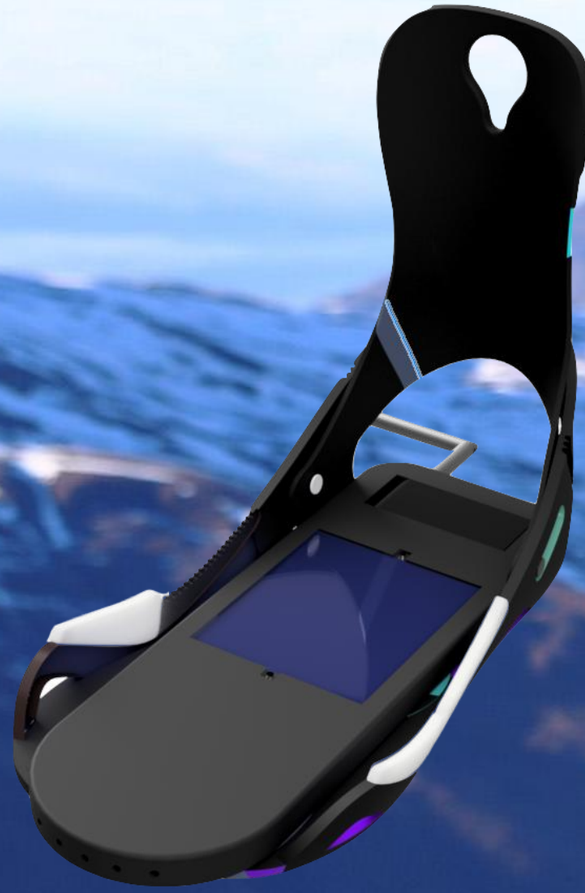
BEYOND.

The Snowboard Brake



SBHS: 430101366

BoS: 32884776

The Need

Runaway Snowboards – Snowboarding is a leisure activity that can be dangerous. This 'mono plank' device has sharp edges and when a ***snowboard runs away,*** they can reach dangerous speeds. The average mass of a snowboard is 3 - 6 kilograms and when travelling without a user, ***can reach speeds of up to 60 km/h***. Without control of a user, a snowboard could hit bystanders and equipment causing immense damage. This occurrence is becoming more common due to the rising numbers of snowboarders on the slopes today.

The 'duo -plank' counterpart, ***Skis, have a braking system*** which stops them from running down a Snow Slope unattended. A skier when in a collision or a fall has a high chance of losing their skis because skis are designed to come off when as skier falls or hits an obstacle. This is because, with 2 skis, your legs can move independently from each other, resulting in harm due to the unexpected torsions and twisting of your legs.

There is no braking system similar to Skis for snowboards, mainly because snowboards are not designed to come off in the same way. But unstrapping a snowboard and carrying it is a much more likely occurrence. Travelling on a flat surface for 'traversing', is much harder on a snowboard causing frequent unstrapping and walking. Because snowboards are more likely to be taken off, there is a higher chance of people dropping them or leaving them in precarious positions. This causes them to run away down the slope without any braking system.

Low Visibility Snowboarding – These ***dangers are accentuated when snowboarding in low light, at night or in whiteouts where visibility is low.*** Snow slopes can get very dark, making it hard to see other snowboarders or skiers on the mountain. Collisions are a normal occurrence during the day but when visual stimuli are lowered, the likelihood of this multiplies. This is similar to Cycling in the dark, but unlike snowboarding, Cyclists have reflectors and lights that they can use so their danger is minimised.

Theft – Snowboards are expensive which attracts people to ***steal them and stopping this is a challenge.*** In the Snow Sports community, trust is a big factor. People leave Snowboards and Skis unattended all the time especially at food venues where there can be hundreds left unattended and vulnerable. This is again similar to cycling, but unlike snowboarding, cyclists can use ***locks which is not practical and dangerous to carry when on the Snow Slopes.***

The Solution – The inherent flaws that come with a snowboard cause major safety and personal concerns. The Ski brake makes Skiing significantly safer and as it is absent in snowboards, the sport becomes dangerous. This lack of a brake has affected many lives and can deter people from snowboarding. ***Whether it be a runaway snowboard, a snowboard being stolen or a collision at low visibility, by integrating the Ski brake into a snowboard, a solution will arise.***

Motivation – All my family and stepfamily are avid Snow Sports enthusiasts and I have been going to the Snow for as long as I can remember. I learnt to ski first and later in my teenage years learnt to Snowboard. I have always been aware of the problem of runaway snowboards, both when I skied and when I snowboarded. ***There were many situations where I or someone close was almost hit by a runaway snowboard. When I started snowboarding, I had first-hand experience where I had my snowboard runaway down a slope.*** Snow Sports are leisure activities but there can be dangers involved. Through my Design and Technology HSC MDP, I believe I can improve the Snowboarding experience, ***so I aim to make the Sport safer by minimising the risks of runaway snowboards.***

Exploration – There are several approaches and methods to investigate the issue of Runaway snowboards. ***Reliable primary and secondary research*** will be vital to gaining a crucial understanding of the problem. A great starting point is identifying and surveying the target market to see their perspective on the problem. This may bring other solutions to stopping runaway snowboards which could be integrated into my design. ***Discovering reliable secondary sources*** is another method to gather information and statistics on runaway snowboards. The use of reliable sources is of utmost importance as ***unreliable information will misdirect*** and indicate a problem that doesn't exist. ***Researching into the Author, their Reputation, the date of creation, etc.*** will help avoid information and sources that are incorrect.

Target Market – The Snowsport community is comprised of mostly Skiers and Snowboarders with skiers being the known majority. Of the Snowsport community, ***around 35% snowboard*** and 65% ski. The ***average snowboarder is a 27-year-old male***. Snowboarders are on average 70% male and 30% female with 75% of males weighing from 65 – 85kg, ***most common being 75kg*** with females from 50 – 60kg, ***most common being 57kg***. The boot size for 80% of male snowboarders is from a US8.0 to US10.5, ***most common being a US10*** with females from a US6.0 – US8.0, ***most common being a US7.5.***

- Average Snowboard is length 155cm
- Most Snowboards are produced by Burton.
- Average Price New being $590
- Average Price 2nd Hand being $275

∅ Ski rack at the Sun Valley Nordic Centre.

∅ The braking mechanism for skis.

∅ Snow Slope at night in Oregon United States.

∅ Perisher Snow Slope in NSW Australia.

Identification and Exploration of the Need – Secondary Research

Injuries by Runaway Snowboards – Injuries caused by runaway snowboards are incidents that are very often overlooked. These unattended snowboards can be a danger to any ***unsuspecting bystander and the user.***

Case 1:

Injury has been a common result from snowboards sliding down the mountainside unattended including a case shown in the Marquette Sports Law Review: Snowboarding Liability: Past, Present and Future Reference 92, "11-year-old Jennifer Campbell found the ski trail that she was on was too challenging for her to finish riding down, so she took off her skis and began to walk down the mountain until she was at a point where she felt comfortable riding again. Once past the challenging part of the trail, she sat down on the mountainside and began to put her skis back on. While putting her skis on a runaway snowboard came sliding down the mountain and ***hit an unsuspecting Jennifer in the lower back***. The reason for this runaway board crashing into young Jennifer was due to the ***snowboarder's lack of responsibility to wear his ankle safety leash."***

Case 2:

A more serious but indirect example of injuries caused by runaway snowboards, is the example shown in the Daily Mail Article by Richard Shears, "British-born TV director aged 44, plunges to her death from New Zealand mountain Mt Ruapehu ***as she tried to retrieve her runaway snowboard. Caroline Johnstone slipped on ice while trying to retrieve a snowboard and fell 15m - before plunging a further 150m to her death***. An Official said that although Miss Johnstone had been skiing with friends earlier in the day she was on her own when she ***lost the grip of her snowboard***. Police Constable Conrad Smith said she had made the tragic decision to try to recover it. 'She's gone past warning signs and danger signs ***to look for her board and she's fallen off a cliff***,' said Constable Smith."

Case 3:

Another Article showing the dangers of Runaway Snowboards is that of The Telegrams: Runaway Snowboard Could've Killed Someone, "The snow-covered slopes at White Hills, Clarenville, were packed with skiers and snowboarders on Sunday afternoon, Feb. 22. Snow conditions were good, and, at the bottom of the hill, long lines of men, women and children were waiting patiently for their turn on the chairlift. Little did they know that an event had just happened halfway up the hill that put them all at great risk. Some 300 feet up, a snowboard had just dropped from the ski lift. While its owner remained firmly, on the lift, no doubt stunned by what had happened, or perhaps just stunned, the snowboard plummeted about 70 feet to the ground. Thankfully the snowboard, with its sharp steel edges, did not decapitate anyone as it fell. When it hit the ground, it bounced, ***landed upright then took off down the steep hill as unattended snowboards have no braking system***. A loud cry for help came from the snowboard's owner to an innocent skier on the ground, hey buddy, can you stop my snowboard? The skier just happened to be stopped about 100 feet below the level of the runaway snowboard as it hurtled down the hill. The innocent skier had little time to react and had very few options. ***The board hit him, wiping him off his feet, before coming to a halt.*** I was shocked by the force of what I had witnessed and frightened by what could have happened had that snowboard, unlike it did continued its accelerating path down the hill. To the innocent skier who stopped the snowboard, I salute you. You are an unsung hero. Perhaps you had little time to react, or perhaps you deliberately stood your ground to stop that snowboard, sensing that the ***many people at the bottom of the hill would be in far greater danger if you allowed it to past."***

Case 4:

On January 29, 1994, Sophie walker then 22 years old, was skiing down the World Cup ski run at the Heavenly Valley Ski Resort when she stopped and ***removed her skis due to ice on the slope***. She walked down the remainder of the hill, and at the bottom, she sat down to put her skis back on.
Eric Derylo, then age seventeen, was snowboarding down the same run. He stopped approximately 100 yards from the bottom and ***removed his snowboard due to fatigue*** and ice on the slope. After he had removed his feet from the bindings, the snowboard **slid out of his control and down the slope**, swiping a young Sophie off her feet and caused a ***broken collar bone.***

Quotes:

From SnowHeads.com

1. "Some of us saw a runaway board. It had got up quite a speed, as it went over bumps on the piste it got airborne to ***around head height and could have definitely caused nasty injuries if it had hit someone***. I followed it down the piste as much as I could and eventually saw it veer off the piste into some trees covered area. I guess the owner would have had a long search to find it" – Alastair Pink

2. "The runaway snowboard hit him, and he dropped to the ground. I saw the snowboard on the ground close to the chaps head, he wasn't dead and I don't think he died later (wasn't talked about around resort), but it was certainly a nasty injury, ***skin split open skull showing through and a lot of blood***, very fortunately, we were just meters away from a lift station and pro help was there in seconds, he got helicoptered off the slope between 5 and 10 mins after the accident. ***I accept that no snowboarder wants to chuck their board down the mountain, but accidents do occur***." – Kel Johnson

1. Stay in control and avoid other people and hazards.
2. Use appropriate protective equipment, especially helmets, to minimise the risk of injury.
3. You must have the ability to use each lift safely. If in doubt ask the lift attendant.
4. Obey all signs and warnings, and keep off closed trails and areas.
5. It is your responsibility to avoid and give way to people below and beside you.
6. Do not stop where you are not visible from above or where you obstruct a trail.
7. Before starting downhill, or merging into a trail, look uphill and give way to others.
8. Use care to prevent runaway snowboards.
9. If you are involved in or see an accident, alert and identify yourself to Resort Staff.
10. Be aware that it is dangerous to ski, board or ride lifts if your ability is impaired by drugs or alcohol.

KNOW THE CODE. IT'S YOUR RESPONSIBILITY.

This is the Alpine Responsibility Code for ***Perisher*** and Rule ***No.8 clearly states to use care to prevent runaway snowboards.*** This means the Snow Sports Officials have deemed Runaway snowboards a problem but have provided no viable way of preventing it.

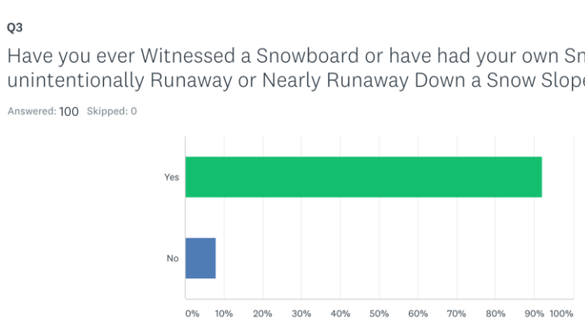
∅ Caroline Johnstone – 44

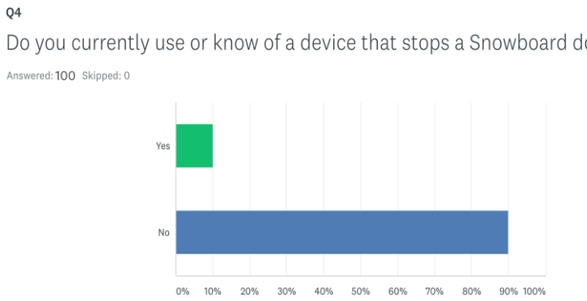
Evaluation:
As seen by the 4 Case Studies and the Quotes from Snowheads.com, there are many examples of runaway snowboards harming people or resulting in people placed in situations where their life is in risk like Caroline Johnstone. This is caused by the obvious lack of a prevention mechanism for runaway snowboards. Alpine authorities have recognised the problem as it is mentioned in the code of responsibility, yet this problem still occurs. This section of research indicates the primary need for a snowboard brake, preventing injuries and deaths.

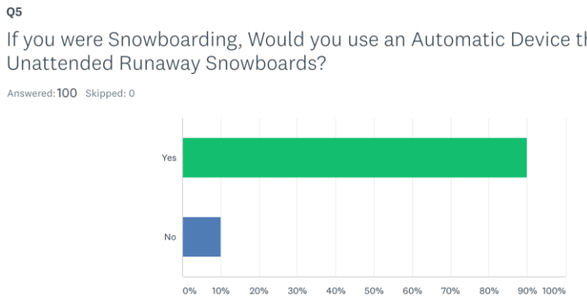
Application of Conclusions:
Now indicating there is a need, surveying the target market and get their point of view on the problem is the next step. I will also see if any products exist now that come close to solving the problem. The Snowboard Leash has been mentioned a few times throughout this section of research so that will be my starting point for a market search on existing products.

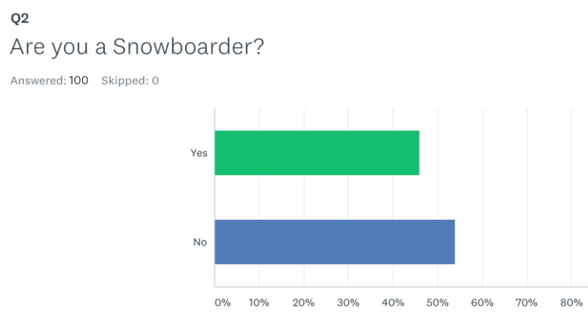
Identification and Exploration of the Need – Survey

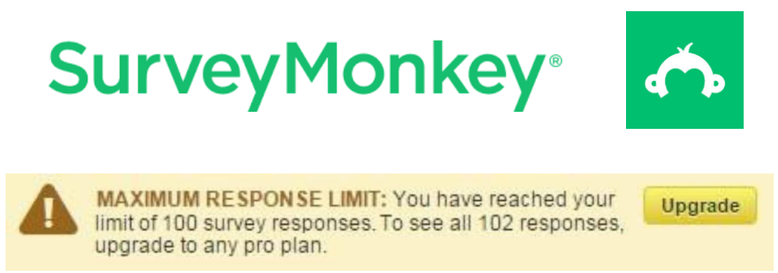
Runaway Snowboard Survey – I surveyed 100 people from the Snow Sports demographic, ***circulated a school environment and distributed through the perisher website to the target demographic***. Contact was made with Perisher.com ***(seen to the Right)*** and they circulated the survey around the target snow sport demographic. There were multiple quantitative and qualitative question asked. This survey was done with Survey Monkey.

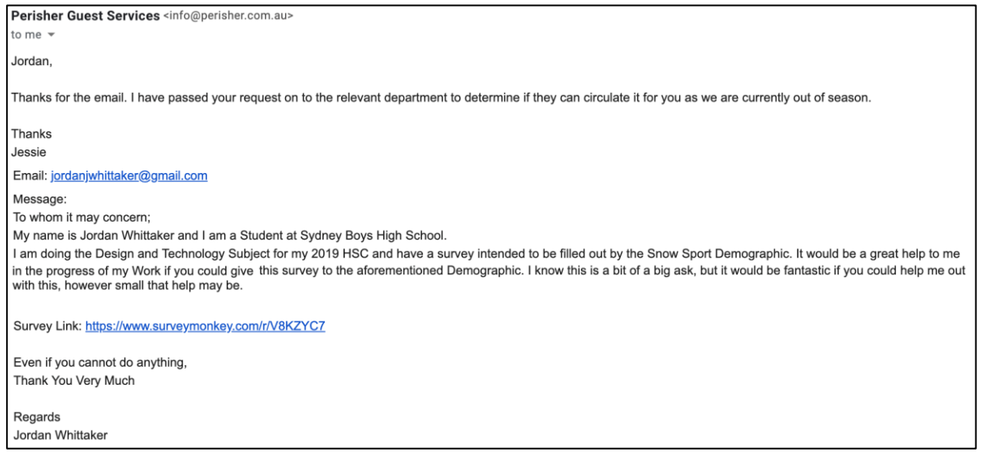












Perisher Guest Services <info@perisher.com.au>
to me

Jordan,

Thanks for the email. I have passed your request on to the relevant department to determine if they can circulate it for you as we are currently out of season.

Thanks
Jessie

Email: jordanjwhittaker@gmail.com

Message:
To whom it may concern;
My name is Jordan Whittaker and I am a Student at Sydney Boys High School.
I am doing the Design and Technology Subject for my 2019 HSC and have a survey intended to be filled out by the Snow Sport Demographic. It would be a great help to me in the progress of my Work if you could give this survey to the aforementioned Demographic. I know this is a bit of a big ask, but it would be fantastic if you could help me out with this, however small that help may be.

Survey Link: https://www.surveymonkey.com/r/V8KZYC7

Even if you cannot do anything,
Thank You Very Much

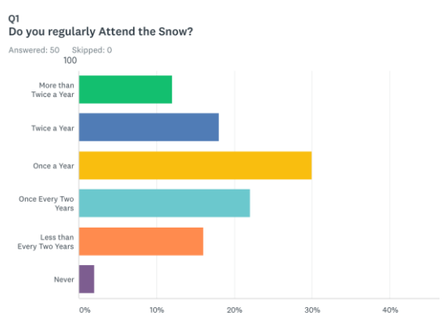
Regards
Jordan Whittaker

Q3: Have you ever witnessed a snowboard or have had your own snowboard unintentionally runaway down a Snow slope? – Question 3 of my demographic survey shows the issue that I have indicated of runaway snowboards. The results say that ***over 90% of people have witnessed such events of having had a snowboard runaway down a snow slope.*** This shows that for a large majority of people, ***there is a desire for a product that fixes this problem***. Knowing that the majority of the normal snow sports community has been put in danger from runaway snowboards, strengthens the need.

Q4: Do you currently use or know of a device that stops a Snowboard doing this? – Question 4 of my demographic survey is meant to provide information about current products and whether the demographic uses them. ***The overall majority of people said they have not heard of any product and do not currently use that would solve this problem.*** This again strengthens the need as the demographic who sees the problem first-hand, have no way of fixing it. From the small percentage of people who did know of a product that stopped runaway snowboards, several products were mentioned. ***The main products were the 'Snowboard Leash' and the 'Foot strap' and these products will need to be further researched.***

Q5: If you were Snowboarding, Would you use an Automatic Device that stops Unattended Runaway Snowboards?– As seen in question 5 of the survey, ***90% of the demographic believe that it would not only be useful to have a device that stops runaway snowboards but would themselves use a device that does so.*** There were a couple of responses that said to No to a device. Their reasoning was "I don't want anything stuffing with the way I snowboard", "I do not go to the snow", ***"weight and mobility issues that would hinder the experience and cost for such a casual activity" and "Because I am a professional snowboarder and I don't want any device affecting the way I snowboard"***. From this I can see that reasons people don't want to use such a device are because they believe it will affect the way they snowboard, just for leisure or in cases of professional snowboarding. This means I will need to make sure that my product ***will affect the users snowboarding ability in the smallest way possible.*** I can also conclude from this that my target market will not be professional snowboarders as they need their boards to be as fast and agile as possible.

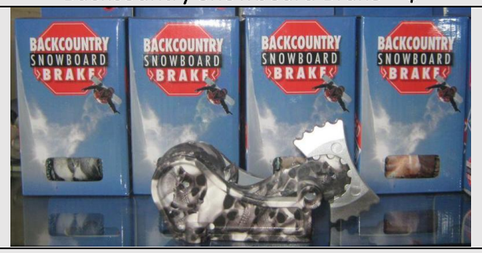
Q1 & Q2: Do you regularly Attend the Snow? & Are you a Snowboarder? – I implemented Question 1 & 2 into the survey so that I could make sure that ***the demographics that I surveyed were correct***. The question asked the frequency of attendance to the snow and as seen in the results a large majority of people go to the snow very often and only 2 people out of the whole survey haven't been to the snow at all. ***This is mostly from surveying the correct demographic which was done by contacting the perisher website and getting them to circulate the survey to snowboarders and skiers.***



Application of Conclusions:
This survey further indicates the need for a snowboard brake and now cements it with statistics. From the survey it is indicated that people will not use the product if it hinders their ability to snowboard. To avoid this, I will need to consider this during the design stage of my project. The snowboard leash was again mentioned in this section of research so the next step in my project is to conduct a market search on existing products, starting with the snowboard leash.

Identification and Exploration of the Need – Market Search

<u>Note</u> – Concluded from research, there are a minimal number of products that even come close to trying to solve this problem on a snowboard. The best two products are detailed below;

Market Search – Existing Products		
Product	Burton Web Leash – $19.99	Backcountry Snowboard Brake – $
Picture		
Information	• The leash is attached to the board and then is attached to the user's leg. • Can be clipped on and off for when the user decides to leave the board. • Made from a high strength elastic cord. • Comes in many colour schemes.	• Spring loaded manually set snowboard brake which is attached to a board. • A cord is attached from your foot to the device and when your foot is removed the device engages. • The device shoots a prong into the snow stopping the snowboard from moving.
Positives	+ It keeps the user and the board together at all times. + Made from a nylon covered surf style leash which can withstand high pressures and won't break. + Easy release buckle. + Designed to wrap around the user's leg for when not in use.	+ When engaged, the device stops a snowboard from moving. + It Automatically deploys when you leave the board. + Has a camouflage colour scheme. + Easily resettable. + Prong is jagged to get grip into the snow. + Very powerful spring pushing into the snow.
Negatives	– When leaving a snowboard unattended it is highly Ineffective. – Easily gets caught on trees, poles, other snowboarders or skiers, etc. – Trips up the user and others around them hindering the snowboard experience. – Not aesthetically pleasing. – Slows down the strapping in process.	– The Device has to be manually reset. – Locking mechanism easily gets filled with snow and seizes up. – Protrudes from the board causing safety concerns to the user and to others. – The cord can get caught when riding and deploy prematurely.
Interesting	▪ Comes in many forms, a strap, a leash etc.	▪ The colour scheme is customizable.

Evaluation:
The Web Leash device is an effective way of keeping your board to your person however a major design flaw of the Leash is that the user always has to be present and strapped in for it to stop runaway snowboards. Difference to my design will allow the user to be able to leave the board unattended while still preventing runaway snowboards. The backcountry brake is the closest product to solving the problem of runaway snowboards, but it is not automatic. It needs to be manually reset leaving room for human error being an inherent design flaw.

Application of Conclusions:
I will implement the spring feature from the Backcountry brake into my design but make the device automatic and not manually reset. The next aspect of my project will be to research into why the product, the snowboard leash, has only a small number of people currently using it.

Identification and Exploration of the Need – The Snowboard Leash

<u>The Lack of use of the Product: The Snowboard Leash</u> – Through surveying the target market and researching into the product 'The Snowboard leash', it was found that the ***average snowboarder does not use the leash even though in the majority of ski slopes it is mandatory.*** There are many reasons why the Snowboard leash is not used and to create a successful product I need to avoid these reasons in my design.

From an Article published by Pat Donahue called <u>The Rise and Fall Of The Snowboard Leash</u>, a Discussion page published by Highlyobssesed.com called <u>The Snowboard Leash: Useful or Useless?</u> and other sources, reasons can be seen. The resources mainly talk about the ***uselessness*** and the ***inconvenience*** of using the ***Snowboard Leash***. Excerpts from the Articles show this;

Uselessness:
"When snowboarding skyrocketed in popularity in the 90s and early 2000s, the crotchety suits in the ski industry made a brilliant observation: snowboards do not have brakes as skis do. The powers that be deduced that if a ***snowboard comes loose and torpedoes down the hill, there could be a serious injury.*** This observation may have resulted from a general lack of understanding of how a snowboard binding works. Still, the solution was clear, ***snowboarders should be required to use leashes at many***", "As the years went on, this policy lost its steam and began to fade. People began to realize that, unlike ski or telemark bindings, ***it is really hard to pop off a snowboard binding strap in a crash***. It is especially difficult to break two or four straps to send your board shooting down the hill. In 2018, you are ***hard-pressed to find any resorts or ski patrollers demand to see a snowboard leash.", "My leash does nothing except satisfy this rule***. It is about two inches long and buckles my front bootlace to my front binding. It is lower profile than my binding straps, and even if I undid the straps, I couldn't even remove my foot from the binding without unbuckling the leash, ***so it resolves none of the issues, other than the rule that a leash must be worn."***

Inconvenience:
"There was also the particularly goofy long strap. This thick strap would run from your binding and loop around the rider somewhere near the knee. ***It would undoubtedly get hooked on objects, trees, ski poles, pretty much anything.*** The idea of a snowboard leash seemed simple and harmless but in practice ***only caused more problems than it solved***.", "Skiers are not happy that their 'monoplank' friends have yet another step to ***further slowdown the process of attaching a snowboard***. Snowboarders do not enjoy having to ***take their gloves off to unclip their strap*** every time they need to boot pack up something or go into a lodge.", "***Not wearing a leash saved the life of a friend of mine***. He was caught in a small avalanche and was able to quickly reach down and unbuckle his bindings, floating to the top of the rolling snow. ***Had he been leashed to his board; it would have dragged him under."***

Evaluation:
The snowboard leash is a great example of a product that tried to solve a problem but narrowly missed. Either from a lack of understanding or a lack of testing, the snowboard leash is never effective when it needs to be. When your strapped into the leash you're almost always strapped into the snowboard rendering the device useless. And when your leash is on, it gets caught on everything. This causes safety concerns to the user and to bystanders as the device can catch on other people as well.

Application of Conclusions:
Learning from this, I will need to thoroughly test my product to ensure it fixes the problem and doesn't cause any more. When designing my product, I need to design it in a way that doesn't hinder the unstrapping process and can safely conduct an emergency unstrap if needed. After this section of research, there is a strong enough need to continue with the idea. Next aspect of my project will be to start collecting constraints and important due dates for the project and start looking into areas that will need to be investigated throughout.

The Design Brief

Design Brief – To create an automatic device that stops an ***unattended snowboard*** to unintentionally runaway down a Snow Slope. This device will be able to integrate into most snowboards with little to no ***interference*** with the users snowboarding experience and it should also have the ability to be stored safely. It needs to be ***durable***, so it will be able to withstand the weight of an average 75kg male and also the interactions it will have with the environment while snowboarding (hitting obstacles, cold temperatures etc.) It should have secondary functions of creating a ***safer environment for snowboarding in low visibility*** as well as a mechanism to ***deter theft.*** A set of workshop drawings and circuitry diagrams will be produced for the manufacturing of the product.

Functions –

1. *Stops a Runaway Snowboard*
2. *Safer Environment for snowboarding in low visibility*
3. *Thief Deterrent*

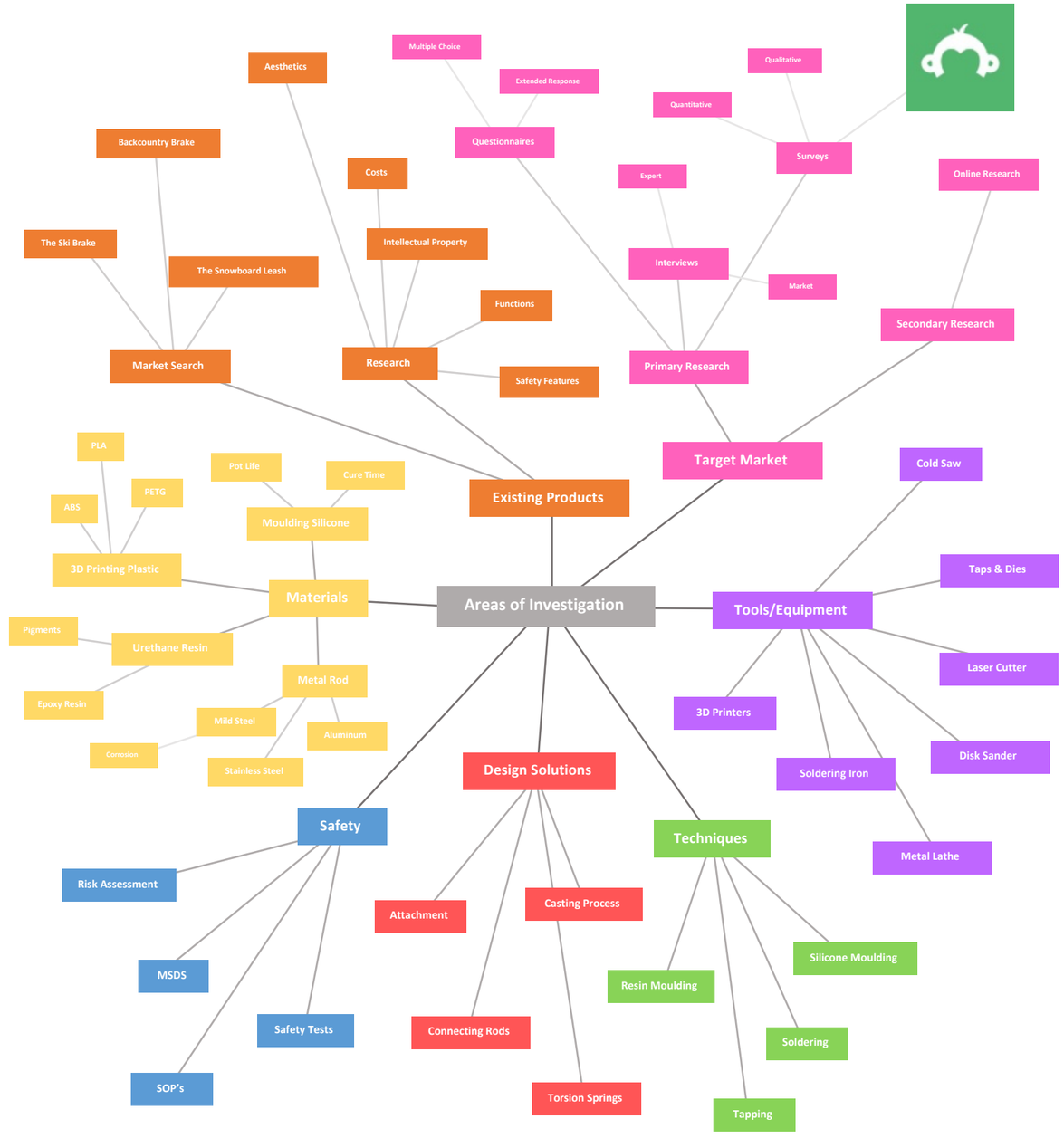
Constraints/Parameters

Parameter/Constraint	Limitation	Consideration
	1. General	
Time	1 Year – 4 Terms Product Due - 29/08/19 Portfolio Due - 9/09/19	The project has 4 terms to utilise, 2 of these terms will be mainly design, while the latter 2 will be on manufacturing. Time will also need to be allocated for exams and other subjects.
Budget	$400	To fulfil this, I will need to sometimes prioritise costs over quality to fit inside my budget although this is somewhat flexible.
Portfolio	40 Pg. A3 or 80 Pg. A4	I will format my portfolio in 40 A3 pages.
Product Testing	Testable Product Completed by 16/07/19	In the second week of the July holidays I am going to the snow where I will be able to test my product. This means I will have to have a testable product by 16/07/19.
	2. Experience	
Workshop Tools	Expert Knowledge	I have been using workshop tools for 5 years using hand tools, power tools, and machinery. I have over satisfactory knowledge on this.
Plastic Working	Base Knowledge	My skills fall short with plastics and I have never worked with casting silicone and resins. This will need research and experimentation to produce a quality product.
CAD Skills	Satisfactory Knowledge	I have been using Inventor for 5 years and have competent experience using Fusion 360.
Metal Working	Base Knowledge	I have had some experience with metal working, but my skills fall short with metals. This again will need research and experimentation to produce a quality product.
3D Printing	Satisfactory Knowledge	I have printed numerous items on 3D printers and can use them to a satisfactory level for this project.
Coding & Circuitry	Satisfactory Knowledge	I can code python a coding language but have limited experience using microcontrollers.
	3. Manufacturing	
Equipment	School Workshop, Home Workshop, Parents Work Resources.	My school's workshop is satisfactory for woodwork and some metal work. My home workshop is limited but I can borrow tools from outside sources. My Parents work have an extremely extensive workshop with metalworking so if need be, I have a second option.

Application of Conclusions:
The gaps in my knowledge are plastic working, metal working, Coding & circuitry and 3D printing so these areas of investigation will need to be thoroughly researched. The next step is to brainstorm other areas of investigation relevant to my product.

Areas of Investigation – Mind Map

Cognitive Organiser – Cognitive organisers are visual tools that assist learners to represent facts, ideas, concepts and the connections between them. Examples of cognitive organisers include concept maps, ***mind maps*** and graphic organisers.



Areas of Investigation

What will be investigated?	Pages	How it will be Investigated?	Why it will be Investigated?
Existing Products – Backcountry Brake – Ski Brake – Snowboard Leash – Snowboard Bindings – Electronic Components	6, 12	I will conduct market searches, listing prices, displaying images of the product and conducting a PMI on each product to evaluate existing solutions in the marketplace. With the aid of comparative studies, I can compare different products and their features and decide what will be suitable to implement into my design.	By conducting PMI's and thorough research on each individual existing product I can evaluate the positives and negatives of each design, implementing positive features and avoiding any negative features. By doing this I am automatically ensuring no other product can be superior to my own and further ensuring the success of my product. By researching past products, I am implicitly researching what the target markets think of these existing products. I can use this information to shape my product to what the market wants and ensure a successful product.
Target Market – Needs & Wants – Financial Factors – Ethical Factors	1, 3	To investigate this, I can conduct Surveys, Questionnaires or Interviews and ascertain information relevant to my product. I can contact people who work in the industry, for example, the Perisher or Thredbo websites and see if they can link surveys with people that are the correct demographic/target market. From this, I can also contact experts to gain knowledge on the demographic I should target my product towards.	Despite my own personnel opinion of my product, if it is not what the target market desires then the product will not sell and will not be successful. By researching into what the target market desires I can factor in their needs & wants while also considering financial and ethical factors. This means the product is moulded to what the target demographic needs before the product is released. This appeals to more of my demographic resulting in more sales of the product. If this is not done, the market may not want to buy the product even if it does solve the problem of runaway snowboards.
Materials – Moulding Silicone – Urethane Resin – 3D Printing Plastic – Metal Rods – Electronic Components	17 – 29	Using the internet, I can conduct secondary research into all the specific materials. I can find out properties, costs, safety information, availability, usability, etc. With the aid of comparative studies, I can compare different materials and their properties and decide which would be suitable to implement into my design. I can use primary research methods of observing how the materials behave by testing and experimenting with them.	Through comparing many types of materials to find most suitable material for my product properties like durability, strength, cost etc. become known and with this information I can make a more informed decision on what material I should use. If this wasn't done, then the chosen material would have been chosen on no factual basis and could be an inappropriate material. The product could break or could malfunction and especially when it is a safety device like my product, this is an imperative as people's safety in contention.
Tools – Cold Saw – Taps & Dies – Metal Lathe – 3D Printers – Soldering Iron	17 – 29	Using the internet, I can conduct secondary research into all the specific tools on the operation, safe use, effective use and ways to use of all the tools that I will operating. Most tools have Safe Operation Procedures (SOP's) and tutorials showing helpful information on the safe use and operation of tools. I can also use primary research methods of conducting investigations about the tool by testing and experimenting with them.	Through researching on the operation of the tools, I will become more knowledgeable about the tool and will aid in the production of a higher quality product. Without the knowledge of the operation of tools, it is very easy to misuse the tool and lower the quality of the product. During investigation, you learn about the safety of a tool and the operation in a safe manner. This way you can utilise the tools potential as well as using safe operation techniques.
Techniques – Silicone Moulding – Resin Casting – Soldering – Tapping	17 – 29	On the internet, there are resources and tutorials explaining various methods and techniques. On YouTube there are in depth videos showing moulding and casting as well as circuitry and soldering etc. Obtaining expert advice on methods is a good way to make sure I conduct myself in a safe manner. I can use primary research methods of conducting investigations about the techniques by testing and experimenting with them.	Researching into techniques conveys useful information about the correct way to conduct a technique. Most commonly with techniques, abundant video tutorials will aid in the understanding of how to use a specific technique. While researching techniques, other useful techniques will arise which can aid you in the production of your product. This can also give you the ability to design your product better as for example finding a better joinery technique which improves the aesthetic of the product. Techniques specifically, are complex processes and without thorough investigation can be done incorrectly and unsafely resulting in a low-quality product and an endangerment to yourself.
Design Solutions – Casting Process – Attachment – Connecting Rods – Torsion Springs – Prototyping	23 – 29	Design solutions are specific to a product so the investigation of them is mostly using primary research methods of conducting investigations about the solutions by testing and experimenting them. Using secondary research methods, like the internet, can be useful to see if other designers have encountered the same problems.	By testing design solutions, problems in your design will be resolved and design flaws can be eliminated. It is hard to see flaws in your own design during the design stage and encountering problems in the production stage is common. By conducting investigations on ways to solve these problems, these holes in your design can be filled creating a higher quality design. Just by testing parts of your product, or a prototype of your product can help in the visualisation of issues not previously foreseeable and aid in the production of a higher quality product.
Safety – Risk – MSDS – SOP – Safety Tests – PPE	17 – 29	Finding SOP's (Safety Operating Procedures) and MSDS's (Material Safety Data Sheet) on all tools and materials can help with the safe handling of the materials and machinery. My school, Sydney Boys High School, supplies mandatory machine safety tests on the safe operation of all the school's machines. Before conducting any experiment, I will conduct a risk assessment on the specific Tools & Materials I am using.	This step of investigation is of utmost importance as the safety of yourself is of higher priority than the success of your product. Gathering information from MSDS's and SOP's and running risk assessment before every experiment is an easy way to minimise safety concerns and risks to yourself. This way there is a minimal chance you could be harmed. Keynote, a product is replaceable, but you are not.

Criteria to Evaluate Success

Criteria	Priority	Why this will be achieved?	How it will be Evaluated?
Function *The action(s) the product has been designed to perform* – Stops runaway snowboards – Low visibility Snowboarding – Thief Deterrent	5/5	If the product has the correct working functions outlined in the design brief, these being stopping a runaway snowboard, discourage stealing and make it safer to snowboard in low visibility, then the need will be satisfied. If the functions are not implemented to a satisfactory level, the device will not function correctly and won't satisfy any need. The primary function of the device will be to stop runaway snowboards, and this is of top priority. The secondary functions of thief deterrence and a light system will be a lower priority but if the device does not meet the functional criteria the product would be a failure.	This will be evaluated by testing it on real snow slopes and having video evidence of me doing this. It can be deemed successful if it can stop snowboard on a variety of hill slopes.

Criteria	Priority	Why this will be achieved?	How it will be Evaluated?
Safety *The danger/safety risks of an object or action* – Doesn't interfere with surroundings – Ability to Snowboard normally – No sharp protruding parts	5/5	The product is a safety device specifically for the prevention of runaway snowboards but if the product causes other safety hazards then the safety device would be causing another problem. This could put a user in more danger than if they were not using the device. This defeats the purpose of the device and customer satisfaction will be low. By making the device have low interference with the surroundings, let the boarder to continue snowboarding normally and have to sharp protruding objects then product would fail because it would cause harm.	I can test whether the product protrudes out of the snowboard and effects the snowboarder. If it effects, then some danger could be caused to the user and can be deemed unsuccessful.

Criteria	Priority	Why this will be achieved?	How it will be Evaluated?
Ergonomics *The relationship between the human user and the product* – Comfortable to ride – Easy to use – Light & Portable	4.5/5	The product interacts with the user nearly all the time it is being used which means the ergonomics of the device needs to be desirable for the user and not affect the users snowboarding experience. The product also needs to be simple enough so that it won't impede on the time it takes to strap in a snowboard. The device will most likely be placed under the foot like the Ski Brake so it can't make the rider feel lopsided or uncomfortable. If it can do this while being light and portable, then the product will be a success.	This will be evaluated by showing all parts are easy to use without any protruding edges and minimal effect on the snowboarding experience. It will also be shown that it takes minimal effort to use the device and doesn't impede on the strapping in process. Video evidence will be shown of the device interacting minimally with the environment and not impede on the user's experience.

Criteria	Priority	Why this will be achieved?	How it will be Evaluated?
Durability/Quality *Expectations of the product to work as designed consistently* – Can withstand weight of a human – Operate in sub zero temps – Can withstand collisions	4/5	When the product is being used, the product will have the forces of human weight placed on it, which means it needs to be durable enough to withstand large forces. The device will also need to be durable enough withstand any interactions between the environment and it for example collisions, cold weathers etc. If it can't do this then then the product will break easily and not work or fulfil any of the needs.	By using the product in its environment for extended periods of time the durability of the product can be evaluated. This process is called 'Soak testing' and is commonly used in industry and if my product is durable, it can be deemed successful.

Criteria	Priority	Why this will be achieved?	How it will be Evaluated?
Aesthetics *The physical appearance of the product and its visual appeal* – Low key – Integrated	4/5	The product is meant to be minimalistic which means that it should have little to no effect on the overall aesthetic of the snowboard. This will ensure that the aesthetics will not be a negative factor in the purchasing decision of the consumer.	I will conduct a demographic survey to ensure that my product is aesthetically successful. When testing the product, the lack of people noticing it will tell me that it is minimalistic, and they can be deemed successful.

Term 4 & 1 Action Plan

Term 4 & 1 Action Plan				
P	Action or Task	Due Date	Variation	Justfication for Variation
1	T4 Action Plan	Wk 1	+ 0	
2	T4 Time Plan	Wk 1	+ 0	
3	Chapter 13 & 14	Wk 5	– 1	Working Ahead
4	Market Search	Wk 6	– 1	Not many products to research
5	Factors of Design	Wk 5	+ 0	
6	Design Situation	Wk 4	– 1	Working Ahead
7	Motivation	Wk 4	– 1	"
8	Exploration	Wk 5	– 1	"
31	Target Market	Wk 6	– 1	"
13	Snowboard Leash Research	Wk 6	+ 0	
12	Injuries Research	Wk 7	+ 0	
9	Parameters	Wk 7	+ 0	
10	Surveys/Questionarries/Interviews	Wk 8	+ 1	Planned to Much for Wk 8
11	Need Identification/Analysis	Wk 8	+ 1	"
14	Design Breif	Wk 6	+ 0	
15	Waste Plan	Wk 20	+ 0	Will do in evalution as LCA
16	Financial Plan	Wk 7	+ 0	
17	Idea Generation Sketches	Wk 20	+ 0	
18	Criteria To Evaluate Success	Wk 8	+ 1	Planned to Much for Wk 8
19	Areas of Investigation	Wk 8	+ 1	"
20	Mind Map	Wk 8	+ 1	"
21	**Research/Experiment Materials:**	Wk 25		
22	– Resins	Wk 25		
23	– Plastics	Wk 25		
24	– Rubber	Wk 25		
25	– Silicon	Wk 25		
26	– 3D Printing Plastics	Wk 25		
27	**Research/Experiment Techniques:**	Wk 25		
28	– Metal Latheing	Wk 25		
29	– Metal Bending	Wk 25		
30	– Resin Casting	Wk 25		
32	– Rubber Casting	Wk 25		
33	– Silicon Casting	Wk 25		
34	**Research/Experiment Tools:**	Wk 25		
35	– 3D Printers	Wk 25		
36	– Metal Lathe	Wk 25		
37	**Research/Experiment Design Solutions:**	Wk 25		
38	– Prototyping Mechansim	Wk 25		
39	T1 Action Plan	Wk 26	+ 0	
40	T1Time Plan	Wk 26	+ 0	
41	Application of Conclusions	Wk 26		

Legend	
	On Time
	Late
	Early
	Next Term

Term 2 & 3 Action Plan

Term 4 & 1 Action Plan				
P	Action or Task	Due Date	Variation	Justfication for Variation
1	Idea Generation Sketches	Wk 28	+ 2	Went Overtime
2	Application of Conclusions	Wk 20	+ 5	Exam Period
3	Jsutification of Ideas & Resources	Wk 27	+ 1	"
4	Research/Experiment 3D Printers:	Wk 22	+ 2	3D Printer Availibility
5	Research/Experiment Metal Lathe:	Wk 22	+ 1	Went Overtime
6	Research Resins:	Wk 23	+ 2	"
7	Research Silicon:	Wk 23	+ 1	"
8	Research Plastics:	Wk 23	+ 0	
31	Research Resin Casting:	Wk 23	+ 0	
13	Research Silicon Casting:	Wk 24	+ 0	
12	Research Metal Bending:	Wk 24	+ 2	Workshop Availibility
9	Research 3D Printing Plastics:	Wk 24	+ 0	
10	Experiment Resins:	Wk 25	– 1	Worked Ahead
11	Experiment Silicon:	Wk 25	– 1	Worked Ahead
14	Experiment Silicon Casting:	Wk 26	+ 1	Prioritised Idea Generation
15	Experiment Resin Casting:	Wk 26	+ 1	"
16	Experiment Desgin Solutions:	Wk 27	+ 2	"
17	Experiment CAD Techniques:	Wk 27	+ 2	"
18	Testing Resin	Wk 27	+ 0	
19	Testing Silicon	Wk 28	+ 2	Workshop Availibility
20	Testing Metal Rods	Wk 28	+ 2	"
21	Production Plan	Wk 24	+ 2	Exam Period
22	Formal CAD	Wk 26	+ 2	"
23	Order Materials	Wk 28	– 1	Free Time After Exams
24	Production	Wk 30	– 1	"
25	3D Printing	Wk 31	+ 1	3D Printer Availibility
26	Silicon Moulding	Wk 33	+ 0	
27	Resin Casting	Wk 35	+ 0	
28	Metal Rod Working	Wk 37	+ 0	
29	Portfolio Presentation	Wk 39	+ 1	Printer Availibility
30	Evaluation of Aesthetics	Wk 37	+ 2	Exam Period
32	Evaluation of Function	Wk 37	+ 1	"
33	Evaluation of Safety	Wk 37	+ 1	"
34	Evaluation of Ergonomics	Wk 37	+ 1	"
35	Impact on Individual	Wk 38	+ 0	
36	Impact on Society	Wk 38	+ 1	Underestimated Workload
37	Impact on Environment	Wk 38	+ 2	"
38	LCA	Wk 39	+ 2	"
39	Relationship to Proposal	Wk 39	+ 0	
40	Final Evaluation	Wk 39	+ 1	Illuminate Evaluation

Overall Time Plan

Task	Term 4									Term 1											Term 2											Term 3					
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5	6
Project Proposal																																					
Identification/Exploration of the Need																																					
							X																														
Areas of Investigation																																					
									X																												
Criteria to Evaluate Success																																					
									X																												
Project Management																																					
Action/Time/Finance Planning																																					
											X																										
Project Development																																					
Evidence of Creativity																																					
																															X					
Consideration of Design Factors																																					
					X																																
Research & Experimentation																																					
																															X					
Project Realisation																																					
Application of Conclusions																																					
																															X					
Identification/Justification of Resources																																					
																															X					
Use of Communication Techniques																																					
																																				X	
Evidence of Practical Skills																																					
																																		X			
Project Evaluation																																					
Ongoing Evaluations Procedures																																					
Evaluation of Function/Aesthetics																																					
																																				X	
Indvidual/Social/Enviromental Evalution																																					
																																				X	
Relationship to the Project Proposal																																					
																																					X

Legend	
	Proposed
	Actual
	Constant
	Exams
X	Completion

Finance Plan

	Item	Supplier	QTY.	Proposed $	Actual $	Variation $	Justification
1	Task 15 Urethane Resin	Smooth On	1L	$113.22	$101.76	$11.46	Student Discount
2	Mold Star 16 FAST	Smooth On	1L	$70.87	$70.87	$0.00	Student Discount
3	Torsion Spring	The Spring Store	5	$18.25	$18.25	$0.00	
4	Metal Rod	Mascot Steel	3m	$11.04	$0.00	$11.04	Supplied for Free
5	PLA 3D Printing Plastic	InkStation	250g	$6.24	$6.24	$0.00	
6	Foam Core	Riot Art & Craft	2	$16.00	$8.00	$8.00	EOFY Sale 50% Off
7	Black Urethane Pigment	Barnes	1	$13.20	$13.20	$0.00	
8	Talcum Powder	WoolWorths	500g	$2.50	$2.50	$0.00	
9	Rust Proof Paint	Bunnings	100ml	$15.00	$15.00	$0.00	
10	Thread Locker Loctite	Bunnings	1	$14.98	$14.98	$0.00	
11	M4 Tap & Drill Set	Bunnings	1	$24.98	$24.98	$0.00	
12	M4 Bolts	Bunnings	1	$4.53	$4.53	$0.00	
13	1200 Grit Sandpaper	Bunnings	2	$2.16	$2.16	$0.00	
14	600 Grit Sandpaper	Bunnings	4	$4.32	$0.00	$4.32	Supplied by School
15	WiPy 3.0	Core Electronics	1	$44.50	$44.50	$0.00	
16	Solar LiPo Charger	Core Electronics	1	$7.93	$7.93	$0.00	
17	1000mAh LiPo Battery	Core Electronics	1	$13.95	$13.95	$0.00	
18	Peizo Buzzer	Core Electronics	3	$8.55	$8.55	$0.00	
19	Accelerometer BMA220 (Tiny)	Core Electronics	2	$7.93	$15.86	-$7.93	I Kinda blew it up, got a second one
20	1W Solar Panel	Core Electronics	1	$7.73	$7.73	$0.00	
21	Solder Board	JayCar	1	$4.50	$4.50	$0.00	
22	Male to Male Wire Pack	JayCar	1	$5.95	$5.95	$0.00	
23	Breadboard	JayCar	1	$4.59	$0.00	$4.59	Supplied by School
24	1mm Music Wire	NB Hobby Store	2m	$5.90	$5.90	$0.00	
25	Portfolio Folder & Printing	Officeworks	40 A3	$55.20	$0.00	$55.20	Mums Work Printer & Folder
–	**Total**	–	–	**$484.02**	**$397.34**	**$86.68**	Under Budget

Evidence of Purchases


Northern Beaches Hobby Centre

ABN: 88125706032
858 Pittwater Rd, DEE WHY, NSW, 2099, AU

Served By: Greg Bakla on Register #1 at 3:03:08pm, 15th July 2019

#POS01-3873

2 Music Wire 1Mm Dia - 1 Meter Length - 1P - Kse-3941 $2.95 each $5.90

Sub total $5.36
Total GST 10% $0.54
Total $5.90

Payments

Cash $5.90
Tendered $20.00
Change $14.10

Total amount paid $5.90

Total Price Includes GST

858 Pittwater Road, Dee Why, NSW, 2099


BUNNINGS warehouse
EASTGARDENS WAREHOUSE
BUNNINGS GROUP LIMITED
ABN 26 008 672 179
PH: (02) 9887 2100

Thu 04/07/2019 08:44:34 PM
RETURNS/INFO DESK R12

Sale
** TAX INVOICE **

Total $36.67
GST INCLUDED IN THE TOTAL $2.33
CARD NO: 402239-028
CREDIT

Rounding $0.00
Change $0.00

'+' Indicates non taxable item(s)

Thank you for shopping with Bunnings
Please retain receipt for proof of purchase

Have Your Say
Give us your feedback online at www.bunnings.com.au/haveyoursay


BUNNINGS warehouse
EASTGARDENS WAREHOUSE
BUNNINGS GROUP LIMITED
ABN 26 008 672 179
PH: (02) 9887 2100

Thu 04/07/2019 08:19:20 PM
TOOL SHOP R13

Sale
** TAX INVOICE **

1 3 Subtotal: $24.98

Total $24.98
GST INCLUDED IN THE TOTAL $2.27
CARD NO: 402239-028
CREDIT $24.98

Rounding $0.00
Change $0.00

'+' Indicates non taxable item(s)

Thank you for shopping with Bunnings
Please retain receipt for proof of purchase

Have Your Say
Give us your feedback online at www.bunnings.com.au/haveyoursay


jaycar

Bondi Phone: (02) 9369 3899
125
Bronte Road
Bondi Junction 2022
ABN# 65000087936 Tax Invoice: 1170639

Branch: 425 Till: 1 Date: 29/06/19
Operator: 5993 Time: 11:59

Sale

Code	Qty	Price	Extn
HP5540	1	$4.50	$ 4.50
PCB VERO 95X75MM 0.9MM HOLES			
WC6024	1	$5.95	$ 5.95
LEAD JUMPER PLG - PLG 40 PC KIT 150MM			

Purchase Total: $ 10.45
Includes GST of $0.95

Payment Tendered:

Jaycar Electronics
125 Bronte Road
Bondi Junction NSW 2022

Tyro Payments EFTPOS

Visa Credit
AID: A0000000031010
Card: XXXXXXXXXXXX0249(t)

Purchase AUD $10.45
Total AUD $10.45

APPROVED 00
No pin or signature required

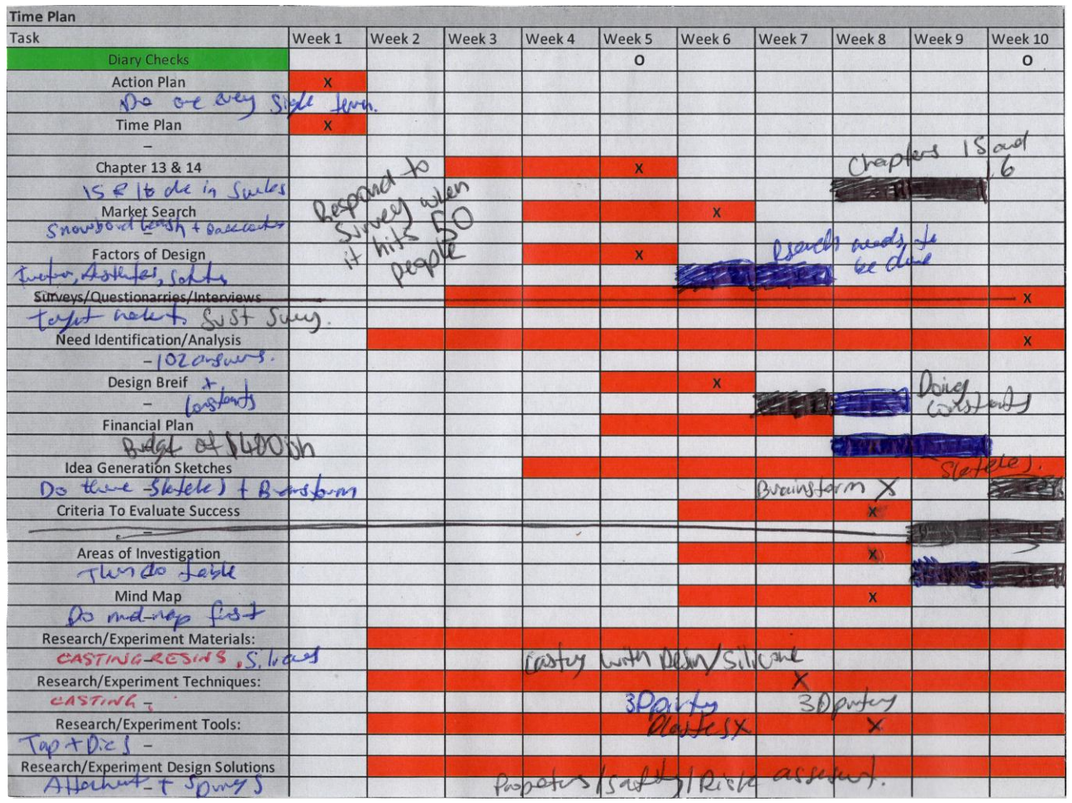
Terminal ID: 43
Transaction Ref: 931800
Authorisation No: 082[illegible]
29 Jun 2019 at 11:59[illegible]

Visa $ 10.45
Change: $


ART & CRAFT RIOT!
Eastgardens
Shop 304/305 Westfield Shopping
Centre Level 3 152 Bunnerong Rd
Eastgardens 2036 NSW
Telephone: 02 9343 6855

ART & CRAFT RIOT!
Eastgardens
Shop 304/305 Westfield Shopping
Centre Level 3 152 Bunnerong Rd
Eastgardens 2036 NSW
Telephone: 02 9343 6855

Evidence of Application


Time Plan

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Diary Checks					O					O
Action Plan	X									
Do one every Single week.										
Time Plan	X									
–										
Chapter 13 & 14					X					
IS & 16 due in Studies										
Market Search						X				
Snowboard bench + Bascetas										
Factors of Design					X					
Twelve, Ashtel, Sobha										
Surveys/Questionarries/Interviews										X
target makets. Just Surv.										
Need Identification/Analysis										X
-102 answers.										
Design Breif +						X				
– Constants										
Financial Plan										
Budget of $1400ish										
Idea Generation Sketches										
Do three Sketch) + Brainstorm										
Criteria To Evaluate Success										
–										
Areas of Investigation										
Then do table										
Mind Map										
Do mind map first										
Research/Experiment Materials:										
CASTING RESINS, S. Tools										
Research/Experiment Techniques:										
CASTING –										
Research/Experiment Tools:										
Tap + Dies –										
Research/Experiment Design Solutions										
Attachment + Spring										

Respond to Survey when it hits 50 people

Chapters 15 and 16

Research needs to be done

Brainstorm X

Sketches.

Doing Constants

3D Printing Masters X

3D printing

Testing with Resin/Silicone

Properties/Safety/Risk assessment.

Management Reflection

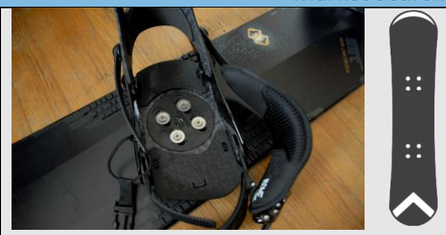
Evaluation:
In my major design project, there was a successful application of my management plan. The Gantt charts were helpful in planning times and kept me on track. See in shown time plans. Various tasks throughout the project were finished late and this was because of the over planning of weeks. A week would have to much planned and I couldn't keep up. The action plan helped me visualise the tasks that needed to be completed and helped me see the coming workload. They were used and it helped seeing due dates and how well I followed them. The finance was well planned, and the overall project was under budget. Receipts were kept showing evidence of some of the purchases. The Management section of my design project was completed to a satisfactory level.

Evidence of Creativity – Existing Products

Existing Product – The Ski Brake	
Picture	
Information	• Lever action spring brake when pressed down prongs come out of the snow. • Conversely, when released the prongs protrude into the snow, stopping the Ski. • Brake is integrated into the boot clipping system so when the boot is clipped in, the brake is engaged. • Prongs run parallel to the Skis Edges. • Prongs have rubber tips.
Positives	+ It keeps the skis from running down the mountain when unattended. + It doesn't interfere with the skiing experience or interfere with the snow. + Rubber tips help with grip and safety of the user and others. + Secondary Function; connects the two skis together for easy transport.
Negatives	– Prongs can catch on objects like trees, rope, clothing etc. – The device can catch snow in the mechanism, and it can seize up. – When transporting the skis, the prongs can catch on roof racks and other securing devices.
Interesting	▪ Skis come off very easily so was deemed necessary to develop such a device, contrarily to snowboards.

Evaluation:
The ski brake is a highly effective way of preventing runaway skis as at all times the brake can operate. The lever action mechanism works well while keeping the mechanism simple for easy use and repair. The prongs running parallel to the edges keeps the prongs from interacting with the environment.

Application of Conclusions:
The ski brake is the main idea inspiration for the snowboard brake. The essence of my design will be integrating the ski brake into the form of a snowboard.

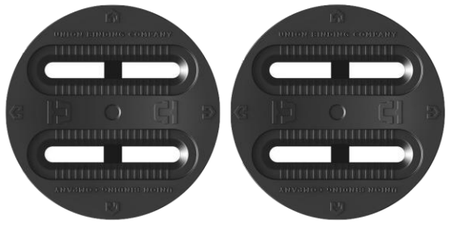
Market Search – Comparative Study: Snowboard Binding Types			
Picture			
Type	*4x4*	2x8	Channel
Information	• *Binding which connects to a snowboard and straps onto your feet.* • *Secures your feet to the board so you can control the snowboard.* • *Connects it to the snowboard with 4 centred screws.*	• Binding which connects to a snowboard and straps onto your feet. • Secures your feet to the board so you can control the snowboard. • Connects it to the snowboard with **6 centred screws.**	• Binding which connects to a snowboard and straps onto your feet. • Secures your feet to the board so you can control the snowboard. • Connects it to the snowboard by locking it in a **channel on the board.**
Positives	+ *Quick assembly as there are only 4 screws.* + *Easy to assembly as there is only one setting.*	+ Have more degrees of turning space so you have a more variable binding angle. + More screw holes so there are variable positions for different uses.	+ Is very quick to release. + Large Horizontal binding space for variable uses.
Negatives	– *Not variable with the setup spacing.* – *Only one setting.*	– Takes a long time to setup as have 12 screws to setup per board.	– Not as secure as there are only two pints of contact, one on each side.
Interesting	▪ *It is the Most common Binding Type*	▪ The most secure binding type.	▪ Was developed for professional speed snowboarder for its variable positioning.

4x4 Snowboard Binding – The 4x4 snowboard binding is the most commonly used snowboard binding. To make my product available for the most people I will integrate the attachment method into a 4x4 binding system.

The binding is placed on the board over the holes at desired angle. The attachment plates are then tightened into the board with the binding in between attaching the binding securely.

∅ 4x4 Snowboard

∅ 4x4 Snowboard Bindings

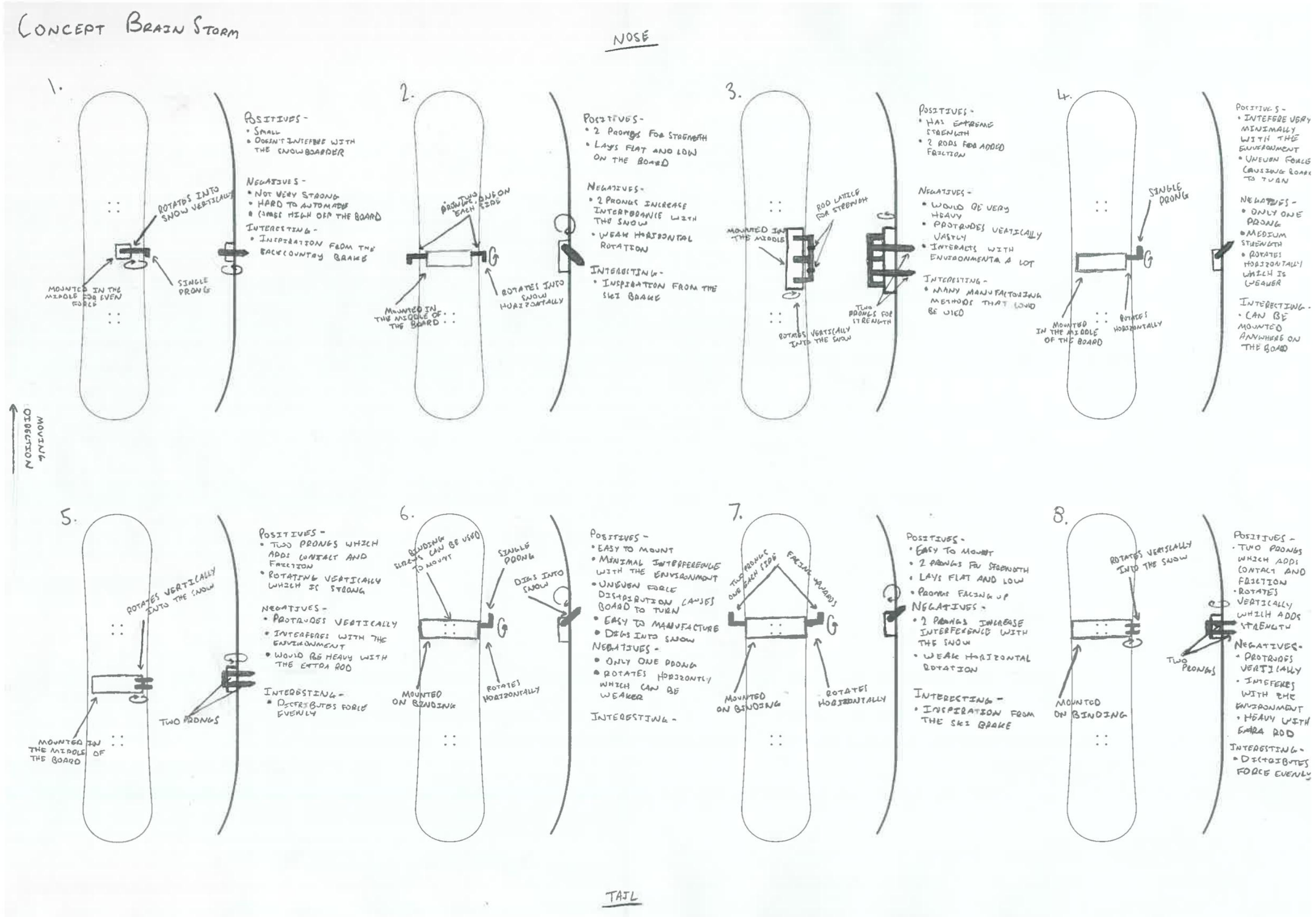


∅ 4x4 Attachment Plates

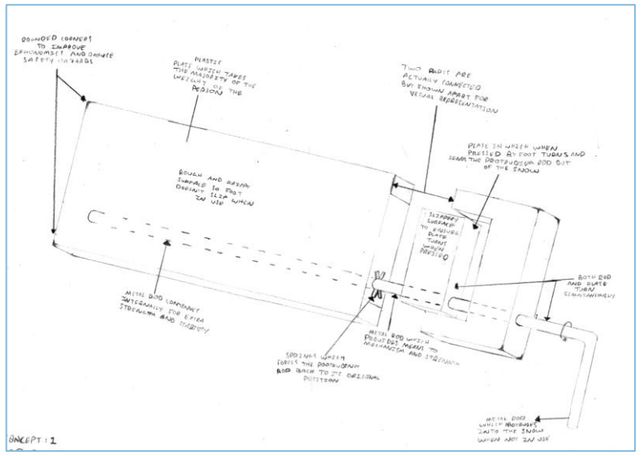
Evaluation:
Seeing as the 4x4 is the most commonly used snowboard binding, I will design my product around that too attach the device it will need to integrate with the 4-screw attachment method. This will make the attachment of the device simple and only as complicated as setting up a snowboard. Future prospects would see a braking system integrated into a standard snowboard binding similar to the ski brake being a standard in all ski bindings. This way there would be no need for separate device and the user wouldn't need to worry about attaching it.

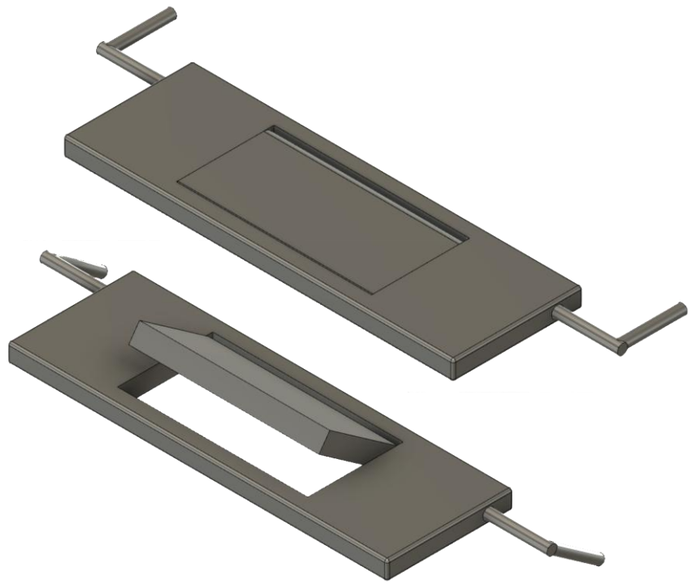
Application of Conclusions:
During design stage, I will need to integrate an attachment method that integrates into the 4-screw method. Design solution & testing will need to be conducted to ensure the method of attachment is viable.

Evidence of Creativity – Idea Generation: Brainstorm



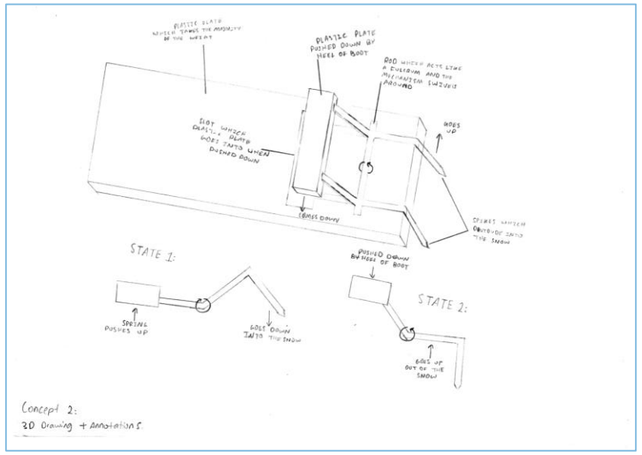
Evidence of Creativity – Idea Generation: Concept 1

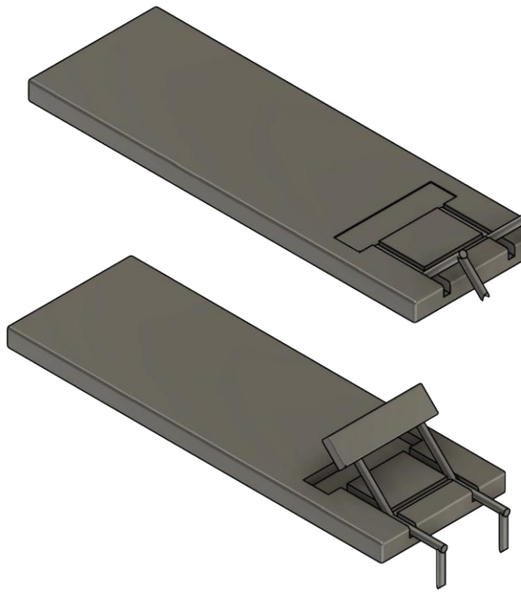




- When the plate is pressed down, the prongs will rotate out of the snow, when it is released, they rotate into the snow, one on each edge of the board.
+ 2 prongs, one on each side for added friction.
+ Lifts the board up off the snow with the prong on each side.
– Has very even force distribution, even on both sides of the board causing the board to remain facing down the hill when activated.
▪ 2 springs can be put in the device for added strength, one on each side

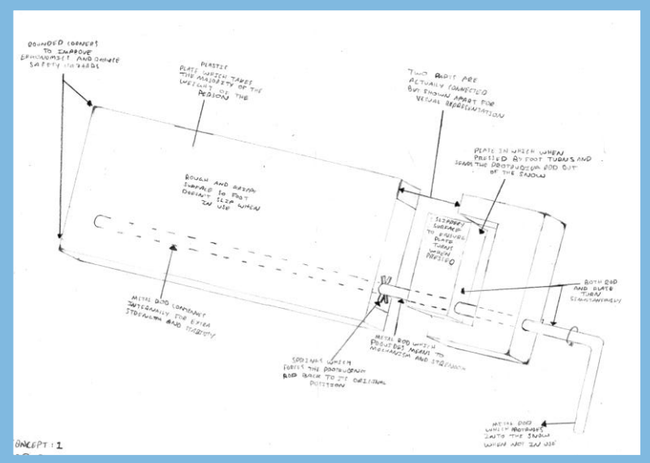
Evidence of Creativity – Idea Generation: Concept 2

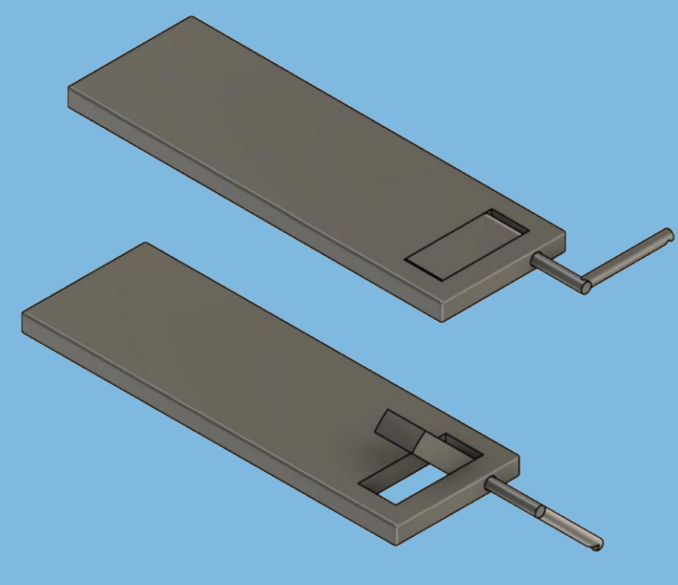




- When plate is pressed down, the prongs rotate out of the snow, when it is released, they rotate into the snow stopping the board.
+ 2 Prongs for added friction to the snow, slowing faster.
+ Symmetrical force distribution causing even slowing.
– Flimsy mechanism as only 5mm rod.
– Easily bent pressing plate as it has long rods connected to it.
– Sharp prongs causing a safety concern.
– Complicated design will be hard to produce or replicate.
▪ Cannot over rotate as it has physical limits.

Evidence of Creativity – Idea Generation: Concept 3



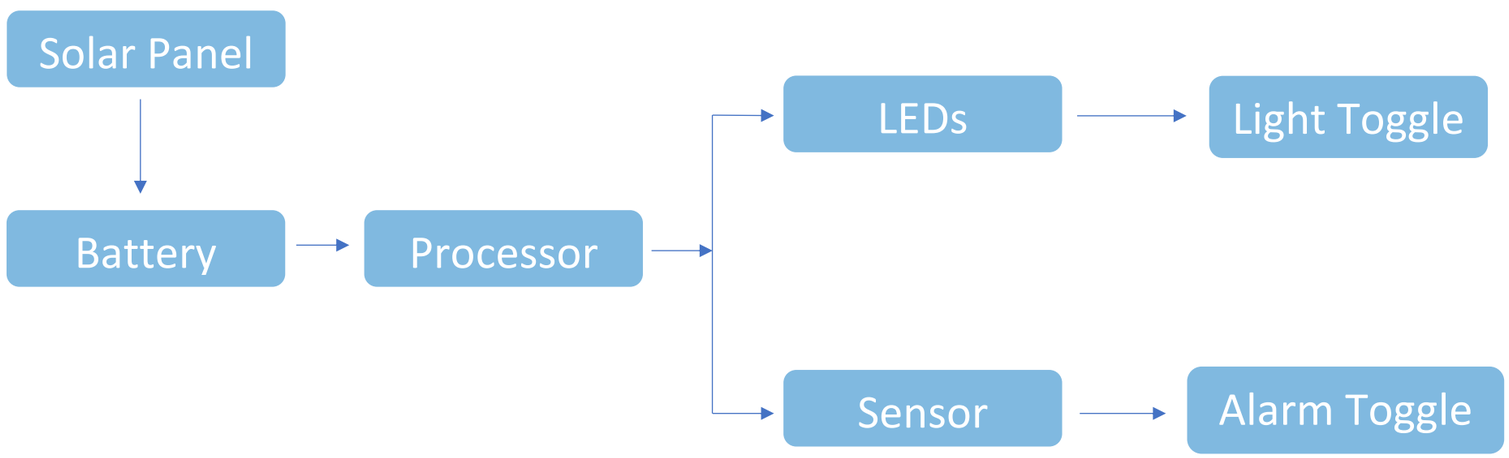


- When plate is pressed down, the prong come out of the snow, when it is released, it returns into the snow stopping the board.
+ Strong mechanism as it only has 2 pieces of rod at 8mm.
+ Simple design so it can easily be produced & replicated.
+ Has more physical real estate to house secondary functions.
– Asymmetrical force distribution causing uneven slowing.
– Can over rotate as it has no physical limits to the prong.
– Single protruding prong going into the snow.
▪ Can either bend the rod from 1 piece of metal or join 2 pieces at 90°.

Application of Conclusions:
I have chosen Concept 3 to further develop because of its simplistic design and its functionality. It applies a force more on one side thus turning the board perpendicular to the snow slope. This aids in the stopping of a runaway snowboard, a feature that the other concepts do not have. The design also allows a large real estate for other functions to be implemented as the mechanism for stopping runaway snowboards is compact.

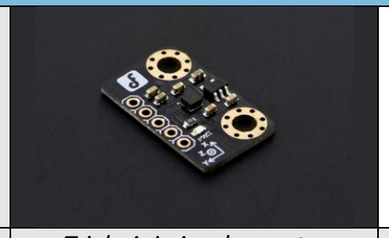
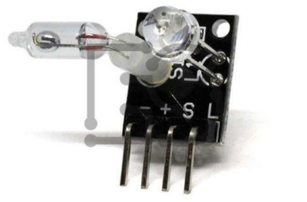
Evidence of Creativity – Idea Generation: Electronic Features

Electronic Logic Flow



Evaluation:
The electronic features are going to be a lighting system which solves the need of low visibility snowboarding, will be an alarm system which solves the need of thieves. They will be done by a circuit which can be controlled by your phone or a device that can turn on lights and turn on an alarm. This will be fit inside a cavity of the snowboard brake and will have to waterproofed. Also, the sensor will need to be researched as it was unspecified in the idea sketch. This was done so the best sensor for the design can be chosen.

Application of Conclusions:
Now the there is an idea for the electronics a specific cavity can be delegated in the real estate of the device and this will need to be done in further idea generation and development. The Alarm sensor will need to be chosen and then all other electrical components.

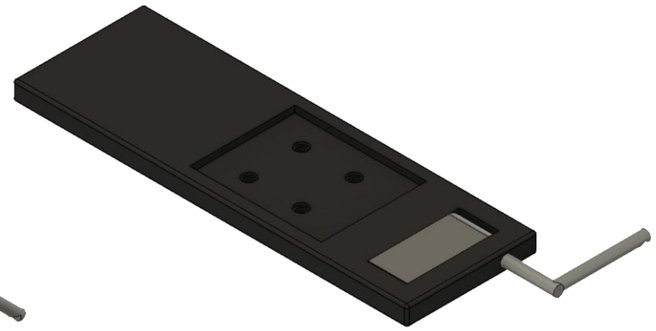
Function – Alarm Sensor						
Picture						
Feature	GPS	Bluetooth	WiFi	*Triple Axis Accelerometer*	Tilt Sensor	Gyroscope
Action	Location Tracking	Proximity Sensor		Motion Sensor		
How it Works?	• Any Change in location would sound the alarm.	• When the device is taken out of a Bluetooth range the alarm will sound.	• When the device is taken out of a specific WiFi range the alarm will sound.	• ***When the accelerometer senses any movement, the alarm will sound.***	• When the Tilt sensor senses any movement, the alarm will sound.	• When the gyroscope senses any movement, the alarm will sound.
Positives	+ Accurate detection and bonus of being able to track the perpetrator.	+ Very low power consumption. + Can be used to communicate with the user.	+ Low power consumption. + Can be used to communicate with the user.	+ ***Works anytime, anywhere.*** + ***Tracks direction & Magnitude.***	+ Works anytime, anywhere. + Easy to code.	+ Works anytime, anywhere. + Easy to code.
Negatives	– Very Power Consuming – Large Module	– Very small range.	– Has to be in a range for the method to work.	– ***Medium power consumption.***	– Only tracks movement not direction or magnitude.	– Only tracks movement not direction or magnitude.
Interesting	▪ Can also be used to track Snow slopes, Speed etc.	▪ Has range of up to 20m	▪ Has range of up to 1m	▪ ***Can detect up to 3g Accelerations.***	▪ Uses mercury as a liquid conductor to sense tilt.	▪ A gyroscopic module would be used, not a gyroscope.

Evidence of Creativity – Idea Generation: Concept 3 CAD Development

1. Initial model of the design.

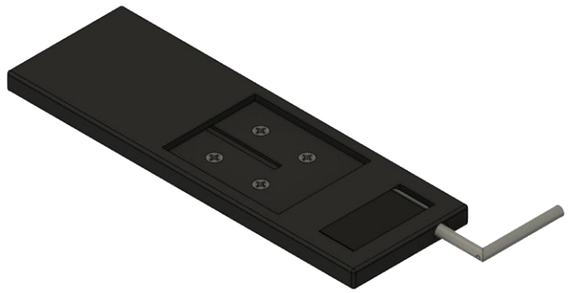
2. Modelling the colour, texture and material of the design.

3. Developing the Press Plate so it locks into the rod.

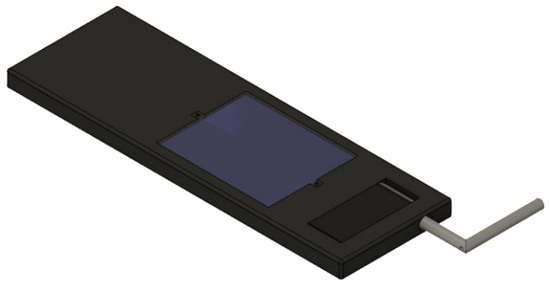


4. Adding a place for the solar panel and screw holes to attach it to the board.

5. Creating a 80 x 100 x 10 mm cavity to house any electronics inside.

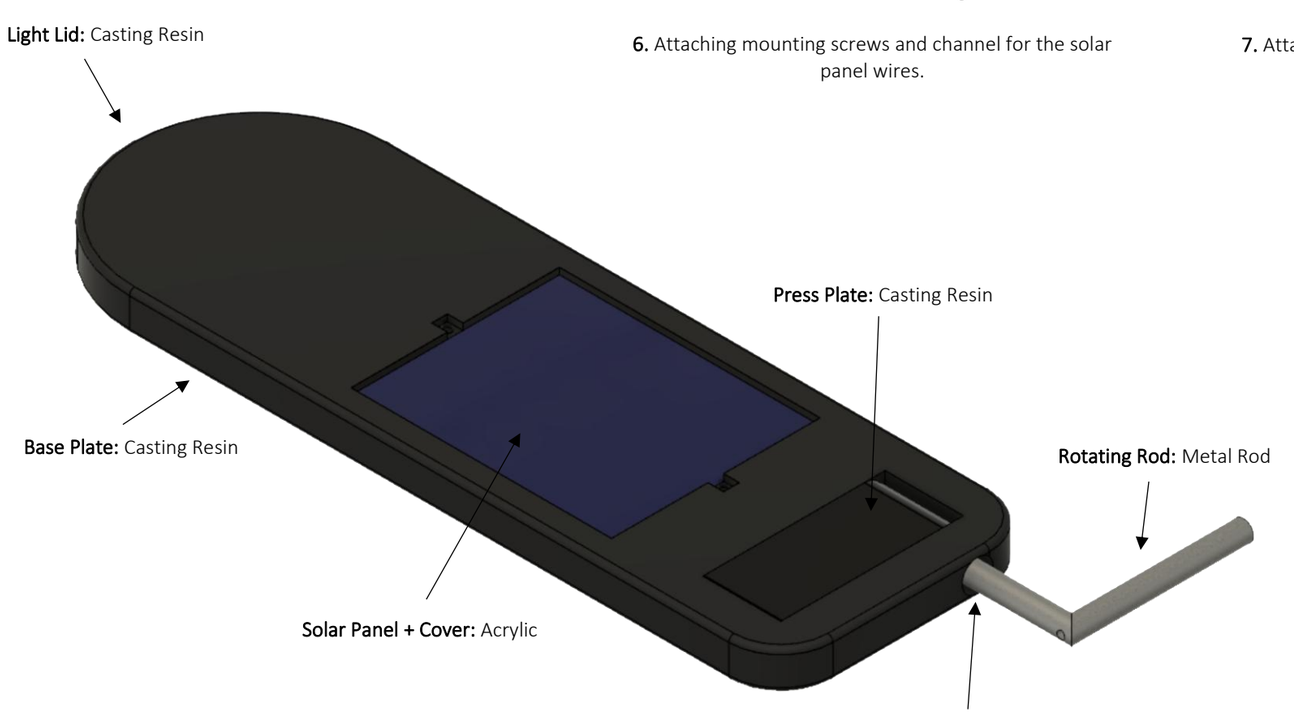


6. Attaching mounting screws and channel for the solar panel wires.



7. Attaching solar panel and the Solar Panel Cover

8. Curving the corners for ergonomics & creating an Electronics Lid to waterproof the electronics.

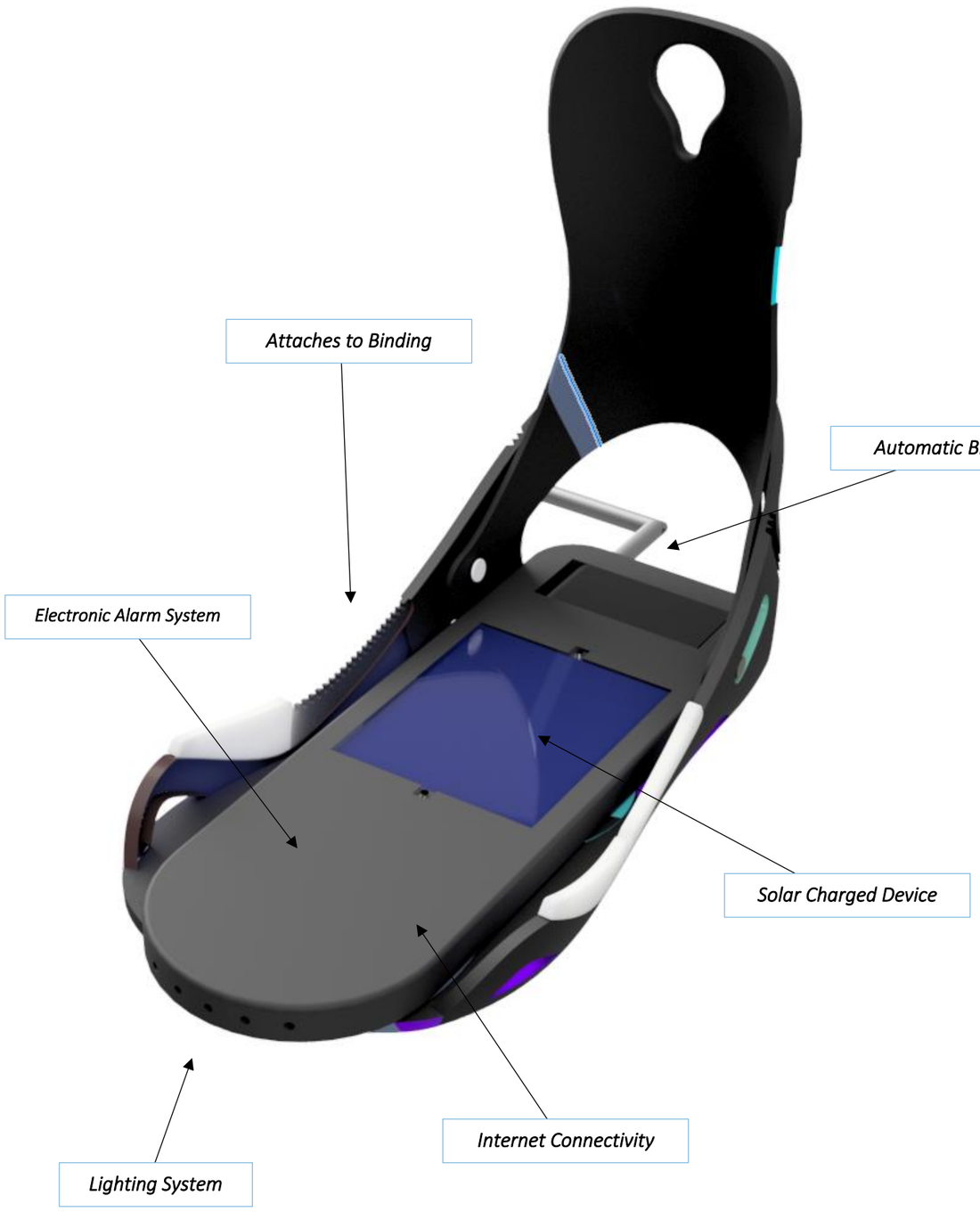


9. Final Design (Material Choice)

Evaluation:
The design consists of a base plate which takes most of the weight of the person. This will need to be made from a strong castable resin, so it won't fracture. The press plate is attached to the rod which is rotated up via a spring. The rod, attached to the press plate, will rotate simultaneously with the movement of the press plate. As the press plate is pressed by the user's boot, the rod will rotate in and out of the snow. When the rod is rotated into the snow, the friction between the rod and the snow will keep the snowboard stationary. When the user presses the press plate, the rod will rotate out of the snow, letting the user snowboard normally.

Application of Conclusions:
Now the design is finalised, and an idea for the materials have been chosen, I can now research & experiment into the specific materials, tools, techniques and design solutions relevant to my design.

Evidence of Creativity – Degree of Difference



Degree of Difference – When generating my design and researching into existing products, ***there was a significant lack of current products that prevented runaway snowboards***. There are 2 products which try but fail to solve the problem but neither come close to solving the need indicated.

Automatic Braking:

The snowboard Brake has a braking system that operates with minimal human operation. All the user needs to do is strap in normally for the device to operate. This was designed so that there is no chance that the device could malfunction due to human error. ***Comparatively to the Existing Products on the market, the devices all need human operation to function.*** For example, the Backcountry Snowboard Brake needs to be reset every time it is activated. The Snowboard Leash need to be clipped on and off every time the person takes their snowboard off. The manual aspect of these products leaves room for human error thus endangering people on the snow slopes.

Attaches to Binding:

The Snowboard Brake is attached to the binding where it is operated by the process of strapping in. It utilises the attachment method of the binding to create an easy & secure way of holding the product to the board. Comparatively to the existing products on the market, ***no other product is attached to the binding or operated by the foot.*** Without this secure attachment method, or for example the Backcountry Snowboard Brake, will come off in collisions or falls because of the weak connection the device has with the board. In collisions, there is a high chance of a to snowboard runaway and is why I have implemented this feature into my device.

Internet Connectivity:

The Snowboard Brake has an electronic system inside its body which houses electronic parts, one of which is the WiPy 3.0. This microcontroller hosts a local WiFi network allowing the device to talk to a user's phone. ***No other Existing product has any electronic system or any internet connectivity.***

Electronic Alarm System:

The Snowboard Brake has an Alarm system where if the device is locked and the device is moved, it will set an alarm off and notify the user. This feature was implemented into the device as there is no way of securing a snowboard and preventing people stealing them. ***No other existing Snowboard Brake has this feature, and in general, no other snowboard product has this feature.***

Lighting System:

The Snowboard Brake has a lighting system where the user can turn on and off a set of LEDs' at the base of the device which aids in people seeing you in low light situations. This feature was implemented because of the dangers that are accentuated when snowboarding in low visibility. This could be at night or in a whiteout, the likelihood of collision because of the lowered visual stimuli increases. ***No other existing Snowboard Brake has this feature.***

Solar Charged Device:

The snowboard brake has a Solar Panel which charges the battery powering the electronics. When the user is not using the device, the solar panel will trickle charge the battery. This allows the operation of the device to happen completely void of the user. This again reduces room for human error while also being environmentally friendly and not using fossil fuel produced power. ***No other existing Snowboard Brake is solar powered and in general, no other snowboard product has this feature.***

The Ski Brake:

The main inspiration for the Snowboard Brake is the Ski Brake. My idea was ***an integration of the ski brake into a snowboarding scenario***. This design shows this as the features of the ski brake exist in my design. The Ski Brake has an automatic braking system, is attached to the Ski Binding and is also operated by the process of clipping into the binding. ***The main differences being the electronic features; the Internet Connectivity, The Alarm System, the Lighting System, and the Solar Panel.***

Factors of Design

Consideration of Design Factors		
Design Factor	Consideration	Application/Justification
Function  *The ability of the product to repeatedly perform the primary and secondary tasks for which it was designed.*	• Must incorporate the primary functions, dictated by the need and design brief (Stopping a runaway snowboard) • Should also incorporate additional secondary features (Low light snowboarding, Thief deterrent)	In idea generation, a mechanism to stop runaway snowboards must be incorporated as the functions of my design are the most important design features and the main appeal for my product. A form of thief deterrent and lighting system will also need to be incorporated to fulfil the design brief. All these functions will also need to be tested during the development stage to ensure they work as intended.
Safety  *A designs ability to not pose any hazards throughout its life cycle from design-production, use and disposal.*	• Must Prioritise the safety of the user above all, protecting from or avoid risks of injury caused by faulty or dangerous construction, inappropriate materials, lack of durability/quality, or unsuitable measurements or dimensions. • When manufacturing, Materials, Tools & techniques can pose major safety concerns.	All materials, tools, and techniques before testing will have a risk assessment ran to ensure the safe operation. The device, in essence, is a safety device. How the product works will determine how safe snowboarding will become but other safety considerations will also need to be made. During realisation, the product will need to be checked for any hazardous parts and will be tested to ensure this.
Ergonomics  *The relationship between the human user and the product.*	• Must be easy for the user to use without hindering their snowboarding experience. • The interaction between the user and the products is comfortable and has no noticeable negative effects.	The product will need to be designed in a way that any protruding parts do not affect the way snowboarders ride. This will need to be tested and approved by an expert. The way the product interacts with the user's boot will also need to be evaluated so the operation of the device is easy & comfortable. Other existing products have issues of them interacting with the user and their surroundings, so it is imperative for my device to be ergonomic.
Quality/Durability  *The ability of a design to last for its designated life in its particular environment.*	• Must continue to work to a high quality of the expected lifespan of the product. • Critical failure before the specified life span would render the product non – durable. • Must be able to withstand general wear and not pose any danger if misused by a user.	The snow slope environment is unforgiving, so my product will need to be designed and produced with an effective design and constructed with quality materials. Cold temperatures and large pressures are constantly exerted on the device and its resistant against this will need to be factored in. It can be Soak Tested to ensure quality and durability over extended periods.

Consideration of Design Factors		
Design Factor	Consideration	Application/Justification
Aesthetics  *The physical appearance of the product and its visual appeal to the target market.*	• Must be aesthetically pleasing to attract customers. • Consideration trends should be followed to guide design language. • Unique aesthetic properties are the deciding factor of two functionally similar products.	The aesthetics of my design need to be subtle so it can be placed on any snowboard and be aesthetically pleasing. Using lowkey colours like black helps to design a product that doesn't stand out. This can be tested by using the device and seeing if anyone notices it. Contacting an expert or the target market will also help determine whether the device is aesthetically pleasing.
Environmental Consequences  *Short-term and long-term impacts of the product ad its manufacturing process on the environment.*	• Must have minimal negative effects on the environment from all stages of design. • Sustainable materials & production methods must be prioritised during development and realisation. • As much waste will need to be reused/reduced/recycled to ensure the minimal effect short term and long term on the environment.	To track and check whether my design is environmentally sustainable, I will run a Life Cycle Analysis (LCA) to determine my impact. This will need to be done for every stage of the design process (Cradle – Grave) from the sourcing of materials, the production of the product and its disposition. It is necessary to minimise impacts on the environment so when choosing materials, like resin and silicone its environmental impact will need to be factored in. For electricity, using sustainable power like solar or wind and implementing solar charging into the device will need to be undertaken.
Finance  *The monetary costs with all the phases of design development and manufacturing.*	• Must be priced suitably for the target market in accordance with existing products to ensure the purchasing of my product. • Must not exceed the proposed budget of $400 by a substantial amount of money.	Finance will need to be factored into the manufacturing of the product so that I can stay under budget. This will also aid in reducing the cost per product so if placed in an industrial setting, the mass manufacturing of the product would be feasible. This can be done by using a finance plan which tracks and keeps count of all your purchases for your project. Making compromises on the quality of material, tool, etc. for price may need to be undertaken to ensure financial success.
Time  *The deadlines associated with all the phases of design development and manufacturing.*	• All aspects of the major design project must be completed within the deadlines set during initial planning and by NESA. • Exams must be factored in during initial time and action planning.	To manage my time and keep to these set deadlines I will need to use time management techniques. These consist of using Time-Action Plans and using Gantt Charts. This can be done weekly with the renewal of these plans every 10 weeks. Contingency plans will need to be created to ensure successful time management even if aspects of the design run overtime.

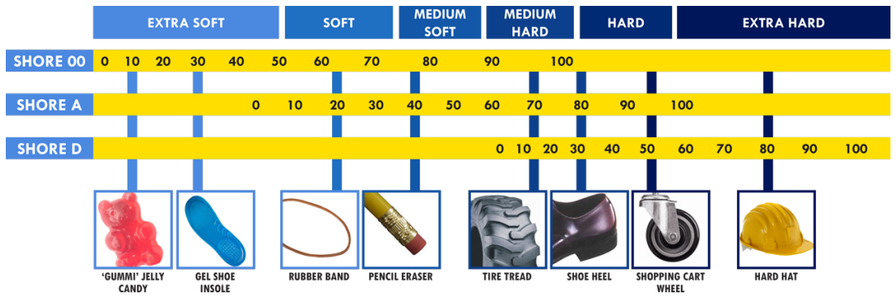
Documentation of Research – Material: Urethane Resins

Properties of Castable Urethane Resins – There are many properties of castable urethane resins that determine whether the resin will be suitable for the product's needs. These would be durability against impacts and cold resistance.

Some properties that determine the suitability of a Urethane Resin is the ***Shore Hardness Scale, Elongation @ Break, Tensile Strength, Shrinkage & Cure Time/Pot Life:***

Shore Hardness Scale:

There are 3 Shore Hardness ranges, Shore 00, Shore A and Shore D, all different ranges of the same Hardness Scale. Shore 00 and Shore A are used for moulds which need to be very soft and their ranges stay with materials that aren't very hard. Shore D range reaches plastics that are extremely hard and at the top end, these plastics become very brittle and for my product become unusable. On the **Shore D range somewhere in-between 60 – 90** would be the safest bet when choosing a Urethane Resin. This keeps the plastic durable enough to withstand impact but not to brittle that it would shatter.



Elongation @ Break:

Elongation @ Break is a percentage of which a cured resin can stretch until it breaks. A softer resin will be able to be stretched a higher percentage of itself that a harder resin. A lower % would mean a resin is harder than one that is of a higher %. For my purpose a **lower % would** suffice so that large strains on the device will not cause any warping or stretching.

Tensile Strength:

Similar to the Elongation @ Break, the tensile strength of a Material is the Maximum amount of stress the material can take without any sign of the formation of fractures. This is measured in pressure and shows the strength of a material and a good indication of how durable a material is. A **material with very high tensile strength** can take a large amount of pressure before deforming and for my product an ideal property.

Shrinkage:

When a resin is casted, the material while curing will shrink a little. This becomes a problem when you are trying to cast something that fits with another piece. If the mould is to scale but the material shrinks than the piece will not be to scale and be useless. **A very low shrinkage rate is ideal** but for Urethane Resins the shrinkage rates are near to negligible.

Cure Time/Pot Life:

Cure time is the amount of time a resin takes to completely dry and be at its strongest point. Some resins can take an Hour to set while others can take over 24 hours. A low cure Time is ideal, but most Cure Times are short enough that a mould can be left overnight and be cured. A pot life is the time where a Resin can be transferred from being mixed to being placed in the mould. **A higher Pot Life** means that there is more room for error when transferring the resin into the mould and is ideal for most products including my own.

Documentation of Research – Market Search: High Strength Semi-Rigid Urethane Resins

Market Search – Comparative Study: High Strength Semi-Rigid Urethane Resins			
Picture			
Name	TASK™ 12	***TASK™ 15***	TASK™ 16
Price	$135.19/L	***$ 113.22/L***	$70.87/L
Hardness	D60	***D75***	D30
Manufacturer	***Smooth On***		
Elongation @ Break	300%	***20%***	233%
Tensile Strength	18.6 MPa	***18.8 MPa***	15.6 MPa
Shrinkage	0.001in. / in.	***0.0042 in. / in.***	0.0025 in. / in.
Cure Time	16 hours	***1 hour***	24 hours
Pot Life	20 mins	***6 mins***	6 mins
Colour	Translucent Clear	***Opaque White***	Opaque Orange
Positives	+ High handling strength. + Long Pot life creates ease of use.	+ **Makes tough prototypes.** + **Rotationally castable.** + **Extreme temp resistant.**	+ Great energy absorbent. + Very low shrinkage for Intricate moulds.
Negatives	– Not meant for home use as fumes are very toxic. – Quite expensive in only Industrial quantities.	– **Pot life is short, making resin working harder.** – **Higher shrinkage, not as good for intricate designs.**	– Very soft & deforms under high pressure. – Cannot change the colour
Interesting	▪ Translucent & easily dyed.	▪ **Opaque white can be coloured easily.**	▪ Bright colours can be used for safety.

Market Search – Comparative Study: Urethane Resin Pigments			
Name	Polyurethane Pigment	***Urethane Pigment***	So-Strong® Colorants
Type	Powder	***Concentrate***	Concentrate
Price	$11.07/25g	***$13.20/25ml***	$10.73/25ml
Manufacturer	Dalchem	***Barnes***	Smooth On
Availability			
Colour	Opaque Black		Translucent Black
Recommended %	0.5% – 5%	0.1% – 3%	0.01% to 3%

Evaluation:
The Resin Task™ 15 is the best resin as it can withstand the most pressure which is important in a high impact activity like snowboarding. It also has a low Elongation percentage which means the product will not deform under large amount of pressure, a necessity when more than a human's weight of pressure will be constantly on the product.

Application of Conclusions:
This resin will be the main material used to construct my product and Task™ 15 is the most suitable. The next step is to research into its specific properties and start to experiment and test with it. From there I can start to research into other materials like Silicone and metal rods.

Documentation of Research & Experimentation – Material: Task™ 15 Urethane Resin

Task™ 15 Urethane Resin – Task™ 15 is a 2 Part (75A:100B) castable urethane resin from a line of High-Performance Casting Resins called 'Task™.' Task™ series runs from Task™ 1 – Task™ 21 each having different properties, and each made for different purposes. Task™ 15 was specifically chosen out of all of them because of its properties concerning durability and hardness. The resin is an opaque white at base but can be dyed with specific solutions to create a coloured resin. The resin is very impact resistant and can be machined and sanded

Shore Hardness Scale:
75D is high on the Shore D Scale which means that the materials when set is resistant to scratch's and dents. The hardness of the material is said to be similar to a Hard Hat, being hard and protective while also being resistant to cracks and breakages. Resins with higher Shore Scores will be more resistant to scratches because of its hardness but when a material reaches the end of the Shore Scale, the material becomes very brittle and prone to cracking and breakages. This level of hardness is perfect for the collision and impact prone environment that is Snowboarding.

Elongation @ Break:
For my purpose, the plastic that needs to resist strains of more than a human body weight and on multiple occasions. A low Elongation @ Break percentage like 20% means that the material will warp at Maximum 20% of its original volume at its total strain. This is compared to Resins that will stretch more than 100% which when under high strain will compress and warp and ruin any mechanism for braking a snowboard.

Tensile Strength:
Having a tensile strength of 18.8 MPa is sufficient to withstand the constant high pressures that will be on the plastic. This combined with the low Elongation @ Break of 20% it can withstand large amount of pressure and still retain its shape to a factor of 20%.

Shrinkage:
When casting the model of the Snowboard Brake the mould will have intricate details which will need to fit into other parts and if the model shrinks with any significance then the parts will not fit together. A shrinkage of 0.0042 in. / in is insignificant enough that the shrinkage that occurs will not affect the design.

Cure Time/Pot Life:
Although not as significant as other properties having a short cure time like 1 hour means that I can minimise any wasted time. Pot life is not that short and even though a longer pot life would be more convenient it doesn't have any significant detriment to my product.

Task™ 15 Urethane Resin Experimentation –

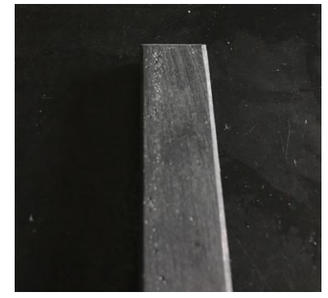
Aim: To experiment with the properties of and the process of casting with Task™ 15 Urethane Resin.

Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Burning skin as resin when cures releases heat.	Low	If handling after the resin has been poured, use gloves to prevent burns.
Inhalation of toxic Fumes are released when curing.	Medium	Keep the curing environment well ventilated and don't stay in the room for long periods of time.
Getting resin in your eyes or mouth.	Low	Wearing goggles and a face mask will reduce the risk of this. Not mixing the resin too vigorously will ensure to prevent this.

Mixing & Pouring Testing Method:

1. Weigh in ratio of 1A:1B

2. Mix thoroughly & evenly



Results: Successfully Set Resin

Strength Testing Method:

1. Pour resin into testing jig.

2. Demould Testing jig.

Results: Has high strength but still did fracture.

Evaluation:
Task™ 15 castable resin is durable hard plastic that would be perfect for the main material in my product. It doesn't deform under pressure and it has a very high fracture point. This is paired with a very low elongation @ break making it very impact absorbent. It can withstand high impact collisions that the product will occur during its lifetime on the slopes. It has minimal safety Hazards which are no extreme concern when working with the material. To prevent any harms that could occur, I will use the material in well ventilated areas and wear respirators and other PPE. From experimentation the resin showed its high strength, even though it did fracture, large amounts of pressure were applied to do so. It has enough strength to withstand a human's weight and not fracture or fail.

Application of Conclusions:
I will use this resin for the casting of the main components of my design. This includes the base plate, press plate and the light lid. Now having competent knowledge in the chosen Urethane Resin, the next step for in my project would be researching silicone moulding to see what the best moulding material would be for Task™ 15 Castable urethane resin.

Documentation of Research – Market Search: Casting Silicone

Market Search – Comparative Study: Casting Silicone			
Picture			
Name	Mold Star™ 15 SLOW	Mold Star™ 30	***Mold Star™ 16 FAST***
Price	$71.84/L	$71.84/L	***$70.87/L***
Hardness	A15	A30	***A16***
Manufacturer	Smooth On		
Core	Tin Core	Platinum Core	
Cure Time	4 hours	6 hours	***30 hours***
Pot Life	50 mins	45 mins	***6 mins***
Elongation @ Break	300%	399%	***440%***
Tensile Strength	2.6 MPa	2.9MPa	***2.8 MPa***
Colour	Green	Dark Blue	***White (Blue Dye Optional)***
Rigidity	Soft	Semi-rigid	***Soft***
Shrinkage	<.001in. / in.		
Mixing Ratio	1A:1B		
Positives	+ Soft & easy to demould.	+ Higher rigidity can capture more detail.	+ ***Short Cure time.*** + ***Soft & easy to demould.***
Negatives	– Long Pot/Cure time.	– More rigid silicone makes it harder to demould.	– ***Hard to pour as it has a short Pot Life.***
Interesting	▪ Work temp of 230°C to –55°C.	▪ Shrinkage is less than 0.001 in. / in.	▪ ***Can be used for Forensic Capture.***

Mold Star™ 16 FAST Casting Silicon – This castable resin is great for time constrained projects that need precision and accuracy when moulding. It has a 1A:1B mixing ratio which makes it easy to create the Mould without the use of a scale.

There are many properties that concern Casting Silicon, all relevant properties are Shown Below. Mold Star™ 16 FAST specific properties are the following:

Properties			
Shore D Scale:	16A	Shrinkage:	<0.001 in. / in
Cure time:	6 mins	Pot Life:	30 mins

Documentation of Research & Experimentation – Material: Mold Star™ 16 FAST Silicone

Mold Star™ 16 FAST Casting Silicone Experimentation –

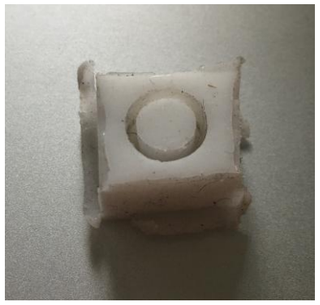
Aim: To experiment with the properties of and the process of casting with Mold StarTM 16 FAST Casting Silicone.

Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Inhalation of toxic Fumes are released when curing.	Medium	Keep the curing environment well ventilated and don't stay in the room for long periods of time.
Getting resin in your eyes or mouth.	Low	Wearing goggles and a face mask will reduce the risk of this. Not mixing the resin too vigorously will ensure to prevent this.

Mixing & Pouring Testing Method:

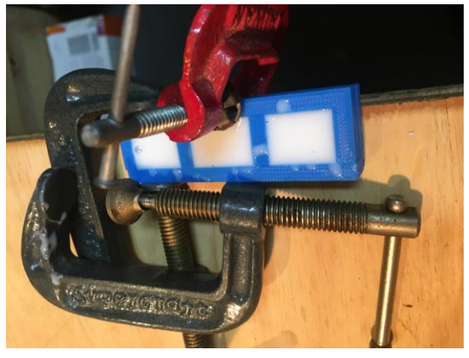
1. Weigh in ratio of 1A:1B

2. Mix thoroughly & evenly



Results: Successfully Set Silicone

Detail Retention Testing Method:



1. Pour silicone into testing jig and place detailed objects.

Results: Great detail retention over all 3 tests.

Evaluation:
Mold Star™ 16 FAST seems to be the best Casting Silicone for my needs as it can be cured in a very short amount of time and is very easily worked and demoulded. For the MDP, there are large time constraints which means that time is factor and any time saving that can be done without being a detriment to the product must be taken. It has minimal safety risks but still only cured in a well-ventilated area so no chance of inhalation with any irritating substances can occur. It will be easy to mould a 3D printed model of the product and cast it with resin with this Casting Silicone with accuracy precision and haste. Through experimentation it is shown that even though it has a low cure time it can still retain large amounts of detail.

Application of Conclusions:
This silicone is what I will use to mould the 3D printed primary and create my product. It is easy to use and is very fast and time efficient. The next step of my project would be to research into the production of the rod section of my design and chose materials.

Documentation of Research – Material: Torsion Spring

Torsion Springs – A torsion spring unlike a regular compression or tensions springs uses the torque produced by rotating/tensioning the material. This way when connected to two objects the spring will resist any independent rotation. They are used in many items for example Car Suspension, Resistance tools, Door handles, Garage doors, Clothes pegs etc. There are a few types of torsion springs in which the properties are listed below;

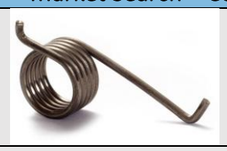
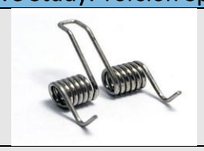
Clearance:

When a Torsion Spring is under tension it compresses, and the inner diameter of the spring will reduce. This means that **clearance in between the rod and the spring needs to be given.** The springs inner diameter will need to be **10% more than 8mm** so it will operate in my design.

Maximum Rotation:

A torsion spring has a limit to in which it can be rotated before it will cease to go back to its original position. For a specific spring, at a certain amount of rotation, the spring will **exceed its elastic deformation stage and start to plastically deform**. When this happen, the spring will permanently deform and not return back to its original position.

Market Search – Comparative Study: Torsion Spring

Picture			
Type	**Torsion Spring**	Double Torsion Spring	Spiral Torsion Spring
Price	***$3.65/spring***	$5.21/spring	$4.34/spring
Availability	***High***	Low	Low
Manufacturer	*The Spring Store*		
Inner Diameter Ø	10mm		
Outer Diameter Ø	***12mm***	12mm	20mm
Wire Diameter Ø	***1mm***	1mm	3mm
Active Coils	***9***	12	5
Leg Length	***20mm***	10mm	5mm
Body Length	***10mm***	17mm	3mm
Torque @ 360°	***193.456 N/mm***	*234.523 N/mm*	*62.349 N/mm*
Compression @ 360°	***1.8mm***	*1.74mm*	*4.4mm*
Positives	+ ***Compact*** + ***Strong***	+ Strong + Even torque distribution	+ Body length is Compact
Negatives	– **Uneven torque distribution**	– Body length is not compact	– Not strong – Outer diameter is not compact.

Evaluation:
For the purposes of my design, a single torsion spring will Suffice to spring power it. It has a compression of 1.8mm when on tension @ 360° which is under 10% the total inner diameter and will work in my design. The Double torsion spring is too wide for my application and for the space I have to put it. The spiral torsion spring is not powerful enough being nearly 3 times less as powerful as the single torsion spring and twice the size.

Application of Conclusions:
I will use the torsion spring as the main force, pushing the rods into the snow. The next step of my project is to research the type of metal I will use with my rod. This will further determine the springs power requirements as if I use heavier metals, my spring will need to exert more force.

Documentation of Research – Material: Metal Rod Material

Metal Rod Material – The rod for my project needs to be able to withstand all the forces a high velocity snowboards can exert and needs to be able to withstand the cold and water abundant environment of the snow slopes.

Strength:

The forces from the rod to the snow can be upwards of your body weight so the substance of the rod needs to be strong enough to take this and not bend or fracture.

Corrosion:

The environment of the snow slopes is water rich which means the corrosions of the substance needs to be taken into account when choosing the material.

Rust:

With ferrous metal (iron content), the oxidisation of iron turns it into rust which will eat away the component. This will happen slowly overtime for mild steel.

∅ Steel Chain Rusted

Market Search – Comparative Study: Rod Material

Picture			
Material	***Mild Steel***	Stainless Steel	Aluminium
Price	***$3.68/m***	$10.50/m	$4.21/m
Diameter Ø	***8mm***	8mm	10mm
Manufacturer	***Mascot Steel***	The Stainless Shop	Aluminium Warehouse
Availability	***High***	Low	Low
Tensile Strength	***370 MPa***	465 MPa	241 MPa
Density	***7.7 g/cm³***	8.0 g/cm³	2.7 g/cm³
Hardness (Moh's)	***4.5***	6.0	2.5
Reactivity			
Workability			
Welding	✓	✓	✗
Positives	+ ***Easily Machined*** + ***Very Cheap***	+ High Strength + Does not Corrode	+ Does not Corrode + Very Light
Negatives	– ***Does Corrode*** – ***Requires rust proof coating.***	– Difficult to work with as is very hard – Very Heavy	– Not very strong – Cannot Weld

Evaluation:
Mild steel is best choice for my project as it is the cheapest and still very strong material. Aluminium was too soft for the forces going through the rod even though it would be easy as aluminium does not rust or corrode. With stainless steel, it is too hard to work with as it very hard and will blunt my tools and equipment. It also has a higher density that Mild steel and would weight significantly more in the final product.

Application of Conclusions:
Now knowing the material used for making the rod, the next step in my project is to research into the tools and equipment used to work Mild Steel. I can experiment and test the tools with the specific material and gain knowledge it its properties and aid me in the construction of my product.

Documentation of Research – Market Search: Electronic Components

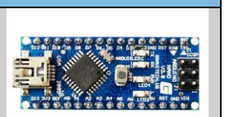
Note – No electrical component can exceed a height of 10mm, all electronics must fit in an 80mm · 100mm plane & all electronics must operate at Sub Zero Temperatures.

Microcontroller – There are many microcontrollers currently on the market suitable for my design. They range in coding languages, features, price, ease of use etc.

Features Needed:

The microcontroller needs to be able to power and control a lighting system, an accelerometer, an alarm system, buzzers with an ability to send and receive instructions from an app on a device. This all needs to be done at an operating temperature of below 0°C.

Market Search – Comparative Study: Microcontrollers

Picture				
Name	Bluno Beetle	***WiPy 3.0***	FiPy	Arduino Nano
Manufacturer	DFRobot	Pycom		Arduino
Price	$24.55	***$44.50***	$135.00	$22.00
Dimensions (mm)	28.8 x 33.1 x 2.6	***42 x 20 x 2.5***	55 x 20 x 3.5	18 x 45 x 3.4
WIFI	✗	✓	✓	✗
Bluetooth	✓	✓	✓	✗
GPS/Cellular	✗	✗	✓	✗
Range	20m	***1km***	50km	–
GPIO Ports	12	***24***	22	22
Port Capability	PWM, UART, I2C	***PWM, UART, sPI, I2C, I2S***	PWM, UART, sPI, I2C, I2S, DMA	PWM, sPI, I2C
Coding Language	C	MicroPython		C
Operating Voltage	5V	***3.3V – 5.5V***	3.3V – 5.5V	5V
Operating Temp	-10℃ – +85℃	***-40℃ – +85℃***	-40℃ – +85℃	-40℃ – +85℃
Positives	+ Very Small + C is an easy coding language.	+ ***Long Range*** + ***Many GPIO Ports*** + ***Long Range WiFi*** + ***Cheap***	+ Long Range + Cellular + GPS + Long Range WiFi + Many GPIO Ports	+ Many GPIO + C is an easy coding language.
Negatives	– Range is 20m – Small amount of GPIO Ports – Operates on 5V	– ***No GPS***	– Expensive – Large Dimensions	– No Wifi – No Bluetooth – Operates on 5V

Evaluation:
The WiPy 3.0 is the best choice for my project as it is a good price compromise from the FiPy but still having enough features like WIFI, Bluetooth and an array of GPIO ports. It has 24 GPIO ports which is plenty for my application. It has a range of 1km via the WIFI network which will suffice for my project as the snowboard will never be that far away from the user. It has a relatively low profile which is better as I have space limitations for my electronic compartment.

Solar Panel Controller – A solar panels input varies greatly on its position and amount of light hitting the solar cells. This creates a range of power inputs and to control this and make sure no harm comes to any electronics, an input controller is used. With a LiPo battery, If the battery is overcharged, then the battery can heat up, swell, and in longer exposures of current can result in an explosion. This controller is the safety buffer for the electronics and for the battery and in essence the most important part of the electronic circuit.

Features Needed:

The solar panel Controller needs to be able to input a low current solar panel and output 3.7v. It also needs to be able to charge and discharge a LiPo battery while also outputting a main current to power other electronics. This all needs to be done at an operating temperature of below 0°C.

Market Search – Comparative Study: Solar Panel Controllers

Picture				
Name	Sunny Buddy	USB Solar Charger	***Solar LiPo Charger***	Solar Power Micro
Manufacturer	Sparkfun	Adafruit	DFRobot	
Price	$40.22	$33.25	***$7.93***	$20.62
Dimensions (mm)	45 x 45 x 8	41 x 33 x 2	***33 x 33 x 12***	30 x 30 x 4.5
Power Charging	✓	✓	✗	✓
Charging Voltage	6V – 20V	3.7V – 4.2V	***3.7V – 4.2V***	3.7V – 4.2V
Input Voltage	6V – 20V	5V – 6V	***4.4V – 6V***	0.5V~4V
Output Voltage	6V – 20V	3.7V – 4.2V	***3.7V – 4.2V***	3.7V – 4.2V
Max Charge Rate	450mA	500mA	***500mA***	100mA
Operating Temp	0℃ – +45℃	0℃ – +50℃	***-40℃ – +85℃***	-40℃ – +85℃
Positives	+ Has wide Charging, Input & Output Voltages.	+ Can Charge from a USB	+ ***Cheap*** + ***Small*** + ***Low Temps***	+ Very Cheap + Very Small + Low Temps
Negatives	– Large – Expensive – 0℃ lowest	– Large – Expensive – 0℃ lowest	– ***Low Variable Voltage.*** – ***Will have to solder off the 12mm headers.***	– Low Charge Rate – Input is 0.5V~4V

Evaluation:
The Solar LiPo charger is the best Solar Panel controller for my project as it has all the functions of the other products but for a significantly cheaper price. It has green Power In headers which are over 10mm so they will need to be soldered off and the Power In & Out soldered to the board directly. It has a low profile which is better for my limited space and can withstand temps down to –45C° utilised for a snow environment. It has two green connectors which are 12mm tall. They can be soldered off and the connections soldered straight to the board.

Application of Conclusions:
Now the main components of my electrical system have been chosen, the next step in my project is to choose the other feature component like battery, buzzers, Accelerometer & solar panel. The microntroller has specific power ouputs which will lmit the type and number of electrical compapnets I have. The Solar LiPo Charger has a limited power input and charging rate so the battery and solar panel will have to fit in those requirements. Another step in my project will be the research and experimentation of soldering for building system circuit and connecting all my electrical components.

Documentation of Research – Material: Electronic Components

Lithium Ion/Polymer (LiPo) Battery

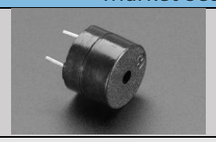
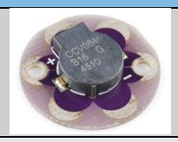
– LiPo batteries are very efficient compact batteries and they range in capacity, price and size. As space is a limitation in my design there may need to be compromises on price and capacity so that the battery will fit. All of the chosen LiPo batteries can be connected straight to the Solar LiPo charger.

Market Search – Comparative Study: LiPo Batteries				
Picture				
Milliamp Hour	400mAh	***1000mAh***	2000mAh	2400mAh
Manufacturer	Core Electronics			
Price	$10.95	***$13.95***	$15.95	$19.95
Dimensions (mm)	38 x 25 x 6	***51 x 34 x 6***	56 x 56 x 6	67 x 60 x 6
Voltage	3.7V			
Operating Temp	-10℃ – +50℃			

Evaluation:
The 1000mAh battery has the best compromise between power and space so it can power my unit but also fit into the confined space of the electrical compartment. There is a possibility if the power is too little, stacking 2 and placing them in parallel will increase the power output but not take to much more space in the device.

Buzzer

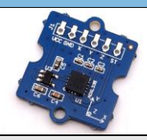
– The buzzer will be enclosed in the electronics compartment so it needs to be loud enough and have a high enough frequency that it can penetrate the resin walls. Having more than one buzzer may need to be taken into consideration.

Market Search – Comparative Study: Buzzers				
Picture				
Frequency	2kHz	***2kHz – 10kHz***	0.7kHz – 10kHz	2400mAh
Variable Frequency	✗	✓	✓	✓
Manufacturer	Adafruit		Pololu	Sparkfun
Price	$1.80	***$2.85***	$2.00	$6.50
Dimensions (mm)	12 Ø x 9.7	***11.9 Ø x 6.53***	30 Ø x 7.5	20.0 Ø x 2.4
Voltage	3V – 5V	***3V – 30V***	1V – 30V	2.5V – 4.5V
Operating Temp	-10℃ – +50℃	***-10℃ – +50℃***	-40℃ – +85℃	-30℃ – +70℃

Evaluation:
The 2nd buzzer is the best choice as it has a loud enough sound but also has a low profile on 6.93mm. It runs on 3 – 30V so will easily be powered by a 3.7v LiPo battery. It has a large Hz range for a small buzzer which gives modularity for when coding the buzzer.

Triple Axis Accelerometer

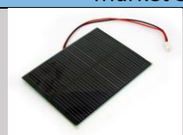
– The module needs to be sensitive enough that it can detect when there is a movement of the device but needs to be modular enough so that it can be calibrated so that a gust of wind doesn't set it off.

Market Search – Comparative Study: Triple Axis Accelerometer				
Picture				
Name	***BMA220 (Tiny)***	MMA8451	LilyPad – ADXL335	Grove
Manufacturer	***DFRobot***	Adafruit	Sparkfun	Seeed Studio
Price	***$7.93***	$15.10	$23.83	$16.66
Dimensions (mm)	***13 x 22 x 2.5***	21 x 18 x 2	20 Ø x 2.25	22 x 22 x 3.5
Voltage	***2.0V – 3.7V***	3V or 5V	1.8V – 3.7V	3V – 5V
Scale Range	***±2g ±4g ±8g ±16g***	±2g – ±8g	±3 g	±3 g
Operating Temp	***-40℃ – +85℃***	-40℃ – +85℃	-40℃ – +85℃	-10℃ – +50℃

Evaluation:
The BMA220 (Tiny) is the accelerometer that I will use in my project as it is the smallest unit, useful as I have tight space limitation, the cheapest unit and has the most sensitivity. Its data connection is I2C which the WiPy 3.0 has built in. It can operate at temperatures of 45C° which is useful for the very cold environments it will be subjected to on the Snow Slopes

Solar Panel

– The brake is 100mm thick and has about 200mm of length real estate where the solar panel can sit. The wattage doesn't need to be too high as it can trickle charge the battery in the sun when the device isn't being used.

Market Search – Comparative Study: Solar Panel				
Picture				
Watts	***1W***	1.5W	2W	1W
Manufacturer	Seeed Studio			Adafruit
Price	***$7.73***	$11.59	$15.45	$47.37
Dimensions (mm)	***100 x 80 x 2.5***	137 x 81 x 2.5	180 x 80 x 2.5	113 x 89 x 5
Voltage	***5V – 6.4V***	5V – 6.4V	5V – 6.4V	6V
Typical Current	***170mA***	270mA	360mA	180mA
Waterproof	✗	✗	✗	✓

Evaluation:
The 1W solar panel should output enough current to trickle charge the 1000mAh battery over the day when not being used. It can output currents of 170mA which is more than the WiPy 3.0 says is standard current draw. It is perfect size to fit on the surface of the brake and has the benefit of being the cheapest solar panel out of the 4 options.

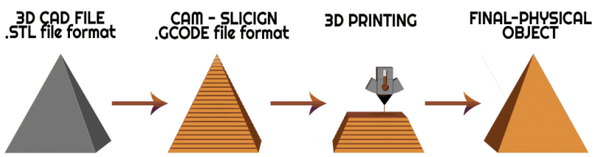
Application of Conclusions:
Now knowing all the components for my circuit, another step in my project is to research and experiment with soldering and then conduct a design solution test of the configuration of the components and how to wire them. All these components can be soldered to the WiPy 3.0 and the Solar LiPo Charger without any special techniques the main challenge will be fitting them in a 10mm high space.

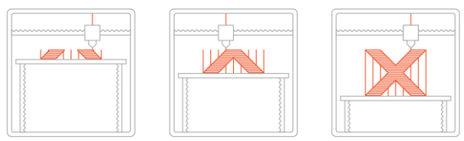
Documentation of Research & Experimentation – Tool & Material: 3D Printers

3D Printers – There are many different 3D printers all with different properties, each one bringing advantages and disadvantages of their own. These properties determine the quality of the print, speed of print, ability to print materials etc. all determining whether suitable for the purpose in my project.

3D Printing Process:

Every 3D printer builds parts based on the same main principle: a digital model is turned into a physical three-dimensional object by adding material a layer at a time. This where the alternative term Additive Manufacturing comes from. The process always begins with a digital 3D model - the blueprint of the physical object. This model is sliced by the printer's software into thin, 2-dimensional layers and then turned into a set of instructions in machine language (G-code) for the printer to execute.



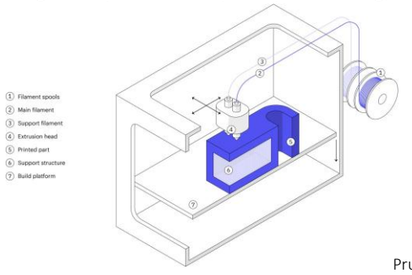


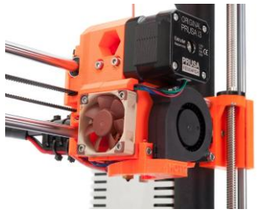
Types of 3D Printing:

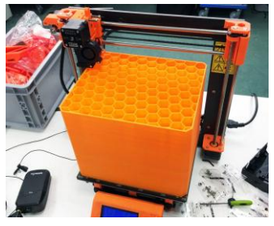
- **Material Extrusion:** Material is selectively dispensed through a nozzle or orifice (Most Common)
- **Vat Polymerization:** Liquid photopolymer in a vat is selectively cured by UV light
- **Powder Bed Fusion:** A high-energy source selectively fuses powder particles
- **Binder Jetting:** Liquid bonding agent selectively binds regions of a powder bed
- **Direct Energy Deposition:** A high-energy source fuses material as it is deposited

Material Extrusion:

My method of 3D printing will be Material Extrusion which is the most accessible and easy to use form of 3D printing. In FDM, a spool of filament is loaded into the printer and then fed to the extrusion head, which is equipped with a heated nozzle. Once the nozzle reaches the desired temperature, a motor drives the filament through it, melting it. The printer moves the extrusion head, laying down melted material at precise locations, where it cools and solidifies (like a very precise hot-glue gun). When a layer is finished, the build platform moves down, and the process repeats until the part is complete. After printing, the part is usually ready to use but it might require some post-processing, such as removal of the support structures or surface smoothing.

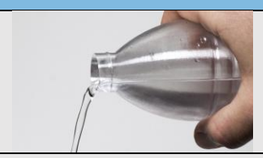






Prusa 3D Printer – Available at School

3D Printing Plastics – There are many different types of 3D printing Plastics but the 3 most compatible and suitable for my project are listed below. **They are ABS, PLA and PETG plastics**. There properties and technical details are all listed below;

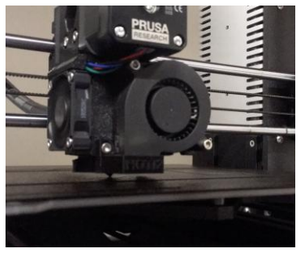
Market Search – Comparative Study: 3D Printing Plastics			
Picture			
Type	ABS	***PLA***	PETG
Price	$24.94/kg	***$24.94/kg***	$39.27/kg
Availability	High	***Low***	Low
Manufacturer	InkStation		HobbyKing
Strength	40 MPa	***65 MPa***	53 MPa
Stiffness			
Durability			
Printability			
Density	1.04g/cm^3	***1.24g/cm^3***	1.23g/cm^3
Extruder Temp.	220 – 250°C	***190 – 220°C***	230 – 250°C
Bed Temp.	95 – 110°C	***45 – 60°C***	75 – 90°C
Heated Bed Required	✓	✗	✓
Features	+ Impact Resistant + Heat Resistant	+ ***No heated bed required***	+ Water Resistant + Chemically Resistant + Fatigue Resistant

Experimentation –

Aim: To experiment with a Prusa 3D Printer & ABS plastic to deduce how to safely operate the tool & material.

Method/Process & Results:

1. Model & Slice print in Fusion 360 and Prusa Slicer.



2. Print in PLA Printing filament.

Results: Quality scale replica of the design.

Evaluation:
The 3D printer is an easy and viable way of modelling my design. The use 3D printers have in my project is that I can 3D print a scale model of my design and mould it in silicone. From there I can cast it in resin and have a very strong and durable product. The choice of 3D printing plastic will be PLA as it is high quality for its price. It also has a secondary feature that by using acetone (or other substances), it will smooth out the rougher parts of the 3D model. This way the cast of the model will be much cleaner and avoid much touching up in the post - cast process.

Application of Conclusions:
This will be the method of creating the primary model to cast with. Now the method of creating the primary model has been chosen, the process of moulding and casting can be researched and experimented with.

Documentation of Research & Experimentation – Tool: Drill Press

Drill Press – A drill press is a machine that spins a spindle where a drill bit can be attached. Via a turn wheel precise up and down movements can be made making vertical drilled holes. This is done with a high level of accuracy compared to a handheld drill and can work metals, woods and plastics.

Details:

- The chuck on the spinning spindle locks in a drill bit and rotates it at high RPM, which then can be moved very precisely with the turn wheel.
- The turn wheel acts as a fulcrum and adds a significantly higher amount of pressure at the drill bit as you are applying a force over a distance thus increasing the torque.
- Most Drill press will have a turn table which can rotate on its own centre axis as well as a secondary movement where it can rotate around the structural rod. With these 2 axes, just by clamping the piece down anywhere, any specific point can be reached.
- Eye protection is required when using the saw, as well as usual Workshop PPE (apron etc.). The device can get very loud, so ear protection Is recommended.

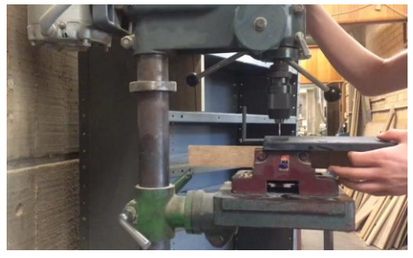
Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Contact, impact or entanglement from moving parts/ loose objects.	High	Remove any loose items of clothing and keep hands and hair away from the rotating spindle.

Experimentation –

Aim: To experiment with the drill press to deduce how to safely operate the tool with my materials.

Method: To use the machine, twisting the chuck and place the drill bit inside then tighten it. Clamp the piece down to the table and using the 2 axes find the drilling point and lock the tables. Turn the machine on and bring the turn wheel down slowly until the hole is complete.

1. Clamp the rod and drill bit in.



2. Rotate the handle until the hole is complete.

Results: Quick and accurate hole creation in mild steel rod.

Evaluation:
The drill press is a viable tool to use in the drilling of metal & resins and reduces time and increases accuracy compared to a hand drill. Experimentation gave operation techniques which will aid me in the production of the device.

Application of Conclusions:
I can use the drill press when drilling holes into the rod and also for the cylindrical section where the rod rotates in the base plate.

Documentation of Research & Experimentation – Tool: Metal Lathe

Metal Lathe – A metal lathe is a machine that locks in a piece of metal and rotates it at high RPM's. It lets cylindrical objects to be cut from rectangular or irregular stocks of metal as well as brings a viable working tool for round bar. It is useful when working with round stock as the roundness of the piece is conserved.

Details:

- The chuck on the spindle locks a piece in and rotates it on a settable speed. A Chuck key is used to open and close the chuck.
- It has a moveable slide on the axis of rotation which drill bits can sit and can drill out the centre of a piece. It has a turn wheel for very precise movements.
- For perpendicular cuts, there is an independent rail which can be pushed in out to create precise cuts. This has two turn wheels, one for moving bits perpendicular to the piece and one to move it parallel.
- Eye protection and dust mask are required when using the saw, as well as usual Workshop PPE (apron etc.). The device can get very loud, so ear protection Is recommended.

Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Contact, impact or entanglement from moving parts/ loose objects.	Medium	Remove any loose items of clothing and keep hands and hair away from the rotating spindle.

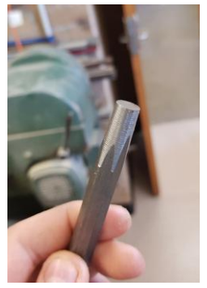
Experimentation –

Aim: To experiment with the metal lathe to deduce how to safely operate the tool with my materials.

Method: To use the machine, lock your piece into the chuck using the chuck key making sure it is centred. Set the speed dependant on the cut and the material and turn on the machine. Using a variety of drill bits turns, sandpaper etc. with the multiple turn wheels, to make the desired cut.

1. Clamp the rod into the machine with the chuck key

2. Measure and sand until desired finish is achieved.



Results: Quick and accurate sanding and machining of steel rod.

Evaluation:
The metal lathe is a viable tool to use in the sanding & polishing of metal rods and reduces time and increases quality compared to a hand sanding. Experimentation gave operation techniques which will aid me in the production of the device.

Application of Conclusions:
I can use the metal lathe when sanding & polishing the metal rod. The metal lathe allows the metal rod to keep its cylindrical shape while also become polished.

Documentation of Research & Experimentation – Tool: Cold Saw

Cold Saw – Cold saws are circular saws specifically designed for cutting metals. It uses a toothed blade to transfer the heat generated by cutting to the chips created by the saw blade, allowing both the blade and material to remain cool. It's different to an abrasive saw, which wears down the metal and generates a great deal of heat absorbed by the material and the saw blade.

Details:

- Powered circular-bladed drop saw, used to make accurate crosscuts and mitres in metal.
- Coolant is run along the blade to help transfer heat to the cutting chips.
- Cutting head is attached to the platform with a sliding rail to allow for wider pieces of metal to be cut. This allows wide flat bar and round stock to be cut.
- Cutting platform can be angled to cut mitres. Cutting head and vice can also be rotated to allow for compound mitres to be cut into the metal.
- The blades cutting depth can also be set on the cutting head.
- Eye protection is required when using the saw, as well as usual Workshop PPE (apron etc.). The device can get very loud, so ear protection Is recommended.

Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Spinning blade could cut the user.	High	Keep extremities and items of clothes away from the blade at all times while also wearing Safety goggles.

Experimentation –

Aim: To experiment with the Cold Saw to deduce how to safely operate the tool with my materials.

Method: To make a cut, the metal piece is placed inside the vice and the angles and depths checked. The cutting head is then pulled back and the blade turned on. Coolant will then run, and the cutting head can now be dropped. The cutting head is heavy, so little force is needed to cut the metal. Applying small amounts of pressure while letting gravity do the work is recommended. The blade then cuts through the piece and bringing the cutting head back up and stopping the machine will stop the coolant.

1. Clamp the piece in the vice.

2. Measure and cut to desired length

Results: Quick and accurate cutting of a metal rod.

Evaluation:
The cold saw is a viable tool to use in the cutting of metal rods and it reduces time and increases accuracy compared to a hand saw. Experimentation gave operation techniques which will aid me in the production of the device.

Application of Conclusions:
I can use the cold saw when cutting length of the rod and also for cutting 45° angles so I can connect two rods to create a 90° angle.

Documentation of Research & Experimentation – Tool: Taps & Dies

Taps & Dies – A tap takes a drilled hole and cuts threads so a bolt of the same thread can be screwed into it. A die does the opposite where it takes a size of round bar and cuts threads on the outside of it where it can be screwed into a similarly threaded hole.

Details:

- Handheld thread cutting devices both for creating bolts and threaded holes.
- Tap and die handles are used to increase the torque at the centre and make it easier to thread the hole or bar.

∅ Tap Handle

∅ Die Handle

∅ M4 Die

- When taps and dies cut, they remove small amounts of material, so they are designed so the cuts are pushed out the bottom.
- The use of cutting oils or grease can be applied to create smoother cuts and threads.

∅ M4 Tap

Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Slipping and cutting the user.	Medium	The user puts large amounts of pressure into the tool to operate it, so to minimise risks, keeping limbs out of the line of fire.

Experimentation –

Aim: To experiment with the taps & dies to deduce how to safely operate the tool with my materials.

Method: To create a thread, in the case of a tap, choose one which has is 1mm bigger than the hole it is tapping. For a die, choose one which is 1mm smaller that the bar it is threading. Apply lubricant to the device and rotate it on the metal until thread has caught. Make one full rotation and then rotate it back 90° to break the cut. This breaking is usually audible. Every 10 – 15 rotations completely unscrew it to clear out any residue. Continue this until the thread is completed.

1. Have a hole, 1mm smaller than your desired tap.

2. Tap the hole with a tap 1mm bigger than your hole.

Results: A tapped hole that a screw can be secured into.

Evaluation:
Using Taps & Dies are viable tools to use when threading metal and resin. It reduces time compared to buying brackets and drilling them in as well as aesthetics. Experimentation gave operation techniques which will aid me in the production of the device.

Application of Conclusions:
I will use them when attaching two pieces of rods at 90° as well as for locking the rod into the pres plate to keep the mechanism secure and durable.

Documentation of Research & Experimentation – Tool: Disk Sander

Disk Sander – Disk sanders are machines used for quickly removing large masses of material. They work by rotating a disk of sandpaper at high RPM's which when a material is pushed into it will rapidly remove the the material. It can be used for plastics, woods, metals etc.

Details:

- Powered sanding tool to remove mass amounts of material.
- The sanding disk is spun at high RPM's can then remove mass amounts of material quickly.
- Many different sanding disks can be used on the machine foe specific purposes.
- Low grit sandpaper for tough materials or large mass removal. Higher frit sandpaper for more intricate/polishing sanding jobs.
- Large flat metal surface to keep the material flat when sanding.
- Has a jig which can slide left to right which can be used as a barrier to keep the material straight when sanding.
- Eye protection in the form of safety goggles & dust protection in the form of a dust mask is required when using the saw, as well as usual Workshop PPE (apron etc.). The device can get very loud, so ear protection Is recommended.

Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Sanding your skin or a piece of clothing getting stuck.	High	Keep hands, limbs and any pieces of clothing away from the disk sander so they don't get caught or cut in the spinning disk.

Experimentation –

Aim: To experiment with the Disk sander to deduce how to safely operate the tool with my materials.

Method: To use the disk sander, place the material on the metal plate and lock the jig in position for your desired outcome. Slowly can carefully push the material into the rotating disk, moving too fast will burn the material. Keep fingers and items of clothing away from the devices spinning parts at all times.

1. Chose & mark out your desired space to disk sand.

2. Following the method, disk sand out the desired space.

Results: Crude but fast & controllable method of mass material removal.

Evaluation:
The disk sander is great tool when trying to remove mass amounts of material but when it comes to intricate sanding, hand sanding will need to be substituted to get desired finish. As seen in the results of the experimentation the sanding disk leaves deep vertical lines which will need to be sanded off with sandpaper.

Application of Conclusions:
Any post casting sanding that needs to be done can be done with the Disk sander with aid from normal hand sandpaper to create a nice finish.

Documentation of Research & Experimentation – Tool: Laser Cutter

Laser Cutter – A Laser cutter is a precision manufacturing tool that uses a high-powered laser to cut though material. It is fully automated & is controlled by a computer program where you can rasterise designs & cut them out on a sheet of material.

Details:

- Powered high precision CAM tool.
- Modular as can change laser intensity for different materials.
- In specific materials, the laser cutter can cut, etch out designs communicated by a controlling computer.
- Uses Adobe Illustrator, a CAD Software, to rasterise images and make them usable for the laser cutter.
- Common materials are Plywood, Acrylic, MDF, Sheet Metal, Cardboard, Veneer, Leather etc.
- The most common method of laser cutting is the Vaporisation Method. This is when the laser produced is so intense and concentrated the material instantly vaporises and is sucked away by fans under the

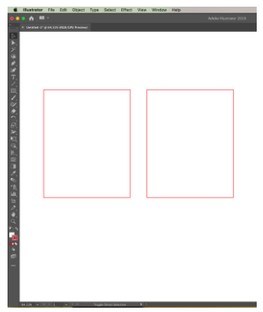
Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Inhalation of Toxic Fumes	Low	Always have the fans running when using the laser cutter so no fumes are released to you or harm the laser machine.

Experimentation –

Aim: To experiment with the Laser Cutter to deduce how to safely operate the tool with my materials.

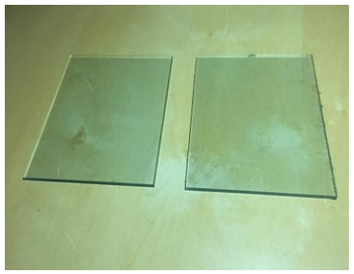
Method: Create the desired layout on Adobe Illustrator in RGB red which tells the laser cutter to cut out the design not etch it. Rasterise the image & print the design onto the laser cutter, selecting its positioning. For the material, Acrylic, set the laser cutter to its Acrylic setting and the thickness which is 2.5mm. Turn on the fans and laser cut the design.

1. Chose acrylic sheet and set the specific cutting settings.



2. Rasterise the design in RGB red on Illustrator.

3. Send the design to the laser cutter and start the cut.



Results: Highly accurate replica of the CAD design, cut out from acrylic.

Evaluation:
The laser cutter is a great choice of tool for creating the solar panel cover as it is very accurate, and I will be able to laser cut it to the exact dimensions of the solar panel ensuring a perfect fit. It also avoids any scratch marks from cutting by hand/sanding.

Application of Conclusions:
During realisation, the laser cutter will be used to create the solar panel cover and any other etching/cutting of materials that could be needed. Etching a logo is an example of this.

Documentation of Research & Experimentation – Technique: Casting Process

Casting Silicone and Resin – There are many different ways to cast an item, they are all dependant on the detail in your design and the resin/silicone you are using. The main two methods of Silicone and Resin casting is moulding your primary in either a one-part or a two-part mould.

Casting Silicone:

1. One Part Mould

One-part moulds are used when there is a flat face on your primary which can be stuck to a surface. They are made by;

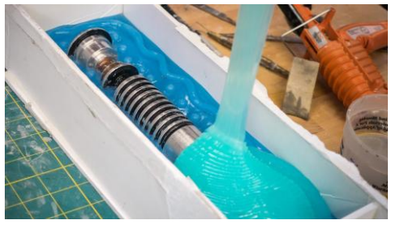
1. Stick an object to a plate of foam core or acrylic.
2. Create a sealed box around it with acrylic or foam core and hot glue.
3. Pour silicon into the box making sure the whole object is covered.
4. After the silicone is cured, the primary can be pushed out from the open face and the mould can be casted with.

One-Part Mould

2. Two Part Mould

Two-part moulds are used when there is no free face that can be stuck to a Surface and are more complicated with more detail. They are made by;

1. Covering the bottom half of an object in clay.
2. Construct a sealed box around this clay using foam core or acrylic.
3. Pour silicon onto the top half of the mould and wait till it cures.
4. Remove the all the clay and apply spray release or talcum powder.
5. Pour silicone into the bottom half and wait till it cures.
6. Separate the halves and cut a pouring spout in a high location.
7. Places rigid sheets usually foam core or acrylic, around the mould.
8. Place rubber bands or tape around the mould making a tight seal.
9. The resin can then be poured, and all air bubbles can rise to the top.



Two-Part Mould

Casting Resin –

Casting resin is as easy as mixing the Part A resin and the Part B hardener together with any pigments and pouring it into a mould. This mixing and pouring stage have to be down in the designated Pot Life, which is the time the resin will have a low viscosity and still be poured. To aid the resin to release from the mould after curing, a spray release or light application of talcum powder should be put into the mould.

Air Bubbles:

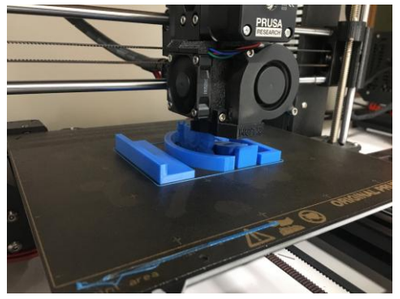
Air bubbles are the biggest issue faced when casting an object in resin & silicone. There are many techniques which can be used so that bubbles are minimised. Some of these are;

1. Mixing the resin/silicone slow and carefully.
2. Heating your resin/silicone before mixing.
3. Pouring your resin/silicone from a large height.
4. Roll the resin/silicone around in your mould.
5. Using a Vacuum Chamber. (Most Effective)
6. Using a Pressure Pot. (Most Effective)

Casting Process Experimentation –

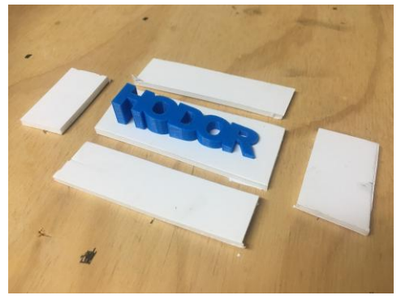
Aim: To experiment with the drill press to deduce how to safely operate the tool with my materials.

Method/Process & Results:



1. 3D Print the design.

2. Sand the design to remove grain.



3. Cut 5 faces out of foam core.

4. Build a watertight moulding box around the model.

5. Mix the correct volume of silicone.

6. Pour the silicone onto the design and into the moulding box.

7. Mix the correct volume of resin and pigment

8. Pour the resin into the silicone mould

Results: Very detailed replica of the model in strong black urethane resin.

Evaluation:

A one-part mould is the best for my project as my model is relatively simple & I can stick the bottom flat surface of my device and pour silicone around that. I do not have access to a Pressure Pot or Vacuum Chamber so other Air bubble removal techniques will need to be used. Using foam core as the material for the box construction keeps everything cheap and easy as foam core is easy to outsource. Through experimentation, it was found the process of moulding in silicone and casting in resin is an easy viable process.

Application of Conclusions:

I can use this process in the production of the main components of my design. I can use this process in making the base plate and press plate for my design. It will make it fast and accurate reducing production time and increasing accuracy & quality of the end result.

Documentation of Research & Experimentation – Technique: Soldering

Soldering – Soldering is the process of attaching two electrically conductible items together with the aim to create a viable circuit. A tool called a soldering iron melts a specific material called solder. Solder has a low melting point and is a good conductor.

Details:

- A soldering iron is a handheld powered device that heats a metal prong to temperatures of up to 350°C.
- This melts a substance called Solder which can then be applied to circuitry to permanently connect to electronic parts.
- A lead-free Solder is typically made up from an alloy of tin and copper. It has a layer of flux to stop the alloy oxidising when is melted.
- The soldering iron can get very hot so wearing Gloves is a smart idea. When melted, the flux layer burns off and these fumes are harmful so always solder in a well-ventilated environment. This can be aided by wearing safety glasses and respirator.

∅ Soldering Iron

∅ Solder Spool

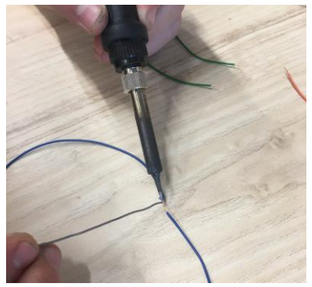
Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Burns to the skin	High	Making sure hands and clothes are all clear of the iron during the operation of the tool.

Experimentation –

Aim: To experiment the process of soldering to deduce how to safely operate the tool, material & technique.

Method: To solder something, plug in the soldering iron and wait until it is a viable temperature. To test if it is at temperature, place a small piece of solder on the tip and see if it nearly instantly melts. When at temperature, melt a small amount of solder on the iron and place it one each end of the connecting pieces. Then place the pieces together and melt the solder so they fuse.

1. Cut & strip wires so there is even exposed copper wiring.



2. Place the wires together and melt solder directly onto the desired ends.

Results: Electrically sound connection between both the wires.

Evaluation:
Soldering is a great technique in connecting circuits together which has better connection that butt connectors or crimping. It is fast and can be done to all my chosen electrical components.

Application of Conclusions:
After research & experimenting with soldering, I now have a viable way to conduct a design solution into how to design my circuitry.

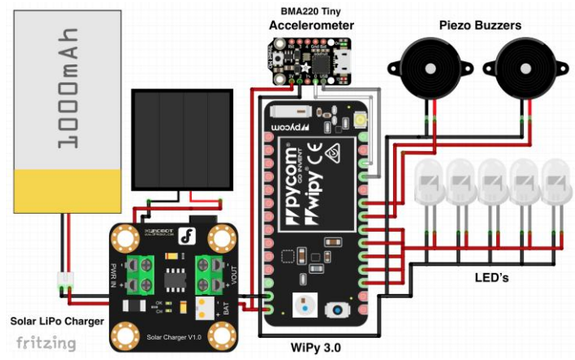
Documentation of Design Solution – Circuitry

Circuitry – In my design there are 7 components, the WiPy 3.0, Solar LiPo Charger, 1100mAh LiPo Battery, Piezo Buzzer, White LED's, BMA220 (Tiny) Accelerometer and a 1W Solar Panel. The layout and configuration of the electronics needs to be identified. A soldering board will be used to make the insertion of the electronics into my design easy used but for the sake of convenience I will use a bread board to experiment.

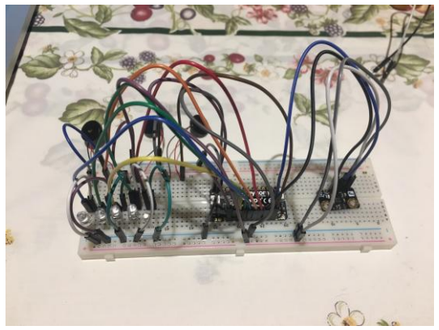
Risk Assessment		
Possible Risk	**Severity**	**Prevention Plan**
Electrocution	Medium	Wearing gloves and making sure the components are grounded at all times.

Aim: To deduce how to configure and wire my circuit of electronics for their best operation.

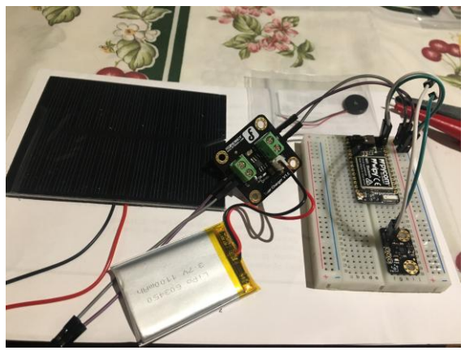
Method: Plug all the components into the breadboard using Male – Male jumper wires in a configuration which allows for the circuit to operate correctly and efficiently.



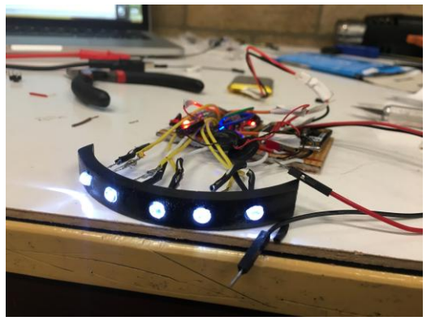
1. Decide the layout of the electronics in Fritzing, an online circuit designing program.



3. Plug in all secondary components and test if they operate correctly.



2. Plug in all the main power input components and test if they operate correctly.



Results: The circuit working & a successful dry fitting of the electronic components on the soldering board.

Evaluation:
The way I set out my electronics in the experiment is the way I will solder my electronics for the production of the device. This showed that the electrical flow and current draw for all the electronics is sound and all my components are rated correctly.

Application of Conclusions:
During the production stage, all I need to do is solder the components together as the layout fo the circuit has already been decided.

Documentation of Design Solutions

90° Angle Rod – The rod is at a 90° so it can rotate in and out of the snow without any interference with the boot or binding. The way of creating this rod needs to be tested to ensure the best method is chosen.

Aim: To deduce the best way to create the 90° angle in the rod.

Method: First, Heat & Bend a select piece of rod until it reaches a 90° angle. Second, cut 2 pieces of rod with 45° ends. Drill, tap & Screw them securely together.

1. Bending Method

2. Screw Method

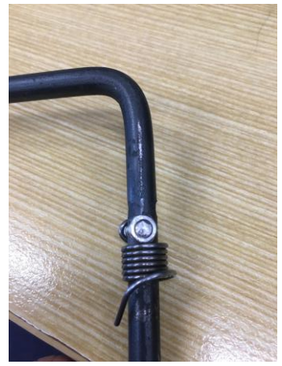
Evaluation:
The screw method while is weaker than the bending method is more aesthetic as I will be able to get it at a perfect 90° angle.

Torsion Spring – The driving force of the rotating rod in created by a torsion spring, a spring that creates resistance torque during independent rotation. How this is attached to the rod and to the base plate needs to be tested to ensure it operates correctly.

Aim: To experiment how to successfully attach the torsion spring so the device operates.

Method: On a prototype, test the attachment of the spring to the base plate, as well as to the rod.

1. Attachment to the base plate with a small cavity.



2. Locking the spring around the rod by drilling a hole and clamping the spring tight with a bolt and nut.

Evaluation:
This will be the way I put the torsion spring in the device as it is easy to replicate and is very powerful when the rod is rotated a few times.

Attachment – The most common snowboard binding attachment type is the 4x4 method. To attach my device, it will need to utilise the 4x4 screws so it can be securely attached to the snowboard binding.

Aim: To deduce a method of securely attaching the device to the snowboard using the 4x4 screw binding method.

Method: On a prototype, test the attachment of the base plate to the binding via drilling holes for the screws and experimenting.

1. The 4x4 screw binding attachment method.

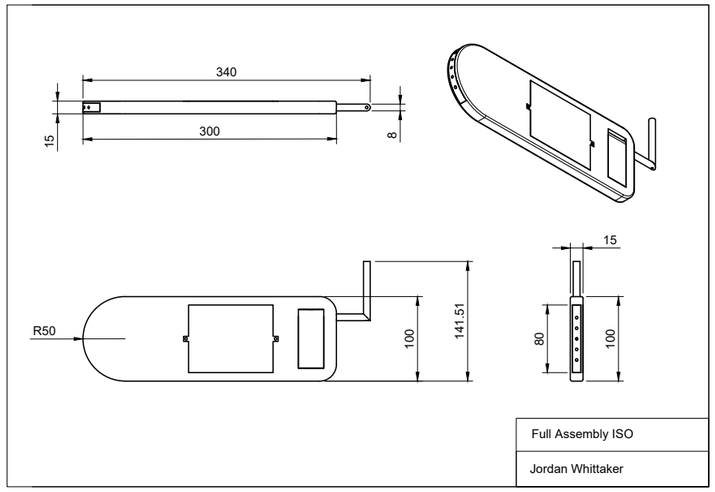
2. Drilling 4 holes to attach to the snowboard binding.

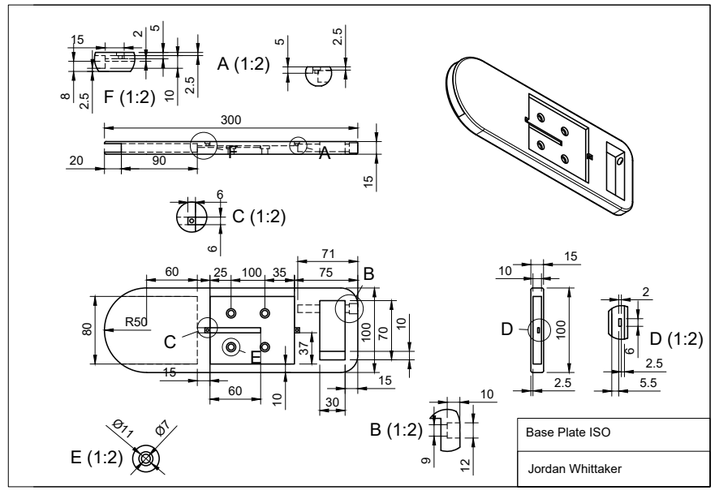
3. Attaching the device to the snowboard with the 4 screws.

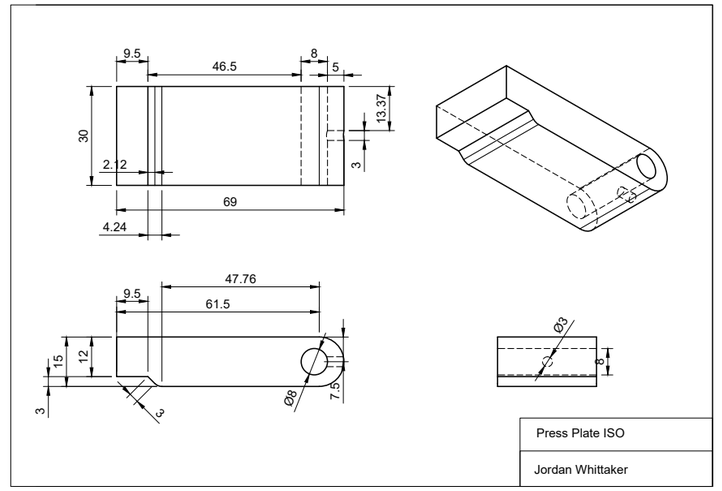
Evaluation:
This will be the way I will attach the device to the board as I can hide the screws underneath the solar panel for aesthetics.

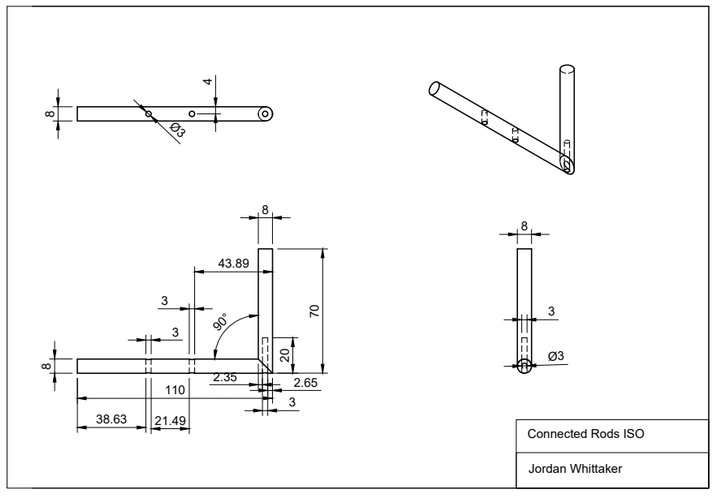
Application of Conclusions:
Now all my problems are solved, I can now move to realisation.

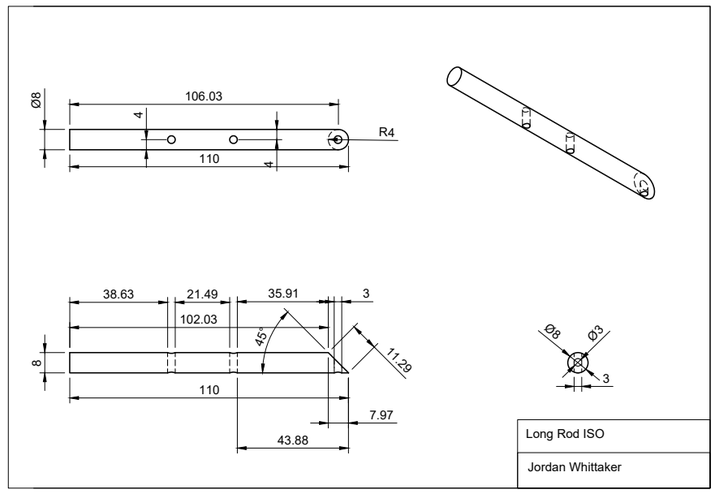
Final Workshop Drawings

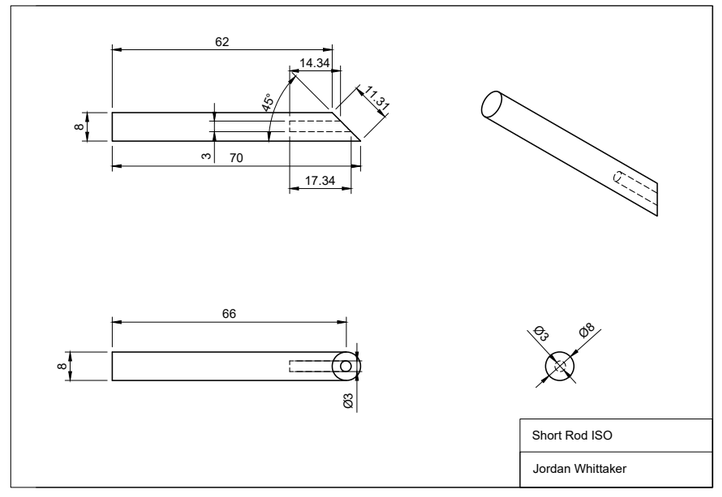


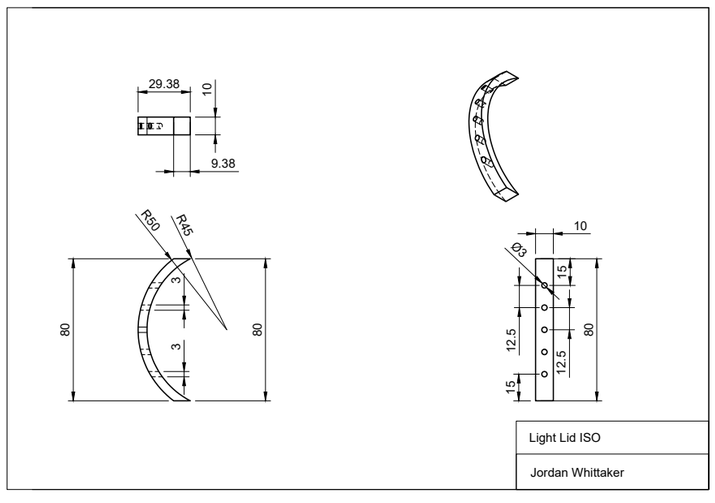


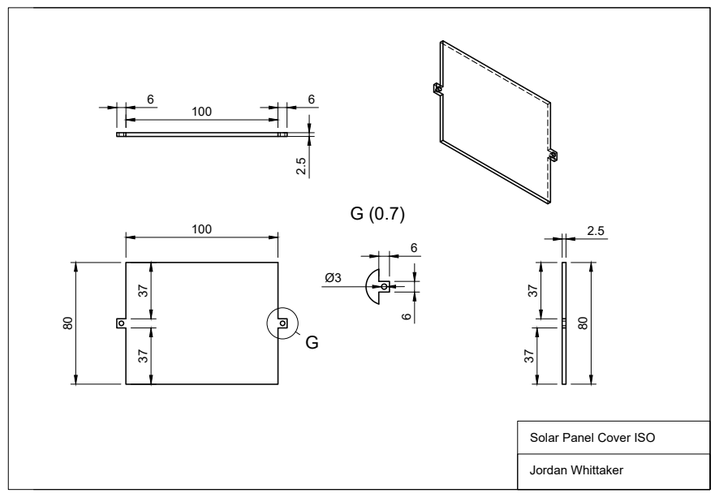


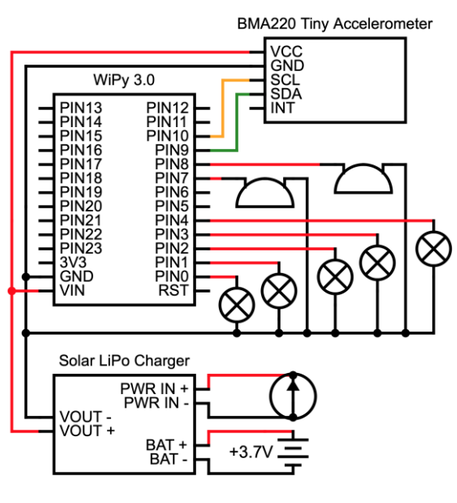








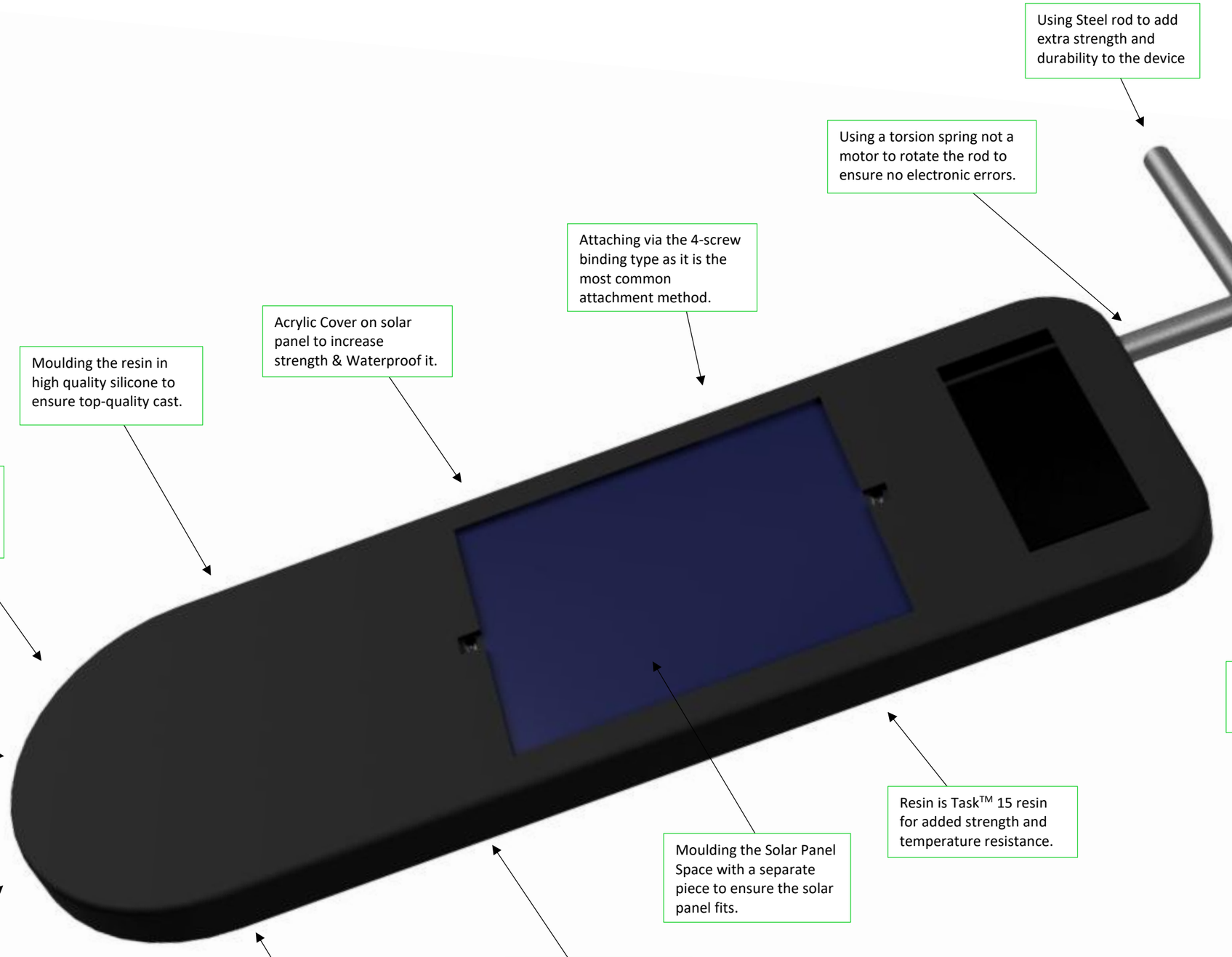




Identification and Justification of Ideas and Resources Used

Resource	Contribution	Justification
People		
Mr. Scrivener	Offered knowledge and insight on actually realising the product in the workshop	He has worked in the industry for many years and is my DT teacher
Mr. Comben	Helped me with the coding of my electronics and access to helpful documentation.	He is a robotics and software teacher at SBHS with years of expert knowledge coding python
Tracy Whittaker	Aided me in the areas of Soldering, Circuitry and Coding & Gave access to high quality printing and a way to bind my portfolio for free.	She is an electrical engineer and has had many years of experience with electronics. Printing and binding the portfolio in any other place would have costed $55
Ben Kernohan	Aided me with the completion of my circuitry.	A student at SBHS who is an international robotics champion with years of experience.
Eric Holmstrom	Helped me with the coding of my electronics and access to helpful software.	A past Design & Technology student who specialised in creating systems.
Timmy Huang	Helped me with the coding of my electronics and access to helpful documentation.	A student at SBHS with expert knowledge in coding micropython.
Materials		
Task™ 15 Urethane Resin	The main material to construct my product, the base plate and the press plate.	It is the best high strength urethane resin that was available to me as it has high tensile strength, low elongation @ break and a high Shore D hardness.
Mold Star™ 16 FAST Casting Silicone	The material that was used in moulding the 3D prints and casting with the urethane resin.	It had great detail retention and a short Cure time making it a quality resin that can be used efficiently.
Mild Steel	To create the rod that rotates into the snow.	It is strong but lighter than stainless steel while being cheap and very available.
Single Torsion Spring	To power the rod mechanism.	It is compact and powerful and at very low price.
WiPy 3.0	The microcontroller, controlling all the electronic components & connecting it to the internet.	Has the most features with WiFI, Bluetooth, a range of 1Km all being at a moderate price.
BMA220 Tiny Accelerometer	Used to detect movement on the device.	It is the smallest and cheapest, perfect for my small form factor.
Solar LiPo Charger	To convert variable solar panel inputs to a regular 3.7v output.	It is the cheapest and without the headers is the smallest board.
1000 mAh Battery	To store charge when the solar panel is not in use.	It has a good capacity to physical size ratio and can operate at low temperatures.
Piezo Buzzer	Used to deter thieves from taking a snowboard.	Has a good ratio of sound volume to size and can operate on low input power.
1W Seeed Studio Solar Panel	Used to power the electronic components when on the slopes.	Is small in size which can easily fit on my design and has decent power outputs.
Tools		
3D Printer	Used to create the Primary model of my design to mould and cast with.	Is a faster and more accurate method compared to creating the design by hand from wood or plastics.
Drill Press	To drill holes in the rod to connect them at a 90° angle and to the base.	It is fast and significantly more accurate than using a handheld power drill.
Metal Lathe	To polish the rods and apply the coating of Rust proof paint.	Allows the rod to be sanded and polished while keeping its cylindrical shape.
Cold Saw	To cut the Rods into their correct lengths and at a 45° angle.	Cuts metal fast and replaces hacksaws which would have taken significantly more time.
Taps & Dies	To thread the holes drilled in the rods to connect them.	Allows for the bolts to be screwed in instead of just cemented which adds significant strength to the rod.
Soldering Iron	To electrically connect all the circuitry together.	Prevents the use of jumper wires which can disconnect easily and ruin the circuit.
Laser Cutter	To cut out the Acrylic Solar Panel cover.	They are extremely accurate and won't make any scratch marks which cutting acrylic by hand does.
Disk Sander	To curve the edges of the device.	Removes material rapidly and can be controlled to create the curved ends of the base plate.
Software		
Fusion 360	To create the CAD models of my design	Simple and accurate CAD Software compared to Inventor or AutoCAD.
Prusa Slicer	To slice the CAD models so they can be 3D Printed	It is the default software used for the specific 3D printer I used, the Prusa MKIII.
iMovie	To create the HSC MDP Video	Simple and easy to use software that I can do straight from my home computer.
Adobe Photoshop	To create the HSC MDP Video	Allows editing frame by frame and more intricate details to be added.
Microsoft Word	To create the HSC MDP Portfolio	Simple and easy to use software compared to InDesign, etc.
Illustrator	To communicate a design with the laser cutter	It is the default software to communicate with laser cutters.
Fritzing	To create a visual circuit diagram	It allows for the components to be shown not just their schematic.
Circuit Diagram	To create a schematic for the circuit	It is a professional and free schematic builder.
Ideas		
Braking System	Is the main function of the device which is used to stop runaway snowboards.	The idea was inspired from the existing product, the ski brake which uses a similar braking system to stop runaway skis. The idea is a spring powered lever mechanism that works automatically without the dependency on any electronics or the user.
Placed Under the boot in the Binding	The brake is attached to the board to the binding and to operate the device you step into the binding and it operates.	The idea was inspired from the existing product, the ski brake which uses a similar braking system to stop runaway skis. It is an effective idea as the user doesn't need to do anything differently compared to not using the device as all the user does is strap in normally.
Alarm System	Using an accelerometer and Buzzers, the device can be locked and when moved will sound an alarm and notify the boards owner.	Creating a physical lock for a snowboard is difficult as there are limited places to lock the device to. The next best thief prevention method is to scare the thief away with alarm noises.
Lighting System	Using multiple LED's which can be toggled to increase visibility of yourself to others which prevents collisions in low visibility.	Justifies the name of the device, 'Beyond', as not only does it stop runaway snowboards, but it has a lighting system as well as the Alarm System.

Application of Conclusions



Using Steel rod to add extra strength and durability to the device

Using a torsion spring not a motor to rotate the rod to ensure no electronic errors.

Screwing Method of rod construction to reduce drag and improve aesthetics.

Attaching via the 4-screw binding type as it is the most common attachment method.

Acrylic Cover on solar panel to increase strength & Waterproof it.

Moulding the resin in high quality silicone to ensure top-quality cast.

Pouring the resin and silicone from a great height to ensure no air bubbles are trapped in the mould.

Rust Proof paint coating to stop the steel from corroding

Single Prong design to increase strength and durability of the device.

Implemented Lights to create a safe environment to snowboard at night.

Resin is Task™ 15 resin for added strength and temperature resistance.

Moulding the Solar Panel Space with a separate piece to ensure the solar panel fits.

Implemented Accelerometer and Buzzers to prevent theft.

Simplistic Design so aesthetics doesn't deter people from using it.

Black Coloured resin so it can integrate into any snowboard.

Production Plan

#	Action
a.	**3D Printing**
1	Model my design in Fusion 360.
2	Separate the Base Plate, Press Plate & Light Lid to 3D print
3	Slice the CAD files in Prusa Slicer.
4	3D Print the Model, the base plate, press plate & light lid.
5	Sand the surfaces of the 3D prints until there is minimal printing texture.
b.	**Moulding**
6	Stick the model down to a flat piece of foam core.
7	Build a watertight box around the model with foam core and hot glue.
8	Calculate and mix the correct volume of Silicone for the moulding box.
9	Pour the silicone into the mould from a large height.
10	Move the moulding box around to ensure no air bubbles are trapped.
11	Wait 4 hours until the silicone has fully cured to demould.
12	Demould the 3D prints and clean the mould.
13	Trim any flashing that occurred.
c.	**Casting**
14	Cover the inside of the mould in Talcum powder.
15	Empty all the excess Talcum powder using compressed air.
16	Calculate and mix correct volume of Resin and pigment.
17	Pour the Resin into the mould from a great height.
18	Move the moulding box around to ensure no air bubbles are trapped.
19	Wait 2 hours so the resin is fully cured and demould.
d.	**Rod Construction**
20	Cut lengths of 8mm Rod on the Robo Saw, 110mm & 75mm.
21	File off any burs and clean the surfaces.
22	Cut a 45° angle on one end of each of the rods.
23	Again, file off any burs and clean the surfaces.
24	Clamp the rods together on their 45° ends creating a 90° angle.
25	Drill a 3mm Ø hole 25mm into the clamped rods.
26	Tap the drilled hole with an M4 tap aided with grease.
27	Drill a 3mm Ø hole 25mm & 45mm down the 110mm rod at a 90° angle.
28	Tap both these holes with an M4 tap
29	On a metal lathe, sand the rods down with fine grit sandpaper.
30	Apply 2 coatings of rust proof paint.
31	Sand the paint down to a uniform shape.
32	Use a 25mm M4 Bolt and thread locker to connect the two rods together.
33	Cut off the bolt head with a hacksaw and sand flush.
34	Screw a 4mm M4 bolt into the hole 25mm down the rod.
35	Finish by dry fitting the assembled rod in an 8.5mm Ø hole.

#	Action
e.	**Base Construction**
36	Drill 9mm Ø hole into the Base Plate to house the rod.
37	Drill an 8mm Ø hole into the Press Plate to hold the rod.
38	Drill a 12mm Ø hole into the Base Plate to house the spring.
39	Drill a 3mm Ø hole into the Press Plate to connect to the rod.
40	Tap this hole with an M4 tap.
41	Drill a channel for the Solar Panel Wires.
42	Sand all surfaces down to a 1200 grit sandpaper.
43	Use a polishing compound to create a Gloss Finish
f.	**Electronics**
44	Solder down the WiPy 3.0 Chip in the middle of a Solder board.
45	Connect the Piezo Buzzers to the PWM Ports of the WiPy 3.0.
46	Solder down the Accelerometer and connect it to the I2C Ports of the WiPy 3.0 Chip.
47	Solder separately in series 5 white LED's & super glue them into the light lid.
48	Connect the LED circuit to any digital output Ports of the WiPy 3.0 Chip.
49	Remove the Green Vertical Connectors of Solar LiPo Charger.
50	Solder wires to the Power in of the Solar LiPo Charger.
51	Solder wires to the Power out and then solder the other ends to the Power in of the WiPy 3.0 Chip.
52	Connect the battery to the Solar LiPo Charger.
g.	**Assembly**
53	Push the Rod through the Press Plate and the Base Plate.
54	Line up the hole in the Press Plate with the one 45mm down the Rod and use an 8mm M4 Bolt and thread locker to connect them together.
55	Slide the spring in the top of the rod.
56	Anchor one end to the base plate, and the other to the bolt.
57	Screw the solar panel into position pushing the wires through the cut channel into the electronics section.
58	Connect the Power in wires of the solar LiPo Charger to the wires of the Solar Panel.
59	Place the fully connected solder board into the electronics section and screw/glue it securely to the walls.
Finished!	

Evidence of practical skills seen in HSC MDP Design & Technology Video.

Analysis and Evaluation of Function, Aesthetics and Other Relevant Factors

Function

Criteria	Achieved?	Evaluation
Stops runaway snowboards	5/5	The device can successfully stop a runaway snowboard on multiple inclines of snow slopes. This was done by testing the feature out at the snow and filming it in the process. The device not just stops the board by friction but successfully turns the board perpendicular to the slope, slowing the board in the direction of its propagation. Some improvements could have been making the spring more powerful so that it would be able to stop boards at on steeper inclines.
Low visibility Snowboarding	4/5	The lighting system works fine and when in the dark the user becomes significantly more visible than without at night. It can be toggled on and off with your phone making it easy to use. Problems with the design of the system is that it runs off the IO ports from the WiPy instead off the direct current from the battery. This resulted in a lower brightness of the lights and slightly lowers the effectiveness of the system mostly in white outs.
Thief Deterrent	4/5	The Alarm system works fine and when the locked device is moved, the alarms trigger and a notification is sent to your phone. The device can be locked and unlocked from your phone successfully and has a large range. Problems with this design is that the buzzers were located inside the device which lowered the noise level slightly. The buzzers were also very small which again lowered the noise levels of the device. For the purpose of deterring a thief who is presumably very close the alarms are loud enough to deter.

Safety

Criteria	Achieved?	Evaluation
Doesn’t interfere with surroundings	5/5	The device interfered with the environment very minimally. The rod interfering with the environment was factored into the design, but it was not expected to perform as well as it did. The rod is placed parallel and raised above the snowboards edge which allows the snowboarder to successfully manoeuvrer tight turns and the device not interfere. Evidence of this is seen in the MDP Video where go pro footage of the devices interaction with the snow is found.
Ability to Snowboard normally	5/5	The device again surprisingly didn’t affect the ability for the user to snowboard properly at all. It didn’t stop the ability to make tight turns or perform stops. The added height to one foot doesn’t make it dangerous for a user to snowboard.
No sharp protruding parts	4/5	The overall design of the brake has no protruding parts apart from the rotating rod. The edges of this rod are not sharp, but the 90° angle and the bolt head protruding can cause damage if fell on. The fact that it sticks out the back of the snowboard means that it can catch obstacles like ropes and trees. The design of the rod was to have the least amount of protrusion without the rod interfering with the environment. While testing the product, it did not catch on anything but through an inherent design flaw it always needs to be considered.

Aesthetics

Criteria	Achieved?	Evaluation
Low key	5/5	The device was designed to be unnoticeable when in use. The placement of the device under the foot made it hard to see paired with the colouration of the device being black. During the testing of the device, no person noticed the device was on and I confirmed this by asking witnesses around me.
Integrated	4/5	The device was well integrated into the snowboard binding with little protrusion of the device. The only aesthetic problem is that the rod sticking out the back was not integrated into the binding and could be noticed. An improvement could be to design the brake in the binding, combing them and further reduce the adverse effects that aesthetics has on the purchase of the device.

Ergonomics

Criteria	Achieved?	Evaluation
Comfortable to ride	5/5	The device is placed under the foot which raises one leg by 15mm. This was a concern during the testing stage of my product but through testing it became clear that the 15mm of extra height made no difference to the comfortability of a snowboarder. It doesn’t create a lopsided feel and make you feel off balance.
Easy to use	5/5	The device is very easy to use as it is an automatic device that works without any manual assistance. All the ser needs to do is strap in normally and the brake functions. The rest of the functions, the Lighting System and the Alarm system are easy to use through the internet and function well.
Light & Portable	4/5	The device is relatively light and portable, but its design has some setbacks. The protruding rod does catch on objects when trying to store the product or transport it. The rod I made from mild steel which is a heavy substance making the device heavier than it could be. Improvements for this could be creating a pouch where the device could be stored for transport and researching into lighter material methods for the rod.

Durability/Quality

Criteria	Achieved?	Evaluation
Can withstand weight of a human	4/5	The device can successfully withstand a human’s weight but because of the cavity, if there is more weight that myself, 70kg, the cavity starts to bulge a little bit. A significant increase in weight could cause damage to the electronics inside.
Operate in sub zero temps	5/5	All the electronics were chosen for their ability to operate in low temperatures and when testing the electronics in cold environments they all operated successfully.
Can withstand collisions	4/5	The device is good at absorbing the pressures from collisions and hitting obstacles. It is made from a high strength urethane resin and its design ensures no plastic parts which are vulnerable to breakage. The resin slightly deformed when hitting a hard surface but didn’t fracture and was successfully durable.

Impacts on the Individual, Society & Environment

Individual Impacts			
Positives	Negatives	Evaluation	Recommendations
+ Increased piece of mind for an individual as the risk of a snowboard running away down the slope will be significantly decreased. + The user can leave the board unattended knowing that it won't runaway down the slope or be taken without the knowledge of the individual. + The user can snowboard in low light environments with minimal risk of having someone collide into them. + A decreased chance for a snowboarder to lose their unattended snowboard. + Less chance that an individual will be hit by a runaway snowboard.	– The device increases the chance of a user getting caught on obstacles when they are snowboarding. – The device raises one leg of the snowboarder up 15mm, which can create a lopsided feeling when snowboarding. – The device can be uncomfortable as the bindings will have to be tighter for the user as they need to go around the device as well as the boot. – Makes snowboarding a more expensive activity if an individual wish to be safe.	The device creates an overall ***positive*** impact on the individual. The device allows for a safer snowboarding experience allowing the user to be more laid back when snowboarding as well as when their snowboard is unattended. It does negatively affect the snowboarding experience by the device's physical size, but these negative impacts do not outweigh the positive impacts that the devices features bring.	To create a more comfortable snowboarding experience when using the device, it could be ***made thinner***, so it doesn't detract from the way a user snowboard. It could also be ***integrated into a snowboard binding*** and not be 2 separate devices (seen in the Ski Brake) so a user doesn't have to attach the brake themselves.

Social Impacts			
Positives	Negatives	Evaluation	Recommendations
+ Less people in the Snowsport community will be hurt/endangered by runaway snowboards. + Less thieving will occur on the snow slopes as the device brings an active thief deterrent. + Brings an Increase of people who will participate in Snow Sports because of the safer environment. + Less ridicule of snowboards on basis of safety increasing number of snowboarders on the slopes. + Increase in younger kids snowboarding as there is less chance a snowboard can be dropped by a child and endanger someone. + From the increase in people, an economic boost for local Snowsport businesses and food venues.	– Creates a more expensive safety standard which will deter people to go to the snow on a monetary basis. – Snow slopes may become overcrowded due to the increase in activity.	The device creates an overall ***highly positive*** impact on society. The device creates a better environment for people to participate in Snows Sports. It makes it safer and with less crime bringing people and families to come to the snow. This boosts local economy which encourages higher quality and more available ski lifts & attire. There are negative social impacts, but they are minor and don't out way the positive impacts.	In industry, the device could be made cheaper by mass producing it and using ***cheaper*** materials. This would avoid any monetary deterrence from using the product.

Environmental Impacts			
Positives	Negatives	Evaluation	Recommendations
+ Reduces the number of snowboards being lost into the environment. + Reduces the amount of plastic that is being used in reproducing lost snowboards. + Less wildlife and plant life being ruined by runaway snowboards. + Using a solar panel to power the electronics reducing the amount of non – renewable energy used.	– The product is made from plastic which when is put into landfill does not biodegrade very well. – From an increase in people going to the snow brings an increase of waste being produced and being littered in the environment. – Electronic components made from non-renewable metals. – The production of the product creates wasted silicone moulds.	The device creates an overall ***neutral*** impact on the environment. The device has some positive impacts on the environment mostly stopping the wastage of plastics from lost snowboards but itself is produced from plastics. Among other outlined impacts the product is in a state of environmental equilibrium where it has minimal positive or negative effects.	The product could made from more renewable & more durable materials for example with biodegradable and reusable resins as well as using remouldable silicone. The circuitry can be made into a ***custom circuit*** comparatively to the individual chips used to reduce material usage as well as durability. With an increase durability brings a ***longer lifespan*** decreasing the amount of plastic that goes into the environment.

LCA (Life Cycle Analysis)

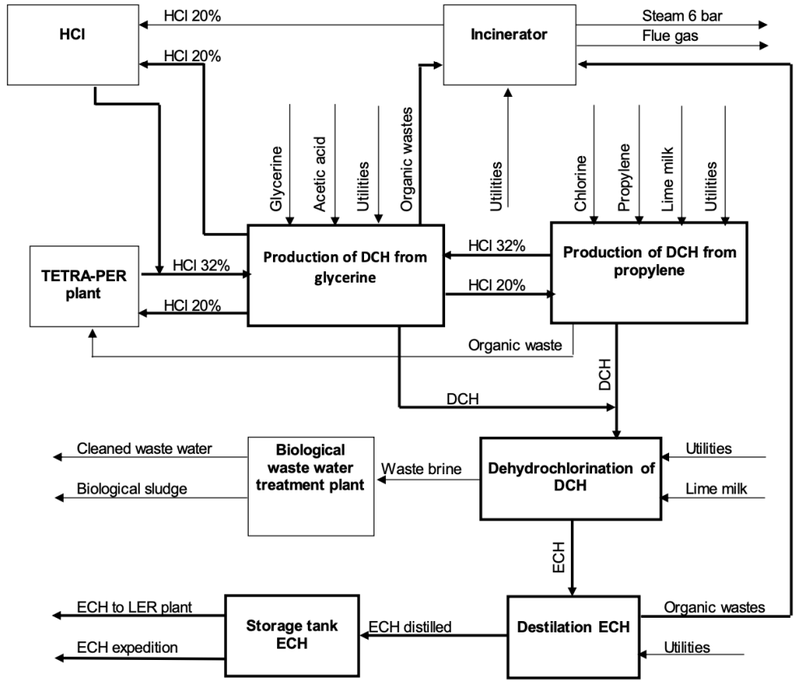


Fig. 1: Schema of epichlorohydrin production

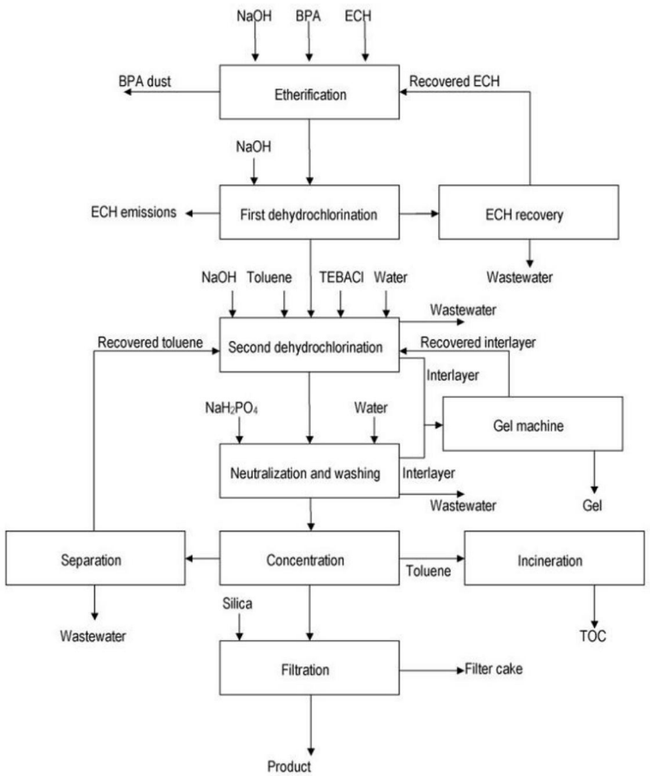


Fig. 2: Schema of liquid epoxy resin production

Ethical Aspects of my MDP

Ethical designing is associated with the responsibilities and duties of a designer in relation to practices and processes throughout the design process. This often involves following the Code of Ethics of design to ensure that the integrity of the occupation is not tarnished.

Ethical Concern	How this was addressed?
Privacy with Surveys	I made sure that all of my online surveys were anonymous. This is to ensure honesty but also for people who took the survey a layer of protection. This worked extremely well as the results I received were both authentic and helpful. I also made sure that all of the people I interviewed & surveyed knew that their research was going to be used. Any of other information that was utilized I made sure to promote the individuals that did the research and have their site/s linked for further investigations.
Safety	Manufacturing my design involved machines and materials that are dangerous When using them certain items of PPE were important to wear so no injury was inflicted on myself. To combat me breathing any harmful chemicals when either casting or sanding I made sure to wear a safety mask and safety goggles. I made sure to read the Material Safety Data Sheets (MSDS) and understand the Safe Operating Procedures (SOP's) that the different types of machines have. This meant conducting risk assessment for every test I did to ensure my safety.
Environmentally Friendly Manufacturing processes and Material Selection	Most of the production of the design's uses machinery which uses energy to power them. I had to compromise between saving power and making sure that I was actually using my equipment properly. For the most part I was successful with this, with only a couple of incidents were I had to redo some work which meant that electricity used had to be reused again. The material selection was key for my product and as mention before making sure that the material was biodegradable was important part of the selection of the design.
Sourcing Websites, Magazines and other mediums	While doing research, it was critical I kept a log on where I got the information from and sourced them respectively. This was done by either citing the links used or giving the selective person the praise that they deserved. In doing this I was able to protect the intellectual rights of all of the sources used which is something that is not only important for a future designer who might want to know how to make the product but it allows for the people who actually did the work behind the research exposure.
Maintaining the Integrity of the Design Occupation	Throughout my designing process of the Beyond Snowboard Brake, I've placed the needs of the market before my own profitable gains. My primary focus of this design was to improve the quality of snowboarding for individuals and to counter safety issues with snowboarding. I have followed these ideals throughout the entirety of my project and produced a result of which is suited towards my market. Professionalism in my experience with design is also seen with critical evaluation of ideas/processes and collaboration with expert opinions to ensure I achieve the best possible outcome to satisfy the need (and not always assuming my own opinion was fact).

Target Market Quotes

Dr. K A Jagger
The Principle of Sydney Boys High School
A long-term Snow Sport enthusiast

“It’s a great product, just make sure it works on more than a 20° slope”

Joseph Darr
Student at Sydney Boys High School
An avid snowboarder

“Out of a lot products, this is the product I would actually invest in”

Dhruv Agrawal
Student at Sydney Boys High School
An avid snowboarder

“The idea is excellent; the product is good but could have helped with a higher-quality finish”

Charlie Clay
Student at Sydney Boys High School
An avid snowboarder

“The product looks very similar to the renders in the Folio, Well done, but the outside of the device was a bit rough, some attention could be taken to make the device a bit better looking.”

Rajesh Baluwal
Parent at Sydney Boys High School
An avid skier

“This is such a great idea and the way you’ve made it is excellent”

From direct feedback, people who see my project believe that it is a good idea, that there is a really strong need, just some aspects of the manufacturing could have been completed better. With the resources and time, I had for this project, the quality of construction could only be minimally improved. If this product was getting mass produced, the casting process can be done in more controlled environments to avoid bubbles and imperfections. With my resources & budget, a device like a pressure chamber was not viable, but in industry it would. The whole process of the creation of The Snowboard Brake can easily be mass produced as all it needs is one primary model and mould, then hundreds of castings can be taken. To improve the problems indicated by this feedback, more professional options like these could be taken.

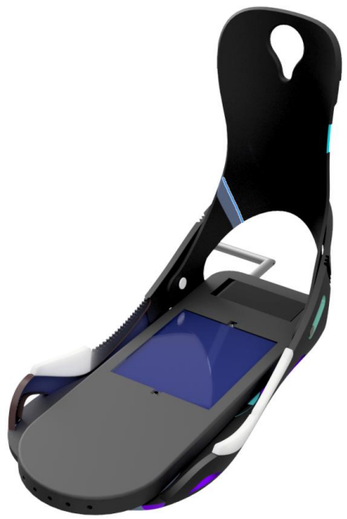
Target Market Survey

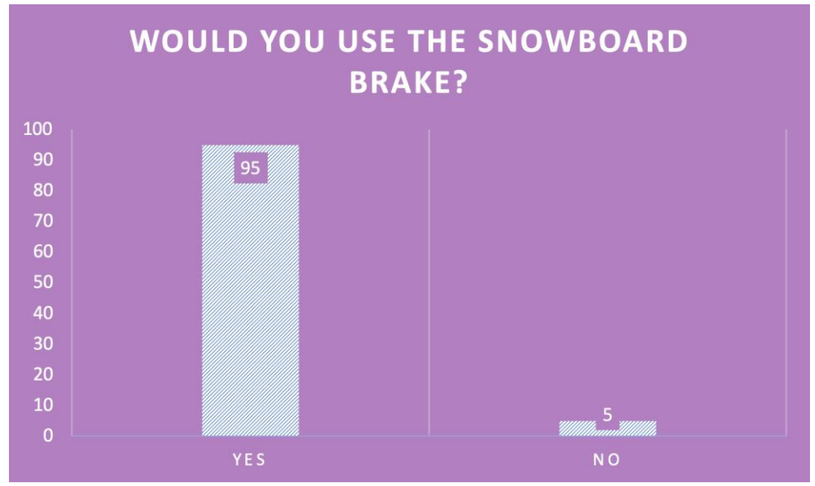
Final Demographic Survey:
I surveyed 20 people from the Snow Sports demographic, ***circulated a school environment and distributed through the perisher website to the target demographic***. Using the same as the initial survey, Contact was made with Perisher.com and they circulated the survey around the target snow sport demographic. This survey was done with Survey Monkey.

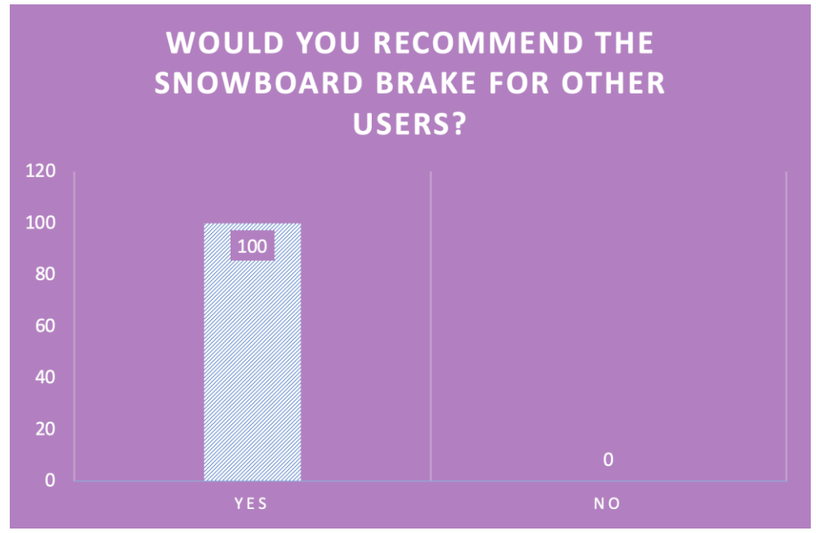
The Survey:
Q1 – Would you use The Snowboard Brake

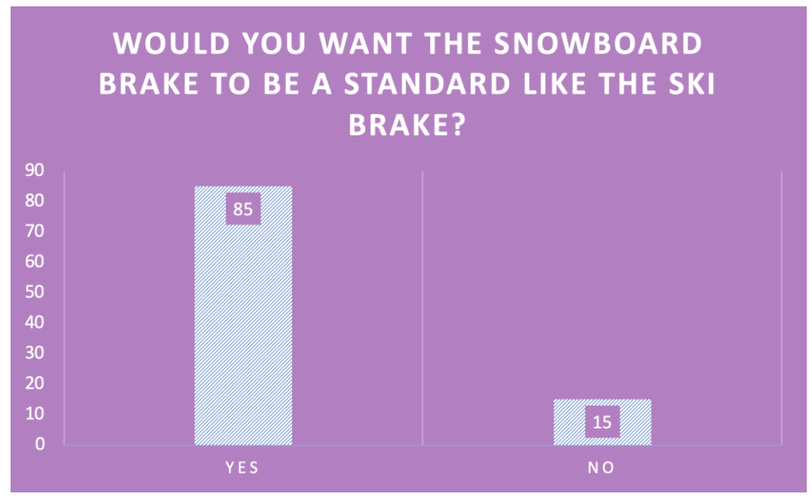
Q2 – Would you recommend The Snowboard Brake for other users?

Q3 – Would you want the snowboard brake to be a standard like eh ski brake?









Relationship to the Product Proposal

The Product Proposal

Did I Complete what was Stated in the Project Proposal?

I completed the majority of my Areas of Investigation but there were some deviations. Firstly, as the project progressed I realised that it was no longer relevant to research specific items. Some of these areas were rubbers & welding etc. The laser cutter and disk sander were not researched because of my already expert knowledge in these machines. Some Areas of Investigation were completed to a high degree of detail due to their importance and other areas completed to a satisfactory amount. I still kept documentation of the less important research, but it was reduced to comparative studies between viable options as opposed to a full study of the material/tool/ technique. This makes it possible to state I completed my Areas of Investigation to produce a high quality MDP. I was able to follow all my limitations within the MDP. I completed the MDP within the time frame provided and remained under budget. I successfully tested a working prototype at the snow on the outlined date. I was able to gain expert knowledge in areas of Plastic working & metal working where previously I had base knowledge to successfully produce a quality product. I was able to work around my manufacturing constraints and create a product of as high enough quality that can be expected with my current budget and access to tools. From this, I was able to conform to the majority of limitations set in the Design Brief.

Did I Satisfy the Need?

Design Brief	
Feature	Checklist
Stops Runaway Snowboards	✓
Safer in dark Environments	✓
Minimal Interference	✓
Thief Deterrent	✓

The snowboard brake successfully satisfied the need as it met all the critical functions and features specified. It Stops runaway snowboards; it has lights which creates a safer environment for low light snowboarding, it has a method of deterring thieves as well as interfering minimally with the environment. The devices functionality was displayed in the video showing that it does actually stop runaway snowboards. Its Light functionality can be seen working in photos & its Alarm functionality can be tested in person.

Don't believe me? Ask an Expert:

"Hey Jordan,
The idea of the snowboard brake is amazing. Skis have a break and I can't see why snowboards don't. Absolutely nobody uses the snowboard leash and no resort really enforces them. I see this device being popular for beginner snowboarders as there lack of experience probably causes more snowboards to run away. More experienced riders, the raising of one leg would affect the way they ride and as they're experience their snowboard wont runaway as much. You could have made the device a bit thinner but with the electronics it's a bit hard. Overall man well done; I hope to see people using the snowboard brake the next time I come to Australia."

Scotty James
Australian Professional Snowboarder
Age: 25

Final Evaluation –

Successful Areas:

The areas where the product was successful was in the areas surrounding its function, ergonomics, safety, durability, quality and its aesthetics. It completes all its functions to a satisfactory level while being integrated and lowkey. It works well and it's easy to use and doesn't interact with the environment around it when riding. This doesn't cause any major safety concerns plus it won't degrade over time and create any new ones. In terms of the design process, the Major sections were done well. The proposal stage successfully showed the need and how people are effected by the problem today. This was then followed by good management and application of the time, action and finance plans. For development, idea generation designed a quality project and research experimentation meant I completed realisation safely and to the best quality possible.

Unsuccessful Areas:

Concerning the product, there were a couple issues that arose when evaluating my design. For function, the 2 secondary features, the Alarm & Light systems didn't have enough power and weren't loud/bright enough. The alarms in the device were also small and inside the device which reduced noise levels as well. The physical size of the device was too large, and its width slightly deterred from the experience. For the weight of the device, mild steel is heavy and detracted from the device. In terms of the design process, management was my weakest section. Although the management was completed, the planning of too much in a week happened often and made managing time hard.

Recommendations:

For the device, I recommend combing a snowboard binding and the device into one which will create an even more integrated product. Placing a GPS system into the device will also allow the user to track their paths/elevation and gets statistics of the snow experience plus the implementation of a temperature sensor would be useful as well. To improve the current device, I could supply the lights and buzzers with a higher current to make them brighter and louder. Making the form factor of the device smaller and lighter would have been useful as well.

Final Statements:

The design process and the creation of the 'Beyond Snowboard Brake', was a success. The design process was successful in the design, development and realisation of the product and created the best product I could. I believe I have justified its name, '***Beyond***.', as it is not just a snowboard brake but a security and safety device as well. There are still many improvements that could be made to the device making the device better and more suitable for a mass production environment. This project is going to help me tremendously in the future. This project has taught me so much about time management and the design process. When planning for studying or in the workplace, I will use skills I learnt over the past year to help. I have learnt so much and was 100% worth it in the end.