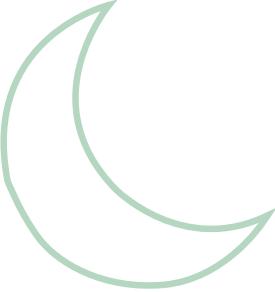


PROJECT SLEEP



Year 12 Major Design project | PROJECT SLEEP



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PROJECT PROPOSAL AND MANAGEMENT

IDENTIFICATION & EXPLORATION

MOTIVATION

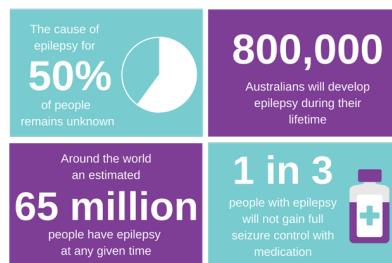
Motivation for this project is largely driven by personal interest and experiences. Personally, my interests include technology and health. When I was 13 years of age, I developed a childhood epilepsy that was triggered as I woke in the morning. Finding detection devices for epilepsy was both limited and expensive. When I obtained a detection device it was unconfutable, bulky and had short battery life that needed to charge every day, if the device was not charged when I needed to sleep, I could not use it. The accuracy was limited, and it would often get triggered just from stretching at night and in the morning. My idea is to combine my passion of health and technology with my experience to create a device that does it all. The device will work as a nocturnal epilepsy monitoring system that is permanently above the bed. It will not need to be charged and will work passively to switch on whenever the occupant is in bed.

SITUATION

Prevalence of Epilepsy in Australia

In Australia 250 000 people have been diagnosed with epilepsy, which correlates to over 1% of the Australian population. In Australia it is more common than Parkinson's, Cerebral palsy, MS and muscular dystrophy, however it is one of Australia's most widely misunderstood conditions.

What is epilepsy?: Epilepsy is disease of the brain characterised by the tendency to have recurrent seizures. It is the fourth most common brain disorder after migraine, stroke and Alzheimer's Disease.

Epilepsy: The Facts

Who does It affect? Although it is more likely to be diagnosed in childhood or senior years, it can be diagnosed at any age. It can affect people of any intelligence, gender, or race.

What causes it?: Epilepsy can sometimes be caused by head trauma, stroke, infectious disease of the brain, or abnormalities of the brain from birth. Genetics also play a role in some people. About half of the people with epilepsy never know the cause of their epilepsy.



What is a seizure?: A seizure is a temporary disruption of the electrical activity in the brain. There are many different types of seizures that present in many ways including changes to sensation, awareness, behaviour or movement. Not all seizures involve convulsions and not all seizures are diagnosed as epilepsy.

How is it treated?: The first choice of treatment is medication. Up to 70% of people become seizure free when taking medication. Other treatment options include surgery; Vagus Nerve Stimulation (VNS); the Ketogenic Diet or Modified Atkins Diet; and more recently Deep Brain Stimulation (DBS not yet in Australia). Education and lifestyle changes are also important.

Can certain triggers set off a seizure?: Sometimes specific events or circumstances can increase the risk of having a seizure. These are usually called seizure triggers. Recognising these triggers can help to reduce or even avoid seizures. Some common triggers people report include lack of sleep, missed medication, fatigue, physical or emotional stress, hormonal changes and illness.

Nocturnal epilepsy

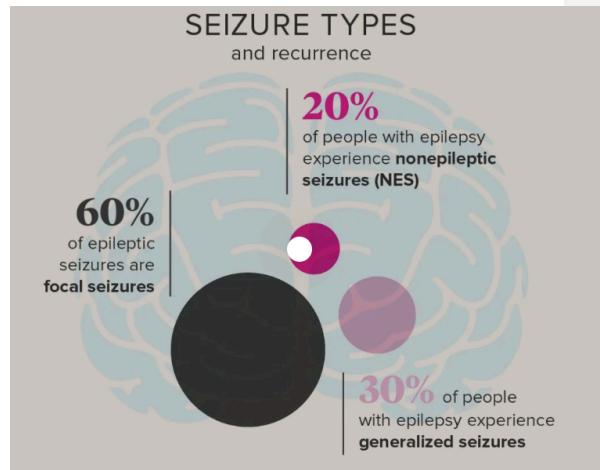
Nocturnal epilepsy is a common disease throughout Australians of all ages. Approximately 30,000 people around Australia suffer from nocturnal epilepsy. This disease is something that takes many people's privacy and independence away. For many people this is highly restricting in their daily life and is difficult on mental health.

Seizures that occur while sleeping

Many types of epilepsy associated with night-time seizures start in childhood. 70-80% of these at some stage will experience seizures while sleeping. The types of epilepsy associated with night-time epilepsy include:

- Juvenile myoclonic epilepsy
- Tonic-Clonic Seizures upon waking
- Benign Rolandic
- Landau- Kleffner syndrome

According to the New England Journal of Medicine (2014) almost 2/3 of seizures occur between 8pm and 8am. In addition, People who experience night-time seizures are more than twice as likely to have an unexpected death, opposed to those who only experience day time seizures.





Symptoms	Causes
Individuals may: <ul style="list-style-type: none"> • Cry out and make unusual noises, especially before muscles tense • Suddenly appear very rigid • Wet the bed • Twitch or jerk • Bite their tongue • Fall out of the bed • Be difficult to wake • Display confused behaviour 	<ul style="list-style-type: none"> • Genetics • Head trauma • Brain infection • Strokes, blood vessel malformation and tumors
Treatment and prevention	Preventive measures
<ul style="list-style-type: none"> • Nocturnal seizures are potentially dangerous and increase the risk of dying from epilepsy. • Having a seizure while sleeping can also make a person prone to injuries • Individuals who experience night time seizures are more likely to suffer low blood oxygen during and after the seizure. <p>Tracking symptoms, triggers and sleep activity are extremely helpful to identify if the individual's treatment plan is working</p>	<p>Individuals should:</p> <ul style="list-style-type: none"> • Choose a low bed frame or have mattress on the floor • Put a safety mat or spare mattress next to the bed • Use wall mounted lamps rather than table lamps • Keep furniture away from the bed • Use a nocturnal seizure monitor that alerts a loved one when a person has a seizure <p>(Moawad M.D 2019)</p>

Importance of Alerting others to night-time seizures

- A seizure device may help notify others if a seizure happens, it can be an important intervention that enables an individual to reposition the person, make sure they are **not unconscious** and make sure they do not fall asleep on their stomach afterwards (increasing breathing difficulty). They may be able to administer any seizure medications and if breathing problems do occur they are able to medically intervene and call for assistance. These early interventions that would otherwise not be able to occur, can have **life saving** impacts.

Importance of sharing health data

The New England Journal of Medicine (2015) identifies that to increase patient safety and health outcomes, continual collaboration between other clinicians, the patients' clinicians and the patient requires the safe and timely sharing of their health information. Currently health information can be shared via my health record, but **no current** seizure device can a user download their health information and send it to their clinician. By allowing real time data the current treatment plans of individuals can clearly be monitored and the effectiveness of the current treatment plan can be assessed. In addition to this, the sharing of health data and tracking an individual's habits can allow for any new seizure triggers to be identified and treated accordingly.



Primary Research

Statement from Director of Intensive Care: Norwest and Mater Hospital. Dr Stephen Nolan – Intensive care, Respiratory and sleep medicine physician



Individuals who experience seizures at night time are at significant risk of potentially catastrophic injury or health complications, when compared to individuals who experience day-time seizures. A significant contributing factor is the individual's inability to alert health services or others around them, as unlike during the day unless sleeping in the same room, there are no witnesses to these events, and even then, time and time again we see distressed parents who have slept through the seizure. In addition, as a medical professional, the more health data that can be collected on an individual's sleeping pattern the better we can assess if the treatment plan is working, or recommend any adjustments.

I have been a disability support worker for the past 3 years, in that time I have worked with various young adults who experience significant night-time seizures and therefore cannot be left alone at night.

Even though we don't sleep whilst on the overnight shift, we don't often stay in the room with the individual to not take away from their privacy (unless it is a required care). One of my biggest fears is not waking up to the individual and them suffering injury because of this. Everyone I have worked with does have a device that they wear on their wrist to alert us to a seizure, but I often find individuals are not compliant in wearing them as they are bulky and can lead to reduced sleep quality. A product needs to exist that counteracts this bulkiness. Although I am unsure what that would be.

Interview with 22-year-old female disability support worker

Initial Interview with Andrew Maxwell – Founder and managing director Chatsworth associates

Chatsworth Associates is a boutique advisory firm providing strategic advice to innovators, entrepreneurs and established business owners of high growth companies in the Bio-Medical, Medical device, Mobile health, Health It and my more sectors.

Through a contact I reached out to this firm as Andrew has worked on many medical innovations and bought these successfully to market. Including ground breaking epilepsy and Parkinson's devices. The initial conversation was around my thought process around what I am thinking and further determining if there is a strong need. The feedback from Andrew was extremely positive and he agreed there was a strong need for my idea, he also has agreed to reach out to software developers and epilepsy research teams and put me in contact with these individuals .

DESIGN BRIEF

To create a sleep epilepsy safely tracker and alarm that allows people suffering from the disease to live a more normal self-sufficient life. The device will provide peace of mind for people affected and carers looking after these people.

Who

The device can be used by anyone who experiences epileptic fits whilst in bed.

What

The product will gather raw data on the sleeping condition of a person suffering from epilepsy. It will track the position of the person sleeping using thermal imaging technology and use parameters to detect rapid movement/ epileptic fits.

When

The product will be able to be used 24/7 whenever the patient is sleeping or lying-in bed. It will have the ability to be used during the day and at night as it used thermal imaging technology.

Where

The product will be used in the bedroom (above the bed) of the person with nocturnal epilepsy. It is designed more as a perinate solution for the patient's bedroom, but it will have the ability to be moved if needed. For example, a holiday situation in a foreign bed.

Why

There is a need for this device. Many people suffer from nocturnal epilepsy and this device is designed so that those people can have a better quality of life. There are products out there that offer similar services but not in the same way this will. This is designed as a hassle free perinate solution that is much lower maintenance.

How

The product will be made of many materials ranging from 3D printing to micro processing technologies. It will use a thermal imaging camera to identify the sleeping condition of the person sleeping. The raw data will be gathered and processed by a microcomputer. The enclosure will be made of 3D printed abs plastic or wood metal ect.

Ongoing Evaluation: The primary and secondary research along with the design brief and 5W's and H of design have made it extremely clear that a better product needs to exist in this space. The device that I will be making will minimise the need for family and careers to be always checking on the person suffering. This will help many with their privacy and independence, the device aims to improve mental health of the individuals affected and provide peace of mind to carers. **The device will detect when a fit is about to happen and will alert a career. A sensor will detect body movement and a device that will measure body temperature will use data to decide when a fit is coming on. The device will overall increase the safety and the mental health of all people affected by this disease.**

Costs

- How much will the tech used cost?
- How much will the product sell for?
- How much will it cost to develop the code?

Existing Ideas

- What sleep tracking devices already exist.
- What epilepsy sleep trackers already exist.

Sleep Conditions

- Insomnia
- Sleep apnea
- Restless legs syndrome

Areas Of Investigation

Target Market

- Who is the product intended for?
- What age group will use the product?
- What conditions would people have to use the product?

Ergonomics

- What are traditional sleep tracker attachment methods.
- How do traditional devices share data with the user?

Sleep epilepsy

- How many people have it.
- What injuries can come from having it.

Health risk of wearable technologies

- How do technologies affect the human body.
- What medical conditions can come from technology.

Computer technologies in health

- What types of computer technologies are used in health.
- What sensors are used in medical technology.

Epilepsy

- What can trigger epilepsy.
- How can epilepsy develop.
- How to minimise epilepsy.

Areas Of Investigation

Importance of sleep

- Why is sleep so important?
- How many people actually get the right amount of sleep.

Legislative guidelines using technology in health

- Is there privacy laws and regulations surround technology in health and if so what are they.
- Do the decices have to reach a certain reliability rating or testing to be eligible

Micro computing technology

- What micro controllers are there that could be used for medical purposes.
- Is there any micro controllers specifically designed for medical purposes.

AREAS OF INVESTIGATION – FURTHER DIRECTION

Area:	What needs to be investigated:	Justification:	How it will be investigated:
Costs	The cost to develop and manufacture the product.	This needs to be investigated to see if it is an achievable project to fund.	By: Researching the cost of the needed technologies and where it can be purchased.
Existing Ideas	What sleep tracking and epilepsy tracking devices already exist.	This is to identify what technologies are involved in health tracking. Find different methods that are used to monitor the human body.	By: Looking into the features and the description of various sleep tracking and epileptic tracking devices.
Sleep conditions	Sleep conditions that exist in humans.	This is to distinguish how nocturnal epilepsy differs from traditional sleep disorders to provide more understanding of the severity of the disease.	By: Research into sleep disorders, the signs, and symptoms along with the possible injuries that can occur from having these conditions.
Target market	Who could use the device is there any age restrictions.	This needs to be researched as the product is likely to need to cater to a wide demographic.	By: Researching who has epilepsy, how many people have epilepsy, what ages do most people develop epilepsy.
Ergonomics	How the traditional health tracking devices interact with the user.	This needs to be investigated to identify the positives and negatives of existing devices to better the new tracker.	By: Researching how traditional devices attach to the user, read reviews of these trackers, and identify if they are well received features. Identify what the best way for the users to access the data the device tracks.
Sleep epilepsy	How many people have it and what	This is to identify how many people are actually affected	By: Researching the amount of people



	effects can come from it.	by this and how it can effect peoples lives, how severe are some of the injuries.	that suffer from nocturnal epilepsy. Research what injuries have been recorded that are caused by nocturnal epilepsy.
Health risk of wearable technologies	What are the health risk of wearing wearable technologies and what are the health conditions that can develop.	This needs to be researched in order to understand the benefits of using a device that does not come in direct contact with the patient's body.	By: Researching events where people have suffered from conditions caused by technology being in direct contact with their body.
Computer technologies in health	What are existing computer technologies that are used in the health area and what are the sensors that they use.	This is needed to identify what technologies could be used in a nocturnal sleep tracking device. To find the possibilities of using different sensors to gather data on sleep.	By: Researching the specification and descriptions of current technological devices used in the health industry. Researching how the sensors are used to monitor the patient.
Epilepsy	The triggers of epilepsy, how it may develop and how it could be possibly minimised.	This needs to be researched to ensure that the tracking devices don't add to making the epilepsy worse. In addition to identify what else the device could do to minimise the effect of epilepsy on the patient.	By: Researching into what are the causes of epilepsy how it can develop on different people and what methods other than medication can minimise epilepsy.
Importance of sleep	Why sleep is so important and how many people actually get the right amount of sleep.	This needs to be researched to identify how nocturnal epilepsy can disrupt daily life.	By: Researching sleep generally not just in terms of someone who is affected by epilepsy. Researching the impacts of lack of sleep in general life.
Legislative guidelines using technology in health	Is there any laws and regulations regarding the use of technology in the health sector.	This needs to be investigated so that the device is abiding by the law and does not have any legal	By: Researching the laws governing the use of technological



		complications if it were to be taken to market.	devices in the health industry.
Micro computing technology	What micro controllers would be usable for health applications and is there any devices that are specifically designed for the health sector.	This needs to be investigated to identify if it is needed to use a health specific device in this application or if general micro controllers are capable to be used in the health industry.	By: Identifying the needs of the device and how well it needs to perform and determine if it is possible for a health-related application. Research the health devices and distinguish if there is any differences to a typical micro controller.

Ongoing Evaluation: As the project progresses and changes with new and refined ideas, more areas of investigation might be added, or existing areas might need adjusting. The simple table format will allow me to refer back to it and ensure I am investigating and researching all needed aspect to better my project. The mind map is a great visual that I can easily identify each area that I need to research. To ensure I have further direction, the table has been created, this gives me a great platform that I can use to direct my research.

CRITERIA TO EVALUATE SUCCESS

Functional Criteria

Criteria:	Analysis:	Impact if not achieved:	Measure for success:
Quality	Testing the durability and finish of the materials used. Using a microcontroller that has high build quality rating.	If the quality of the device is not met it will heavily impact the usability as it is used in a medical environment of which quality needs to be to the highest standards.	The materials will undergo a series of durability tests to determine the most suitable material, in addition once the product is completed it will be tested in a variety of different environments to ensure it
Accessibility	Making the product easy to use and operate for any individual of any technological skill level.	If this is not met it will be difficult to recommend or sell the device as it needs to be used correctly for it to work.	The product will be tested with various members of the target market and then they will be asked a series of targeted questions through surveys
Personal Cost	Cost of development micro controller and development accessories to initially build the device.	If the cost of development is too high, this cost will need to be passed onto the consumer, this will negatively impact the devices potential sales.	The finance plan will be monitored throughout the project
Client cost for kit	The cost to client will be varying depending on the market it is released in and the total cost to get the product to market.	If the cost to purchase is to high, individuals will not purchase the product and it won't be successful.	The target market will be surveyed to determine if they would buy the product.
Accuracy	The accuracy of the results is vital as the device will be relied on to increase safety.	If the product is not accurate the data will not be able to be used for its intended purpose. It would also decrease safety to the user and potentially have serious impacts to the users health	A series of tests will be undergone using coding ect. In addition, a professional evaluation will be conducted.



Reliability of device	Device will have high quality connections between components. It will have a reliable highly rated micro controller and many testing and experimenting will be done in order to fine tune the device's reliability.	If the device is not reliable it will impact on the safety of the device. If the device cannot meet the safety standards it will be unable to be sold as it could potentially harm the user.	A professional evaluation will be conducted by a IT specialist along with the target market being surveyed.
Ease of Use – App	The prototype app design must be easy to use with a functional layout that can be navigated by individuals easily without problems	If he app is not easy to use it will not be a successful product as individuals will not be able to use the device effectively	As the app will be a prototype I will survey members of the target market on its layout ect, however this may be in paper form, with a basic working prototype.

Aesthetic Criteria

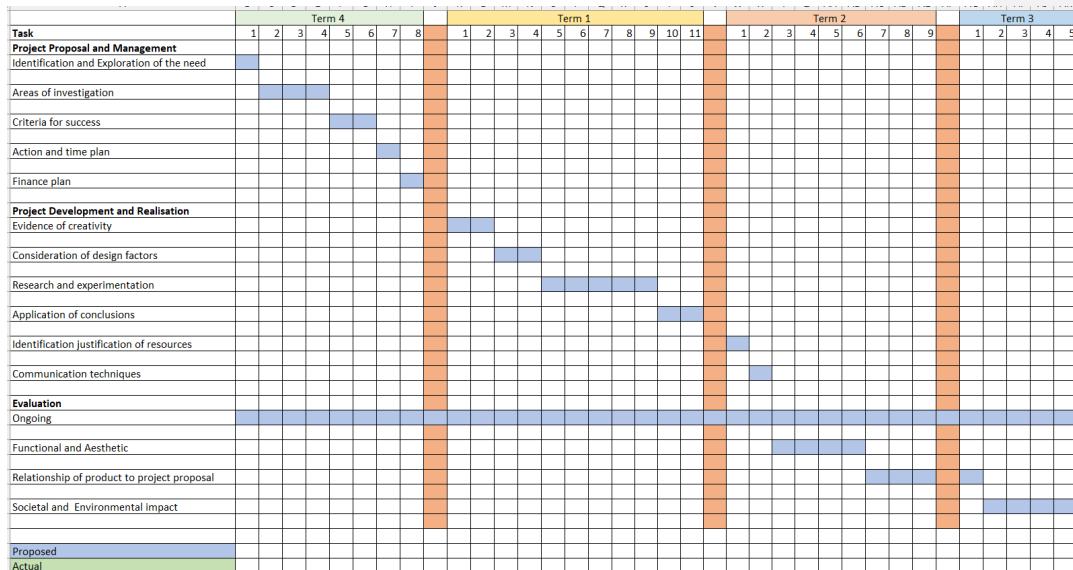
Criteria:	Analysis:	Impact if not achieved:	Measure for success:
Originality	The product will be used in a unique way no other devices are used. It will offer a well-designed enclosure different to other options of the market.	If the product is not original, there will be no appeal for people to buy the product over ones that already have an established product	The target market will be surveyed to determine if they think the device is original.
Visually Appealing + Functional literacy	The device will have a sleek modernistic design with smooth subtle finishes in order to not offend the environment it is put in.	If the product is not visually appealing the individual will not want to purchase and have it in their bedroom as it will become an eyesore	Survey the target market to ensure they find the design visually appealing. If they do not, make any changes needed
Colour	The colour must not be intrusive to	If the colour is intrusive, it won't be attractive for the user to buy	Conduct various tests and experiments on colour and then survey the target market on the colour of the product.

Ongoing Evaluation: The criteria to evaluate success gives me a set of criteria that I am able to continually refer back to during the entire design process. This will allow me to ensure that I am continually meeting the set needs of the project and allow the designs to stay on track during the entirety of the process.



PROJECT MANAGEMENT PLANS

Gantt chart



Ongoing Evaluation: The time management plan allows me to gather information about my time management, it also allows me to visually assess the time of each section of completion. The time management plan allows me to find specific target areas that are going to take more time or that need more focus and work due to size and need

Finance Plan				
Product	Estimated cost (\$)	Actual cost (\$)	Date Purchased	
Raspberry pi	\$ 150.00	\$ 152.54	9-Nov-21	
Thermal Camera	\$ 120.00	\$ 155.47	9-Nov-21	
Wiring	\$ 20.00	\$ 34.57	17-Nov-21	
Software development				
Enclosure	\$ 10.00			
Total:	\$ 300.00	\$ 342.58		



Action Plan

ACTION PLAN			
Item	Action	Proposed Date	Actual Date
Project Proposal and project management		Completed by Term 4, Week 8	
Identification and Exploration of the need	Identify a real-world problem and come up with an effective idea that will be useful to the people around me. I will talk to parents, friends, and teachers about suggestions for the project.	Weeks 1, 2, 3, 4, and 5; Term 4	Weeks 1 and 2, Term 4
Areas of Investigation	Identifying resources, tools, websites, interviews, and mind maps that help me outline the need and the product that I am creating.	Weeks 4, 5, 6, and 7; Term 4	Weeks 3 and 4, Term 4
Criteria for Success	I will investigate design considerations and their relevance to my MDP to create a set of criteria that will make my product a success.	Weeks 6, 7 and 8; Term 1	Week 5, 6, 7 and 8. Week 1 Term 1
Action and Time Plan	I will create a table and excel spreadsheet to effectively plan out my MDP and visually display the progress of my project.	Weeks 3 and 4; Term 1	Week 1 and 2, Term 1



Finance Plan	I will create a finance plan that outlines all purchases that I need to make during the development of the project. This will allow me to visually estimate the price of the project and the materials and resources I will need to source.	Weeks 4 and 5; Term 1	Weeks 3 and 4, Term 3
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Project Development and Realisation		Completed by Term 2, Week 9	
Evidence of Creativity	I will show evidence of creativity by developing my design idea with original concepts and using research sources to show that my idea is original.	Weeks 1, 2, 3, 4, 5, 6; Term 1	Weeks 1, 2, 3, 4, 5, 6 Term 2 and 3
Consideration of Design Factors	Using the design factors such as timing, emerging technology, historical, cultural, political, legal, and economic factors to influence my decisions and design.	Weeks 3 and 4; Term 1	Weeks 1, 2, 3 Term 3
Research and experimentation	I will use the internet and resources around me such as teachers to help refine my ideas and make my product the best it can be.	Weeks 5, 6, 7, 8, 9, 10 and 11; Term 1	Weeks 5, 6, 7 Term 2
Application of Conclusions	I will apply my conclusions by evaluating and testing my design in the	Weeks 7, 8, 9; Term 2 Weeks 1, 2, 3; Term 3	Weeks 4, 5, 6 Term 3



	classroom environment.		
Identification and Justification of Resources	I will identify and justify my resources by using sources around me such as the internet and teachers to provide me with resources to develop my product.	Weeks 1, 2, 3; Term 1 Weeks 1, 2, 3, 4, 5, 6; Term 2	Weeks 1, 3, 4 Term 2
Communication Techniques	I will develop communication techniques within my portfolio that help me better my project.	Weeks 1, 2, 3, 4, 5, 6, 7, 8; Term 4 Weeks 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11; Term 1 Weeks 1, 2, 3, 4, 5, 6, 7, 8, 9; Term 2 Weeks 1, 2, 3, 4, 5; Term 3	Weeks 1, 2, 3, 4 Term 2 Weeks 4, 5, 6 Term 3

Evaluation		Completed by Week 5; Term 3	
Ongoing Evaluation	I will evaluate my project as I complete it and identify mistakes and things that went well. I will evaluate my research, process and decisions made throughout the completion of the project.	Weeks 1, 2, 3, 4, 5, 6, 7, 8; Term 4 Weeks 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11; Term 1 Weeks 1, 2, 3, 4, 5, 6, 7, 8, 9; Term 2 Weeks 1, 2, 3, 4, 5; Term 3	All weeks
Evaluation of Aesthetics and Function	I will evaluate the function and aesthetics of my project by getting other people to review my project. I will also self-review	Weeks 1, 2, 3, 4, 5; Term 3	Weeks, 2, 3, 4, 5, 6, 7 Term 3



	my project during this time.		
Relationship of Product to Project Proposal	I will evaluate the product in comparison to my original idea. I will evaluate the final product compared to what my original idea was and it in comparison to my proposed idea.	Weeks 1, 2, 3, 4, 5; Term 3	Weeks 6, 7 Term 3
Societal and Environmental Impact	I will evaluate the product and the impact that it has on society, whether it be negative or positive. I will also evaluate the impact that the product has on the environment in terms of waste produced and how it impacts natural life.	Weeks 1, 2, 3, 4, 5; Term 3	Weeks 1, 2, 3 Term 2

Ongoing Evaluation: The action plan will allow me to gather information about my project and also plan for my time management to stay on track. This will provide me with further direction on how to complete everything set out in my gantt chart and put it into action. It will also allow to visually evaluate how my time management has been over the entirety of the project.

SOCIAL, ETHICAL AND ENVIRONMENTAL IMPACT OF DESIGN- JUSTIFICATION OF MDP

As a designer, there are many aspects of design that must be considered when designing an innovative product. It is of upmost importance to consider the social, ethical, and environmental impacts the design will have.

When creating products to be used by society designers must strive to ensure **equal accessibility to their product**. The less able, minority groups or those suffering from a disability must be given equal opportunity to benefit from any new product. The product I will create throughout the design process aims to make **epilepsy monitoring for individuals**



assessable, regardless of their socio-economic standing. Through creating a monitoring device that can alert individuals to a seizure, is easily mounted on a individuals bedroom roof and can increase individuals' safety. The product will be sold at a reasonable price to ensure it is accessible for anyone that would benefit from the product.

I reached out to Dr Stephen Nolan an intensive care specialist, respiratory and Sleep medicine Physician and the Director of Norwest Intensive Care and former Chief medical officer of the Mater Hospital in Sydney. **He saw a great need for this product and immediately saw the positive impact that this could have on many individuals' lives.** Stephen then put me in contact with Andrew Maxwell the Founder of Chatsworth associates. Chatsworth and Associates is a boutique advisory firm that provides strategic advice in emerging and high growth companies innovating in the Bio-Medical, Medical Device, Mobile Health, Health IT, Aged Care, Hospitality, Food Service and Food Technology sectors. Following several conversations with Andrew, it is clear there is a **very real genuine need for this project.** Andrew has offered to mentor me through this project, with opportunity to peruse this after the completion of the MDP.

Ongoing Evaluation: The conversations with Dr Nolan and Andrew have shown a clear and genuine need for this project, Projects these individuals have been involved with are extremely innovative including reducing hypoxia in TBI patients and a hearing aid inspired by insect hearing systems, mimicking natures response to sound waves. It's an exciting prospect that they have taken an interest in this project and has provided me with the motivation to pursue this project.



PROJECT DEVELOPMENT AND REALISATION

RISK AND RESOURCE TABLE

Resource	Picture	Justification	Risk	Risk Assessment
Computer		A significant amount of coding will need to occur for the project to work, without a computer a majority of the elements of the device will not be able to be completed	Eye strain from screen	Take frequent breaks away from the screen and use blue light reducing glasses when working on the screen for a long time
Mr Moore, Mr Thompson		Conversations with these teachers take place to help plan and generate ideas around executing the testing and experimenting of the code.	Getting to much work done by them and it not being my own work.	Ensure that the conversations are just ideas generation based and not physically writing the code.
Band saw		Band saw will be used to efficiently create a mount for the device to attach to the bed for testing and experimenting purposes.	Eyes getting struck by dust, fingers getting cut off.	Ensure that fingers do not come close to the blade. Wear safety glasses.
Drill		Drill will be used to screw the parts of wood together to create the testing and experimenting bracket to attach to the bed.	Screwing into hands and fingers, risk of wood going into eyes.	Make sure components are secure attached to table and keep hands well clear of the screws. Ensure the use of safety glasses.



Fusion 360/Tinker cad		To develop detailed designs in order to 3d print and produce.	n/a	n/a
3D Filament		To use in 3D printer and thus print out prototypes.	Rafts are sharp Produces fumes when hot	Wear gloves when taking rafts off printed parts. -Avoid breathing in fumes
3D printer		To 3D print the prototype designs.	Electrical Fire	- Ensure printer is maintained and clean. -Monitor printer whilst printing.

Ongoing Evaluation

Through completing the risk and resource table, I am able to identify all appropriate risks and manage these risks ensure I am completing my MDP risk free, meeting the design consideration of WHS and safety. The list of resources enables me to easily keep track of all the required resources I will need to source and provide guidance of who I can seek help from.

AREAS OF INVESTIGATION- FURTHER RESEARCH

SLEEP CONDITIONS:

Sleep conditions are conditions that effect the ability of people to sleep.

- **Insomnia:**
 - Difficulty falling asleep or staying asleep.
- **Sleep apnea:**
 - Abnormal patterns in breathing while you are asleep.
- **Restless legs syndrome (RLS):**
 - Uncomfortable sensation and an urge to move the legs while you try to fall asleep.
- **Nocturnal epilepsy:**
 - Epileptic fit whilst asleep or in bed.



Sleep disorders can directly influence physical and mental health, safety, and quality of life. Many sleep conditions have proscribed medications that dodge the underling health condition.

COST

How much will the tech used cost?

The primary component used in the device will be a mini computer and will need to be powerful enough to achieve high processing rates of raw data being output by a thermal camera.

The devices being investigated for this use case are:

- Raspberry Pi - \$95.00
- Nvidia Jetson Nano - \$225.00
- ASUS Tinker board S R2.0 - \$150.00

Each of these individual devices require additional power cords and storage devices. These additional components can range from \$50 - \$150.

Another main component of the device is the thermal camera. The specifications needed by the camera will differ to the use case and this will influence the price. The accuracy in this use case is important which can make the thermal camera expensive. Considering that the temperature range needed is common and the resolution needed is relatively low the cost of the overall needed camera is not overly expensive in relation to other thermal cameras.

Thermal camera module:

- MLX90640 thermal camera - \$140.00
- Lepton 2.5 thermal camera - \$395.00

Each thermal camera needs additional hardware to connect the camera to the computer. This hardware may include cables, connectors or connector modules. All these extra components alone would range between \$50 - \$100.

How much will the product sell for?

The product itself on components alone would range in price from around \$350 all the way up to \$900. To make this device profitable it would need to have a minimum consumer price point of more than \$1000.00. With buying these items in bulk the cost of components would considerably decrease. As there are many other expenses compiled into each device selling the product for around \$1500.00 would both give the device a considerable margin without overcharging for a medical device that could hugely enhance the lives of many.



Cost to develop code.

The cost to develop the code is not a simple cost to project as there are many factors that would go into coding the device. The average hourly rate for a software developer in Australia is \$30 an hour, considering the challenges that may be faced with the setup of the device and advanced problem solving needed to get such a device working I would estimate that it would take a professional around 30 hours. This means that the development of the code would cost around \$900.00. In this case the code and all setup will be done by myself and hence there will be no cost to develop the code.

EXISTING IDEAS:

What sleep tracking devices already exist?

Many fitness tracking related devices have a sleep tracking function. This research will only include sleep specific devices, this is because many of the fitness trackers are not practical as a sleep tracker in terms of accuracy and needing to charge them.

Current Popular sleep tracking devices:

1. Amazon Halo
2. Oura Ring
3. Whoop Strap
4. Withings's sleep
5. Beauty Rest
6. EMFIT QS

These devices are all seen to be accurate with sleep tracking. They all use similar characteristics in their usage of the data they gather. All the above devices track the movement of the body. 1, 2, and 3 use temperature sensors to gather sleep information. Those are the most commonly used sensing techniques in sleep trackers, most trackers then use a series of secondary data to cross reference with the primary data to then determine a person's sleep condition.

What nocturnal epilepsy sleep trackers already exist?

Nocturnal epilepsy specific tracking devices:

1. **SAMI Alert monitor**
 - a. Camera monitor (watched by someone).
 - b. Time stamped movement.
 - c. Optional alert can be sounded.
2. **Embrace2 Watch**
 - a. Detect Seizures.
 - b. Monitor sleep activity.
 - c. Bluetooth from device to phone.
 - d. Alert's caring person.
3. **Epi Assist Under Mattress Sensor**
 - a. Sensors Movement.



- b. Can alarm if out of bed.

4. Pulse Guard Monitor

- a. Detects heart rate.
- b. Uses secondary data to flag irregular or different heart rate.
- c. Sounds an alarm to alert carer.
- d. Needs tablet no more than 10 meters away.

5. Night Watch Epilepsy Monitor

- a. Monitors heart rate.
- b. Monitor movement.
- c. Detects and flags seizers and transmitted to base station. (with carer)

These devices all work in similar ways. They all are movement base which is always necessary when detecting epilepsy. They all use the same way to detect the movement, this is through the use of an accelerometer sensor or something very similar. The negatives of using this is that they will alert or alarm if there is any sudden rapid movement, so the chance of a false alarm is highly likely. For example, stretching in the morning or even scratching your head could set off these devices.

TARGET MARKET:

Who is the product intended for?

Many people around the world suffer from epilepsy. There is no one age or certain type of demographic that suffers from the condition. This is why this tracking device will have to cater for a very large audience. Epilepsy trackers are not sophisticated as they can be, this device's intention is to bring a more advanced tracking device for nocturnal epileptic patients.

What age group is the product intended for?

Most sleep tracking devices on the market come across as devices only technologically advanced users can use. Devices with small screens and complex apps are not a device intended for the older age bracket. This tracking device intends to simplify and bridge the gap, the device will only provide the information relevant. In terms of the epilepsy features of the device more options and a level of adjustability will help incorporate the needed data. Using these features the intended age bracket will be as large as the user is willing.

What conditions would people have to use the product?

Most health-related conditions today would benefit from more knowledge about the way you sleep. Although this device will be specifically designed and intended for epilepsy the technologies used could with further development be used for many other applications.

ERGONOMICS:

What are traditional ways sleep trackers are attached to the user?

All sleep tracking devices attach directly with the user, most devices use a band around the body or wrist, some strapped around the head and even some that you lay on. What all these devices have in common is that they are in direct contact with the body in order to apply the needed pressure for the sensors to work.

How do traditional devices share data with the user?



Traditional devices run scheduled upload times in intervals, most devices falling between the 5–30-minute mark. This upload is done via Bluetooth or Wi-Fi, requiring constant connection between the devices. Most devices will have a supporting application that works in conjunction with the device and data will be viewed from there. Less popular upload methods consist of physical connections through plug in cables between the devices. Although reliable and safe the connection method is uncommon as it is less seamless and more hassle.

SLEEP EPILEPSY:

How many people have it?

More than 65 million people have epilepsy worldwide, 12 percent of which have nocturnal epilepsy. Many of these people must have camera monitors in their rooms and/or a person sleeping in the same room. At least 7.8 million people suffer from nocturnal epilepsy, a large majority of these people affected by this condition would have their sleep privacy taken from them.

What are damages/ effects of epilepsy?

Dose related side effects are common throughout epilepsy as most epilepsies need to be medicated. 70% of people who suffer from epilepsy take an AED medication. (Epilepsy Foundation , 2021). Some medicated related side effects come from the initial dose process, more commonly the side effects come from long-term use of medications. For some people AED's must be taken for as long as the person has epilepsy, some grow out of it but if it returns most have to go back onto the medication. Although most AED medications use the same active agent, different brands may use alternate or other properties for absorbing the medication. The overall aim for people using epilepsy medications is to stop fits without side effects, this is not always achievable.

Some of the most critical and severe injuries caused by epilepsy are when the patient is having an epileptic fit and come in contact with furniture around them. Throughout the day this can be horrible, but it is often monitored better as it is rare that a person suffering from epilepsy will be alone during the day. People near the person can move objects out of the way of the person having a fit. What is worse is when these fits happen at night when it is rare that someone is with the patient. The person having the fit cannot control their body and move away from objects, in some cases the person having the fit will be left alone banging their body and even head up against hard sharp furniture. The bruising and the cuts that can come from these repeated blows to the head can be highly damaging.

A less considered effect of epilepsy is psychological and social. Some who are born with epilepsy are less affected by this, but others who may develop the condition at older ages may struggle with these effects. Epilepsy can psychologically impact the way a person feels about themselves. People may feel less as a person, this can be highly influenced by social acceptance of these people. Many who have not been exposed to epilepsy before struggle to react to the condition positively. This can dramatically affect the mental health of the person with the disease. It is common for people who suffer from the condition to feel highly judged by people external to their everyday life. Schools, workplaces, and public facilities are all places many of these people suffer from the psychological aspects of condition most.

IMPORTANCE OF SLEEP

Why is sleep so important?

Sleep is crucial to mental health and daily functioning. Lack of sleep not only effects mood and attitude, but more health-related issues.

- Memory issues
- Mood changes
- Trouble thinking and concentrating
- Accidents
- Weakened immunity
- High blood pressure
- Risk for diabetes
- Weight gain
- Low sex drive
- Risk of heart disease
- Poor balance

These are all effects of lack of sleep. Not sleeping enough not only effects the way a person psychologically functions and feels throughout the day but also physical health. Research suggest that repeated lack of sleep can lead to a certain tolerance to chronic sleep deprivation, this means that people will feel like they are getting enough sleep and they will not get the usual symptoms of lack of sleep. Although the symptoms are not there it does not mean that the effects of sleep deprivation go away. This is why lack of sleep can be so dangerous because it is not always known when you aren't getting enough sleep. Lack of sleep can also lead to immediate safety concerns. If someone is sleep deficient and on the roads or even walking down the street the higher reaction time can be the immediate difference to life or death. Jobs where it is required to be highly accurate in your every move lack of sleep can be putting your life and other peoples lives in danger. For example, doctor's, nurses, bus drivers ect.

How many people get the right amount of sleep?

Inadequate sleep is one of the most common causes for many health conditions people face. 33-45% of the Australia population do not get enough sleep. (Watson, 2018).

HEALTH RISK OF WEARABLE TECHNOLOGIES

How do technologies affect the human body?

What medical conditions can come from technology?

Wearable technologies have been around for many years now. Some taking ideas from traditional watches with materials and fit there are still many issues associated with the constant skin contact with an external device. This is such a vital aspect the epileptic devices because it is medical need to have one of these devices on at all times. Many reports of skin irritation caused by wearing these technologies have been caused by **excessive rubbing**, **allergic reactions** to materials and **moisture build up** between the devices and skin.

As further research uncovers with these technologies being so close to the body can cause symptoms of **electromagnetic field** and **electro sensitivity**.

Symptoms of electromagnetic sensitivity:

- Burning or warm sensations in the face (similar to sunburn).
- Tingling or prickling sensations across the body or face.
- Swelling in the mucus membranes around the nose, ears, throat, and sinuses without any obvious infection.

- Feelings of impending cold or flu symptoms that never quite arrive.
- Issues with memory-loss, concentration problems, and dizziness.
- Pains throughout the teeth and jaw.
- Extreme dryness in the skin and mucus membranes, this might include dry eyes, throat, and mouth.
- Palpitations in the heart or chest.
- Pains and aches throughout joints and muscles.
- Nausea and headaches.

Users reporting of:

- chronic headaches.
- tingling skin sensation.
- ringing ears.
- static feeling in the brain.
- excessive fatigue.
- weakened immunity.
- Dry mouth, and eyes.
- Joint pain.
- unexplained hives and a straight out feeling of body pain.

(Dispatch, 2018).

Application of conclusions: The way in which health conditions can adversely affect the human body has made me think about how I could create a device that is not a wearable. Just having a conversation in the classroom identified several students all who have adverse skin reactions to wearables- to the point of not being able to wear them for a significant amount of time. With this I can now shape my initial ideas around this.

A less researched area of medical conditions that can come from technology is the physiological aspects that these can develop. It is known about more mainstream technologies like mobile phones and social media, but that is not where it ends. Many reports of excessive step counts, and excessive exercise encouraged by these wearable technologies. This has much less impacts on epilepsy tracking devices because the majority of them only track and record information about epileptic fits.

COMPUTER TECHNOLOGIES IN HEALTH

What types of computer technologies are used in health?

The sector of health information technology also known as HIT, is designed to better the health care experience. This is all the technologies in health that assist in the quality of treatment but are not what directly impacts the treatment these are more management related services.

These management technologies are:

- Medical Practice Management System; takes care of administrative and clinical aspects of care.
- Electronic Health Records; stores medical records.
- E-Prescribing Software; electronically generates prescriptions.
- Remote Patient Monitoring; uses new technologies like AR to assist in remote care.
- Master Patient Index (MPI); connecting patient records from multiple databases.
- Patient Portal; Stores history of treatments and other medications.
- Urgent Care Applications; System that keeps track of patients that might require immediate attention.
- Medical Billing Software; management system for the medical billing.

(Writer, 2021)

Other technologies in health are used for the immediate care and treatment of patients. These devices not only increase the quality of care, but they also increase survivability if in a serious situation. There are countless technologies that have been implemented into the medical sector for decades, ranging from x-ray machines to heart rate monitors but there are some more recent technologies that are finding their way into medicine.

These technologies are:

- Automated IV Pumps; Designed to take human error out of the dosages given through drips to patients.
- Portable Monitors; Allows nurses to check on patients even when they are not by their side.
- Smart Beds; Can track movement weight and even some vitals allowing real time check-ups without a nurse needing to be present.
- Wearable devices; Devices that allow everyday people to take health into their own hands and can alert if anything needs seeing to.
- Telehealth and health apps; Lets medical practitioners communicate with patients even when it is not possible to be in person.
- Nanomedicine; Bringing nanotechnology into medicine, devices as small as molecules sensing, diagnosing, and delivery.
- Robotic Surgery; Making surgery less invasive, more precise, less prone to infection, and quicker to heal.

(WGU, 2021)

These technologies are revolutionising health in many ways. Some technologies are still in early development but are set to exist within the general medical world in the near future.

What sensors are used in medical technology?



The sensors used in a medical device is one of the if not the most important part. It determines the strengths and limitations of each medical device. Sensors often have very specific use cases but with high levelled intricate software to support them they can become extremely capable. Medical sensors are used in intensive care units, hospital wards, GP offices, lab equipment, dental practices, and in-home care products.

Device:	Sensors used:	What is the device used for?
Anaesthesia Delivery Machine	Airflow, Pressure, Oxygen, Temperature, Humidity, Magnetic.	Anaesthesia machines are used during medical operations to put the patient in a induced sleep and provide pain relief.
Ventilator	Airflow, Oxygen, Pressure, Temperature, Humidity, Magnetic.	Ventilators help patients who are breathing insufficiently or are physically unable to breath.
Oxygen Concentrator	Airflow, Oxygen, Pressure, Temperature, Humidity, Magnetic.	Oxygen concentrators are used to help patients with respiratory illnesses or lung disease.
Dialysis Machine	Pressure, Force/ Magnet, Thermistor, Barcode.	Haemodialysis machine treatments replace some kidney functions.
Hospital Hardware	Humidity, Magnetic, Magnetic/ basic switches, Positions sensors, Pressure, Thermistor, Thermostat, Barcode.	Used so that patients that receive treatment are comfortable in the hospital environment.

(Ana, Sensing Better Health: Complete Guide to Medical Sensors - Benefits and Applications, 2021)

All of these medical devices serve a particularly different purpose, but they have many similarities in the sensors they use. This is where the software that the device is paired with changes how the device performs.

EPILEPSY

What can trigger epilepsy?

Firstly it is relevant to state that there is a difference between triggers and causes for epilepsy. A trigger is something that immediately started the seizure but the cause could be something dramatically different. Triggers most often differ from person to person.

Most common triggers include:

- Tiredness and lack of sleep.
- Stress.
- Alcohol.
- Not taking medication.
- Specific time of day or night.
- Illness.

- Flashing bright lights.
- Drug use.
- Menstrual cycle or other hormonal changes.
- Bad diet.
- Specific foods (excessive caffeine).

(Epilepsy Society, 2018)

How can epilepsy develop?

The development of epilepsy can be highly dependent on the type of epilepsy. Due to epilepsy being something that can effect anyone at any time it can be highly difficult to pin point how it originally developed. The list of causes for epilepsy is only growing and in many cases the cause is never found. The most common causes of epilepsy are as follows:

- A genetic tendency, passed down from one or both parents (inherited).
- A genetic tendency that is not inherited but is a new change in the person's genes.
- A structural (sometimes called 'symptomatic') change in the brain, such as the brain not developing properly, or damage caused by a brain injury, infections like meningitis, a stroke, or a tumour.
- Structural changes due to genetic conditions such as tuberous sclerosis, or neurofibromatosis, which can cause growth affecting the brain.

(Epilepsy Society, 2019)

How to minimise epilepsy?

The most common way to minimise seizure's is medication. These medications likely just reduce the number of seizures or the tendencies, more suppressing the epilepsy than preventing. 70% of people who suffer from epilepsy use medication for it, building good consistent medication management is the best way around minimising epilepsy. Other methods like diet, and stress-free environments have been used to reduce epilepsy and, in some cases, prevent entirely. Consuming foods free from caffeine, stimulants, grapefruit, and Seville oranges can go along way to minimising epilepsy. Reducing loud noises, flashing lights, and dramatic temperature changes can also minimise seizures. (MedicAlert Foundation, 2019).

LEGISLATIVE GUIDELINES USING TECHNOLOGY IN HEALTH - INTERVIEW WITH EBSWORTH LAWYERS

Is there privacy laws and regulations surrounding technology in health and if so what are they?

Yes, there is laws surrounding this area. In Australia it is the Australian Privacy Principles in the Privacy act 1988 (Cth) (**Privacy Act**). This set of laws is entirely about privacy and less so about the actual operation of the devices. These privacy laws essentially govern why

personal information is collected, whose personal information is collected, How is the personal information collected, what personal information is collected, Is sensitive personal information collected, How is the personal information used and disclosed, the information provided via websites or third-party applications, social networking services, Website analytics and cookies, access and correction, storage and security, overseas disclosure, anonymity, enquiries and complaints, Contact details, and changes to policy. (Australian Government , 2020).

In the research conducted there was no conclusive information regarding exclusive laws around other areas of the technology in health. Considering this it is still appropriate to make educated considerations surrounding the use of technology in the medical sector. Privacy is clearly a point of which needs to be considered but other points do as well.

These are:

- Cybersecurity
- Proposed SAMD reforms
- Product liability and consumer law
- Intellectual property

(HWL EBSWORTH LAWYERS, 2020)

Do the devices have to reach a certain reliability rating or testing to be eligible for medical use?

There was no concluding evidence of other regulations other than SAMD reforms. What is clear is that other companies in the medical technology area consider:

- Accuracy
- Stability
- Configurability
- Long-term supply
- Support

These considerations ensure a safe reliable device that reduces the likelihood of errors occurring in their product. This will safeguard any chances of liability if there was an issue that came into question with the devices. (Ana, 2021).

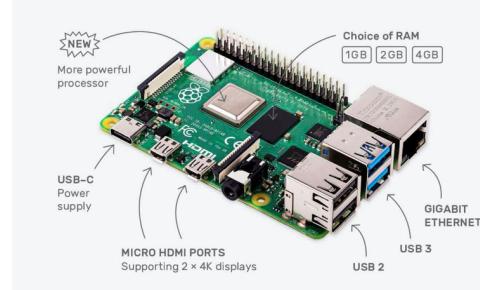
MICRO COMPUTING TECHNOLOGY

Raspberry Pi

- does not require user to have extensive programming experience since it is aimed for the younger generation to learn about programming. Python, the programming language i.e.; Pi uses, is a smaller amount complex than other languages available. It has better code readability and allows the user to type concepts using fewer number of lines. Python also has a automatic memory management function.
- gives a lot of room to experiment and turn it into something else i.e.; entirely different. The SD cards on the board can be easily switched, i.e.; which allows to change the functions of the device without spending a lot of time re-installing the software.



- The Raspberry Pi is perfect for adaptive technology and it is able to display images or play videos i.e.; at high-definition resolution to building systems such as prototyping embedded systems. This product makes it possible to build complex and effective at a cheaper price.
- The product is efficient and i.e.; provides an ethical alternative to small businesses. This small card sized product i.e.; makes it easy to recycle and does not release as much carbon dioxide emissions into the environment, i.e.; unlike big servers that need lots of energy and extensive cooling systems.
- Disadvantages include: - Not as fast processing speed- this may be problematic as it may not be powerful enough to run the code.



Arduino

- Easier to connect to analogue sensors, motoes and other electronic components
- Variety of shields that add functionality
- Quick and easy set up, just need to plug in and run code
- Cheaper than Raspberry Pi
- Disadvantages include: Can only run one code at a time- so cannot multitask activities and has a slower speed.





Materials:

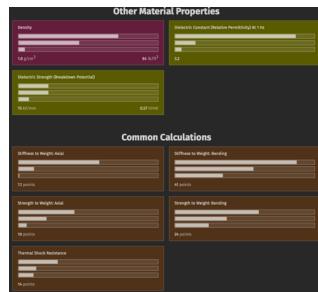
Materials- Prototype

For the initial prototype I will use Acrylonitrile Butadiene Styrene (ABS), a form of plastic that is readily available and well suited to 3D printing. It has terrific thermal properties which allow it to be easily worked with a standard 3d printer and a low cost, whilst its strong mechanical properties allow it to be strong enough for light testing.

ABS plastic has **superior impact strength** over PLA plastic. **ABS has a strong resistance to corrosive chemicals and/or physical impacts.** It is very easy to machine and has a low melting temperature making it particularly simple to use in injection molding manufacturing processes or 3D printing on an FDM machine. ABS is most commonly polymerized through the process of emulsion (the mixture of multiple products that don't typically combine into a single product). ABS is also created, albeit less commonly, by a patented process known as continuous mass polymerization. Globally, the most common methodology to create ABS is the emulsion process. There are countless applications for ABS. Among the most widely identifiable are keys on a computer keyboard, power-tool housing, the plastic face-guard on wall sockets (oftentimes a PC/ABS blend), and LEGO toys. ABS is **relatively harmless** in that it doesn't have any known carcinogens, and there are no known adverse health effects related to exposure to ABS.

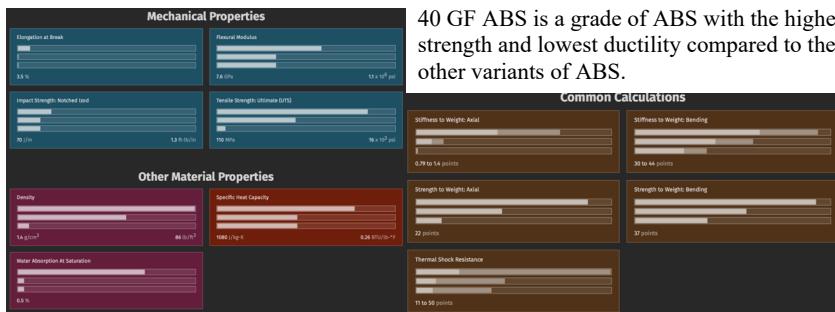
High Impact ABS

High impact ABS is a grade of ABS with the lowest strength compared to other grades of ABS. It however still retains a high strength compared to other thermoplastics.





40% Glass Fibre (40 GF) ABS



40 GF ABS is a grade of ABS with the highest strength and lowest ductility compared to the other variants of ABS.

PLA is **biodegradable** and is produced from already existing manufacturing equipment (those designed and originally used for petrochemical industry plastics). This makes it relatively cost efficient to produce. There are a vast array of applications for Polylactic Acid. Some of the most common uses include plastic films, bottles, and biodegradable medical devices (e.g. screws, pins, rods, and plates that are expected to biodegrade within 6-12 months). The huge benefit of PLA as a bioplastic is its versatility and the fact that it **naturally degrades** when exposed to the environment.

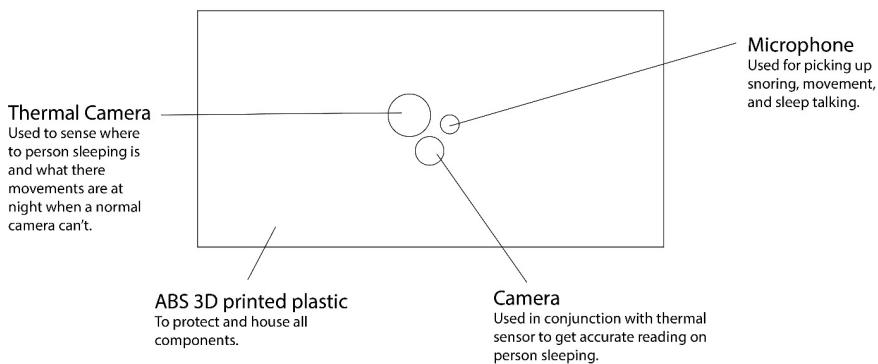
Properties	ABS	PLA
Tensile Strength	27 MPa	37 MPa
Elongation	3.5 – 50%	6%
Flexural Modulus	2.1 - 7.6 Gpa	4 GPa
Density	1.0 - 1.4 g/cm ³	1.3 g/cm ³
Melting Point	N/A (amorphous)	173 °C
Biodegradable	No	Yes, under certain conditions
Glass Transition Temperature	105 °C	60 °C
Cost per spool	\$AUD 33.00	\$AUD 34.75

Ongoing Evaluation: After conducting extensive research in all area's of my MDP, I have become more aware of the different options to make and produce my every element of my product as well as the different aspects needed within my project. I feel I now have direction with my project and can start testing and experimenting with areas researched. As my project develops and ideas are refined, areas of investigation research will be added to expand options



IDEAS GENERATION – INITIAL DESIGNS

Design 1:

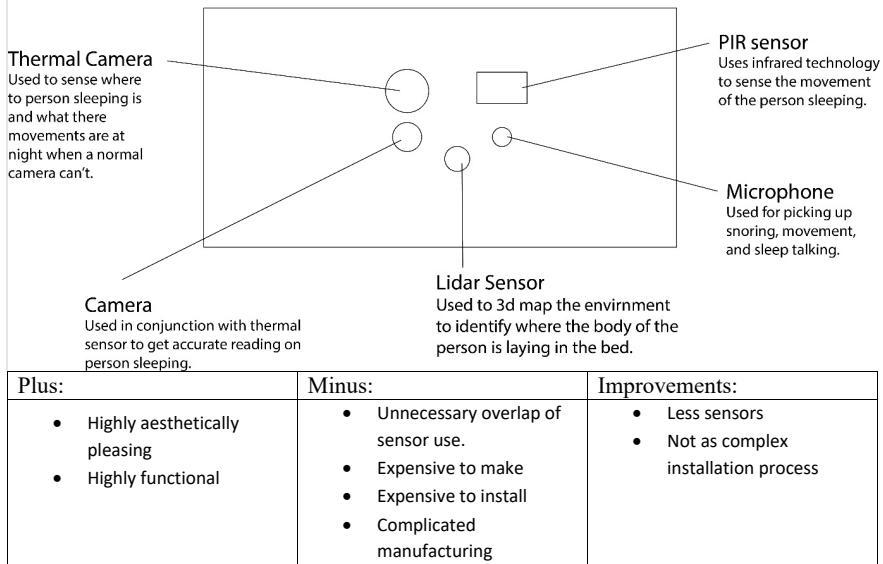


Plus:	Minus:	Improvements:
<ul style="list-style-type: none"> Aesthetically pleasing design. Not over complicated. Provides relevant amount of data. 	<ul style="list-style-type: none"> Expensive materials 	<ul style="list-style-type: none"> Use cheaper material

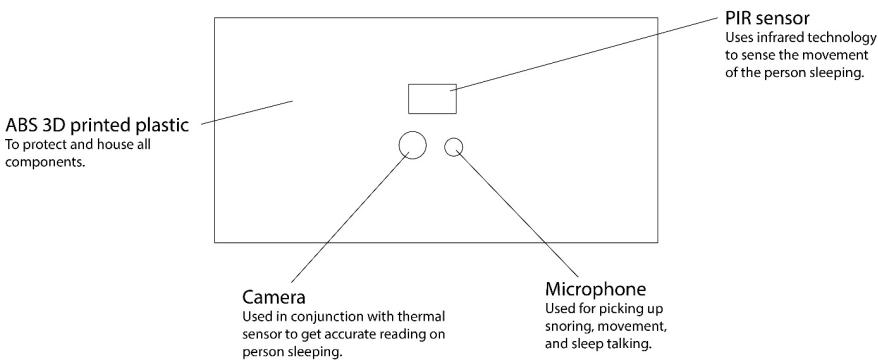
Plus:	Minus:	Improvements:
<ul style="list-style-type: none"> Low-cost design. 	<ul style="list-style-type: none"> Limited sensing capabilities Aesthetically bland 	<ul style="list-style-type: none"> Better selection of sensors Use higher grade materials



Design 3:



Design 2:





Design 4:		
ABS 3D printed plastic To protect and house all components.	Thermal Camera Used to sense where to person sleeping is and what there movements are at night when a normal camera can't.	
Plus:	Minus:	Improvements:
<ul style="list-style-type: none"> • Balance design between cost and function • Aesthetically pleasing • High level of function 	<ul style="list-style-type: none"> • Not perfectly seamless aesthetically 	<ul style="list-style-type: none"> •
Camera Used in conjunction with thermal sensor to get accurate reading on person sleeping.		
Microphone Used for picking up snoring, movement, and sleep talking.		

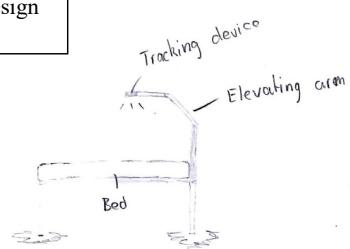
Design 5:		
ABS 3D printed plastic To protect and house all components.	Thermal Camera Used to sense where to person sleeping is and what there movements are at night when a normal camera can't.	
Plus:	Minus:	Improvements:
<ul style="list-style-type: none"> • Cheap to manufacture • Easy manufacturing process • Easy installation process 	<ul style="list-style-type: none"> • Inaccurate data collection • Not aesthetically pleasing 	<ul style="list-style-type: none"> • More sensors • Use more premium finish on design

PROJECT
SLEEP

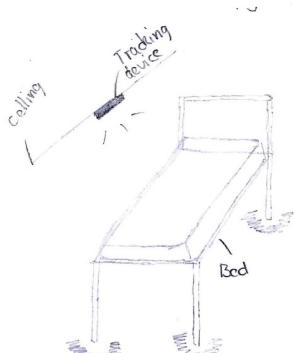
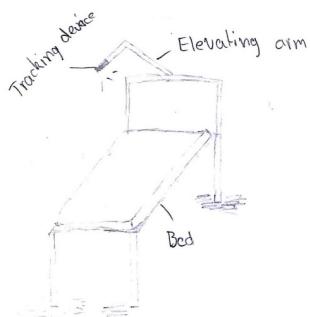


PLACEMENT OF TRACKING DEVICE

Design A:

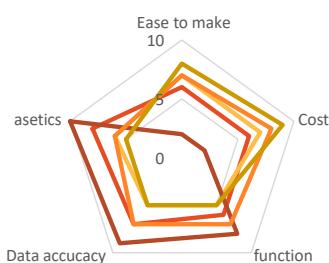


Design B:



Radar Chart

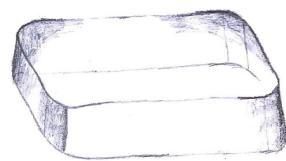
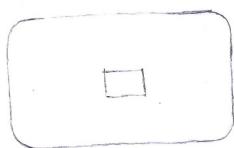
— Design 1: — Design 2: — design 3:
— design 4: — design 5:



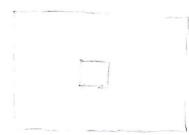


SHAPE OF ENCLOSURE

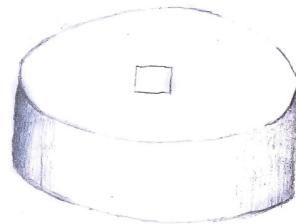
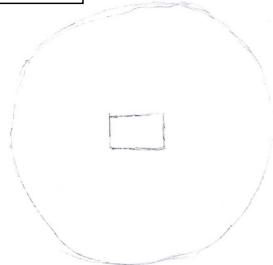
Design
1.1



Design
2.1



Design
3.1



TESTING AND EXPERIMENTING



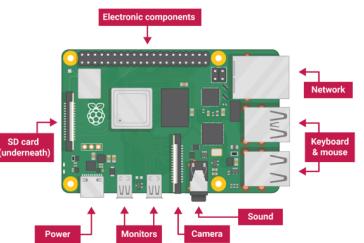
Test 1: Raspberry Pi Vs Arduino

Aim: To determine the most appropriate product to use for the initial prototyping of the project.

Method: Connect Arduino to computer, install drivers, examine user interface for the following qualities:

- Ease of Use of user interface
- Ease of imputing code
- How the device functions
- Sensors available to work with device.

Repeat the steps using Raspberry Pi and compare the two products



Raspberry Pi	Arduino
The user end on computer was very user friendly, I was easily able to input code and there was clear explanations about the features of functions of the device.	The user end was not as friendly as the Raspberry Pi, this may be because I am already familiar with the Raspberry Pi.
The function on Raspberry Pi had everything that I believe that I will need for this project and from the testing it seems like it will be able to run at a fast enough speed.	The code was just as easy to input, but the coding language is different appose to python it is more familiar to c++.
The sensors and documentation to support the pi and sensors together were extensive and therefore would make it easier to debug if any problems arise.	The device seemed to lack the same processing speed as the Raspberry Pi and is likely not going to be able to run at the needed speed.
	Documentation for the device used with sensors was lacking along with debugging resources were not as extensive as the Pi.

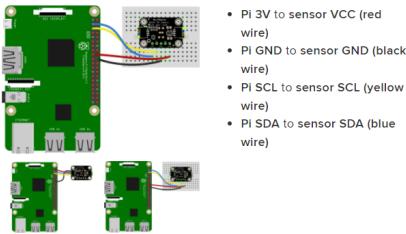
Evaluation: Comparing the results and my experiences when testing both devices, I felt more comfortable in using the Raspberry Pi, the processing speed of the raspberry was faster, as my project is going to be collecting lots of data I think the faster speed is going to be essential. In addition, I found the code easier to input from the Raspberry pi when compared with the Arduino. The additional resources and more in-depth information out there for the raspberry pi will make it easier to debug if problems arise. Because of these reasons, I believe that the Raspberry Pi is going to be better to use.

Application of conclusions: As I have decided to go with the Raspberry Pi, I will order another one so I have a backup if I need, I will also be able to start designing my final casing as I can import the Pi into fusion 360 to get the correct dimensions. I can now also begin to develop the code that I will need for the different features of the device.

**Test 2:** Initial setup.**Aim:** Test Initial setup of sensor working with the raspberry Pi.**Method:** Connect sensor to raspberry Pi and plug all necessary wires in. Then use example code off adafruit to run on the raspberry Pi.**Results:** The raspberry Pi worked well with the sensor, it could read and write the values in the serial monitor – See below evaluation for explanation.

Evaluation: The sample code used will be a good basis to conduct more testing and experimenting to further the understanding needed to make the sensor work correctly

A qwiic pHat in conjunction with qwiic connectors allowed the wiring for this to be highly



```

import time
import board
import busio
import adafruit mlx90640

PRINT_TEMPERATURES = False
PRINT_ASCIIART = True

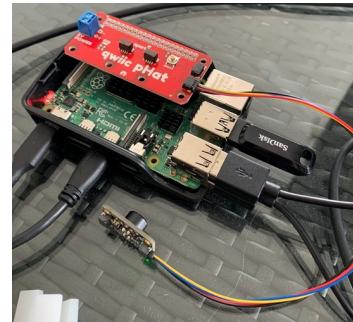
i2c = busio.I2C(board.SCL, board.SDA, frequency=800000)
mlx = adafruit_mlx90640.MLX90640(i2c)
print("MLX addr detected on I2C")
print([hex(i) for i in mlx.serial_number])

mlx.refresh_rate = adafruit_mlx90640.RefreshRate.REFRESH_2_HZ

frame = [0] * 768
while True:
    stamp = time.monotonic()
    try:
        mlx.getFrame(frame)
    except ValueError:
        # these happen, no biggie - retry
        continue
    print("Read %d frames in %.2f s" % (time.monotonic() - stamp))
    for h in range(32):
        t = frame[h * 32 + v]
        if PRINT_TEMPERATURES:
            print("%0.1f" % t, end=" ")
        if PRINT_ASCIIART:
            c = "#"
            # pylint: disable=multiple-statements
            if t < 20:
                c += " "
            elif t < 23:
                c += "."
            elif t < 25:
                c += ","
            elif t < 27:
                c += "."
            elif t < 29:
                c += ","
            elif t < 31:
                c += "."
            elif t < 33:
                c += ","
            elif t < 35:
                c += "."
            elif t < 37:
                c += ","
            # pylint: enable=multiple-statements
            print(c, end="")
    print()

```

Application of conclusions: Now I have completed this testing and experimenting the bases of this code will be used for the final code. I can now continue with the testing and experimenting with code as I have a base.



**Test 2: Testing body heat sensors.**

Aim: Identify if the body heat produced by the body on the bed will obstruct temperature readings after the body has moved.

Method: With the device set above the bed use one reading from the centre of the sensing area. Lay down on the bed Infront of the one section the sensor is reading. Move from the centre and take the reading with just the bed. Repeat 10 X to ensure accuracy

Results: Each time the reading was taken with the body Infront of the sensor and away from the sensor was different. The body did leave residue heat on the bed but for a short time and it was still distinguishable between the two readings.

Evaluation: As the concept of using the thermal camera to track the movement of the person will work as the various tests showed to be the case, this will be the method to track the persons movement just adding multiple more readings to get more accurate results for the device.

Application of conclusions: Now this test is complete I will be able to continue progressing with using this method and adding more points on the bed to read temperatures. To improve the accuracy of the device

Test 3: Elevated mounting bracket for testing.

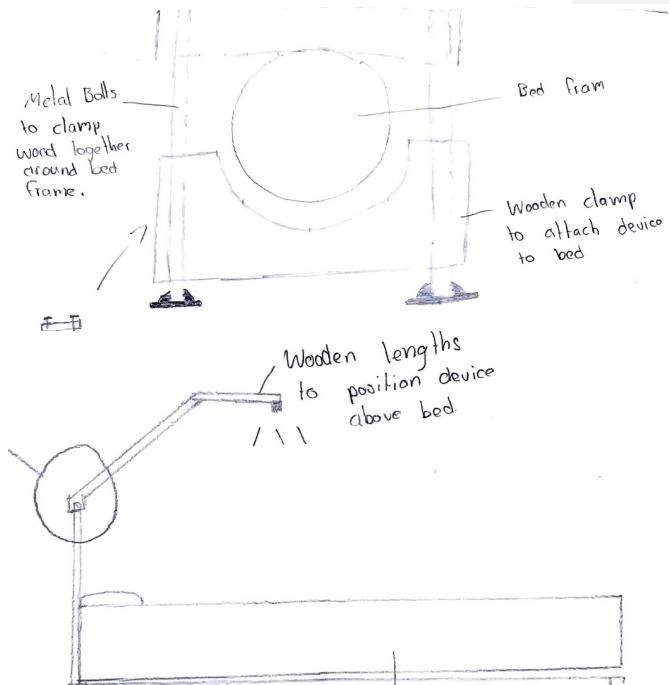
Aim: To build a bracket that can attach to a bedframe to hold the tracking device in the air to read the bed.

Method: Draw up plans.

Then use a mounting mechanism to the bed and attached it to wooden planks that will extend above the bed frame.

Results: The elevated arm works well and will serve well for further testing and experimenting of the code and physical device.

Evaluation: The height from the bed and the perspective the arm gives the thermal cameral works well. This allows the device to get consistent and accurate readings.



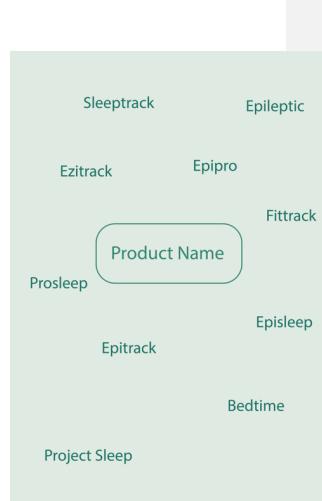
Application of conclusions: The use of a wooden clamping mechanism worked well but if the design were to be refined for the final product a different material should be considered for both aesthetic and structural purposes. Further testing and experimenting and prototyping will be done for the housing of the device



Test 4: Name of product.

Aim: Create a name for device that both explains and identifies what the product's purpose is.

Method: Come up with initial Ideas for name of product, further refine with PMI chart. I will then print out all the different brand name ideas and label each one with a random number and construct a results table to tabulate the results using excel. I will then survey 20 different consumers in the target market. After showing each brand name I will ask them the three questions in the red circle to the right. As each question is answered I will record the results. I will need to ensure they provide their honest options and their answers are not by others.



Question 1: What Brand name do you think best promotes a device used to track epilepsy and sleep and be easy to market with a catchy brand name.

Question 2: Would you buy a product with this product name.

Participant	Question 1	Question 2
1	3 and 2	Yes
2	3	Yes
3	3 and 2	Yes
4	1	Yes
5	3	Yes
6	4	Yes
7	3	Yes
8	3	Yes
9	2	Yes
10	2	Yes
11	2 and 3	Yes
12	2 and 3	Yes
13	2	Yes
14	3	Yes
15	4	Yes
16	3	Yes
17	4	Yes
18	3	Yes
19	3	Yes
20	3	Yes



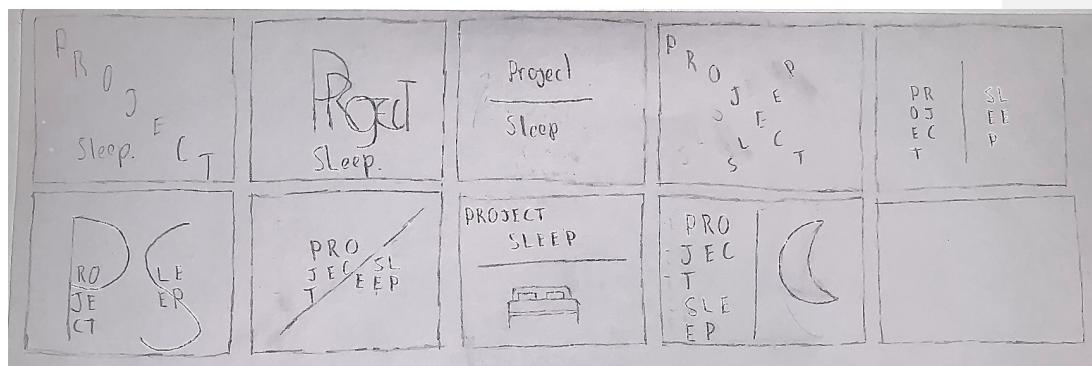
Evaluation: The results from question 1 indicate that brand name number 3- “Project Sleep ” was the brand name associated most with promoting accessibility for all individuals regardless of their individual physical ability. Individuals also indicated that brand name number 2 – “Prot sleep “ and “Sleep track” was also a popular option. Results from Question 2 indicate that of the most popular brand names chosen that each individual surveyed would purchase a product with the brand name they had chosen. This is a promising result and has enabled me to choose the product name – ‘Project Sleep’ for my final product.

Application of conclusions: In conclusion to the evaluation, I have chosen the product name ‘Project Sleep’ the product can now be developed to include the brand name. I believe that it was extremely important to have a name that promoted the tracking device in a way which did not draw attention towards epilepsy, rather seen more as a sleep tracking device that can be used for health purposes. I am very pleased that the survey indicates that it has achieved this and I can now continue with further testing and experimenting with my product and use the product name to create an eye-catching logo. Something I believe will continue to further promote my product

Pro's & Con's of product name		
Pro's	Product Name	Con's
- Catchy. - Easily Understood. - Somewhat describes product. - Sounds professional.	Prosleep	- Broad. - Does not specify epilepsy link.
- Catchy. - Simple. - Describes product.	Epitrack	- Doesn't sound as professional. - Could be confusing. - Doesn't specify sleep.
- Sounds professional & innovative. - Descriptive. - Simple.	Project Sleep	- Long in length. - Does not specify epilepsy. - May describe product as incomplete.

Test 5 – Logo Design

Aim: To determine which logo is the most attractive, eye-catching and unique and appropriate for the product and if a consumer would purchase a product with this logo.





Method: I will firstly create and then print out the options and label each design with a random number and construct a results table for the answers. Then I will lay out the 10 different logo designs in no specific order and then approach 20 different consumers to survey. After showing each option to the person I am surveying, I will ask them the three questions in the pink circle to the left. As each question is answered I will record the answers in the results table below. I will need to ensure they provide their honest opinions and are their answers are not influenced by others' opinions.

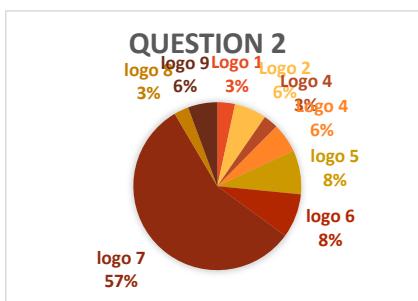
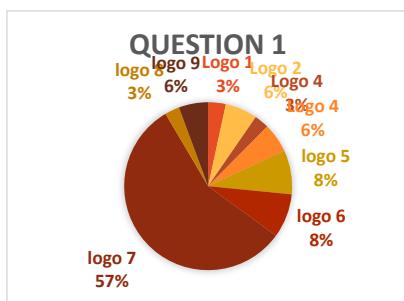


Q1. Which option is more attractive, eye-catching and unique?

Q2. Which logo best promotes a sleep tracking device that can be used by all abilities?

Q3. Would you purchase a product with this logo?

Results:





Evaluation: The results from the survey identify that logo number 7 was the preferred choice of logo, with 57%, 57% and 50% which as a clear majority, the second logo choice was logo 5 and 6 with only 8% of participants surveyed choosing these logo's. Comments of the logo not reflected in the quantitative data include: "logo 7 has clean design lines, while providing insight into the product, without giving to much away."

Application of conclusions: As the results and evaluation identify, logo 7 is by far the preferred choice for the product branding. Now that the logo has been chosen, I am able to begin working on the marketing materials of the product. I will now start designing my packaging and can continue to shape my final product.

PROJECT
SLEEP





Test 6 – Visualising what the sensor is seeing

Aim: The aim of this test is to visualise the data that the device is seeing.

Method:

Import libraries time, board, busio, numpy, adafruit_mlx90640, metaplotlib.pyplot, scripy, and argparse. Using these libries in conjunction with other sample code to create a figure in the py that display the thermal camera readings with colours so that it is easy to visually analyse.

Results:

Creating the figure will help identify the exact shapes that the camera is picking up. When sitting it above the bed it was clear where the body was, but the resolution was not high enough to identify the finer shapes and curves in the human body. (or maybe I'm just not that curvy). The resolution that is displayed will provide enough pixels to identify movement. **The first problem that occurred was the figure that displayed what the device is seeing did not open display the data.** Through problem solving and debugging the conclusion was made that the device was not communicating correctly with the raspberry pi. The baud rate in the code did not align with the baud rate the device was set up with meaning that the devices were not communicating at the same frequency. The fix for this was to go into the setup of the device and change the baud rate specified for the device so that the sensor and Pi communicated correctly together. When running the code again the figure started up with the data being displayed.

Another concern that occurred in this test was that once the thermal camera and the raspberry Pi were connected the frame rate that the device was producing was only between 0.9 and 2 frames per seconded, this is not fast enough to identify repaid movement.

Evaluation:

The evaluation is that the thermal camera will provide enough resolution to identify movement of the body. Although there were complications surrounding the setup of the two devices in the end the camera and Pi worked well together. It is inconclusive if the raspberry Pi has enough computing power to process the data fast enough.

Application of conclusions: From the evaluation the thermal camera and raspberry Pi will be a suitable set up for the device, however as the results are inconclusive on the computing power will be enough to process the data. I will now peruse further testing and experimenting



Test 7: Coding the product

Aim: The aim of this test is to identify if the raspberry Pi is limiting frame rate or if it is the code limiting the frame rate.

Method:

The method is to run a diagnosis software HTOP while running the thermal code to identify where the stress is in the system. HTOP will identify what parts of the Pi memory, cpu, gpu are under load.

Results:

When running HTOP it was identified that 85% of one of the CPU cores was under stress this would indicate why the frame rate is only between 0.9 and 2 frames per second. When reviewing the code there was no limitation's observed which would indicate that only the device is limiting the frame rate.

The first problem that was faced is that the device is only using one of the cores to process the data from the thermal camera. Writing code so that the Pi will use all 4 available cores to process the thermal camera data would theoretically better the frame rate and take load off of the single core.

Another option would have been to potentially tap into some of the GPU processing power of the computer but in this case the raspberry Pi has such a minute amount of GPU processing it would not be a significant increase.

Theoretically if one core is providing 1.45 ± 0.55 using all four cores should produce 5.8 ± 0.55 frames per second which is a dramatic increase.

The limitation of around 5.8 frames per second is that this would still not be enough frames to accurately identify repaid movement of a human body. Hence why it is necessary to use a more powerful computer to run the program.

Evaluation:

Although using multiple cores on the raspberry Pi will increase frame rate up to four times as much it is still not going to be fast enough to accurately sense repaid movement. In this case it is necessary to use a more powerful computer to run and process the data from the thermal camera.

Application of conclusions: From the Evaluation it is clear that the coding is not the issue, but the Raspberry pi that I am using is limiting the frame rate. This is going to significantly limit the product, I will now buy a more powerful raspberry pi to be able to increase the frame speed



Test 8: Frame rate with Data from thermal camera.

Aim: The aim of the investigation is to use a high-powered computer to see what frame rates it can get when processing the data from the thermal camera.

Commented [CNI]: [@Max Keable](#) Finish this off

Method:

The method for this test is to use a laptop computer and run the same python code to determine if a higher frame rate can be reached with a more powerful CPU. The laptop CPU spec is much higher than the Raspberry Pi's CPU specs.

Results:

Using a normal high-powered computer did not work for these circumstances. The thermal camera being used for the device communicates with the computer through an i2c connection. This connection can be made using many different methods including a USB connection however the way in which a normal computer operating system reads its USB ports does not work with an i2c communication.

Just because the ports are the same and it can be plugged in does not mean that the computer can make sense of the information the thermal camera is displaying and vis-versa.

Further research has shown that devices that convert the i2c connection to a connection that a traditional computer can understand do exist. However there is concerns of the delay between the communication conversion hence deeming the whole point of the device in the first case useless.

Evaluation:

This test has shown that a normal computer operating system and environment does not work with the thermal camera used. Even with further research identifying devices that convert the communication the point of using the high-powered computer is useless and there is a delay between converting the communication. Hence reinforcing that a micro-computer with an i2c connection must be used to undertake the processing element of the device.

Application of conclusions:

As shown in the evaluation it is clear that the computer cannot be used for this test and it is clear that an i2c communicating device must be used to undertake this process.

Test 10: Graphical Processing frame rate

Aim:

The aim of this test is to achieve higher frame rates by eliminating graphical processing and only use analysis of raw data to identify temperatures.

Method:

The method is to adapt existing code to eliminate any graphical processing. This was a case of commenting anything relevant out and testing the code until there were no errors. Then identifying pixels on the camera and printing them to the console.



Results:

Eliminating the graphical processing increased the frame rate from 0.9 fps to 4 fps. The individual temperatures at each pixel were able to be printed to the serial monitor.

The first problem that was faced was that adapting the code by taking out the graphical processing segments kept throwing errors. With some alteration and additional code, the errors were ironed out.

The next problem was that the refresh rate specified for the camera was only 2hz which essentially was only going to give 2 frames per second. The thermal camera is rated to 16hz so when initializing the setup of the camera the refresh rate could be changed to 16hz.

The camera would run for a few seconds and then throw an error, this meant that the thermal camera was putting out too many frames for the pi to handle. Changing the refresh rate back down to 8Hz was a good happy medium where the camera would output fast enough for accurate testing and the pi could process all of the data in time.

Evaluation:

After eliminating the graphical interface the frame rate increased to a usable level for the use case of the device. Printing to the console allows for variables to be stored which also allows for parameters to be created.

Application of conclusions:

As shown in the evaluation the new frame rate achieved is usable for the use case and has created an opportunity to begin the process of storing variables of data to allow the device to perform how it is intended.

Test 11: Storing multiple temperatures and alerting rapid movement

Aim:

The aim of this test is to store multiple variables of data in different regions on the thermal camera's pixels in a grid pattern. Using the stored variables data will be collected and stored when the variables chosen flag a repeated higher temperature. This is the detection in movement. Using the flagging an alert will then be created off this action.

Method:

The method for this test is first to identify the selected regions on the thermal image to create the variables. In this case 24 temperature variables have been created across the entire image. Then the temperatures at those chosen regions will be recorded and monitored. After creating the recording process the device will then be coded to flag a repeated pattern identified by the stored variables.



Results:

The results of this test are completely as anticipated the temperature regions selected identified the movement pattern and flagged it when detected. This then created the alert and completed the process that the device is intended to reach.

This process was performed at a frame rate of 4fps which was fast enough for sensing the rapid movement. Storing the variables for the specified 10 seconds was both long enough to detect the movement pattern but short enough to not overload the CPU and ram of the device.

Evaluation:

With the results provided the aim was met and the device performed the tasks that were intended.

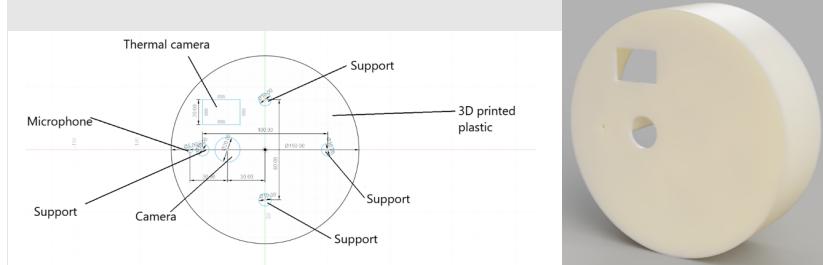
Application of conclusions:

As shown in the evaluation the device has performed how it was intended to hence making this a successful test showing that the device can in fact detect rapid movement.

General																																	
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
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TESTING AND EXPERIMENTING – PROTOTYPING

Initial Prototype 1:



Features of Product:

This Prototype has a thermal camera in combination with a normal camera to create an overlayed image of the sleeping condition of the person. The microphone is to monitor snoring, sleep talking, and the restlessness of the person sleeping. Using a round shape to blend in with the environment that it is put in without being intrusive.

How does the product work coding:

```
from picamera import PiCamera
from time import sleep

camera = PiCamera()

camera.start_preview()

camera.start_recording('/home/pi/Desktop/video.h264')

sleep(5)

camera.stop_recording()

camera.stop_preview()
```

```
import pyaudio
import wave

form_1 = pyaudio.paInt16 # 16-bit resolution
chans = 1 # 1 channel
samp_rate = 44100 # 44.1kHz sampling rate
chunk = 4096 # 2^12 samples for buffer
record_secs = 3 # seconds to record
dev_index = 2 # device index found by p.get_device_info_by_index(ii)
wav_output_filename = 'test1.wav' # name of .wav file

audio = pyaudio.PyAudio() # create pyaudio instantiation

# create pyaudio stream
stream = audio.open(format = form_1,rate = samp_rate,channels = chans, \
    input_device_index = dev_index,input = True, \
    frames_per_buffer=chunk)
print("recording")
frames = []

# loop through stream and append audio chunks to frames array
for ii in range(0,int((samp_rate/chunk)*record_secs)):
    data = stream.read(chunk)
    frames.append(data)

print("finished recording")

# stop the stream, close it, and terminate the pyaudio instantiation
stream.stop_stream()
stream.close()
audio.terminate()

# save the audio frames as .wav file
wavefile = wave.open(wav_output_filename,'wb')
wavefile.setnchannels(chans)
wavefile.setsampwidth(audio.get_sample_size(form_1))
wavefile.setframerate(samp_rate)
wavefile.writeframes(b''.join(frames))
wavefile.close()
```

```
import RPi.GPIO as GPIO
#Importing the library of RPi.GPIO
import time
#Importing the library of time
sensor = 16
#declaring BCM pin 16 which is GPIO 23 of Raspberry Pi
led = 18
#declaring BCM pin 18 which is GPIO 24 of Raspberry Pi
GPIO.setmode(GPIO.BCM)
#declaring the BCM mode of pins
GPIO.setup(sensor,GPIO.IN)
#set the behaviour of sensor as input
GPIO.setup(led,GPIO.OUT)
#set the behaviour of led as output
try:
    while True:
        #initiated a infinite while loop
        if GPIO.input(sensor):
            #checking input on sensor
            GPIO.output(led, False)
            led turned on
            while GPIO.input(sensor):
                #checking input on sensor again
                time.sleep(0.2)
                #generate time delay of 0.2 seconds
            else:
                GPIO.output(led, True)
            #led turned off if there is no input on sensor
        except KeyboardInterrupt:
            #if any key is pressed on keyboard terminate the program
            GPIO.cleanup()
            #clean the GPIO pins for any other program use
```

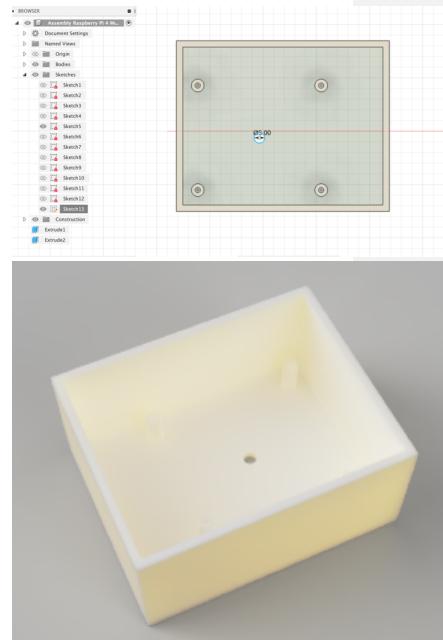
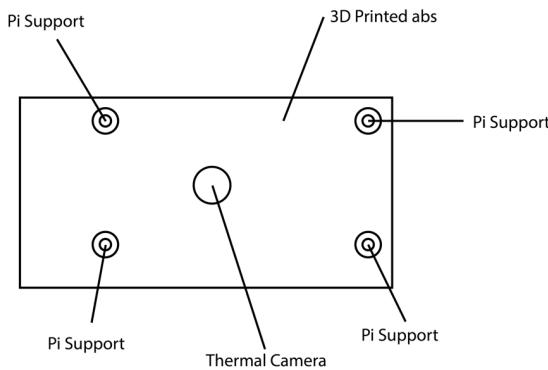
**Evaluation:**

Although Prototype 1 has many features that allow the device to track all aspects of sleep as well as sleep epilepsy it becomes unnecessary to use all of the other sensors in a device that is used primarily as a sleep epilepsy tracking device. The positives is that all aspects of sleep can be tracked and monitored however supporting the added sensors and increased data would require a larger more powerful micro computing device. This makes the added sensors unnecessary and has been taken into consideration when creating prototype 2.



Prototype 2

Commented [CN2]: @Max Keable finish this



Features of Product:

This design incorporates a simplistic approach building upon prototype 1 it was noted that using solely the thermal camera is best suited to the needs of the product. The design consists of a hole out of the bottom to set the thermal camera into holding it into place while 4 supports comfortably hold the raspberry pi above the thermal camera providing enough room for air flow so components do not over heat. The enclosure is made of up 3D printed PLA plastic ensuring for an environmentally friendly durable product.

How does the product work coding:

```

import time
import board
import busio
import adafruit mlx90640

PRINT_TEMPERATURES = False
PRINT_ASCIIART = True

I2C = busio.I2C(board.SCL, board.SDA, frequency=800000)

mlx = adafruit_mlx90640.mlx90640(I2C)
print("MLX addr detected on I2C")
print([hex(i) for i in mlx.serial_number])

mlx.refresh_rate = adafruit_mlx90640.RefreshRate.REFRESH_2_HZ

frame = [0] * 768
while True:
    stamp = time.monotonic()
    try:
        mlx.getFrame(frame)
    except ValueError:
        # these happen, no biggie - retry
        continue
    print("got 2 frames in %.2f s % (time.monotonic() - stamp)")
    for h in range(24):
        for w in range(32):
            t = frame[h * 32 + w]
            if PRINT_TEMPERATURES:
                print("%0.1f," % t, end="")
            if PRINT_ASCIIART:
                c = "A"
                # pylint: disable=multiple-statements
                if t < 20:
                    c = " "
                elif t < 23:
                    c = "."
                elif t < 25:
                    c = ","
                elif t < 27:
                    c = "*"
                elif t < 29:
                    c = "."
                elif t < 31:
                    c = "x"
                elif t < 33:
                    c = "."
                elif t < 35:
                    c = ","
                elif t < 38:
                    c = "#"
                elif t < 40:
                    c = "."
                # pylint: enable=multiple-statements
                print(c, end="")
    print()
    print()

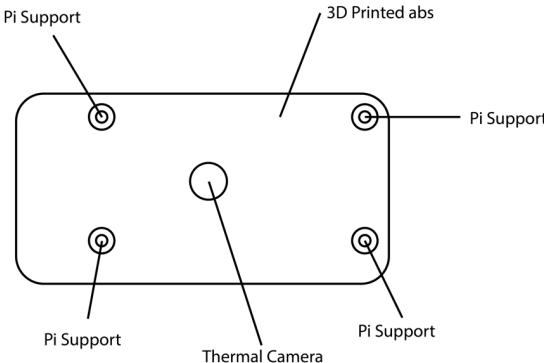
```

Evaluation:

This design works well for simplicity and achieves the intended functionality of the device. However there are multiple improvements that need to be changed for prototype 3. The enclosure needs to be larger, the hole for the thermal camera does not hold it securely it needs some sort of cradle to better position it, the shape of the box is intrusive and does not foster seamless integration into the living environment.



Prototype 3 – Final Design Construction



Features of Product:

The features of this Prototype are much the same as prototype 2 with the single thermal camera and 4 supports for the raspberry Pi. However with the evaluation of prototype 2 there has been an addition of a cradle to hold the thermal camera in place, a larger footprint that is more square with curved edges to be less intrusive on the environment the device will be found in.

How does the product work coding:

```

import time
import board
import busio
import adafruit_mlx0640

PRINT_TEMPERATURES = False
PRINT_ASCIIART = True

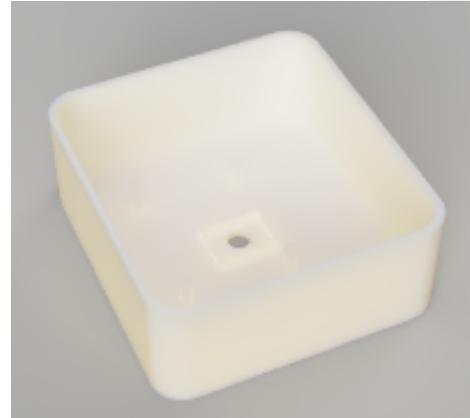
i2c = busio.I2C(board.SCL, board.SDA, frequency=800000)

mlx = adafruit_mlx0640.MLX0640(i2c)
print("MLX add detected on I2C")
print([hex(i) for i in mlx.serial_number])

mlx.refresh_rate = adafruit_mlx0640.RefreshRate.REFRESH_2_HZ

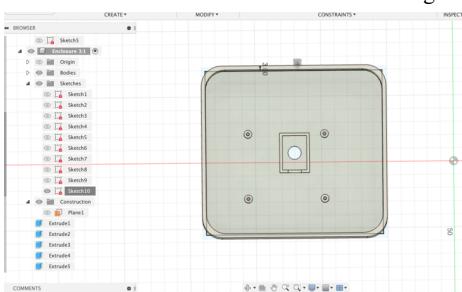
frame = [0] * 768
while True:
    stamp = time.monotonic()
    try:
        mlx.getFrame(frame)
    except ValueError:
        # these happen, no biggie - retry
        continue
    print("Read 2 frames in %.2f s" % (time.monotonic() - stamp))
    for h in range(24):
        for w in range(32):
            t = frame[h * 32 + w]
            if PRINT_TEMPERATURES:
                print("%0.1f," % t, end="")
            if PRINT_ASCIIART:
                c = "A"
                # pylint: disable=multiple-statements
                if t < 20:
                    c = " "
                elif t < 23:
                    c = "."
                elif t < 25:
                    c = ","
                elif t < 27:
                    c = "*"
                elif t < 29:
                    c = "="
                elif t < 31:
                    c = "X"
                elif t < 33:
                    c = ">"
                elif t < 35:
                    c = "#"
                elif t < 37:
                    c = "X"
                # pylint: enable=multiple-statements
                print(c, end="")
    print()
    print()

```



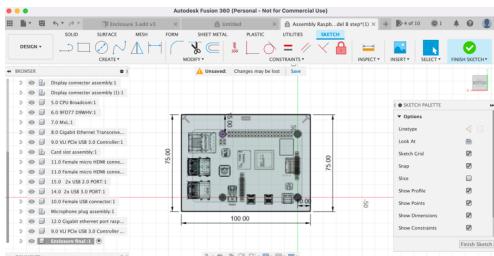
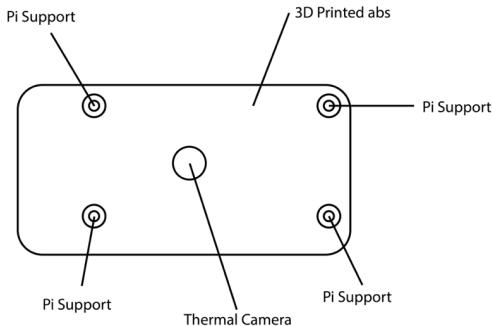
Evaluation:

The corrected shape and size of prototype 3 has worked well for the design however the overall proportion is slightly out and there is an excess of around withing the enclosure. For prototype 4 the same shape should be kept with just changing the overall size. The thermal camera cradle needs slight adjustment to better accommodate the cable going into the camera with a smaller bezel. The last feature that needs to be added to the design is a hole for the power cord to the raspberry Pi.



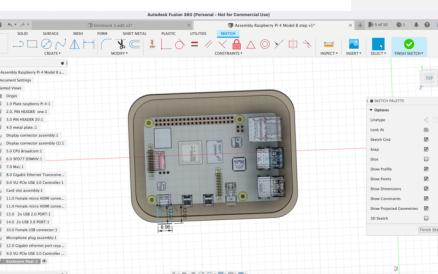


Prototype 4 – Final Design Construction



Features of Product:

The features of this product have been adapted and manipulated to best fit the needs of the design. All negative components of the previous designs have been addressed. The same thermal camera hole with a new and improved cradle has been used. The overall footprint of the enclosure is smaller whilst still retaining a very similar shape. There is also the addition of a hole for the power cord.



How does the product work coding:

```

import time
import board
import busio
import adafruit mlx90640

PRINT_TEMPERATURES = False
PRINT_ASCIIART = True

i2c = busio.I2C(board.SCL, board.SDA, frequency=800000)

mlx = adafruit mlx90640.MLX90640(i2c)
print("MLX addrs detected on I2C")
print([hex(i) for i in mlx.serial_number])

mlx.refresh_rate = adafruit mlx90640.RefreshRate.REFRESH_2_HZ

frame = [0] * 768
while True:
    stamp = time.monotonic()
    try:
        mlx.getFrame(frame)
    except ValueError:
        # this happen, no biggie - retry
        continue
    print("Read 2 frames in %.2f s" % (time.monotonic() - stamp))
    for h in range(24):
        for w in range(32):
            t = frame[h * 32 + w]
            if PRINT_TEMPERATURES:
                print("%.0.1f" % t, end="")
            if PRINT_ASCIIART:
                c = "#"
                # pylint: disable=multiple-statements
                if t < 20:
                    c = " "
                elif t < 23:
                    c = "."
                elif t < 25:
                    c = ","
                elif t < 27:
                    c = "."
                elif t < 29:
                    c = ","
                elif t < 31:
                    c = "."
                elif t < 33:
                    c = ","
                elif t < 35:
                    c = "."
                elif t < 37:
                    c = ","
                # pylint: enable=multiple-statements
                print(c, end="")
    print()
    print()

```

Evaluation:

This prototype has been changed and adapted to better fit the need of the device across 3 previous prototypes hence why this final design construction has no improvements noted.





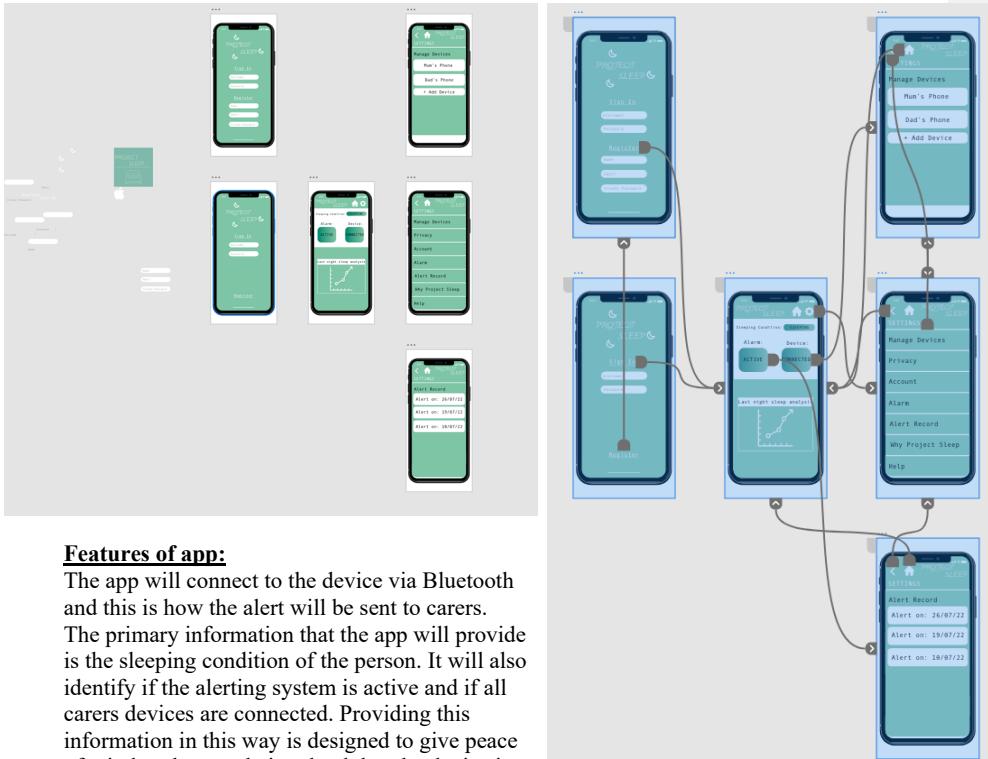
APP DEVELOPMENT PROTOYPE

Illustrator Designs:





XD Prototyping:



Features of app:

The app will connect to the device via Bluetooth and this is how the alert will be sent to carers. The primary information that the app will provide is the sleeping condition of the person. It will also identify if the alerting system is active and if all carers devices are connected. Providing this information in this way is designed to give peace of mind to the people involved that the device is functioning how it is meant to. The app will also allow you to manage connected devices, select privacy settings, setup and change account settings, set different alert tones, access a record of all past alerts and their details, and access to additional help and information about the device.

Steps of construction - working prototype:

To construct a working prototype first I created some simple ideas sketches and brainstormed the functionality that I wanted in the app. I then picked out the style of app design and the simplicity from a few of my favoured app designs. Then I used the colours from the logo of Project Sleep to create the colour palette so that everything matches across the entire product. I then used adobe illustrator to create the design of the app and the different screens within the app. To go onto creating a working prototype I used adobe's app prototyping program XD. This worked well because I could transfer the designs from illustrator straight into XD and make small adjustments there as needed. I then imported all the designs into one board and changed parts of the screens to showcase the features. Then using the prototyping aspect of the program, I connected all of the buttons and calibrated the animations to create a seamlessly flowing and simplistic app.

DESIGN FACTORS RELEVANT TO THE PRODUCT

Design Factor:	Analysis of Relevance to MDP:	How it has been applied to the Final Product:
Appropriateness	The MDP is centred around improving the user experience and accuracy of epilepsy sleep tracking. This device focuses on those who are affected by sleep epilepsy and intends to improve quality of life. It must be noted that project sleep is used for people who have sleep epilepsy only, it is not a tracker intended for anywhere other than in bed. The appropriateness of the design and the marketing of the design must be considered.	Appropriateness has been achieved through extensive testing and experimenting that has allowed for the device to be able to detect seizures through various sensors and modelling. The device is easily fitted to an individual's ceiling adding to the appropriateness of the design. The marketing of the product focuses around sleep epilepsy; however, the device has the potential to monitor for other medical issues if expanded upon with a longer timeline.
Function	The function of the design is one of the most integral design factors to be considered for this project. As the purpose of a sleep tracker is to gather data upon the sleeping condition of the user. The device is going to be relied upon as a medical device, it is vital to the product that it achieves constant reliable data.	Functionality has been achieved and applied through extensive testing and experimenting. The final working prototype gathers information in real time and the potential of the app integration, allows the user to be clearly alerted to any seizure activity. The testing and experimenting of the product have shown that the device meets all functional criteria of the project.
Need	It is important to understand and make connections to the need for Project Sleep. In the case of this device there is currently a major lack in the products and accessibility to products that track epilepsy. The array of devices on the current market that perform epilepsy tracking all use similar technologies. This leaves a gap where the use of other technologies could significantly enhance the industry. Specific sleep epilepsy devices are rare in the market and are not as accurate as conventional epilepsy devices.	Addressing the need has been applied to project sleep as it is giving users an option for a product that is not currently on the market. The device also meets the needs of the user as identified earlier in the project. The product is able identify a caregiver when a user is having a seizure. This increases the safety and wellbeing of the consumer
Aesthetics	Aesthetics become important with this device as it is used at home in a	The final prototype of the design has a sleek modernistic design with



	<p>bedroom. The device intends to work seamlessly in an environment so that it takes away the constant reminder of having epilepsy.</p>	<p>rounded edges that will not look intrusive when mounted to the user's roof. Brand logo uses a soft green that has been shown to be a calming colour. This has been used to give the user the impression that this will be a product that will be calming in nature to the users with an increased sense of security. The app design uses colours that complement each other and aim to draw the consumer in.</p>
Quality	<p>It is vital for this product to be the highest of quality. It will be relied upon to track medical condition. The parts used must never break and will always work especially as the device is meant to be very passive taking away the added responsibility of the user.</p>	<p>Quality has been achieved through Resources and materials that through testing and experimenting have shown that they are high in quality and research demonstrates that the raspberry pi and 3D filament chosen are of high quality. As the materials were only tested over a 6-month period this is not enough to fully determine their quality without relying on research.</p>
Life cycle analysis	<p>The first aspect of the device is function but it is important that the environmental impacts are considered throughout the entire design process. The MDP aims to be as environmentally considerate as possible. In order to do so a life cycle analysis must be utilised to understand the materials being used which allows the product to be designed to suit materials that overall have a more suitable life cycle.</p>	<p>The lifecycle analysis conducted on the project sleep has enabled me to make positive environmental choices throughout the design process when choosing the materials for the product for testing and experimenting. I was limited with the choices of material; however, I ordered 3D filament from a company that uses sustainable energy sources to ensure that the impact was minimised in some way.</p>
WHS	<p>Work Health and Safety is an integral design factor and designer responsibility that must be considered throughout the entire design process. WHS needs to be considered to ensure I am safe as the designer, and everyone in the work environment is working in a safe working environment</p>	<p>Throughout the design process I have ensured that I have met all WHS requirements. This has included using appropriate PPE when working with power tools, ensure the 3D printer was in a well ventilated area.</p>
Ergonomics – User interface	<p>Ergonomics refers to products and the interaction with the human body. The user interface will need to be extremely easy to navigate in terms of on an iPhone easily being able to reach buttons with a finger and placed appropriately on the users screen. If the user interface</p>	<p>The user interface has been designed to be very user friendly. The placement different features have been designed to be able to be easily reached by the consumers fingers of various sizes. In addition the user interface has been designed to be</p>



	<p>is complex, the consumer may be deterred from the product. This may have the impact of individuals not receiving a product that could be potentially life changing for individuals using the device and their parents/carers.</p>	<p>extremely user friendly and testing and experimenting with the app prototypes identified that members of the target market could easily interact with the user interface.</p>
Environmental Consequence	<p>It is important that the environmental consequences of the MDP is considered throughout the entire design process to enable myself as a designer to addresses any environmental issues and design a product that is as sustainable as possible. As a designer</p>	<p>The environmental consequence of project sleep, is minimal, as seen in the project evaluation. However being an electronic product, e-waste can cause significant waste, to counter this once the product idea developed, the idea would be to have a return system for old devices that could have parts recycled for new devices</p>
Cost	<p>Cost as a design factor must consider the cost to produce the product, the cost to the designer and the cost to the consumer, in terms of Project sleep, cost will be issue that will need great consideration if the product goes into production. The product needs to be accessible to all that would benefit from the device, however like other medical products the cost to the designer and production will need to be covered to ensure the product can remain viable</p>	<p>Cost has been an important element throughout the development of the project. I have been able to stick within my original project budget, however when the product goes to market government grants would be applied to try minimise the cost of production. This would allow for the product to become more financially viable for lower SES families and intern increase the wellbeing of Venerable Australians</p>

EVALUATION

Analysis of the functional and Aesthetic Aspects of Project Sleep

Aesthetic

Overall, I believe that the Aesthetic aspects of the project have been achieved to a high standard in both the product prototype and app prototype. This has also been confirmed through testing and experimentation and target market surveys. Although not the main priority of the product as I believe the functionality was of higher importance, I believe that many design elements have been used concurrently to produce a product with a modern design style that would not be an eyesore in any bedroom.

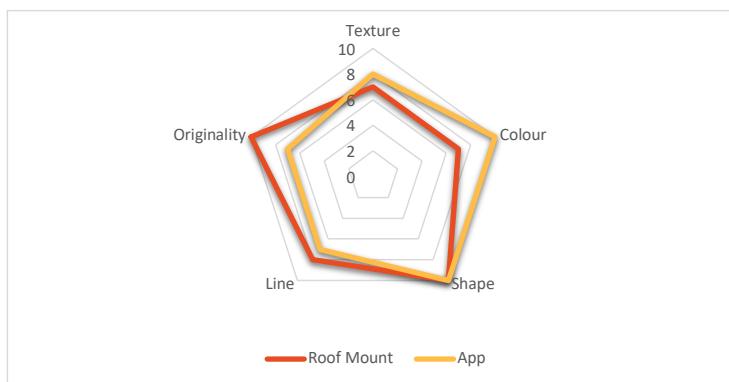
Colour: The product has also been designed to ensure that users would be able to paint the product to the same colour of their roof if they desired a more blended feel with the room. The colours of the app have been chosen to be calming and reassuring of nature, I specifically avoided colours such as red that are often associated with danger, to ensure the consumer experience is positive and non-triggering.

Line: I decided to incorporate curvature of lines around the outside of the product to minimise the harshness of the square feeling. I used horizontal and vertical lines in the app to align the features to ensure minimal confusion of reading different buttons and ensure a smooth user interface for an easy experience

Space: Using white in the background of the app I believe creates a feeling of space and minimises any cluttering or overwhelming feelings to the user.

Shape: The minimalistic design and curvature of the edges I believe ensures the product has a modern feel, the curvature of the sides I believe will also ensure the product blends into the space

Texture: I had limited control with the texture of the product as the prototype is 3D printed, causing a slightly ribbed texture. When the product is mass produced the texture could be changed to a smoother surface, this would allow for smoother painting of the product.

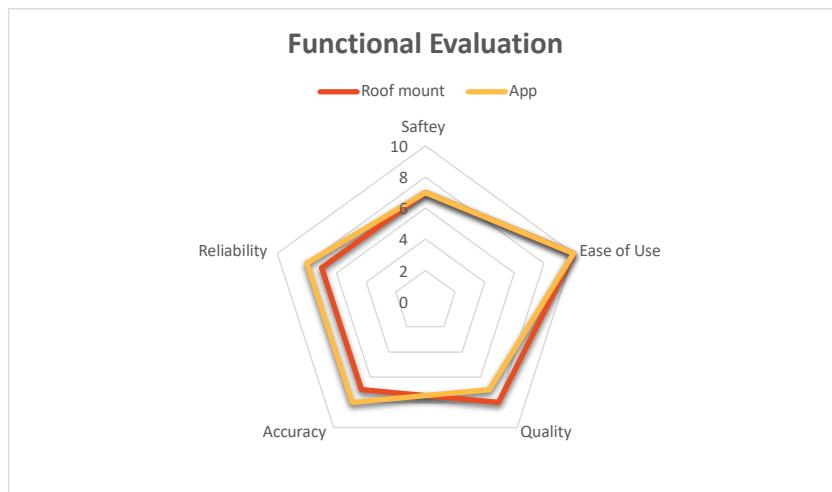


Functional:

Overall, because of the nature of the product, the aesthetics of the product are important, but the functionality of the product is of upmost importance. If the product does not function for its intended purpose the consumer has no benefit from using the product and the **quality of life of the user is not improved**. It is important to note that the product has not been tested on an individual having a seizure, but it has been tested with almost identical movement patterns under the instruction of medical professionals to ensure the coding of the app reflects seizure activity along with thermal imaging. In addition, this can be altered when the product has been tested and approved to go to market.

The product is able to detect seizure activity through movement and thermal sensors. Initially I started the coding with wide margins that would detect any small amount of movement, however testing and experimenting showed that this would detect any form of movement in the room, this would be ineffective as alerts would continually be sent via the app. Narrowing of these margins allowed for better interaction with the app and the wall mount.

The functionality of the app prototype demonstrates that the consumer will be able to receive an alert and data will be able to be stored in the app, the more the product is used the more data can be analysed to track the users sleep patterns and begin to pick up on seizure triggers and patterns. As I do not have the skills to make a fully functional app in the timeframe of the MDP the app is a functional prototype but does not have all the features working. As I am perusing this project after the completion of the MDP I will work with App developers to compete a fully functional app.



Evaluation of the Individual, Societal and Environmental Impact of Project Sleep

INDIVIDUAL IMPACT

Evaluation of the Positive Impacts on the Individual

Socially the impacts on the consumer for this product are highly positive. It is a product that has a focus on increasing the safety and quality of life of the consumer. With a design focusing on allowing the consumer to live a more stress free and normal life. The idea of a set and forget device is aimed at allowing the consumer to not have to be continuously reminded of the condition they face day to day. The increased accuracy over traditional devices brings peace of mind to the individual themselves and the carers around them. A report published by Epilepsia uncovered the significance of phycological impacts from having epilepsy. The most common consideration is the physical effects that could come from having epileptic fits, what is commonly overlooked is the phycological effects that are faced. Epilepsy is limiting to many aspects of life and has proven to be difficult in numerous social situations. Epilepsy has been proven to negatively affect the sense of belonging oneself feels when in an environment. Although the product cannot eliminate these feelings it is designed to positively enhance the more basic freedoms in life. An article by Michael Hills identified the effect perceiving the self as less competent being due to epilepsy can hugely impact one's self esteem. (Hills, 2007).

The device itself is looking at many data points all over the entire body, where traditional devices are worn around the wrist looking solely at the movement of the arm. The addition of gathering data of the entire body increases the accuracy over traditional devices. For example, a person wearing a wrist based epileptic tracker can trigger the device just from moving their arm. This device looks at the entire body and will only trigger when all symptoms of a seizure is flagged. The interface makes the device easy to use and operate, notification of seizures is clear and consistent. The device will have many ways to contact carers so that an alert will always reach the carer in any circumstances. Research has shown that the most important aspects of a user interface is; Input controls, Navigation components, Information components and containers. (JAYE HANNAH, 2021). The device has a main focus on the information component as it is mainly an informative device. It gathers critical health data and informs the condition to a career. This focus on the information component increases safety and provides peace of mind that the correct information reaches the career when needed.

Decrease in negative impacts from seizures:

Epileptic fits can injure people both mentally and physically. The longer a person having a seizure is left unaccompanied the more likely it is for critical injury to occur.

The most common injuries cause by seizures are:

- Head Trauma
- Brocken bones
- Choking
- Cuts and abrasions

(Epilepsy Foundation , 2022)



Monitorization of seizures has proven to be the most effective way to increase the safety of the person having the seizure. Having a human move furniture if needed, support the head with pillows, put in recovery position to reduces chances of choking significantly reduce the chances of critical injury occurred from seizures. (Zenteno, 2009). In the case of this device it is aimed to reduce all of these injuries, having the ability to quickly and accurately alert a career of an epileptic fit allows for someone to help before any of this occurs.

There are many negative effects of seizures that have a negative impact on the brain. Many of these impacts are not easily minimised as most of the damage happens just from having the seizure in the first place. In that case this device cannot help that. One of the largest problems in critical injury caused by seizures comes from epileptic fits that last a long time. When seizures reach a certain timeframe (this can change depending on the person and the circumstances) there is certain drugs that are administered to stop the seizure before critical harm to the brain is caused. This process is highly time sensitive, and the device significantly increases the safety of this process, and the career is likely to have been with the patient since the beginning of the seizure due to the advanced alerting technology. The device is aimed to contact a career almost instantaneously after an epileptic fit begins. The more prompt this process is the more likely the patient will be unharmed.

Twenty one percent of the American population wear a smart watch or fitness tracking device. These devices are made of the same materials and technologies wrist worn epilepsy trackers are. Research has shown that most of these people report of having some sort of irritation to these devices in the time of owning them. (VOGELS, 2020). Due to the similarities in materials used in these devices the irritation problems are much the same. It is incredibly difficult for someone to sleep with a device irritating their skin. Project Sleep device does not come into contact with the body and is solely above the bed. This means that there are no chances of contact with the body to irritate the skin and cause poor sleep quality. Sleeping with the bulkiness of an epilepsy tracker is distracting to many people. Fifty two percent of the American population take their watches off to sleep because they find it uncomfortable. (Stables, 2022). Many wrist watches are less bulky than an epilepsy tracker making it highly likely that the vast majority of people would find an epilepsy tracker unconfutable to sleep with. Project sleep is a device that does not come into contact with the body. This allows a person to sleep exactly in the way that they feel comfortable allowing for no disruption of sleep.

Evaluation of the potential negative impacts on the individual

The product itself is more intrusive into the home environment and much easier to see its out of the ordinary. This could lead to the consumer being self-conscious and not feel comfortable having friends over. For example, a wrist based epileptic tracker is easier to disguise as a sleep tracker or watch rather than a box sitting on the roof of a bedroom. This could become an added stress rather than the intended set and forget device.

Being an intended set and forget device this could make the consumer become lazier and ignore triggers or trigger warnings. For example, if the consumers epilepsy is triggered by a lack of sleep and they are not thinking about how much sleep they have been having because there is no reminder of it, they could run into trouble. It may be easy to become too reliant on the device and build a false sense of security and ignore triggers. Approximately fifty percent



of people ignore health symptoms and potential triggers when they know what the outcome may be. (Loney, 2018).

Having a device sitting on the roof of the bedroom using a thermal camera to detect the body could be very daunting to some. Although the device has privacy protocols the consumer may feel although the device is watching them. This could build an uneasiness that leads to lack of sleep and stress. 81% of Americans feel although the negative risks of companies gathering data far outweighs the positives. (BROOKE AUXIER, 2019). Having a device gathering data in the living environment is likely to be a concern to many. A wrist worn device does not have the same phycological intrusion as a device sitting on the roof may have. 79% of people feel like they have no control over there information that entities gather through there technological devices. (BROOKE AUXIER, 2019). This added stress on the consumer created by the device has negative impacts and hence may result in lack of sleep, increased fits and lower the quality of life of the consumer.

SOCIEITAL IMPACT

Evaluation of the positive impact project sleep will have on Society

The product using different technologies from traditional devices will push further research in the area. Research into other technologies used in different applications will help gather further understanding and potential breakthroughs which will better the lives of many. With more research gathered and different technologies used awareness of the condition in many different fields will increase. Having a larger network of resources will benefit future products and new technologies that could lead to ground-breaking research. For example, a natural energy drink called Arepa was made in partnership with a neurologist to make the best product. Although the drink is mainly in the field of nutrition the effects the drink has on the brain can be analysed by a neurologist. To better the product a neurologist was used, even though the two fields are vastly different one helped another. (Arep , 2022).

The device enables caregivers to use a better more accurate and easier to use monitoring system. This significantly relieves stress and anxiety in an already extremely stressful job. Relying on the device builds a more controlled and consistent management system which allows for less responsibility on caregivers. Stress associated with epilepsy is a huge problem throughout all who are affected by the condition. Diagnosis of epilepsy in a child leads to higher divorce rates, phycological difficulties among siblings, negative impacts on family cohesion and relationships between families and communities. (HILLS, 2007). Out of 400 surveyed caregivers 48% reported that caregiving has significantly bad effect on their phycological, physical and professional aspects of their lives. (Babar Irfan, 2017). Research has shown that caregiving can cause psychological distress, impaired health habits, physiologic responses, psychiatric illness and physical illness. (Richard Schulz, 2009). Having an accurate and effective device will provide stability to a condition vastly unsystematic providing peace of mind to caregivers. This may result in more sleep and lower stress levels for all people living in the same environment as an epilepsy patient.

The device using a new technology in this field may push other research teams and companies to create similar devices. This could better the existing devices making a more accurate smaller more portable solution. Expanding on better user interfaces and more precise

parameters in thermal imaging-based detection methods. Companies could take the existing ideas and technologies and enhance them with greater funding and resources. As of the current product it is not very portable, but companies may change the architecture to support a more portable solution. There are many areas other entities could use resources to better the existing ideas, hence creating better devices. This would make managing the condition easier minimising the impact on the patient and caregivers.

Using interesting technologies may invite more interest in the tech community, ultimately making people more aware of the condition and making the people effected feel more accepted in society. The more people that understand the condition and are aware of it the more supported patients and caregivers would feel. Technologies that many find interesting and exciting invites the general population to participate in supporting a device that changes lives. Showing that technologies can be used for good and are not limited to being used a specific circumstance.

Evaluation of the possible negative impact project sleep will have on Society

The addition of technology into people's everyday life is only growing, this is yet another technological product getting introduced into a living environment. All this technology could have the impact on people that they are not in touch with their own body enough as it is. It is important for people who have a medical condition to be aware of their body and what triggers and symptoms they face. Adding this into their living environment could push them away from being able to rely on what they are feeling and just leave it up to the technological device to sense. It is important for people be able to sense how their body is going and how it is being affected by its environment. The concern with yet another technological device is that this desensitises people to their own body. Research has shown that technology repeatedly desensitises humans from what is happening in the real world, the more people are exposed to technology the more they are desensitised. (Mrug, 2014).

Society is only becoming more cautious of how much data technology is gathering on them. There are many big companies that have been accused of sharing people's private data. This is a device that will be gathering information on people within their living environment. This could be received negatively throughout society as the living environment should feel like a safe place. For some this may pose concerns to their privacy, and they may not feel safe even within their own home. Many people may feel conflicted because this device could help a family member, but it could cause stress and anxiety because they have concerns about their privacy.

ETHICAL IMPACT

How Project Sleep has addressed designer rights and responsibilities

The rights and responsibilities as a designer of this MDP are patient privacy, affordability, accessibility, accuracy of information, and intellectual property. When designing this product it was critical to ensure the privacy of the consumer. The device is used in the bedroom and could contain aspects of people's lives that they do not want anyone else knowing about. To



ensure the privacy of the consumer does not get compromised the device is designed to process all the raw data locally on the device and only store it for as long as needed. It will then delete the data as soon as it becomes obsolete to the device. The cost to manufacture and accessibility of the device was taken into consideration when selecting components.

Affordability was only taken into consideration for components that do not affect the function. This is so that the accuracy of data collection does not get compromised and ensures the device maintains the highest quality. The code to support the components was written by only me, using only open sourced libraries and examples so that there is no copyright issues.

How Project Sleep has addressed potential Ethical issues

For this product the main ethical concern is privacy. This is a device that gathers data actively on the sleeping condition of people within their own home. For the product to work successfully data must be stored and recorded. It is critical that the data that is recorded and then stored is safe and protected from any outside devices. All information from the patients details to thermal imaging data and even sleep times must be protected. This is so that the privacy of the patient does not get compromised. If an outside device got the raw data from the thermal camera, it could essentially create a full thermal image of the person sleeping, this would hugely compromise privacy.

This is a medical device that will be relied upon for the safety of many people. Meaning that the device must always be working at its full capacity and serving its purpose. To ensure that this is achieved the highest quality of components has been used to create the device cutting no corners to save money. The use of more affordable components has only been used on parts that do not affect the operation of the device ensuring the price does not get excessive without compromising on safety.

If this device is truly ground-breaking and could significantly help many people affected by the condition, there are ethical considerations to be made surrounding the price and availability of the device. It would not be ethical to charge an excessive amount of money for a medical device that is designed to enhance the lives of the users. The device should not be placed at a price point that is simply unachievable by most people effected by the condition. Measures have been taken to offer the best product possible at a price point that is achievable to most. What also needs to be taken into consideration is the availability of the device. It is not ethical if the device is only offered in one market and is excluded from others. Measures have been taken to offer the device to as many people as possible, this ensures that the quality of life is enhanced to every person possible within reason.

Evaluation of how Intellectual property been addressed throughout the design process

Intellectual property has both ethical and legislative considerations to be met. In creating the idea for the MDP market research and patent research was conducted to ensure that the product was both unique and had not been done before. The thermal imaging technology used in the device has never been used as a detection method for epilepsy. Thus making this device unique, although the technologies and components themselves are not new, using them in this case is. Code written by 3rd party resources was used in parts of the testing and experimenting but will not be part of the final product and was only used to test certain aspects of the setup and therefore does not require recognition. As this idea of using thermal



imaging technology to detect epilepsy has not been done before the supporting code to run the device was all written by myself using only open sourced libraries ensuring that there will be no copyright issues. In terms of protecting my interest I have researched patents and copyrights. I have been in contact with an intellectual property lawyer and am undergoing the process of patenting the MDP.

ENVIRONMENTAL IMPACT

How sustainable technology will be implemented to produce project sleep for large scale production

The product itself is a computerised product and hence is not very environmentally friendly. Although it is a computer which contains heavy metals it is a small compact computer. It has been designed so that the computer is just powerful enough to get the process done. It is compact so that it minimises the use of heavy metals and unnecessary amounts of silicon in the PCB. Its power consumption is low as the machine is highly efficient. The thermal camera is small and does not require many materials, it runs off only 3 volts and is highly efficient. The rest of the user interface is designed to work with existing devices to minimise the environmental impact. If the device was to be mass produced the processes used and components selected are designed to have as little environmental impact as possible.

Short-term environmental impact of Project Sleep

Computers are made up of heavy metals and toxic chemicals that use fossil fuels and resources to extract and make into the products. The short-term environmental impacts of these devices are the use of non-renewable resources and fossil fuels polluting the atmosphere before the final product is made. The extraction process and manufacturing process of computers can reduce air quality. 3D printing the enclosure has low environmental impact excluding the purchase of the 3D printer. The PLA filament used is made of recycled plastic. The spool itself is made from recycled cardboard to maintain a small environmental impact. The PLA's melting temperature is low, and it does not give off large amounts of pollutants as it changes physical state.

In the short term this device could help reduce the environmental impact in this field. Other epilepsy trackers are worn on the wrist in a location that is likely going to experience greater amounts of wear and tear than something sitting on the roof. The use of software updates to better the product without physically changing components will be a way to minimise the environmental impact. For example, using a software update to make the device better rather than manufacturing an entirely new product. The MDP is designed to have modular components, this is so that if one fails it can be swapped out by one that works without disregarding any other components over all reducing the short term environmental impact.

Long-term environmental impact of Project Sleep

Computers use large amounts of electricity over time, most of this electricity comes from resources like coal and oil. Although this device is small it will be turned on 24/7, over its lifetime it will use a lot of electricity. The process of turning resources like coal and oil into



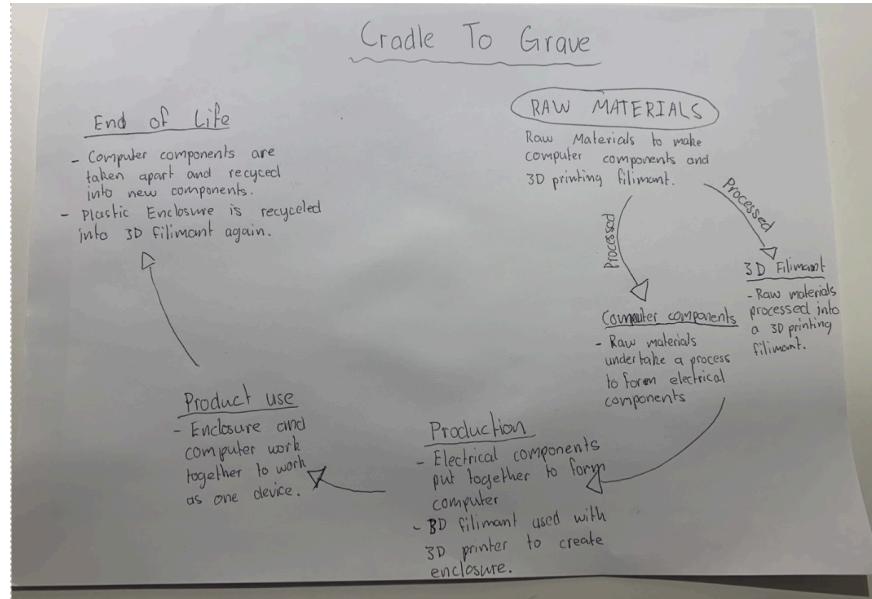
electricity has a hugely negative environmental impact in the long term. Extreme amounts of pollution come from these power plants, exhaling huge amounts of fossil fuels into the atmosphere reducing air quality and contributing to global warming.

The 3D printed enclosure at the end of its life as the device can easily be recycled again and turned into another product. Many 3D printed products get put straight into a machine that will turn it back into 3D filament. If the enclosure is not recycled and is put into landfill it can take up to 500 years to break down. (Gammage, 2022).

When the computer parts become obsolete it is critically important, they get recycled and broken down into their materials. When done correctly the heavy metals can be recouped and recycled into other products, although this process does use resources it is less harmful than extracting these materials as raw materials. The silicon and other materials from the PCB can be recycled and used again in another circuit board.

When computers are not disposed of correctly and end up in landfill the environmental impact is much worse. The harsh chemicals and heavy metals from computers can leak into the ground into the water table, affecting the soil quality and even marine life. The other materials in the PCB board and wiring can take 1000s of years to break down contributing massively to landfill before the process is complete. It is important that the computers are recycled as it has a dramatically more positive environmental impact.

Cradle to Grave of Project Sleep



LCA of all materials used in Project Sleep

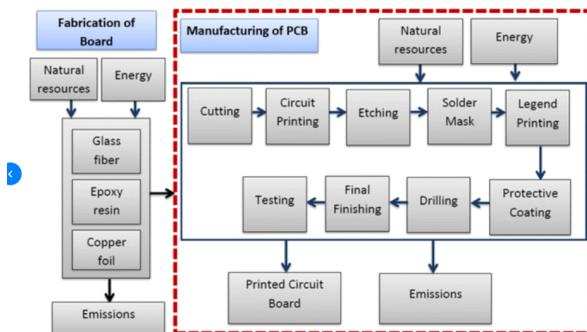


Figure 1: Life cycle and production process of PCB board. This is a critical component of all technological devices.

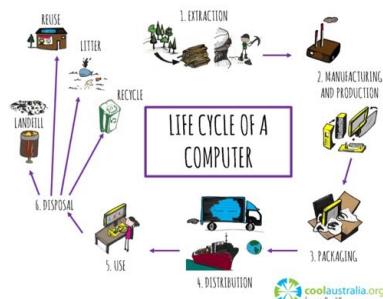


Figure 2: Life cycle of a computer. (Cool Australia, 2021).

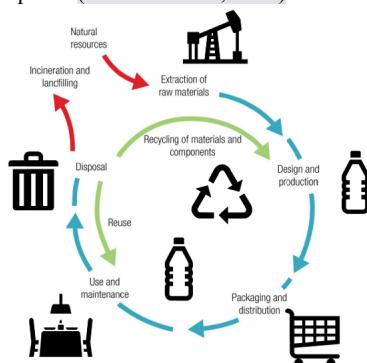


Figure 3: Life cycle of plastic showing life cycle if recycled.



Critically Evaluation of the Global Environmental impact of Project Sleep

My MDP has a global environmental impact due to the use of computers, circuit components and the use of plastics. Although recycling these materials and components will dramatically reduce the environmental impact it does not mean it does not exist. If these materials are not recycled the environmental impacts can be extreme. E-waste is the fastest growing area of waste in the world.

An estimated 40 million tonnes of e-waste are generated every year this is equivalent to throwing away 800 laptops every second. (The World Counts, 2022). Instead of e-waste getting dumped in landfill in the nations its used in most of it is shipped to poorer cotenants like Africa. The EU has and estimated 1.3 million tonnes of e-waste shipped to African countries each year. (Vidal, 2013). This is supposedly for disposal of these machines. Many reports say that these nations do not have the supporting laws, resources, or qualifications to safely dispose of these goods. When these harsh chemicals and heavy metals are not disposed of correctly they can seep into the ground destroying the soil quality, polluting drinking water for these poor countries, and releasing toxins into the air. This is damaging the lives of many in developing countries due to direct and indirect contact with e-waste.

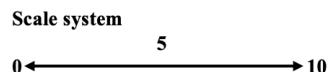
Most of the waste that is shipped off to developing countries is not recycled and ends up in land fill. It is a huge global problem that shipping this waste off to developing countries ensures that the extent of the problem is not easily observed by most. These developing countries are being used as a dumping ground for e-waste, so the rest of the world does not see how bad the problem is. This means that the correct recycling methods and practices are not being met. The hash chemicals and toxins are ending up in the air, water and soil just a different location. These countries simply don't have the resources to correctly dispose of e-waste.





Evaluation of the Relationship of the Project Sleep to the Project Proposal

Functional Criteria



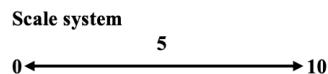
Criteria:	Analysis:	Measure for success:	Rank	Evaluation	Comments
Quality	Testing the durability and finish of the materials used. Using a microcontroller that has high build quality rating.	The materials will undergo a series of durability tests to determine the most suitable material, in addition once the product is completed it will be tested in a variety of different environments to ensure it	8	Overall, I am extremely happy with the quality of the product, I ensured that I used high quality materials and tested these to ensure durability. However, as the product is less than 3 months old, I am not able to fully comment on the quality of the materials as they have not been tested for duration due to time constraints.	Commented [CN3]: @Max Keable Finish this
Accessibility	Making the product easy to use and operate for any individual of any technological skill level.	The product will be tested with various members of the target market and then they will be asked a series of targeted questions through surveys	7	Target market surveys identified that the prototype of the product app was easy to use and that the device and app successfully communicated with each other. In larger houses depending on the proximity of bedrooms the Bluetooth strength will need to be stronger, however at this stage I was limited by cost and skill level of app development. These issues would be addressed further when the product would go to market as a product not prototype.	
Personal Cost	Cost of development micro controller and development accessories to initially build the device.	The finance plan will be monitored throughout the project	10	I was able to successfully manage my budget throughout the project. I did need to purchase a micro controller that added to the cost of the project, however I still came in within my allocated budget.	
Client cost for kit	The cost to client will be varying depending on the market it is released in and the total cost to get the	The target market will be surveyed to determine if they would buy the product at this price.	2	I have been unable to determine the client cost for project sleep as a range of factors including funding, will be incorporated into the final pricing.	



	product into those markets. Taking this into consideration the cost will be between \$500.00 and \$1000.00.			
Accuracy	The accuracy of the results is vital as the device will be relied on to increase safety.	A series of tests will be undergone using coding ect. In addition, a professional evaluation will be conducted.	10	I was able to achieve a high level of accuracy through the 24 points and temperature regions. Achieving a frame rate of 4 frames per second added to the accuracy of the device. Using the Bluetooth connectivity allowed the device to connect securely to the alerting system hence giving the device a very high overall accuracy.
Reliability of device	Device will have high quality connections between components. It will have a reliable highly rated micro controller and many testing and experimenting will be done in order to fine tune the device's reliability.	The device will be run across a course of events recording the times that the device performed correctly and the times that it didn't. This will give an indication of how reliably the alert system is.	8	The device when put to the test in multiple different situations performed perfectly without any inconsistencies in the alerting system. Along with these results the connections and components used for the product are of high quality and extremely unlikely to fail. This level of reliability is absolutely critical in a device used in the medical field.
Ease of Use – App	The prototype app design must be easy to use with a functional layout that can be navigated by individuals easily without problems.	As the app will be a prototype, I will survey members of the target market on its layout ect, however this may be in paper form, with a basic working prototype.	9	The app design was modelled similar to many popular apps. This made the design both easy to use and understand. The features of the app were not over complicated and just displayed the data that is needed. Using a similar design to leading apps was intended to make the interface familiar to all users.



Aesthetic Criteria



Criteria:	Analysis:	Measure for success:	Rank	Evaluation
Originality	The product will be used in a unique way no other devices are used. It will offer a well-designed enclosure different to other options of the market.	The target market will be surveyed to determine if they think the device is original. Secondary research will be conducted and identify if similar technologies are used in the area.	10	The device is extremely original as shown in the secondary research the technology used in Project Sleep has not been used on any other epilepsy sleep tracking devices on the market.
Visually Appealing + Functional literacy	The device will have a sleek modernistic design with smooth subtle finishes in order to not offend the environment it is put in.	Survey the target market to ensure they find the design visually appealing. If they do not, make any changes needed	7	The final design of the product features soft curves and a small footprint. Eliminating any chance of protruding notably in the environment hence making the device highly visually appealing.
Colour	The colour must not be intrusive to the environment it is put in.	Conduct various tests and experiments on colour and then survey the target market on the colour of the product.	8	As the device's enclosure is 3D printed the colour can be chosen from thousands of different filaments to match the intended colour allowing the device to not be noticeable in the environment it is put in.

Final Statement of Designer:



Overall Project Sleep has met the desired aesthetic and functionality created in the initial ideas. The problem that the device is intended to fix can be overcome with the implementation of Project Sleep. The time plan created at the commencement of the product was followed and was accurate in predicting the anticipated times to complete each task. As the device is very new and 1 year is an extremely small amount of time to develop such a device there is much room for expansion of ideas and further functionality. With more time and resources, the device itself could reach higher levels of both functionality and accuracy. With further machine learning and more data, the device has the potential to predict an epileptic fit before it even begins with identifying specific symptomatic movement patterns. The device has the potential to move far beyond just detecting epilepsy. Using the thermal imaging technology there is much more data than can be explored and further development of the app could lead to interpreting more data for health professionals deeming this device great for at home professional monitoring. If I were to make this device again, I would put more time building a more collaborative space. In terms of the potential of the device the final product is rather narrow as to where it could be. I believe that if more collaboration of ideas and development would have to occur the device itself would be far more advanced and be able to have more complex functionality.

Professional Evaluation of Project Sleep

Medical Evaluation

To Whom it may concern,

As an Intensive Care Specialist, Respiratory and Sleep Medicine Physician and as the Clinical Director for Mederev. I believe that this product truly has the potential to significantly increase the wellbeing of individuals. It will provide young individuals with epilepsy monitoring device that will give an added level of peace of mind to both young children and their parents/caregivers. I see great use for this product in and aged care facilities in addition to the household context. Project sleep is a very impressive medical innovation with great potential to change the lives of many.

Stephen Nolan
OAM FRACP FCIM
Clinical Director
Work 03 9563 4212 | Mobile 0429 914 560
stephen@mederev.com.au | www.mederev.com.au

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