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January 31, 2017

Steve Whitmore
School of Engineering Science
Simon Fraser University
Burnaby, BC
V5A 1S6

Re: ENSC 405W Project Proposal for ThinkUp EZG

Dear Mr. Whitmore:

Please find our ENSC405W/ENSC 440 project proposal, *ThinkUp: The EZG Project Proposal* attached. This document provides a high-level outline for the development of our product. We will be developing a portable, adaptable EEG device, with a focus on versatility and affordability.

This document will outline our project scope and purpose, highlighting the risks and benefits, as well as how we intend to manage these risks. It will also provide an overview of competitive products and our target market. Lastly, it will detail our cost considerations and a brief introduction of our team.

ThinkUp is comprised of a diverse range of upper year engineering students, in a variety of specialties: Michael Chyziak, Isaac Cheng Hui Tan, Chloe Hill, Elizabeth Pieters and Nathan Zavaglia. If you have any questions or concerns, please contact chloe_hill@sfu.ca

Regards,

Chloe Hill

ENCLOSED: Project Proposal for ThinkUp EZG

SFU SIMON FRASER UNIVERSITY
ENGAGING THE WORLD

School of Engineering Science

ENSC 405W

ThinkUp: The EZG Project Proposal

Team 5:

Michael Chyziak

Isaac Cheng Hui Tan

Chloe Hill

Elizabeth Pieters

Nathan Zavaglia

Executive Summary

The human brain is a topic of both fierce ongoing research and public fascination, with its complexities baffling scientists and intriguing science fiction writers. Our project is to create an electroencephalogram (EEG) that will provide researchers with a better tool while allowing the public to explore the unknown reaches of their own minds.

EEGs are used to monitor and record electrical signals in the brain. Several electrodes are placed against the head and used to monitor potential differences and generate a signal. Two main forms of EEGs exist today: a complicated setup of wires in a gel cap that covers the user's entire head, and dry EEGs which sit on the surface of the skin without any gel but that provide a lower signal to noise ratio.

Our EZG provides the practical middle ground between these two existing options. Consisting of two electrodes and an ear clip for ground, the EZG is applied with adhesive to the user's forehead. This versatile and portable setup allows for a wider range of studies than a gel cap, with potential applications for sports and sleep studies. However, the use of adhesive and wet electrodes provides a better and more stable contact than the dry EEGs and is more securely and comfortably attached to the user's head.

The EZG is broken down into three components: a grounding ear clip, a central electronics component in weather proof plastic, and a throwaway adhesive strip with wet electrodes. This compartmentalization allows us to maintain sanitation necessary for medical devices while reusing any expensive components. Any risks of electrocution or shorts are minimized as the central electronics component is sealed in weather proof plastic that allows it to be sanitized and provides another degree of protective separation between the electronics and the user.

As for demand, the market for EEGs is large and growing; between 2015 and 2024 the global market is expected to surge by a factor of two from $687.6 million USD to almost 1.4 billion USD [1]. The competition on the market is primarily from the full gel cap and dry EEG devices, but the EZG is a cheaper, portable, and more versatile EEG with a better signal to noise ratio than dry EEG devices. This would open up a market with academics wanting ease of use and the ability to perform the wide range of studies that the EZG allows. It would also open up a commercial market for people curious about how their brain acts, with further potential applications for brain computer interfaces.

Our goals are to complete a design by February 16th, which ultimately leads into our proof of concept for March 21st. These internal deadlines are set intentionally before external ones to provide flex time. The total development costs, including the proof of concept and the final prototype, is expected to be no more than $857.

The low-cost, versatile, and portable EZG strikes an elegant balance between the performance of the full gel cap and the ease of use of a dry EEG. Here at ThinkUp we are excited to develop and produce this highly technical product that will open new doors in the fascinating world of neuroscience.

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List of Figures and Tables

1 Introduction

Electroencephalography, or EEG, is a medical device that allows monitoring and recording of electrical activity in the brain. Discovered in 1929 by German psychiatrist Hans Berger [2], EEG was regarded as a breakthrough technology of its time, as it was one of the first imaging techniques to be developed. Today, EEGs are a standard device that most hospitals and many research centers consider an invaluable tool. These signals can be used to help diagnose many brain disorders, establish a baseline for brain activity, and perform alertness detection [3].

The current EEG products on the market have a huge limitation, as most marketed EEG devices (ABM, ANT Neuro, G.tec [4]) have their electrodes embedded in a mesh or plastic cap, and these are connected via wiring to either a heavy battery pack or directly to a computer. Additionally, a conductive medium is required to ensure a good connection between the electrodes and the scalp. This brings some obvious problems to light including the discomfort of wearing a cap for long term, the risk of allergic reaction to the conductive medium, and needing to wash your hair following the scan. Finally, fitting the cap and prepping the electrodes can be a very time-consuming process. At ThinkUp, we challenged ourselves to come up with an affordable, intuitive system that overcomes these problems, without changing the fundamental technology in the EEG; we are not aiming to redesign the wheel, but simply to find a better way to mount it. EZG will eliminate these inconveniences by creating a portable, cap-less system that records data on a mobile phone or forwards the data to a processing computer. This will also allow the user to move, exercise, or sleep without fear of the device shifting and ruining the signal collection.

The inspiration of our product is the wearable ECG (electrocardiogram) system. Based on the same principles as the EEG, an ECG records electrical signals from the heart. A portable, adhesive, unobtrusive ECG system has been a marketed device for a long time and the EZG intends to mimic these properties. Using adhesive technology will ensure signal integrity, while a smaller set of electrodes will reduce device weight. A rudimentary schematic of EZG is shown in Figure 1. Our end goal is to create a portable, comfortable product, that collects high quality signals and is suitable for long-term wear.

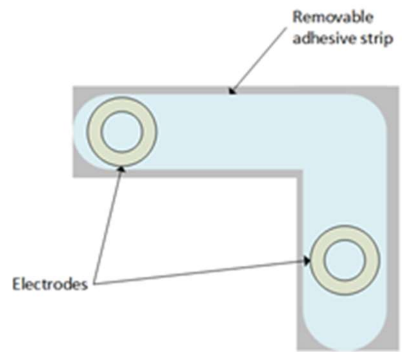


Figure 1: Basic Design of EZG

2 Background

2.1 EEG & EOG

As discussed, the EEG is a method that allows the user to monitor electrical signals elicited by action and graded potentials in the brain. EEG is beneficial as it has very high temporal resolution, meaning that it is has very accurate time detection. It is also a non-invasive and nonradiative device, rendering it very safe for users. However, it suffers a trade-off in the form of very low spatial resolution, meaning that it is very difficult to tell where the signals were elicited [5]. A chart of common medical imaging devices sorted by relative spatial and temporal resolutions is shown below.

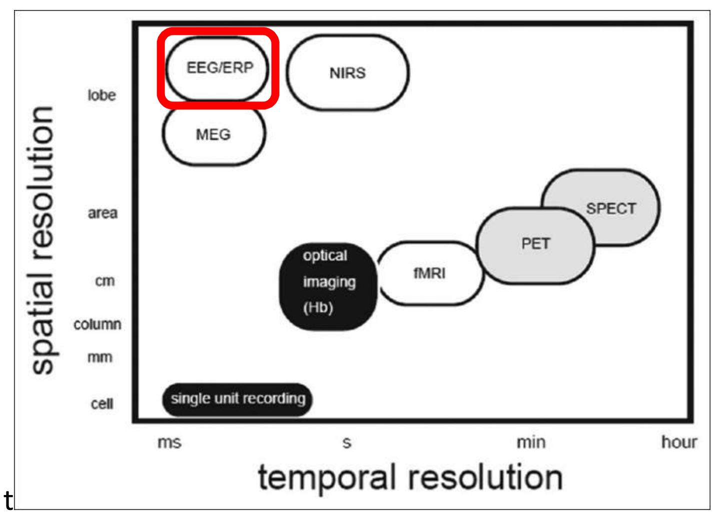


Figure 2: Relative temporal and spatial resolutions of common medical imaging devices [6]

To complete a traditional EEG, between 4 and 256 electrodes are placed against the scalp using a gel medium to ensure minimal impedance, and the electrical signal is then sent to and analyzed on a computer [7]. The computer will filter and sort this data to display the information that is recognized as brainwaves.

Hand in hand with EEG collection is EOG collection. EOG, or electrooculography, is the collection of electrical potentials elicited by movement of the eyes. Because the magnitude of these electrical potentials is much greater than the potentials elicited by the brain, EOG data - commonly referred to as 'blink data' in EEG analysis - is recorded and can be used to filter out the eye movement from the EEG signal in post processing.

2.2 Electrodes

Electrodes are the collection point of EEG data; they maintain contact with the subjects' scalp. Using a proper electrode can vastly change the quality of recorded data. There are multiple types of electrodes, but they can be classified into two main categories: surface and needle electrodes. Needle electrodes are single use needles that are placed under the skin while surface electrodes include EEG caps with disk electrodes and adhesive gel electrodes. These surface electrodes require a gel medium, which can be pre-applied; the requirement of the conductive medium classifies them as wet electrodes. [8]

As EEG has as evolved, a new surface electrode has arisen: dry electrodes. This contrasts the traditional wet electrodes, as it does not require a conductive medium. Dry electrodes require a much more complicated mechanism as they do not have guaranteed contact with the subject; this means they must tolerate high impedances (100-200x more than the wet), and need an apparatus that limits sensor movement, which would otherwise introduce noise into the system [9].

3 Scope

3.1 Project Goal and Benefits

The main goal of this project is to create an EEG that occupies the middle ground between a full gel cap EEG and a dry electrode EEG. Specifically, we want to achieve a higher Signal to Noise Ratio (SNR) and provide better data than the dry EEG, but to have a more portable system than the gel cap. The EZG system is a lightweight system located on the forehead and right temple and attached using hypoallergenic adhesive. This adhesive contact, in combination with wet electrodes will provide better signals than a dry EEG, while the small size, and lack of gel and head cap allows the EZG to be portable and versatile.

There will be some signal processing necessary for the EZG, for instance to remove the 60 Hz noise inherent in electrical connections; however, the goal of the project is to create the device and not to analyze the signals. Other than a simple blink test to verify that the EZG is functioning correctly, the in-depth processing and analysis will be left to the consumer and done on a computer after the EZG has successfully captured and transmitted the signal.

3.2 Structure

The EZG is designed as a three-part system, to balance cost with the necessary sterilization required by biomedical systems. The first component is a throwaway adhesive strip with two embedded electrodes (Figure 1: Basic Design of EZG) which connects to the second component through snap leads. Because of the adhesive and contamination due to contact with the skin, it is unrealistic for this component to be reusable, so it is single use but low cost. The second component is comprised of the electronics sealed in a weatherproof container to allow for cleaning. These electronics include the amplifiers, analog to digital converters (ADCs), and a microcontroller with Bluetooth and Wi-Fi. These are necessary to take the signal from the electrodes, do some simple filtering, and send it to a computer or phone, detailed in Figure 3. The third and final component is an extension that connects the electronics to a clip on the ear which provides a ground for the signals on the forehead.

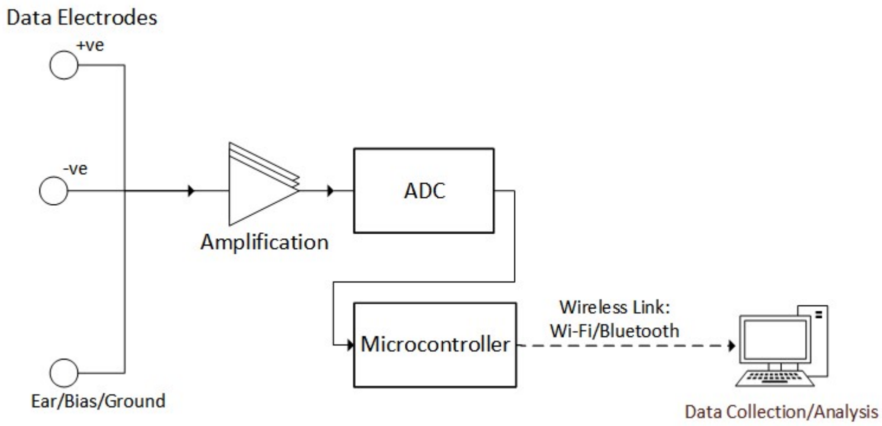


Figure 3: Block diagram of EZG

Our system is a dual channel EEG; this means that although the device is composed of three physical electrodes, there is one electrode for data collection. The second electrode provides the potential difference across the forehead, and the third electrode provides biasing and virtual ground, which will be clipped to the patient's earlobe.

3.3 Benefits: Portability

A portable EEG allows for a whole new range of possibilities for scientific studies as well as recreational use. A user would have the ability to wear the device during numerous activities that would not be possible with a cumbersome gel cap. For instance, the EZG could be used to monitor brain activity during workout sessions, or in a yoga studio to monitor mindfulness. Another application could be wearing the device for musicians who require movement, such as drummers or guitar players roaming around a stage. Sleep studies would be another new realm opened by the EZG, as the twelve-hour battery life would allow for users to get a good night's sleep with only a small device firmly adhered to their forehead. This would allow people to understand their sleep rhythms better and could provide invaluable data for insomniacs. These examples are only a small subset of the possibilities that having a portable EEG provides.

3.4 Benefits: Higher Signal to Noise Ratio (SNR)

While some portable EEG devices already exist, such as the Muse [10], they use a dry contact between the electrodes and the subject. These devices also rely on friction fit, or a band (similar to headphones) to keep the device attached to the user's head. This leads to less than ideal contact between the skin and the electrodes as the device will shift as the user moves - hence a lower SNR. Instead, the EZG uses an adhesive in conjunction with wet electrodes. Together with per-electrode signal amplification, this will result in a higher SNR compared to dry electrode devices.

3.5 Benefits: Comfort

The EZG will be more comfortable, as the adhesive will distribute the weight across the wearer. This is opposed to the Muse, a headset device, which is bulkier and is uncomfortable to wear for long periods of time, as most of the weigh rests on the user's ears.

3.6 Benefit: Affordability

As a relatively low-cost device, the EZG will be more accessible to both researchers and consumers. For researchers the benefit is obvious; the low cost will allow multiple devices to be acquired which will enable EEG testing on multiple subjects simultaneously. For the consumer market, the attraction of a low-cost, high quality device, cannot be overstated. Consumers considering purchasing an EEG headset will naturally be drawn to a device that is easier on the wallet and provides higher quality information.

3.7 Risks

In biomedical applications, safety for the user is the primary concern. Certain risks to the user must be considered for the EZG, especially since it is in close physical contact with the user. The major risk is electric shock, or sudden fires due to electrical shorts in the device. However, having the electronics encapsulated in non-conductive plastic mitigates this risk, as do the lower power requirements of a portable device. Adhesive must also be selected carefully to ensure that it is hypoallergenic and will not cause skin irritation after being worn for the full battery lifetime of twelve hours. An additional concern is the possibility of water, or sweat, leaking into the casing and shorting out the electrical components. This is alleviated by ensuring that the casing is weather proof.

3.8 Regulatory Compliances

The EZG will be considered as a surface device and will hence follow the ISO10993 [11] standard which is recognised by the FDA [12] and Health Canada [13]. The material chosen would have to pass tests for biocompatibility, namely: cytotoxicity, sensitization, and irritation or intracutaneous reactivity for surface applications. A biocompatible adhesive and plastic will have to be selected and must allow for the flexibility to ensure a comfortable fit on the subject's face.

Elsewhere in the world, the product would have to conform to EU 2017/745-6 [14] for the European market.

4 Market

The global market for EEG devices in 2015 was valued at $687.6 million USD and is expected to rise to almost $1.4 billion USD by 2024. In the U.S alone, the expected growth for EEG devices will rise to $355 million USD, as shown in Figure 4 [1]. Our device, EZG, competes primarily with the portable subdivision of the EEG market.

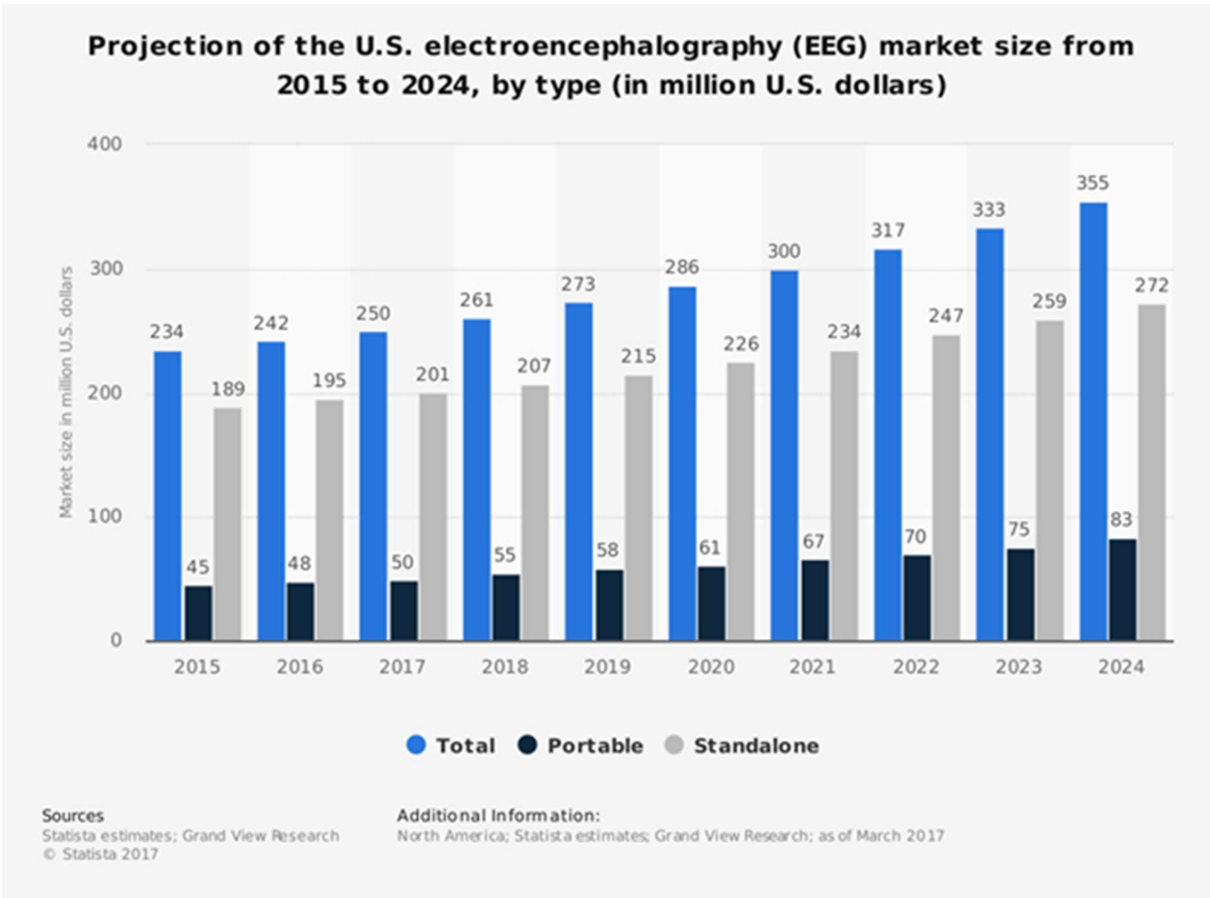


Figure 4: US Market EEG Projections [15]

The EEG market is primarily driven by its demand as a medical device, followed by commercial and academic use, all of which the EZG targets. Standalone EEG devices are used primarily in all the above-mentioned markets whereas portable devices mostly exclude the medical field.

Some uses of the EZG in the medical field may be to help diagnose dementia, sleep problems, epilepsy and seizures, and head injuries. Both dementia and epilepsy affect 50 million people worldwide each [16] [17] making them some of the most common neurological diseases. The EZG would likely not be used in testing facilities such as hospitals to diagnose patients, but out in the field where it is either too difficult or too costly to transport or a standalone EEG device.

One of the main target markets of the EZG is research centers. Much EEG research focuses on analyzing the state and reactions of the brain when the subject is exposed to a variety of stimuli. Recording and analyzing this data allows researchers to understand how the brain processes information. Another active research area is brain computer interfacing (BCI) which is the act of taking signals from the user and using them to control or manipulate a device or object. Since the EZG has a much quicker and simpler set-up process, as well as less messy clean-up, it will encourage greater participation in research studies, as well as a quicker turnaround time between subjects.

Commercially, the EZG can compete with or outperform existing EEG headsets being used for meditation, blink detection, or measuring alertness [18]. As previously mentioned, BCI's are not only used in research, but they also have existing commercial applications such as allowing people to control implanted body parts, playing video games, and controlling vehicles. The EZG could also allow for a new market to emerge in sports due to its increased comfort and reduced size; additionally, the use of an adhesive would allow sport users to move quickly without fear of the device falling off.

5 Competition

The competition that EZG will have in the market can be simplified into three categories: standard (standalone), ambulatory (standalone), and personal (portable) [19]. Standard EEG devices are set up in a testing facility and can require the user to be wired for up to a few hours at a time. Ambulatory EEG devices are similar to standard devices, except that the data is stored on a portable device that is usually carried in a backpack. Lastly, the personal devices are lightweight headsets that use dry electrodes; these allow for wireless data acquisition.

EZG has an advantage over standard and ambulatory devices by being portable, comfortable, and lightweight. The adhesive on the EZG also means that a test administrator will no longer need to prepare the electrodes with either a conductive gel or scalp cleaning which can take upwards of 40 minutes [20].

The main competitors to our device come in the form of other EEG headset devices which are all bigger, more expensive, and less comfortable than the EZG. All the headsets use dry electrodes in comparison to Ag-AgCl electrodes in our device, which are adhered to the skin and give a more consistent and higher quality signal than the dry electrodes [8]. Another unique advantage of EZG is it can be washed, which allows our device to be used by multiple clients in a safe manner. Listed below are a few of the major players in the EEG headset market and how EZG stacks up against them. Some values are given as ranges since they may change depending on what final parts are used.

Table 1: Comparison of specifications of EZG and competitors [21]

Device	Channels	ADC Bits	Sample Rate (Hz)	Battery Length (Hours)	Cost ($USD)
EZG	2	12-32	250-512	< 12	30-99
Muse	4	12	256	5	200
Epoc	14	16	256	6	799
Insight	5	15	2048	4	300
OpenBCI	16	24	250	26	949
Neurosky Mindwave	1	12	512	8	100

6 Project Plan

This project is composed of two, four-month phases. The first four months, Phase 1, are dedicated to finalizing of the design requirements and specifications and the development of a proof of concept for the EZG. The second four months, Phase 2, are dedicated to the creation of a working prototype. These two phases are further broken down into separate stages, which constitute the milestones for the project. Each stage includes the deadlines for the necessary documentation, and the expected completion times for the subtasks relating to each of the major stages. Appendix A contains the full Gantt chart that lays out Phase 1 of the project. The Phase 2 plan will be mapped out as part of the completion of Phase 1 and is not included in this document – see Drafts of Design Specifications, UI Specifications, and 440 Planning Appendix, below.

6.1 Proposal Draft

The initial stage of Phase 1 is the production of this proposal. The expected completion date for the individual proposal draft sections is Friday January 26th, 2018. This is five days prior to the official deadline. We have set all our internal deadlines in a similar manner - usually five to seven days prior to the official deadline. These internal deadlines offset any tendency towards procrastination and ensure that adequate slack time, or float time, is built in for any last-minute changes or debugging, and allows time to edit documentation prior to the official deadlines. This allows slack time to be integrated into the project planning without having to officially schedule it - simplifying the planning process.

6.2 Initial Design

Initial Design	**16 days**	**Wed 18-01-31**	**Wed 18-02-21**	
Requirement Spec Draft	10 days	Wed 18-01-31	Tue 18-02-13	
Requirement Specs Due (pre-deadline)	1 day	Wed 18-02-14	Wed 18-02-14	5
Requirement Specs Editing (due Feb 21)	4 days	Fri 18-02-16	Wed 18-02-21	6
Design Complete	0 days	Fri 18-02-16	Fri 18-02-16	
Design Review 1	4 days	Fri 18-02-16	Wed 18-02-21	

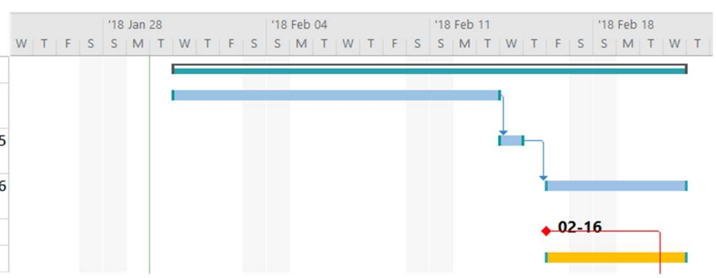


Figure 5: Partial Gantt chart showing Initial Design stage timeline

At this stage the EZG portable EEG design is completed. This includes finalizing the proof of concept design specifications and the overall design requirements. The necessary circuitry will also be designed in preparation for prototyping and construction. During the design phase, the design requirements are also finalized, and the draft document produced.

We have allotted 20 days for this stage of the project - from Wednesday January 31st to Wednesday February 21st, 2018. The internal deadline for design completion is set for February 16th. During this stage, the Requirement Specifications document is also drafted. This document will outline the necessary requirements of the design prototype - and, the minimal functional design of the proof of concept. The internal deadline for the requirement specification is Thursday February 15th.

This phase ends with the Design Review sessions on February 19th and 21st. This constitutes the first major project milestone and leads into the construction of the proof of concept.

6.3 Proof of Concept

Proof of Concept	**26 days**	**Wed 18-02-21**	**Wed 18-03-28**
Order Parts for Proof of Concept	3 days	Wed 18-02-21	Fri 18-02-23
Begin Construction	18 days	Mon 18-02-26	Wed 18-03-21
Proof of Concept Complete	0 days	Wed 18-03-21	Wed 18-03-21
Design Review 2	3 days	Mon 18-03-26	Wed 18-03-28

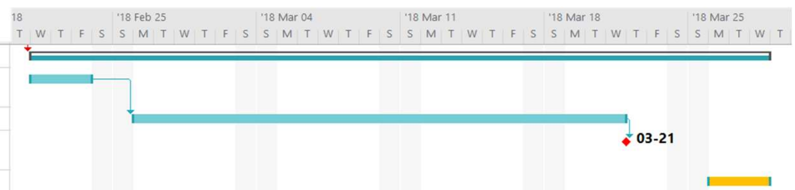


Figure 6: Partial Gantt chart showing Proof of Concept stage

Once the design is completed construction of the proof of concept can begin. This includes ordering the necessary components and constructing necessary circuitry determined in the design phase. At this stage of development our focus is on creating a functional device rather than a polished design prototype.

The completion of the proof of concept signifies the next project milestone. The proof of concept internal deadline is March 21st. This leads into the second design review sessions on March 26th and 28th.

6.4 Draft of Design Specifications, UI Specifications, and 440 Planning Appendix

Draft Specs/UI/440 Appendix	**26 days**	**Wed 18-02-21**	**Wed 18-03-28**
Design Specs Due (pre-deadline	1 day	Wed 18-03-21	Wed 18-03-21
UI Design Appendix Due (pre-deadline)	1 day	Wed 18-03-21	Wed 18-03-21
440 Planning Appendix Due (pre-deadline)	1 day	Wed 18-03-21	Wed 18-03-21
Specs/Appendix Editing (Due March 28)	6 days	Wed 18-03-21	Wed 18-03-28

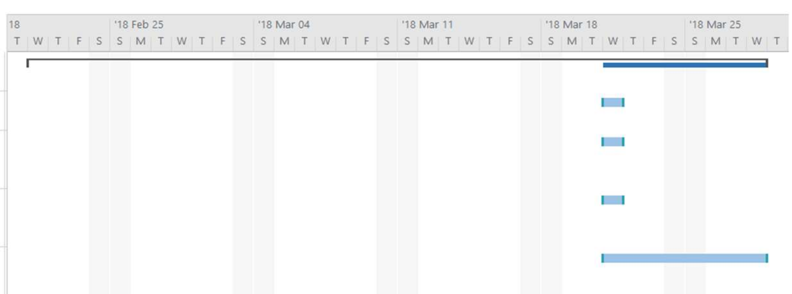


Figure 7: Partial Gantt chart showing documentation timeline

The preparation of these documents is intended to run parallel to the proof of concept construction phase. These documents provide the outline for the development of a prototype device (440 Planning Appendix), the user interface design, and the overall design specifications for the prototype design. The internal deadline for these documents is the same as the expected completion of the proof of concept, March 21st.

6.5 Demonstration

The proof of concept demonstration takes place on April 9th. The represents the final major milestone for this phase of the project. From this point the project moves into the prototype development phase.

7 Cost Considerations

7.1 Estimate of Costs

An initial estimate of our costs is included in the tables below, divided between our prototype and final product.

Table 2: Prototype/Proof of Concept Costs (Est.)

Part	Description	Total Cost (CAD)
MCU w/ Wireless Tx, ADC	Arduino Mega, Raspberry Pi or similar	140
Electronic Components	Voltage Reg, Resistors, Capacitors and auxiliary parts	30
EEG Electrodes (10pk)	Adhesive backed EEG Electrodes	15
Battery, Lithium	Power Source	15
Shipping	Cost of purchases components online	24
PCB	Protoboard or copper etching	20
Chassis	3D Printing (Rapid Prototyping)	30
Total		274

Table 3: Final Functional Prototype Design Costs (Est.)

Part	Description	Total Cost (CAD)
MCU w/ Wireless Tx, ADC	ESP32 or similar, I2C ADC	280
Electronic Components	Voltage Reg, Resistors, Capacitors and auxiliary parts to support MCU	60
EEG Electrodes (10pk)	Adhesive backed EEG Electrodes	15
Battery, Lithium	Power Source	30
Shipping	Cost of purchases components online	48
PCB	PCB Manufacturing by CM	50
Chassis	3D Printing (Rapid Prototyping)	100
Total		583

7.2 Potential Funding Sources

7.2.1 Engineering Science Student Endowment Fund

The Engineering Science Student Endowment Fund (ESSEF) is a fund administered by the Engineering Science Student Society (ESSS) [22]. The fund offers four categories of awards with Category B "Entrepreneurial" and Category C "Class" being of interest. We do not expect any difficulties in obtaining funding from the ESSEF as we meet the criterion in these two classes. However, if parts such as development boards are purchased with the ESSEF, it may be required that they be returned to the ESSS for inclusion into the loanable parts library.

7.2.2 Wighton Development Fund

The Wighton Development Fund is administered by Dr. Andrew H. Rawicz [23]. The fund will assist in obtaining additional funding not yet covered. A proposal will have to be submitted and will be evaluated by the fund's committee.

7.2.3 Engineering Science Student Society Parts Library

The Engineering Science Society Parts Library hosts a collection of various parts available for loan to Engineering Science students. This will come in useful for the initial prototype, as we intend to complete the proof of concept with off-the-shelf available parts.

7.2.4 Personal Funding

If the funding sources listed above are unable to cover the full costs of the project, each member has agreed to contribute up to $100 each to cover the remainder of the costs of the project. This is expected to make up to $500 of available funding.

8 Company Details

We are ThinkUp, a start-up medical device company. ThinkUp was founded in 2017 by 5 like-minded engineering students at Simon Fraser University, each with a passion for creating innovative technology. Our first prototype, the EZG, is a portable, affordable EEG device expected to be completed in August 2018. Joint and equal team effort was put into the production of this project proposal.

8.1 The Team

Chloe Hill – CEO

I am a 5th year biomedical engineering student, and I hope to continue my education with a neuroscience degree. I have experience working with EEG devices and an understanding of brain physiology and anatomy. I have a strong interest in the development and improvement of medical devices and am familiar with the procedures and requirements of bringing a medical device to market. I hope my background in medical technology and market experience will help create a cohesive and successful product.

Nathan Zavaglia – COO

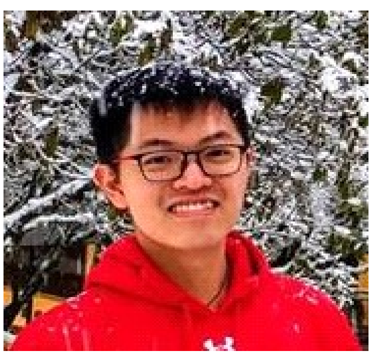
I am currently a 5th year student pursuing a Systems Engineering degree. My interests are wide ranging but primarily center on cybernetics. I also hold a B.Sc. Honours Physics and am well versed in general science. I have a passionate interest in STEM education and the related cognitive science, and, I see EEG as an essential tool to better understand the learning process. As such, I am strongly motivated to create better, easier to use devices for neuroscience researchers and learning specialists.

Elizabeth Peters – CTO

I am a 5th year Engineering Physics student with a passion for figuring out how and why things work. This drives me to inspect every detail of the projects I undertake and to put together a cohesive, well-functioning product. It has also spurred my interest in the human brain, where the detailed questions of how and why are still unknown. My research experiences at TRIUMF and SFU Surrey combined with my technical skills gained from classes will serve me well to make a product that may help shed some light on the human brain.

Michael Chyziak – CMO

I am currently a 5th year Computer Engineering student with a focus on digital logic and embedded systems. My previous work experiences at Intel and Xilinx will help in debugging and interfacing with the microcontroller on the EZG. At ThinkUp I will be working on the software between EZG and a host computer.



Isaac Cheng Hui Tan – CFO

I am a 4th year biomedical engineering student with an interest in electronics. Past experiences include projects involving LED Lighting, Guitar Audio Electronics and getting electroshocked when working on LED Lighting. I will attempt to keep costs down by forecasting needs and sourcing parts in foreign markets in East Asia.

9 Conclusion

The market for EEG devices for academic and commercial use is growing. However, most devices are either uncomfortable to wear for long periods, difficult to set up for each scan, not wireless, or a combination. Further complicating the issue are the electrodes; dry electrodes suffer from weaker electrical contact with the skin and generally have a lower SNR than wet electrodes. Wet electrodes however, are difficult to place in the hair as it requires the use of conductive gels that can be messy to apply and remove.

To address the above issues, we propose the EZG; a smaller, easier to use, more portable, and more comfortable EEG device. The EZG uses wet electrodes for their superior electrical contact properties. This, in combination with adhesive attachment, as opposed to friction or headband, will result in a higher SNR than competing dry electrode devices. The adhesive attachment also improves the setup time. As the device is designed to sit below the hairline, no conductive gels are required during test preparation. Thus, the set-up time is reduced, as is the clean-up time at the end of a scan. As an added benefit, the light weight, strong adhesive and lack of gel make the EZG suitable for long term use.

The longevity, comfort, and ease of use make the EZG an excellent choice for a variety of applications. The portability and comfort of the device translate well to ambulatory and motion studies. The small size and long battery life make the EZG well suited to sleep studies. The ease of use, combined with a low cost and research grade signal quality, make it an excellent choice for commercial use as well – further expanding the marketability of the EZG.

We believe the EZG represents a new paradigm in EEG. A portable, easy to use, research grade EEG device which allows greater flexibility for researchers and a wider scope of applications.

10 References

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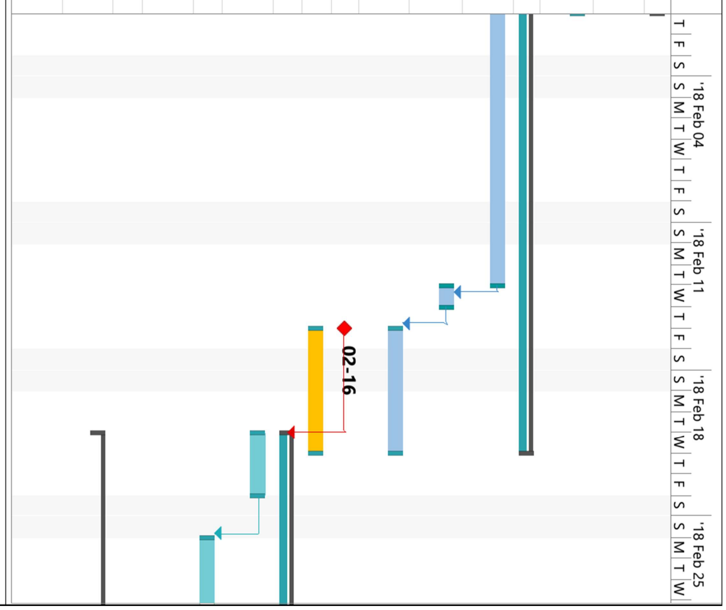
11 Appendix A

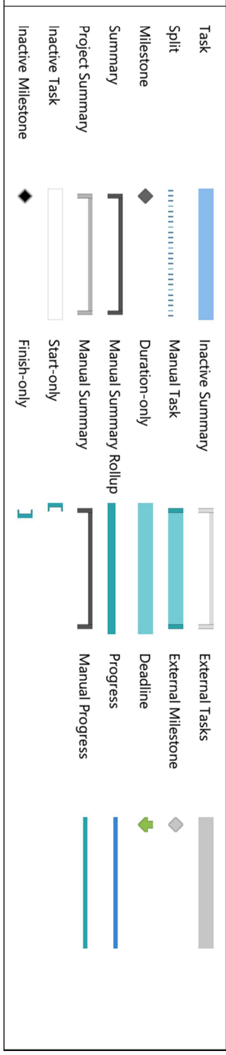
This appendix contains the full Gantt chart from the project planning section. It is split over multiple pages, broken down by month.

February 2018

ID	Task Mode	Task Name	Duration	Start	Finish
1		**Proposal Draft**	**14 days**	**Fri 18-01-12**	**Wed 18-01-31**
2		Proposal Due (pre-deadline)	1 day	Fri 18-01-26	Fri 18-01-26
3		Proposal Editing (Due Jan 31)	3 days	Mon 18-01-29	Wed 18-01-31
4		**Initial Design**	**16 days**	**Wed 18-01-31**	**Wed 18-02-21**
5		Requirement Spec Draft	10 days	Wed 18-01-31	Tue 18-02-13
6		Requirement Specs Due	1 day	Wed 18-02-14	Wed 18-02-14
7		Requirement Specs Editing	4 days	Fri 18-02-16	Wed 18-02-21
8		Design Complete	0 days	Fri 18-02-16	Fri 18-02-16
9		Design Review 1	4 days	Fri 18-02-16	Wed 18-02-21
10		**Proof of Concept**	**26 days**	**Wed 18-02-21**	**Wed 18-03-28**
11		Order Parts for Proof of Concept	3 days	Wed 18-02-21	Fri 18-02-23
12		Begin Constructio	18 days	Mon 18-02-26	Wed 18-03-21
13		Proof of Concept Complete	0 days	Wed 18-03-21	Wed 18-03-21
14		Design Review 2	3 days	Mon 18-03-26	Wed 18-03-28
15		**Draft Specs/UI/440 Appendix**	**26 days**	**Wed 18-02-21**	**Wed 18-03-28**
16		Design Specs Due (pre-deadline	1 day	Wed 18-03-21	Wed 18-03-21



Project: proposal
Date: Tue 18-01-30



ID		Task Mode	Task Name	Duration	Start	Finish
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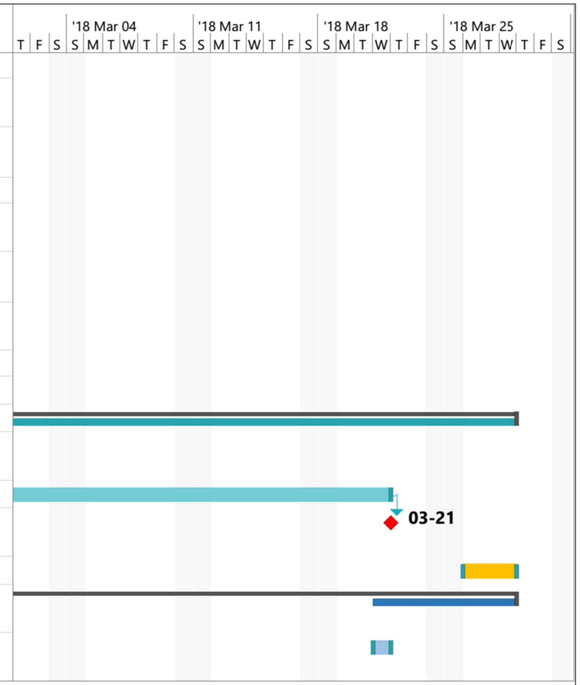
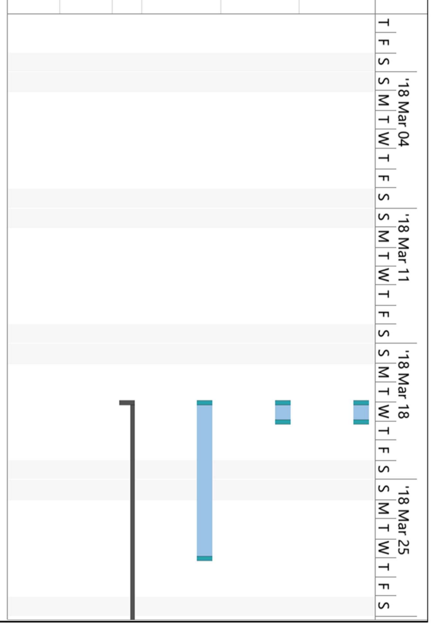


Project: proposal
Date: Tue 18-01-30

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

March 2018 continued

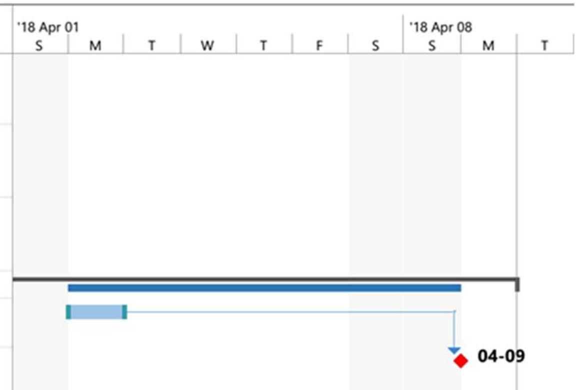
ID		Task Mode	Task Name	Duration	Start	Finish
17			UI Design Appendix Due (pre-deadline)	1 day	Wed 18-03-21	Wed 18-03-21
18			440 Planning Appendix Due (pre-deadline)	1 day	Wed 18-03-21	Wed 18-03-21
19			Specs/Appendix Editing (Due March 28)	6 days	Wed 18-03-21	Wed 18-03-28
20			**Poster Design**	**14 days**	**Wed 18-03-21**	**Mon 18-04-09**
21			Poster due (pre-deadline)	1 day	Mon 18-04-02	Mon 18-04-02
22			Poster Presentation and	0 days	Mon 18-04-09	Mon 18-04-09



Project: proposal
Date: Tue 18-01-30

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

ID		Task Mode	Task Name	Duration	Start	Finish
17			UI Design Appendix Due (pre-deadline)	1 day	Wed 18-03-21	Wed 18-03-21
18			440 Planning Appendix Due (pre-deadline)	1 day	Wed 18-03-21	Wed 18-03-21
19			Specs/Appendix Editing (Due March 28)	6 days	Wed 18-03-21	Wed 18-03-28
20			**Poster Design**	**14 days**	**Wed 18-03-21**	**Mon 18-04-09**
21			Poster due (pre-deadline)	1 day	Mon 18-04-02	Mon 18-04-02
22			Poster Presentation and	0 days	Mon 18-04-09	Mon 18-04-09



Project: proposal
Date: Tue 18-01-30

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone
Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only
External Tasks | External Milestone | Deadline | Progress | Manual Progress