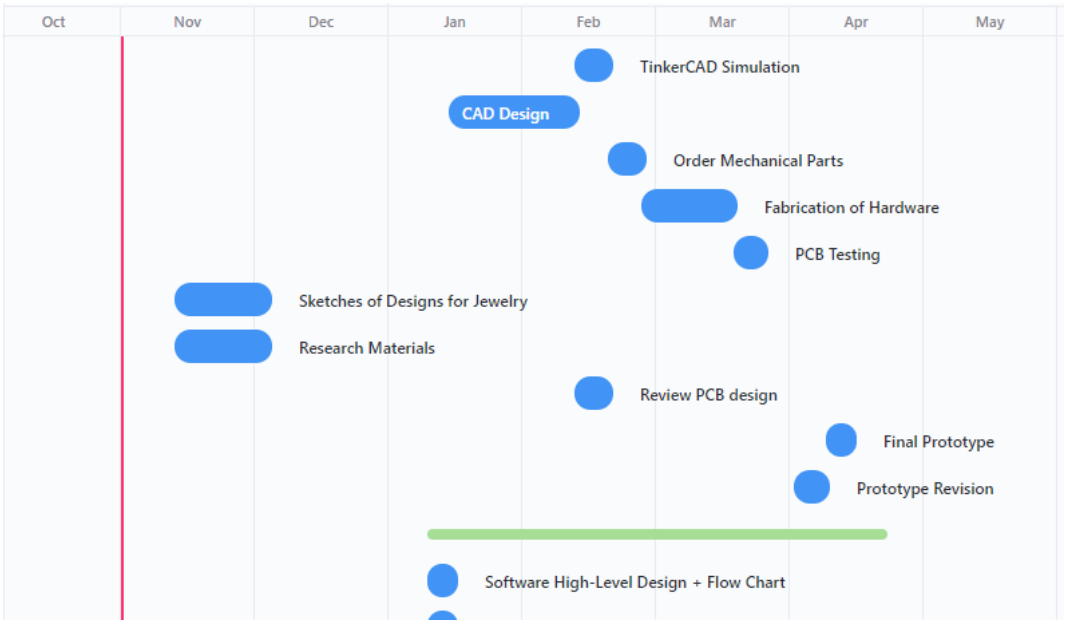
Final Digital Revision
Final Analog Revision
Send Designs to Mechanical and Fabrication Subsystem
Digital Design Verification Plan
Analog Design Verification Plan
Mechanical Subsystem Block Diagram
PCBs Schematic
PCB Board Layout
Order PCB for Printing
Assemble PCBs
Mechanical Prototype and Testing


Oct
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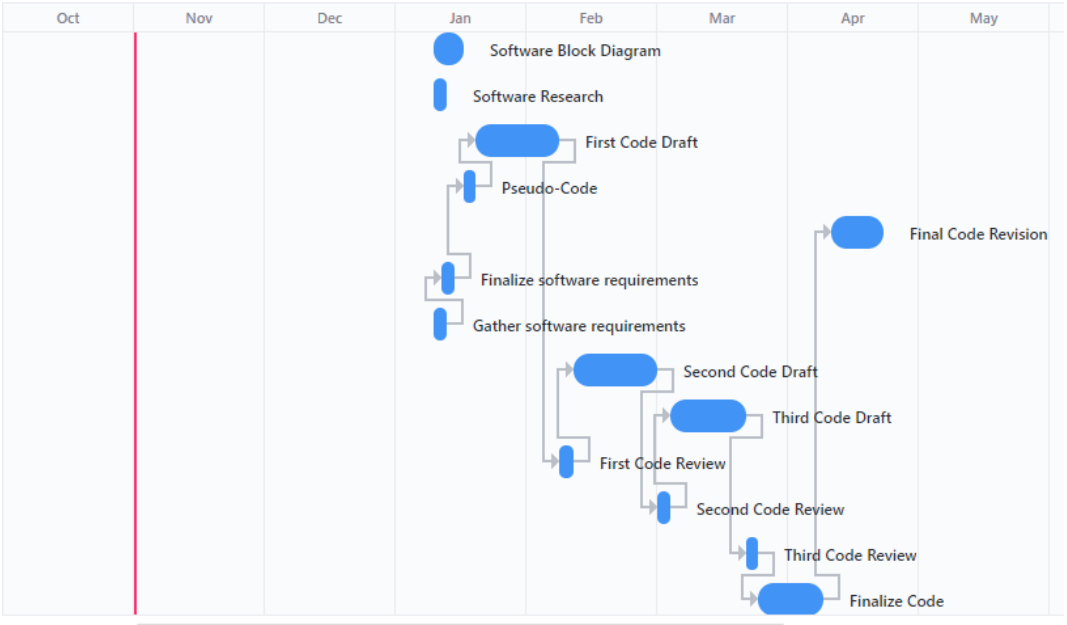
TinkerCAD Simulation
CAD Design
Order Mechanical Parts
Fabrication of Hardware
PCB Testing
Sketches of Designs for Jewelry
Research Materials
Review PCB design
Final Prototype
Prototype Revision
Software High-Level Design + Flow Chart


Oct
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May
Software Block Diagram
Software Research
First Code Draft
Pseudo-Code
Final Code Revision
Finalize software requirements
Gather software requirements
Second Code Draft
Third Code Draft
First Code Review
Second Code Review
Third Code Review
Finalize Code

10 Combined Meeting Minutes

10.1 Productivity

Overall when reflecting on the meeting minutes, I feel we accomplished a lot as we kept our schedule in mind with each meeting. After each meeting, we would record and share our updates with Dr. Hasler.

Meeting Minutes – Sweet Dreams

Location: Molecular Science Building
Date: 9/17/2021
Time: 1:15 PM – 2:00 PM

Attendance

Elizabeth Herrejon

Katie Weatherwax

Katie Roberts

Christine Saw

Radha Changela

Hubert Elly

Lara Kassabian

Agenda Items

1. Introductions
2. Team Name decision
    a. Sweet Dreams
3. Need to get an advisor (does anyone know anyone?)
4. Team Skill Matrix (due 9/24/2021)
5. LettuceMeet for availability

Action Items

1. Fill out availability I everyone I 9/18/2021
2. Skill Matrix I everyone I 9/22/2021
3. Review Skill Matrix I everyone I 9/23/2021
4. Submit Skill Matrix I Katie Roberts I 9/24/2021
5. Make a list of availability I Elizabeth I 9/20/2021

Other Notes

General discussion of product and expectations for this semester.

Already planning subteams based on availability.

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

Meeting Minutes – Sweet Dreams

Location: Virtual (Bluejeans)
Date: 9/24/2021
Time: 1:00 PM – 2:00 PM

Attendance

Elizabeth Herrejon

Katie Weatherwax

Katie Roberts

Christine Saw

Radha Changela

Hubert Elly

Lara Kassabian

Agenda Items

1. Team Skill Matrix review
2. Advisor Decisions
    a. Emailed Professor
3. QFD

Action Items

1. QFD I everyone I 10/1/2021
    a. Research engineering targets
2. Gantt Chart I Lara I
3. Form Teams channel I Katie I 9/24/2021
4. Send email to professor about advisors I Elizabeth I 9/24/2021

Other Notes

Team Skill: reviewing sub teams (deciding leaders, project managers, etc)

Advisor: waiting for response from

Wanting a Teams channel for communicaiton and have all our files in one place

QFD: Elizabeth made the chart

- General discussion of engineering and customer reuqirements
- Potential Competitors:

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

- https://hypebae.com/2020/12/personal-safety-self-defense-jewelry-rings-knockout-brand-kate-davis-founder-interview
- https://www.defenderring.com/
- https://www.invisawear.com/

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

Meeting Minutes – Sweet Dreams

Location: Virtual (Teams)
Date: 10/06/2021
Time: 5:30 PM – 6:00 PM

Attendance

Elizabeth Herrejon

Katie Weatherwax

Katie Roberts

Dr. Jennifer Hasler

Radha Changela

Hubert Elly

Lara Kassabian

Agenda Items

1. Introductions I Elizabeth and Dr. Hasler
    a. Project Introduction
    b. Member Introduction
2. Project Discussion I everyone
    a. Goals
    b. Application
    c. Testing

Action Items

1. Biweekly PowerPoint for Dr. Hasler I everyone I 10/22/2021
2. Discussions I everyone I 10/20/2021
    a. What is our project? What does it do?
    b. Flush out ideas
    c. How are we going to test it?
3. Write down explorations/design notebooks I everyone I 10/20/2021
    a. Get all ideas and drafts down

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

Other Notes

- Christine Saw could not make the meeting due to a class conflict.
- Project ideas: simple circuits
- Research: microprocessors, how we are dealing with charge and clothing resistance
- Dr. Hasler: really liked the project idea but thinks we need a better description and better thought ideas
    - Flush out specific subsystems
    - Start working on technical aspects this semester
    - Do not leave coding till the end
    - Keep a PowerPoint of the design up to date: Use images and tables to show the design and the design updates etc.
        - Will help with the writing of the final proposal
    - Start thinking about how you are going to test it
        - Demo Videos
        - Reach out to ROTC trainees and ask for volunteers for product testing
    - Have shocking circuit trigger when it connects with a body (i.e. punch) and when it reaches a certain acceleration
        - Accelerometer

Meeting Minutes – Sweet Dreams

Location: Virtual (Teams)
Date: 10/15/2021
Time: 1:00 PM – 4:00 PM

Attendance

Elizabeth Herrejon (left at 1:30) (returned at 2)

Katie Weatherwax (left at 3)

Katie Roberts

Radha Changela

Hubert Elly (left at 1:30)

Lara Kassabian (left at 1:30)

Agenda Items

1. Gant and Pert chart
    a. Breaking into subteams and deciding on schedule

Action Items

1. Biweekly PowerPoint for Dr. Hasler I everyone I 10/22/2021
2. Discussions I everyone I 10/22/2021
    a. What is our project? What does it do?
    b. Flush out ideas
    c. How are we going to test it?
3. Write down explorations/design notebooks I everyone I 10/22/2021
    a. Get all ideas and drafts down

Other Notes

- Use this semester for research and brainstorming. Start prototyping and testing next semester

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

Meeting Minutes – Sweet Dreams

Location: Virtual (Teams)

Date: 10/29/2021

Time: 12:30 PM – 2:00 PM

Attendance

Elizabeth Herrejon (joined at 1 pm)

Katie Weatherwax

Katie Roberts

Radha Changela

Hubert Elly

Lara Kassabian

Agenda Items

1. Standards and Codes

Action Items

1. Discussions I asap I everyone
    a. What is our project? What does it do?
    b. Flush out ideas
    c. How are we going to test it?
2. Budget Proposal I 11/12/2021 everyone

Other Notes

Just worked on the assignment

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

Meeting Minutes – Sweet Dreams

Location: Virtual (Teams)
Date: 11/19/2021
Time: 12:30 PM – 2:30 PM

Attendance

Elizabeth Herrejon

Katie Weatherwax

Katie Roberts

Radha Changela

Hubert Elly

Lara Kassabian

Christine Saw (left at 1)

Agenda Items

1. Project Proposal
    a. Discussing Demonstrations
    b. Deciding on final ideas
    c. Clarifying roles
    d. Finalizing budgets
2. Discussing topics, we want to bring up to advisor

Action Items

1. Project Proposal I11/22/2021 I everyone
2. Meeting with Advisor I 11/19/2021 I everyone
3. Final Summary I 11/22/2021 I everyone

Other Notes

Just worked on the assignment

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

Meeting Minutes – Sweet Dreams

Location: Virtual (Teams)
Date: 12/2/2021
Time: 7:00 PM – 7:45PM

Attendance

Elizabeth Herrejon

Katie Weatherwax

Radha Changela

Lara Kassabian

Dr. Jennifer Hasler

Hubert Elly

Agenda Items

1. Discussion
    a. Discussing Project Proposal
        i. Feedback for proposal
    b. Deciding on final ideas
        i. Specifically stun gun circuity

Action Items

1. Add feedback to Project Proposal I12/10/2021 I everyone

Other Notes

- Too many words on the slides --> on software slides put more pictures
    - Maybe draft an app GUI
- Focus on standards that allow users to not get in trouble
    - Think about insulation and charge going to other person
- Break apart fitbit to use pieces, what microcontroller in Fitbit? Or hack into fitbit software (or fitbit knockoff)
    - Use an actual fitbit or knockoff
        - Easier approach since they do a lot of what we want to be done
    - Look for open source fitbit/knockoff code over making our own embedded system

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

- Expand on our test plan for actual shocking part
    - Build the circuit and test it soon (by 1st week of January)
    - Get actual measurement, needed before working on the rest of the project
- Finalize design concept
    - Pretty bracelet vs fitbit
- Half Glove design? Making the connection between wrist and ring flush/flexible
    - Consider possible materials
        - Must be insulated and safe for wearer
- Rest of the materials on slide deck looks good and is useful, just focus on concept first
- What are the questions we don't have answered?
    - Design
    - Circuit - start breadboarding soon
        - Think ahead so we do not fall behind

Meeting Minutes – Sweet Dreams

Location: Virtual (Teams)
Date: 11/19/2021
Time: 4:15 PM – 4:45 PM

Attendance

Elizabeth Herrejon

Katie Weatherwax

Katie Roberts

Radha Changela

Hubert Elly

Lara Kassabian

Dr. Jennifer Hasler

Christine Saw

Agenda Items

1. Discussion
    a. Discussing Demonstrations
        i. How to go about in testing
    b. Deciding on final ideas
        i. Specifically stun gun circuity

Action Items

1. Project Proposal I11/22/2021 I everyone
2. Final Summary I 11/22/2021 I everyone

Other Notes

- For stun gun circuit:
    - Instead of focusing on discharge current focus on charge and voltage
    - What should the voltage be (probably around 100 V)
    - Add a clearer circuit
    - Research what capacitor rating we will need
    - Desired current range: 1- 3 mA
- Testing

    - Start with lab bench testing
    - Then find volunteer to test on (military, Elizabeth's dad?)
- Things to consider
    - Resistance of the human body
        - Sweaty vs dry
        - Fat vs skinny
        - Skin vs clothing

11 Advisor Section

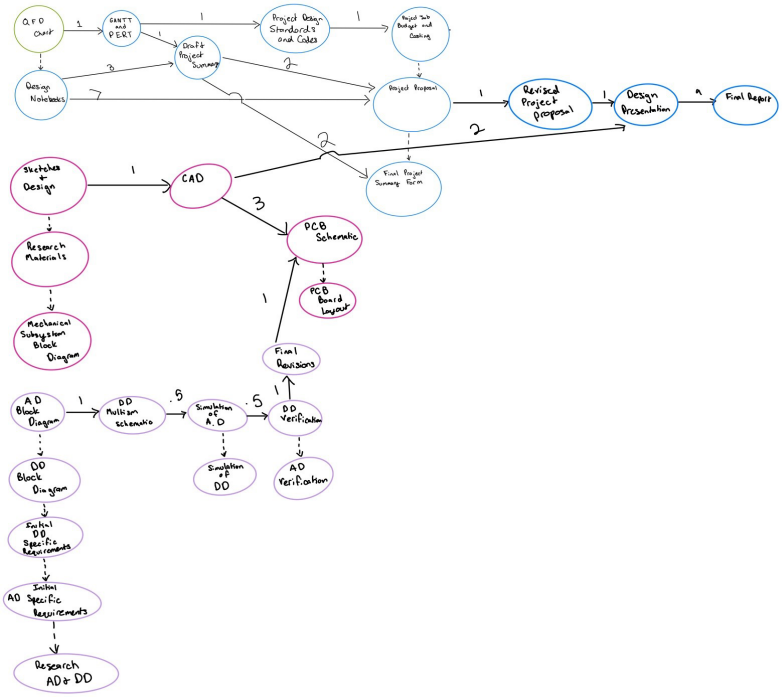
11.1 Dr. Hasler Updates

Motivation Meeting with Dr. Hasler was very eye-opening as she is able to poke and prod through our progress slides and give us solid advice and idea how to proceed with our procedure plan. It was very helpful that she was able to meet three times and we are in a good position for the next semester.

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021



GANTT CHART

- Here is our projected timeline for working on the project: https://sharing.clickup.com/g/h/12at8k-80/b4e8c6b082e4483
- We also worked on our PERT chart (shown on the left)

3

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

INITIAL BRAINSTORMING: DESIGN CONSTRAINTS

- Size and weight of a piece of jewelry
  - Bracelet
    - Main source of power and electronic storage
    - Electronics must be small and light
  - Ring:
    - Will act as the stun gun
    - Must have sufficient insulation so not to shock the user

4

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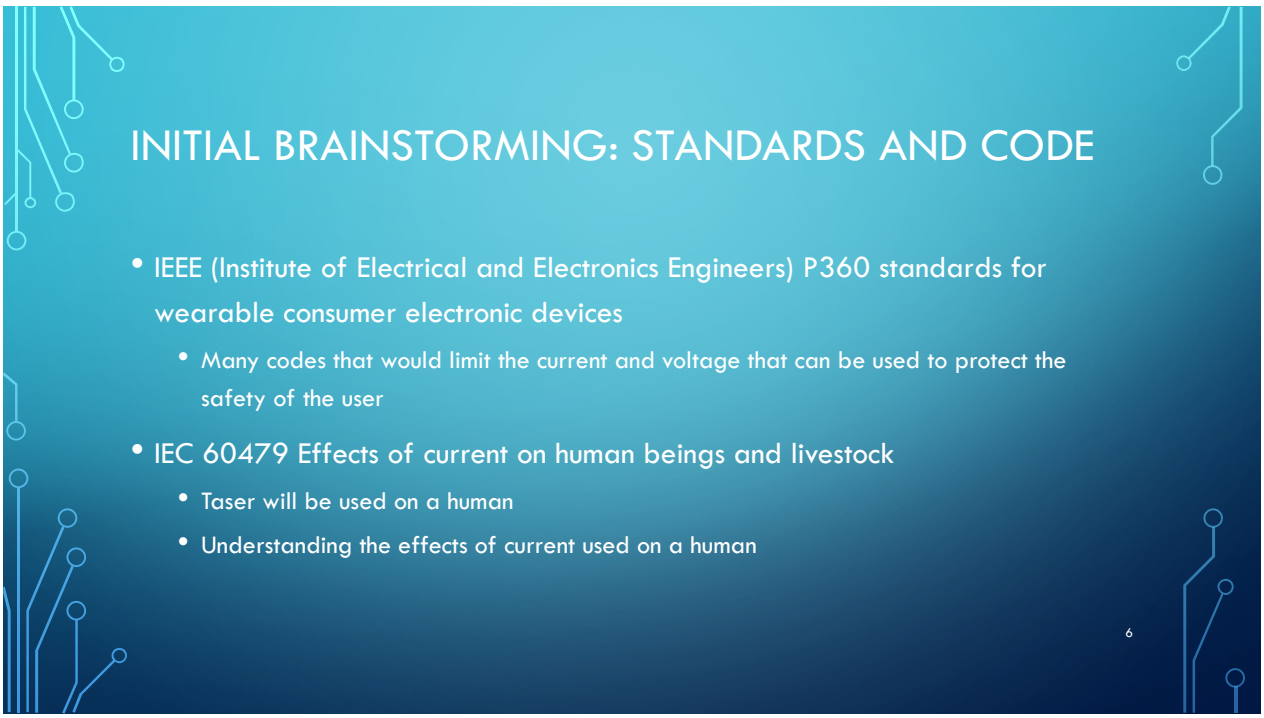

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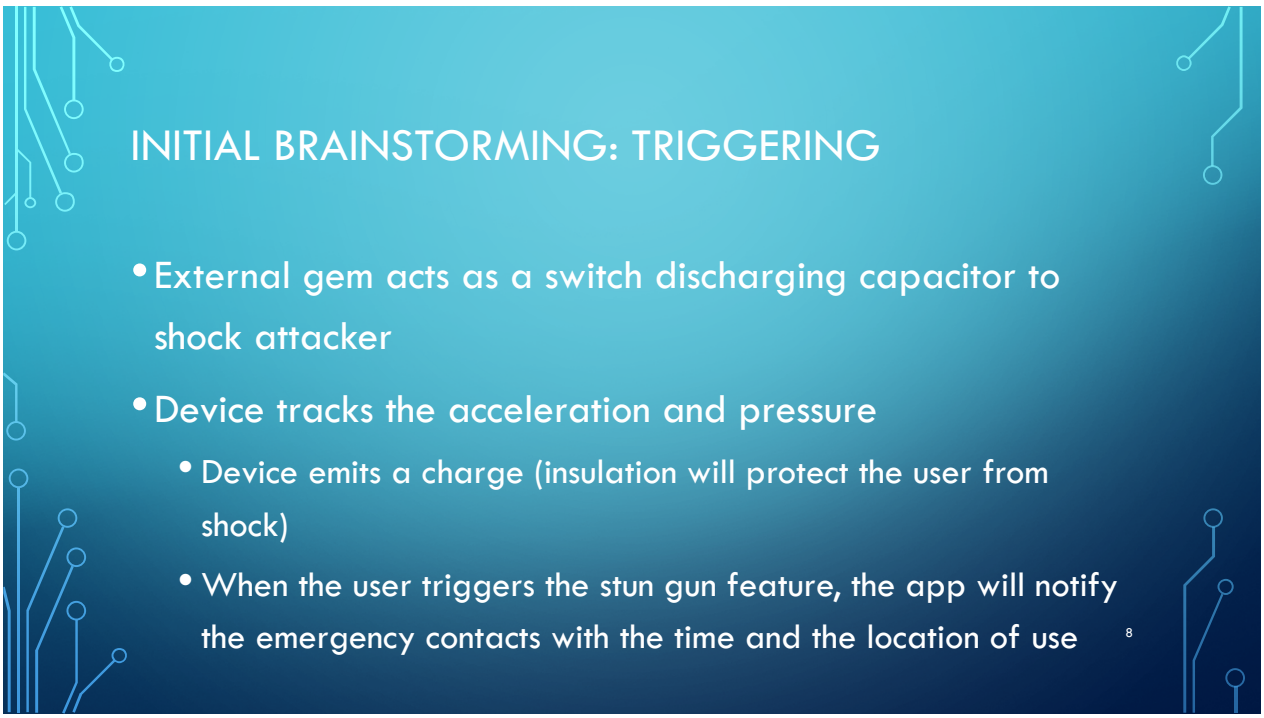
INITIAL BRAINSTORMING: TRIGGERING
• External gem acts as a switch discharging capacitor to shock attacker
• Device tracks the acceleration and pressure
• Device emits a charge (insulation will protect the user from shock)
• When the user triggers the stun gun feature, the app will notify the emergency contacts with the time and the location of use
8

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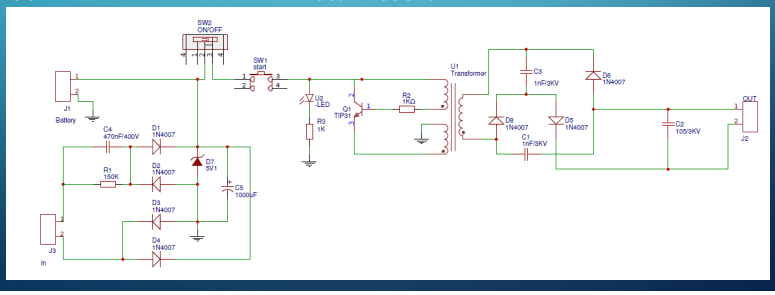
BUDGET – MATERIALS NEEDED : BRACELET

- Wristband A, 2-Shot Injection Molded Polycarbonate & Silicone Rubber - (Qty: 1)
- Enclosure, Main, Injection Molded Plastic, Clear Coat, Printed - (Qty: 1)
- Wristband B, 2-Shot Injection Molded Polycarbonate & Silicone Rubber - (Qty: 1)
- MCU, 32-Bit, ARM Cortex-M3, 32 MHz, 128KB Flash, 16KB SRAM, 24 Channel x 12-Bit ADC - MFG: ST MICROELECTRONICS - MPN: STM32L151C6H6 - (Qty: 1)
- Bluetooth, Single-Chip, V4.0LE - MFG: NORDIC SEMICONDUCTOR ASA - MPN: nRF8001 - (Qty: 1)
- Bluetooth USB Dongle - (Qty: 1)
- Charging Cable - (Qty: 1)
- Accelerometer, 3-Axis, ±2g/±4g/±8g/±16g, I2C/SPI digital output interface - MFG: ST MICROELECTRONICS - MPN: LIS2DH - (Qty: 1)
- Battery, Li-Polymer, Single Cell, w/ Solder Tabs & 2 Insulated Discrete Wires - (Qty: 1)
- Vibration Motor, Coin Type, w/ 2 Discrete Insulated Wires - (Qty: 1)

11

BUDGET – MATERIALS NEEDED: STUN GUN CIRCUIT

1. DS965 NPN Transistor -1
2. Fly back Transformer -1
3. Push button -1
4. LED -2
5. PCB (ordered from EasyEDA)
6. Terminal Block 2 pin -3
7. Resistor 150k -1
8. Resistor 1k -3
9. Capacitor 1nF/3KV -2
10. Capacitor 1000uF -1
11. Capacitor 470nF/400V -1
12. Capacitor 105/3KV -1
13. Power Supply 3v-12v -1
14. 1N4007 Diode -7
15. Zenner diode 5.1v -1
16. On/off switch -1

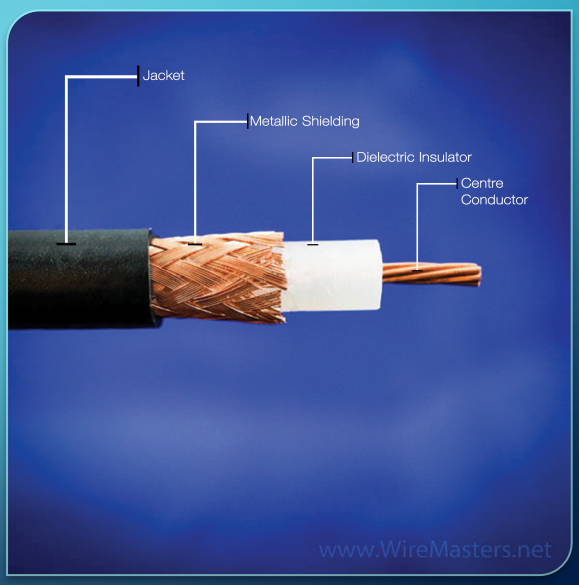


12

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021

BUDGET – MATERIALS NEEDED: CONNECTION

- The connection between the bracelet and ring is a crucial part
  1. Carries the discharge from stun gun circuitry to ring
  2. Must be conducting in order to carry charge
  3. Must be insulated to protect the user from charge
- Solution: PTFE dielectric coaxial cable
  - Pros:
    - Conducting wire in the middle allows for charge to be carried
    - Double layer of insulation on outside protecting user
  - Cons:
    - Not aesthetically pleasing
- Options:
  - Can buy it off market and have it look not as pretty
  - Fabricate it ourselves in hopes to make it blend in with jewelry



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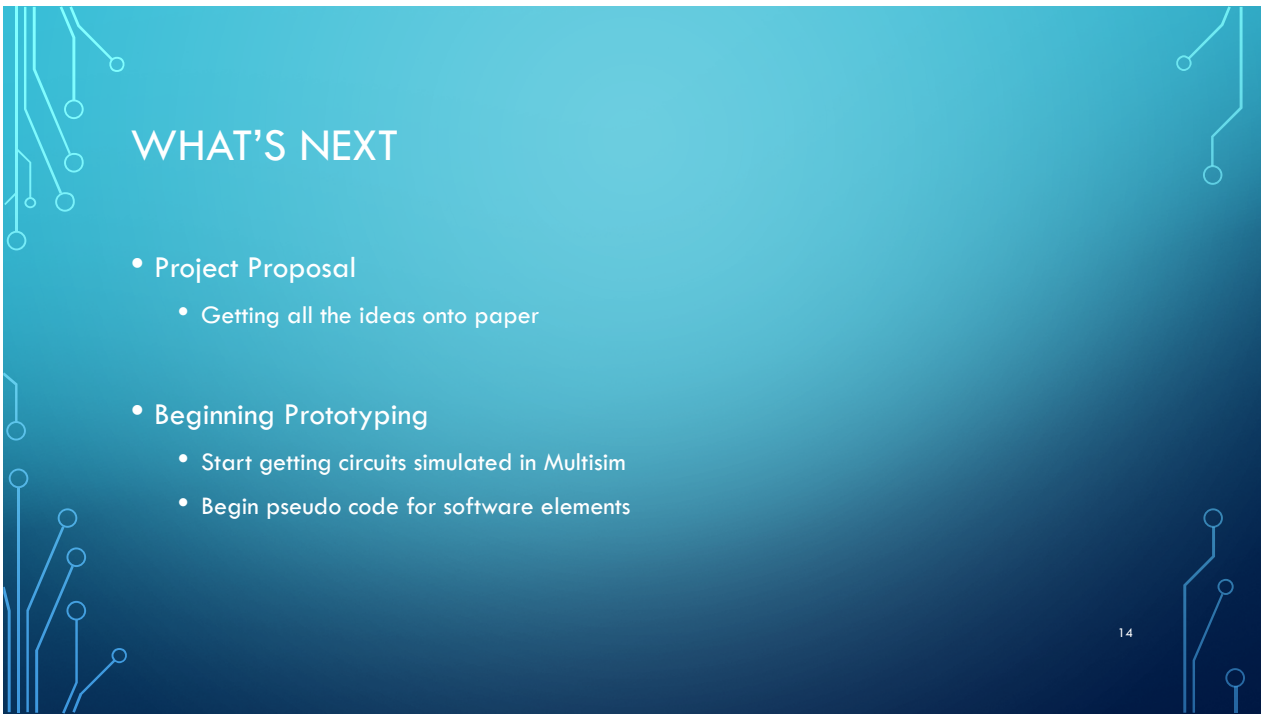

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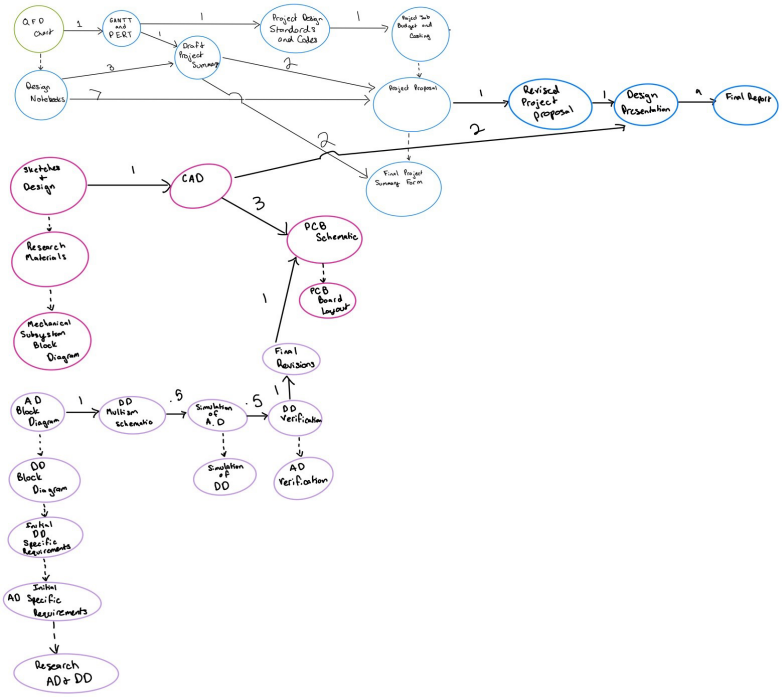

GANTT CHART

- Here is our projected timeline for working on the project: https://sharing.clickup.com/g/h/12at8k-80/b4e8c6b082e4483
- We also worked on our PERT chart (shown on the left)

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INITIAL BRAINSTORMING: DESIGN CONSTRAINTS

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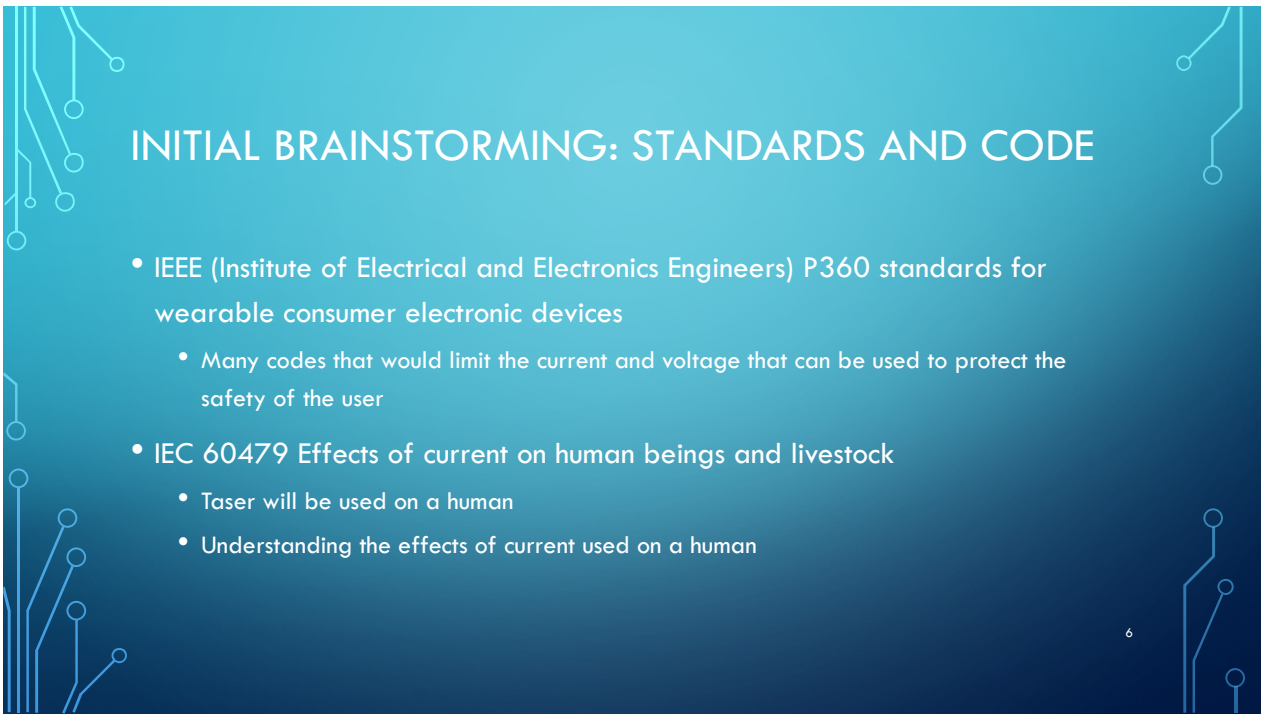
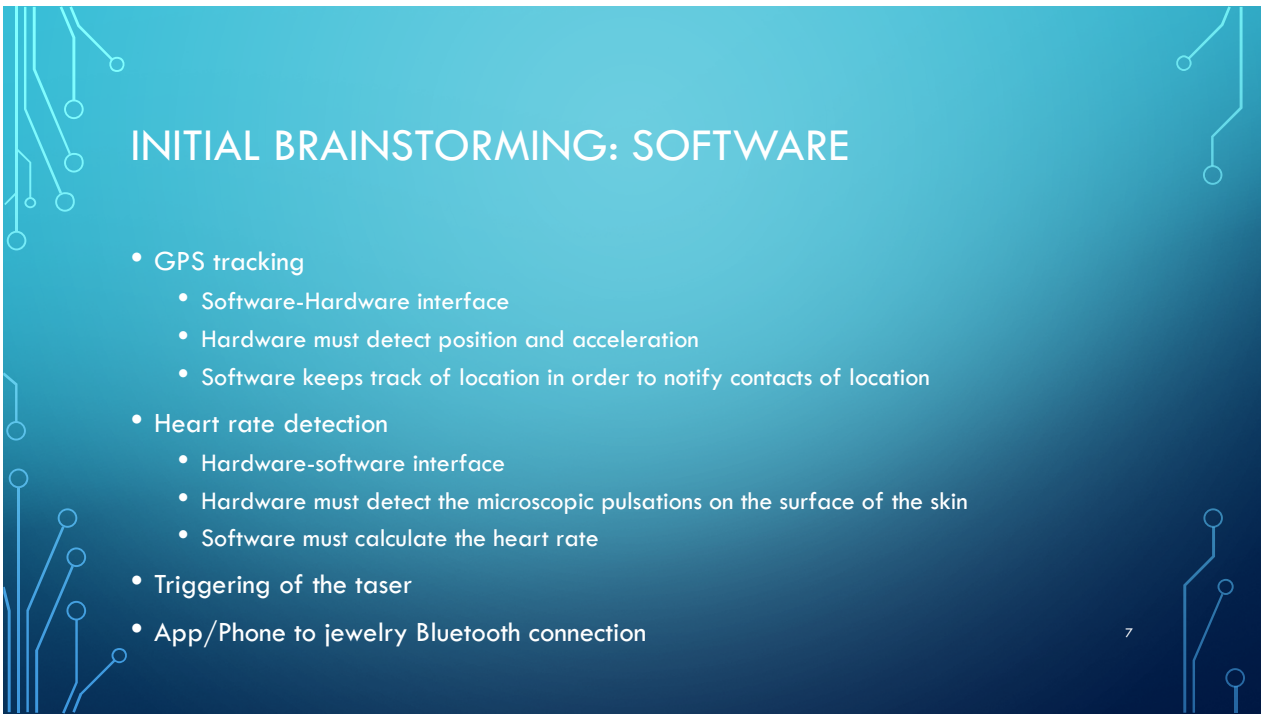

INITIAL BRAINSTORMING: STANDARDS AND CODE
• IEEE (Institute of Electrical and Electronics Engineers) P360 standards for wearable consumer electronic devices
• Many codes that would limit the current and voltage that can be used to protect the safety of the user
• IEC 60479 Effects of current on human beings and livestock
• Taser will be used on a human
• Understanding the effects of current used on a human
6



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• Device emits a charge (insulation will protect the user from shock)
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• If the user heart rate drops below a given threshold (knocked unconscious), this will also trigger the app to notify emergency contacts
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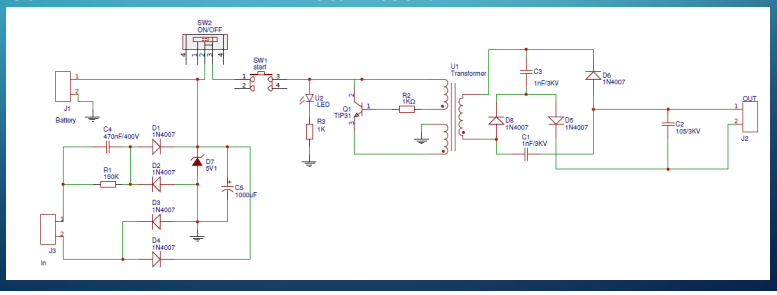

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- Solution: PTFE dielectric coaxial cable
  - Pros:
    - Conducting wire in the middle allows for charge to be carried
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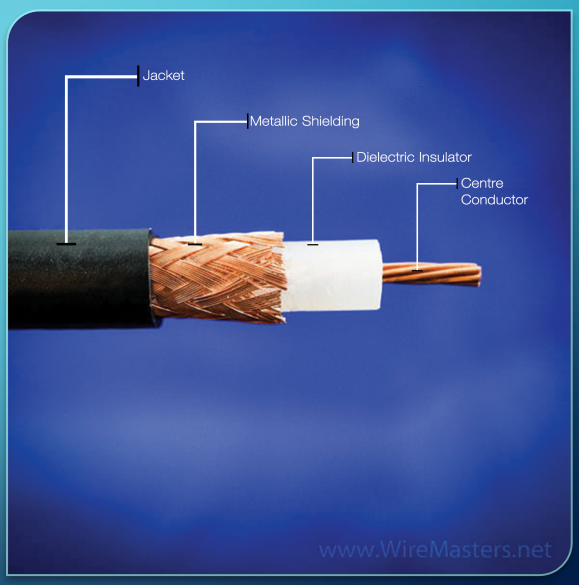

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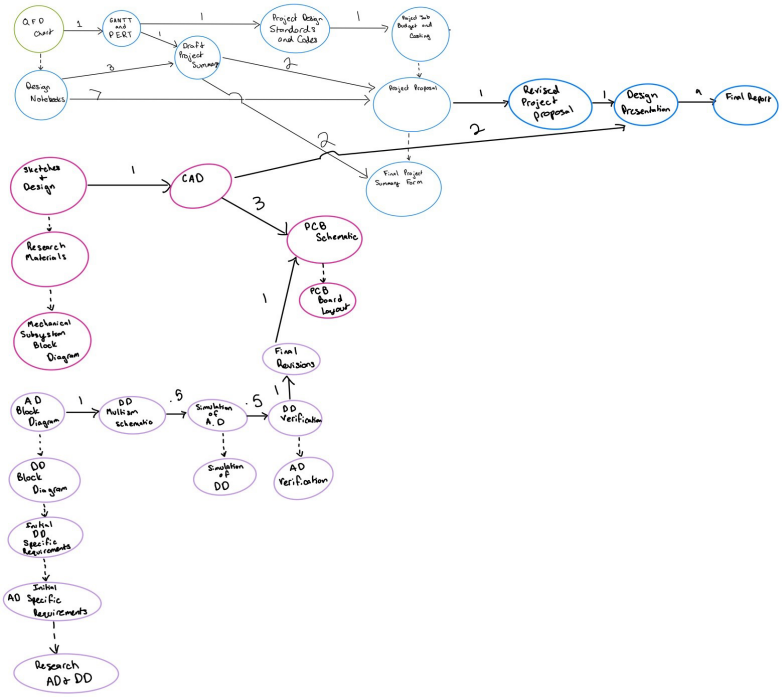

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    - Molded after a Fitbit
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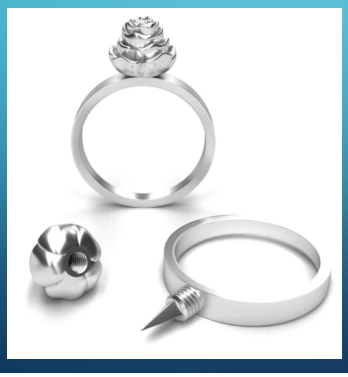
INITIAL BRAINSTORMING: MARKET ANALYSIS

- Similar Products on Market:
  - InvisaWear
  - Defender Ring



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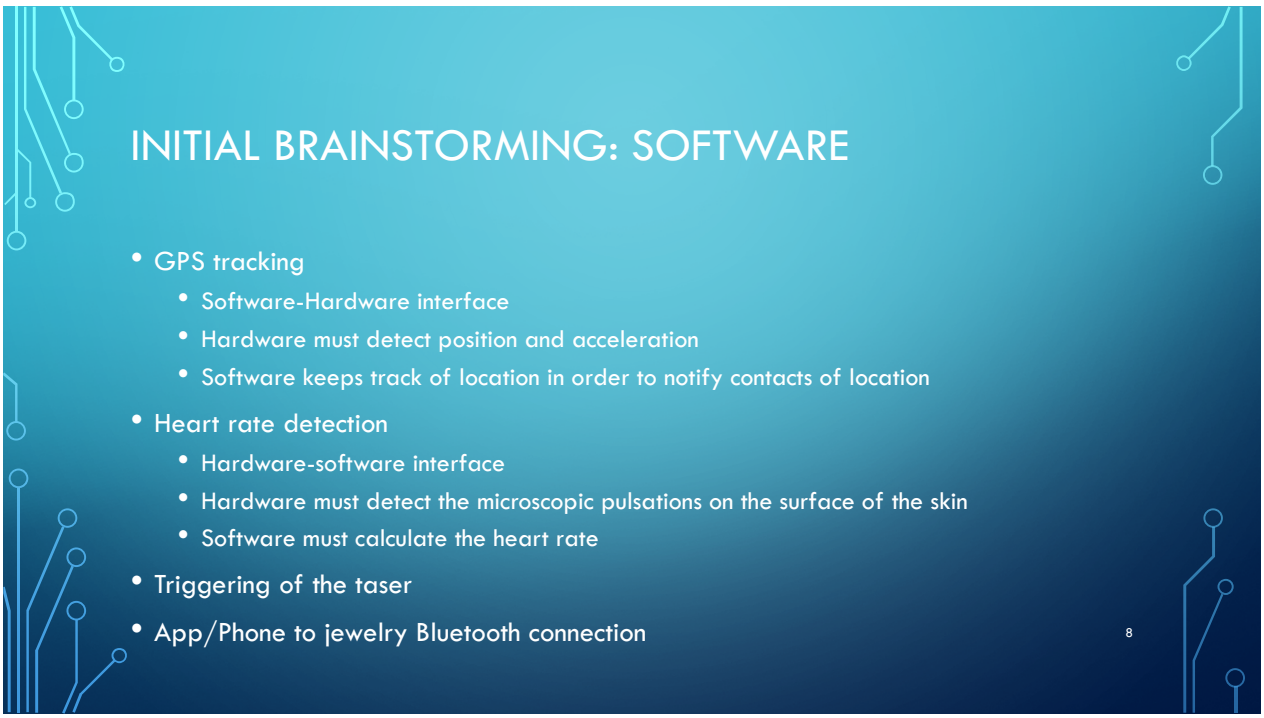

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INITIAL BRAINSTORMING: TRIGGERING
• External gem acts as a switch discharging capacitor to shock attacker
• Safety button hit
• triggers the software to start charging the stun gun circuit and notify the emergency contacts the user is feeling unsafe
• Device tracks the pressure
• Device emits a charge (insulation will protect the user from shock)
• When the user triggers the stun gun feature, the app will notify the emergency contacts with the time and the location of use
• If the user heart rate drops below a given threshold (knocked unconscious), this will also trigger the app to notify emergency contacts
9

SIGNATURE: *Elizabeth Herrejon* DATE: 12/3/2021


BUDGET
• Product can be built on Given budget of $1050
• Expense breakdown:
• Parts: $200
• Bracelet Electrical Components (power, heart rate, etc): $30
• Stun gun circuitry: $70
• Extra 100 for materials and designing the ring
• Testing Infrastructure: $200
• Budget for revising: $200
11

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- Vibration Motor, Coin Type, w/ 2 Discrete Insulated Wires - (Qty: 1)

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BUDGET – COST ANALYSIS: BRACELET

- Cost breakdown on bracelet based on Fitbit Flex

Item	Manufacturer	Quantity	Cost
2-Shot Injection Molded Polycarbonate & Silicone Rubber	Healthy Metrics Research Inc.	1	$20.00
MCU, 32-Bit, ARM Cortex-M3, 32 MHz, 128KB Flash, 16KB SRAM, 24 Channel x 12-Bit ADC	ST MICROELECTRONICS	1	$6.44
Bluetooth, Single-Chip, V4.0LE	NORDIC SEMICONDUCTOR ASA	1	$5.61
Bluetooth USB Dongle	RoHS - TP link	1	$9.99
USB Cables / IEEE 1394 Cables USB Cable, Type A Plug to Type C Plug, USB 2.0, 28 AWG	CUI Devices	1	$5.82
Accelerometer, 3-Axis, ±2g/±4g/±8g/±16g, I2C/SPI digital output interface	ST MICROELECTRONICS	1	$9.97
Lithium Ion Polymer Battery Ideal For Feathers - 3.7V 400mAh	Adafruit Industries LLC	1	$6.95
Vibration Motor, Coin Type, w/ 2 Discrete Insulated Wires	Adafruit Industries LLC	1	$1.95
			$66.73

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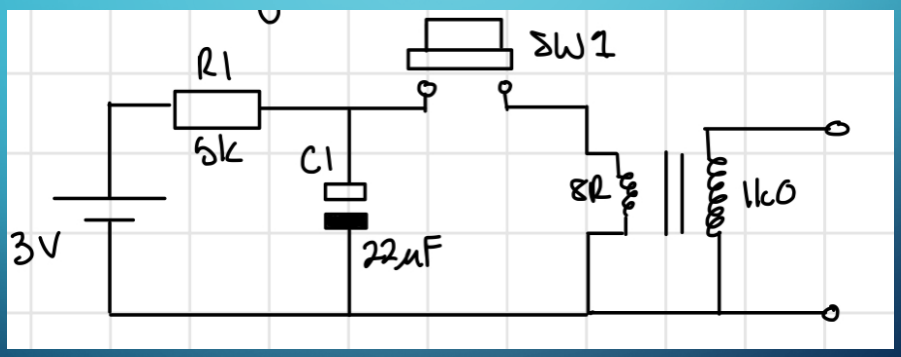
BUDGET – MATERIALS NEEDED: STUN GUN CIRCUIT



14

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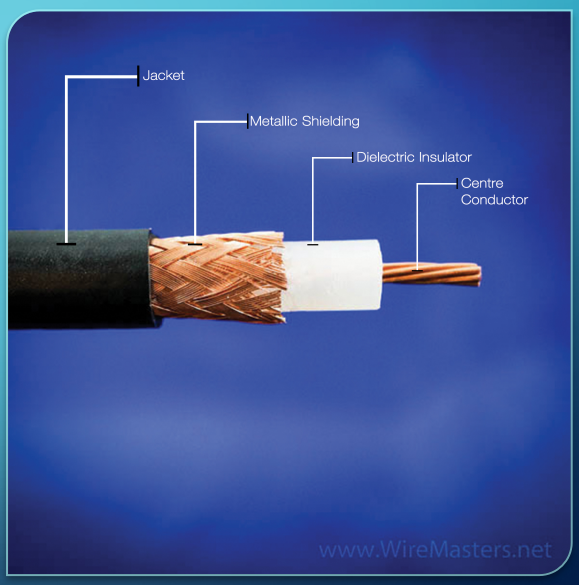

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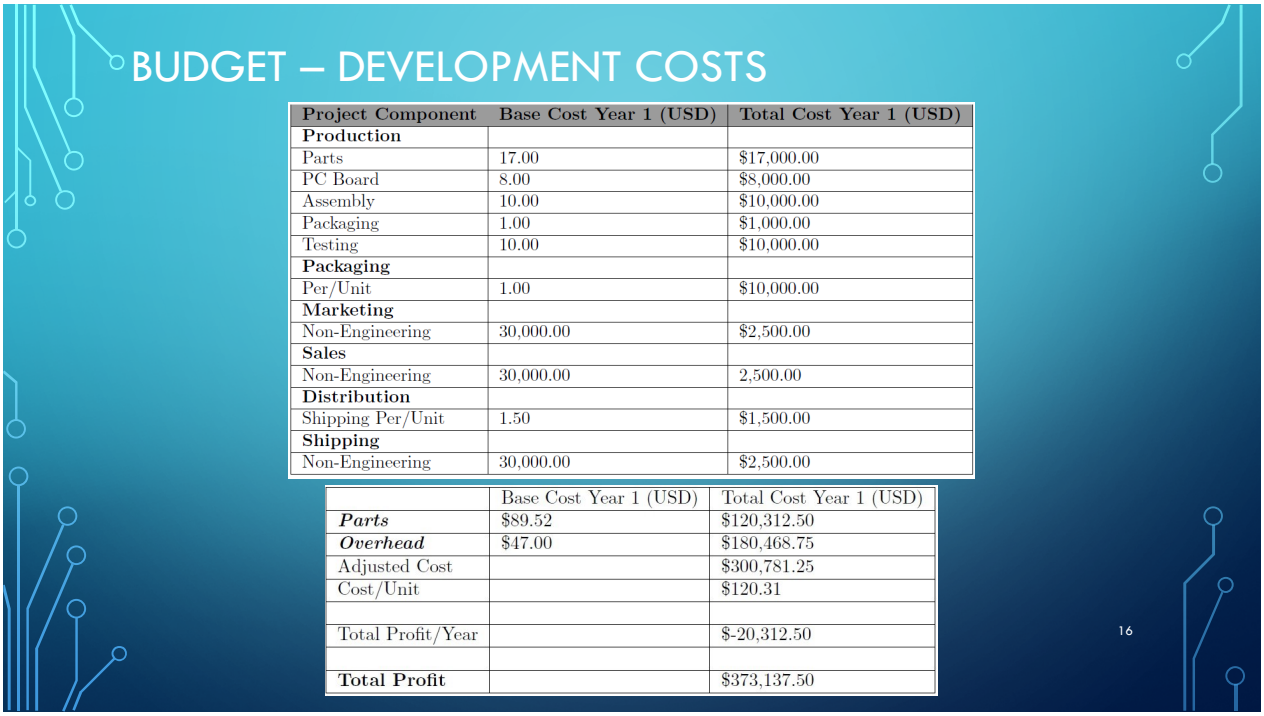

Project Component	Base Cost Year 1 (USD)	Total Cost Year 1 (USD)
Production		
Parts	17.00	$17,000.00
PC Board	8.00	$8,000.00
Assembly	10.00	$10,000.00
Packaging	1.00	$1,000.00
Testing	10.00	$10,000.00
Packaging		
Per/Unit	1.00	$10,000.00
Marketing		
Non-Engineering	30,000.00	$2,500.00
Sales		
Non-Engineering	30,000.00	2,500.00
Distribution		
Shipping Per/Unit	1.50	$1,500.00
Shipping		
Non-Engineering	30,000.00	$2,500.00

	Base Cost Year 1 (USD)	Total Cost Year 1 (USD)
Parts	$89.52	$120,312.50
Overhead	$47.00	$180,468.75
Adjusted Cost		$300,781.25
Cost/Unit		$120.31
Total Profit/Year		$-20,312.50
Total Profit		$373,137.50

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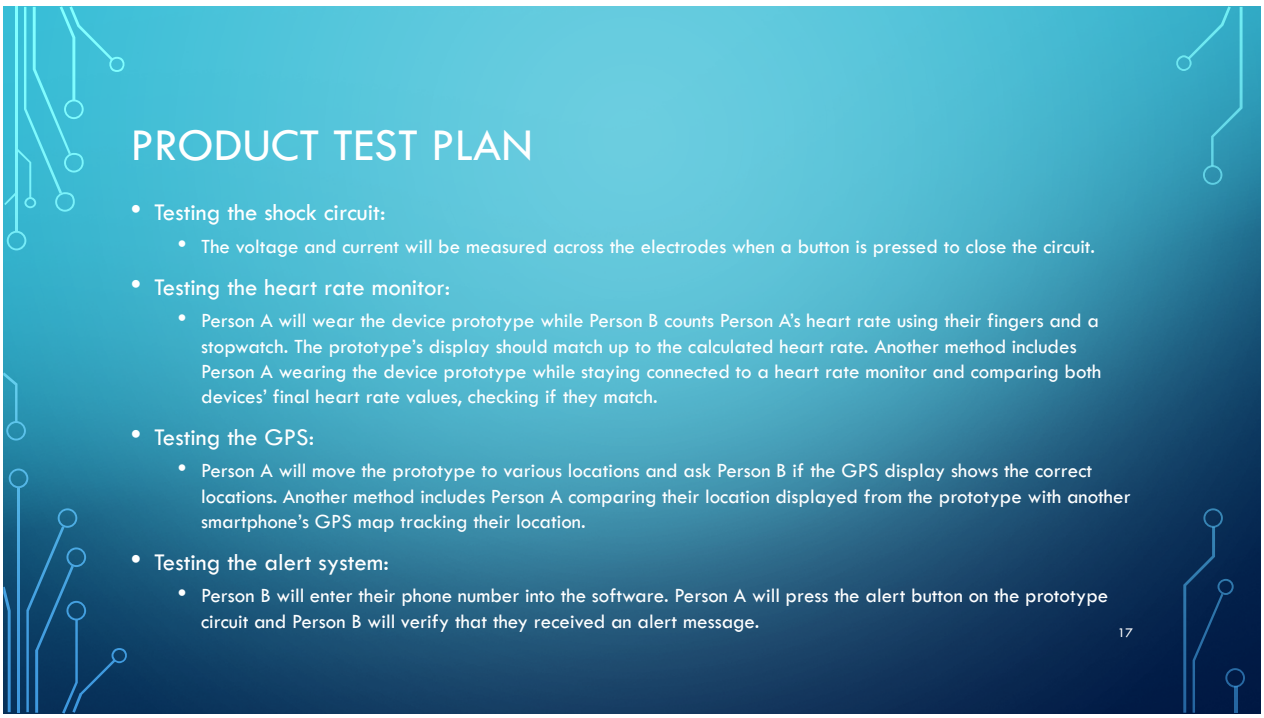
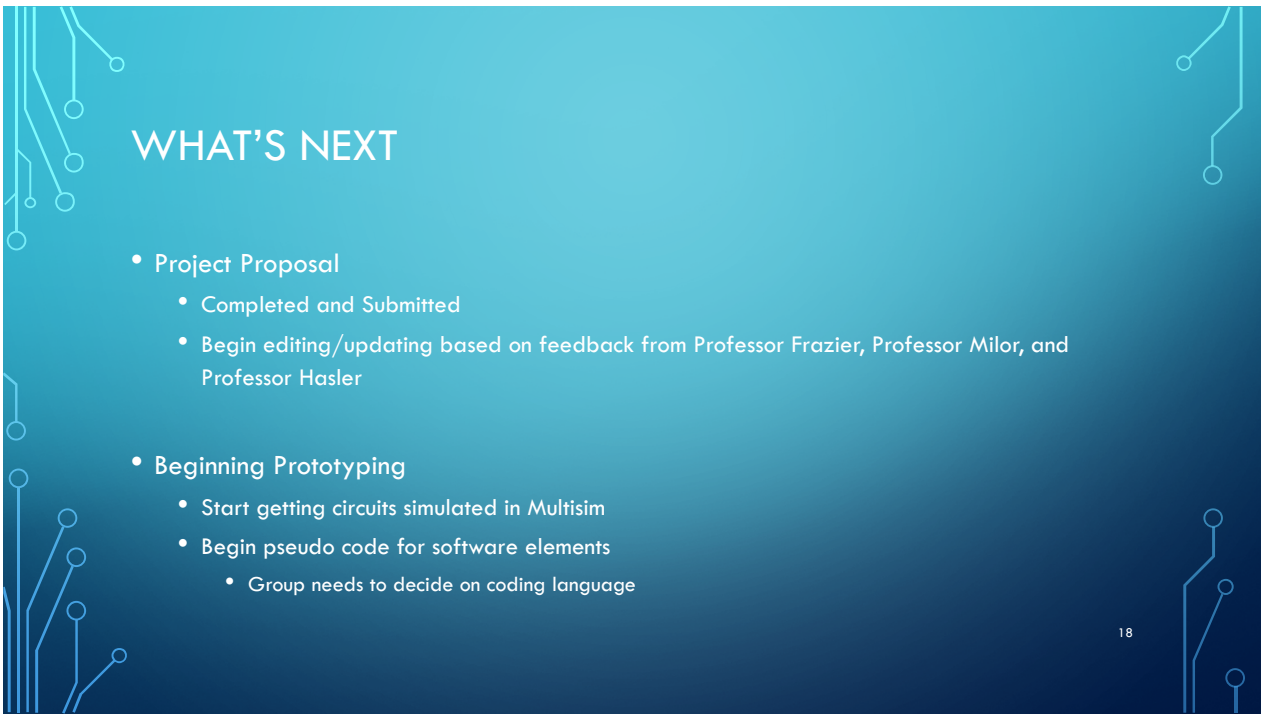

PRODUCT TEST PLAN
• Testing the shock circuit:
• The voltage and current will be measured across the electrodes when a button is pressed to close the circuit.
• Testing the heart rate monitor:
• Person A will wear the device prototype while Person B counts Person A's heart rate using their fingers and a stopwatch. The prototype's display should match up to the calculated heart rate. Another method includes Person A wearing the device prototype while staying connected to a heart rate monitor and comparing both devices' final heart rate values, checking if they match.
• Testing the GPS:
• Person A will move the prototype to various locations and ask Person B if the GPS display shows the correct locations. Another method includes Person A comparing their location displayed from the prototype with another smartphone's GPS map tracking their location.
• Testing the alert system:
• Person B will enter their phone number into the software. Person A will press the alert button on the prototype circuit and Person B will verify that they received an alert message.
17


WHAT'S NEXT
Project Proposal
Completed and Submitted
Begin editing/updating based on feedback from Professor Frazier, Professor Milor, and Professor Hasler
Beginning Prototyping
Start getting circuits simulated in Multisim
Begin pseudo code for software elements
Group needs to decide on coding language
18

12 Next Steps

Throughout this design and development process we have all learned a lot. There are many small details in developing a ring such as this. Attention to those details can make the difference between a winning design and a losing one. We have also gained better insight into the transition between a theoretical model and a working system. As well as which theoretical models will actually work in the real world.