

# **Extreme Weather Cover**

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**Jordan Bilston**

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# Table of Contents

<b>1 Project Proposal and Management</b>	<b>3</b>
<b>1.1 Identification and exploration of the need</b>	<b>4</b>
<b>1.2 Areas of Investigation</b>	<b>6</b>
<b>1.3 Criteria for Evaluating Success</b>	<b>7</b>
<b>1.4 Project Management: Action, time and finance plans</b>	<b>8</b>
<b>2 Project Development And Realisation</b>	<b>11</b>
<b>2.1 Evidence of Creativity</b>	<b>12</b>
<b>2.2 Consideration of Design Factors</b>	<b>17</b>
<b>2.3 Appropriate Research and experimentation</b>	<b>18</b>
<b>2.4 Application of Conclusions</b>	<b>19</b>
<b>2.5 Identification and justification of ideas and resources</b>	<b>20</b>
<b>2.6 Use of Communication and Presentation Techniques</b>	<b>21</b>
<b>2.7 Evidence and application of practical skills</b>	<b>22</b>
<b>3 Evaluations</b>	<b>32</b>
<b>3.1 Record and application of evaluation procedures</b>	<b>33</b>
<b>3.2 Analysis and evaluation of functional and aesthetic aspects of design</b>	<b>34</b>
<b>3.3 Evaluation with respect to the project's impact on the individual, society and the environment.</b>	<b>35</b>
<b>3.4 Relationship of the final product to the project proposal</b>	<b>36</b>
<b>Bibliography</b>	<b>38</b>

## **Extreme Weather Cover**

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# **Project Proposal and Management**

# **1**

# 1.1 Identification and Exploration of the Need

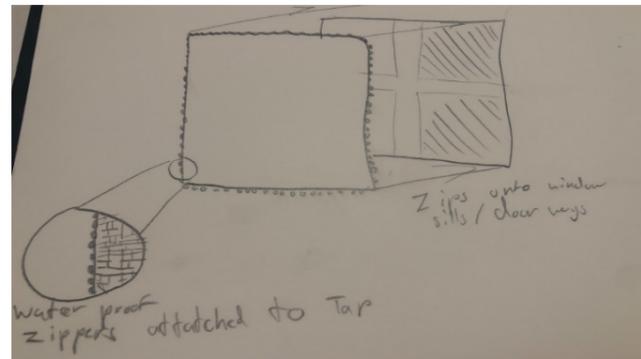
## 1.1.1 Possibilities of the project

For my major design project there are a lot of ideas that I am interested in pursuing that have benefits to myself and society in varying ways. To start the process of organising ideas that could be completed for the project, we first completed a class brainstorm of potential ideas that could be completed for a project across the whole year. From there I went and made my own smaller mind map which focused around my interests that I could complete for my project. I took ideas from things that I enjoy such as sports and cars and other ideas that need to be fixed like natural disasters.

### 3 Possible projects

#### Flooding

Throughout the world every year there are many catastrophic weather events which cause large amounts of damage to homes and possessions. Major floods destroy billions of dollars worth of buildings, vehicles and personal effects each year devastating communities and families. Hail storms and major winds can also cause large amounts of property damage especially to cars. This means there is high demand for products which can reduce the cost on victims of these major weather events and governments who spend large sums of money in aid to these areas. The target market of these products are people who are in flood prone areas globally, like many parts of Australia. Products that can assist by limiting the impact of floods are needed to help people.



#### Rain affecting Formula 1

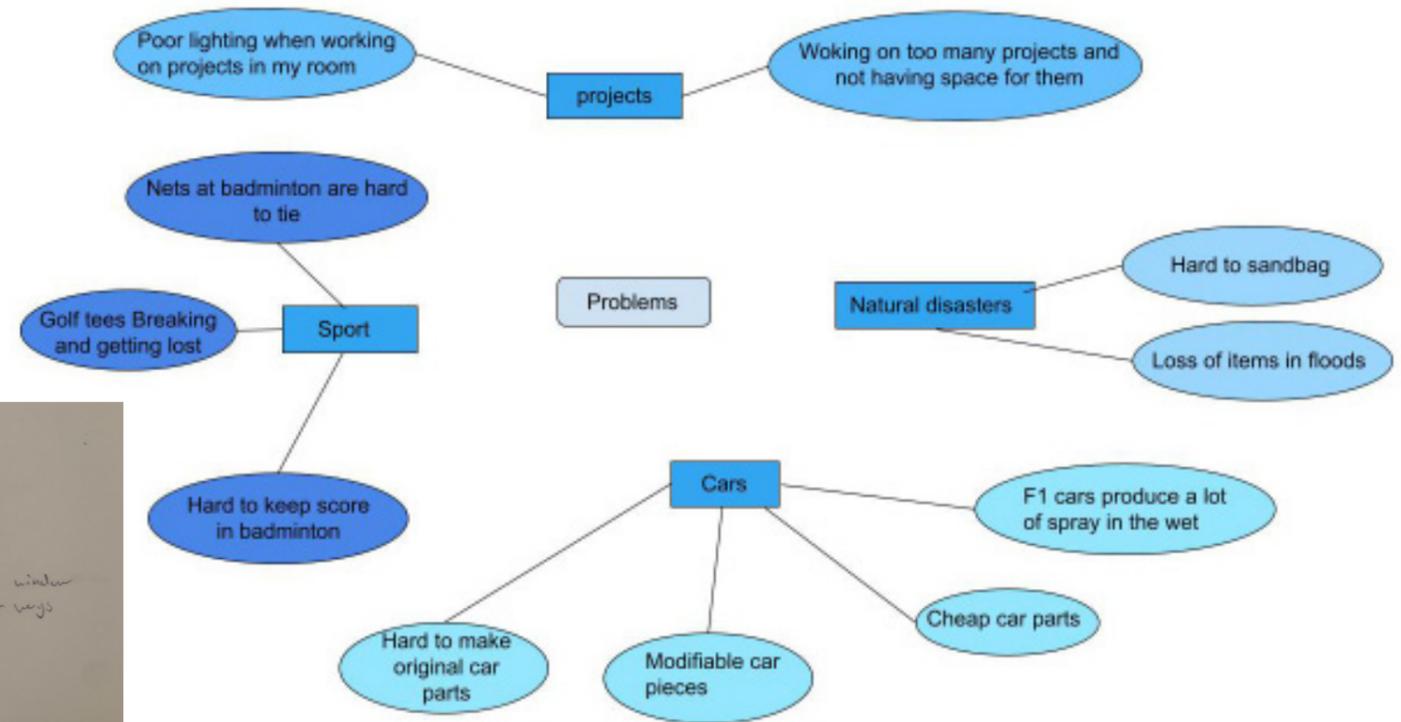
In wet conditions Formula 1 Cars pick up large amounts of spray from wet tires, this causes unsafe driving conditions for the drivers and has led to many serious accidents. To prevent this in the future, redesigned wheels could be used that direct water outwards instead of upwards or the use of covers over the wheels (guards) to prevent the spray from being spun up with the flow of air off the cars. This can be used in many forms of racing not just limited to Formula 1 cars and other open wheel cars series and have implications for on road cars and motorbikes.



#### Justification of Chosen Idea

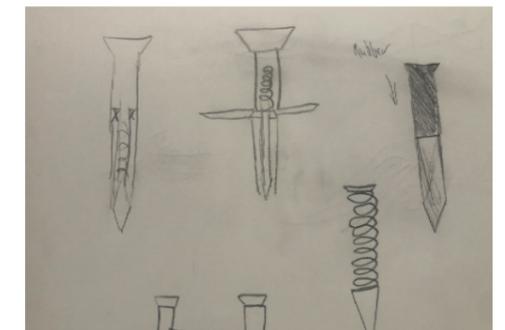
For my Major Design Project (MDP) I have decided to produce something that can assist in the protection of homes and personal items in the event of flooding. I believe that there would be high demand for such products, with much of the world being affected by flooding and extreme weather events. There are limited solutions in the market and a number of them are unsuitable for the design purpose. Developing an affordable solution to this problem would also help large populations that can't afford insurance or the replacement costs.

## MDP Ideas Mind Map



#### Golf Tees

When golf tees are struck they generally fly out of the ground or break. This causes inconveniences for users and can cause waste into the environment and incurs costs over time. A golf tee that can remain in the ground and is more durable could solve this problem and fill a gap in the market for users who want the convenience and money saving benefits of strong golf tees that remain secure in the ground.



#### Evaluation

After making the two mindmaps I was able to determine three ideas that I would want to pursue in my project and by doing some research into the three different Ideas that I was most interested in for the continuation of my project. I was able to decide that I would continue with the idea of creating something to help people in extreme weather. I chose this idea because I believe it can appeal to a large proportion of the population and it can provide a significant social benefit to the community and the world.

# 1.1 Identification and Exploration of the Need

## 1.1.2 Possibilities of the project

### Design Brief

My intention for the project is to create a viable solution to prevent damage to cars and other valuables that are exposed to extreme weather events such as floods, hail storms and damaging winds. The product will need to be able to hold large items like cars, furniture and other valuables that need to be protected in extreme weather events. The solution must be able to be set up in 5 minutes or less to ensure rapid protection due to the unpredictable nature of these weather events. The design needs to be manoeuvrable so that users can move it to where the product can be set up or moved to an area where the valuables are located. It needs to be durable so that it can withstand the forces of nature as well as being used for multiple weather events.

### Design Situation

I have chosen to centre my project around helping people in floods as it is becoming an ever present theme in the media seeing areas globally inundated by water and the scenes of streets full of damaged goods discarded by "1 in 100 year floods". I have identified that currently there are very few methods to deal with this problem and believe it is a very necessary cause to develop a product for people affected and this is creating demand for residents who nearly yearly have damage due to extreme weather. I aim to create a product that will be able to assist people in the protection of their belongings.

### Target Market

The target market of my project are people of all ages who are at risk of extreme weather and flooding. This project is aimed at geographically high risk areas such as areas in New South Wales like Lismore and other national and international areas. This project can also be intended for those who want peace of mind if they can be protected from extreme weather and live in areas of lower risk to them.

## 1.1.3 Exploration of the need

### Initial Research

**29%** of people globally are susceptible to 1 in 100 year floods, **1.47 billion** people each year are exposed to floods over 0.15 metres which is enough to cause damage and destruction.

There is a common perception that a 1 in 100 year floods mean a 1% chance of a large flood each year but this is a misunderstanding. Unfortunately this leads to an unreasonable level of comfort where the risk is actually much greater. Each place is different, but in NSW, a 1 in 100 year flood is determined as a flood over 10 metres where the 'danger height' of floods is only 5.2 metres, demonstrating the severity of the event and hence the significant risk posed to people and property from a 1 in 100 year flood.

In February and March 2022 alone, in Queensland and New South Wales, flood damage caused over \$5.65 billion dollars of damage.

A number of individuals either cannot afford insurance or are in areas that cannot be insured. Likewise the rising cost of insurance has made it unaffordable for some individuals to insure their property and personal items.

## 1.1.3 Exploration of the need

### Evidence



### Conclusions

Over a quarter of the world are affected by floods each year with hundreds of billions of dollars of damage being caused to property, valuables and vehicles yearly. Many of these damaged vehicles and goods having to be written off due to the extent of the damages, this causes large amounts of unnecessary waste in the environment. Insurance costs for people in affected areas are high or uninsurable due to flood risk. This information demonstrates the need for both civilians and the government for better protective measures in floods.

### Sources

<https://blogs.worldbank.org/climatechange/147-billion-people-face-flood-risk-worldwide-over-third-it-could-be-devastating#:~:text=1.,%2D100%2Dyear%20flood%20event>.

<https://www.theguardian.com/australia-news/2022/mar/04/are-eastern-australias-catastrophic-floods-really-a-one-in-1000-year-event>

<http://www.bom.gov.au/water/designRainfalls/rainfallEvents/why100years.shtml>

Uninsured flood victims can receive up to \$20,000 payment under NSW scheme | NSW and Queensland floods 2022 | The Guardian

<https://www.9news.com.au/national/treasurer-warns-flood-disasters-to-cost-australian-economy-billions/19b69f29-ee14-41c0-822d-1a7f890e849b#:~:text=The%20New%20South%20Wales%20and,%245.65%20billion%20worth%20of%20claims>.

### Evaluation

Research demonstrated that extreme weather events cause significant amounts of damage to people and property. That extreme weather events are on the rise and the risk associated with these events is high. Therefore, it is evident that there is a need in the market for affordable solutions to prevent loss or damage to personal items and vehicles. More so in areas where individuals cannot afford insurance or in areas that cannot be insured for the effects of flood. Developing an affordable and viable solution to this problem is essential to the success of my MDP.

# 1.2 Areas of Investigation

## 1.2.1 Areas to be Considered

Area of Consideration	Sub criteria	Explain why this aspect	Method of investigation
Function	Ergonomics	This area needs to be considered to ensure that the product is easy to use and by people of differing ability.	Surveys and Online research
	Safety	This needs to be considered to ensure the product is safe to be used by consumers. Likewise that the product does not become a safety hazard in the weather event (eg. flying debris). Additionally any design standards that the product needs to meet (eg. Australian Standards)	Relevant online websites and independent review.
Aesthetics	Materials	To ensure that the product is strong enough to protect items inside from any possible damage or water on top of it. Likewise the materials need to be durable.	Online investigation and in person testing of materials.
	Colour	Colour of the tarps need to be considered in case the bag floats away it will need to be identifiable.	Surveys and Online research
Manufacturing	Costs	Considering the cost of materials is important. Taking into account what the material costs are going to be and to ensure the production cost is on budget. However, it will always be relative to the cost of replacing the asset itself (car) or the annual cost of insurance is a consideration	Online and in person investigations into costs
	Tools	This aspect will need to be considered to see if there are any tools that I do not have the knowledge of how to use yet in the production of the idea. Likewise, can the product be mass produced with simple tooling.	Research into different tools that will be used and in person testing
Need	Target Market	Identifying specific regions where this product may be used, may help to identify any special requirements that the final design needs to include.	Online research and surveys

## 1.2.2 Research Plan

Area to be Investigated	How it will be investigated
Usage	Primary research
Target Markets	Online research and gaining information through primary research in asking flood affected victims
Costs	Online and in person research of material costs across different places
Size and shape of cars	Online research and primary measurements
Material use of the outer shell	Online research into the different types of tarps and their strengths
Material of interior frame	Online research into strength of materials and their weights
How to sew the tarp	Online research through videos and forums as well as in person testing

## 1.2.3 Limitations and Parameters

One limitation of my project will be the scale of the idea. A full scale model will be very large and require large amounts of money to be able to fully build. This has led me to decide to build a half scale model of my chosen idea to enable me to produce a more cost effective representation of my idea. Another limitation is my current skill and ability with metal fabrication which I have limited experience in, so making time to learn new skills such as welding will help me greatly in the production of my idea.

### Evaluation

Identifying these areas to be researched has given me future direction for my project in what I think I need to look further into to make the final product more successful. Identifying the parameter of my project has also been able to give me a sense of scale for my project and I can look into the overall costs of my project.

# 1.3 Criteria for Evaluating Success

## 1.3.1 MDP Criteria for Evaluating Success

Criteria	Explanation	Method of evaluation	Justification	Importance rankings
<b>Function</b>	Function is a highly important criteria as it will determine how successful the product will be. The finished product will have to be protective and prevent any water from causing damage	When the final product is built I will test how water tight the product is and test its ability to protect an object inside from damage such as hail. To do so I will simulate rain hail and small scale flooding on the design to see if it is viable	Function is the most important criteria for this design as it needs to protect items to be useful and will be crucial in determining the success of the finished product.	1
<b>Durability</b>	The durability of the product is important to ensure that the final design can be used multiple times for longer lasting protection.	To test this I will do some stress test on parts of the product to observe how long they will last.	The product needs to be able to be used over a long period of time to ensure that the materials do not need to be recycled or replaced so that users can have protection for a long time. This also means that the product can be reused over many years as different weather events impact individuals.	2
<b>Safety</b>	Safety is a necessary consideration to ensure users are safe when opening and closing the system. Likewise that the product won't cause secondary harm during the storm event.	I will perform tests to ensure that the design can hold weight and is safe to set up.	Safety is essential to ensure that users are safe whilst using this cover. As well as the safety of any objects inside are also important so that the final product does not become a safety hazard during the weather event.	3
<b>Ergonomics</b>	The ease of use is important to make sure that the product can be quickly set up by one person, so in the event of a flash flood their belongings can be protected quickly.	Timed tests will be conducted to ensure that the setup is quick and efficient.	This product needs to be highly ergonomic so that it is fast and convenient for a user to set up. Next the speed and efficiency of assembly is also important to the ergonomics.	4
<b>Quality</b>	The overall production quality of the product needs to be considered. Each of the joints need to be constructed with high quality techniques to ensure it is strong enough to withstand extreme forces.	Test will be performed similarly to the durability test to test the quality of materials used.	Quality production is necessary to ensure durability, reliability and the safety of the product.	5
<b>Reliability</b>	Reliability of the mechanisms is important so that the opening and closing of the systems is fast and reliable. Further, that they do not fail in times of need.	Testing if the product can be open and closed many times reliably.	It is important that the product can be set up reliably and consistently fast so that the product is effective when needed.	6
<b>Materials</b>	Material choice is an important factor to consider to make sure the product is strong enough to hold back water and ensure that the exterior material is resistant to tears or punctures.	Testing how resistant the different materials are to different forces on them like water and the possibility of tearing.	Choosing the correct materials is important so that it is strong and will last in water for long periods of time. Likewise that the material can support sufficient weight to keep the product anchored.	7
<b>Cost</b>	Comparing the overall cost of my design compared to competitors to see if it is more affordable than other solutions on the market. Likewise the cost of the product against the replacement cost of a car or the cost of flood insurance.	Online evaluation of similar ideas compared to mine and evaluating their prices.	The cost of the project will be important to consider against the consumers alternatives: replacing the vehicle or insurance. This will influence whether the target market purchases my product and the success of my concept.	8
<b>Efficiency</b>	Efficiency of material use is an important factor to make sure it is strong whilst using as little material as possible.	Testing of different materials to find what is the most efficient.	The efficiency of the use of materials will make sure that the product is light and easy to set up whilst meeting the strength needs whilst keeping the cost down.	9
<b>Aesthetics</b>	Aesthetics is not a major factor but having some fluorescent colours on it will help in case it is submerged or the car floats away.	Gathering outside opinions of how the product is appealing to consumers.	Although not a major consideration, the overall look of the product could influence a purchasing decision, so keeping aesthetics in mind is important to consumer demand.	10

# 1.4 Project management: Action, Time and Finance Plans

## 1.4.1 Proposed and Actual Time Plan

Term 4 2022	W1	W2	W3	W4	W5	W6	W7	W8	Holiday
1.1.1 Possibilities of the project	Proposed								
1.1.2 Identification of the MDP Need		Proposed							
1.1.3 Initial research		Proposed							
1.2.1 Areas to Be considered			Proposed						
1.2.2 Research plan			Proposed						
1.2.3 Limitations and Parameters				Proposed					
1.3.1 MDP Criteria for Evaluating Success				Proposed	Proposed				
1.3.2 Most to least Important Factors					Proposed				
1.3.3 Evaluation Methods					Proposed	Proposed			
1.4.1 Action and Evaluation Plan						Proposed			
1.4.2 Proposed Finance Plan						Proposed			
2.1.1 Idea Generation							Proposed	Proposed	Proposed

Term 1 2023	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	Holiday
2.1.1 Idea Generation	Proposed	Proposed	Proposed								
2.1.2 Degree of Difference				Proposed							
2.2 consideration of design factors					Proposed						
2.3.1 Research						Proposed	Proposed	Proposed			
2.3.2 Experimentation									Proposed	Proposed	Proposed

Key	
Proposed	Dark Blue
Actual	Light Blue

Term 2 2023	W1	W2	W3	W4	W5	W6	W7	W8	W9	Holiday
2.3.2 Experimentation	Proposed	Proposed								
2.4 Applications of conclusions			Proposed							
2.5 Identification and justification of ideas and resources				Proposed						
2.6 Use of communication and presentation Techniques					Proposed	Proposed				
2.7.1 Detailed Record of MDP Manufacturing process							Proposed	Proposed	Proposed	Proposed
2.7.2 Production Planning									Proposed	Proposed

Term 3 2023	W1	W2	W3	W4	W5	W6
2.7.1 Detailed Record of MDP Manufacturing process	Proposed	Proposed				
3.1 Record and application of evaluation procedures			Proposed			
3.2.1 Functional Analysis			Proposed			
3.2.2 Aesthetic Analysis			Proposed	Proposed		
3.3.1 Individual				Proposed	Proposed	
3.3.2 Society				Proposed	Proposed	
3.3.3 Environment				Proposed	Proposed	
3.4.1 Professional Evaluation					Proposed	
3.4.2 Self Evaluation					Proposed	Proposed
3.4.3 Final Evaluation					Proposed	Proposed

# 1.4 Project Management: Time and Finance plans

## 1.4.2 Proposed and Actual Finance Plan

Product	Proposed price	Actual Price
Steel 20mmx20mm hollow tube 26 metres	\$126	\$138 (original price did not include gst)
Steel Cuts (6 cuts)	\$30	\$30
Tarps 4mx4m	\$59	\$59 + \$13 shipping
3D printer filament (2kg)	\$60	\$59.90
Waterproof zip and zippers	\$40	\$20.40
Epoxy 4 x 24ml	\$47.4	\$47.40
Waterproof fabric tape	\$10	\$4
Bolts	Unexpected purchase	\$14
Total	\$372.40	\$385.70

## 1.4.3 Evaluation of Time and Finance Plans

### Application of Time Plans

Term 4

Week 2

These weeks have been at the start of idea generation for the project, not much has been found so far but some ideas have been established that could be used in this project.

Week 4

I have established many ideas which I am interested in completing for this project. I have now begun research looking into these many ideas and possible different solutions to this for the task.

Week 6

I have narrowed down my many ideas into 3 to be presented in the pitch task that we have worked on this week. I have narrowed down my primary idea to be around in flood damage prevention and my 3 ideas are all different and target different needs in flood prevention such as protecting houses, cars or items. I chose this idea as I believe it would have the greatest impact if completed well.

Week 8

After presenting my ideas, preliminary research and choosing the idea for my Major Design Project, this has allowed me to start generating ideas for the project over the holidays.

Holidays

Unfortunately I was away for a significant amount of the holidays so I did not achieve as much as I would have wanted to, but I have created 2 potential ideas for my project and have both drawn and created 3D models allowing me to evaluate the designs at the current state.

Term 1

Week 2

I have identified problems with the first design resulting around the lengths of the steel that would make it near impossible for it to realistically work. Work has been done to fix the problems identified in the 3d modelling of the design to ensure that it is still a potential idea.

Week 4

I have finalised my 3 different ideas and have started the assessment looking into our 3 ideas and their positives and negatives. I have also begun the process of selecting which one idea would be the most suitable for my criteria.

Week 6

I have finalised my assessment and have made the judgement that my third idea is the best idea for what I want to achieve in this project as I believe it will meet my criteria the best.

Week 8

During this period I started research on where I could purchase my materials and material needs for the project. I also started the design of the locking hinges

Week 10

Not much was completed in these for the actual prototype with some more design and testing of the hinges being completed but I used this time to work on my portfolio and making sure that was up to date.

Holidays

Research on materials

After finalising my idea I started to finalise my materials that I would need for this project. After which I ordered my tarp and zips from online stores in Australia. I also looked at many places in the greater Canberra region to purchase my steel from, while also being conscious of finding the best price, so that I could try and keep around the projected budget. I found a place that would put me within my budgeted price for the steel which was very good.

Term 2

Week 2

This week I picked up my steel and worked on adding all this information to my portfolio. Over these two weeks I was also starting to test the prototypes for the hinges that would go in between the steel beams and act as the joints for the frame with some steel pieces that I now have. These initial prototypes were primarily designed to serve as a test of the movement of them and the key systems and this worked very well.

Week 4

I used these weeks to finalise my measurements for the front and sides to allow me to get ready to cut my steel. I also continued the development of my hinges, now getting them to be smaller and actually fit inside the steel, but I was not happy with the strengths of the hinge and the key parts, so more testing is needed on the use of different 3D printing settings to make them stronger.

Week 6

This week was a long weekend so I started cutting the height and width sections of the steel allowing me to complete the front and back sides of this project. I also started mass printing the final hinges because I need a lot of them for the design and getting ahead of the cutting will help to keep the project on time.

# 1.1 Identification and Exploration of the Need

## 1.4.3 Evaluation of Time and Finance Plans

### Application of Time Plans

#### Week 8

These weeks were spent designing the corner hinges which only took 2 prototypes to find the final design. There were only minor improvements needed around the width and strength of them. I also cut the top and bottom lengths of the steel into the 3 different sections per side, for the fold out movement.

#### Week 9

At this point I was doing a practice assembly of the design and found that the hinges were loose and causing a bit of flexing in the steel which could cause problems. This resulted in me doing more testing of hinges and their sizing so they fit perfectly and redesigning the overall structure of the rigid part. This new iteration involved putting a beam in the middle to support the top lengths from their own weight. This will hopefully have the result of stopping the sagging effect in the metal beams but I believe this will affect the time it takes to set up the design, it should still hopefully be able to be set up in under 5 minutes.

#### Holidays

These holidays were one of my most productive periods in the construction of the project with large time spent on printing the hinges, testing the structure and problem solving. At this stage I cut and sewed the tarp together and made the final modifications to the design such as the re-designed key systems.

#### Term 3

#### Week 2

This week the whole product has been finished and has been transported to school where I will need to assemble it before taking final photos.

#### Week 4

Trial exams slowed down the continuation of my project but I tried to continue my portfolio work during these times.

#### Week 6

These past two weeks have been very busy in the finalisation of my project with the photography equipment being set up and taking my final product photos for the Portfolio. I have continued my evaluation of the product but have struggled to find a professional to complete my evaluation.

### Evaluation

I have been able to apply my time plans pretty well with my predictions about time usage being very good but there were un expected parts which took longer to complete than I had planned, especially in term 3 I was very busy with trial exams which caused a lot of my predictions in there to need to go over.

### Application of Finance Plans

- I originally budgeted \$100 for the steel but going through different suppliers showed that this was going to be very expensive. Through my investigations in person and through receiving online quotes, it was most likely that I would have to pay around \$200 for the steel, this was too unrealistic for my project until I found InfraBuild in Canberra, which had their steel prices at \$98 + gst. This allowed me to be around my budgeted amount for the steel. As well as cheap steel, InfraBuild could also do cuts on the steel which allowed me to have the long pieces cut out, I could cut the smaller lengths at home. The external cutting at Infrabuild did cost \$40, but was worth it, as otherwise I wouldn't have been able to take the steel pieces home and they would have had to have been delivered which would have been more expensive. Due to a change in the design of my prototype I was left with large amounts of excess steel that could have saved me ~\$50 in costs of steel and cutting it down to length.
- Originally for my waterproof zips I could only find suppliers in Europe which had high prices and very expensive shipping rates, this would also take a long time for the parts to arrive from Europe. Subsequently, I found a supplier in Queensland who was more affordable and had shorter delivery times, ultimately being a better choice for my project.
- The tarp was easy to find, with many within my budget, but I had not accounted for the shipping costs of large items like the tarps. So not being able to find a local supplier meant I had to exceed my budgeted costs for the tarp top on account for shipping.
- I made the decision to epoxy the hinges in place to ensure they wouldn't slip out and break which added a cost, this was an expected cost but I couldn't predict how much epoxy I had to use and so that caused my estimate to be wrong.
- Unfortunately, due to some damage to the 3D printed parts because the product fell over and I had to make some quick repairs, I had to buy some bolts to fix the corners. This was an unexpected additional cost that wasn't accounted for in budgeting.

### Evaluation

I applied my finance plan very well. My overall budget was very close to what I had originally expected with the unexpected cost of bolts setting me over my budget but I was very happy being close to what I had originally planned for even if some costs were more or less than expected. I was still able to end up around the cost that I was expecting for this project

## **Extreme Weather Cover**

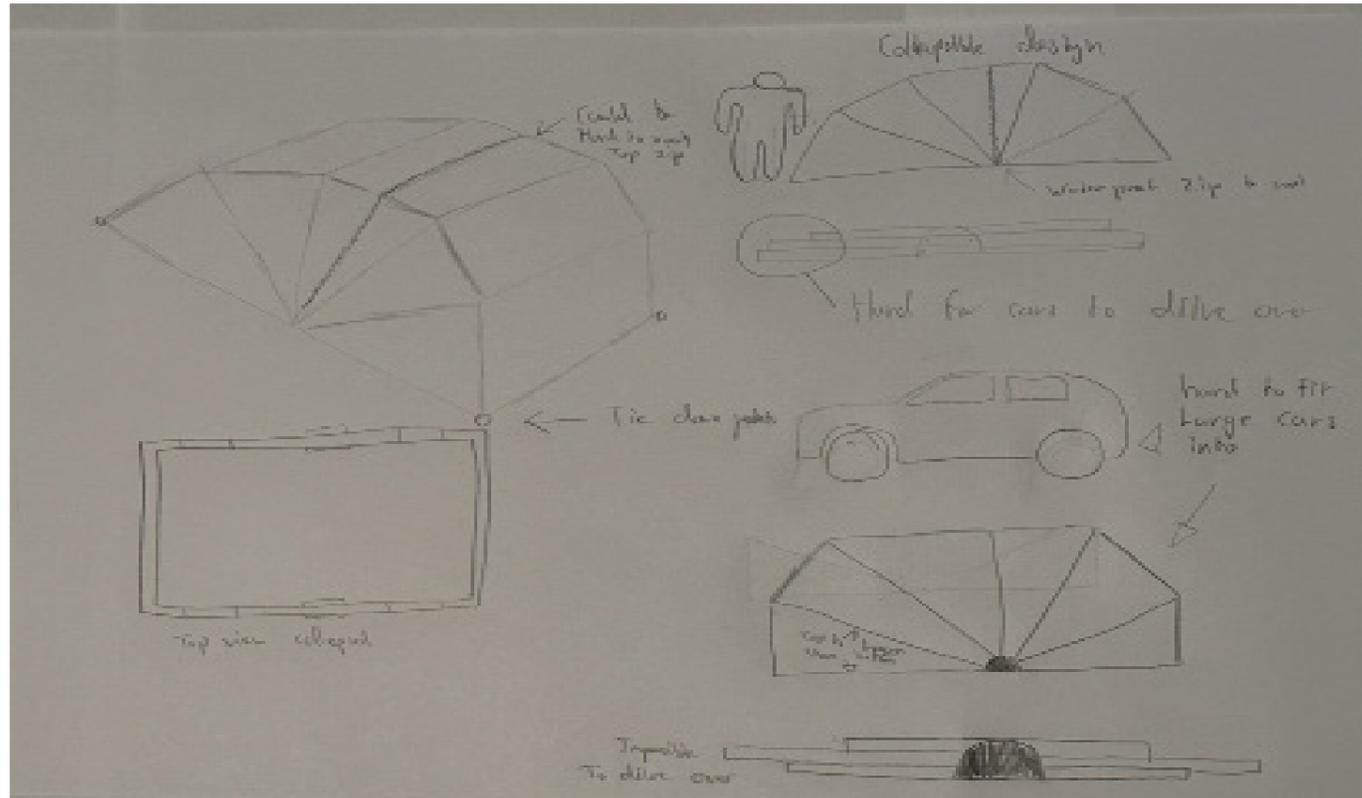
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# **Project Development and Realisation 2**

# 2.1 Evidence of Creativity

## 2.1.1 Idea Generation

### Idea 1

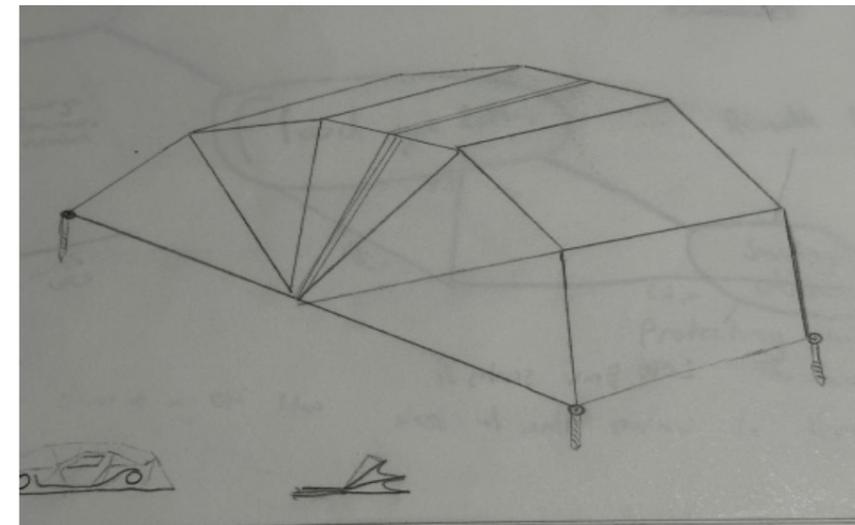
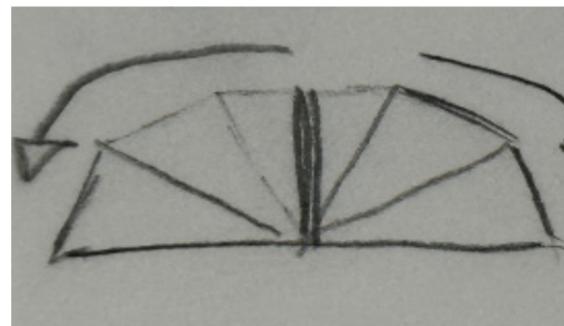
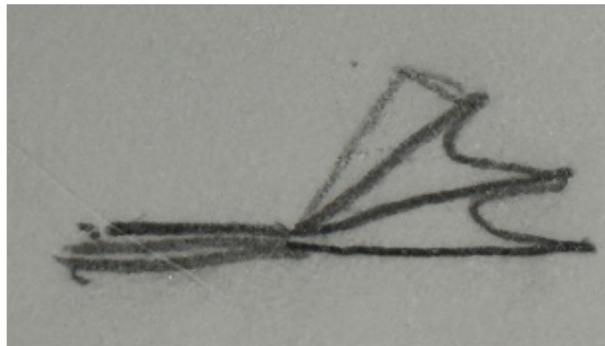


### Introduction into Idea 1

The first idea is a rigid car cover that folds up from beneath and over the car. The poles are located on top of each other for increased strength, a simplified locking mechanism allows for a fast setup. The two ends fold up into the middle section where they are secured.

### Operation

To use Design 1 the user is required to drive their car or place their valuable objects onto the base of the cover. Then pull up one side of the cover from the ground using the locking mechanism to secure that half in place, next pull up the other half and lock it in place as well. The last step is to zip the cover up fully to stop water from entering the cover if submerged.



### Positives

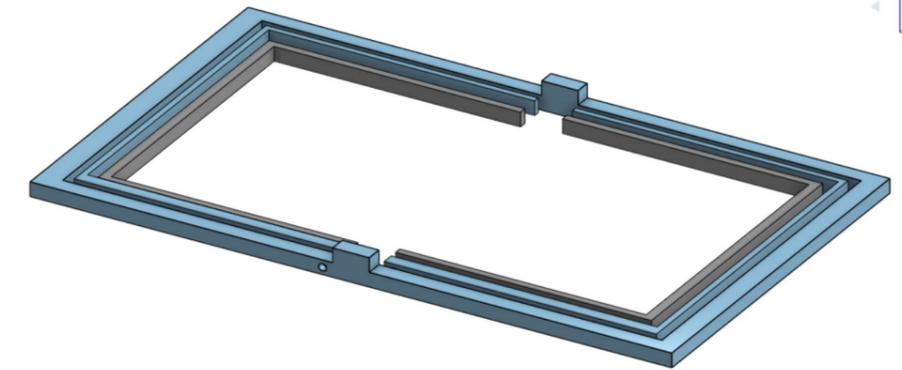
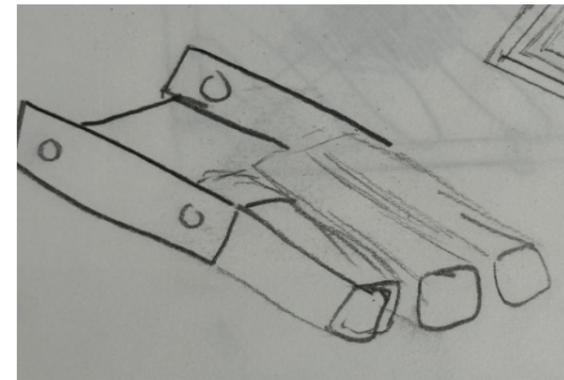
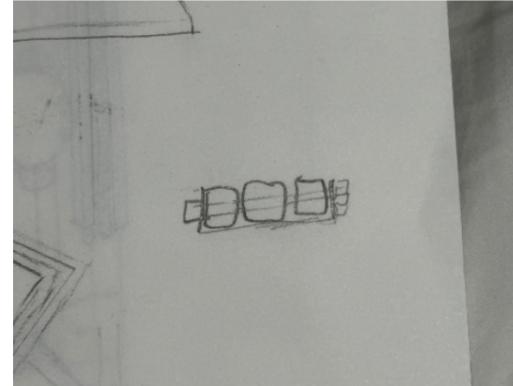
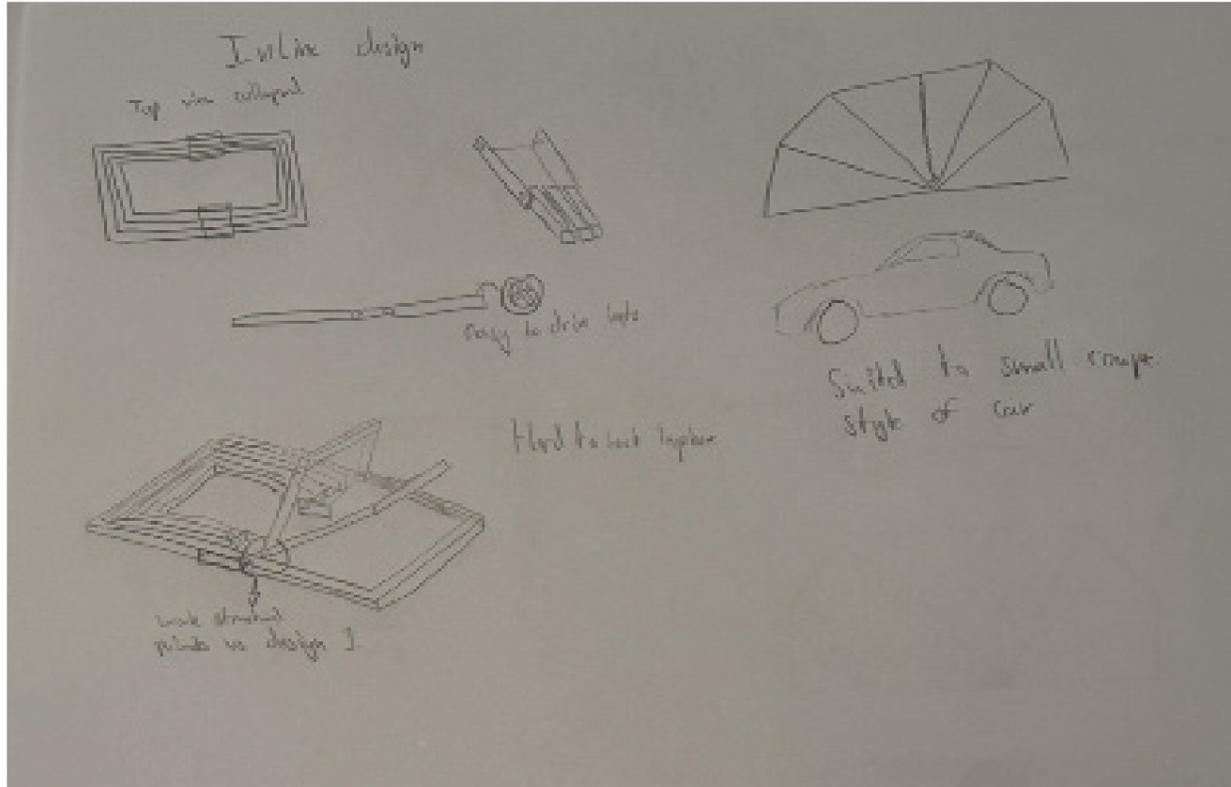
1. A positive of this design would be that the material usage would be the most efficient of all the designs.
2. The efficiency of the materials also means that it would be more affordable.
3. The simplicity factored into the ergonomics, make it easy to produce and set up.
4. The pressure of the water would be well distributed on the cover providing better protection for the car and valuables.

### Negatives

1. There are a couple flaws with this idea, this is due to it having the poles stacked on top of each other. Users would need to drive over the stacked steel sections to position the car on the tarp. This issue effectively made this design unrealistic. Especially for cars with low ride heights. Let alone the potential that the steel sections and jointing can get damaged by the car driving over them.
2. Without some more support poles this design has a single point of failure at the joint.
3. Poor versatility for vehicles of different shapes and dimensions.
4. The semicircle design is highly inefficient for storing an object which is shaped more like a box.

# 2.1 Evidence of Creativity

## 2.1.1 Idea Generation

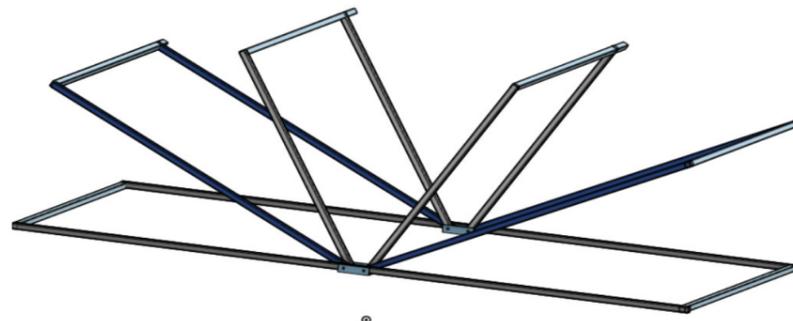


### Introduction into Idea 2

This second idea is very similar to the first idea, however instead of having the steel poles on top of each other they are adjacent to each other which reduces the problems identified with cars not being able to drive into idea 1. This design would also require the use of a locking mechanism but this would be a lot different to the other one as it would have to support more individual supports.

### Operation

The operation of this design is very similar to design 1. The user is required to drive their car or place their valuable objects onto the base of the cover. Pull up one side of the cover from the ground using the locking mechanism to secure that half in place on both sides, next pull up the other half and lock it in place as well. The last step is to zip the cover up fully to stop water from entering the cover if submerged.



### Positives

1. This design reduces the problems with the first design by making all the poles sit flat alongside each. Making the system easier for a car to enter.
2. Similar to design 1 it would be simple to set up.
3. The design requires simple techniques to build the design compared to the other designs which have complex shapes.

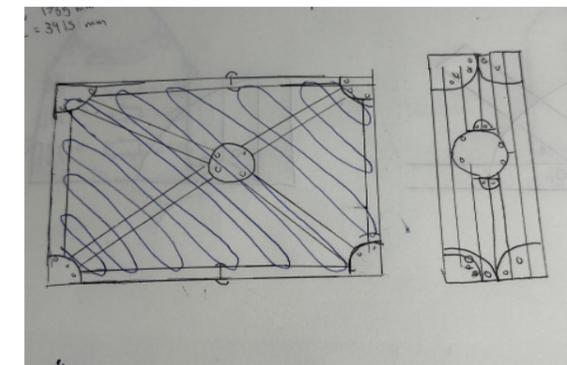
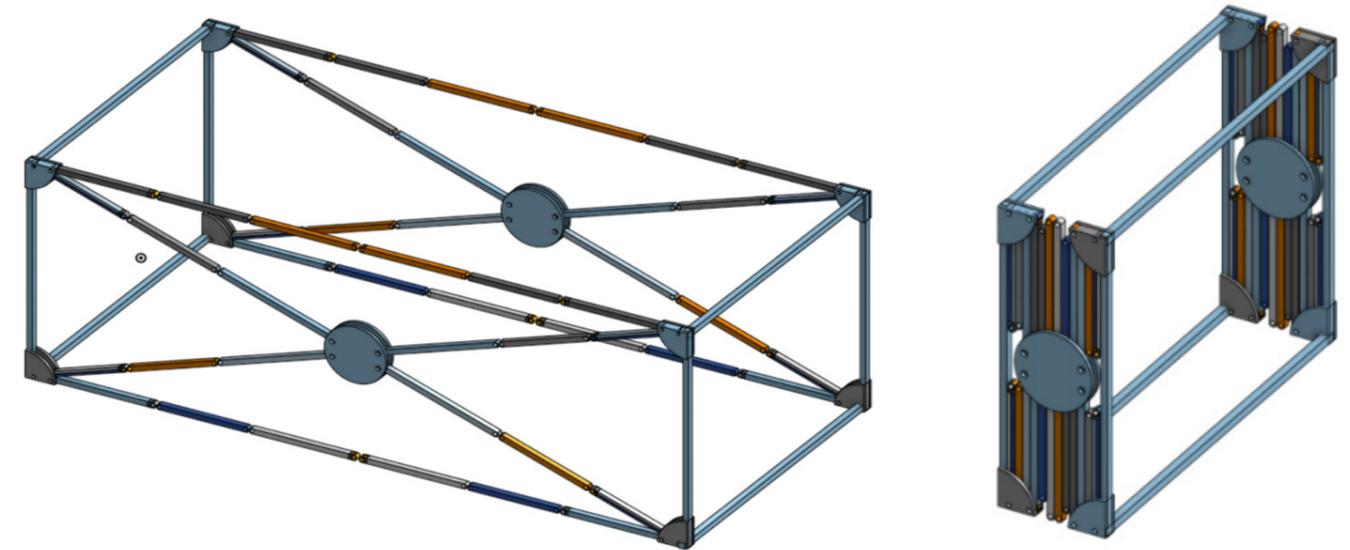
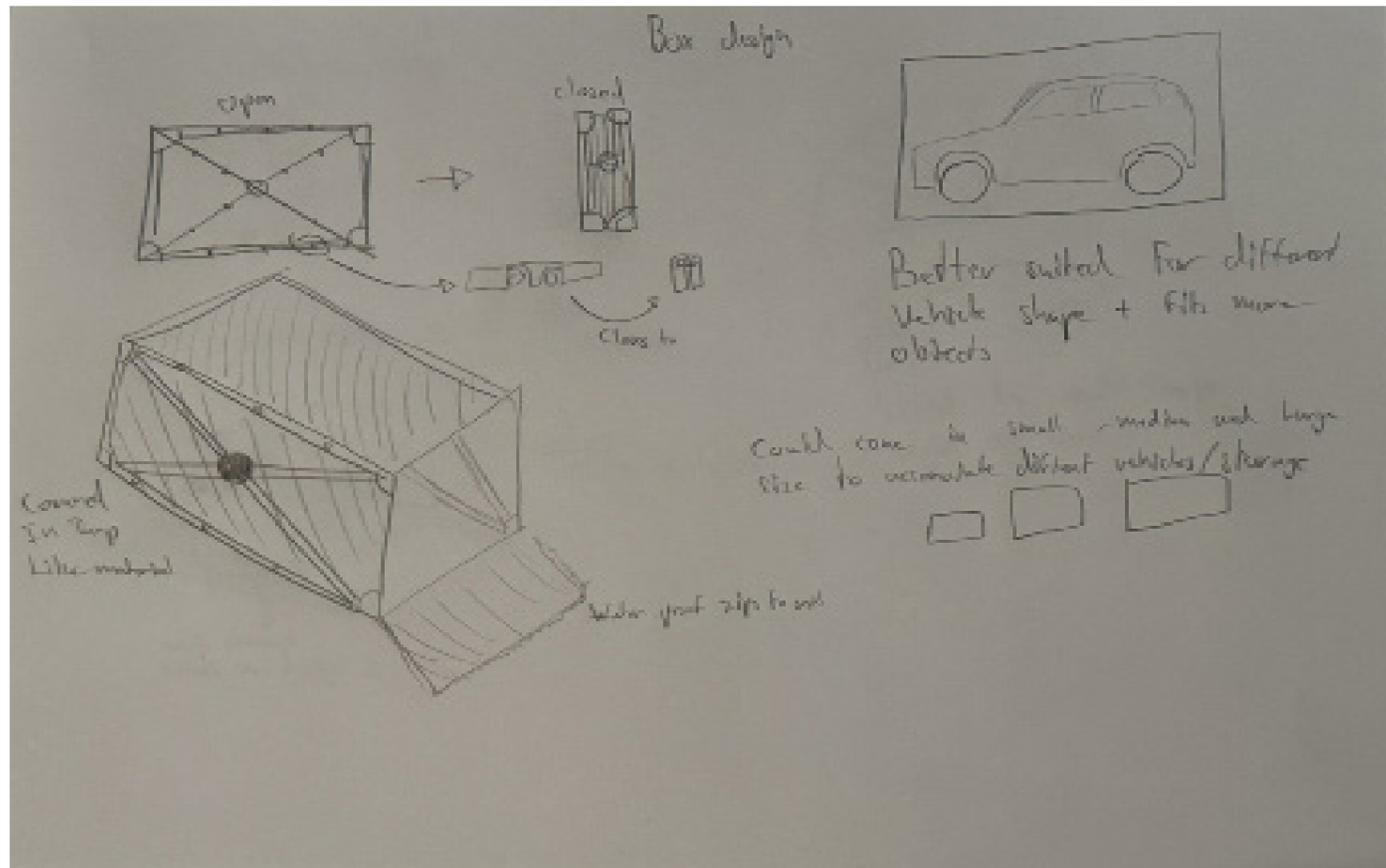
### Negatives

1. This design is likely to be much weaker than the first due to having the pressure spread out across all the beams in different locations, applying the force four fold on the locking mechanism.
2. Similar to design 1, poor versatility in what cars can fit inside the car cover.
3. Support beams would be needed to ensure that the cover does not collapse when under the increased load.

# 2.1 Evidence of Creativity

## 2.1.1 Idea Generation

### Idea 3



### Introduction into Idea 3

The third idea is very different to the previous two, that the cover extends outwards instead of folding from upwards from below. This design's major point of difference to the other designs, is that it extends from the back and it also has greater versatility for cars with different shapes and sizes. Allowing it to suit cars of different shapes and sizes, increasing versatility in the market. This cover also works better at protecting other household items such as paintings and expensive appliances that people would want to save in the event of a flood due to its shape.

### Operation

To operate design three, a user would first need to pull the collapsible frame out, extending it to its full length. After the frame is fully extended the user would then use the securing mechanisms to ensure that the cover is locked in place and will not collapse. Finally the user can drive their car into the bag and fully zip up the bag sealing their car inside. This process is aimed to be completed in under 5 minutes and the car can also be changed out for other objects such as furniture and paintings.

### Positives

1. This design has the ability to scale for small, medium and large cover sizes. The box shape allows for more car shapes and types to fit into one size of tarpaulin cover as well as valuable items.
2. Less usage of expensive parts like waterproof zips.
3. Smaller storage space is required due to this design's ability to fold up and fit in smaller spaces.

### Negatives

1. Would require more locking mechanisms to secure the whole strength of the bag.
2. The scale of this cover could make it more costly even if designed for a small car.
3. Complex design would make the manufacturing process longer.

# 2.1 Evidence of Creativity

## 2.1.1 Idea Generation

### Comparative Evaluation of the Designs

Idea	Strengths	Weaknesses	Opportunities	Threats
Idea 1	Fastest setup time of all the other ideas due to the simplistic nature and simple locking feature compared to the other designs. The first design would have the lowest material cost due to the efficient design of the cover.	There is not a lot of versatility in the shape of the cars or belongings that can fit into the cover. Low cars would not be able to make it in without the assistance of ramps. Depending on the shape of the cover there may be awkward bumps for cars to get over which might damage the structure of the cover or car.	Different shapes and sizes of car cover for different cars.  Designing it differently to accommodate more car types in the one size.	Another company produces a similar design better suited towards the different car shapes using better materials. Hence a design patent is necessary.
Idea 2	Fast setup time similar to Design 1 in that setup is quick but the added locking mechanisms per pole increases this time.  Easy ability to drive into due to all the beams being flat allowing more car types than Design 1 inside of the car cover.  Flatter storage compared to Design 1 due to the poles being inline.	Increased material usage due to the beams being flat when packed away.  Poor versatility in what can go into the cover including the type of car or size of belongings that are going inside the cover	Use of effective locking mechanisms to secure it quickly.  Designing it differently to accommodate more car types in the one size.	Another manufacturer could make this idea for cheaper or with better quality materials that I do not have access to. Hence a design patent is necessary.
Idea 3	Versatility of what can fit inside one of these covers from cars to fridges or washing machines. This high versatility makes it have more uses than the other designs and likely to be more desirable for consumers.  The design enables it to be packed down to the smallest size for storage and handling.	Slow setup time but still could be under the 5 minute setup time criteria.  Highest material cost of all the designs due to the large number of joints.	Cars of different shapes would be able to fit into one size. The design can easily scale to have 3 sizes: small, medium and large. Further design development could improve the design to enable the structure to be assembled much quicker. Things such as quick release hinge locking could be explored.	Another manufacturer produces something cheaper or improves the design to where it is easier and faster to set up by using self locking mechanisms. Hence a design patent is necessary.

### Chosen Idea and justification

I have decided to go with Design 3 for my Major Design Project. I believe this design will ultimately fulfil the design brief to the best ability by allowing the most protection for cars and other valuable objects that people have within their house. The design also best meets my criteria for success. The function of this design will be the best of the three due to the high versatility of what can go inside whilst being able to protect it from the elements. Although the overall cost of this design will be more than the other ideas, it is offset by a stronger design than the first two ideas. This option is the easiest one to zip up, as it does not require the user to zip the cover over the top of the vehicle and it only zips at one end. The safety of this design will be the same, if not better, as there will be no risk of an unsupported side falling on a user. Material choice would be very similar across all three designs, but the amount of jointing needed for Design 3 is the greatest of all the designs. However, this helps this design to be the strongest design of all. Quality will be harder to maintain in this design, due to the size of the product. This design requires more joints, with more joints there is an increased probability of a joint failure. This can be mitigated by improving the strength and durability of each joint to improve the quality and reduce the risk of failure. The durability of this design is the best of all the designs, as it will be better handling the many times this is used under varying conditions, with repairs being able to be made very easily. Reliability of Design 3 is a potential factor to worry about due to having many moving parts, this may cause problems if a single joint fails to open not allowing the whole bag to open correctly but this can be tested for and ways around it can be discovered in the further research of this final product. Although the Aesthetics are not a major part of the overall design, it can help if the cover floats somewhere and needs to be found. Efficiency of the product is the final item to consider when looking at how fast the setup process is, due to one of the main goals being a setup time under 5 minutes. This design achieves this and is the final reason why I chose Design 3 to produce for the rest of this project.

# 2.1 Evidence of Creativity

## 2.1.1 Idea Generation

Similar Product	Image	Similarities	Differences
Flood Tough Bag		The flood tough bag is similar as it is designed to wrap around a car and prevent any water from getting in when it is flooding and is made out of similar materials to what I plan to use in my design.	Due to the bag not being able to stand on its own, it requires at least two people to be able to put the car inside the bag. The Flood Tough bag is also not rigid and so allows floating debris strikes to cause damage to the vehicle inside. The absence of tie down points means the car can float and be washed away.
Car Bubble		This idea is similar in the way it protects vehicles in the event of hail and rain through the use of a material that is kept off the main body of the car.	This style of design is inflatable which works well in conditions of rain and hail but requires constant power to keep it inflated. In most extreme weather events power supply is one of the first services interrupted leaving the car unprotected and susceptible to damage.
ClimaGuard		This is a solution aimed at protecting cars in floods which is a tarp material which the car is driven onto and sealed by folding the cover around the car. The operation of this cover only takes one person. The inclusion of tie down points prevents it from floating away. It is sealed using a water proof zipper	This design is very similar however there is no protection for the car inside the bag, floating debris can cause large amounts of damage to the car inside, whereas in my design the rigid design ensures the protection of the cars and items inside by having a rigid structure around it preventing damage to it.

### Evaluation

I found it difficult to identify similar products to my project due to the uniqueness of the idea. Whilst I did find the Tough Bag and Car Bubble, neither provided the level of protection I was seeking to achieve. Hence my research suggests my proposed solution is truly unique and could be highly marketable.

# 2.2 Consideration of design factors

## 2.2.1 Consideration of Design Factors

### Function/Ergonomics

The collapsible design allows for it to be moved around easily with this having a large impact on the success. This is one of the main reasons it has a collapsible design, making it easier to store in a house when it is not needed whilst still having a fast set up time. The design of the key locking mechanism has had ergonomics in mind with the key having a large area to grab and pull them out when packing the structure up. The simplification of the closing mechanism by using a zip allows for ease of opening and closing of the enclosure for any user.

### Life Cycle Analysis

The car cover has been built with the lifecycle of the product in mind, through the 'Cradle to Cradle' idea. Although built to be strong and able to be used for many years, the car cover is assembled using 3D printed parts and steel with hot glue being used to secure parts together. Due to this the hot glue can be reheated and then the frame can be disassembled into its original components. This ensures that the design can be recyclable when it reaches its end of life, due to PLA being recyclable and the steel can be scrapped. To help prevent this and with parts being able to be mass produced, spare parts can be sold separately if there is the need to fix or replace broken parts to help extend its life cycle (joints and locking keys).

### Materials, Tools and Techniques

Materials, tools and techniques have been used to create the design in such a way that repairs or replacements can be made to the design at home, allowing for this to be more user friendly and can extend the life cycle of this product. The product includes all parts required to assemble the structure without needing any tools to build it.

### Impact on Individual, Society and Environment

This product will have a positive impact on the Individual, Society and Environment. The individual will see a major impact due to the sense of safety, having a product like this can have on an individual, knowing that they have systems in place to protect their personal belongings in the event of sudden extreme weather events like hail and flooding. Although I assume, due to the heavy duty design of this product, there will be a small impact on the environment, it would serve as a great way to prevent the waste that flood damaged goods have on the environment. Preventing these items from being damaged can stop them being sent to the tip or harmful chemicals that cars have in them from leaking into the environment during floods. By reducing impacts on the Individual and the Environment, this product goes a long way to reducing the total impact of extreme weather events on Society.

### Economics

The materials that would be used in the design are highly available and so should make the overall design cheap to produce, especially if the design was produced at full scale, it would remain cheap to produce. There are lighter and stronger materials that could be used like aluminium, however that is more expensive and is not necessary for the scale prototype which will be produced for my Major Design Project. This could be explored in future development though.

### Physical Characteristics

The consideration of the overall size is a major factor in the success of this product, as if it is bulky and hard to store it could prevent potential users from purchasing it. So maintaining a low profile design is important for storage whilst being able to maximise the space inside the cover when it is used. The weight of the product also needs to be considered in the ability for the cover to be moved and stored (by a single user) when it is not in use and so ensuring that the design is both strong and lightweight is important.

### Safety

The inclusion of tie down points, so as to tie the cover down would be useful to ensure that the cover does not end up like debris already in the water, the rigid frame design will also ensure the safety of objects inside the cover. Joint failure is one of the greatest safety concerns, hence why additional emphasis has been placed on the joint design and quality of production.

### Sustainability

The materials used in my design have been carefully considered to minimise their impacts on the environment with the use of steel and 3D printed PLA materials to ensure that they can be recycled at the end of their usage. They are both 100% recyclable. This design should also prevent more damaged goods being sent to the landfill or having harmful chemical leaking from cars, this design will help prevent damage to the environment. I had to be mindful and prioritise the strength of the structure as it is essential to the performance of the design. Whilst timber could have been used as a more sustainable product, it would not provide sufficient strength.

# 2.3 Appropriate Research and Experimentation

## 2.3.1 Research

### Primary Research

To gather primary research for my project I conducted an interview with flood victims and asked many questions relating to what they would expect from a piece of protective equipment in floods as well as what they would be willing to pay and use the cover for.

**Q: How much would you be willing to pay for a device that can protect expensive belongings that you couldn't take with you in a flood?**

A: "I would pay up to \$1500 for a device that could protect my belongings."

A: "\$400"

A: "Up to 1000 dollars, due to the at risk region I live in it would be extremely helpful in protecting my belongings, especially due to how frequent this problem can be in flood season"

**Q: Is the weight of a protective device an important consideration if you were in the market to purchase one?**

A: "As long as the device is mobile enough to move it into place then I think the weight shouldn't matter too much."

A: "Yes, or at least it should be able to come apart so weight does not impair my ability to use the device when living alone."

A: "Yes, I would rather buy a lighter device over a heavier one, although heavier ones are more heavy duty and strong I'd rather have a light one for quick assembly due to the prevalence of flash floods."

**Q: In a flood, what items would you want to protect if you had to leave them behind?**

A: "If I had to leave it behind I would want to protect my valuable items like my pc and other electronics and if I couldn't leave by car I would want to be able to protect that.."

A: "Items of sentimental value."

A: "I would want to protect my car over anything else, most home appliances can be replaced with a reasonable cost, but my car is an expensive investment and I would rather not need to purchase another one, even with car insurance it is an extensive process, if there was any other room I would try to place any other home electronics that would fit in the car."

### Evaluation

I was only able to find a few flood victims to survey and so my responses are limited by still gave me some valuable information especially about what consumers would want from a protective device. If I did this again I would try to extend my reach by using a survey and try and get results from a larger age range to help give me more information about differences between target markets.

### Secondary Research

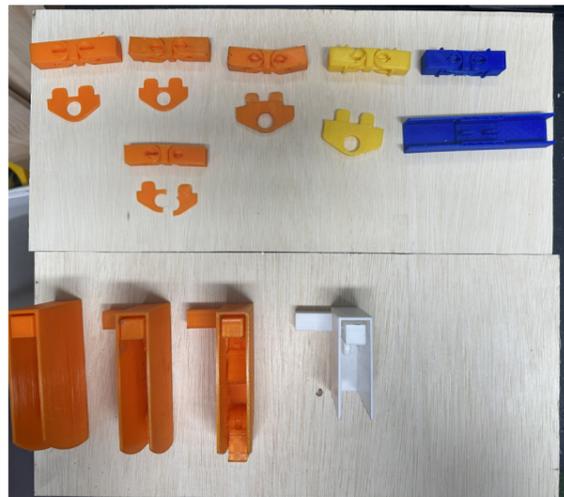
Area to be Investigated	Result of investigation
<b>Usage</b>	I determined that most users are looking to save large expensive items that are too bulky to move at the last minute, this can include some large pieces of furniture and electrical items like tv's as well as their cars that they cannot take.
<b>Target Markets</b>	To identify my target markets I found that there are many areas around the world globally which suffer significant personal losses from flooding. I reduced this down with a particular focus on regions of Australia which sit in flood plains. Similarly, areas in America such as Florida or Texas which suffer the impacts of hurricanes. These areas also have sufficient personal wealth to be able to afford to spend on a product to protect their items from extreme weather conditions. Hence areas with needs and the financial capacity.
<b>Costs</b>	I determined there are many different outlets that I can purchase my materials from. They have varying costs associated with them. I have determined that the best place to purchase the steel is locally, due to being able to transport it myself and lowering any shipping costs associated. Unfortunately, there were no major tarpaulin suppliers in my area so I had to order online which incurred shipping costs.
<b>Size and shape of cars</b>	I determined that I would design for a compact coupe style of car. This is due to having the ability to gain measurements and test on one, furthermore, allows for the project to be cheaper as it is a small style of car. If this solution were to be scaled, it would come in many different shapes and sizes to accommodate for many car styles. The ability to fit a car will also allow this to cover other valuable items like furniture, appliances, art or pieces of technology like tv's that are bulky and hard to transport quickly.
<b>Material use of the outer shell</b>	After researching many different materials that could be suited for the exterior of the canopy, I have concluded that the best material will be a tarpaulin type material. However, testing will need to be conducted to determine the exact specifications of the tarpaulin so that it is durable, waterproof and is resistant to small scratches.
<b>Material of interior frame</b>	I have discovered that the best material for the inner structural poles will be hollow square steel tubes that are 20mm x 20mm, this has been decided by its strength and durability qualities when compared to other possible materials such as timber and carbon fibre struts. Likewise the additional weight (rather than aluminium) will help keep the structure on the ground. The hollow sections enable the joints to be easily inserted as well.
<b>How to sew the tarp</b>	After researching many types of stitches I found that the best suited stitch would be a flat felled seam. This is because it forms a tight multilayered seam that reduces the ability for water to get in. I will also need to add a sealant or other form of sealing adhesive to ensure it is 100% water tight

## 2.3 Appropriate Research and Experimentation

### 2.3.2 Experimentation

#### Testing Hinges

A main component of my design is how the hinges function and their ability to lock in. As well as having two hinges side by side when they were folded. To make these hinges I would have to have them on the inside of the steel lengths to allow for them to fit next to each other, this presented challenges in designing the hinge to be manufactured for the many joints that move in the construction of the design. Making a locking mechanism was easy to design, I designed one myself as there were no suitable options already made. I 3D modelled my ideas and used a 3D printer to produce them. Many versions were needed until I found one that fit well and was strong enough to support the weight of the steel. Pictured below are all the photos of all the versions lined up in order of when they were made.



#### Testing Tarp joining and sealing

Another area that needed to be tested was the joining of the tarps and to test how waterproof these joints would be. To do so, I used some offcuts that were from the main tarp portion. I practised a flat felled seam with the help of my Grandmother and her sewing machine. After the seam was sewn, I made a box using the tarpaulin and the flat felled seam on all the corners and then filled it with water to test how waterproof the seams performed. This confirmed that I would be able to use this seam type on the final product that I was producing. The holes produced by the sewing had caused some minor leaks and so I tested the use of silicone (from the inside) and waterproof fabric tape (from the outside) to see which had the best sealing properties. Both proved to be effective however the silicone was unable to bend far enough to fold up the tarp when packing it away. The tape had a strong hold and could flex easily proving to be the better option.



## 2.4 Application of Conclusions

From the testing I was able to conclude that the chosen tarpaulin material is suitable for use on my project as it will be waterproof and the seams used will be able to prevent water from entering the cover in the event of flooding. I was also able to conclude that the hinges that I designed were able to take the necessary weight of the prototype cover along with the weight of the steel. The joints were sufficiently strong enough to hold weight and some lateral forces. The joints were all produced using 3D PLA, however the actual joints would need to be produced using aluminium or steel for the full force of the storms. The designs I've developed can easily be constructed from aluminium or steel and can easily achieve my design intent. I have also been able to determine that I will use a flat felled seam when sewing my cover and seal using a fabric tape to ensure a full seal.

#### Evaluation

Through experimentation I have been able to produce much higher quality parts for my prototype that look and function better because of the processes undertaken to make them better. Experimentation and testing has also allowed me to also determine that I needed a sealing feature for the seams and to conclude that waterproof fabric tape was the most ideal solution. The application of these results will result in a better function final prototype.

# 2.5 Identification and Justification of Ideas and Resources

## 2.5.1 Table of Resources

Resource	Identification and Justification
<b>People</b>	<p>Teachers - Mrs Sutherland, Mrs Deeves and Mr Schroeter have been crucial in assisting the design and construction stages to help finish, as well as providing advice on different designs and my portfolio.</p> <p>Brendan Bilston - Supervision of myself when working on the project and assistance in ideation and construction.</p> <p>Dr Mark Rebentrost - Dr Rebentrost was critical in the evaluation and feedback of my final design helping identify what I can do to improve my product.</p>
<b>Materials</b>	<p>Steel - Steel is a common material with many sizes available at many stores including in my region. Steel is very sustainable as it is 100% recyclable but it does take large amounts of energy to produce. Steel is also strong enough for my prototype and final design application.</p> <p>PLA plastic - This was chosen as I didn't have the access or budget for custom made aluminium hinges for this project. In a full scale production aluminium hinges would definitely be the intent.</p> <p>Epoxy - I used epoxy as it was the best at bonding between metal and plastic when I needed to connect those two materials.</p> <p>Polyethylene Tarp - Most suited type of tarp for my project as it is water tight and easy to cut and sew to form the cover.</p> <p>Thread - The thread was needed for sewing the tarp.</p> <p>Waterproof zipper - A 3 metre waterproof zipper was chosen as it is a strong and reliable way to seal something that needs to prevent water from getting in.</p> <p>Bolts - I had to use some 35mm M8 bolts to secure hinges that broke in the corner after my project accidentally fell over. This was a quick fix to ensure it would be presentable.</p> <p>Waterproof tape - This was used in the sealing of the seams and corners as an extra layer of protection for the seal of the design after I had determined just the seams were not enough</p>
<b>Tools</b>	<p>3D printer - I used a 3D printer to prototype and build the parts for my project including the hinges, corners and keys.</p> <p>Computer - I used a computer to write up my portfolio and needed it to 3D model my parts.</p>

Resource	Identification and Justification
<b>Tools</b>	<p>Angle grinder - I used the angle grinder to cut my steel sections and clean the edges once they had been cut.</p> <p>Metal file - I used a metal file to file sharp edges.</p> <p>Sewing machine - Used so sew the tarp and sew in a zipper.</p> <p>Drill and drill bit - used to drill holes for bolts to be inserted to secure corners.</p>
<b>Techniques / Skills</b>	<p>3D modelling - I used my skills and knowledge in 3d modelling to produce the hinges and keys seen in my design</p> <p>Metal fabrication - I used some of my experience with metal fabrication to cut and clean the metal tubing that I used.</p> <p>Sewing - Sewing was used in the project to join the different parts of the tarp to form the rectangular prism.</p> <p>Sketching - I had to use sketching to initially represent my ideas before 3d modelling them</p>
<b>Software</b>	<p>Google Docs - I used google docs to write all my information in my portfolio as it accessible from multiple computers and allows for easier peer feedback on my portfolio</p> <p>In design - I have used Indesign to format my portfolio after completing all my writing as it allows for more creative freedom in the display of my text and images.</p> <p>Onshape - I used onshape for all my CAD work because it is simple to use and cloud based making it more accessible.</p> <p>Flashprint - I used flashprint to be able to turn my 3D models into a printable format.</p>

# 2.6 Use of Communication and Presentation Techniques

## 2.6.1 Communication and Presentation

### Fonts

The font that I used in my portfolio is Arial size 12 as this is slightly bigger than size 12 Times New Roman and also looks better for the sleek modern aesthetic of the portfolio. Additionally, I feel that this looks better across a larger page size like the A3 page used for my portfolio and feels easy to read. I used Arial Black for headings as it is a slightly thicker font making the headings even bigger and easier to read.

### Colour

I have used a blue colour theme throughout the portfolio as it ties into water and flooding and helps theme the portfolio. Colour has been used to make headings and subheadings pop out on the page, I decided to make the Headings and subheadings different shades of blue as it makes them easier to distinguish between. I have used blue boxes for evaluations as it helps them to be seen clearly and distinguished from regular text. I have kept the colouring theme the same across the whole portfolio as I believe it looks better and wouldn't serve much purpose changing it for the 3 different sections as the headings are at the top of each page. I have also used colour in tables to help make the headings of columns and rows stand out more.

### Graphic Methods

I have used many graphic methods to present facts in section 1 of the portfolio to help demonstrate some of the facts around flooding and the effects that it has on people and to visually demonstrate how much money is spent due to the effects of floods in countries. The use of graphic organisers such as mind maps and tables have been helpful to demonstrate the ideas for this project and the many different focuses I had coming into this project with this mainly being seen in part 1 of this project showing my different ideas for this project with the tables being helpful in the organisation of research and investigations. I have also made great use of photos to help the markers visualise the process of the making of the practical component that is the ½ scale cover, this helps show the steps taken, tools used and the assembly of the design.

### Consideration of Markers

I have made the layout of my portfolio following the topics from the marking rubric so it is in order and easier to mark. Large headings at the top of each page also allow for the markers to know exactly what section they are in on every page. The evaluations are in a separate colour in order to stand out to markers and easily see my progress and continued evaluation and conclusions made about my assignment. Use of images and other modes of communication including visual mind maps, pictures, the use of renders from 3D programs allow for easy communication of my ideas to the markers. The accompaniment of finished picture of the design also allow for greater visibility of all angles of the design for the markers to be able to evaluate my final product.

### Headings

To make the headings clearer I increased the font size to size 28 for main headings and size 20 for sub section headings to help distinguish obviously at a glance which is which, along with putting them in different colours. I also put the heading under the section at the top of each page to make it easier to recognise which section the reader is in as well as the sub heading where appropriate. Size 16 has then been used for headings of specific parts underneath the section headings to distinguish from normal text.

### Formatting

I have used A3 pages as they are larger and allow for the better presentation of text and images on pages with more freedom in where they go. A3 page also allow for larger images to be seen more clearly. with the help of InDesign I have been able to set out my pages to be neat and layout text and images in a cleaner way than any other program could. I have also ensure that all my images meet the 50mmx80mm requirements that NESAs has set out for photo clarity.

### Prototype and Model Display

To accompany my prototype I have made a testing display board with my hinges and their evolutions, including ones that had been broken during the testing stage and the reasons that they failed. I have also made a small testing display of the tarp and the stitching used from my prototyping. This is due to the fact that the scale prototype could be hard for the markers to see the inside of the rigid car cover clearly so well taken photos have also been provided.

### Markers Display

The central piece is the ½ scale prototype that has been made for this project, this demonstrates the practical component that was completed for this task with it being well built and tested to determine its strength. Having a working scale prototype for the markers, helps them to see how thought out the design process was and how the construction was completed and the quality of the design. I have decided not to have the prototype extended for the marker's display as it is very fragile as it is only a prototype and is quite large.

### Evaluation

I believe I set out my portfolio really well with clear headings making it easy to distinguish where the reader is and what they are looking for. I believe I have used graphic methods effectively to demonstrate my ideas but I think I should have used some more throughout my portfolio to further help represent some of my ideas. I believe the overall communication in my portfolio has been made with the reader in mind so that it is easy to read and understand.

# 2.7 Evidence and Application of Practical Skills

## 2.7.1 Detailed Record of MDP manufacturing Process

### Stage 1

#### Time: 30 Minutes

The first stage in the construction of my final design was marking all the lengths of steel that need to be cut. To achieve this I used masking tape to identify the rough area that needed to be cut and then measured using a measuring tape and drew a line with a pencil around the masking tape to make the line visible and easy to see for cutting the steel from all sides.

#### Evaluation

In this part there were no major issues identified other than sometimes the lines were uneven due to slight measuring mistakes but posed no real issue as I left excess steel on the end which could be cleaned off once cut.



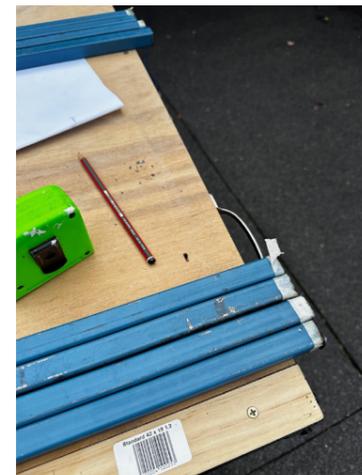
### Stage 2

#### Time: 2 Hours

The second stage in the manufacturing process was cutting all my steel lengths to the size needed for each of the sections. This was made easy as the supplier that I purchased the steel from, was able to do some cheap cuts from the original 6.5 metre lengths down to lengths that I will use in the large sections of the design. Along with the cuts from the steel business, I needed to make the smaller cuts in the section that are required to bend. To make these cuts in the steel length I used an angle grinder to cut the sections a bit above where I marked to allow room for finishing the sections off.

#### Evaluation

Cutting the steel sections was made more difficult as the angle grinder's cutting blade diameter wasn't big enough to cut through the whole steel section at once, requiring me to rotate the steel to cut all the way through, this made some uneven cuts in the steel which would later need to be made clean and flat. Another problem encountered was also the accuracy of my cutting which left some cuts angled, a minor problem which was addressed later in the cleaning process but my cutting skills improved throughout the process.



### Stage 3

#### Time: 1 Hour

After finishing all the cuts needed in the design, the next step was to clean all the cuts up. To do this I used a grinding attachment on the angle grinder, files and pliers. I used the angle grinder to make most of the cuts flat. Next I used a file to remove any leftover steel from the outside of the lengths and because the file couldn't fit inside. I used pliers to remove any material left inside of the steel sections.

#### Evaluation

There were no problems encountered in this section and it was very necessary to complete this part to help in the future parts of the project but it just took large amounts of time to complete this process as there were a lot of steel sections to clean up.



# 2.6 Use of Communication and Presentation Techniques

## 2.7.1 Detailed Record of MDP manufacturing Process

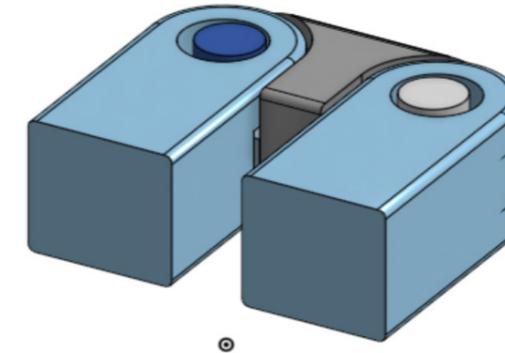
### Stage 4

#### Time: 3 Hours Design 8 Hours Printing

Once the steel cuts were finished the next part of the process was to make hinges that would allow the rigid parts to bend. I could not find any standard hinge designs that would lock, so I designed my own in Onshape. This allowed me to have a hinge that once folded would have the two steel lengths parallel to each other and once extended they could be locked into place in line to each other allowing for the extension of these poles and locking into place. It took many attempts to perfect the hinges which is evident in my experimentation which allowed to me to effectively work on my project and continue construction.

#### Evaluation

This section took a long time due to the amount of prototyping that was required to get a good fit that was also strong enough to hold the steel beams, even in the final version there is a bit of sag due to the parts flexing and not being tight enough. But the system locks together well and works enough to prove my concept as the prototype is intended to.



### Stage 5

#### Time: 2 Hours Design 40 Hours Printing

This stage involved designing and making the corners of the main frame, this was very easy as I used the main functioning mechanism of the hinge to make the parts that needed to move and then added some horizontal and vertical joints to connect the width sections of steel and the height sections of steel, I then printed these designs and it took one prototype before the final design was finished.

#### Evaluation

This part was completed very well; only requiring some time to complete the design and printing of the prototype design. Although since the parts being printed were much larger than the hinges it took much longer for each corner to be produced with each corner taking 5 hours to print, this left me with not a lot of physical work that I could be doing during this time I was waiting.



### Stage 6

#### Time: 30 Minutes

At this stage I did a test fit of all the parts except the bending joints. This allowed me to have a feel for how the parts were going together and the strengths of all the parts. and the overall shape of the design. at this tage I realised that the original design was going to be too time consuming to make and switched to the simpler design which allowed for beter support and helps minimise sagging of thetop lengths of the beam due to previously unsupported weight.

#### Evaluation

I found that everything fit and held well whilst it was in position, this gave me confidence in what I was doing and the final design being assembled. I found the design to be very strong and capable of supporting my weight on top of it. One issue I discovered was that there was lateral sway in the assembled structure. I think this can be fixed by securing the joints futher or modifying the corners to be stronger. Here I was able to also resolve the issue of the overcomplicated design that wouldnt have assisted in the structure, this allows for a much simpler design that will be easier to produce. This will also leave with with extra unused steel that will nolonger be used on this project.



# 2.7 Evidence and Application of Practical Skills

## 2.7.1 Detailed Record of MDP manufacturing Process

### Stage 7

#### Time: 2 hours

After the test fit I found that my design was too long, this was because I did not allow for the length of the hinges in the design. To overcome this I cut down the metal sections which originally had excess on it because the design had allowed for it due to the change in design. To do this I had to use the angle grinder to cut and clean the metal pieces again. I also modified the corner hinges by cutting off the front hinge that is no longer needed by using a hacksaw, this gave me the perfect length that I was looking for in my original design.

#### Evaluation

This needed to be done due to unforeseen issues that the hinges would have on the overall length but was easily overcome due to changes that were made in stage 6 where the redesign happened which made the front hinge on the corner obsolete allowing for the removal of it



### Stage 8

#### Time: 1 Hour 30 Minutes

To attach the hinges to the steel on my first attempt I used hot glue which worked well, however, there were some broken hinges in the process because there was insufficient space for the glue. My first attempt at using epoxy using the self mixing nozzle was a disaster as the mixing nozzle didn't mix the epoxy well enough preventing it from setting. Later I had to redo this because some epoxy didn't activate leaving it sticky and not set hard therefore not securing the hinges to the metal. On my second attempt using epoxy, it worked very well as I hand mixed the epoxy and applied it to the hinges and put it in the steel sections. This had the best results as it dried quickly and set strong to hold the steel.

#### Evaluation

This showed me the importance of testing different methods to find the most suitable. Even though the first attempt failed, the improved application produced a better finish and much stronger connection between the two materials.



### Stage 9

#### Time: 1 Hour

This stage involved the cutting of tarp to the correct dimensions. To do so, I laid out the tarp and put the metal sections on top of it to get the right sizes for sewing. I then measured out 10 extra centimetres for a seam allowance and contingency for errors and cut it out using normal scissors as the tarpaulin material was very easy to cut and didn't fray as I had expected it to.

#### Evaluation

This section was completed quickly and well, I encountered less problems than I had expected such as not having the tarp cut by the tarp fray and having to overcome that which helped in the quick completion of this stage.



# 2.7 Evidence and Application of Practical Skills

## 2.7.1 Detailed Record of MDP manufacturing Process

### Stage 10

#### Time: 2 Hours

Through research I found that the best way to attach the tarps would be to sew them using a flat felled seam. After cutting the tarps and measuring, firstly with the help of my Grandma, we sewed the zip onto the sides at the opening and closing flap. Once complete I then attached the zipper piece. After more measuring and cutting (leaving 5 cm of area for the seam to be sewn onto). The tarps were sewn together. Once the tarps were fully sewn together I sewed up the corners to ensure they were waterproof. Then I cut away any excess

#### Evaluation

The sewing was made difficult due to the large size of the tarp. This made it difficult to manoeuvre and rotate around the corners, having 3 people helping sew and hold the tarp made this part easier. The quality of stitching was very high allowing for a very good seal on the tarp with testing needed to determine if there will be an internal sealant like silicone required or an external tape to seal the overlap.



### Stage 11

#### Time: 30 Minutes

At this point I attached the D-links to which the frame could be tied down to the outside of the tarp. The process involved hand stitching them on and then covering them with the waterproof fabric tape to seal.

#### Evaluation

This was quick but had to be hand stitched due to being unable to sew with the cover complete and has overall had a positive impact on the design being an improvement that I had not thought of until it was nearly done that would have a significant impact on the overall success of the prototype.



### Stage 12

#### Time: 1 Hour design 3 Hours Printing

In this stage I redesigned the key systems that were used to hold the hinges in place, this is due to there being too much sagging in the original design. This caused it to not look and function correctly, the re-design involved adding external casing to it to keep them straighter once they were locked into place. This involved me editing my original key design on Onshape

#### Evaluation

Although it cost more in time and filament used in the printing this would overall benefit the design and operation of the prototype.



# 2.7 Evidence and Application of Practical Skills

## 2.7.1 Detailed Record of MDP manufacturing Process

### Stage 13

#### Time: 1 Hour

At this point the only thing left to do in the construction of the cover was to tape all the seams using a waterproof fabric tape. Doing this allowed assurance that all seams and holes were covered and would not allow any water inside the casing.

#### Evaluation

This stage was necessary to ensure the complete closed seal of components and took some time to complete due to the awkward size of the tarp. Although the use of the tape did minorly detract from the aesthetics of the overall designs due to holes, the requirement to cover holes in the tarp from when it had D links attached is necessary for the success of the prototype product. This process did take some time due to the awkward shape of some of the seams that needed to be sealed.



### Stage 14

#### Time: 30 Minutes

This stage involved the placement of the rigid frame inside the cover which was a complicated process as the frame was assembled outside the cover and was lowered into place, there were problems encountered when the tarp was going in due to the small tolerance that the inside of the cover had which made it a tight fit and took 4 people to effectively lower it and manipulate it into the bottom of the cover. Once it was in this completed the manufacturing process of my project.

#### Evaluation

This stage was made difficult due to the little tolerance I had left in my design which caused it to take a long time and struggle to be able to sit correctly in the tarp but once it was in it fit snugly and allowed for the use of the Extreme Weather Cover.



# 2.7 Evidence and Application of Practical Skills

## Stage 15

### Time: 3 Hours

Although not required at this stage I used InDesign to make a small instruction booklet which details the contents of the Extreme Weather Cover as well as how it can be assembled. This will assure that users with minimal knowledge of the product will be able to set it up with easy to read instructions. The manual is both in the markers display and on the next pages for easy access.

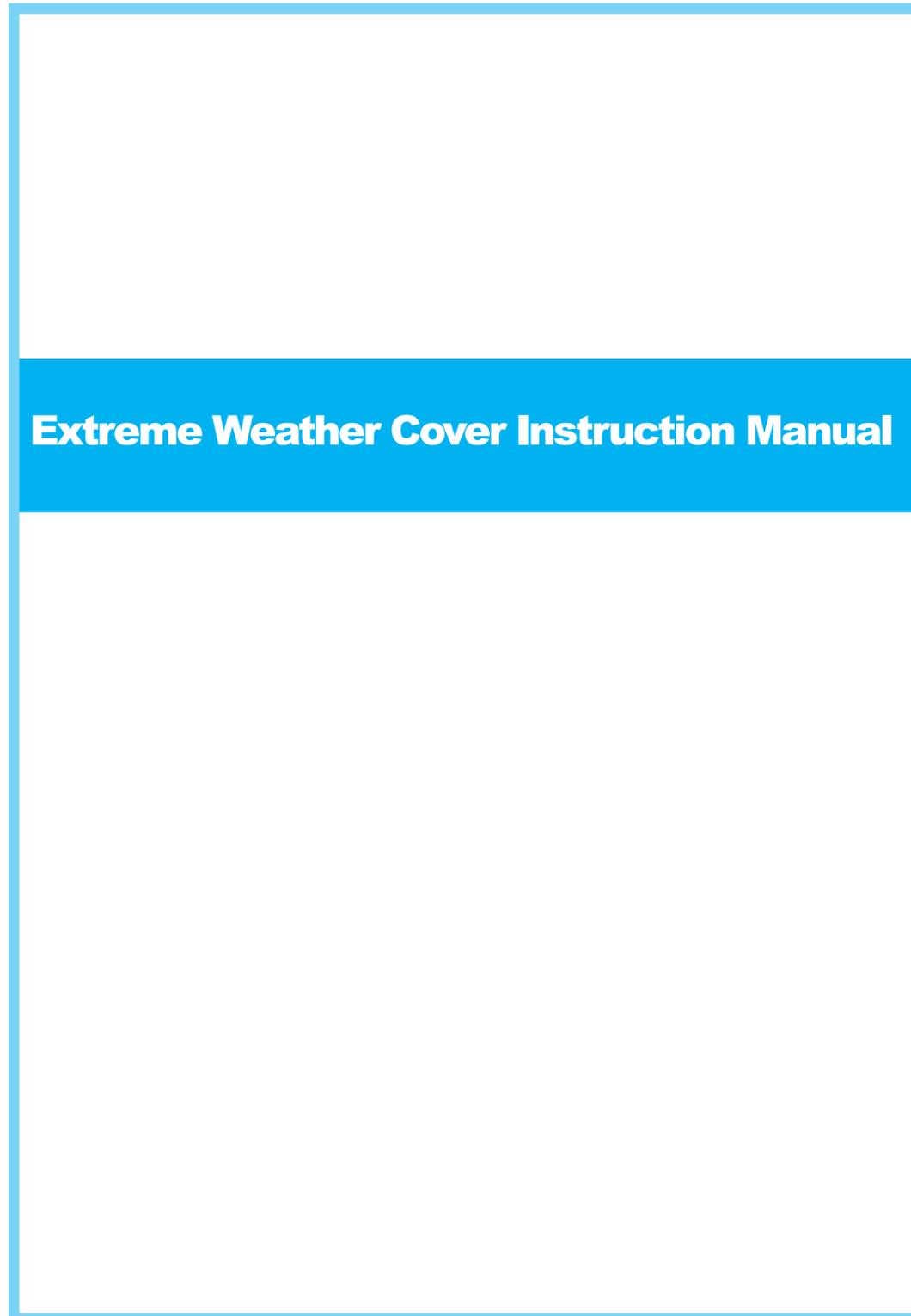
### Evaluation

I am happy with the way the manual was made as it was a quick way to be able to let others test my product and gain more of an understanding into how it works.

### Instruction Manual

The instruction manual has been made to help viewers be able to understand the assembly of my product. There is a title page, Page of Contents and 3 pages for the steps it takes to assemble the frame. The Instruction manual provides simple instructions on how to use the special parts of the frame. Colour has been used to allow people to see direction of travel and identify points where the keys need to go into.

## 2.7.1 Detailed Record of MDP manufacturing Process



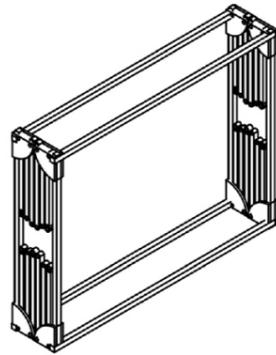
# 2.7 Evidence and Application of Practical Skills

## 2.7.1 Detailed Record of MDP manufacturing Process

### Instruction Manual

#### Contents Included

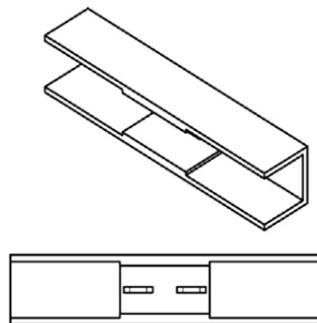
1 x Frame With Cover



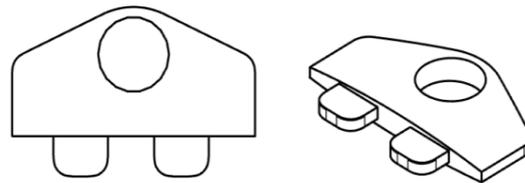
2 x Middle Supports Beam (MSB)



16 x Beam Keys (BK)



4 x Middle Support Keys (MSK)



*The product comes with the frame inside of the tarpaulin bag, zipped closed.*

#### Assembly

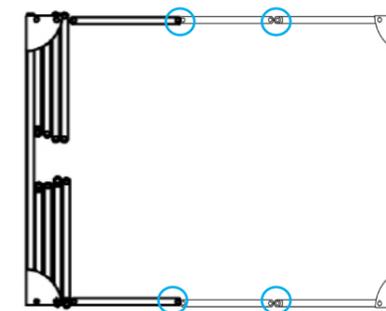
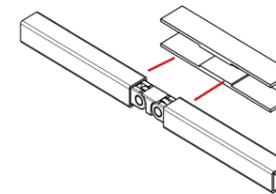
Stage 1 Setout



Open the enclosed frame with the bag to lay out flat and pull out all contents inside. Next ensuring that the frame is standing perpendicular to the floor before starting to extend

Stage 2 First 2 Sections

Unzip the bag and extend the frame until the first three steel sections (from the zip end) are extended exposing 2 joints per Beam. Using the Beam Keys (BK) secure each hinge (top and bottom beams) by inserting the Beam Key (BK) from the outer side of the frame. The Beam Key (BK) is designed such that when both beams are horizontal key should be able to slide in vertically and secure itself.



These blue circles demonstrate where the Beam Keys (BK) should be on left and right sides of the internal frame

# 2.7 Evidence and Application of Practical Skills

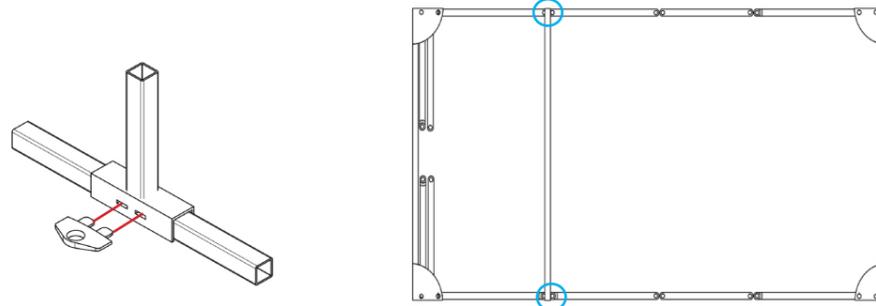
## 2.7.1 Detailed Record of MDP manufacturing Process

### Instruction Manual

### Assembly

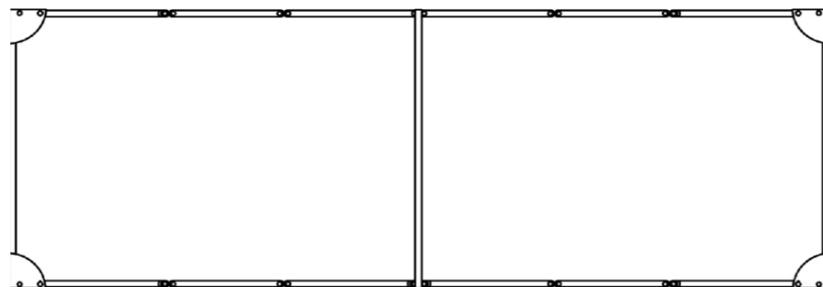
#### Step 3 – Securing the Middle Support

The 3rd joint in each beam is the middle joint. At this point insert the Middle Support Beam (MSB) with the three-way connection overlapping the middle joint. Once in place insert the Support Key (SK) from the outer side of the structure. This locks the joint from moving vertically as well as securing the Middle Support Beam (MSB) which reduces vertical flexion and provides additional rigidity to the frame.



#### Step 4 - Securing final Beam Sections

Extend the last Beam Sections exposing the last two joints in each Beam Section. Similar to Step 2, using the Beam Keys (BK) secure each hinge (top and bottom beams) by inserting the Beam Key (BK) from the outer side of the frame. The Beam Key (BK) is designed such that when both beams are horizontal key should be able to slide in vertically and secure itself. The metal structure is now fully extended and all joints are secure in place.



### Assembly

#### Step 6 – Closing the Bag

In this step you either drive a vehicle into the storage unit OR you place your personal items inside the storage unit. Once all items are inside the storage unit you are ready to enclose the bag by zipping the zip from the open position to the fully close position. The metal structure is now fully extended and all joints are secure in place.

## 2.7 Evidence and Application of Practical Skills

### 2.7.2 Production planning

Tool	Hazard	Possible Injuries	Risk (1-5)	How to Minimise risk
<b>Angle Grinder</b>	Spinning blade Sparks Electrical Cables	Cuts Burns Electrocution	5	Doing all the correct pre-work safety briefs and teaching on how to operate the tool. Wear clothing that covers all body parts to prevent sparks from getting on them and wearing correct footwear that is fully enclosed. Wear safety glasses to prevent any damage to eyes and wear headphones to minimise risk of hearing damage. Have the teacher or parent watching to ensure the tool is being used safely. Always be mindful of having the electric cable behind you and away from the blade.
<b>Files</b>	Small metal pieces Sharp edges	Splinters cuts	2	Making sure the tool is used properly to not cut myself. Be careful not to touch the sharp metal edges with your hands as small metal splinters can easily pierce your hands. Best to use gloves.
<b>Epoxy</b>	Fumes Contact with skin	Lung damage Damaged skin	3	Wearing of gloves to prevent epoxy getting on hands and wearing a mask to prevent inhaling of the fumes. Using it in an area with good ventilation or applying it in an outside area can also limit the impact of the fumes.
<b>3D Printer</b>	Hot Extruder tip Fumes	Burns	3	Make sure to keep hands away from the extruder whilst printing until it is cool and have the printer in a well ventilated area to ensure fumes do not build up.
<b>Sewing Machine</b>	Needle	Needle piercing hand/ fingers	3	Have supervision when using the machine and be cautious whilst using it. Having correct instructions on how to use it and doing the safety courses before using it.
<b>Hacksaw</b>	Sharp blade	Cuts	2	Making sure the material being cut is secure and having one hand on the hacksaw with the other holding the material being cut. Ensuring that correct footwear is worn in case of dropping the tool.

# 2.7 Evidence and Application of Practical Skills

## Photos of Finished Prototype



**Extreme Weather Cover**

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# **Evaluation 3**

# 3.1 Record and Application of Evaluations

## 3.1.1 Record and Application of Evaluations

### Project Proposal

I have completed the part of my project very well being able to identify many possible needs that I could complete for this project. I was able to determine which I would continue with and I think I completed this section well with my ideas being relevant and I would be happy to continue with. I identified areas that will need researching into for my idea about flood protection further I was able to create a brief to which I would use to guide the rest of my project. The use of graphic organisers helped in organising my ideas from which I was able to identify areas that had to be considered for my project which then guided my criteria for success of the project.

### Project Development

Through out the project development of my MDP I have been able to express my ideas for the project and how I could complete this project. This started in the idea generation of my project where I was able to come up with multiple ideas that are all possible for the completion of this project, from here I was able to select the best design that I would use for the rest of my project as I felt that this best met the criteria that I had identified for a successful product. I found similar products to what I was designing and was able to assure that my idea was unique. After I considered what factors would be crucial in the design element of my project. These design factors influenced my research and experimentation for my project. I believe I completed the research and experimentation into my project well and this has influenced the success of my project.

### Project Management

To manage my time first I made a time plan which involved all of the topics that need to be completed for the project, I then used this to keep me on track with my time and allow myself to set goals for completion of tasks for my project which helped allow me to manage my time effectively. Estimating my budget for the project helped me aim to keep costs low for the cost factor that I had identified in my criteria for success, managing my finances went very well and I ended up only a bit above my original budget.

### Project Realisation

The project realisation was done well and demonstrated my use of tools and technology well in being able to build and design custom parts for my project. In the realisation of my design I overcame many challenges with parts of my project and their design which had to be further researched and experimented on. Having a 3D model was beneficial in having an idea how the design should look and function and therefore improved the quality of my final product. I also ensured that my design had all features as I had intended from the initial parts of my design although I nearly forgot to add the D link tie down points.

# 3.2 Analysis Evaluation of the Functional and Aesthetic Aspects

## 3.2.1 Functional Analysis

The solution used to solve the problem has effectively been able to achieve the desired outcome of this project. The design solution fulfils the needs of a portable cover for personal belongings and cars in situations of extreme weather events. A product that is easily transported, stored and quick to set up. The function of this design has been a success as it has achieved the goal of being able to be set up in under 5 minutes, which was tested in multiple tests. The design has effectively been produced to collapse and fold up into a small storage space minimising the impact of storage for owners of this product. The product also successfully fulfils the aim to prevent water from coming into the cover and stopping damage from hail and small falling branches on any objects inside the cover. The design was made with ergonomics in mind to assist in the fast setup of the product with the simple design allowing for easy setup that doesn't require hard to use tools. This was achieved by making simple locking mechanisms that only require hands to insert, without any tools. The reparability of the pieces in the design allows for continued usage well into the future. Through research I confirmed that the steel and plastic parts can be recycled through various methods with the tarp having to be disposed of or given away. If the zipper is not damaged it can be reused, similarly the bolts can be reused if they aren't damaged. The material selection is therefore highly recyclable and minimises waste going into the environment. The overall quality of the finished half scale prototype is very good with well selected materials fit for the need. The construction quality was reasonably high. Testing of materials and processes has allowed me to find the optimal way to assemble the cover in a way to keep it together and strong. The joints produced a very snug fit, reducing play in the joint and improving the rigidity of the structure. The quality of the structure in a full scale product would be significantly enhanced by having aluminium joints with snap release locks. The durability of this prototype is not the greatest due to the weaknesses that the 3D printed parts have, however, in a more refined final design I would choose to have all the 3D printed pieces made out of custom machined aluminium as this would remove the weaknesses that the plastic has. This would also allow for a much stronger overall design and even more precise manufacturing leading to less sway. The finished product would be available for the target market due to the cheap cost of production and the ability for it to be mass produced. This allows it to be used and distributed globally for an affordable price allowing more of my target market to purchase it. Marketing my product in large retailers such as Bunnings and Repco (which both have an online presence) would also help get my product to my target market. This also provides maximum reach across places like Australia in many regions and remote areas where flooding is most likely to occur. The costs have been kept under control and allow the design to be accessible to all types of markets due to the minimalistic cost saving design of the product. The parts used demonstrate how at a larger scale model could be produced and scaled at an affordable price. Economies of scale mean that the more of the materials needed the cheaper it would be to produce at higher quantity and at the full scale size. There would be some larger costs associated with the full scale design such as custom made aluminium joints that would be used in the design instead of 3d printed parts but this is necessary to provide the required strength and durability. After the final design was finished the size and weight of this prototype was evaluated and it can be concluded that it was relatively easy to carry but the size made it hard to move by an individual, however, it was very easy among two people. The design would be able to be stored easily by people when it is not in use. The inclusion of a bag to keep the product in when stored could also be beneficial to consumers as this would help in making sure that nothing is lost and gives more options to where the product could be stored.

## 3.2.2 Aesthetic Analysis

During the design and development stages of my project I ensured that the aesthetics was not a key priority but was still on my mind as it is important for it to stick out in floodwaters and by making it a contrasting colour to brown will make it easier to see in the event of major flooding taking it away. The aesthetics is also an important consideration when looking at whether people will purchase the product or not, this is important to consider in the success of the product as consumers' purchasing decisions are influenced by the aesthetics of a product. The simplicity of the design is aesthetically pleasing and is expected to appeal to consumers and will assist in making this a successful product.

# 3.3 Evaluation of the Impact on the Individual, Society and Environment

## 3.3.1 Individual

This product will help the individual by minimising worry about water damaging valuable items such as cars or tv's or appliances. This can help ease stress in situations where a whole home or town is flooded. This makes life easier for those affected by floods having a reliable way to protect their valuable property in a quick and easy way that also eases fears of damage from flash floods and hail storms. These factors are also helping improve quality of life as they do not have to worry about damage to their property when it is in use and do not have to replace items lost due to damage. By increasing peace of mind during the stressful time of a flood, this product increases the quality of life of an individual. Difficult situations such as making an insurance claim or being without transport are negated, allowing the individual to further focus on important things such as the wellbeing of themselves and their loved ones. Thus, vastly improving the quality of life. Consumers who live in flood prone areas would no longer have to factor the risk of car damage in purchasing their car. Therefore their behaviour may change in that they are more likely to purchase another car knowing that it is protected. The design increases people's knowledge of how they can protect their items in the event of flooding through the designs ability to quickly protect their items in the event of flooding and therefore has a very positive impact on individuals who would purchase this product.

## 3.3.2 Society

Community cleanup efforts after floods and other weather events will require less clean up and disposal of items like furniture that have been destroyed because of water damage if they use the Extreme Weather Cover. As tie down points are used in my design, it is unlikely that the car would be swept away in floods. Since free floating debris is one of the biggest risk factors of death in a flood, this product will drastically increase the overall safety of the residents of a flooded area. People will now have improved awareness on how they can protect their belongings in flood situations. Users of my product are able to spend less time on insurance claims and repairing damage and thus will have more free time after a flood event as there is less to clean up, dispose of and replace items that will no longer be lost.

## 3.3.3 Environment

The usage of recyclable materials allows for this to have a minimal impact on the environment with the steel and PLA plastic both being 100% recyclable meaning that at the end of its life cycle the cover is very environmentally friendly. Due to the incorporation of tie down points, my product will not contribute to flood swept debris that pollute and damage the area. Therefore, mitigating the effect on the environment as the car would be less likely to flow into and destroy landscapes. However, the heavy use of plastics in my design does contribute to increased pollution in the extraction of crude oil and add to global waste as it cannot be recycled if damaged. Additionally, my product encourages the use of cars, which may further contribute to the pollution of the planet but it is better than having unusable cars that are written-off due to water damage that will most likely be used for scrap metal. Therefore my design does have an overall positive impact on the environment. The design is very sustainable with many recyclable materials being used and has allowed me to limit the impact that the construction has on the environment. The usage of the cover will also assist in the protection of the environment from waste that is caused by flooding.

# 3.4 Relationship of the final product to the Project Proposal

## 3.4.1 Professional Evaluation

22-Aug-2023

### RE: Independent Review of Jordan Bilston's Extreme Weather Cover design and prototype

To Whom It May Concern,

A request has been made to undertake an independent review of Jordan Bilston's *Extreme Weather Cover* design and prototype prepared as part of a school project. My review comments are hereby presented based on provided criteria and an understanding of structural engineering and extreme load events.

I am uniquely qualified to provide structural engineering comments holding a Civil Engineering Degree (Honours) and a PhD in the topic of overload behaviour of structures. My career has provided me with the opportunity to publish more than 30 independently reviewed articles on structures, delivering many projects that considered extreme loading environments and having more than 20 years' experience in engineering and the construction industry. Engineers Australia made me a Fellow of the Institute of Engineers Australia four years ago.

The Objectives of the Extreme Weather Cover were described as follows:

- Quick and simple set up process;
- Providing durable and reliable protection of a valuable object (i.e. a car); for
- Extreme weather situations including rain, hail, and flooding.

The following information was provided for the review:

- Description of the design including isometric sketches
- Photos of the prototype
- Instruction manual (draft, partial completeness)

The design solution presented consists of a frame structure in a cuboidal shape with a rectangular footprint and square end with connections that allow the structure to collapse in a folding manner along the longest sides. The prototype is constructed with standard steel rectangular sections (RHS 20x20) and various connections are produced from 3D printing. It is noted that the prototype uses steel sections, and the final design would be made from machined aluminium. The frame supports a cover made from tarp with watertight zip and seams to protect the internal space. The information provided provide are adequate for a conceptual review. A small improvement in presentation is the dimensioning of the prototype drawings.

In principle the design meets the Objectives by providing a collapsible lightweight frame structure with a durable cover against rain and hail. The design of the linear connections and corner hinges shows an appreciation of functional, and requirements and insights gathered of a unique design solution.

The design can be further commemorated for using a prototype that utilises a combination of readily available standard steel sections and 3D printing for rapid development of the connections.

While the tarp cover is deemed to be watertight, the lightweight structure will not provide sufficient mass to resist extreme wind associated with rain/hail and the forces floodwaters will exert on the structure.

A design solution for extreme weather should consider ease/safety of erection/placement, robustness (strength, stiffness, ductility/deformability, durability, repairability), level of protection and re-useability/recyclable.

The design scores well against the ease of erection/placement and reusability (tarp)/recyclable (steel, Aluminium to lesser extent) considerations. Steel and Aluminium are durable especially with a coating.

Robustness requires further considerations. As already discovered in the prototyping process, deflections of the longest sections are observable and whilst countered with a connection design need further considerations in a final design; larger main member cross sections will provide higher stiffness. The resistance of the structure and tarp cover against wind and water loading, while not thoroughly reviewed, is likely to be inadequate. A temporary increase in mass when the cover is in place would improve the resistance to such loads; a possible solution being sandbags and rope ties to the structure. Similarly, the supporting frame should be cross braced to create triangles that provide a robust load path increasing the resistance of the frame against wind and other loads. A final idea is to extend the tarp cover to the floor of the frame further protecting the underside of the protected object (i.e. car).

Other considerations listed above, mainly repairability are for further exploration in the design.

Faithfully,



Dr Mark Rebentrost  
MAICD, FIEAust, CPEng, NER, APEC Engineer

## 3.4 Relationship of the final product to the Project Proposal

### 3.4.2 Self Evaluation

I believe I achieved what I set out to do in my initial idea for this project. Although some aspects changed over the course of the project to include altering my design throughout the process, changing the quality of the mechanisms involved and materials choices in order to create the final product. I think it turned out well for a scale prototype. While I had challenges throughout the year, my design has exceeded my expectations in how well it functions both assembled and disassembled. The design is strong and durable and would be enhanced if the 3D printed parts were made out of metal. The 3D printed pieces created weak points in the product that could be improved upon, for a full scale product which has left the prototype to be very fragile which made it hard to assemble due to the risk of breaking. Some parts did fail which were replaced but meant that the final prototype needs to be assembled very carefully and slowly but it still functions. If I were to complete this project again I would make it simpler. I believe I over complicated the design by trying to make it one piece. If I were to do this again I would produce more of a DIY kit that owners could purchase and assemble. This would most likely take longer to set up but would still have the same effect and probably be stronger and easier to produce. It would not have as many weak points that my current prototype has and I believe would have been simpler to set up. If I were able to tell myself something at the start of the project, it would be to not get fixated on one idea like the collapsible design and explore more options before coming to a conclusion as I believe this would have had a better result. While these insights are valuable I have come to believe and understand that this process is common in design and I hope to learn from this as I continue in life. As a result of the professional evaluation I have also been able to identify what I would change to my current design by adding triangular cross bracing, this would make much of the current structure more rigid and suitable against the elements it needs to face. The professional evaluation has also allowed me to confirm some of my original theories about the overall structure with the current use of 3D printed parts being inadequate for the design but the use of aluminium parts being a good solution for a full scale product. Overall, I am very happy with the professional evaluation both to understand a professional's perspective on my idea, as well as a learning tool. I feel this was a very valuable experience. I had assumed there would be challenges with the process but I believe I overcame some large ones throughout the process of my MDP and I am extremely proud of being able to present a fully functional scale prototype of something that I believe can have a great impact on people around the world.

### 3.3.2 Final Evaluation

I believe I have effectively met what I had aimed to achieve from my project proposal by completing a solution to assist in the protection of items during times of extreme weather. I believe the broadening of my idea from a car cover to a cover for more items improves the versatility of the design and makes it a better solution for people in the protection of their items. I have effectively met all the criteria of success with some being to varying degrees of successfulness. The function of the final product is as good as I expected it to be with set up times being consistently around 5 minutes even with other users. Set up can be made even quicker with more people. The cover has the ability to function it's current prototype state but would be improved with more pressing and the use of stronger components. The current durability of my design is weak due to the 3D printing components failing in areas but the operation of the product is still the same but it serves it's purpose as a scale prototype with clear improvements for metal parts being used on a full scale version. This would allow it to survive multiple applications in a final design. Safety of belongings can be assured by the strong materials used and the addition of simple operating procedures leaves it to be very safe to assemble and disassemble. With a main component of the design being how easy it is to open and close the design has achieved the ergonomics criteria very well with easy setup and disassembly with clear instructions. I believe the overall design quality is very high with many of the parts like the steel sections and tarpaulin cover are made to a really high quality and suit the need very well, quality of the 3d printed parts could be improved with more refinement or the use of machine aluminium pieces instead. These factors all allow for the more convenient operation for the user. Reliability has been achieved due to the simple design and strength of materials for the prototype and clear connections to the reliability of a full scale model can be seen through the better quality. The strength of all the materials used in my design allow for a strong yet lightweight design, the materials in my design have also been used efficiently which allow for the lightweight design to be easy to move further improving other aspects of my design such as cost and ergonomics. Costs have been kept to a minimum to achieve a better comparison compared to other designs that are currently in the market which are more expensive and offer less protection to the belongings inside. Although the aesthetics of my prototype were not and large factor influencing my design I believe I still have been able to make a good looking design that would be attractive for people to purchase. I believe that overall my project has been successful with there being clear improvements for a polished final design if I were ever to make one which could further improve the success of my product.