A level Coursework portfolio

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Identifying and outlying possibilities for design

Client/End user

Wendy Morrell, my grandmother, lives in a lovely village called Kirk Deighton, she is 81 years old and her hobbies are charity work as well as gardening and cooking. She is especially fond of her plants and loves to sit out in the sun in summer. She is energetic and chatty however as she has aged she has found her usual daily tasks a challenge. She is currently retired and so has lots of free time. Wendy is very aware on the topic of climate change and so she likes to buy environmentally friendly products as well as she likes to recycle where she can.

Design context

Needs of the elderly

Information gathering

As part of gathering my primary information I did the following. Firstly I spoke to my client asking them general questions such as there hobbies and what they do on a day to day basis etc. After this I asked them some more questions related to identifying a product. As a result of this Q+A I found that Wendy has arthritis in both of her hands which as a result she says she finds it hard to grab onto items such as pens. Another thing my Q+A resulted in was that I found out she finds it hard to bend down to move things and when she does bend down she says it makes her exhausted very quickly. She says she finds daily tasks have become very tiring and that a solution too some of these problems would be very helpful. Many people her age struggle with the same sort of issues and so when designing I must be inclusive of these people. Ways in which I could archive this could be through adjustability for people and ergonomic design.

On top of this I emailed a few retirement homes and websites (listed below) asking for information to do with everyday tasks the elderly struggle with. One replied sending me some links to some useful websites that explains the struggles for elderly people. I found out from the websites listed below that many elderly people have back problems from lifting heavy objects as well as many have problems with their hands which restrict them from doing everyday tasks. On top of this I spoke to my rugby physio about why and how arthritis occurs to try and understand more in order to help aid my design to people who struggle. `That said the main focus is to be inclusive for all ages and abilities.

Maria Pickard <maria.pickard@ageukyork.org.uk>
to me

Hi William
Thank you for your email which my colleague has forwarded onto me. I hope your project is going well. Falls can be a large problem for older adults and can lead to poor mobility from injury and loss of confidence. You will find some useful information on falling and mobility on the age UK national website- www.ageuk.org.uk
You will also find useful information on aids and adaptations on Nottingham Rehab Supplies. This is the leading place for aids in the UK- www.nrshealthcare.co.uk.
I wish you the best of luck in your project. If you would like any further information please don't hesitate to contact me.
Kind regards
Maria (Occupational Therapist, Age UK York Day Clubs)

From: William Stevens [mailto:william.stevens@boothamstudent.co.uk]
Sent: 22 January 2018 10:54
To: Age UK York <ageukyork@ageukyork.org.uk>
Subject: Elderly and Design

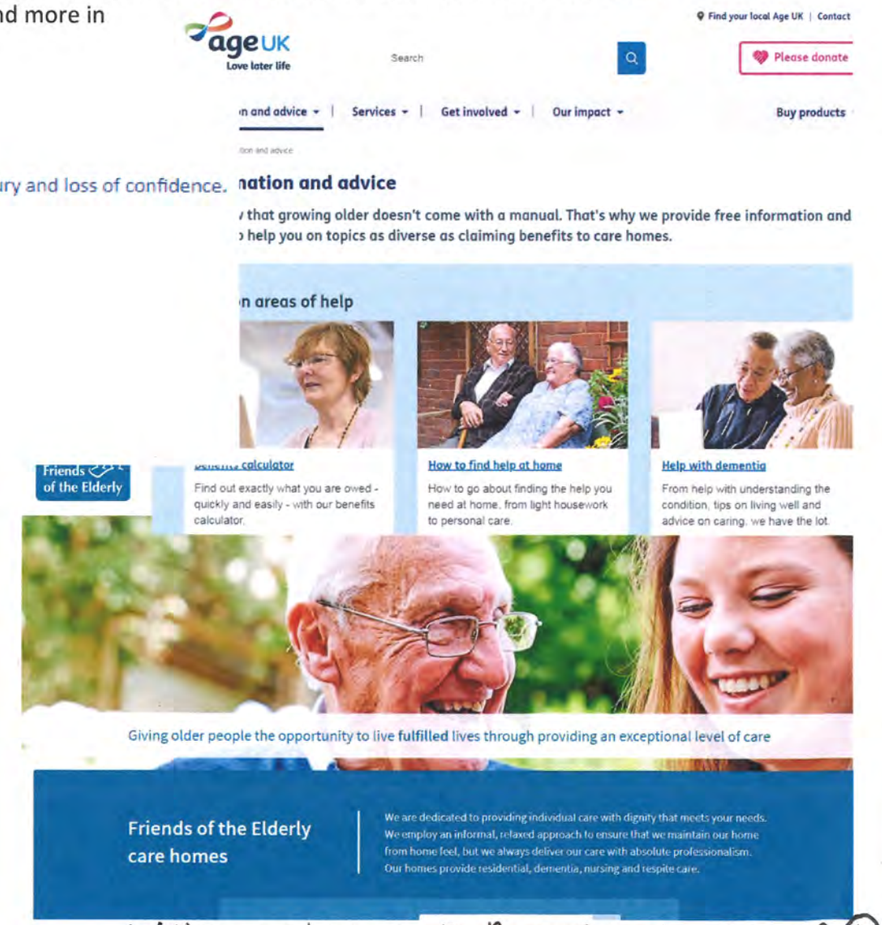
Email List and email sent
info@helpage.org
widdershins@ageconnectsorfaen.org
ageukyork@ageukyork.org.uk
contact@ageinternational.org.uk

Dear Sir/Madam

I wonder if you can help me? I am currently starting a major DT A level project. I am a pupil at Bootham school and I am looking at problems that the elderly have with mobility (such as walking or bending down to pick something up) I was wondering if you could inform me with any scenarios where the elderly struggle with mobility or point me to any useful websites. This information would be greatly appreciated and I hope to help solve these problems as my A level Coursework. I plan on creating a solution to these problems. Any help or advice would be very helpful.

Kind regards

William Stevens



William Stevens - Bootham School - 483494 (1)

I also went in to Roseville's Lime tree care home opposite my house to ask some questions to the elderly and the general response was that gripping items was difficult as well as mobility and moving around had become generally difficult. I then spoke to Mike who is one of the workers there and he said that the elderly struggle with mobility as well as they often drop things.

User needs

The first user need for my client would be a device that could easily transfer firewood from my Wendy's garage to her log basket next to her fireplace. This is a short walk from the garage to the upstairs living room. At the moment, she takes a lot of time to move a sufficient number of logs and she says it causes her back and hand pain, not only this she says she often ends up with splinters in her hand which are painful. A device that could move this load easily would be very appropriate as it would speed up the moving process as well as it would reduce pain and effort from the task. The product must be able to travel over the gravel path and rough terrain as well as easily go up vertical inclines and steps. The product would also have to reduce the chance of getting splinters from the logs. The best way to do this would be to avoid contact with the logs as much as possible. Whilst my client hasn't said how many logs she wants carrying, she said it should carry more than her previous solution. This way the number of journeys she makes should be reduced.

The second user need is kitchen related. Wendy says she struggles to pick up heavy items such as drinks cartons. She also struggles too grip onto kitchen utensils as well as she struggles to open jars and tins. This is due to her arthritis which has worsened with age. At the moment, she has to struggle to do these activities and she often leaves jam jars open so that she doesn't have to open the jars which results in the food going off. A device that makes these jobs easier would be very useful for Wendy. To reduce the weight the product would most likely need to pivot on something to produce a moment or possibly use more of the body such as wrists and arms to increase strength. The device would also need to be inclusive for people who struggle with arthritis and other conditions. This is especially important as 350 million people have arthritis worldwide. Ways in which this could be achieved would be to identify the anthropometrics needs for these people as well as ergonomic design catered and inclusive for people with arthritis.

The third user need is to do with gardening. My gran is an avid gardener and she loves to look after her large garden. This includes looking after flowers, weeding, digging and planting new seeds. However, as she has aged she said she finds it difficult now to use all her tools required for these tasks. For example she says she doesn't has the strength to dig plant holes and she says she finds it hard to hold tools such as a trowel. Her tools often get mixed up and lost. A device that could make these tasks easier would make these tasks more enjoyable. As well as this the device must be able to store the tools. Again, a design that would be inclusive of people with arthritis would be needed here. A lot of ergonomic thought would also need to go into a product to help her to try and make the gardening as enjoyable as possible for the user. The user would also need a way of storing all the tools in one place. Approaching a design like this would require a lot of thought but mainly planning. The tools would need to be organised and easily accessible for my client as well as they would need to be easy to transport around the garden. This would likely result in a product with wheels similar to a trolley.

The fourth user need is that often Wendy struggles to lift her shopping bags from her car to her house. She says she has to take multiple trips to collect all her shopping and that it is also very hard work. She says she often needs the help of other people to either do the task for her or help her complete it. A device that could make it a lot easier to lower/carry the load of the shopping would be needed. Allowing to complete this task alone would make her life a lot easier. This would reduce the strain on Wendy and make the task a lot easier. The device would have to somehow lower the weight needing to be carried whilst maintaining the quantity of shopping that can be carried. I would also have to make the bags easier to grip/carry due to her arthritis if that approach was to be chosen. The user would also need a way to easily unload the shopping and easily put the food away. A design to solve this problem would have to prioritise function over form to solve this problem as well as it would require a lot of thought into how to solve the problem.

Quantifiable/factual research

- 10 million people have arthritis in the UK
- 350 million have arthritis worldwide
- Arthritis can affect people as young as 30
- 11% of the population in the UK have lower back pain
- A million older people in England struggling with everyday tasks, such as washing and dressing, are being left to fend for themselves according to Age UK
- One third of elderly people say they struggle with a task they once found easy according to Age UK
- Over 2 million in the UK have sight problems

As we can see there are a few problems that affect people as they grow older. Throughout the design of the problem I choose to address I must consider these points throughout in order to be inclusive for the elderly.

Initial Client Interview

Q: As of now what are your hobbies and past times?
A: At the moment, I would say I am heavily into gardening as it is very rewarding to me. Due to me now being retired I have a lot of spare time to do what I want and this is mainly gardening when the weather is nice. I also like to cook from time to time as I like to eat a lot of cake!

Q: Usually, what does your day consist of?
A: As I am retired now I have a lot of free time. What I do with this free time changes quite a lot, I like to play cards and watch films but on other days I will cook and go out to the garden centre to shop for some new plants.

Q: Currently do you suffer from any medical problems?
A: Well apart from my poor eyesight the only medical problem I have is that I have arthritis in both of my hands, it makes it very hard to hold items such as pens and so it can be a struggle sometimes.

Q: Apart from this do you find any other tasks difficult?
A: Yes, most certainly, I struggle to bend down and pick up anything as it hurts my back, as well as these heavy objects are hard to pick up and sometimes my hands lose grip and I drop the item on the floor. Carrying too much weight on my wrist and back has led being in more pain when doing the things, I love.

Q: Could you give some examples of these problems?
A: Yes of course, I struggle to carry logs from my garage to my living room where the fireplace is, it is quite a long distance and it usually takes a long time as well as it is very tiring. The weight of the logs usually becomes too much and I need regular breaks. Furthermore, another example would be that when I have breakfast in the morning I often struggle to pick up the drinks cartons as they are so heavy. Just a couple of days ago I dropped a carton and it spilt everywhere.

Sources-
https://www.ageuk.org.uk
https://www.royalvoluntaryservice.org.uk
http://www.fote.org.uk
https://www.thesilverline.org.uk/what-we-do/

Design Brief

Problem

My client, Wendy, has problems moving logs from her garage to her fireplace due to them being too heavy and her having arthritis in both her hands. She says she can't move enough logs currently and she says she is often in back pain as a result of moving logs.

Brief

Design and make a product that reduces the load on Wendy when carrying logs and making easier for the logs to be picked up without putting anymore strain on my client. The product should allow multiple logs to be moved safely and easily as well as some consideration must be taken into how the logs are loaded and unloaded into the product. My client would like the product to be as eco-friendly as possible.

Situation

Task analysis and things I need to research

Ergonomics/Functions-

- Stable so that logs don't fall over/product tips over
- Function over form
- How the logs will be loaded/unloaded
- Easy to grab handles/pulleys
- Adjustable features to reduce strain/problems
- Centres of gravity
- How to travel across uneven surfaces/up stairs

Aesthetics/Form-

- Following a theme/design era
- Fit the surroundings/ not an eye sore
- Creative design
- Uniform shape

Anthropometrics-

- Average hand size for 65-100
- Average height for 65-100
- Average arm length 65-100

Dimensions-

- Spaces to fit in (e.g. doors)
- Volume of logs carried
- Overall size

Safety-

- BSI/CE
- What machine/workshop standards to follow
- Sharp edges/correctly made
- Toxic/harmful materials/finishes

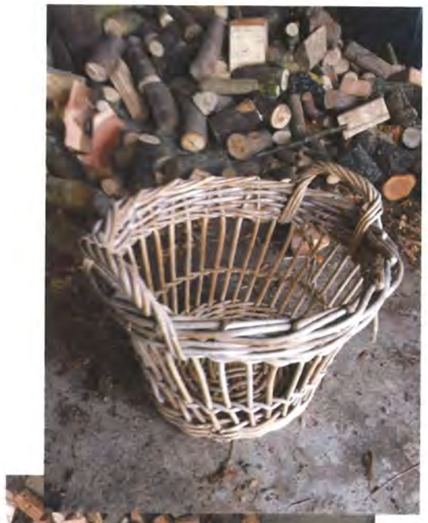
Process, mechanism, techniques

- Design to be mass produced, batch produced, one off?
- Use of mechanism to gain mechanical advantage
- Time efficient
- Correct joining technique's regarding product
- What degree of accuracy I should use
- What mechanisms reduce force/effort of lifting/unloading etc
- Strongest/best materials to use regarding product
- How labour intensive will it/should it be

Sustainability-

- Long life cycle
- Recycle/recycled materials
- FSC/Eco-friendly resourcing
- Using materials efficiently/what materials
- Limit machine use to save power/energy efficient

In depth interview



Question: Whilst transporting your logs from the garage what do you find most difficult doing?

Answer: The main problem with moving the logs is that they are very heavy which means I can only carry a few logs. This requires me to make multiple journeys which is very time consuming. I also find reaching the logs on the floor causes me back pain and occasionally I get splinters.

Question: In terms of comfort/ergonomics where would you say your current method of moving logs (basket) could be improved?

Answer: The handles could definitely be improved. They are difficult to grip I think the handles are not wide enough which makes it even harder to hold the basket. Another thing I find uncomfortable is unloading the logs. Emptying the basket creates an awkward angle which hurts my wrists.

Question: Your current solution to this problem is quite small, would you like my solution to be a similar size?

Answer: I think to create a good solution the product will need to be able to carry a few more logs. As long as the product can fit through my doorway I have no real opinions on the size of the product.

Question: You said you found picking the logs up hard, how do you think this could be improved?

Answer: At the moment picking up the logs strains my back, I would like to see my new product use a method that doesn't require me to bend over when I pick up the logs. Whether this is done with a sort of log grabber or another method I do not mind.

Question: What would your price range be for a product like this?

Answer: I think it depends on the solution that you create. I think a product that is robust and meets the problem could be worth around £50-£100.

Question: Are you willing to have your solution contain mechanisms that could create mechanical advantage or better comfort?

Answer: As long as the mechanisms are useful as well as they are easy to operate for someone like me I think mechanism could be great and hopefully they will make the solution more inclusive.

Question: How do you think the product should look and fit into its environment?

Answer: I think that the solution should have a modern look that is preferably a metal and not a wood construction. I plan on storing the solution in the garage next to my husband's work bench and therefore and "machinery" look would be good.

Question: What is your stance/opinion on this solution in regard to the environment?

Answer: Truthfully this product will resort in a carbon footprint. However, I think steps at each stage of production must be taken to reduce this carbon footprint. If there are steps in the production solution where you have the chance to be more environmentally friendly I would like you to take them.

Question: Any final comments on the problem?

Answer: Yes, I would like the solution to use wheels if possible. I think this would make the solution at lot more effective and then also I can use the solution for other uses.

Existing Solutions

Aerocart Firewood Carrier

300 x 400 x 500mm

After watching a video review of this product I felt like I understood the product and its function. The Aerocart can hold up to 80kg of logs which is plenty more than my gran will be able to lift. It is well made ergonomically as it has rubber grips for handles as well as it is stable. It's designed so that it adjusts the loads to the centre of gravity for a balanced and easy-to-manage load.

It has two rubber wheels which mean the logs don't have to be directly lift which reduces the load on the user. These rubber wheels also mean the Aerocart can handle different terrains which is good as my gran must cross a gravel path whilst transporting her logs. They don't need to be inflated and so this increases the lifespan of the product. The log cover/bag is held in by a spring latch mechanism on either side which I will discuss on my mechanism page.

The wheelbarrow itself is made from steel mainly which is highly durable. This will stop dents from the logs which will again increase the lifespan of the product. Not only this we can see that it may be used for more than carrying just logs and so this could solve multiple problems for Wendy potentially. This product has been made in batch production from welding and therefore prices will be lower.

In terms of sustainability this product is very average. The wheels are made from rubber which can be easily recycled. The fabric bag I would assume is recyclable as almost all fabrics are. The wheel arches are made from PVC which can also be recycled. The steel can also be recycled. The only problem with recycling all this is that the product must be disassembled which can be a long and complicated process, more than likely it will end up in a rubbish dump.

https://www.youtube.com/watch?v=-NenQoBZq_E

Log grabber

650mm long

I have chosen this product as I think it might be a useful device for the picking up and placing the logs without having to bend over which will help make the task of picking up logs easier. It does this using a claw and a scissor lift mechanism which I will talk about on my next page. I think this device would possibly be an attachment to a product as it would not be good for transporting multiple devices.

The product itself is made from steel and has a clean powder coat protecting it. As a result it is very durable and has a long lifespan. In terms of function I think it has been poorly designed for my client. The handle looks small and uncomfortable as well as it looks like it has no grip and so my client with arthritis would struggle to use this product.

I think this product would be very easy to mass produce and so I think if I was to recreate something similar to this making it on a mass production level would be easy and so this would drive the price of the product down.

In terms of sustainability I think personally this product is hard to judge. It is made out of steel which can be recycled however it has a finish on it which might make it hard to recycle. However it has a long life span so it means its average CO_2 output over time will be low.

https://www.amazon.com/Grabber-Carriers-Holders-Fireplace-Tweezers/dp/B01NBSXPKH

Worx Firewood Transporter

600 x 800 x 700 mm

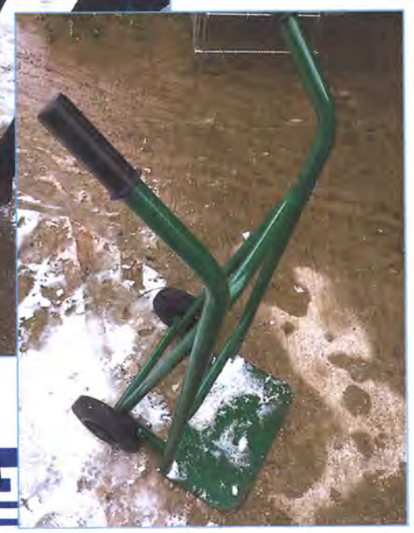
As we can see from the product the Worx Firewood transporter appears to be very simple yet effective. It has a large plastic tub which is capable of tilting on hinges to unload the logs which I will talk about later. It can hold up to 500kg of firewood in the steel coated tub. It has 4 all-terrain rubber wheels with the back two being adjustable through the handle and an axel system which I will again mention on my mechanisms page. These wheels mean it has no problem travelling over gravel which my client Wendy has to transport the logs over.

The handle has an ergonomic rubber grip to help the user as well as the handle can also be attached to the back of a lawnmower etc. The tub can also be used to carry other items such as tools and plants. By doing these things the designer is trying to make an inclusive product. Function is priority for the product. The axels and tub are made through welding and heating the metal to shape it.

I think the main flaw in this design would be lifting the tub up whilst full of logs or loading the logs into the tub. The effort needed to do these tasks would more than likely be too great for my client and so I would possibly need an attachment of sorts to load the logs into the tub easily and without having to bend down.

The materials rubber and steel are mainly used in this product, both are recyclable and so this product is eco-friendly. The life cycle of this product is very long as the product is very durable.

350 x 400 x 800mm



Upon looking for real solutions in various places I found the following product. After using the product for a while I felt I fully understood how it worked.

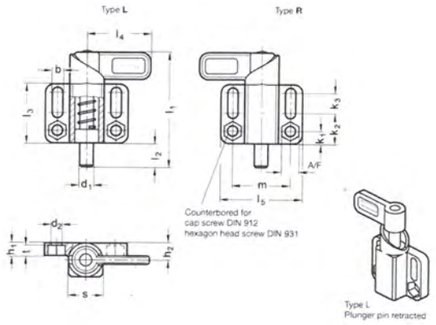
In turns of function the product was mediocre. It had two ergonomic handles to help for grip which was good as well as it had a foot bar to help lift the weight of the logs when moving. However I found that the smaller logs had a tendency to fall off which was bad. However the weight of the logs had been taken into account and I found that the centre of gravity when the logs were loaded was perfect which made the logs easy to manoeuvre as well as it made the transporting part stable and safe. As for form the product is designed purely for function and so the product wasn't particularly aesthetically pleasing.

I would assume that this product is mass produced as it is quite a simple deign to produce using jigs/templates. The materials used in this are mainly steel and rubber for the wheels and handles. The product is then finished in a layer of green paint with the metal being welded together. As a result I would imagine that the product is very strong/durable and therefore it will have a long lifespan. The cost of the product was fairly good at £29.99.

In terms of sustainability I would assume this product if basic. Steel can be recycled as well as rubber can also however dissembling this product may be complicated and so possibly not all parts of the product will be recycled. In terms of life cycle the main body of the product will last a very long time however the inflatable wheels could become damaged and so a replacement could be needed at some

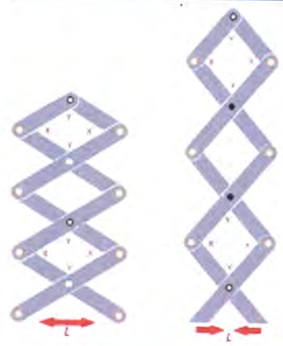
Mechanisms from Existing Solutions

Spring latch system



The spring latch system works by having a spring-loaded bolt that is angled off at the top edge. It works by the user applying a force to "unload" the bolt and when this is released the spring uses the built up mechanical energy to return to its original position and effectively lock back in place. It will not become unlocked unless a user physically unlocks the spring latch.

Scissor lift system

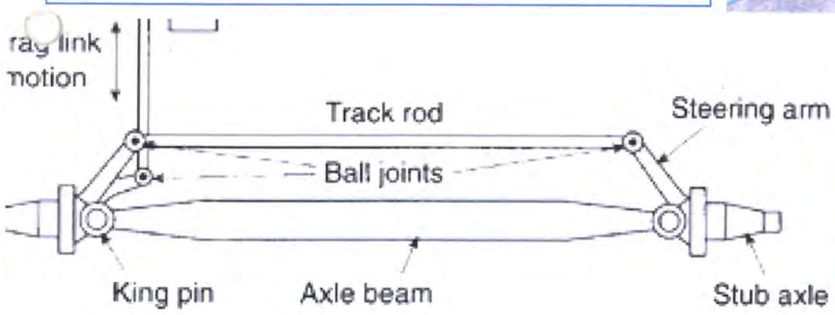


This mechanism uses a criss-cross pattern also known as a pantograph. Dues to this criss-cross pattern it gives the user more mechanical efficiency as well as it reduces link inertia. This mechanism could become very useful in my product as it could be used to extend town and pick up logs without my client having to bend down to pick the logs up herself.

Axle system

The axle system used in the Worx firewood carrier could potentially be very useful for my product. The system works by a main handle/rod being pulled in the direction of travel, this then causes the track rod to change the angle of the wheels on the king pin. The wheels turn and so the cart travels in the direction on the pulling force. This could be useful for a product of mine as it would give easy steering of the logs when needed.

The average wheelbarrow wheel size is 400 x 100mm



The wheel and axle consists of a wheel attached to a smaller axle so that these two parts rotate together in which a force is transferred from one to the other. A hinge or bearing supports the axle, allowing rotation. It can amplify force; a small force applied to the periphery of the large wheel can move a larger load attached to the axle.

Hinges and tub

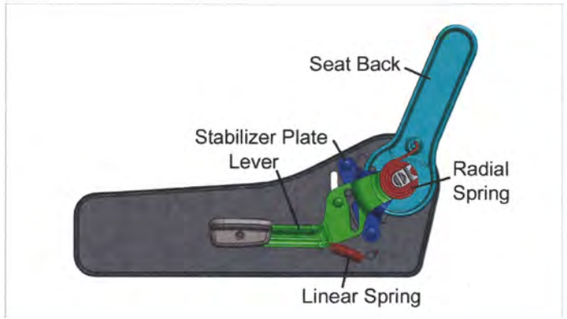
As well as the axel system the Worx firewood transporter also uses some sort of hinge system, although this may appear very basic hinges have lots of advantages. The first being that the hinge will dissipate any pressure as well as hinge will give the user mechanical advantage. As well as this it makes the product easier to place back in its original position without being exposed to damage as well as wear and tear. The hinges also give the product an extended life span which is good regarding the environment.

Gyro ball

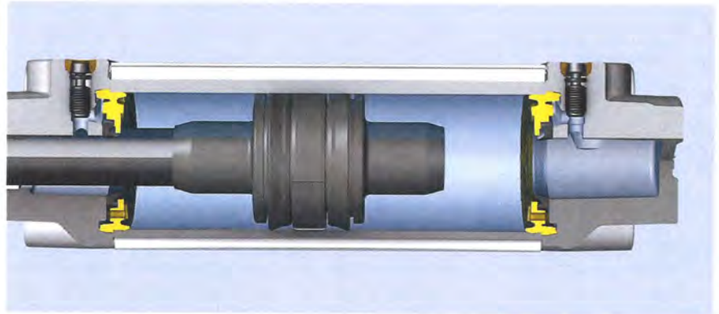
Whilst looking for real life solutions I can across a wheelbarrow with this gyro ball, although this isn't directly used to transport firewood I thought it could become useful potentially for my end design. It works by having an axel running through the middle of the ball which allows it to rotate. This in turn then lets turning become easier as well as smoother. The only downside is that it could potentially lead to the product becoming unstable.

For wheels that are attached individually under shopping carts for example the wheels use a lazy Susan to rotate/turn and the individual wheels are attached by the axle system just on a smaller scale.

Adjustability and inclusivity



This adjustable mechanism is from a car seat however it could be possible applied to my design. It uses a variety springs which lock in place to hold the seat in place. It helps give a range of angles for the user. I think I could use this mechanism to change the angles of my product to provide more comfort and suit the user better.



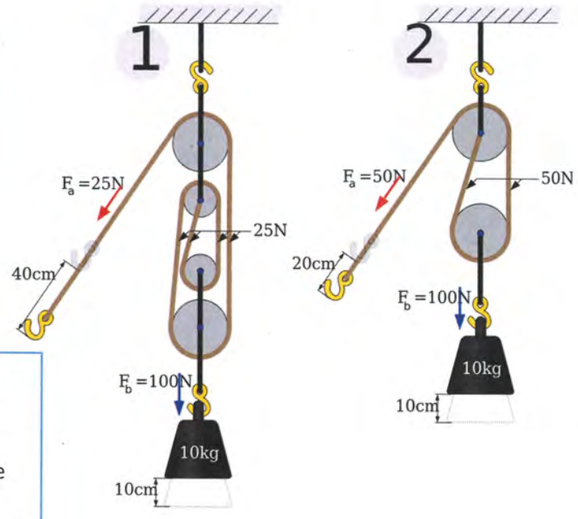
This is the internals of a hydraulic piston. Hydraulic pistons have many applications and so it could be applied to my product. Pistons respond to changes in weight (i.e. logs) and so I could apply this when there are different masses of logs being carried. Lightweight could mean the piston is less activated and so the logs would remain at a higher position making them easier to unload. That way you could control the access to the logs through the weight of the logs being carried. That way a user who struggles to unload the logs could only carry a little amount to making unloading easier.

This is an example of inclusive design. This is actually a pen holder for someone who has suffered from a stroke. The designer has designed the handles to make it easy to grip. The ben itself doesn't even need to be held by the user. This would be a good idea to implement for my handles and mechanism. Making them easier to hold without struggle will make the product easier to use for the user. Using mechanism that don't have to be directly interfered with instead with larger parts of the design will make it more inclusive for people who struggle.

Sometimes a design prioritises function over form. This keyboard is a prime example of this. Although this keyboard may look 'wacky' it has been designed for maximum comfort. The design itself helps reduce carpel tunnel syndrome. Sometimes it is more important to prioritise ease of use for a product. For my design, I must consider doing this to maximise comfort for the people who struggle such as my client.

This is another example of an adjustable mechanism. It is a crank system that when the handle is squeezed the height of the base changes. This concept could also be integrated with an ergonomic handle to maximise its comfort and effectiveness. Changing the heights of the logs on a platform could be done by squeezing two of these ergonomic handles together.

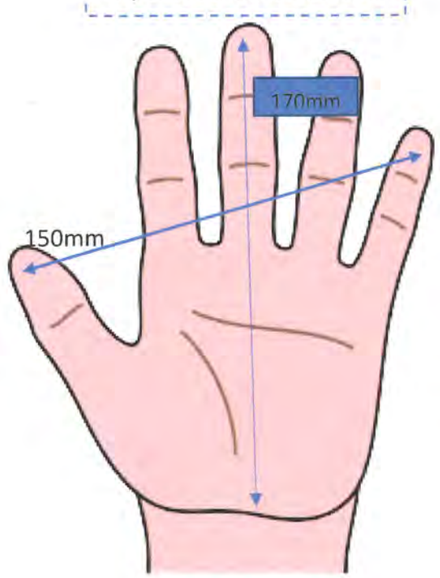
This is another example of an adjustable mechanism. It is called a drop plate. It runs on a sort of rail track system and use two pins to change the height. Not only could this system be changed manually, I think it would be possible to attach a pulley system so the component of the weight could be reduced by using multiple pulleys. This would make carry 10kg of logs only 2.5kg if four pulleys where used.



From the pram, we can see a range of handle angles are available. Sometimes users find using products in different ways to others more comfortable. This way it is important to include all aspects of how a product could be used such as the angles of the handles. That way the product will be suited comfortably to a wider range of users without an impact to how the product itself works.

Sometimes a product needs to be completely reinvented to suit people who struggle. These scissors are a prime example. They have a complete new look to suit people who struggle to grip (arthritis). Whilst designing items that may be hard to hold I need to look at the bigger picture and remember to include people who struggle with tasks that might not be immediately obvious.

My client's measurements



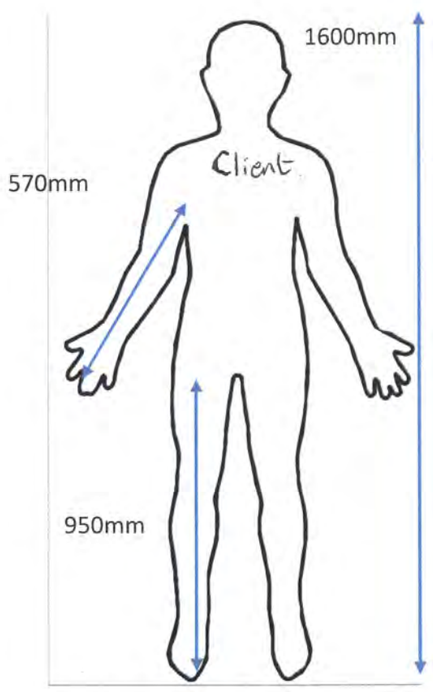
Arthritis, Anthropometric data and Product Standards

Anthropometrics

Anthropometric data can vary a lot depending on many factors. These include the targets audience; young children will be smaller than fully grown adults for example.

The product I will produce will be made for my client but I must also take into account that she may be smaller/taller than the average person and so I must take into account anthropometric data for all the measurements I use. My product will be used by adults in an estimated age range from anything from 19 years old to 65+ years old.

Dimension	Gender	5th percentile (mm)	50th percentile (mm)	95th percentile (mm)
Hand length	Male	173-175	178-189	205-209
	Female	159-160	167-174	189-191
Palm length	Male	98	107	116
	Female	89	97	105
Thumb length	Male	44	51	58
	Female	40	47	53
Thumb breadth	Male	11-12	23	26-27
	Female	10-14	20-21	24
Index finger length	Male	64	72	79
	Female	60	67	74
Hand breadth	Male	78	87	95
	Female	69	76	83-85



Dimensions	Man (Percentiles)			Women (Percentiles)		
	5%	50%	95%	5%	50%	95%
Height	1630	1745	1860	1510	1620	1730
Leg Length	850	935	1020	750	820	890
Arm Length	730	790	850	650	715	780

Anthropometric data of British individuals aged 19-65 years old

Product Standards

Every product today has to meet lots of standards and requirements. In Britain there are two main standards that my product should meet these being British Standards Institute (BSI) and European Conformity (CE). These two organizations one for Britain and one for Europe set out safety standards and requirements that each product has to meet so that it can be sold on the market.

Some examples of these requirements are as followed:

- Quality management (BS EN ISO 9000 series)
- Requirements for electrical components (BS EN 50088)
- Environmental management
- Safety of machines/mechanisms (BS EN 418, BS 8800)
- Design of products- accessibility (BS 888)
- Symbols and terms (BS 5378-2)
- Information and communication technology management (BS EN 61082)

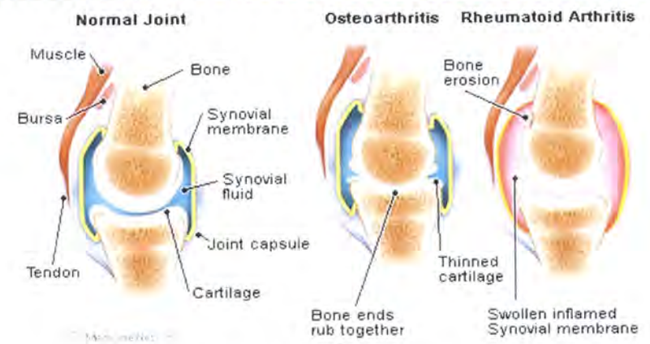
BRITISH STANDARDS

CE

Arthritis

Arthritis is a common condition that causes pain and inflammation in a joint. In the UK, around 10 million people have arthritis. It affects people of all ages, including children. Due to my client having arthritis as well as possible many others using this product could have arthritis I thought I should research into what it is and how I need to adapt my product to help make the task at hand easier for my client and possible future users.

In general arthritis targets four key areas these being the hands, spine, knee and hips. Arthritis can cause movement to be more difficult than usual, leading to pain and stiffness. This can lead to gripping items or bending over to pick up logs for example difficult and painful and so when designing I must take into account these problems so that my design is inclusive for all people including my client.



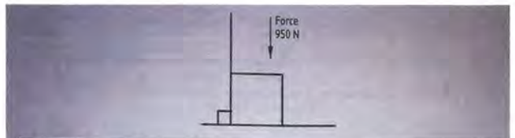
Normal and Arthritic Joints

William Stevens - Boolham School -48349

British Standards

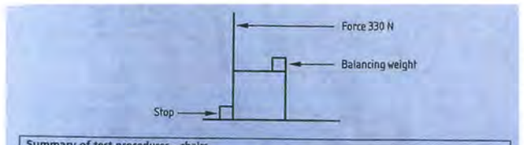
My product will need to meet BSI standards if it is to be sold in the UK. Here are the main standards I must meet with my product:

BS 4875-1 and BS EN 1728 apply to my design. Test 1 for this standard is the static load test on a scale from 1-5 based on the performance of the product. My product will need a performance rating of 4 to make it have the longest realistic lifespan possible.



Summary of test procedures – chairs

Test no.	Title	Description	Test level (see Table 2)				
			1	2	3	4	5
1	Seat static load test	Test force (in N)	-	1 100	1 300	1 600	2 000

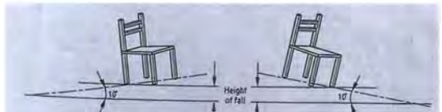


Summary of test procedures – chairs

Test no.	Title	Description	Test level (see Table 2)				
			1	2	3	4	5
2	Back static load test	Test force (in N)	-	410	560	760	1 060

The second test my product will have to pass is the back-static load test. This test look at the stability of products with forces applied. My product will need to be stable to meet this standard. This standard is especially important as the product will have to remain very stable whilst going over rough terrain and up vertical inclines (stairs).

Test 3 for this standard also look at the stability of product, but up inclines, again this is very important for my product is it will have to travel up inclines. My product will need to be inclined at 10 degrees when it's been manufactured and still be stable. I will apply a varying amount of force to see which level 1-5 it meets. I will aim to meet level 3 or higher for my product.

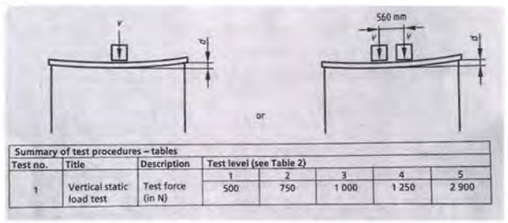


Summary of test procedures – chairs

Test no.	Title	Description	Test level (see Table 2)				
			1	2	3	4	5
3	Drop test	Drop height (in mm)					
		Non-stacking chairs with legs longer than 200 mm		150	200	300	450
		Chairs and stools with legs shorter than 200 mm		75	100	150	250
		Stacking chairs and stools with legs longer than 200 mm	150	300	450	600	900

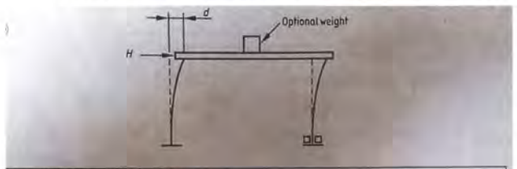
Another BSI standard it must meet is BS EN 1730. Again, the forces to be applied depend on the test level.

Test 1 is the vertical static load test. This test applies a vertical load in the centre of the product to see how much it bows under the force. Level 5 for this test uses two forces 560mm apart. For this test, I am aiming to meet the test level 3 requirement to ensure that my product does not bow under the maximum load of the logs which I have stated to be 50kg.



Summary of test procedures – tables

Test no.	Title	Description	Test level (see Table 2)				
			1	2	3	4	5
1	Vertical static load test	Test force (in N)	500	750	1 000	1 250	2 900



Summary of test procedures – tables

Test no.	Title	Description	Test level (see Table 2)				
			1	2	3	4	5
2	Horizontal static load test	Test force (in N)	175	300	450	600	900

Test 2 is the horizontal static load test. The test applies a horizontal force to the edge of the table top to check the amount of lateral movement. The base of the product should be held in place whilst the top has a force applied to it. I am again looking to achieve test level 3 for my product. Therefore, the horizontal load it can carry will be equivalent to 45kg.

The final BSI standard I want to focus on is BS 3963-6. This is the impact test. In the test, the resistance to mechanical damage is tested using a steel ball dropped from a height of two metres. For my product to achieve test level 5 the ball must not crack the product when the ball is dropped on it.

Appearance of test area	Rating
No surface cracking	5
Slight cracking, e.g. one or two circular cracks	4
Moderate or severe cracking confined to the area of indentation	3
Cracking extended outside the area of the indentation and/or slight flaking of the finish	2
More than 25 % of the finish removed from the edge of indentation	1

Ergonomics

Lifting heavy items is one of the leading causes of injury in the workplace. In 2001, the Bureau of Labor Statistics reported that over 36 percent of injuries involving missed workdays were the result of shoulder and back injuries. Overexertion and cumulative trauma were the biggest factors in these injuries. Bending, followed by twisting and turning, were the more commonly cited movements that caused back injuries.

When designing my product, I must look at the ergonomics and principles of my design problem and how I can look to address the following:

- Use mechanical means (e.g. hand trucks, pushcarts, etc.) when possible for heavier or awkward loads
- It is easier and safer to push than to pull
- Keep loads as close to the body as possible and do not twist while lifting, carrying, or setting down a load.
- Minimize reaching
- As a general rule, bend at the knees, not the hips.
- Get help when needed. Do not lift or carry things you don't feel comfortable with, no matter how light the load
- Plan ahead for all parts of the lift: lifting, carrying, and setting down
- Try to utilize proper handholds while lifting
- Use personal protective equipment where needed, such as gloves with good grip
- Implement rest breaks
- Place items to be lifted within the "power zone". The power zone is close to the body, between the mid-thigh and mid-chest of the person doing the lifting. This is the area where the arms and back can lift the most with the least amount of effort.

Addressing these points through design will lead to a final product that is easier to use and is at less risk of injuring the user. Some points will be easy to address like providing appropriate handles to the product. However, some points require a more complex solution such as using mechanisms to the advantage of the user.

Resources: https://ehs.unc.edu/workplace-safety/ergonomics/lifting/

Levels of production, form, function, sustainability and life cycle regarding existing solutions

Levels of production

After researching and looking at existing solutions I came to the conclusion that a product similar to mine will use batch production. This will be the best method of production as it will be cost effective for the scale of my product. Using batch production has three main stages the first being the set-up such as creating jigs to help improve speed/accuracy of the product. The second is cutting the components out and acquiring the needed components that can't be made in the workshop. The last stage is the time taken to make the product.

As I am working in a fairly basic workshop I will buy in the parts such as wheels that can't be made to help produce a better solution. I will employ the use of jigs where I see fit to help produce a better and more accurate design.

Sustainability

Looking at these products I think the sustainability is of a good standard. With many of the designs materials are used sparingly. Although it is hard to tell I would imagine the product are made suing only one or two different metals or other materials. This make recycling easier at the end of the products life. Continuing on from this looking at these products many of them are finished in paints which provide little damage to the environment. The only place sustainability would be an issue would be being parts have been welded together as this uses lots of energy.

Life cycle

Looking at the life cycle of similar products I came to the conclusion that this sort of product starts with a relatively high carbon footprint but due to the product lasting a long time it is split over many years.

The key points I took from my research was that the raw materials needed for the product often required lots of energy to extract, an example be bauxite ore which is used to make aluminium. It has to be extracted from the environment which uses energy.

In terms of manufacture the way this product is made varies the carbon footprint immensely. Product that were welded together had a much higher carbon footprint than products that had been joined using temporary joins such as nuts and bolts or rivets.

Distribution remained mainly the same throughout the products as they all were transported from their factories.

The way the product is used generally results in no carbon footprint. The only exception to this was when an existing solution used an aid such as an electric motor or petrol engine to help with movement.

Finally, with the end of life with these products it varies greatly depending on the product. Some products can be easily dismantled which makes them easy to recycle however others are a lot harder to recycle as they use a mix of materials and welds.

Function

The function of these products is very basic and it is hard to create a product that doesn't function for this brief. That being said I don't think any of these products are particularly well suited to someone who is elderly. Many of the products don't use mechanical advantages to their benefit and I can imagine lots of these products struggle to appeal to people who struggle in life. Another flaw that I spotted was with many of the designs I could imagine the logs falling out easily. That being said I would say 95% of the products I looked at well-made and functional.

Form

Regarding the form of this sort of product they are all very similar. I found many products were made from metal and had a sort of minimalistic look. The products were often painted a bright colour to give the product a less dull look to the eye. A problem with this is that with the logs I can imagine would leave scratches on the product which could ruin the aesthetics. As a result of this I think that dip coating would be a more scratch resistant and corrosion resistant finish. I would say though with a product like this the function is more important than the form.

https://www.carbonfootprint.com/factors.aspx

Refined design brief and User requirements/performance requirement

Refined design brief

After consulting and interviewing my client I now know exactly what my design brief is. The product I intend to make must carry more logs that my client's current method which is a log basket. The solution must meet the BSI standards that I have researched as well as further safety must be applied to mechanisms so that the force required to use them is less. All mechanisms must be designed so that they are easy to use for someone who is elderly. This could mean making larger handles or automatic features which require no human input. My client has specified that she would like the solution to have a modern look that preferably uses metals throughout the design. My client has given me a fixed price range which will help determine the size and quality of the product.

The goals and objectives I have set myself are to create a final product that appeals to wide ranges whilst solving the task at hand. Although my main target audience is for the elderly I want my product to be usable for all ages. The product should make moving the logs easier. In terms of schedule for this product it should be finished by the end of April. During the construction of this product I will be working mainly alone in the workshop and out of school apart from feedback from my teacher.

In terms of sustainability my client would like a product that damages the environment as little as possible. She would prefer it given the choice between two materials/finishes etc that I choose the more environmentally friendly option. Throughout my project I will take multiple steps where possible to be more environmentally friendly and to reduce my carbon footprint of my solution.

User requirements/performance requirements

To summaries generally what the client has asked for, the product must consider the following as well as meet the requirements of the client where necessary:

- Price must be affordable
- Mechanisms must be safe/easy to use without causing additional strain to the user
- BSI/CE
- Form
- Function
- Use of materials and how they can affect the environment
- Age consideration and how the product appeals to all ages
- Safety
- Scale of production
- Efficiency of production/meeting deadlines
- Sustainability

*BS=British Standards

Specification

Function

1. The log mover must carry a volume of 50L of logs.
2. There should be a method of easily loading/unloading the logs
3. The product must make the logs easy to transport
4. All mechanisms must function at all times, even under a strain of 100 Newton's or towards end of life (6 years)
5. The product must support a total mass of 50 kilograms
6. The product must have some form of adjustability

Justification

1. This is the volume of my client's previous solution and so this many logs carried would mean the log carrier is just as efficient as a wheelbarrow
2. The product must require little energy you use in order to reduce strain on the body and risks of injuries. This means not picking the logs up and bending down, they must be loaded using as little energy as possible
3. The products purpose is to make the logs easy to transport, this means reducing strain on the body and making the process of mobbing logs quicker and more efficient
4. The products mechanisms must function for the product to work as intended, they must be able to work under stress or there would be no need for the product
5. The product must be able to carry a lot of logs and so it must support them
6. Adjustability will mean more people can use this product as it will fit more people. As well as this people can adjust the product to their specific height which will make the product easier to use.

Form

1. The product must be aesthetically pleasing
2. Ergonomic consideration must happen when designing the product
3. The product must not offend any genders or religions.
4. The product must fit into all its environments
5. The product must be of modern day design
6. Function must be prioritised over form

Justification

1. If the product is aesthetically pleasing then it will be more likely to be purchased by multiple people and so sales would be better
2. The product must fit the user well and the design must ensure that the product is comfortable to use
3. The product should be neutral so that it will not offend people and risk being taken of the market/boycotted for being offensive.
4. The product must be designed so that it matches well with other colours and that it fits in its environment, it must not be an eye sore when placed in a user's environment
5. I want my product to look modern and follow trending designs so that more people will buy my product as well as more people will think it is trendy
6. The product must look good but how the product works is the main focus of this design problem

Performance requirements

1. The product must be stable, must meet BS EN 1730 standard
2. BS 4875-1 and BS EN 1728 must be met
3. BS 3963-6 test level 5 must be met

Justification

1. The product must be stable at all times including loading/un-loading and whilst moving in order for the logs not to fall off the log mover
2. The product must be able to support the force from the logs and other masses
3. The product must be resistant to mechanical damage otherwise the product will not fit its desired function

Quality Control

1. Must be made to a ±5mm accuracy
2. Product must be thoroughly checked before being placed on the market

Justification

1. This means the product will be correctly made and so all its functions will work
2. This ensures that the product will be of the highest quality

Dimensions

1. The product must be no larger than 600mm x 600mm x 500mm
2. The product must have no jetting out edges of more than 150mm
3. The product must have a maximum displacement adjustability of ±400m
4. The product must have handles with a maximum diameter of 50mm

Justification

1. The product should be able to fit into confined spaces such as through a door frame so that the logs can be transported from outside to inside the house
2. This is to ensure that the product is compact and can fit into confined spaces
3. The product must be adjustable if necessary however the product must not extend the limit otherwise it will be unusable for some users
4. The handles need to be a reasonable size so that as many people as possible can use the product

Safety

1. My product should meet the BSI sharpness test
2. The product must have a mass of no more 15 kilograms
3. All mechanisms must have safety precautions such as avoiding finger traps

Justification

1. My product must be soundly made as well as safe otherwise there is a risk of the injury.
2. The log carrier must be lightweight to reduce strain injuries on the body especially the back
3. Mechanisms must have safety features to reduce injuries and the product breaking

Materials

1. The log mover must be hard and durable according to BS EN 1730
2. The product must use waterproof materials and be resistant to all types of corrosion
3. The log mover should be made from long lasting and sustainable materials
4. Low maintenance materials should be used

Justification

1. When the logs are moved or dropped into the log carrier there is a risk of the product being dented/scratched and so the product must be hard/tough to prevent the product being damaged, otherwise the products shape will deform easily and this could render the product unusable
2. My product will be used largely outside in poor conditions and so it must be resistant to physical and biological corrosion as well as it must be waterproof. The product must not corrode and if the material does it must be coated to protect the metal
3. My client wants her product to be as eco-friendly as possible and would like to cause as little damage as possible on the environment (e.g. FSC sourced wood)
4. Materials used should have a low up-keep in order for the product to remain functional as well as for it to look good

Ages

1. The product must fit the age range of 18-89 years old
2. The product must have no parts a young child could injure themselves on

Justification

1. My client is currently 81 and so she is above the usual maximum of 65 for many products, because of this I would like the product to suit as many ages as possible.
2. This is so that the product can be used in family environments etc as well as it will stop more injuries

Cost

1. The product should cost no more than £100

Justification

1. Current existing solutions vary in prices greatly but I feel for this price a high quality well-made product can be designed and produced

Scale of production

1. One-off but looking to Batch production for the final product
2. Jigs will be used

Justification

1. My product is mainly focused on my client however it could easily be batch produced and by allowing for this I will be able to respond to market trends to improve my product
2. Using jigs will increase the accuracy and quality of my product as well as it will speed up manufacturing speeds

Sustainability

1. The log mover should be made from long lasting and sustainable materials
2. Varnishes/sealers used on the product must be eco-friendly and non-toxic where possible
3. Un-used materials must be recycled if possible
4. Machines should be used as little as possible
5. Similar materials must be used
6. The product should be easy to disassemble at the end of the products life

Justification

1. My client wants her product to be as eco-friendly as possible and would like to cause as little damage as possible on the environment (e.g. FSC sourced wood)
2. My client would like the product not to harm the environment as well as toxic chemicals must not be used in order to protect the user/environment
3. If as much unused material is recycled the carbon footprint of the product will be less and so it will have less impact on the environment
4. To reduce the carbon footprint of the product, high energy machines should be used at a minimum
5. Using similar materials will make the product easier to recycle at end of life
6. By making the product easier to take apart it will be easier to recycle

User requirements

1. The product must carry more logs than the previous log mover she moved
2. My client says she wants her product to be generally eco-friendly

Justification

1. My client not only wants a better product she also wants it to carry more logs so she can reduce the number of log journeys she makes
2. Although quite a general term I will look to implement eco-friendly design and manufacture methods where possible

Design Ideas

"Architecture" by Barton Willmore

Maths Box

If the diameter of the cross-length is 400mm then the cross sectional area is 63,000 mm² using πr^2

This can be reset using hot water.

The handle will use a SMA to remember how the user grips the product.

The handle is placed at a height where most people can use it.

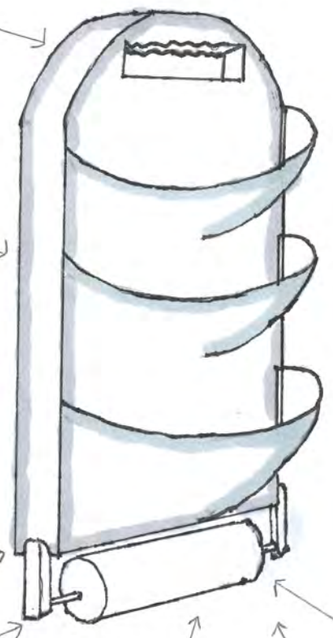
The 3 baskets can be removed and replaced very quickly using minimal effort.

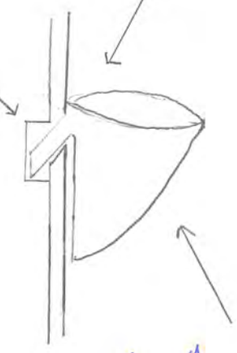
The basket slides into the main frame using a fish hook mechanism

Using a fabric reduces the weight of the product.

The baskets have a mild steel frame which is welded together. The rest of the basket is made from a durable fabric.

When all 3 baskets are attached 65kg of logs can be carried however the user can choose to carry less than this.





As the baskets can be removed they can be used to carry the logs or empty the logs to the desired location.

The product can be loaded flat. This could be for loading or storing away.

The fabrics will have little holes to reduces water intake if left outside

The axel will be welded to the main frame as this is a very strong joining technique.

Welding uses a vast amount of energy. Therefore as little time should be used for welding to reduce the impact on the environment.

Once again the wheels can easily be access and replaced if faulty.

As there is only a singular the product can be moved at the desired height of the user.

Due to the wheels large size it can easily manouvre difficult terrain.

One large singular wheel allows the product to be moved easily.

As the baskets can be removed my client could only move one basket at a time which would reduce the strain on her.

The frame of the product is made from Aluminum. This reduces the weight of the product

Aluminum is resistant to scratching and denting. This means the frame will last the 6 years it needs to meet the specification.

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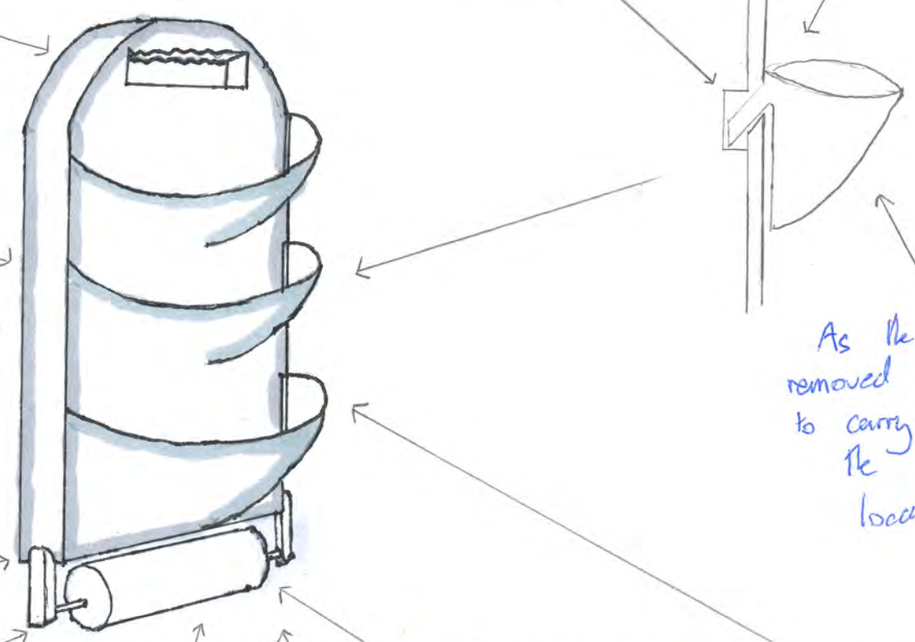

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(2)

Design Ideas

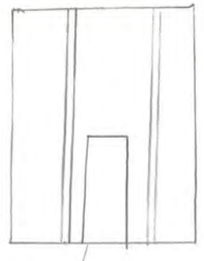
"Machinery"

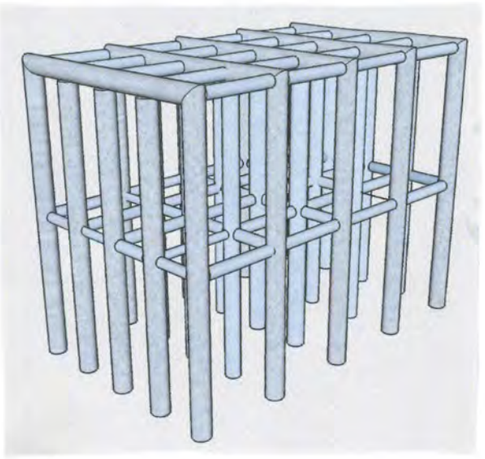
The motor will be electric and so can be plugged in to recharge

All edges will be rounded so that they meet the BSI sharpness test.

A motor will power the back set of wheels which will in turn move the treds forward.

Tubes slide over eachother



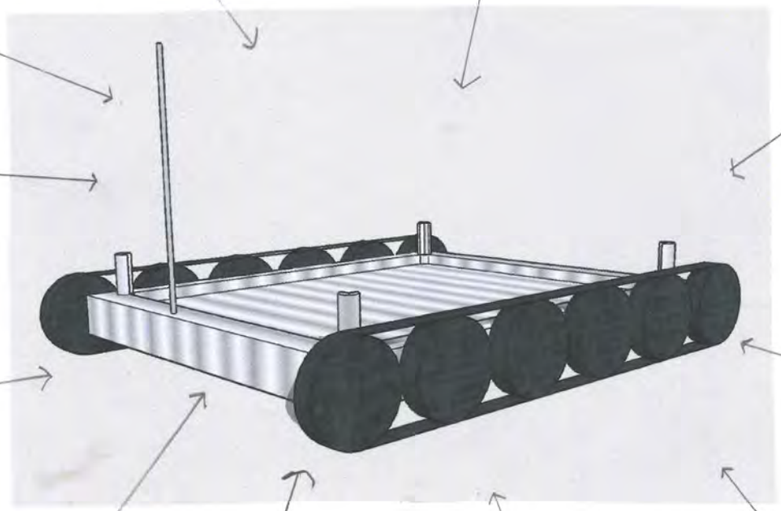


The radio wire can be removed when not in use

The controls will be forward, rotate left/right. This will make the product very easy to control

This product will be radio controlled through a remote controller

Due to the low height of the product it can easily be stored under a table or alongside a wall.



If the user wants to carry more logs without having to make an unstable height pile they can use this attachement. Once connected to the 4 points of attachement it allows a greater volume of logs to be carried whilst remaining safe and stable

65 litres Volume

The product has a very wide base so that it is safe and stable.

BSI EN 1730

Tire treds allow the vehicle to move easily over uneven terrain

I plan to use old bicycle tires as the treds. This will have less impact on the environment.

Using similar materials will make it easier to recycle at the end of the products lifespan.

The product will be made from Aluminum. This is a lightweight material, therefore my product will meet the required weight.

Aluminum is durable and will absorb dents from logs being dropped.

BSI EN 1730

The corners will be pop riveted together

Metal overlap pulled together using pop rivet gun

By using bike treds with this product it allows the treds to be easily replaced.

This leads to easier/cheaper maintance of the products which in turn leads to an extended lifespan of the product.

I will finish the wheels in a black primer and leave the Aluminum as it is as it is already corrosion resistant.

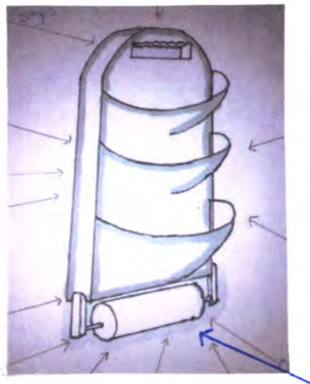
Maths Box

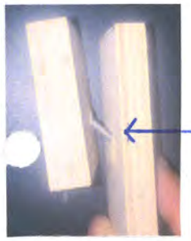
Distance between wheels = $6 \times \frac{C}{\pi}$

$C = 500mm$

Distance = 955mm

Further modelling and explanation of design ideas 1 and 2





Steel bar is used as the 'fish hook' to hold the basket in place. Steel is used as it is very hard and so won't deform easily.

The bar will pass through the back of the basket to provide extra strength.

The beam will pass through at a low angle, this will result in more contact time and therefore greater strength.

I found using 3 rollers gave improved maneuverability.

This nut ensures the axel remains attached.

This part on either side will be welded to the main frame.

Drilled using the pillar drill

The screw thread would be made using Tap + Die.

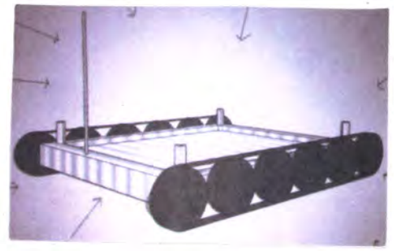
The main axel is made from Brass as it has a low friction coefficient.

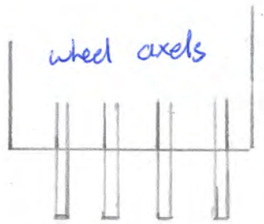
Little gaps results in improved maneuverability

The inside is coated with Brass to reduce friction and corrosion

The nut holds the 3 rollers together

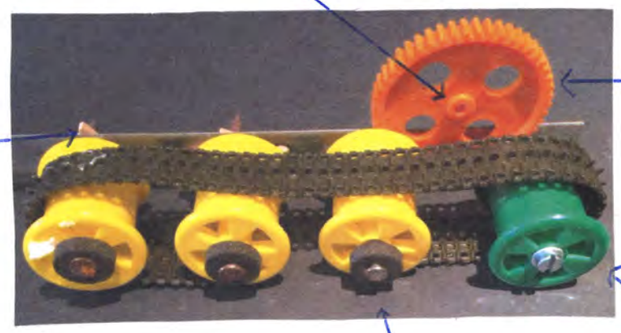
A washer distributes the pressure of the nut evenly over the surface.





The wheels will all need an axel that goes into the main body of the product.

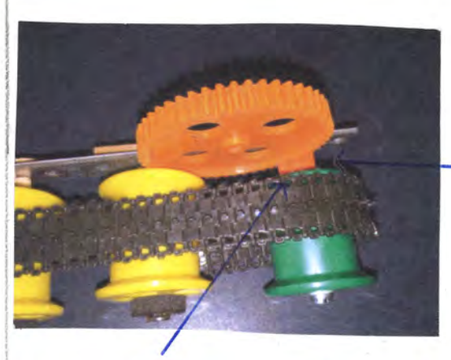
The motor would rotate the large gear which would rotate the smaller gear which would in turn rotate the rear wheel.



A smaller gear could be used to reduce size but this would reduce the RPM.

A nut either side will hold the wheel in place.

One wheel must be accessible so that it can be removed when a new track needs to be added



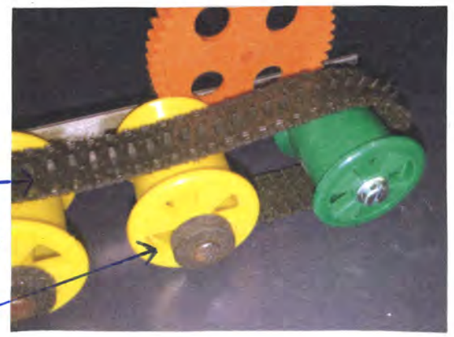
A second gear is needed so that the main gear doesn't hit the floor

A smaller gear allows the RPM to increase without using a more powerful motor.

The axel has a smaller diameter to allow the wheels to bend/change height when going over obstacles

The wheels will have to be the same size as the tracks to avoid the wheels scrapping the floor.

Washers are needed to reduce the pressure on the nut.



Design Idea's 3

Post modernism architecture

Made from mild steel which is durable and long lasting.

very strong joining method → more durable product → extended lifespan

The product is low maintainence which extends its lifespan

Welded frame ← Arc welding provides a very strong join

The finish will be paint as this is a cheap but effective way to protect the metal and reduce corrosion.

Rounded edges for safety (BS EN ISO 9000)

lots of room to hold required 65litres

Jigs can be used to recreate the curved metal

platforms provide multiple areas to hold logs

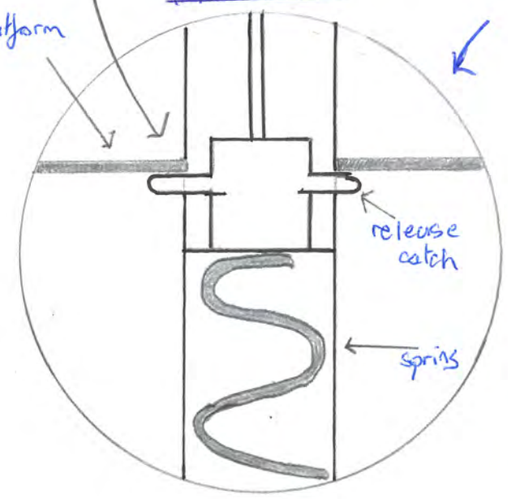
The button is placed below the platform to stop the platform interfering with the mechanisms

Potential for attachement that lifts the logs individually onto the platforms.

platforms made from steel to reduce scratching/denting

little material used which is better for the environment as less material needs to be extracted.

Mechanism



Spring force = $k\Delta h$

Platforms can move vertically to adjust for size of logs

Maths Box

$c = \sqrt{b^2 + a^2}$

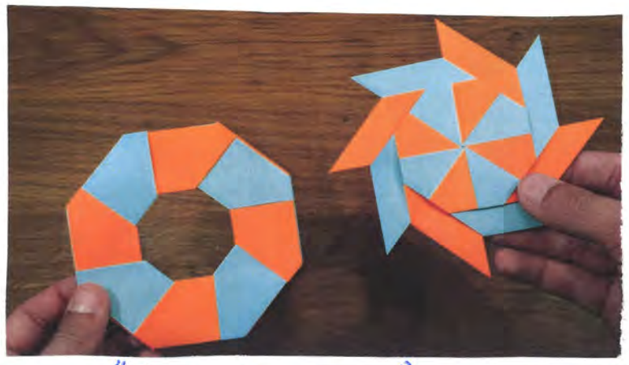
Metal pattern gives added grip for logs

as a result the total weight is reduced.

wide base leads to a more stable product (BS EN 1730)

large wheels allow the product to move on uneven terrain

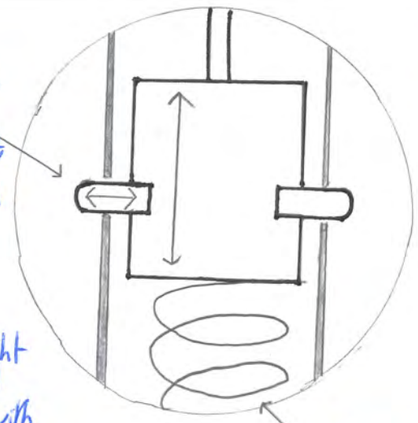
Design Ideas



"2 in 1 design" from Origami

The mechanism will be in a cover to improve safety

Pins move in to allow height change, when released they pop into chosen height.



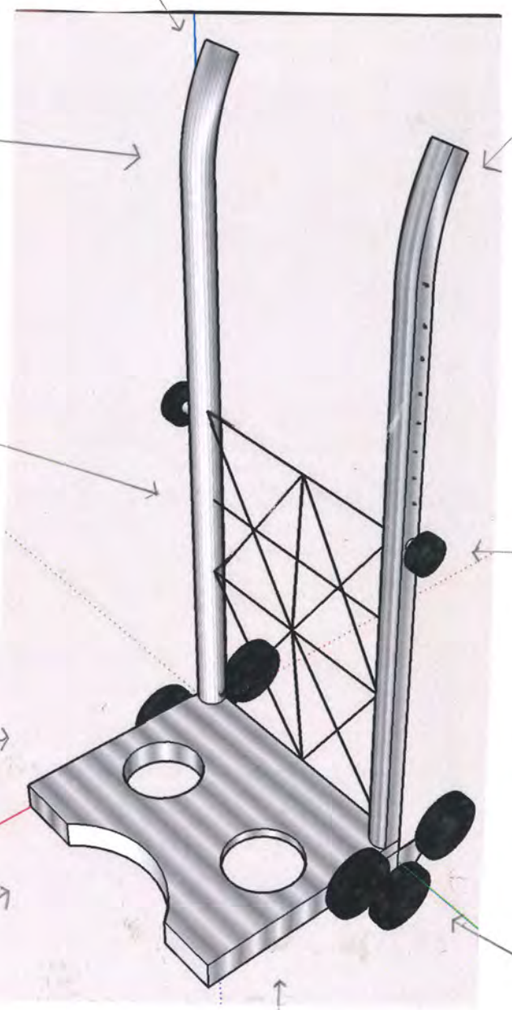
The handle bars height can be adjusted to support users with different heights

Spring holds the weight of the inner tubing without restricting manoeuvering.

All edges and corners will be rounded off to meet the BSI sharpness test

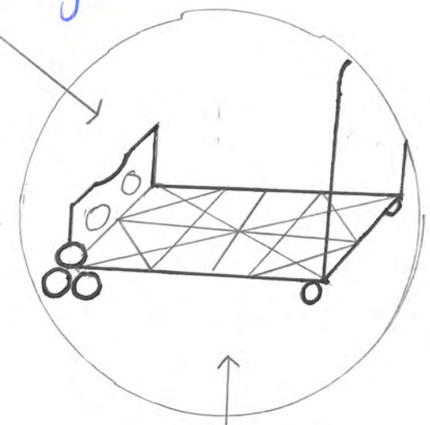
This will create better accuracy and greater speed which will reduce unit cost.

Jigs will be used to recreate identical curves



The wire mesh stops the logs from falling of the trolley as well as it reduces the total weight of the product.

This mode also reduces the needed strength to move the logs



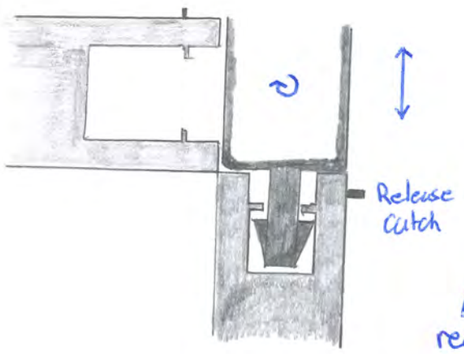
The product has a second mode which allows a more stable way to carry more logs

When the product is in this format it allows 65% of logs to be carried

The metals will then be coated in paint to reduce corrosion.

The metals will mainly be welded together. This will create strong joints.

Transform Mechanism



The product will be mainly made from Stainless steel and Aluminum

Aluminum can be recycled, it has less impact on the environment this way

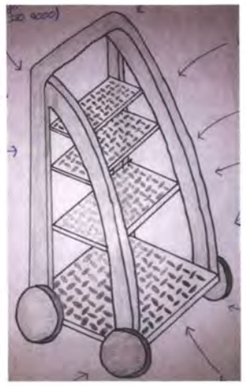
Tri-wheels allow the trolley to manoeuvre easily across hard terrain as well as steps/inclines.

The base of the trolley is made from steel which is very strong and damage resistant to the logs.

As this makes the base heavy two holes have been cut away to reduce weight

Less material is therefor used which reduces the cost of the product.

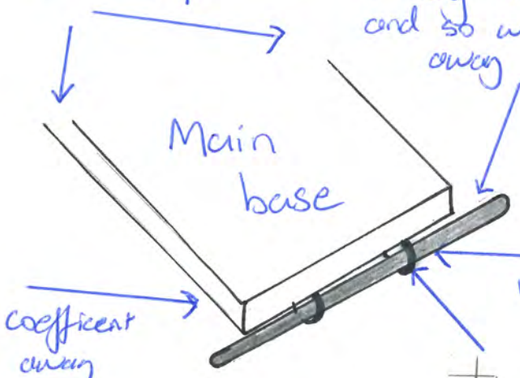
3



Further Modelling and explanation of design ideas 3 and 4

The back wheels use the same setup.

Steel axel, steel is very hard/durable and so won't wear away over time.



The "U" is made from brass. Brass has a low friction coefficient and so it won't wear away over time.

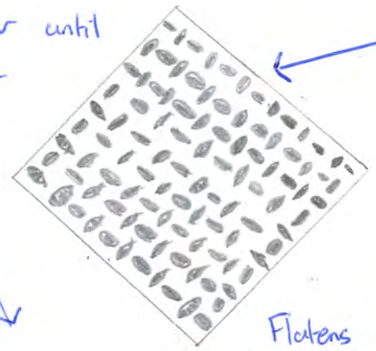
Under the main base.

Screwed in on both sides to hold in place

"U" frame holds the axel in place.

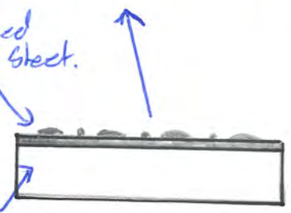
This is done using a Pop riveting plyers.

Pliers squeeze together until either stem snaps or the head breaks off.



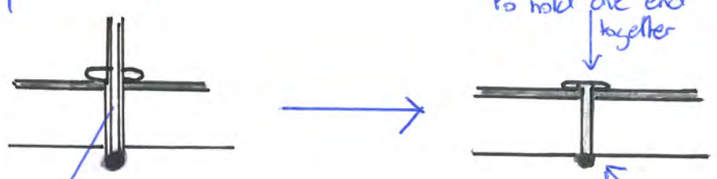
Pre-formed sheet, this will be joined onto a metal base using pop riveting.

Pre-formed sheet.



main base

Pop Riveting



Flattens out to hold one end together

Stem snaps off once pieces are firmly together.

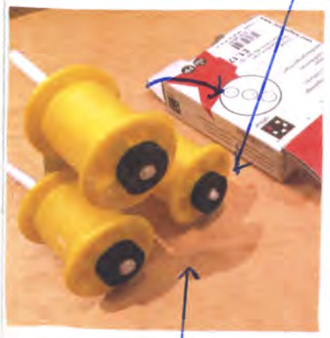
Bulge holds the sheets together.

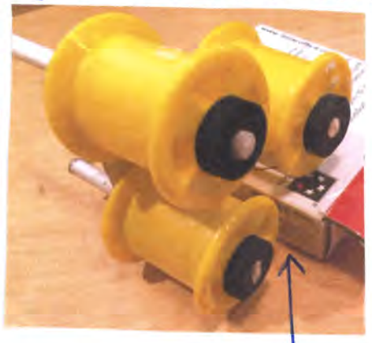
William Stevens - Dorham School - 48349

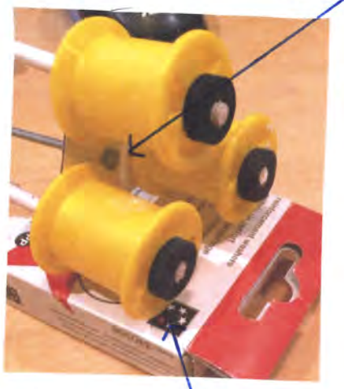
4

This model is intended to show how the tri-wheel functions as well as to show how it attaches to my design.

① The front wheel hits the raised surface such as a curb.







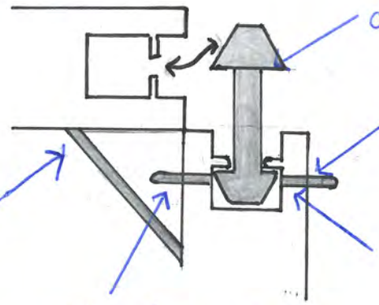
A central axis is where the triangle wheel frame is joined.

② The top wheel flips onto the raised surface such as a curb.

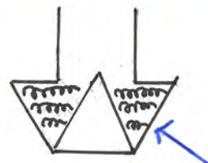
③ The back wheel hits the raised surface.

④ The back wheel moves onto the raised surface.

Support beam supports the mechanism and stops it snapping off.



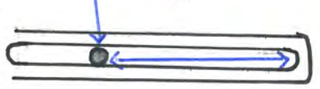
These 2 catches will need a hole to be drilled beforehand, this will be done using the pillar drill.



The catches then releases the edges so that the main frame can be changed into its 2nd form.

Springs allow the edges to fold in but then return to the original position

Beam slides up and down when changing modes.



This sliding folding side when in its 2nd mode

Support beam on both helps support the product

Springs made from titanium to make sure they last the lifespan of the product.

Design Ideas

An "existing solution" to moving heavy goods such as logs

Using this as inspiration

Maths Box

length of ramp Z =

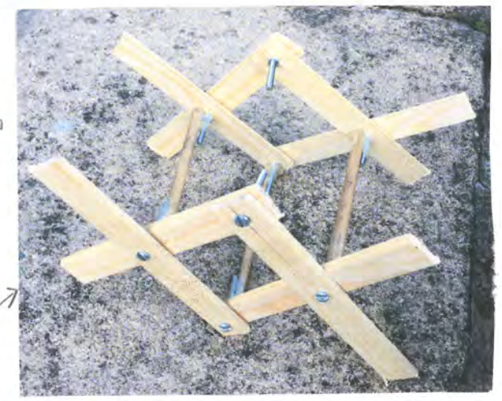
$Z = \sqrt{y^2 + x^2}$

Due to the shape the handles reduce the strain on back which will help my client and older clients.

Handle shape allows trolley to be pushed or pulled.

Reduces the load for the less abled.

As a result of the model I learnt that support beams may be needed to stop the mechanism twisting.



Made from mild steel due to its tensile strength

A support beam ensures the product is stable and secure

BSI EN 1730

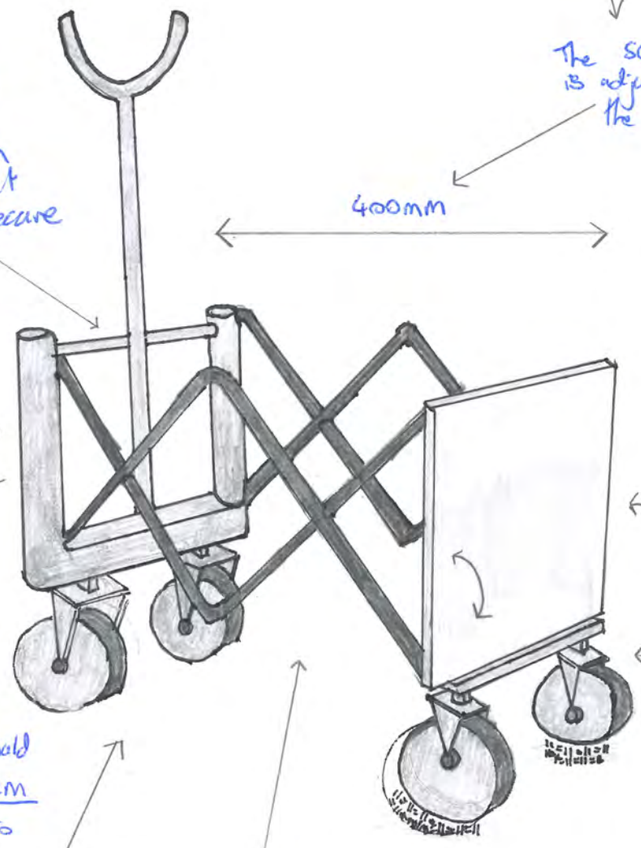
The scissor part is adjustable to fit the amount of logs needed

400mm

I also learnt the wheels must be raised in order to avoid a collision with the middle of the mechanism

I created a model of mechanism to test the strength and functionality of my design

The bends in the metal can be recreated using jigs for repeated accuracy and increased speed of production.



A bag is placed in the skeleton frame to hold the logs

The main frame would be made from Aluminium to keep the weight to a minimal.

The front section can be unclipped allowing a ramp to be created. This allows logs to be loaded just by pushing into them.

Swivel wheels allow improved manoeuvrability

Direction of logs

Direction of trolley

The 'scissor frame' would be made from mild steel in order maintain a strong and stable product.

The bag can easily be removed which means logs inside can be lifted and emptied easily.

When folded away its reduced size can easily be stored in confined spaces.

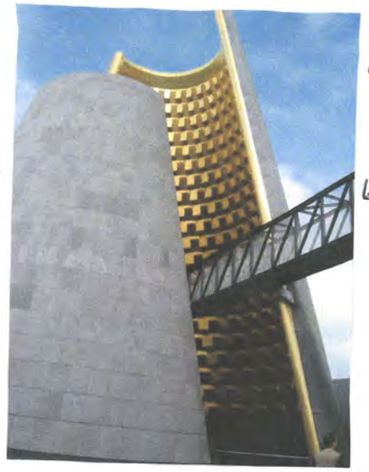
Due to the skeleton frame the product is less than the required 15kg.

Wheels are held in by pins, this allows for easy replacement if a fault is discovered.

As a result less materials are used which results in less environmental damage

Extends the lifespan of the product beyond 6 years in check with specification.

Design Ideas



Architecture inspiration

Post-modernism

Could model handles for client to see which provide the best comfort

handles can lay flat to provide stable loading platform

metal tracks for sliding cover that holds logs in place during transport

Would either be made from Aluminum or Wood

Aluminum
↑
lightweight
Strong
Hard to construct

Wood
↑
FSC
Better for environment
Strong
Durable

With this idea the logs will need to be moved to a greater height which could be a problem for my client.

Idea after modelling

Mild steel as very durable

Brazed/welded together

These handles provide a large variety of hand spacings for added comfort and ergonomics to all users.

By creating a model and experimenting I found it best with the cylinder lying horizontally as the logs are less likely to fall out.

Centre of gravity at front which makes it easier to move.

wheels need to be large to avoid runners

slider needs a way to be locked close (Magnet?)

The opening tab may need to be changed to help fit the elderly

Handles too short?

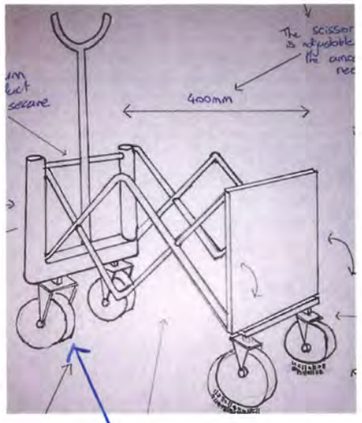
logs stored inside

mostly hollow to reduce weight

As a result of my model I learnt that the wheel axel must be placed at a specific point otherwise the axel interferes with the metal sliding cover.

This was about to be scrapped.

5



Further Modelling and explanation of design ideas 5 and 6

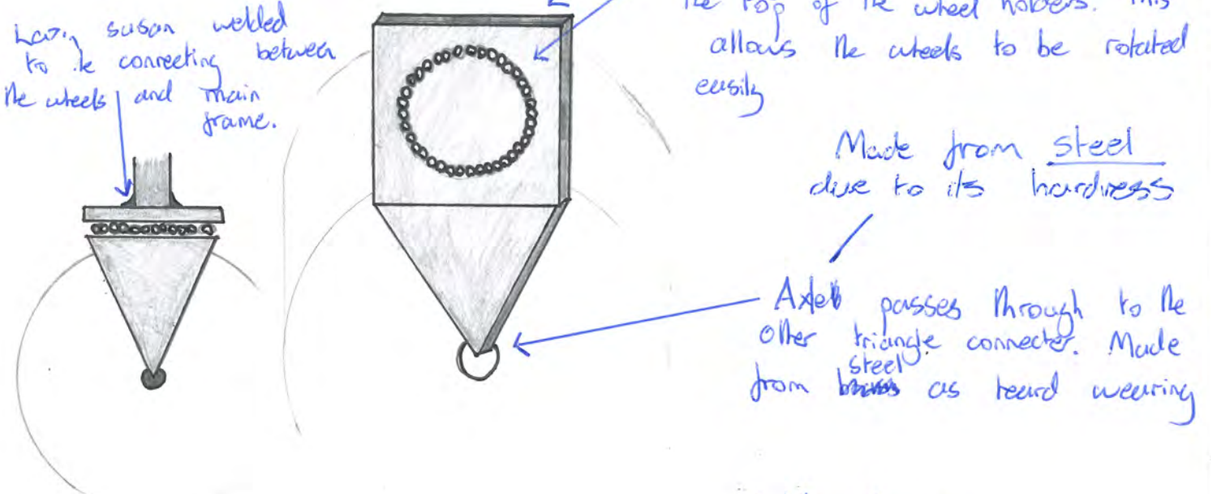
Lazy susan will have a plastic cover. This can easily be removed so that the mechanism can be maintained.

A lazy susan is screwed into the top of the wheel holders. This allows the wheels to be rotated easily

Lazy susan welded to the connecting between the wheels and main frame.

Made from steel due to its hardness

Axle passes through to the other triangle connector. Made from ~~brass~~ steel as heard wearing



Wheels would be made from recycled rubber. This way the product will have a smaller carbon footprint.

Catch either side holds the ramp in place.

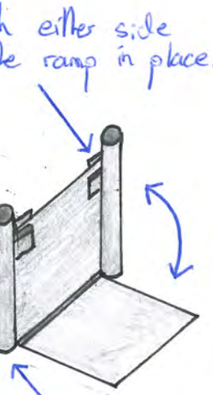
Springs allow latch to be pushed in to release/trap the ramp.

Springs made from titanium so that the products lifespan is beyond 6 years in accordance to the specification.

Steel beam used to connect both sides.

ramp

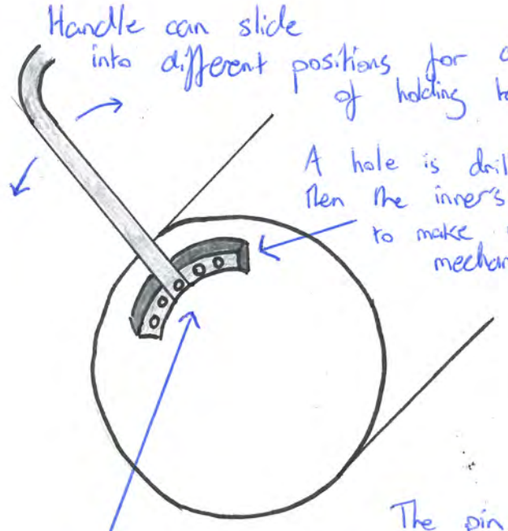
Ball bearings allow the ramp to move up and down.



Handle can slide into different positions for a range of holding heights/angles

A hole is drilled and then the inners are removed to make room for the mechanism.

This mechanism is on both sides. The handle can only move when both pins have been removed.

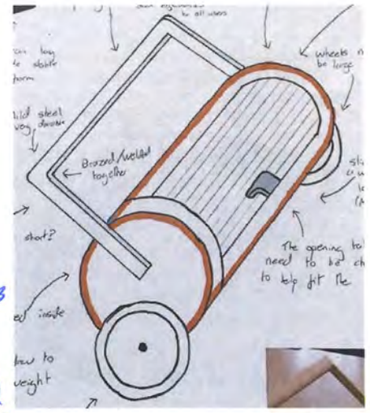


The pin can be removed which allows the handles to move.

A steel pin holds the chosen handle placement in place.

Magnets make sure the pin doesn't accidently fall out.

6

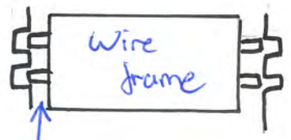


From making this model I realised that a platform will need to be introduced to avoid the legs interfering with the sliding cover.

The platform will have a wooden frame which will have a metal wiring in the middle.

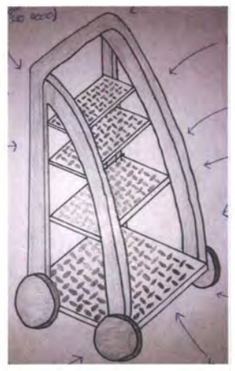
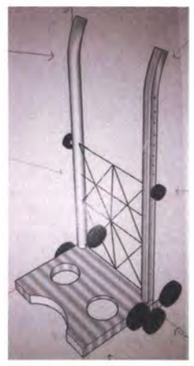
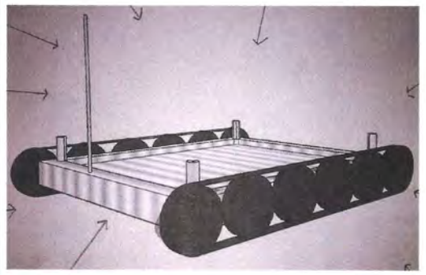
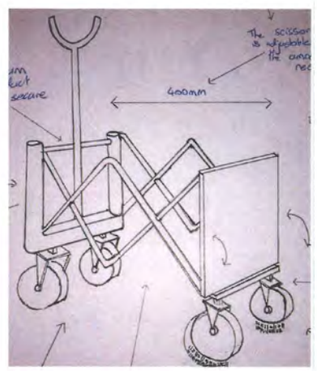
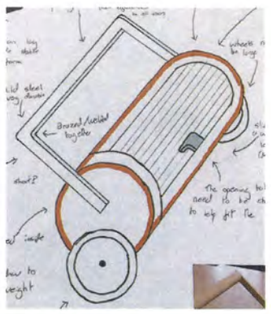
A wiring will reduce the weight of the product.

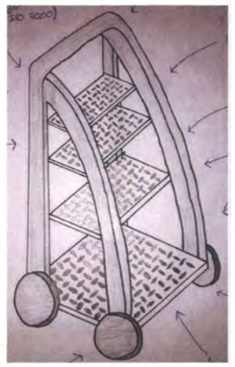
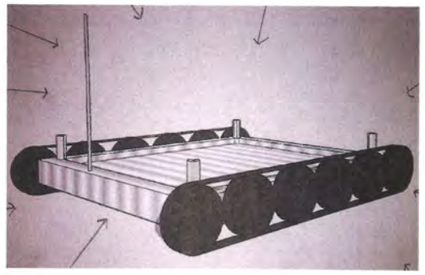
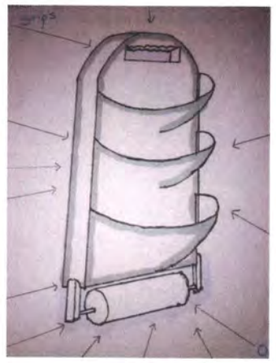
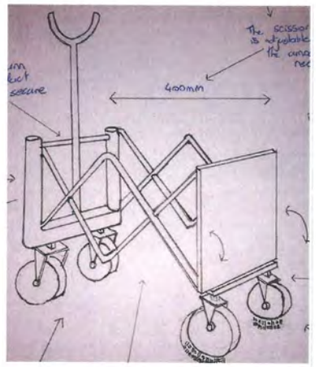
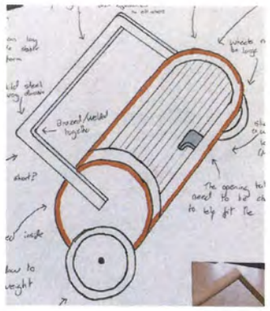
The platform will have to be connected before the outer cover is installed due to its size.

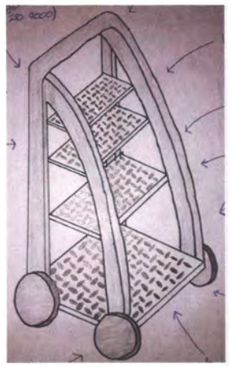
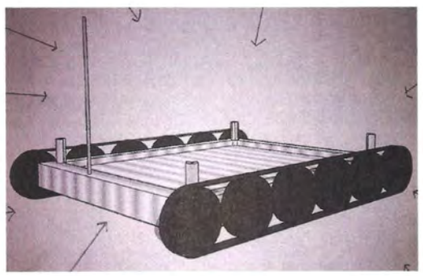
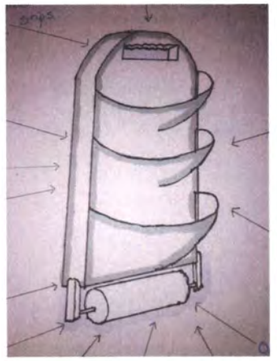
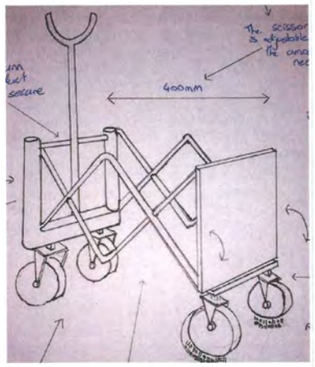
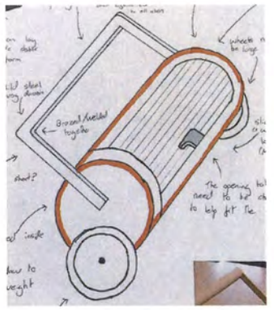


Dowell connecting rods are installed to provide added strength to the joining area.

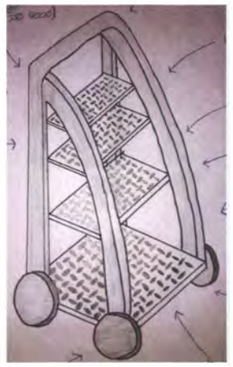
Evaluation of Design Ideas

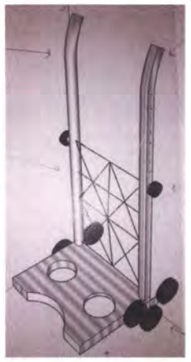
Key aspects of my specification						
Function	The product would carry around the required 65L as well as with the four wheels the product is very stable. Furthermore, not only is the product adjustable it is also very strong and so it will be able to support the 50kg. I also believe that the mechanisms are fairly simple and so wont buckle under pressure. The only area I think my product falls down is with loading/un-loading as I think this could be problematic for someone who is less abled.	This product meets the required 65L of logs needing to be carried however this is only in one of its modes. In addition to this I think unloading/loading logs could be difficult for an elderly person. Among these negatives there are still many positives about this design. Due to its wide base, it is not only stable but it is able to hold the 50kg weight not to mention withstand the 500 Newton's of force. As the product has "step wheels" it makes obstacles easier to manoeuvre which makes moving the logs easier. Finally, this product has lots of adjustability to fit different users which is required from the specification.	In terms of function this idea is excellent. It has a wide base which makes it stable as well as it allows it to carry the 65L of logs. This wide base also spreads out the weight over more area which allows for the 50kg weight of logs. Although the design has no complicated mechanisms it does have a motor, due to this whether the motor can support 500N stress is unknown. Albeit there is no clear method of unloading the logs the log carrying frame could second for carrying the logs from the main body. Whether this would be to heavy I would have to test more. This log frame also means the adjustability quota is met.	Whether this design carries 65L it is hard to tell. Whether the basket volume needs to be increased we can decide later. In terms of loading/unloading the basket method makes this very easy to do. The problem with this idea is that it is unstable, this will put extra strain on the user. Furthermore, this design has no adjustability, only parts that can be removed individually. Finally, whether the rolling wheel at the bottom can support the 500N force will need to be tested further.	Although this is one of my more complex design I still think it functions as it should. With a fully stretched basket it will meet the 65L volume requirement. Alongside this the product has 4 base point which will result in it passing BSI EN 1730. With some form of adjustability, the only specification points that might not be met are the 50kg weight and the 500N stress. Further testing will be needed to deduce the strength of the scissor frame. Before these tests I will assume they meet the specification. Furthermore, the basket for the logs can be removed which allows for easy loading/unloading.	In terms of function I think this idea works as intended. The hollow frame allows 65L of logs to be carried as well as the wide base means stability is good when moving. However, when loading the logs, a sort of stabilizer will have to be added. I think this product will be able to handle the 50kg weight as well as I am sure the cover will not falter under 500N. However, although this product has an adjustable cover it doesn't have an easy method to unload and load the logs. This must be reconsidered if the product is going to pass this specification section.
Form	Even though my product is simple I think I can say that it easily fits in most environments. It also clearly doesn't offend any cultures which is good. The design is modern which is what my client wants. Even though my design isn't "ugly" I would say its aesthetics are not outstanding.	I regard this idea as aesthetically appealing due to its sleek design. Not only is it modern looking it also fits in many environments without offending genders/cultures. Moreover, the product is designed with ergonomic consideration. The handles can be adjusted to fit all heights. I think the only way to improve the form of this product would be to engrave some sort of pattern into the product.	I think many people will find this design not only quite cool but also aesthetically pleasing. Its symmetrical sleek design is very appealing. Ergonomics are not considered partially with this design as the user has no interaction physically with the product most of the time. This design also does not offend cultures as it has no obvious patterns/symbols. This modern design will fit in many environments as the product has a low profile. Due to this, this idea easily meets the specification.	Although this product has no fantastic aesthetics it isn't exactly ugly either. The design is unlike others however I still believe it is modern looking without offending any cultures. Not only this but I think the product would fit into any environment placed in. Ergonomics have been considered, the handle is not only made to fit a hand but is also placed at an average height for the comfort of the user when manoeuvring- the product.	Not only does the "U" handle provide and comfortable handle at the right height it also ensures the product can only be pushed. Due to this back strain will be reduced. Furthermore, this minimalistic design ensures it fits into most environments. Not only this but it is also a neutral design and so hopefully should offend nobody. I also believe this sort of design has never been created with logs and so it is "modern".	I think this design, with the right materials, could be very aesthetically pleasing. With an ergonomic handle which is large so that different grips can be adopted I think this design is very modern looking. Not only this but I think everyone can say this design is not offending in any way as well as I think it will easily fit into any environment. I think in conclusion to this I can say the form of this product is excellent.
Quality Control	Due to the design being rather simple it requires no complex parts/components. Due to this the accuracy at which parts are made can be easily monitored. With the use of jigs this accuracy will improve even more.	I think due to complexity of this design quality control management would be difficult. The accuracy of small parts and mechanisms would have to most likely more accurate than ±5mm for the product to function. This is more accurate than my specification required. As a result, the product would have to be thoroughly checked before being placed on the market which would cost both time and money.	Much similar to my last design the complexity of some parts such as the motor will make quality control management very difficult. The motor would have very small parts most likely so a ±5mm tolerance might not be enough. Due to this each product will have to be thoroughly checked before being put onto the market.	This idea uses simple mechanisms and therefore I think the ±5mm accuracy will be suitable for checking the product over including the mechanisms. Checking the product over will be simple as there are no hidden parts that could be faulty.	The complexity of this idea means a ±5mm tolerance for accuracy is not enough. This will have to be greatly increased to ensure the product does not falter. In terms of checks made before the product is placed on the market these will have to be incredibly thorough otherwise a faulty mechanism or wheel could become a danger to the user's safety.	I think a ±5mm tolerance for accuracy should fit perfectly for this design. Its mechanisms are relatively simple and therefore I think they will be easy to maintain and produce easily. Due to this I believe checks completed before the product is placed on the market will be sufficient.

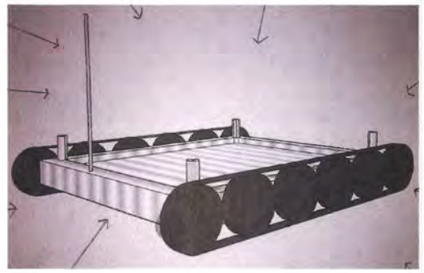
Key aspects of my specification						
Dimensions	In terms of dimension requirements this design is excellent. It easily fits inside the required size of the product. Not only this but the product has no jetting out edges and it easily meets the adjustability requirement. Finally, the handles have a diameter greater than 75mm.	The dimensions of the product are in line with the dimensions required in the specification. Depending on handle extension the dimensions can exceed these values. The product as jetting out parts but none are more than the 150mm limit mentioned in the specification. As well as this the product has the 400mm adjustability required by the specification. Lastly, the handles which can be moved have a diameter larger than 75mm and so they will be easy to hold.	This design easily fits in the dimensions required from the specification. Although this design has 4 jetting out edges, they are not over the 150mm limit. Even though there is no immediately obvious adjustability when the idea uses the log frame there is over a 400mm difference in the height achieved. As a result, I think the specification point is met. Whether the 75mm diameter handle requirement is met depends on how the idea is controlled. Further designing and development is required before evaluating this point.	The dimensions of this product easily fit in the required quota. However, in terms of jetting out edges this is not so clear. Whether the baskets count as jetting out edges will be up to the decision of the client. Furthermore, whether the fact the baskets can be removed counts as adjustability will be up to the client to decide also. Finally, the cut-out handles result in the diameter being well over 75mm which means it meets the quota from the specification.	Whether the product fits inside the required dimensions is hard to tell. However. this design is definitely on the larger side. Moreover, the product does have a jetting out edge, the handle. These may have to be redesigned if this idea is developed further. However, some positives of the idea are that it has handles with a 75mm diameter as well as it has exactly 400mm adjustability which is required from the client's specification.	Although this product is quite wide I still think it will fit inside the required dimensions. On top of this the product has no jetting out edges of more than 150mm, as long as you exclude the handle. In terms of the 400mm adjustment this is a bit of a grey area for this design. The cover is adjustable and it is over 400mm so whether this is what the client wants I will have to discuss further. Lastly, the handles have a diameter that is greater than 75mm and so all specification points are met.
Safety	My product has rounded edges so it will easily pass the BSI sharpness test. As well as this due to the frame structure of my product it shouldn't weigh more than 15kg. However, due to the mechanisms being on the outside covering them up for safety reasons would be hard without removing access to the mechanism itself.	This product is full of many complex parts, due to this I would imagine some mechanisms would have sharp edges so it is possible it would fail the BSI sharpness test. However, I believe the mass would be no more than the 15kg maximum stated by the specification. Finally, finger traps would need a special cover to reduce injuries otherwise they could become a safety problem.	The design has no sharp edges so I believe it would pass the BSI sharpness test with ease. Alongside with this I think due to the whole frame of the main body the product would weigh no more than 15kg, depending on the weight of the motor this value could change though. Finally, in regard to finger traps I think this product would fail. Although there is no obvious danger if a person was to place a hand into the track area they could trap a finer or at the least injure themselves.	My product will have sharp edges however these edges, on the back of the baskets, will be covered unless the baskets are being moved. To fix this some sought of finger trap cover would have to be designed in the development of my idea. In hindsight though I believe that this product will weight no more than 15kg. If it was more than this a featherweight material could be used for the baskets.	Due to the mechanisms, this product uses it would be a hazard for young people. The scissor part could trap finger/hands if not carefully watched. However, with rounded edges this could reduce the chance of injures. Moreover, with the main body of the design being a scissor frame the weight of the product would unlikely be over the 15kg limit.	In terms of safety I think this product has no issues. The cover on top has to be physically closed by a person which will reduce injuries. The main sliding part of the product is hidden at either end of the product and so can't be reached accidently. The product has a wide base which will spread out the weight allowing it to support the 15kg. Finally, the product uses rounded edges in all possible areas and so it should pass the BSI sharpness test.
Materials	Due to the product being made from mainly metals such as mild steel it will pass BS EN 1730 as mild steel is both hard and durable. The product is finished in a paint which will not only make it waterproof but will also reduce corrosion, due to this it meets the requirements from the specification.	The materials used in this product vary from part to part. However, the metals used are all hard wearing which means the product meets BS EN 1730. The materials used are also low maintenance but only after a finish has been applied. In terms of the sustainability of materials used, Aluminium can be recycled widely which is the main metal used in my product.	The product is made from Aluminium which is not only easy to recycle but it is also a low maintenance material that will require little upkeep. Aluminium is hard as well as waterproof/corrosion resistant meaning it will meet the BSI EN 1730 requirement. The other main material is rubber which poses many similar materials to Aluminium. Although it is less hard wearing however it can be replaced easily and at a low cost.	The product uses 3 main materials. Aluminium, mild steel and a fabric. Whilst Aluminium and mild steel meet all the specification requirements I am less sure about the fabric. Many fabrics are semi-waterproof, this means that they absorb most of the water. This would not be good for the product as the water would add to it weight. The fabric chosen must be thoroughly tested before becoming part of the product.	This product is made using only metal. These metals being Aluminium and mild steel. Both these metals will pass the BSI EN 1730 hardness checks. Not only are these materials long last but they are also waterproof and corrosion resistant when the right protective finish is applied. This in turn leads to a low maintenance product. As a result, it passes the material specification part.	I decided that this product would use either Oak or Aluminium. Both materials are hard wearing and durable and so should meet BSI EN 1730. If wood is used a waterproof varnish will be needed however Aluminium is waterproof/corrosion resistant. Both these materials are long lasting as well as low maintenance so whichever material is used it still meets the material specification.

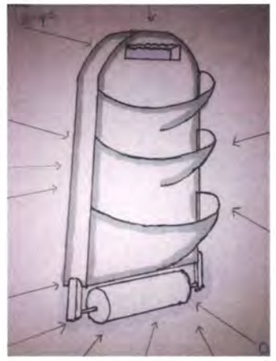
Key aspects of my specification						
Ages	The product is simple to use as it has no very complicated mechanisms. Due to this I think my product fits the required age of the specification which is 18-99. Furthermore, due to the simplicity of the product it has no small parts that a child can play with hence meeting the specification.	The product is fairly complex but any adult should be able to understand how the product and mechanisms works. However, someone who struggles with lifting/moving may struggle to use some of the mechanisms. Without some sort of aid the product may not appeal as much to people who struggle more in life.	My design is easily suitable for ages 18-99. With the use of remote control, it removes any strain that could be on the body. If the controller was design simply and in mind of the elderly than this would be the perfect product for all ages and abilities.	Any abled 18 to 99 year old would have no problem understanding and using this product. However, a less able-bodied person may struggle to support the product when it is fully loaded which could be up to 50kg. For my design to pass this part of the specification I think a second wheel/stabilizer would be needed to make the product more stable.	The product is developed has been developed with all ages and abilities in mind. Four wheels means no weight is carried. The handle reduces the strain on the users back as well as the logs can be unloaded from the product which means older ages shouldn't struggle with using this product.	Although this product is very easy to understand I still think some work is needed if the product is going to applicable to people who struggle lifting objects. Due to the product only having two wheels this means the user has to apply a force to keep the product from falling over. Due to this I think older aged people will struggle, because of this I think the product doesn't quite meet the age specification.
Cost	I think that my product could be made for less than £100. I believe this for many reasons. The product uses little materials due to its skeleton frame. As well as this it uses similar materials which in turn reduces the cost.	The complexity of this product could hazard a problem regarding the cost of the product. Depending on how much certain parts/mechanisms cost the product might fit inside the price range asked by the client.	Although the main frame of the product would be fairly cheap to create as well as using recycled tires to reduce the cost I believe that the cost of the motor would be the main contributor to the cost. The cost at which the motor could be made/bought would be the key difference between meeting the cost requirement or not.	The relative simplicity of this product would result in a reasonable price I believe. The product uses sheets of metal which will be shaped during manufacture. This results in a lower cost product. My design also removes metal rather than adding more on which means cut-offs can be used for mechanism such as the handles on the basket or a part of the mechanism attached to the main wheel.	Due to the minimal material used in this idea I think this would reduce the price. Although the mechanism is complex It would only use nuts and bolts to be created which could be done cheaply. As a result of this I couldn't see a situation where this product cost more than £100.	Due to the relatively simple design of the product complex materials/parts will not be needed. Due to this I believe this product can easily be made for less than £100. As a result, my product passes this part of the specification.
Scale of Production	Jigs can be used in manufacturing this product. The curves are exactly the same so a bending jig could be used to shape the metal when it has been heated. Jigs could also be used to recreated the metal imprint of the metal plates. Due to the fact multiple jigs can be used I think this product would be suited batch production which is required by the specification.	Although this product is complex many features can be repeatable made using jigs. The base plated would use a jig as well as the main beams could also use a bending jig. This would increase speed of production which means batch production would be suited to this idea. Furthermore the "pin holes" could be recreated exactly using a drilling jig. Due to this I believe it easily meets the requirements of my specification.	Due to the simplicity of the main parts of the design cutting jigs could be used repeatable to manufacture the main body. Using recycled tracks also means new ones don't have to be manufactured. Bending jigs could also be used to create the bends in the long frame. Due to the repeatable reason jigs can be used I think this product would be well suited to batch production. In a factory, I believe a robot could assemble this product which would reduce the employment cost.	Depending on the materials used for the basket the curve on the basket could be shaped using a bending jig. The main frame could be cut using a cutting jig, this would create exact copies of the slants on either side of the frame. As a result of heavy jig usage, I think the product would be perfect for batch production.	The complexity of this design will make many parts difficult to make and assemble. This will take time and slow down production. Whilst some parts can be recreated using jigs others will require humans to make and assemble parts. Due to this batch production will be hard to implement. Meticulous planning will be the only way an effective batch production system is implicated.	Jigs can be used for the bends in the handle but apart from this there is little use for jigs. However, because the product uses little complex parts, I think this product can easily be assembled using batch production. Many parts can quickly be assembled together without the use of heavy machinery etc which means batch production would be ideal.

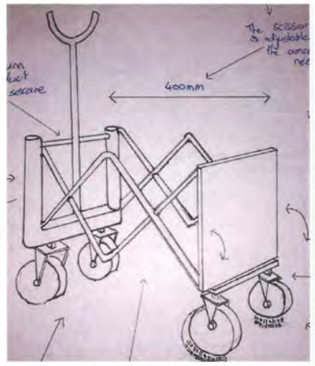
Key aspects of my specification

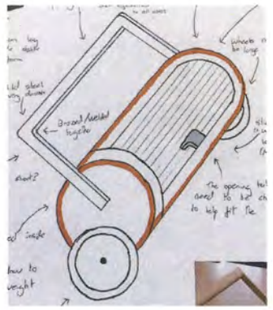












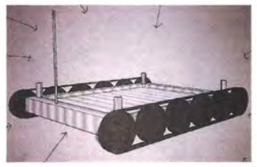
Sustainability					
I think the sustainability of this product is very mixed. It uses similar materials which makes it easier to recycle at the end of the products life. As well as this the product is finished in paint which is one of the eco-friendlier finishes more this sort of product. As well as this mild steel which my product uses is a long	In terms of sustainability I think product has room for improvement. My idea uses 3 different metals which will make it harder to recycle at the end of its lifespan. My product will also use lots of machinery during the manufacture process which uses lots of energy. The product will be finished mainly in paint which is better for the environment than most finishes. I think to improve the products sustainability recycled materials should be used.	The sustainability of this idea is excellent. Not only does it only use one metal, which makes it easier to recycle. The metal used is aluminium which is widely recycled. it also uses recycled tires as tracks reducing impacts on the environment. Moreover, aluminium is self-finishing so no finish is required reducing the impact on the environment. The only place this design falters could be with the log frame. The log frame will need lots of welding to be created. However, this could be substituted for nuts and bolts to reduce energy usage.	The fact that this product only uses one metal will make it easier to recycle at the end of the products life. There is little to none high energy processes which will mean the product will have a smaller carbon footprint. I also believe that the material used for the basket could use recycled metals/elastomers. Finally, the only sort of finishes used would be a sort of water based sealant for the fabric, it would only be used in small amounts and so should have no impact on the environment.	Although both metals used have very long lifespans the fact there are two metals makes recycling harder at the end of the products life. The product is likely to be finished in some sort of paint, hopefully this will reduce the products effect on the environment. Whilst unused material will likely be wasted it can be said that hopefully the product will be bolted together. This will make disassembly easier when recycling as well as using bolts it's a low energy joining method which will reduce the products carbon footprint.	Not only are the materials for this design chosen recyclable but they are also long lasting which will reduce their harm on environment. I have also used only water based varnishes for this product which are less damaging on the environment. Not only this but many parts are bolted/glued together which are low energy methods of joining materials together. Finally, the use of similar materials throughout this design will make the product easier to recycle at the end of the products life.

Design Idea

Clients comments regarding my initial design ideas

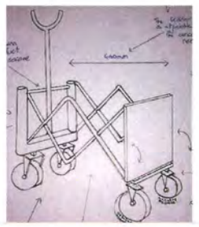
"I really like the idea of the moving platform, hopefully it will be easy to understand how to change the height of the platforms. Not only this but I think the little bumps will provide extra grip for the logs so that they don't fall off whilst I push the trolley up my concrete ramp. Although there is a wide handle I was hoping for something a little more comfortable, maybe a rubber handle or something similar to that? As well as this I know there are four wheels, which will help stability but I am unsure how easy it will be to turn the trolley round without having to lift the product itself. My final comment is that I am really happy with the size of the product. The height at which everything is placed looks suitable for me. Overall, I think with a few adjustments this product could improve."

"Although this design is very complex I really like the products main features. The fact the product has a second way to carry logs makes me happy. As I'm told the second mode can carry more logs without me (the user) having more strain on their body which impresses me. As well as this form of adjustability I think the idea of the handles acting like crutches is great. This means I can set the handle height to anything I like and then when my husband uses it he can change the height to suit him. However, there are two things about this idea that concern me. The first is safety, with all these mechanisms how will you make them safe to operate? My other problem is with the product sustainability. Using many different materials as well as welding will increase the products lasting damage on the environment. Could you think about redesign so that bits fix together instead of welding?"

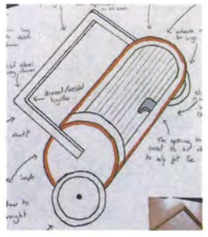


"I think this idea is quite bizarre but I think it might have potential. The idea of me not even having to push the product does sound very good but whether I'll be able to remote control I am unsure. The designer promised me the controller is extremely simple but I know people my age struggle with technology and so I think I would need to see how the product works before buying. In terms of recharging the motor I am also dubious as to how easy this will be. Another issue would be the wheels. I would like to see some sort of wheel guards to protect not only the user but also the wheels from dirt/gravel next to my logs. Everything else about this idea is great and I think this design has great potential."

"Although I think this design may place strain on my back I still think that this can be fixed resulting in a great idea. The method that this idea uses to move around is very inventive. I think it also a functional idea and with its wide base it will be easy to manoeuvre around my house. I also like how the logs can be loaded and unloaded using the basket method. On top of this the fact I can choose to carry only one basket is a great idea as it will make it easier to carry logs. The only issue I can with is stability. I think a second wheel of some sort would be needed to ensure that the transporting is easy and less strenuous. In general, I think this is an idea that could be good but needs little tweaks for improvement."



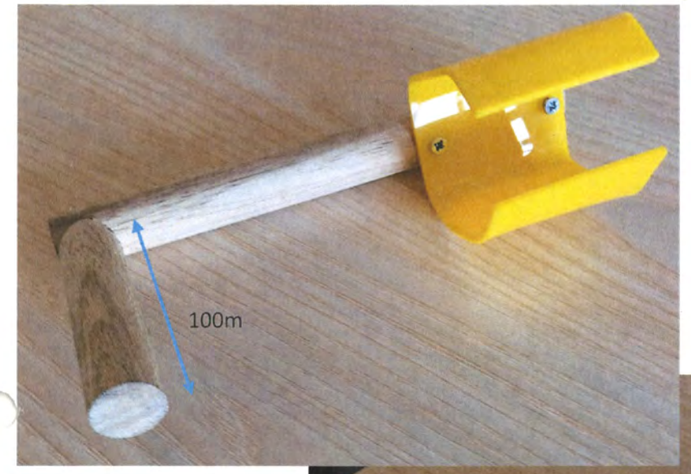
"I think this is possible my favourite idea. The four wheels not only make the product very stable but the fact they can swivel allows me to easily manoeuvre the product. I also like the idea of the ramp that folds down meaning that I can ramp the logs into the basket without having to pick them up. I also like the handles design as it promotes the use of using two hands and I am also told that the design reduces stress on the back which is good for someone of our age. Furthermore, the fact that the design can fold up when not in use appeals to me as it can easily be stored in my house. The fact the basket can also be removed when unloading/loading is also very good. In general, I am very pleased with this design."



"Although this product is a little simplistic, I think it is original as well as it has potential. The way the logs are carried is quite clever and I like that aspect of the design. Furthermore, I like the idea of a large handle allowing different grips to be used. However, I think unloading the logs could be a challenge for someone of my ages. As well as this, wouldn't dirt or mud get stuck in the mechanism if it was on the inside next to the logs? I think some sort of protective cover would be needed to stop the dirt jamming the pull over cover. Overall, I think it's a clever design but it does need some fine tweaking to improve its function."

William Stevens - Bodmam School - 98349

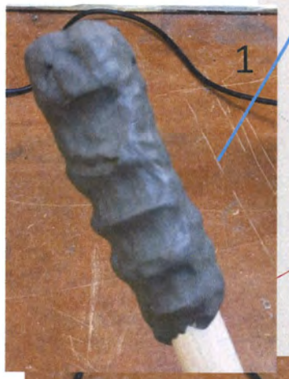
Development

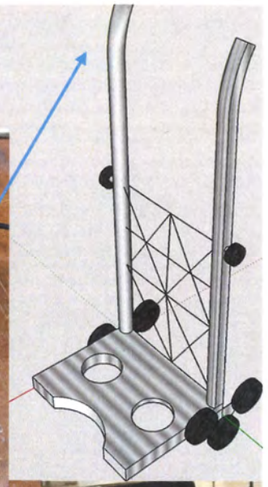


My original handle was quite basic and I think some less abled people would have struggled to use it. As a result, I made an almost crutch like handle. This is going to replace the original handle and therefore hopefully should be easier for less abled people to use. As a result of the mode I realised some of the weight of trolley could be distributed alongside the wrist which will reduce the pressure on the hand. The wrist catch also means you are less likely to accidently let go of the trolley, hopefully this will improve safety.

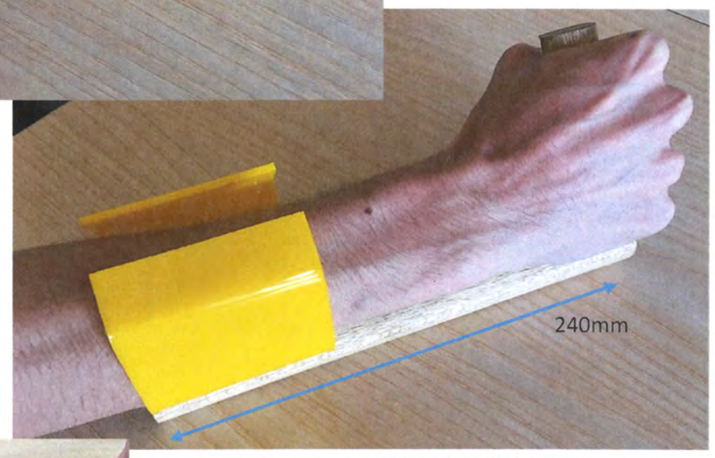
Choosing the correct handle for this product is very important. The handle must be comfortable for all users of all ages. As a result of this I decided model a few handles to try and find the right one for my product. The first handle I modelled was very comfortable to hold but when another user used it they said the handle didn't quite fit their hand. If I was to use this handle I would have to use a more generic hand hold so that it can be used by more people. Handle number two was surprisingly good. The circular holes provide a suction like grip for your fingertips and so I found this handle very easy to grip. I was less impressed by my third design. Although the lines provided some grip for the handles, the end result was that there was little grip for the handle.

As a result of my modelling I have concluded that a combination of model one and two would provide a suitable grip for all ages and abilities.

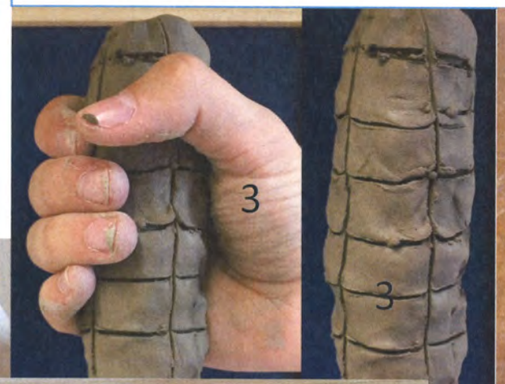


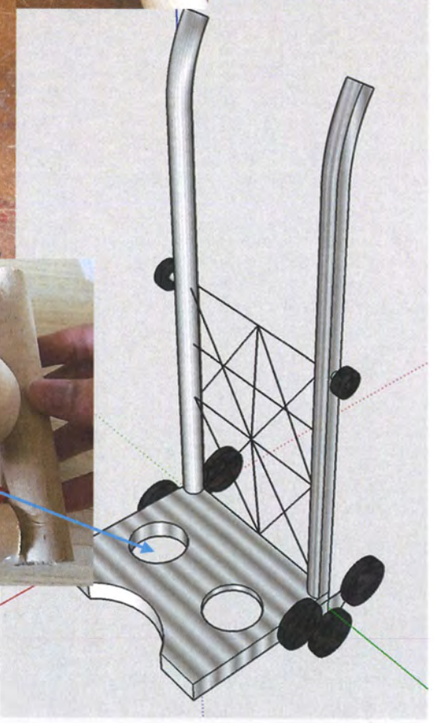


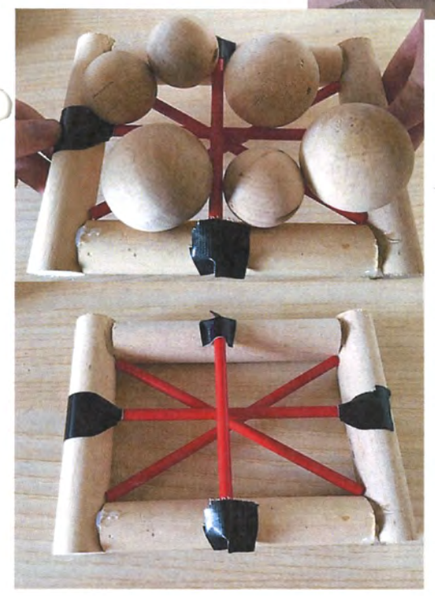
The handle will have an ergonomic grip which I will experiment with before deciding on the grip I want to use. Once I have decided a grip it will wrap round the current handle frame.



The main frame of the handle will be made from steel tubing which has been welded together. The arm cuffs will be made from High impact polystyrene. This combination of materials should result in a very strong yet durable handle.

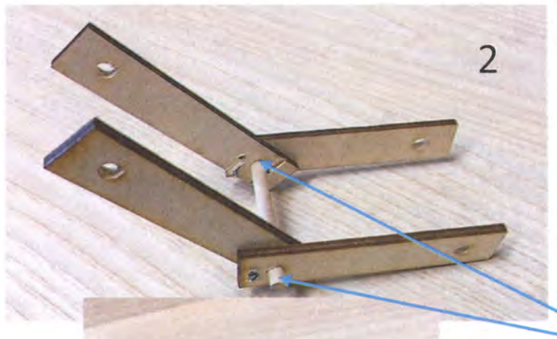


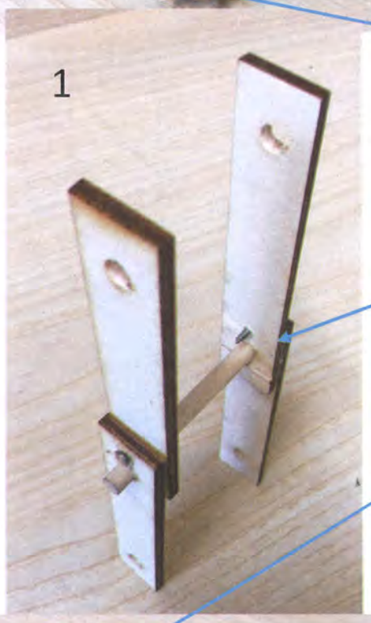


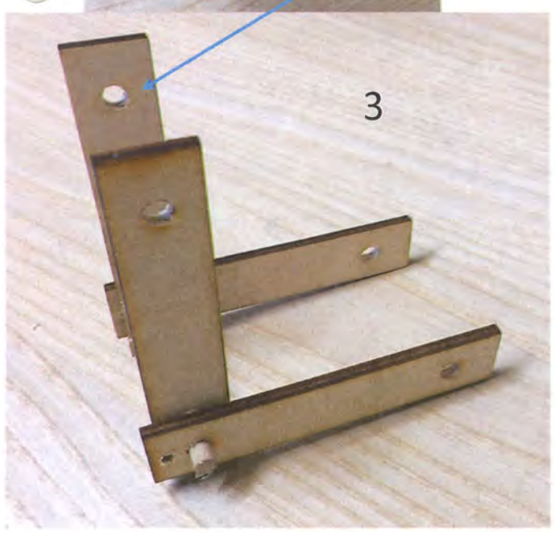


Due to the base frame of my idea being very heavy I decided to develop the idea to see if I could find a solution which reduced the weight. Using a quick model, I found that the best way to reduce the weight would to create a thin metal wire frame. The first frame I made consisted of a cross pattern. Although this would be the lightest model, I found it only held the largest logs and therefore would be ineffective. My second model added on a plus shape to the already existing cross. I found this model to be a lot more effective as it caught most of the balls. However, the smallest balls still managed to fall through the base. To counter this, I plan on butting a thin wire frame under the thin metal beams. This wire mesh will only need to be very thin as it will only support the smallest of logs and therefore will not need to support much weight.

Development 2







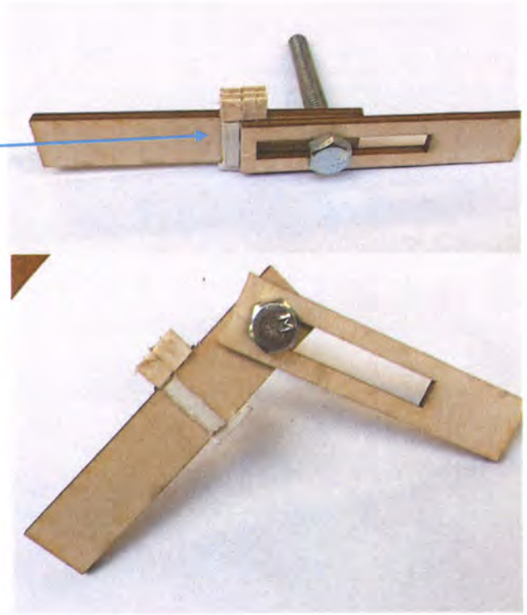
Transformation of trolley mechanism 1

Whilst looking at my original design I wanted to look at how I could better interchange the two modes of the trolley. Upright and at a right angle. To look at this I created a variety of models and designs to try work out the best option.

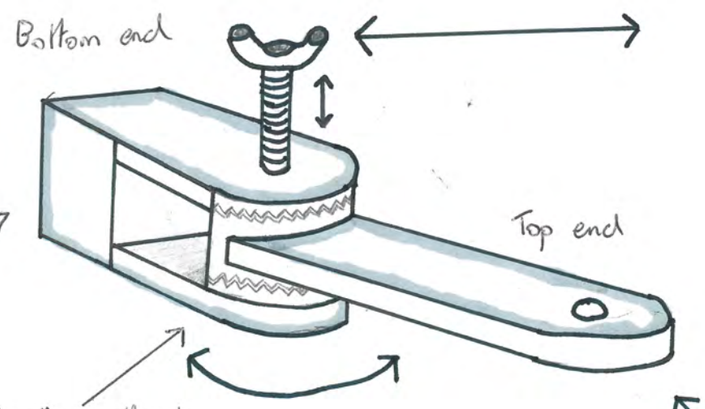
My first model was taken from how a gym machine changes the rest positions for different anthropometrics. It uses a pin to hold the rest at different angles. Using this concept, I applied it to the model as shown. I experimented using three different angles. As a result of my model I realised that there must be plenty of space between the centre beam/rod and the pin holes, without this space I realised that the trolley would be structurally weak in this area. However, I think if the dimensions where slightly better this model would be perfect. As the legs can rotate around each other using the main connecting beam there is great strength between the two separate pieces. The only issue I can see with this is that there would have to be a handlebar at the very top of the rods. This would be to stop the metal bending towards each other under the stress and strain whilst the product is being used. Overall, I think this could be a great way to intertwine the two different versions of my product.

Transformation of trolley mechanism 2

My second idea for transforming the trolley gave a great range of positions for the angle of the trolley handles. These angles include past to 90-degree mark which could lead to the product being able to fold up. The upright position is held by "sidebars" which hold the trolley handles in their upright position. To escape the straight up version, you simply lift up the handlebars and rotate the handles around the bolt. Although this design gives a great range of adjustability it needs a locking mechanism to hold the handlebars at the different angles chosen. This mechanism will need be very strong and durable so that it does not falter over time. Looking at existing solutions to this problem I came across something called internal tooth lock washers. I planned on fixing this on to my original idea however this "locking screw" gave me a completely new idea.



Mechanism 3

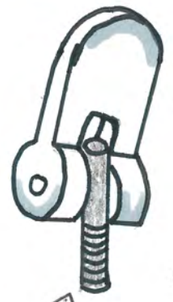


Using a square block at the end of the mechanism will allow the second wheels to easily be joined to the main frame of the product.

The teeth allow many different angles for the trolley to be positioned at.

Maths can be used to calculate the number of positions.

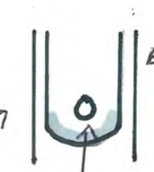
Due to the complexity of this third idea I decided to construct a model. This model is shown on the next development page.



As a wing nut would be difficult for the elderly using a plug tightener will be easier for them.

Screw thread to hold locking washers together.

Made from Aluminium to reduce weight.

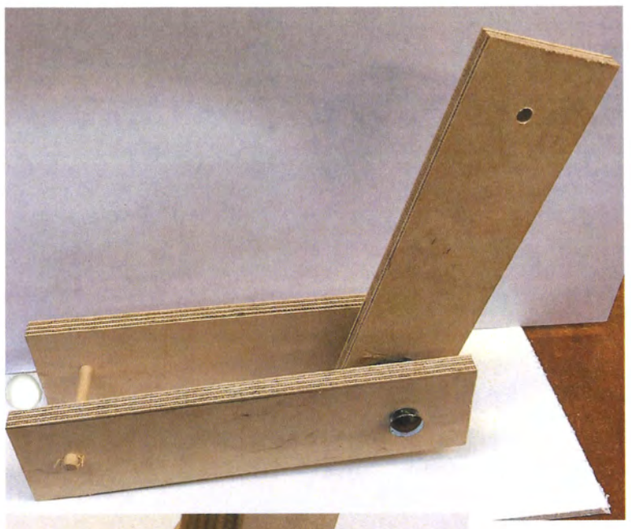


Exterior tubing

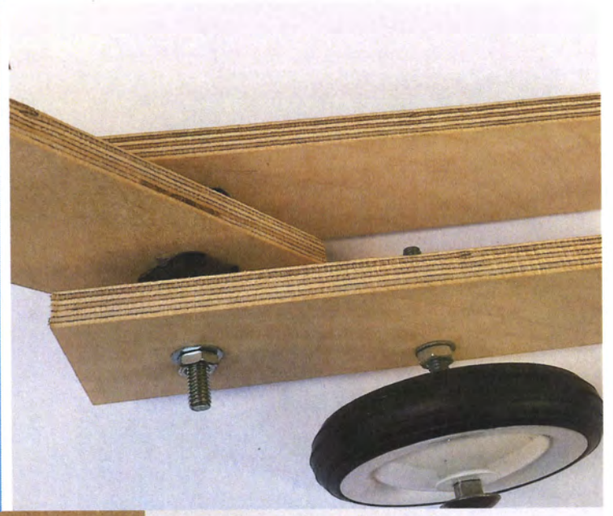
Using this method we can still use the crutches tubing.

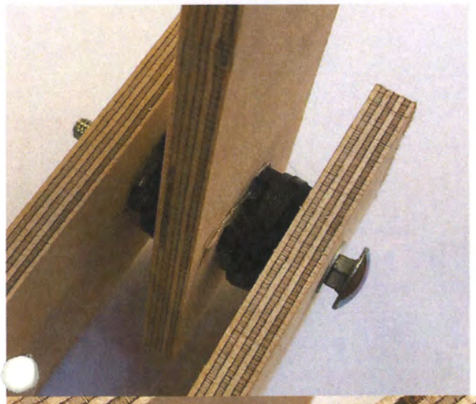
The pin hole, this is for the crutch adjustable system.

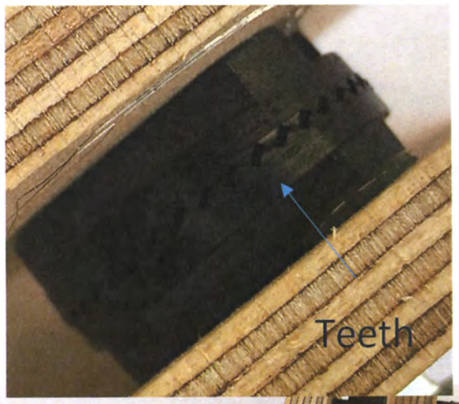
Development 3

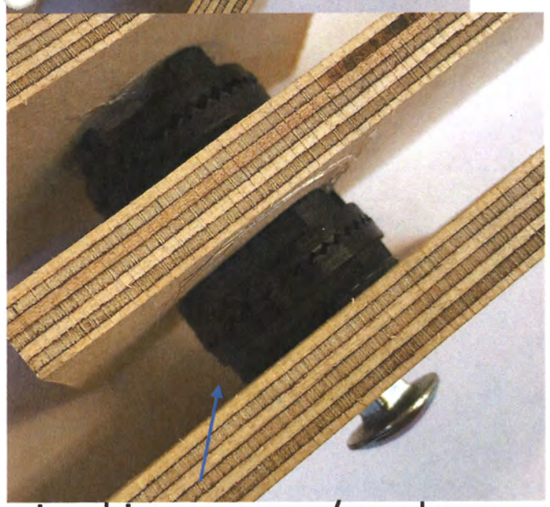


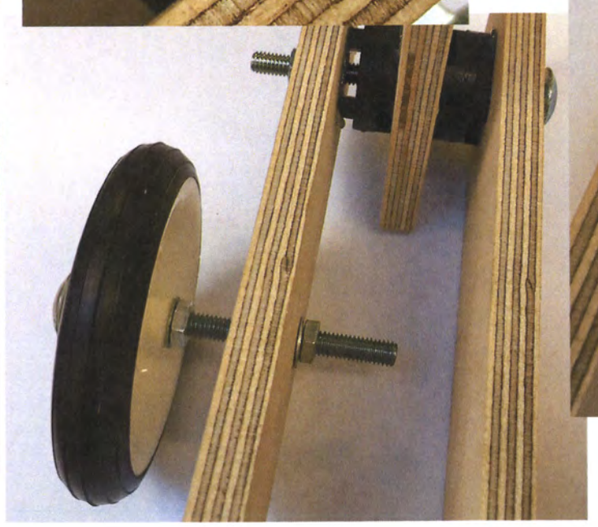
As a result of my last model I created this mechanism. It works by using four locking screws/washers and a central axis. I found from this model that the four locking screws/washers must be correctly aligned otherwise when the beams are at both positions they may be incorrectly aligned. I also learnt from the model that the secondary wheels must be placed slightly down the lower beam in order for it to avoid blocking the mechanism above it. Structurally my model was very strong. However, like my last model the further away from the central mechanism the more the beams bend towards each other. To help fix this I plan to add structural support beams along both the top and bottom beams. As a result of adding the wheel I also learnt that the axel for the wheel must pass through both beams, this will help the beams to stay strong as well as the wheel wont bend upwards with the weight. As a result of my model I also decided the crutch mechanism which uses metal hollow tubes would be easier to construct by using to separate beams which are joined together. This beam will have holes allowing for the adjustability of the heights of the beams. The two outside beams will be joined by thin panels either side. To help work out the dimensions of this idea I made a model as seen on the next page. In terms of this model I think it really helped me move forward my project. Although it had its flaws it helped me to work out these problems as well as how to improve my design.

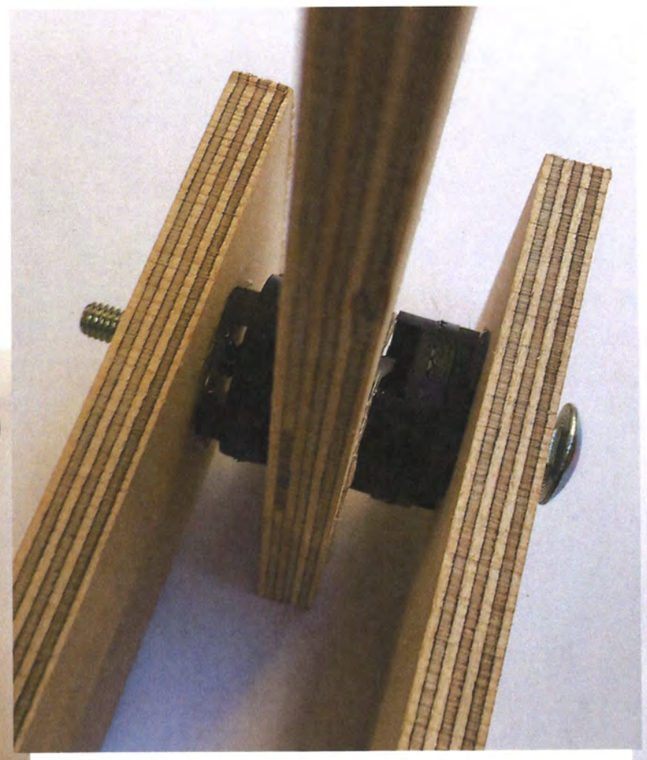


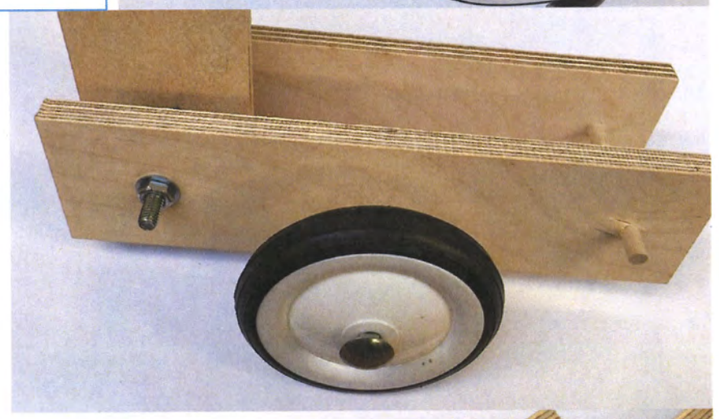


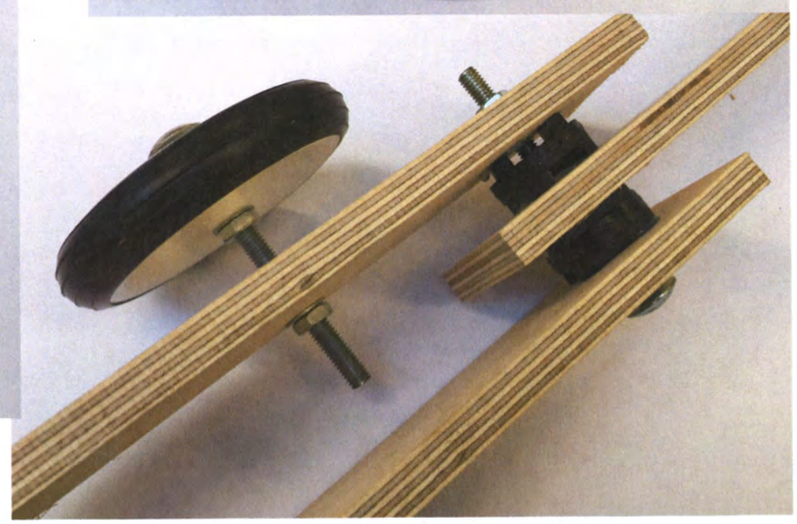




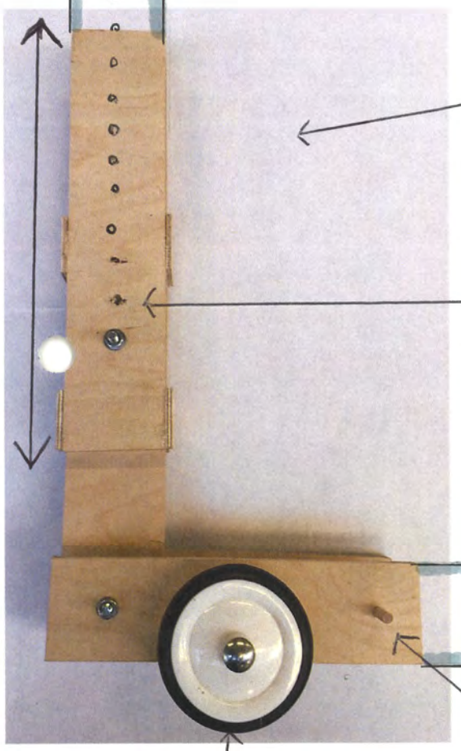






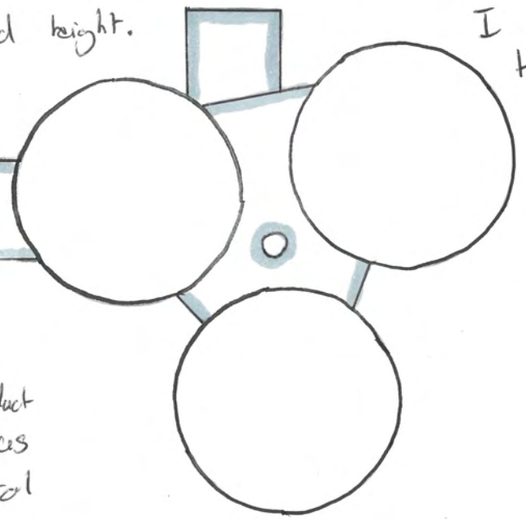


Development 4



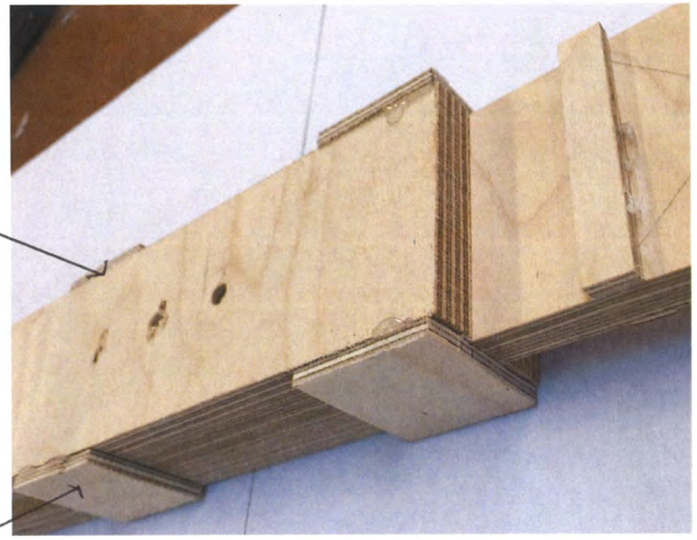
This is roughly what the second mode of the product will look like.

These holes allow for the adjustability of the height of the handles. A single loose pin with a nut can hold the beam at the desired height.



The strips will be on both sides and will be joined to the metal using brazing as there will be little stress on the product in this area.

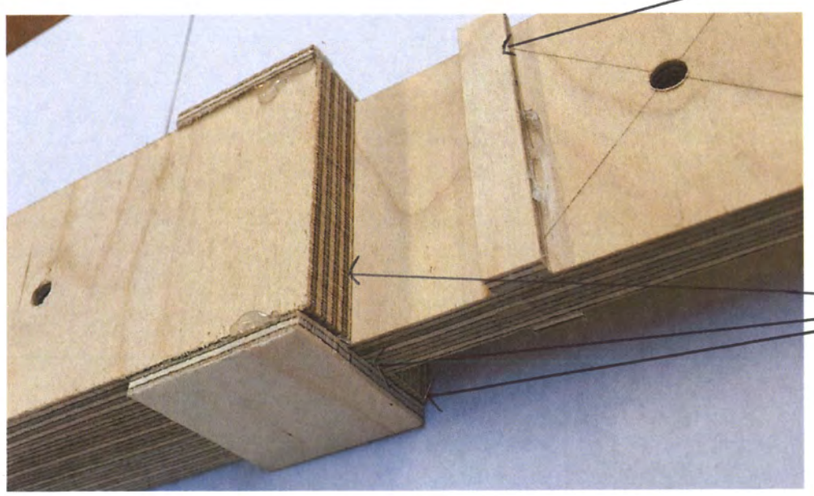
I will use Aluminium to reduce weight



The strips that hold the inner beam must run the entire length of the beam. This way the inner beam will always be correctly aligned.

I found the wheel must be away from the mechanisms to the left to avoid interfering.

Support rods will be used to keep the product strong/durable as well as to maintain the structural integrality.

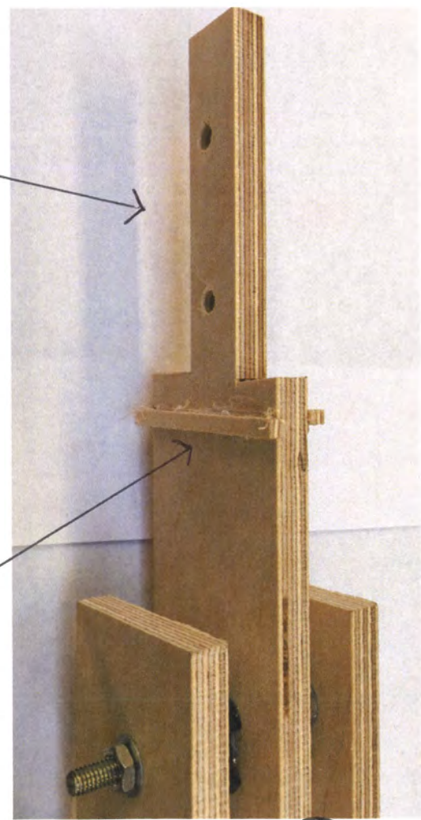


Blocker to protect the wheels if the user accidently drops the beam. Will be welded on to the main frame.

Welding provides an incredibly strong joint

The crutch mechanism is now made up of three rectangle beams. This will make construction easier as well as it should improve the products structural integrality

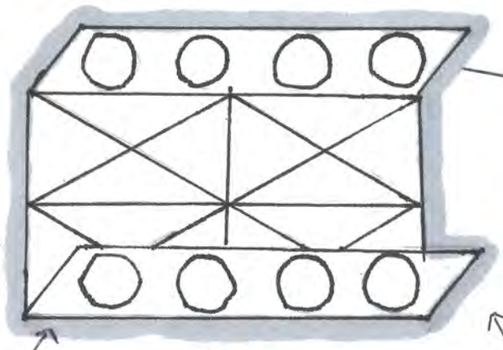
Whilst working out how the crutch mechanism worked I realised the central support axis must be a lot larger for greater structural support.



I also learnt there must be a 'stopper' so that if the user drops the beam it does not hit the wheels or mechanisms.

Development 5

Mid Section



I raised this bit up to help hold the logs in place better.

Aluminium due to its light weight

Metal sheets with holes cut out / punched out.

Development

New idea

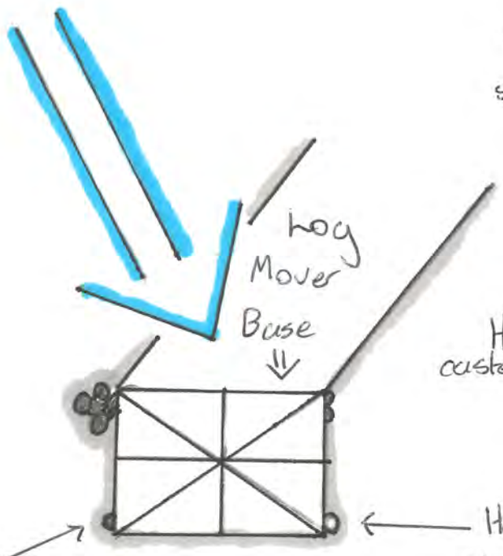
Metal frame will remain the same, just it will have a wire mesh intertwined with the frame.

The frame will be bolted into the mid-section.

This is a development of my original idea. By removing the metal sheet and just using rope the waist of the product should be reduced.

This idea will still use a metal frame to keep the mid-section strong and durable.

The hooks will slide to allow the logs to fit into different positions.



This will make carrying logs in the products in first mode safer and easier.

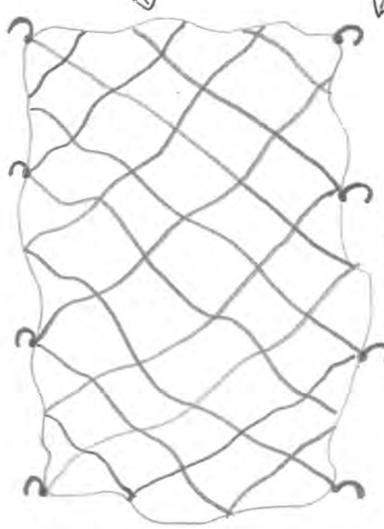
Hooks center casted to speed up production (same mould)

The hooks allow the cargo net to attatch to the base

Hooks at the end of the base on both sides

The rope will intertwin to stop logs falling through the net.

The hooks attach to the mid-section to help hold the logs down.

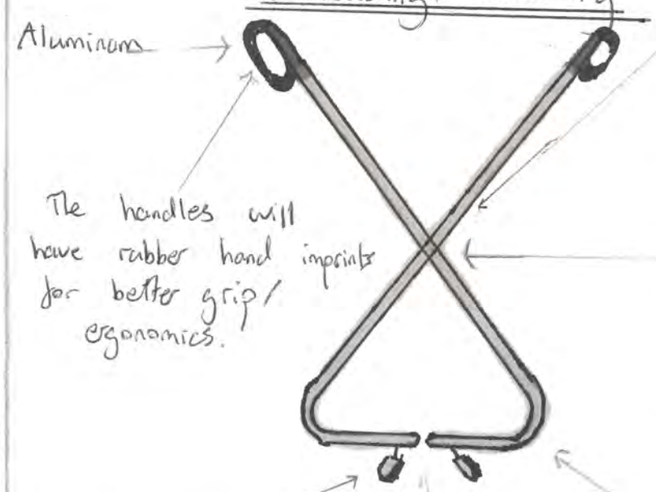


The hooks clip onto the raised sides.

The net is made from strong stretchable nylon rope.

Provides flexibility for the net

Unloading / loading



A thin bolt will pass through both metal frames holding them together

The handles will have rubber hand imprints for better grip / ergonomics.

The mechanism will have brass washers to avoid abrasion / the mechanism wearing down.

The covers will protect the user and sharp edges when the grabber isn't being used.

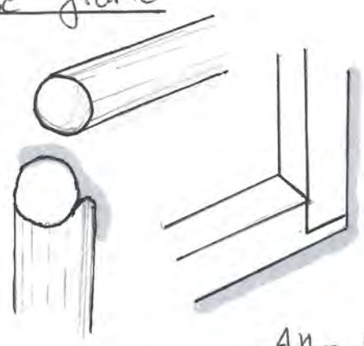
Sharp edges will pin the log in place whilst it is being picked up

The bends will be made using a jig and heat until the metal is the correct shape

Materials, Dimensions and Construction techniques

Base frame

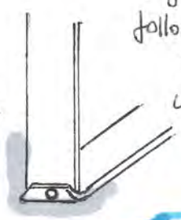
Brazing



Welding

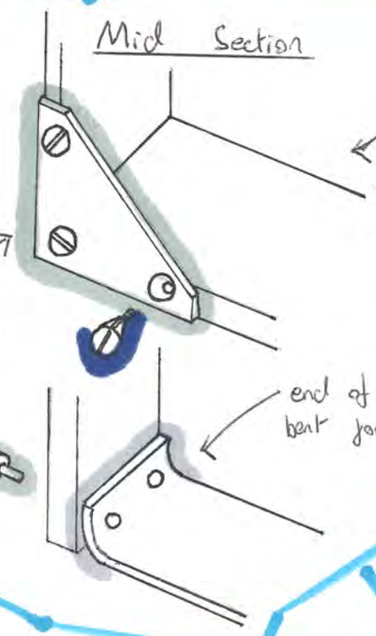
I will use brazing as it provides a strong joint. It is a quick and easy process to learn so it will be the most effective for making my product.

Pop riveted



After looking at the following joining techniques I decided that brazing would be the best joining technique.

Mid Section

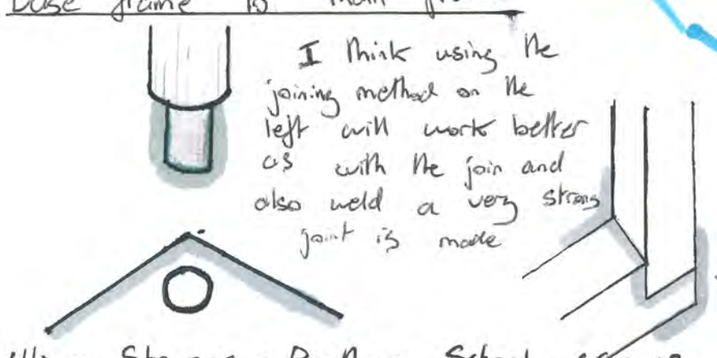


Although this temporary joining method is more complicated it is stronger and requires less machinery. Therefore I will use this joining method.

joining the mid section to the raised section

end of mid-section bent for screw holes

Base frame to main frame



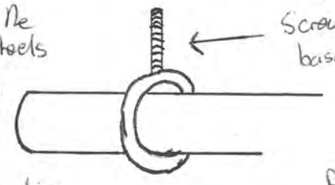
I think using the joining method on the left will work better as with the join and also weld a very strong joint is made

little grip for joint therefore less strength in the weld

Wheels to base frame

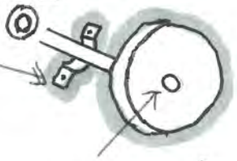
Axel for the wheels

Screws into the base of the main frame



washers to reduce friction

Pop-riveting is possible



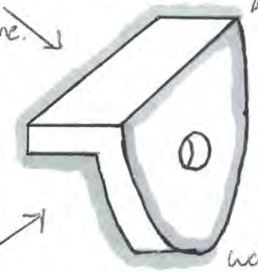
domed locking nut

Both ends of axel are thread using tap and die

Some joining method for axel

Top area brazed to the main frame.

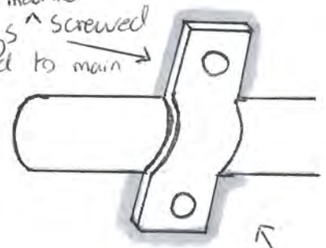
metal bent to 90° using jig



Bolts and washers used to hold axel in correct place.

machine screwed

Casings or welded to main frame



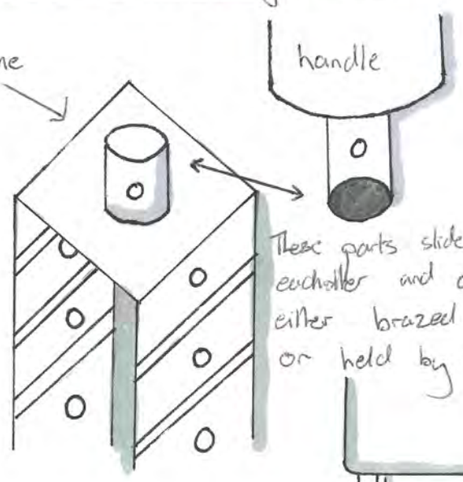
For my final product I will use both techniques. I will use the screw in the middle for main strength supported by four casing supports that are screwed in.

Axel pinned in to main frame by multiple casings.

Handles to main frame

main frame

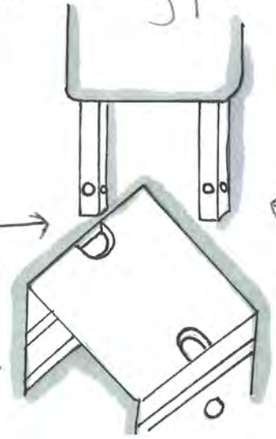
handle



If I use pins for this construction technique I will be able to change/replace the handles easily if there is a fault with the handles at some point.

These parts slide over eachother and are then either brazed together or held by pins

Pins slide in and are then bolted down using a big screw and a locking nut.

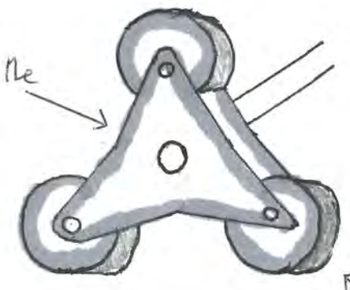


I think this method will be stronger and easier to construct so I have chosen it.

3 Wheel Construction

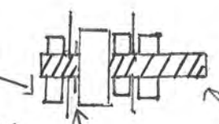
Steel sheet metal holds the three wheels in the correct place

Main Base



large rubber wheels for better stability

Nuts will hold the wheels in place



Washers either side to reduce friction and corrosion.

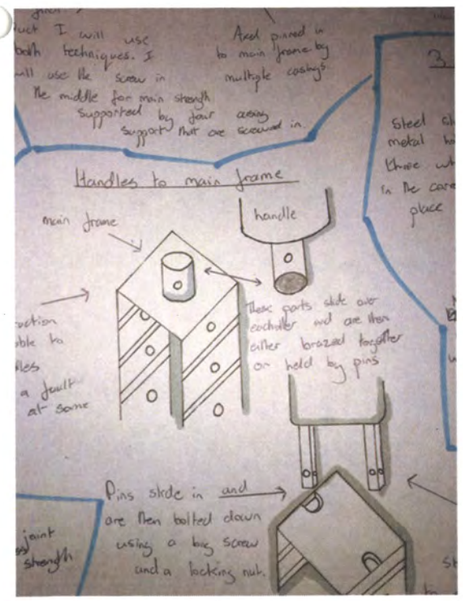
Bolt passes through each wheel

Bolt passes through both sheets of metal and a little further to allow room for the nuts and washers.

Comments on development of design

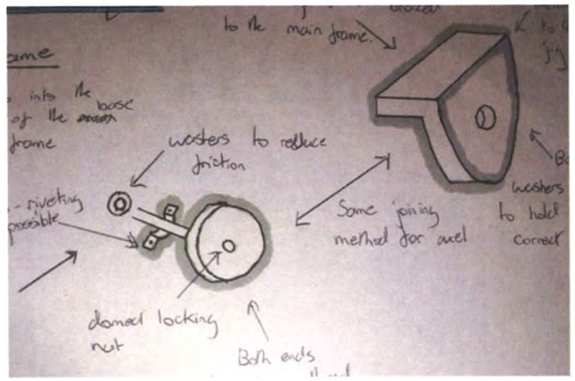
Crutch Handles- "After breaking my wrist last summer I think having the extra support on the handles will greatly benefit someone like me. Spreading the force over more area should make the product easier to use."

Handles- "I really like the way you've created the handles, I often struggle to grip items and products but by the looks of what you've developed here it looks suitable for someone like me."

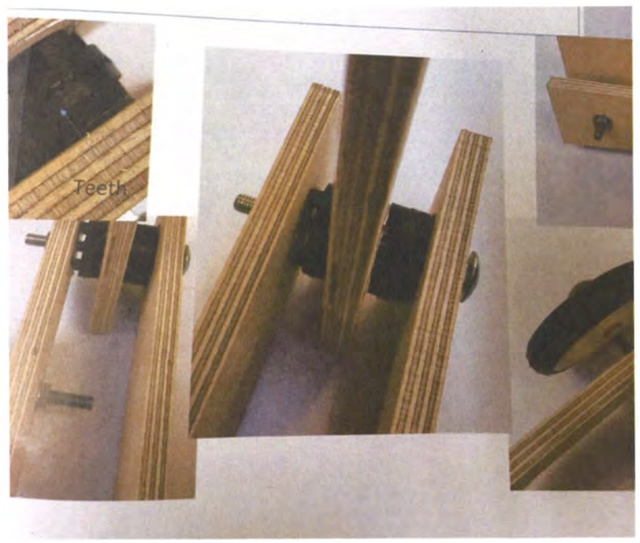


Crutch adjustment- "Another very thoughtful design. As many different heighted people will use this product, it must be adjustable and I think this is a very clever way to do just that."

Unloading/loading- "The concept of using a grabber as a go between from the ground to the mover will be very useful."



Construction techniques- "Although I don't really understand many things with construction Will explained it all very well and as a result I can say that the construction looked very well thought out and clear."

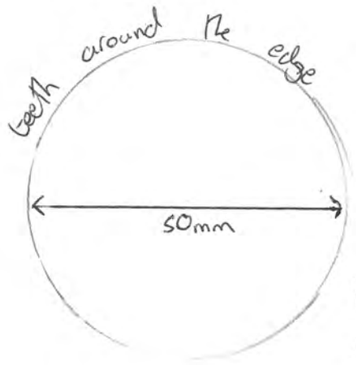


Folding mechanism- "This mechanism is very clever and I like the way it works. As long as I am strong enough to move the mechanism I think it is a great idea."

Mathematical/Scientific principles and commercial production possibilities

* If they are to hard to produce in the workshop they will be bought in from elsewhere.

locking washer

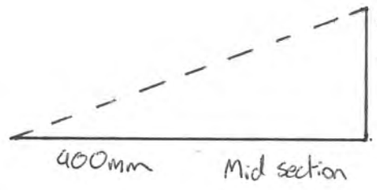


Circumference of circle is equal to $2\pi r$

The circumference is $2 \times \pi \times 25 =$ ~~[illegible]~~ 50πmm or 157mm (3sf)

Say we have 40 teeth for the locking washer they would need to be spaced just less than 4mm apart.

Cargo net length to reach the base

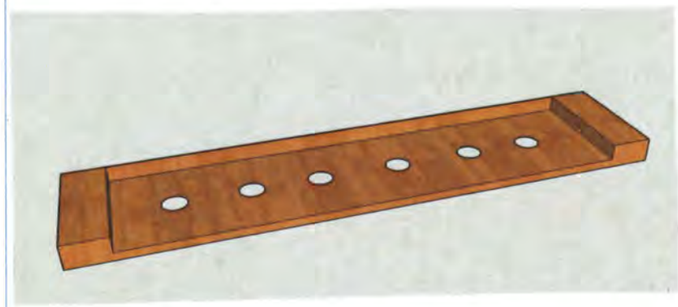


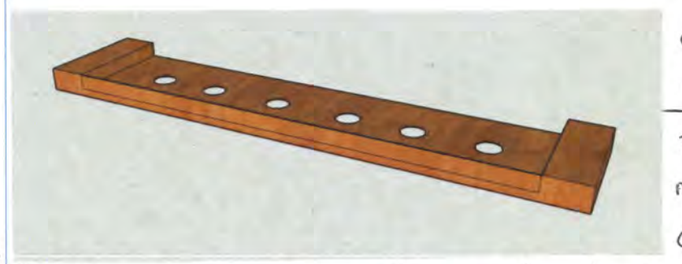
Using the triangle rule we know that $a^2 + b^2 = c^2$

Therefore we know that the length of cargo net needed is $\sqrt{400^2 + 250^2} = 472mm$

To allow for a little slack I have decided the cargo net length should be 475mm.

Looking at how batch production could work for a problem like this I looked at jigs/templates for this product. Using jigs/templates helps speed up production





I designed this jig on CAD, it shows how I plan on cutting out the main frame above the mid-section.

How it works

The correct sized peice of metal is cut and jored. It is then slid into the jig and locked in place with two clamps. Once secure the jig is placed on the pillar drill where the correct holes. are drilled the correct distance apart.

handle bends as well as the handle grips. This would be done using a mould. I would also use bending jigs for various components throughout my design.

If I do choose batch production as my scale of production I will also create jigs to help create the crutch

Scientific principles

Throughout my manufacturing/designing I will perform tests on materials/processes used.

Brinell test - I will use this test to evaluate the hardness of the materials I plan to use for my product.

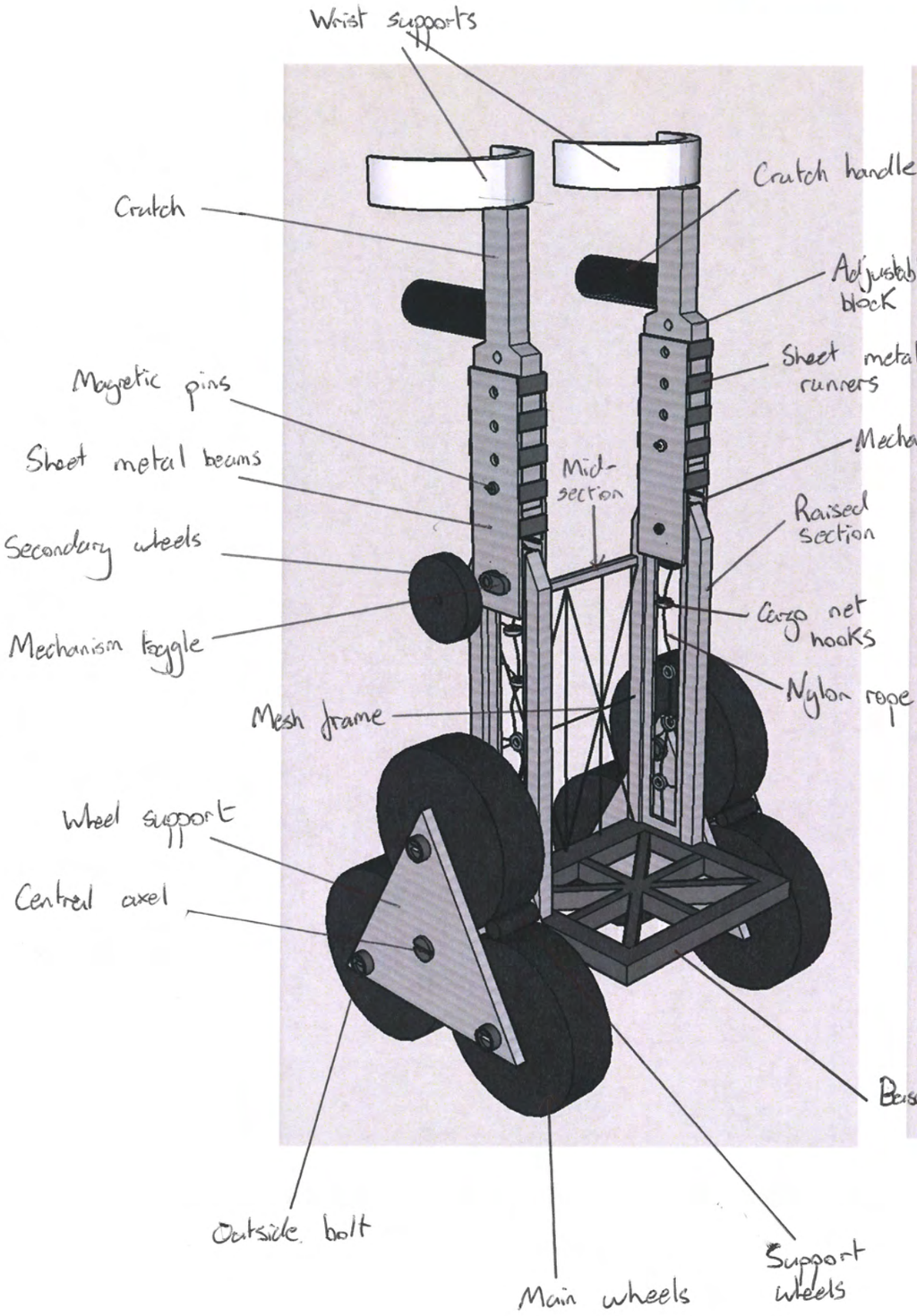
Izod impact test - I will use this test to see the toughness of the parts I plan on using. This is very important as logs will be dropped on my product at some point and the product must withstand these impacts.

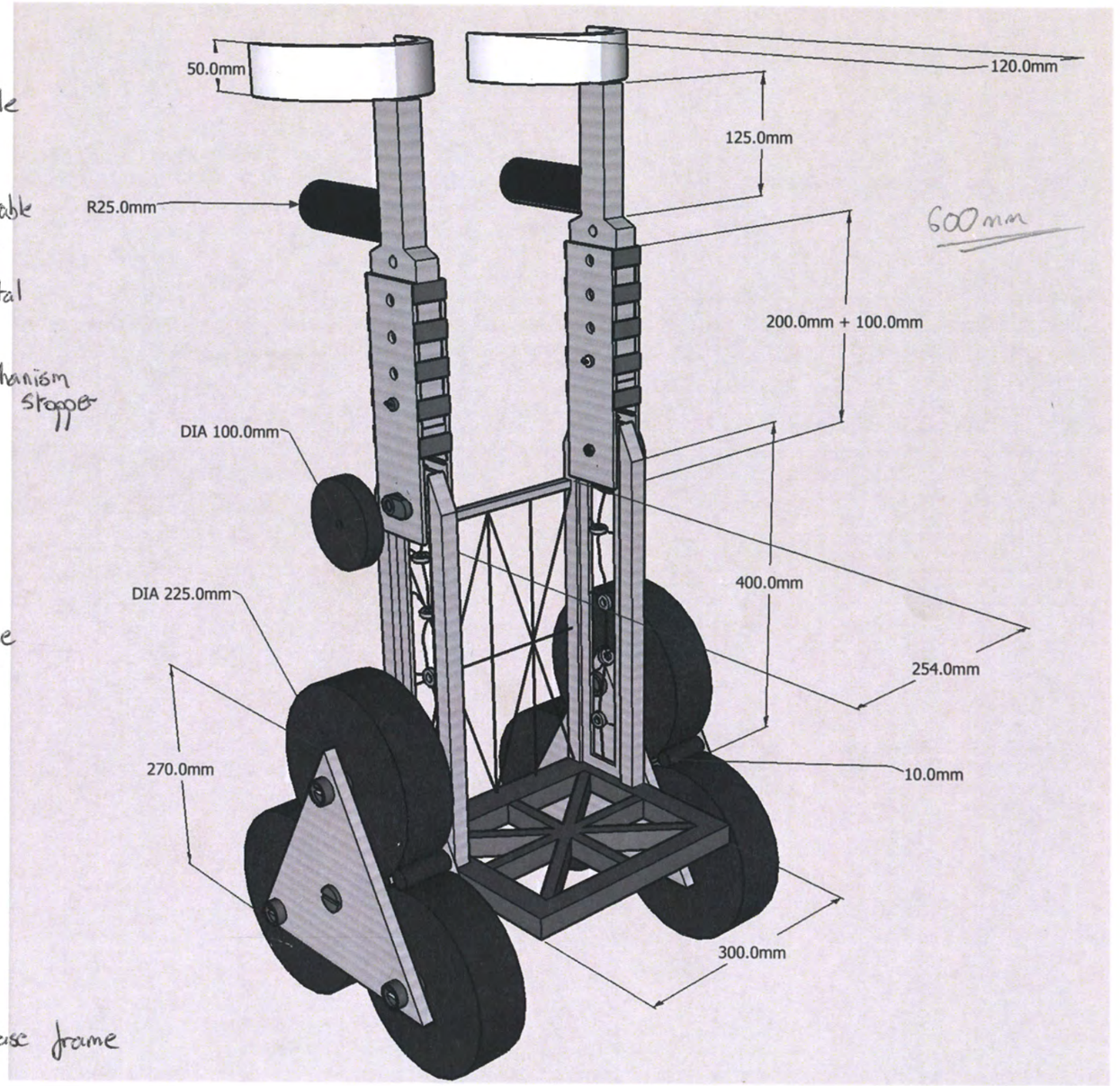
Tensile Strength - Using ~~[illegible]~~ nylon rope and other materials that could be pulled apart means I must choose materials that can handle high tensile stress.

Although this product will be a one-off production it would be time consuming and expensive to make each of this product the same way. Making products like this using one-off production is ineffective. For this reason I will try to employ batch production or continuous production techniques throughout the production and manufacturing stages.

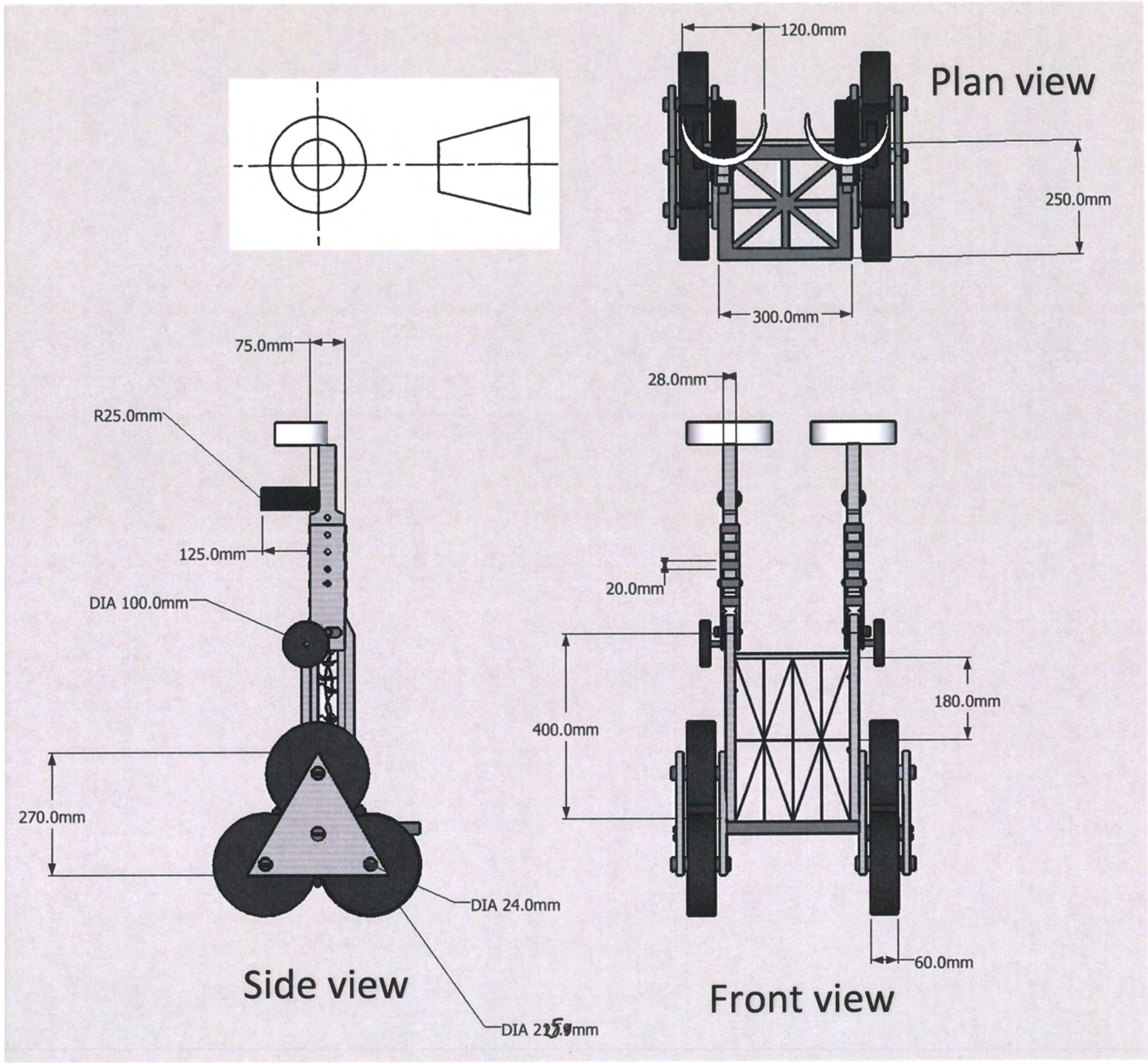
Some methods of continuous production could be employed throughout the making of a product like this. A production line method could be introduced is a real world environment. This would greatly increase the speed of production for the product. However using a production line leads to little flexibility of the product meaning if a fault was discovered after the testing stage it would be expensive to fix the problem by changing the machinery.

Final design in isometric

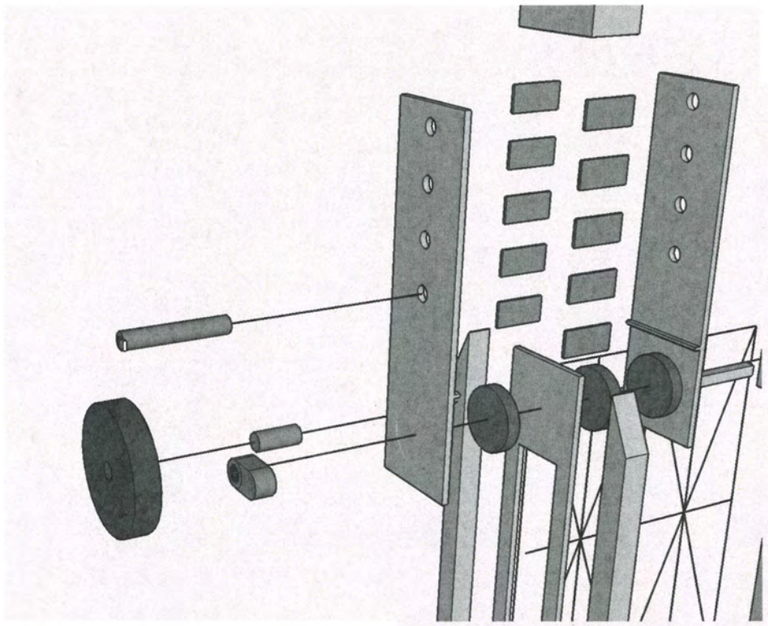


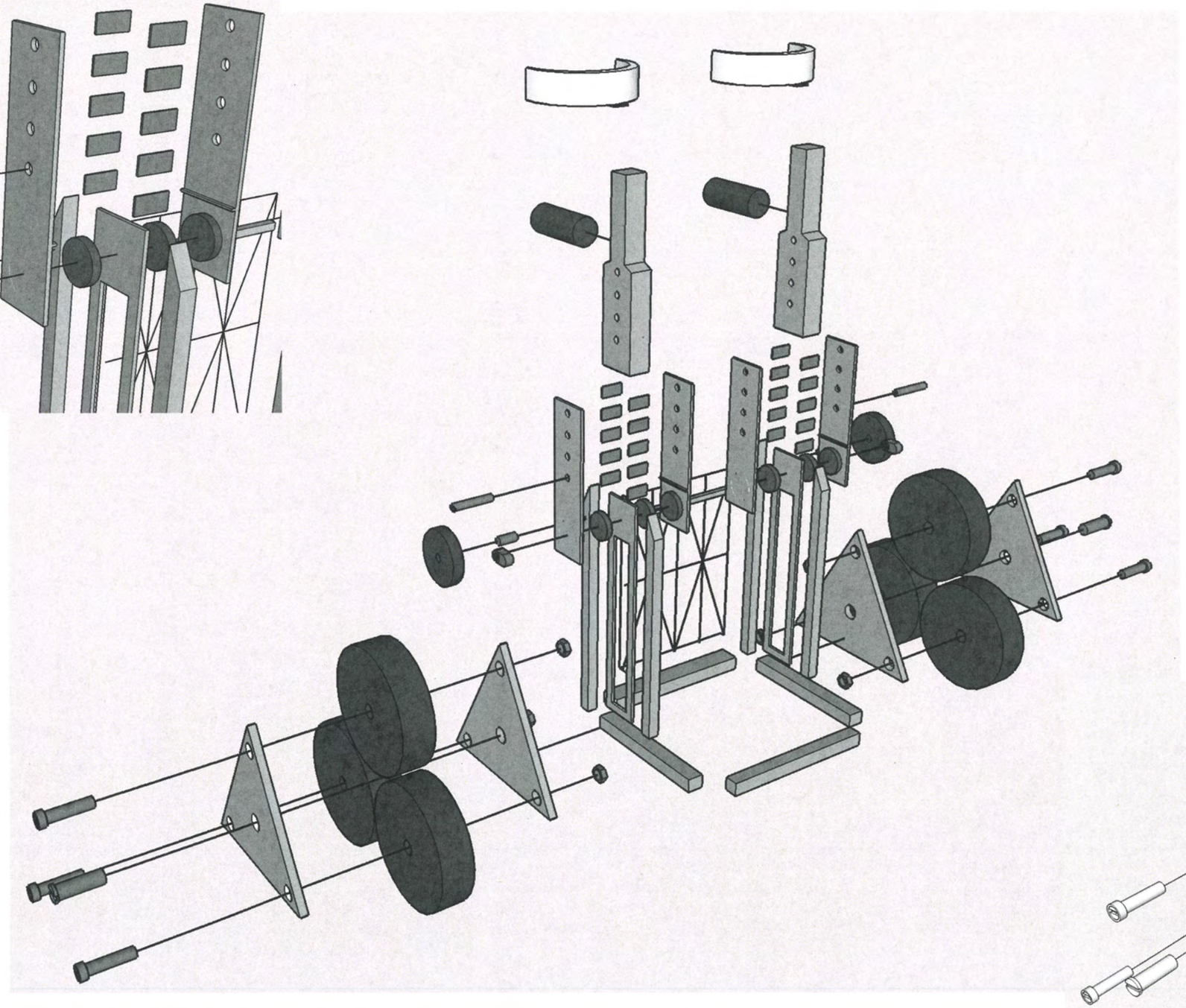


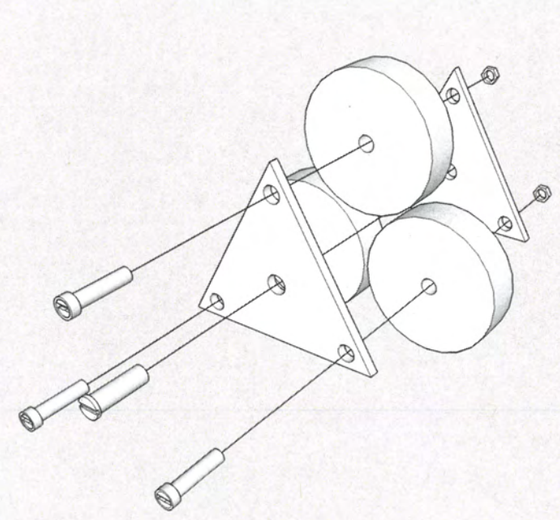
Third angle orthographic drawing to scale



Exploded drawing

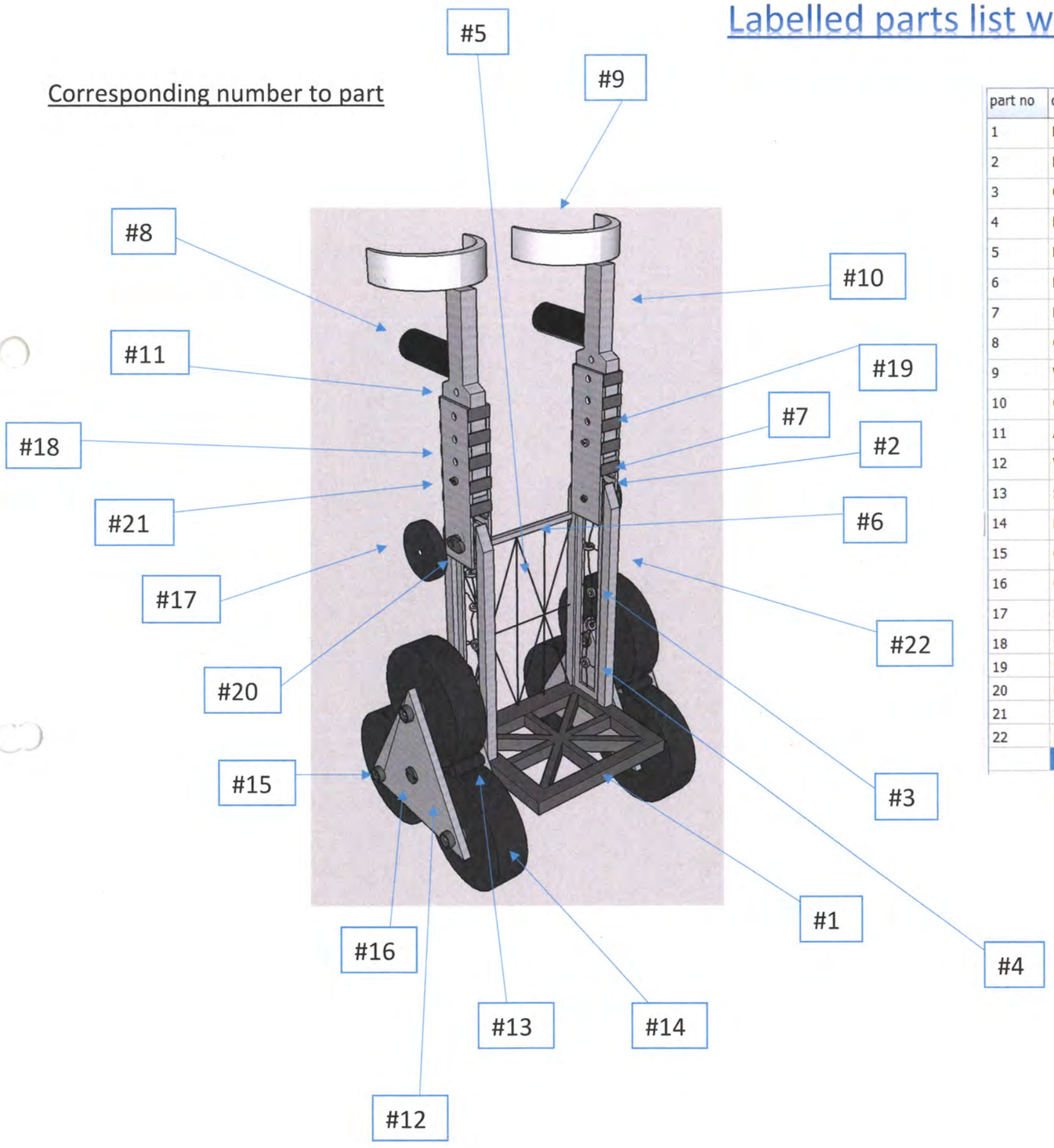






Labelled parts list with costing

Corresponding number to part



part no	description	material	no. off	size/item	length	width	thickness	unit cost	total cost
1	Base frame	Aluminium	1	20 [square tube]	1.800 m			£1.38 per m	£2.48
2	Locking washer	Nord locking washer	8	25mm				10p each	80p
3	Cargo net hooks	Circular hooks	10	20mm				4p each	40p
4	Nylon rope	Nylon rope	1	6mm	2.000 m			96p per m	£1.92
5	Mesh frame	Mild Steel	1	3 [round]	2.500 m			30p per m	75p
6	Mid-section	Aluminium	1	6 [square]	300 mm			£2.07 per m	62p
7	Mechanism stopper	Aluminium	1	12 x 3 [strip]	300 mm			£1.80 per m	54p
8	Crutch handle (-rubber)	Aluminium	1	25 [round]	250 mm			£14.37 per m	£3.59
9	Wrist support	PVC	1	75x75x10mm	400 mm			£1.20 per m	48p
10	Crutch beam	Aluminium	2	20 [round]	125 mm			£10.10 per m	£2.52
11	Adjustable block	Aluminium	2	25 [round]	350 mm			£14.37 per m	£10.06
12	Wheel support (second hand)	Wheel support	1	270x270x15mm	270 mm	270 mm		1p per sq m	0p
13	Support wheels (second hand)	Support wheels	6	100mm circular				1p each	6p
14	Main wheels (second hand)	Main wheels	6	225 circular				1p each	6p
15	Outside bolts	Bolt, coach	6	M10 x 130mm				20p each	£1.20
16	Central axel	Aluminium	1	12 [round]	400 mm			£4.35 per m	£1.74
17	Secondary wheels	Secondary wheels	2	100m diameter				1p each	2p
18	Sheet metal beams	Aluminium	4	1.6 mm [sheet]	250 mm	75 mm		£65.00 per sq	£4.88
19	Sheet metal runners	Mild Steel	20	0.9 mm [sheet]	40 mm	20 mm		£7.90 per sq n	20p
20	Mechanism toggle	Pewter	2	25x25x100mm				£1.64 each	£3.28
21	Magnetic pins	Magnetic pins	2	75x12x12mm				95p each	£1.90
22	Rasied section	Aluminium	4	12 [square tube]	400 mm			£1.00 per m	£1.60
								Total	£39.10

Total cost = £39.10

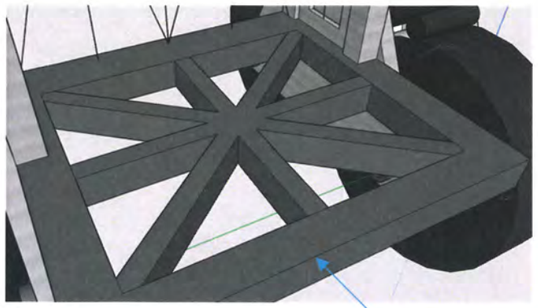
Plus £2.86 for cost of joining methods = £41.96

Add 20% text = £41.96 X 1.2 = £50.35

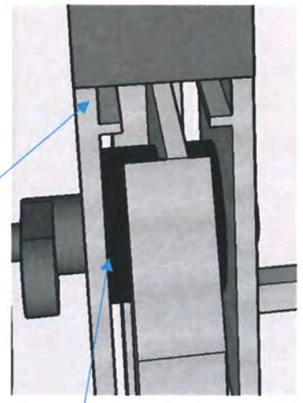
Final cost = <u>£50.35</u>

Justification of all materials and processes

*Numbers relate to parts list



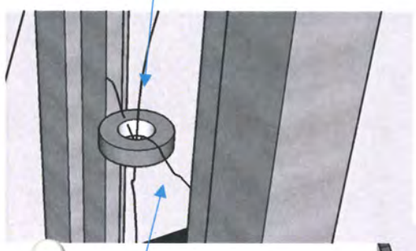
Base frame



Mechanism stopper

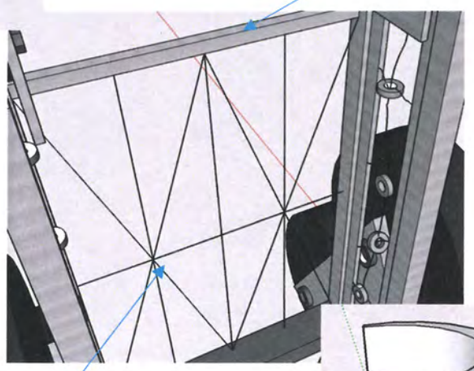
Adjustable mechanism

Cargo net hooks



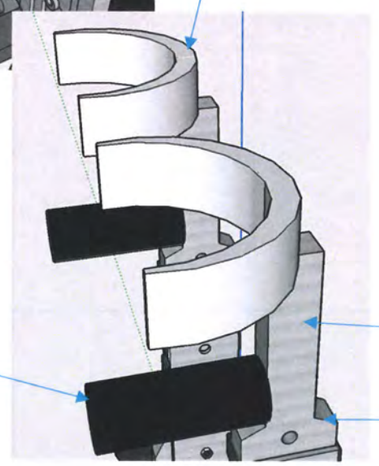
Nylon rope

Mid-section



Wrist support

Mesh frame

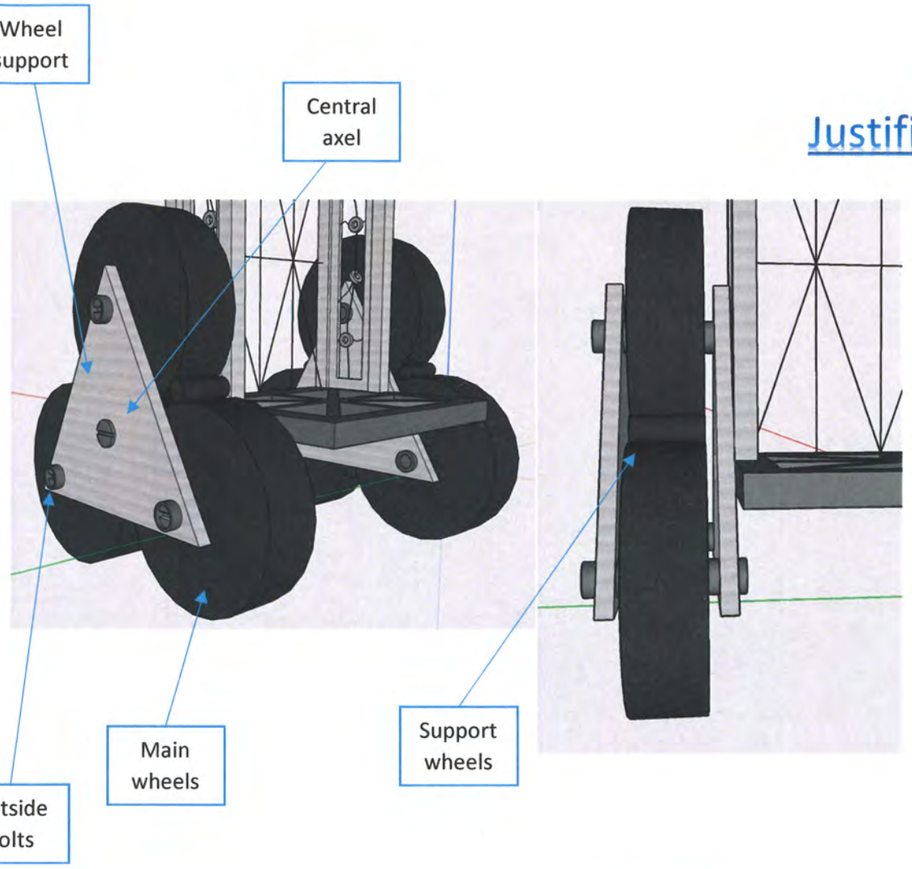


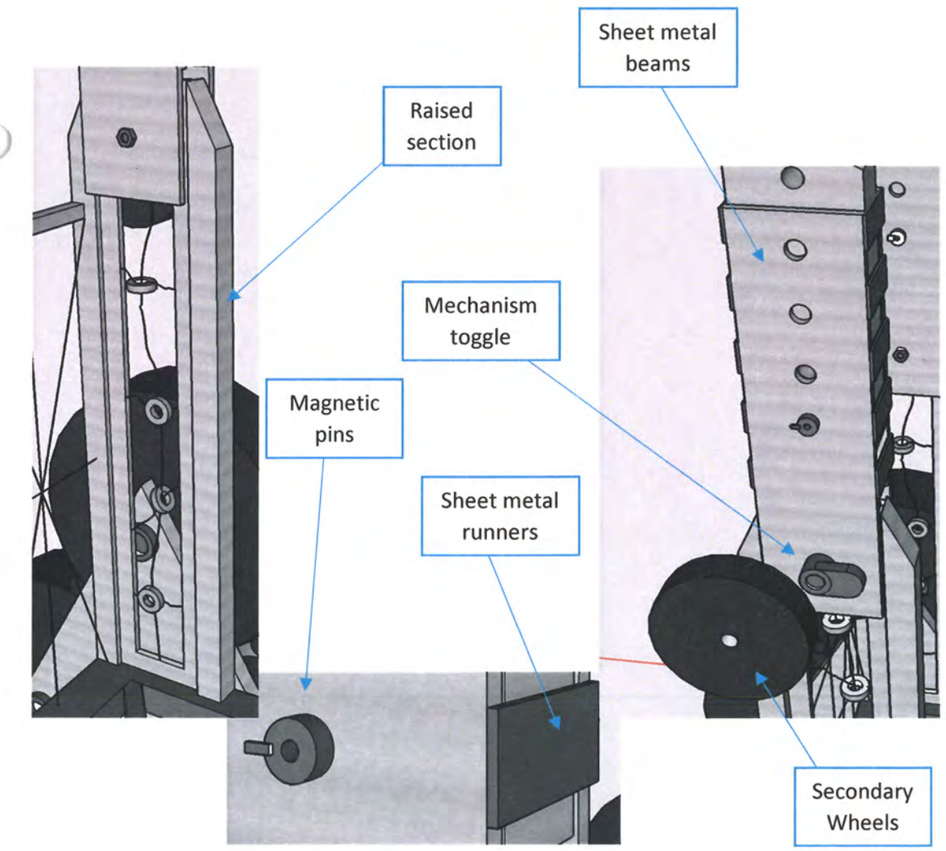
Crutch handle

Crutch beam

Adjustable block

Part	Material	Justification	Process	Justification
Base frame (1)	Mild steel	Steel is an incredibly strong metal; therefore, it will withstand the forces placed on it from the weight of the logs	Welding	Welding is a very strong joint that can withstand large impacts and forces therefore it is perfect for the base frame. Brazing is energy intensive so its use must be limited
Adjustable mechanism (2)	Mild steel	Steel is an incredibly strong metal; therefore, it will withstand the forces placed on it from the weight of the logs. Mild steel is very durable, extending the lifespan of the product	Nuts and bolts	Using a temporary method of joining allows the mechanism to be easily accessed and replaced if there is a fault. This stops the whole product needing to be replaced if there is a fault
Cargo net hooks (3)	Pewter	The cargo net hooks are complex shapes and therefore using pewter casting can mean we can achieve this complex part.	Pewter casting	Pewter casting will be a suitable process as it is easy to repeat multiple times which will be needed for these hooks
Nylon rope (4)	Nylon	Nylon rope is readily avbailable as well as it is very strong meaning it can hold the weight of the loges if nessary. It can also slightly eleastic tio allow room for more logs. Nylon is made from crude oil which can be harmful to the environment/it's a finite resource	Tied together	The nylon rope will be tied together using knots and they will be tied to the cargo net hooks
Mesh frame (5)	Mild steel	Steel is an incredibly strong metal; therefore, it will withstand the forces placed on it from the weight of the logs	Brazing	Brazing is a strong permanent joint as well as it is easy to learn. Brazing will allow for precise joins. Permanent joins can make the product harder to recycle.
Mid-section (6)	Aluminium	Aluminium is a lightweight material with great strength. It is corrosive resistant as well as it can be recycled. It does not require a finish. Aluminium can also be recycled	Brazing	Brazing is a strong permanent joint as well as it is easy to learn. Brazing will allow for precise and durable joints.
Mechanism stopper (7)	Mild steel	Steel is an incredibly strong metal; therefore, it will withstand the forces placed on it from the weight of the logs	Welding	Welding is a very strong joint that can withstand large impacts and forces therefore it is perfect for dealing with the mechanism stopper
Crutch handle (8)	Rubber	Rubber is a eleastic material and therefore can change sgape to fit the users hand making the product more ergonomic. Rubber can be recycled multiple times	Nuts and bolts	Using a temporary method of joining allows the part to be easily replaced if there is a fault. Nuts and bolts are a zero-energy joining method
Wrist support (9)	Polyvinyl chloride	PVC is a strong thermoplastic that can be moulded into shape. It is also a very hygenic material and is easy to upkeep	Brazing	Brazing is a strong permanent joint as well as it is easy to learn. Brazing will allow for precise joins. Permanent joins can make the product harder to recycle.
Crutch beam (10)	Aluminium	Aluminium is a lightweight material with great strength. It is corrosive resistant as well as it can be recycled. It does not require a finish	Brazing	Brazing is a strong permanent joint as well as it is easy to learn. Brazing will allow for precise joins. Permanent joins can make the product harder to recycle.
Ajustable block (11)	Aluminium	Aluminium is a lightweight material with great strength. It is corrosive resistant as well as it can be recycled. It does not require a finish	*Not physically attached	This part of the product slots into my design and it not physically attached





Justification of all materials and processes

*Numbers relate to parts list

Part	Material	Justification	Process	Justification
Wheel Support (12)	Aluminium (second hand)	Aluminium is a lightweight material with great strength. It is corrosive resistant as well as it can be recycled.	Nuts and bolts	Using a temporary method of joining allows the wheels to be easily replaced if there is a fault
Support wheels (13)	Rubber (second hand)	Rubber has great tensile strength and impact resistance therefore the pressure from the larger wheel will not cause a mechanical fault	Nuts and Bolts	The force of the two larger wheels will hold the support wheel in place. This way removing the wheel will be as easy as removing one large wheel
Main wheels (14)	Rubber (second hand)	Using rubber will allow for a stable product that will be able to traverse many terrains. It is also very durable/strong and so will last a long time	Nuts and bolts	Using a temporary method of joining allows the wheels to be easily replaced if there is a fault or they need replacing
Outside bolts (15)	Mild Steel	Steel is an incredibly strong metal; therefore, it will withstand the forces placed on it from the weight of the logs	Nuts and bolts	Using a temporary method of joining allows the wheels/outside bolts to be easily replaced if there is a fault
Central axel (16)	Mild Steel	Steel is an incredibly strong metal; therefore, it will withstand the forces placed on it from the weight of the logs	Nuts and bolts,	Using a temporary method of joining allows the wheels/axel to be easily replaced if there is a fault
Secondary Wheels (17)	Rubber (second hand)	Again, rubber is very strong/durable. Using second hand wheels will reduce the carbon footprint of my product	Nuts and bolts	Using a temporary method of joining allows the wheels to be easily replaced if there is a fault
Sheet metal Beams (18)	Aluminium	This is a large part of the product and so must be lightweight. Aluminium is also strong as well as it doesn't need a finish making it more environmentally friendly.	Brazing	Brazing is a strong permanent joint as well as it is easy to learn. Brazing will allow for precise joins.
Sheet metal runners (19)	Stainless steel	They must be very strong to hold the adjustable mechanism correctly in place. Steel is also resistant to corrosion.	Brazing	Brazing is a strong permanent joint as well as it is easy to learn. Brazing will allow for precise.
Mechanism toggle (20)	Pewter	The mechanism toggle is a complex shape and therefore using pewter casting can mean we can achieve this complex part.	Nuts and bolts	Using a temporary method of joining allows the wheels to be easily replaced if there is a fault
Magnetic pins (21)	Iron	Iron is a strong material whilst it is also magnetic therefore it will be able to hold the sheet metal beams without being structurally weak	Uses magnets to hold in place	Using magnets mean the part can be easily removed and replaced quickly without any faults occurring
Raised section (22)	Aluminium	Aluminium is lightweight and it is a good material to weld. These properties make it great for this part of the product	Pop riveting	Pop riveting is sufficiently strong for the raised section, it is a quick and easy process, as well the mid-section will support the pop rivets.

*Same sustainability issues as first page

Life cycle assessment

Life cycle assessments allow designers to consider the impact of a design on the environment. A way to measure the sustainability of a design is to calculate how much CO_2 the design releases from the extraction of raw materials to its end of life. Using LCA calculator I calculated how much CO_2 my design released. I calculated that my design would release about 54.6kg of CO_2. To put that into perspective it is the equivalent for driving a car for 2 hours or flying a plane for 6 seconds.

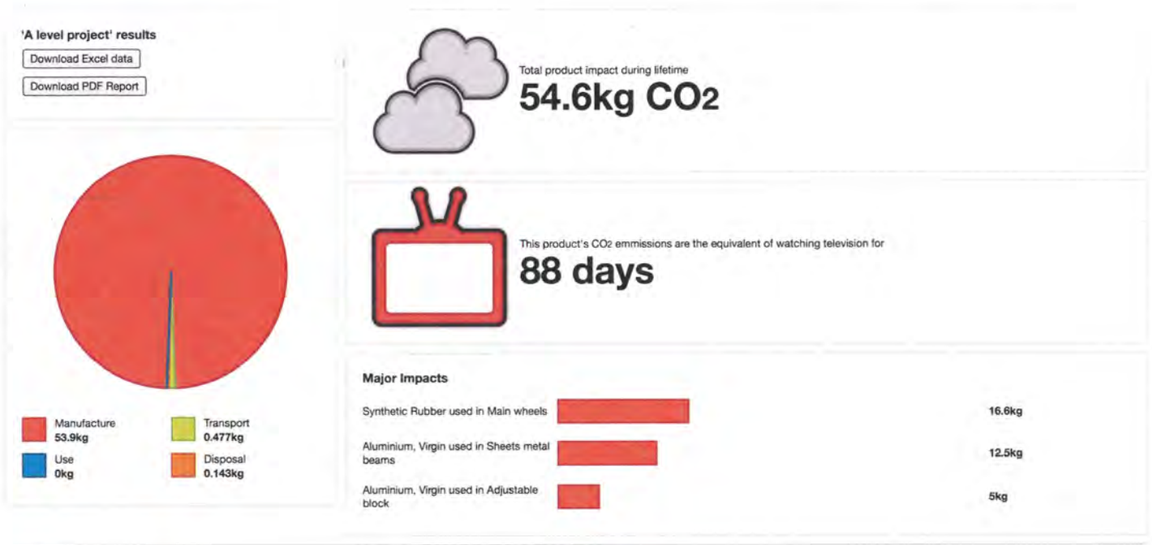
Raw materials: As my product is made mostly from metals such as aluminium and mild steel the extraction of these materials will be energy intensive. The extraction of bauxite ore and the electrolysis needed to get the aluminium can use a lot of energy. To reduce raw materials needed I am going to recycle metal were possible as well as to remove unnecessary parts of my design where I feel fit. Another major contributor to my CO_2 output is synthetic rubber used in the wheels. For this reason, I am going to try and use second hand wheels from an old go kart.

Manufacture: The two most used processes in my design are brazing and joining with nuts and bolts. Brazing is a process which requires heating and melting metals together. It is energy intensive and so I intend to limit its use where possible. Nuts and bolts however release zero CO_2 when being joined, they also allow parts to be replaced instead of the whole design which will further reduce CO_2 emissions throughout the products use and lifespan.

Transport: As this product is a one off the CO_2 emitted is relatively low as it only needs to be transported to one destination. If the design was to be batched produced, bulk buying of materials could help reduce transport emissions however the overall emissions would still increase. If batch production were to be introduced I would buy my raw materials locally in an attempt to reduce transport emissions as well as transport costs

Use: As the product does not use energy during its use the CO_2 emission for this part would be zero. However, if the product is not used correctly this could lead to parts needed to be replaced which would result in CO_2 being emitted.

After life: After the product has been used for its intended use and no longer works as intended the product will need to be dismantled and recycled where possible. As some of the product is made from nuts and bolts it can easily be dismantled and recycled. The rubber wheels can be shredded and used for other purposes. However, the parts that are welded will be harder to recycle. Separating the welded parts can be difficult and energy intensive. Therefore, I would limit permanent joining methods where applicable



Manufacture and disposal

Your disposal phase notes:

Wheels *Manufactured in: Europe (EU)*

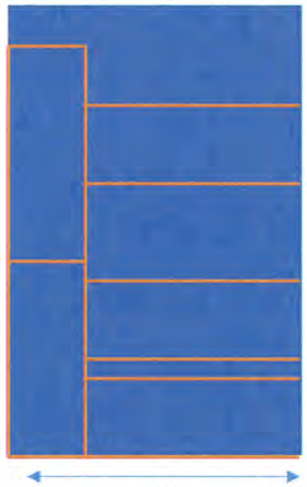
Part name	Material	Part mass	Qty	Notes	CO2
Raised section	Aluminium, Virgin	0.15kg	1	Notes	1.88kg
Magnetic pins	Cast iron	0.05kg	1	Notes	0.0816kg
Mechanism toggle	Aluminium, Cast Alloy	0.05kg	1	Notes	0.162kg
Sheet metal runners	Steel, Low alloyed grades	0.05kg	20	Notes	2.21kg
Sheets metal beams	Aluminium, Virgin	0.25kg	4	Notes	12.5kg
Secondary wheels	Synthetic Rubber	0.3kg	2	Notes	1.67kg
Central Axel	Steel, carbon steel	0.3kg	1	Notes	0.532kg
Outside bolt	Steel, carbon steel	0.1kg	6	Notes	1.06kg
Main wheels	Synthetic Rubber	1kg	6	Notes	16.7kg
Support wheels	Synthetic Rubber	0.2kg	2	Notes	1.11kg
Adjustable block	Aluminium, Virgin	0.2kg	2	Notes	5kg
Crutch beam	Aluminium, Virgin	0.2kg	2	Notes	5kg
Wrist support	PVC, flexible	0.15kg	2	Notes	0.64kg
Crutch handle	Synthetic Rubber	0.15kg	2	Notes	0.834kg
Mechanism stopper	Steel, Low alloyed grades	0.05kg	4	Notes	0.442kg
Mesh frame	Steel, Low alloyed grades	0.4kg	1	Notes	0.883kg
Nylon rope	Natural rubber cert.	0.1kg	2	Notes	0.416kg
Cargo net hooks	Aluminium, Cast Alloy	0kg	10	Notes	0kg
Adjustable mechanism	Steel, Low alloyed grades	0.05kg	4	Notes	0.442kg
Base frame	Aluminium, Recycled	0.1kg	4	Notes	0.601kg
Wheel support	Aluminium, Recycled	0.2kg	4	Notes	1.2kg
Totals:		13.8kg			53.9kg

Transport

Transport name	Assembly transported	Mode	Distance	Notes	CO2
Delivery to client	Final Assembly	Car	25km	Notes	0.477kg
Totals:					0.477kg

Use

Calculations to plan the most efficient use of materials and reduce waste



Total area of 1mm thick metal grid= 1000 X 500 = 500,000mm^2 (0.5m^2)

Total area being used = (350X10) + (350X110) + (350X140) + 2(450X110) + (350X210) + (350X240) = 347500mm^2 (0.3475m^2)

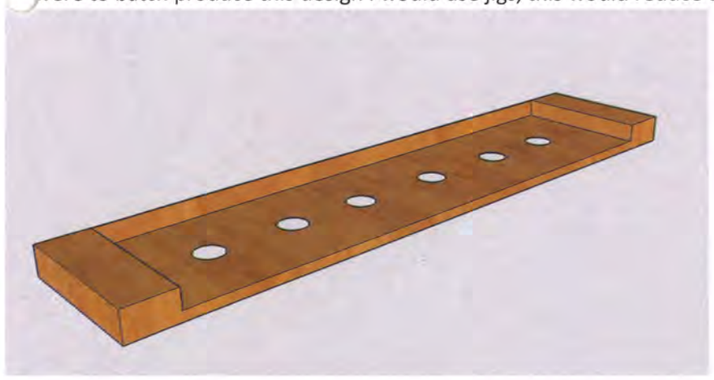
Percentage of area of metal sheeting being used = (347500 ÷ 500000) X 100 = 69.5%

Therefore, the metal being wasted is 30.5%

For my project, I plan to find a use for wasted materials. Whether this being recycling them or integrating them into my design depends on the situation. For this metal square frame, I plan on donating it to the DT workshop where if will be used and not thrown away.

Whilst cutting out parts I plan to employ a few methods to reduce waste as much as possible. The first being at the first stage of manufacture. I plan to ben very accurate with my marking out so that I make no mistakes which could lead to wasted materials. For example, in the example above, when marking out the dimensions I was very accurate. If I had made a cutting mistake I would have needed a whole new sheet of metal grid which would have doubled my costs.

were to batch produce this design I would use jigs, this would reduce the number of dimensional errors in manufacture. This would reduce waste material which would in turn save money. Employing jigs to repetitive manufacture processes in my design would reduce material wastage and would make the most efficient use of materials.



Obviously, there will be some material that is wasted, for this material I plan to find another use for it. For example, the wasted metal Swarf and be either recycled or collected in large drums before being sold to a scrapyard. This way a little amount of money can be regenerated from the scraps which will help reduce the price of the product as well it will have less of an impact on the environment.

The most efficient use of materials

Using materials in the most efficient way can help reduce CO_2 and make the design eco-friendlier. For example, when laser printing my crutch handles from acrylic I will make sure the piece being cut is as close to the top left corner so there is little wasted material. The bulk of the leftover material can be used for other purposes and other designs.

If I was to make my design in bulk it could lead to a lot of waste material and wasted money

For bulk buying I would buy a 3mm thick 600mm by 400mm sheet at a price of £5.87 from Kitronik

Sheet Area = 600 X 400 = 240,000mm^2 (0.24m^2)

Area needed for one support = 250 X 80 = 20,000mm^2 (0.02m^2)

Waste from one waste support = π X (8.5)^2 = 227mm^2 (0.000227m^2

Pieces fitting on one sheet is (400÷80) = 5 width and (600÷250) = 2.4 = 2 length (5 X 2) = 10 wrist support per sheet

Waste per sheet so far = (100 X 400) = 40,000mm^2 (0.04m^2)

This leaves room for one wrist support length wise

So, 11 wrist supports fir per sheet which means the total wasted material is equal to (11 X 4) X (227) + (150 X 100) + (20 X 400) = 32,988mm^2

So, the area wasted is 32,988mm^2 (0.032988m^2)

As a percentage, the waste can be calculated by (32,988÷240,000) X 100 = 13.745 %

This means that per sheet 81 pence is wasted per sheet

This is a relatively low waste in industry, the layout of the wrist support use as much as the material as possible, which saves money and reduces emission

Review of improvements and development based on the specification

	Improvements and developments
Function	• By adding ringed loops and a cargo net I was able to increase the capacity of the log carrier to help meet the 50L volume of logs required • After experimenting with different bases, I developed a more effective base whilst managing to reduce the mass of the product. This will reduce the overall mass of the product so it should meet the 15kg mass limit • As a result of testing my main mechanisms, I developed its strength and rigidity which will lead to a stronger final product. Performing these tests during development should allow me to produce my real mechanism with the same strength • As well as this I made the mechanism easier to use by using more ergonomically designed locking nuts. The quick release mechanism should allow for easy adjustability of the product • I also created ergonomic handles using many models to try get the best grip for someone who is elderly • I created a crutch handle with wrist supports which I found took a lot of weight off the wrist • Using the cargo net development, it helped me meet my client's requirement for the volume of logs carried to be greater than her last solution
Form	• In terms of form I looked mainly chose to prioritise ergonomics as my product is focused on function over form • I stuck with my minimalistic design as I designed my product to the client's specification • I only used necessary features throughout to keep my design to a minimalistic design
Quality Control	• Although quality control can't really be developed properly at this stage in production I did look at ways the quality of my product could be improved through things such jigs. I developed a jig for the adjustable heights of the handles. By introducing jigs, I can recreate the adjustable mechanism with extreme accuracy • Through development I looked at how accurate things need to be made to gage an idea of what my tolerances should be • During the manufacture stage I plan to look at where else I can implement jigs
Dimensions	• Through the development of my idea the dimensions changed little • The adjustability that I developed effects the maximum displacement however it has no overall effect on the dimensions of the actual product • Little dimensions changed such as I added a raised section to the mid-section, however no huge dimension changed where added
Safety	• I developed my mechanism so that it fit on the inside of the product, as a result the user can't access the mechanism accidently risking an injury to themselves • I developed attachments such as the wrist support that reduced strain on fragile parts of the body to reduce the chance of injury whilst lifting heavy loads • I designed a cargo net and rings so that the logs are less at risk of falling out and possibly injuring someone • I developed the mechanisms to be strong and stable so that they didn't break and injure the user whilst being used
Materials	• Whilst developing my design I always looked at using the most effective and eco-friendly materials • I also looked at reducing materials where possible such as the base frame • However, where reducing the material effected the product such as with the strength of my mechanism I did not compromise the strength of my design • I looked at different materials for my mechanisms to see which material could provide the optimal strength and efficiency • I prioritised materials that would help me meet my performance materials for the hardness test
Ages	• Whilst developing this design I always looked at how to include as many ages as possible, whether this was through making the design more applicable for older people (wrist supports, easy handles etc) or creating dimensions suitable for the younger side of the spectrum
Cost	• Looking at my development I can see there was little thought with the cost. However, by reducing material usage throughout the development would have greatly reduced the cost of my product
Scale of production	• I looked at three commercial production options. In a real manufacturing process, I would use batch production to allow flexibilities in my design if a fault was discovered • I also developed a jig with a plan to look at how I can use more jigs in my manufacturing stage
Sustainability	• Whilst developing my product I look at creating temporary joins and mechanism where possible without effecting performance so that welding, a high energy process, is not needed • When designing/developing my design I only looked at using a maximum of two different materials so that recycling will be easier at the end of the products life • When looking at finishes for design I only looked at ones that would have little to no effect on the environment and its surroundings

Evaluation of final design solution based on the specification

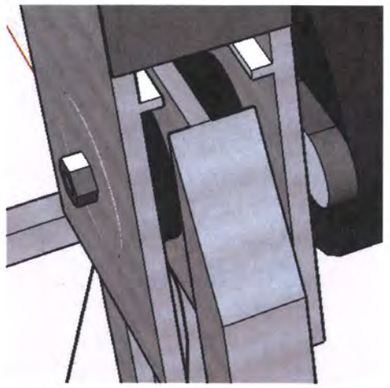
Specification point	Has the specification been met
Function	
1. The log mover must carry a volume of 20L of logs	30x40x25=30,000cm^3 which is equal to 30litres
2. There should be a method of easily loading/unloading the logs	I have designed a log grabber which could be bought, this would make loading and unloading easier. However, this won't be made during production
3. The product must be stable, must meet BS EN 1730 standard	My product has a wide base with two wheels as well as it has been designed so that the weight is evenly distributed. It also has the second function mode which has 6 wheels on the ground at the same time, thus making the product very stable
4. The product must make the logs easy to transport	With large wheels the product should be able to scale any terrain
5. All mechanism must function at all times, even under a strain of 500 Newton's or towards end of life (6 years)	I will test this specification requirement once the design has been made
6. The product must support a total mass of 50 kilograms	I will test this specification requirement once the design has been made as I can't predict how much mass the log carrier can take
7. The product must have some form of adjustability	The design has two forms of adjustability, the adjustable crutch handle and the adjustable mechanism, therefore this criterion has been met
Form	
1. The product must be aesthetically pleasing	Both my client and I believe the design is aesthetically pleasing, I think the design is sleek and well fitting for its environment
2. Ergonomic consideration must happen when designing the product	The handles and wrist support have both been modelled to make them as ergonomical as possible, this has been transferred to the design
3. The product must not offend any genders or religions	As far as I'm a where the product does not offend anyone, it has used neutral colours and has no possibly offensive symbols/shapes
4. The product must fit into all its environments	Both my client and I believe the design is aesthetically pleasing, I think the design is well fitting for its environment
5. The product must be of modern day design	The product uses modern materials, modern techniques, therefore I think it can be considered modern looking
Quality control	
1. Must be made to a ±5mm accuracy	I cannot evaluate this point until after making the design
2. Product must be thoroughly checked before being placed on the market	I cannot evaluate this point until after making the design, however the mechanisms have already been thoroughly tested
Dimensions	
1. The product must be no larger than 600mm x 600mm x 500mm	When the product is in its storage mode it meets this requirement, however in its fully extended mode it breaches this requirement
2. The product must have no jetting out edges of more than 150mm	The product has been designed to have no jetting out edges
3. The product must have a maximum displacement adjustability 0f ±400mm	The product has many adjustments, none of them are over the 400mm requirement
4. The product must have handles with a maximum diameter of 50mm	The handles on my log carrier have a dimension of exactly 50mm so the design meets the specification
Safety	

1. My product should meet the BSI sharpness test	This specification will be tested after the product has been made
2. The product should have a mass of no more than 15 kilograms	The product will be weighed once it has been made
3. All mechanisms must have safety precautions such as avoiding finger traps	The adjustable mechanism and crutch mechanism are both enclosed to fingers cannot reach them
Materials	
1. The log mover must be hard and durable according to BS EN 1730	This specification will be tested after the product has been made, however all materials that have been chosen for my design are considered to be hard/durable
2. The product must use waterproof materials and be resistant to all types of corrosion	All the materials chosen are waterproof, however mild steel is prone to rusting therefor it will need to be finished in a paint or protective layer
3. The product should be made from long lasting and sustainable materials	All the materials are definitely long lasting, they have been chosen especially for this purpose, however mild steel and aluminium are both quite energy intensive to extract and manufacture. Although aluminium and mild steel can be recycled they are not the most environmentally friendly materials to use
4. Low maintenance materials should be used	The material chosen for my product are all low maintenance
Ages	
1. The product must fit the age range of 18-89 years old	The product has been designed to fit all ages however whether this product could be used for some of the ages required is opinionated
2. The product must have no parts a young child could injure themselves on	The product has safety precautions, no finger traps or lose parts therefore it has met this specification point
Cost	
1. The product should cost no more than £100	After doing a parts list for my design and adding the cost of all the material up and adding VAT the total cost was £50.35 which is less than £100
Scale of production	
1. Batch production	Parts of my design have been designed so that jigs can be used if batch production is implemented, I am confident this design could be batch produced without a problem
2. Jigs will be used	I have designed my product with jigs in mind, many parts can be made with repeatable accuracy using jigs
Sustainability	
1. The log mover should be made from long lasting and sustainable materials	All the materials are definitely long lasting, they have been chosen especially for this purpose, however mild steel and aluminium are both quite energy intensive to extract and manufacture. Although aluminium and mild steel can be recycled they are not the most environmentally friendly materials to use
2. Varnishes/sealers used on the product must be eco-friendly and non-toxic where possible	My design is mostly self-finishing for the exception of the mild steel which will covered in a paint, therefore I consider this specification point passed
3. Un-used materials must be recycled if possible	This specification point is more aimed at production so I will evaluate it after the product has been manufactured
4. Machines should be used as little as possible	This specification point is more aimed at production so I will evaluate it after the product has been manufactured
5. Similar materials must be used	My design uses very few materials, however I think that the different material welds will make the product a lot harder to recycle at the end of the products lifespan so I would consider making some changes during production otherwise this specification point will not be met

Risk assessment

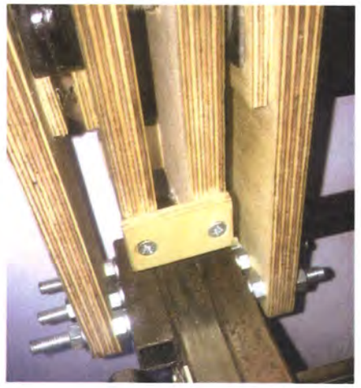
Machine/Process	Likelihood (1-5)	Consequences	PPE required	Safe working practice
Pillar drill 	3	• Pieces flying off into your eyes etc • Hands and fingers can be caught in machine • Hair and clothing can become entangled • Lack of space or concentration around the machine can lead to accidents • Continuous use can cause fire	• Safety goggles • Apron • Use of guards	• Tie all hair and clothing back • Use the machine in breaks and not for long amounts of time • Hold onto work firmly • Wear goggles and use the guard on the drill • Make sure to remove key chuck before use
Metal band saw 	4	• Bits can fly off unexpectedly • Overuse can cause ear damage • Blade can snap un-expectantly • Hair and clothing can become entangled • Lack of space or concentration around the machine can lead to accidents	• Safety goggles • Apron • Heatproof gloves	• Use Goggles • Wear ear defenders • Tie all hair and clothing back • When using the machine give it your full attention and make sure you have room when working.
Band saw 	4	• Bits can fly off unexpectedly • Overuse can cause ear damage • Hands and fingers can be cut • Hair and clothing can become entangled • Lack of space or concentration around the machine can lead to accidents	• Safety goggles • Apron • Use of guards	• Use Goggles • Wear ear defenders • Use a push stick for small items • Tie all hair and clothing back • When using the machine give it your full attention and make sure you have room when working.
Metal grinder 	2	• Burn injuries • Metal swarf flying off • Hair and clothing can become entangled • Lack of space or concentration around the machine can lead to accidents	• Safety goggles • Heatproof overalls • Heatproof gloves	• Use heatproof gloves • Use Goggles • Tie all hair and clothing back • When using the machine give it your full attention and make sure you have room when working
Laser 	1	• Damage to eyes • Hazardous fumes • Possibility of fires	• N/A as computer controlled	• Make sure the fume extract is turned on • Do not look directly at the laser for long periods of time • Set all materials and thicknesses correctly to avoid fires/overheating
Strip heater 	2	• Hazardous fumes • Possibility of fires • Burn injuries	• Heatproof overalls • Heatproof gloves	• Work in well ventilated area • Use heatproof gloves if working with small objects • Tie all hair and clothing back • When using the machine give it your full attention and make sure you have room when working
Brazing/ welding 	3	• Burn injuries/fires • Eye damage • Dangerous fumes	• Heat proof overalls • Welding mask • Gloves • Overalls	• Appropriate training • Work in well ventilated area • Take regular breaks from piece • Use all PPE stated
Pop riveting 	1	• Pin flying off once force applied • Pressure from pop rivet	• Safety goggles	• Make sure work is fully secured before pop riveting • Be aware of flying pins • When using the machine give it your full attention and make sure you have room when working

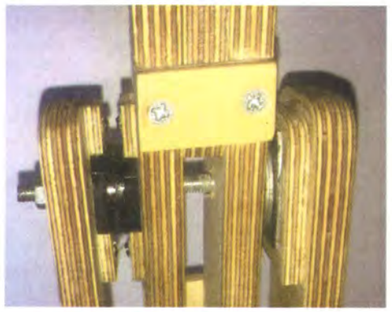
Modifying testing and improving during manufacture

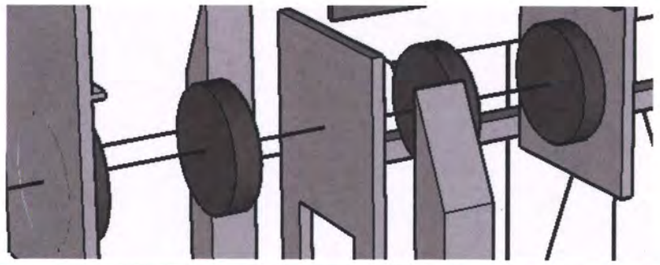


One major change throughout manufacture of my product is that I chose to use pop riveting over welding due to It being a quicker and easier process whilst still providing great strength.

Due to this some parts of my design changed. Whilst the design shows the mid-section as the inside of the adjustable mechanism the final product was different. Due to the mid-section being wider than anticipated I had to make an adaptor to the adjustable mechanism which can be seen from the pictures. It required to flap sections which were then bolted across the mid-section using 3 bolts and the required washers/nuts. This modification made the overall product a little taller than previously stated but had no everlasting changes on the product.

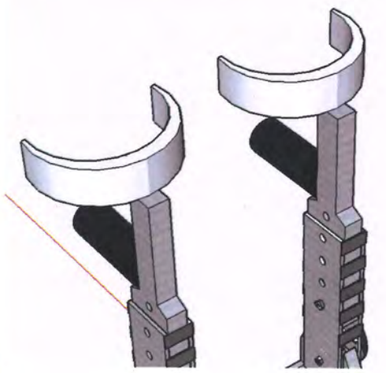






After making the set of adjustable crutch handles I modelled them to see which way round they felt most comfortable. I found that myself and other people included thought the opposite way to the original design felt better and so I decided to swap the way the handles and wrist support went.

I also decided to change the shape of the wrist support to more of an enclosed shape in order to keep more support. This did however have some negative impacts (see evaluation)



As we can see from the photos above the adjustable mechanism itself also changed. In designing I thought four nord lock washers would be sufficient but whilst making I found that they had a tendency to slip under little weight. To fix this I used a pair of Nord lock washers and a pair of plastic lock washers. I found that this gave the product added strength.

Whilst the plastic lock washers where stronger in terms of holding the mechanism together. They often broken free from the flaps. To fix this I placed a piece of plywood tightly inside the plastic lock washers and screwed them into the flaps. This stopped the lock washers from rotating when they shouldn't have.

I also made a few minor changes to my overall design. Instead of using many steel support beams for the base frame, which would have added too much weight, I used one support beam and some mild steel mesh.

I also attached another support beam across the adjustable crutch mechanisms. This did not affect the mechanism itself but gave the top half of my product more strength as well as it meant that when changing the product to its second adjustable mode, I could change both handles at the same time to the same setting. This greatly reduced the time to reduce the product to its second adjustable mode.

Another small change I made was I replaced the mild steel frame with a mild steel mesh. Not only was it stronger but it was also more effective as it is capable of catching more of the log material. It did however have some negatives (see evaluation)

Another quite important change I made is the addition of support beams. After testing the I initial frame that I created I felt that it did not have the best strength. In order to fix this I pop riveted a series of mild steel bars. I found this made the product much stronger.

The final adjustment I made was that I added a short wooden block on either side so that the trolley wouldn't fall over when left standing up.

Plan of production

Task	Tools/equipment	Risk 0-5	Safety precautions	Q.C. Enquiry	Q.C. check	Week of production	Estimated time	Changes/notes
Cut out the aluminium blocks and drill the holes for the adjustable mechanism, then weld the two pieces (x2)	• Pillar drill • Metal band saw • File	4	• Training on how to use metal band saw • PPE • Safety goggles • Make sure work is properly secured	• Is the cut the correct size and angle on the adjustable block? • Are there any sharp edges as a result cutting the metal?	• Check dimensions of the cuts and use protractor to measure angle (±2mm) • Use a file if necessary to smoothen the cuts	Week 1	120 minutes	• Material changed to plywood • Screwed together
Cut the dowel handles and wrap them in rubber, use 2D design and the laser cutter to cut out the wrist supports (x2)	• Band saw • Cutting knife • Laser	3	• Use correct PPE, use push sticks • Use cutting mat • Cut away from body	• Are the dowel handles equal size? • Is rubber covering the whole handle?	• Check the dimensions of both handles (±2mm) • Do a visual check to see if the rubber is covering the whole hand	Week 1/2	90 minutes	• Handles finished with polymorph
Drill the holes in the PVC and handles as well as bend the PVC in shape. Then join them using nuts and bolts	• Pillar drill • Strip heater • Nuts and bolts	2	• Clamp work securely • Use correct PPE/follow signage • Use gloves with strip heater	• Do the wrist supports have the correct angles? • Are the holes accurately drilled?	• Use a protractor to measure the angles (±1°) • Check the holes are central and line up with crutch beam (±0.5mm)	Week 2	100 minutes	• n/A
Use the metal band saw to cut the sheet metal beams, sheet metal runners and mechanism stopper and drill the appropriate holes	• Metal band saw • Pillar drill	4	• Training on how to use metal band saw • PPE • Safety goggles • Make sure work is properly secured	• Are the pieces the correct dimensions? • Do the holes line up for the adjustable mechanism?	• Check the dimensions of all the cuttings (±4mm) • Line up the adjustable mechanism to check everything aligns (±0mm)	Week 2	75 minutes	• Material changed to plywood
Weld the mechanism stoppers on, braze the sheet metal runners to the sheet metal beams	• Arc welding set-up • Brazing torch • Flux	3	• PPE • Use Arc welding face shield • Gauntlets • Heatproof overalls	• Are the mechanism stoppers parallel to the sheet metal beams? • Are the sheet metal runs at 90 degrees?	• Use an engineer square to make sure all the angles are at 90 degrees to each other (±0°)	Week 3	90 minutes	• Mechanism held in place using nuts and bolts
Slide the adjustable beam into the slot making sure they slide smoothly, cut the magnetic pins and slide them into position	• Metal band saw • Metal file • Emery cloth	3	• Make sure iron rod is fully secure when cutting • Be careful not to catch fingers in the adjustable mechanism	• Does the adjustable function smoothly? • Do the magnetic pins stay in place?	• Make sure the adjustable mechanism is made to a tolerance of less than 2mm total using a ruler • Leave the pins in and see if gravity displaces them	Week 3	30 minutes	• n/a

Following this create mould and pewter cast the mechanism toggle and place the adjustable mechanisms in place before attaching the mechanism toggle	• Pewter casting • Pewter • Nuts and bolts	3	• Be careful not to spill pewter or overfill mould when pouring	• Does the adjustable mechanism both line up? • Has the pewter casting finished well?	• Do a mechanical check to make sure the adjustable mechanisms have lined up • Check for burrs and structural faults, file smooth any sharp edges (BSI sharpness test)	Week 3/4	90 minutes	• Due to timing I replaced the toggle with wingnuts
Cut out all the parts for the lower section using the metal band saw and drill the appropriate holes required	• Metal band saw • Pillar drill	4	• Training on how to use metal band saw • PPE • Safety goggles • Make sure work is properly secured	• Does the base frame make 90 degree angles to each other? • Do the holes line up where appropriate?	• Use an engineer square to check the angles ($\pm 0^0$) • Line up all the parts where holes overlap to make sure they align	Week 4	100 minutes	• n/a
Weld the base frame together, pop rivet the raised section before welding the mid-section to the raised section	• Arc welding set-up • Pop rivet gun	3	• PPE • Use Arc welding face shield • Gauntlets • Heatproof overalls	• Are all the parts parallel to each other? • Is the raised section fixed to the base frame correctly?	• Use an engineer square to check the angles ($\pm 0^0$) • Make sure the pop rivets have fully formed and are strongly joined (Tensile strength test)	Week 5	90 minutes	• I used pop riveting instead of welding
Attach the secondary wheels using nuts/bolts, weld the main axel to the base frame	• Arc welding set-up • Nuts and bolts	3	• PPE • Use Arc welding face shield • Gauntlets • Heatproof overalls	• Is the axel aligned correctly with the base frame? • Do the wheels spin smoothly on the bearings?	• Use an engineer square on both side of the base frame to make sure the axel is at 90 degrees • Check the bearings are clean and spin smoothly	Week 5	90 minutes	• Axel was pop riveted to main frame
Attach the cargo net hooks using the nylon rope and braze the mesh frame into place	• Nylon rope • Brazing torch • Flux	2	• Gauntlets • Heatproof overalls • PPE	• Does the mesh frame fit inside the lower section? • Is the nylon rope attached securely?	• Check the mesh frame directions allow it to fit in the lower section (±5mm) • Apply pressure to the net to make sure it holds in place (Young's modulus test)	Week 6	60 minutes	• Cargo net was not made due to timing • Mesh was pop riveted in place
Put the second-hand wheels on the axels and use locking nuts to hold them in place	• Nuts and bolts • Spanner	1	• The wheels have possible finger traps so be careful to avoid this	• Do the wheels support the trolley? • Do the wheels rotate smoothly and up/down stairs?	• Wheel the trolley to make sure the trolley is support by the wheels • Use the wheels on the stairs to make sure they function	Week 6	25 minutes	• n/a
Clean the metal parts and fully tighten all nuts and bolts where necessary	• Spanner • Wire wool • Emery cloth	0	• No safety issues	• Are there any scratches marks on the product? • Are there any lose nuts?	• Do a visual check of the product and use emery v Cloth to remove marks • Tighten all the nuts until they can't move	Week 7	120 minutes Total time: 1080 minutes (18 hours)	• Black paint and danish oil were used for finishes

Gantt Chart

Projected time

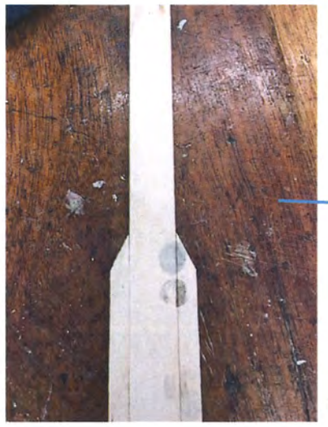
Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Cut out the aluminium blocks and drill the holes for the adjustable mechanism, then weld the two pieces (x2)							
Cut the dowel handles and wrap them in rubber, use 2D design and the laser cutter to cut out the wrist supports (x2)							
Drill the holes in the PVC and handles as well as bend the PVC in shape. Then join them using nuts and bolts							
Use the metal band saw to cut the sheet metal beams, sheet metal runners and mechanism stopper and drill the appropriate holes							
Weld the mechanism stoppers on, braze the sheet metal runners to the sheet metal beams							
Slide the adjustable beam into the slot making sure they slide smoothly, cut the magnetic pins and slide them into position							
Following this create mould and pewter cast the mechanism toggle and place the adjustable mechanisms in place before attaching the mechanism toggle							
Cut out all the parts for the lower section using the metal band saw and drill the appropriate holes required							
Weld the base frame together, pop rivet the raised section before welding the mid-section to the raised section							
Attach the secondary wheels using nuts/bolts, weld the main axel to the base frame							
Attach the cargo net hooks using the nylon rope and braze the mesh frame into place							
Put the second-hand wheels on the axels and use locking nuts to hold them in place							
Clean the metal parts and fully tighten all nuts and bolts where necessary							
Testing and final quality control							

Actual time

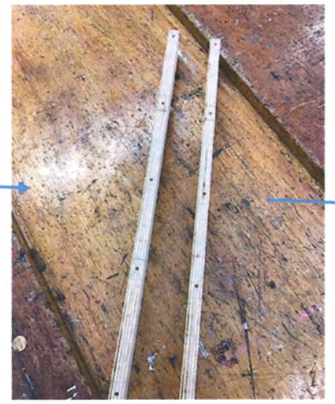
Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Cut out the aluminium blocks and drill the holes for the adjustable mechanism, then weld the two pieces (x2)							
Cut the dowel handles and wrap them in rubber, use 2D design and the laser cutter to cut out the wrist supports (x2)							
Drill the holes in the PVC and handles as well as bend the PVC in shape. Then join them using nuts and bolts							
Use the metal band saw to cut the sheet metal beams, sheet metal runners and mechanism stopper and drill the appropriate holes							
Weld the mechanism stoppers on, braze the sheet metal runners to the sheet metal beams							
Slide the adjustable beam into the slot making sure they slide smoothly, cut the magnetic pins and slide them into position							
Following this create mould and pewter cast the mechanism toggle and place the adjustable mechanisms in place before attaching the mechanism toggle							
Cut out all the parts for the lower section using the metal band saw and drill the appropriate holes required							
Weld the base frame together, pop rivet the raised section before welding the mid-section to the raised section							
Attach the secondary wheels using nuts/bolts, weld the main axel to the base frame							
Attach the cargo net hooks using the nylon rope and braze the mesh frame into place							
Put the second-hand wheels on the axels and use locking nuts to hold them in place							
Clean the metal parts and fully tighten all nuts and bolts where necessary							
Testing and final quality control							

Photographic evidence of making

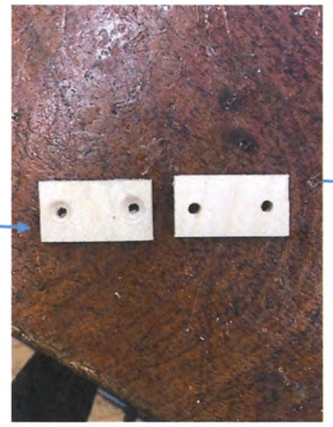
Cutting the crutch beam and block for the adjustable crutch mechanism



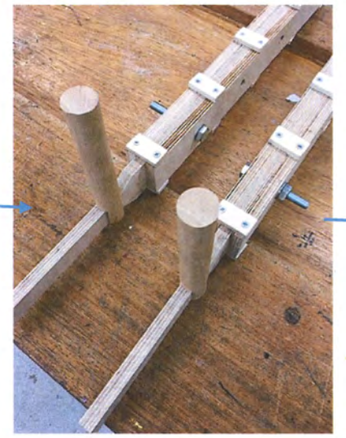
Marking the wholes for the sheet metal runners and drilling pilot holes



Cutting the sheet metal runners and countersinking the holes to provide a flush finish with the screws

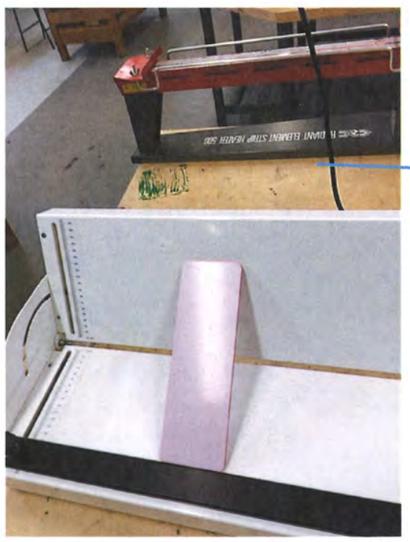


I then cut the dowel handles and drilled them into place

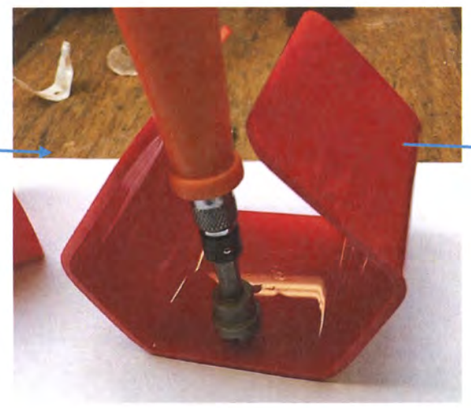


Next, I used techsoft 2D design to produce my wrist supports. I then cut them out using the laser

I then used an angled line bender and strip heater to make the angles for the wrist support

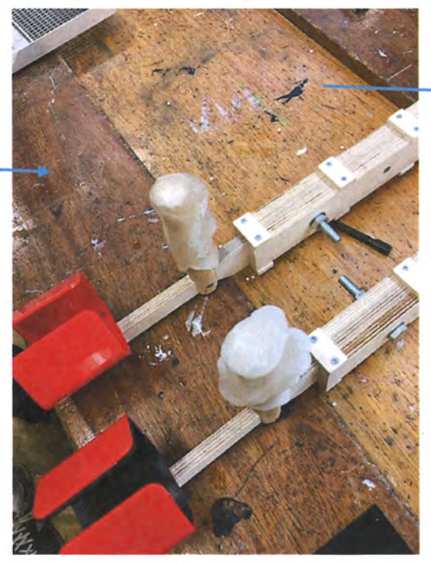


I then drilled and countersunk two holes for each wrist support and attached them to the crutch beam



I then boiled some water and used polymorph to create my ergonomic handles from my development

Following this I added some rubber grips to the wrist support which left me with the top part of the product completed



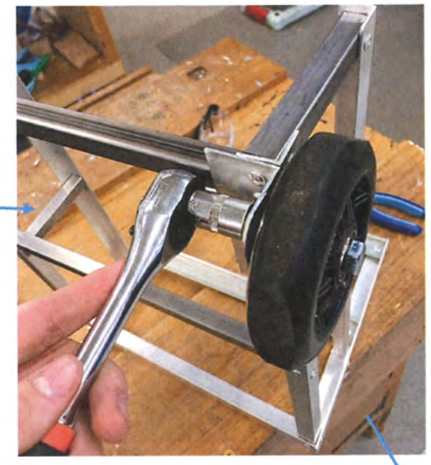
After this I created the base frame using four metal sheets and pop riveting

I then cut the metal for the raised section before pop riveting it all together (including the support beams

Throughout this process I made sure to file flat any of the beams being joined at 90 degrees

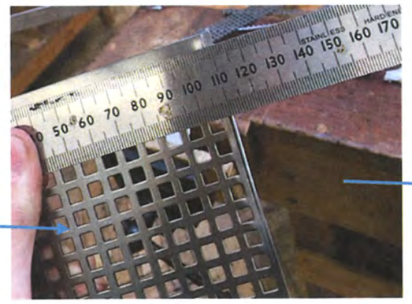
Following this I cut out two L-brackets and drilled multiple holes (for strength) and pop riveted them to the main frame

I then attached the wheels using a locking nut and a spanner set making sure the ball bearings where well lubricated



I then used the shear press to cut the pieces for the mesh frame and mesh sides

Throughout this process I made sure the dimensions where correctly cut (±2mm)



I then placed all the mesh frame pieces in place to make sure they fitted snuggly

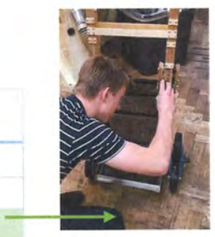
I then pop riveted the axel on before attaching the wheels

After making my improved mechanism I attached it to the adjustable crutch and attached this to the main frame

After making some small adjustments (central support beam) the product was finished

Testing against specification

Specification point	Has the specification been met
Function	
1. The log mover must carry a volume of 50L of logs	After measuring I found the volume to be 0.0525m^3 which is equivalent to 52.5 litres
2. There should be a method of easily loading/unloading the logs	I believe this is the one serious fault with my design, although the logs are somewhat easier to load, the user is still required to bend down, if I had more time I think a log grabber attachment would have been perfect to fix this problem
3. The product must be stable, must meet BS EN 1730 standard	The product can take myself standing on it therefore I would consider it stable, with the wooden support blocks the product is unlikely to fall over
4. The product must make the logs easy to transport	My client found it easy to carry the logs up the stairs as well as around the house
5. All mechanism must function at all times, even under a strain of 100 Newton's or towards end of life (6 years)	Using the Newton metre, I found that the adjustable mechanism could carry a strain of over 150N
6. The product must support a total mass of 50 kilograms	The product can take my mass, which is over 50kg therefore this specification point has been passed
7. The product must have some form of adjustability	My product has many forms of adjustability, one form is given here in the photo
Form	
1. The product must be aesthetically pleasing	Speaking to my client she believes that the product looks good considering the intension of which it is meant to be used
2. Ergonomic consideration must happen when designing the product	Throughout manufacture I attempted where possible to make the product as ergonomic as possible
3. The product must not offend any genders or religions	Me and my client talked and agreed that the product didn't offend any genders
4. The product must fit into all its environments	Me and my client agreed that the product was fairly neutral in its environment and therefore didn't look out of place
5. The product must be of modern day design	Me and my client talked and agreed that the product had a modern day feel about it
Quality control	
1. Must be made to a ±5mm accuracy	Throughout manufacture I always tested against my set tolerances
2. Product must be thoroughly checked before being placed on the market	After I finished manufacturing my product I meticulously checked it for any faults or errors
Dimensions	
1. The product must be no larger than 600mm x 600mm x 500mm	When my product is in its 'storage mode' it fits within in the required dimensions, however when the product is in its working mode it is greater than these dimensions
2. The product must have no jetting out edges of more than 150mm	If you include the handles as jetting out then this specification point would not be met, however depending on opinion this point has been met
3. The product must have a maximum displacement adjustability 0f ±400mm	My product is adjustable however it never passes over the 400mm requirement
4. The product must have handles with a maximum diameter of 50mm	The handles I made fit within this specification point

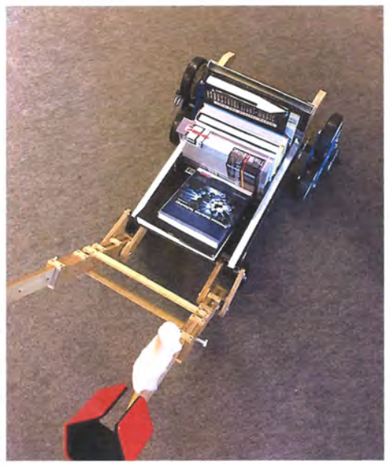







Safety	
1. My product should meet the BSI sharpness test	Any sharp corners I found with my product were rounded off, as a result my product meets the BSI sharpness test
2. The product should have a mass of no more than 15 kilograms	After using 4 newton metres and dividing by g I found the weight was 11.2Kg which was below the maximum weight
3. All mechanisms must have safety precautions such as avoiding finger traps	Due to the mechanism design change, there was a slight risk of a finger trap injury, this could be fixed easily in a second prototype
Materials	
1. The log mover must be hard and durable according to BS EN 1730	I used the Rockwell hardness test on my product, finding that it was resistant to drops and bangs without structural faults arising
2. The product must use waterproof materials and be resistant to all types of corrosion	My product was finished in black paint and Danish oil, paint is waterproof and protects from corrosion, Danish oil is also water-resistant
3. The product should be made from long lasting and sustainable materials	Aluminium and mild steel are very durable materials, they are resistant to corrosion with required finishes and so are long lasting. Plywood is another great material, it is a composite material with great strength and so it long lasting
4. Low maintenance materials should be used	All materials that I used all have a lifespan of well over 10 years
Ages	
1. The product must fit the age range of 18-89 years old	Due to the component of the weight about the centre of gravity the actual strength required to use this product is low, although opinionated believe this product fits the age range
2. The product must have no parts a young child could injure themselves on	Although there are no small parts a child could easily access, if a nut or washer was too fall off this could become a potential hazard
Cost	
1. The product should cost no more than £100	After doing a parts list for my design and adding the cost of all the material up and adding VAT the total cost was £50.35 which is less than £100
Scale of production	
1. Batch production	Use a FMS system I believe my product could be automated, making it suitable for batch production
2. Jigs will be used	Many manufacturing processes I used during product can easily be recreated using jigs (such as the drilling of holes)
Sustainability	
1. The log mover should be made from long lasting and sustainable materials	All the materials I used are durable, with a finish they will last even longer
2. Varnishes/sealers used on the product must be eco-friendly and non-toxic where possible	Whilst I would say my product is eco-friendly I did use paint as a finish. If possible next time if would use a low VOC paint
3. Un-used materials must be recycled if possible	Material I didn't use has been sent back to the workshop so it can be used for other products in the future
4. Machines should be used as little as possible	Although I did use machines, I changed my main joining method from welding to pop riveting and nuts and bolts
5. Similar materials must be used	Throughout the manufacture of my product I used two metals and one wood, therefore I believe this point is met

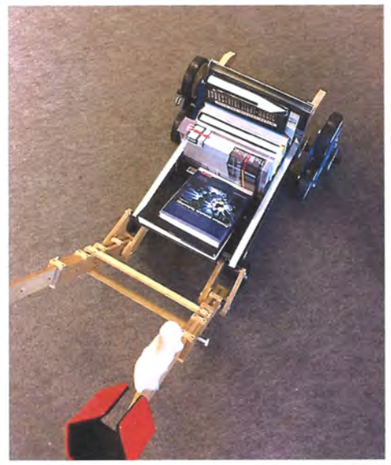
Testing against specification 2

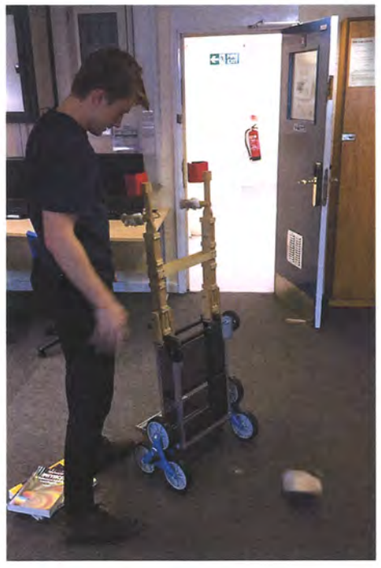


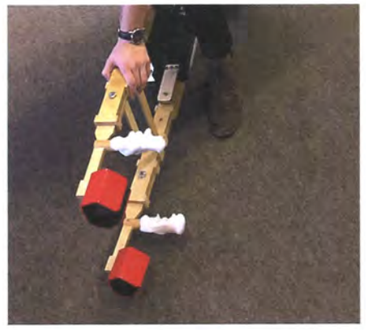
Below I am performing a workshop related vertical static load test. Both modes of the product reached test level 3 for the mesh frame, however the mild steel bars themselves reached test level 4 due to their increased strength. I didn't set a specific requirement for the vertical static load however level 3 for both modes are sufficient to meet my other specification points such as strength and durability.

Here I am testing BS 4875-1 and BS EN 1728. In the first mode to product reached test level 3 according to the data tables which suggests to me the product has been made sufficiently strong and is also stable under the force applied. The second mode reached test level 4 in the table due to the four-wheel base making the product more stable and spreading the weight over a larger area. This reduce the component of the force through the centre which allowed the product to carry more mass

The second test for this BSI standard is looking one again at the stability of the product on an inclined slope. Both product reached test level 4 however I would say that once again the second mode of the product looked and felt more stable at this incline. Again, probably due to the wider base. Again, due to test level four being met my manufactured product has passed this specification point as it was only required to meet test level 3. As a result, I can say the product is more stable than I anticipated.







Although it was hard to simulate a horizontal static load test I tried my best to replicate the conditions. Applying the force horizontally had little effect on my product and the product felt strong. I think guessing a test level would be difficult to predict so I won't pass or fail this specification. However, I would say my product definitely passed test level 1 so it can still meet the BSI standards to be sold in the UK

The final BSI performance test I carried out was BS 3963-6, the impact test. Unfortunately, I could not find a 2kg steel fall so I used a 2kg brick as a substitute to this. I dropped the brick from a height of 2m from the impact area. I found that my product reached test level 5 as the product did not dent from the impact of the brick. Therefore, this specification point has been met.

End user evaluation/ Client evaluation

Modifications

I made many changes to my final design to both improve its form and function. Many of these changes had a positive impact on my design, however, a few also had a few drawbacks

The first change I made to my design was that I changed the materials of the product. The top half was meant to be made from aluminium, but due to the nature of the prototype I used plywood. This greatly increased the speed of production allowing me to rapidly produce a prototype. Due to using plywood I did however lose some strength. I also believe an all-aluminium design would be more aesthetically pleasing. However, the benefits of changing to plywood outweigh the negatives

Another critical material addition I made was the mild steel support beams. I added these to provide greater horizontal and vertical strength to my design. By adding these beams my product became a lot stronger, enough to support my body weight. It also provided an anchor point for my adjustable mechanism.

Another change I made was the adjustable mechanism was slightly redesigned in that the mechanism was basically flipped upside down. This was as a result of the raised section being wider than expected. This change actually had a few positives, it allowed the product to fold up into a compact box shape, it also allowed the range of angles for the second mode to be increased.

I also changed the shape of the wrist supports in an attempt to give the user more support. Although these provided great strength it did make it harder for the user to actual get their hand inside the wrist support to grab the handle. This is because many peoples handed are a lot wider than their wrists. If I was to modify this I would look into a wrist support that can be adjusted to fit the persons comfort and sizes.

Another change I made was to use a large mild steel mesh instead of a more open version, this greatly improved the amount of log debris being caught. It also made the product more rigid as it increased horizontal strength. It did however have one key drawback, it was very heavy. Although my product did not exceed the 15kg limit the mesh made it a lot heaver. An alternative solution would have greatly reduced the weight. Evaluating this, I would change the mesh to a lighter metal such as aluminium, this would reduce the mass of the product by over a kilogram, meaning the product would then have a mass of less than 10kg

The final major change I made was that I reversed the direction of the handles and wrist support. After making the handles I experimented with them and surveyed people asking them which they found more comfortable. Almost everyone preferred the reversed version and so I decided to change this part of the design.

I slight adjustment I made to my final product was that I decided to paint the mild steel in black instead of a sealer. This was due to the mild steel being slightly rusted before I could apply the sealer. I feel this improved the aesthetics of the product without hindering its function

Strengths and weaknesses with improvements if necessary

The main strength of my product is that it works as intended. It is able to carry many logs, well over the required amount from specification. The raised mid-section also keeps the logs tightly together so that they can't fall out easily. Although my product carries the required 15 litres I think this could be improved, if I were to make a second prototype I think I would try to increase the volume of the logs up to 30 litres. One way I could do this would be to raise the mesh frame higher up so that it covers more surface area. This of course would add to the weight of the product.

Another great strength of my product is the three-wheel system. This allows the product to easily be carried up vertical inclines such as stairs. Due to the wheels, the mass of the product and logs doesn't need to actually be carried. The component of the weight about the pivot on the three-wheel system is less than the normal reaction, therefore the force needed to lift the logs is less. The three-wheels also allow the product to easily traverse rough terrain. The only disadvantage of this three-wheel system is it makes the product quite hard to turn with heavy weights

Another strength of my product would be its range of adjustability. These features such as the crutch handles or varied handle angle allow the user to fit the product to their needs. This greatly increased the comfort for the user without sacrificing strength to the product. The range of angles that are achievable is over 120 degrees to meet the user's ergonomic requirements. The second mode achieved with this adjustability provides greater stability for people who may struggle to carry the weight of the logs. A four-wheel base also allows less weight to be carried for the user. It also allows more logs to be transported at once although this weight may become too heavy for some people

A weakness of my product would be the way the adjustable mechanism connects the two parts of the product together. Although the mechanism works, I found that it can be quite complex to change the angles. Due to the nature of the mechanism it has many nuts and bolts that held it in place. These could be quite hard to adjust at times and so I would say this part of my product needs improving

If I were to improve this part of my product I would consider using metal for the flaps. That way they could be welded on which would not only increase the strength of the joint but would mean the product would not need as many nuts and bolts. The

adjustable mechanism itself would still be the same but it would now be stronger than before. The locking washers themselves are made from plastic and metal for my product. If I were to redesign them I would die cast them. This way they would be stronger and the mechanism would work better. I think I would also reduce the number of teeth for the lock washer and make the teeth deeper. This way the adjustable mechanism would have less discrete angles but would have greater strength at these angles. The overall range of adjustability would not be effected and would still be over 120 degrees.

Another slight weakness of my product would be its upper rigidness. Although the product is incredibly stable from following over I think the upper handles could be more secure. One way this could be improved would be to make the adjustable mechanism stronger, which I discussed above. Another way I could improve this strength would be to add a support beam between the wrist supports. Not only would this increase the rigidness, it could also provide more place the user can hold the product. This would be especially helpful for someone who does not need the wrist supports. It would also allow the trolley to be attached onto the back of a lawnmower or quadbike allowing for even more logs to be carried.

Another change I would make would be to the aesthetic appeal to my product. One such example of this would be to change the handles of my design. Although they are very ergonomic I think I could improve their aesthetic appeal. By giving them a more rounded edge finish and giving them a streamline look I think they would look better. I would also cover them in a rubber polymer layer. By doing this it would also improve the ergonomics of the product

One final change I would make would be to slightly adjust how the three-wheel system works. If I were to remake my product I would design an axel system that allows the product to turn at least 45 degrees on the axels. This would allow for a pivot turn. This would make it easier for the user to turn when carrying the weight of the logs without sacrificing stability.

Client evaluation

After showing my client my final product and allowing her to use it for some time and get a feel for the product she evaluated it and said the following.

"Firstly, I would like to say the product is fantastic and has made moving logs a lot easier for me, of course there is a few areas for improvement but the overall product is good."

"One feature of the product I have found helpful are the stair climber wheels, they allow me to go up my stair easily without much effort. However, when I was half way up my stairs and had to turn 90 degrees I did struggle a little bit. I had to do lots of little turns to make one big turn. If it was possible I think you should make it easier to turn the trolley on the spot without having to move it"

"Another success of your product is how stable the logs are, when I moved the trolley the logs felt securely fitted in-between the raised section, unlike my previous solution where they would often fall out when moving the trolley over the gravel. Along with this the wire mesh holds the logs and stops them falling out the back like my previous solution. The wire mesh is also very good at catching the log debris. I really like this aspect of the design."

"A slight flaw to this product is the wrist support. I was able to use them fairly well however they were quite uncomfortable at times. When my husband used the trolley he simply could not get his hands through the wrist supports as they weren't wide enough. I think next time the wrist supports need to be larger."

"My last slight complaint is with the adjustable mechanism. Although it has some great aspects I would like to see a quick release system implemented. This would allow me to easily change the mechanism without much struggle."

"That said overall I think the product is fantastic and I look forward to using it."

Signed: Wendy R. Morrell

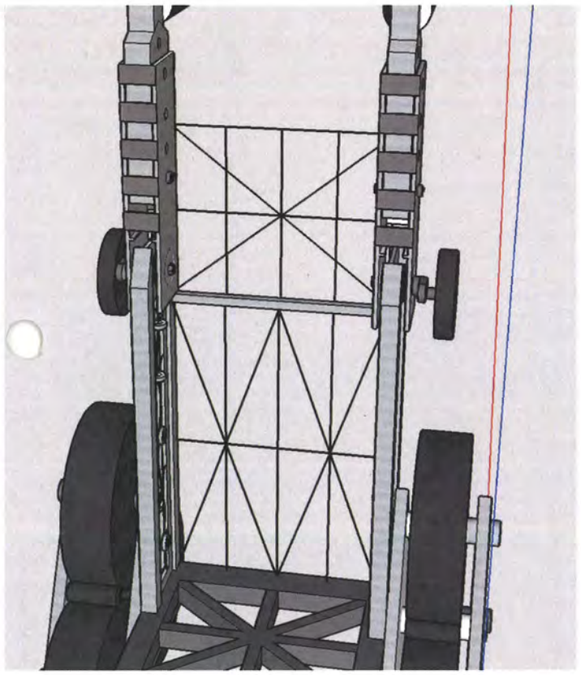
Response to client evaluation

In response to my client's evaluation I think her points are justified. Whilst I have addressed most of these points already there are a few new points I wish to discuss.

I think my client was right in saying that the adjustable can be quite difficult to use. Whilst my initial design had a quick release mechanism I was not able to implement it during manufacture due to the complexity of the design.

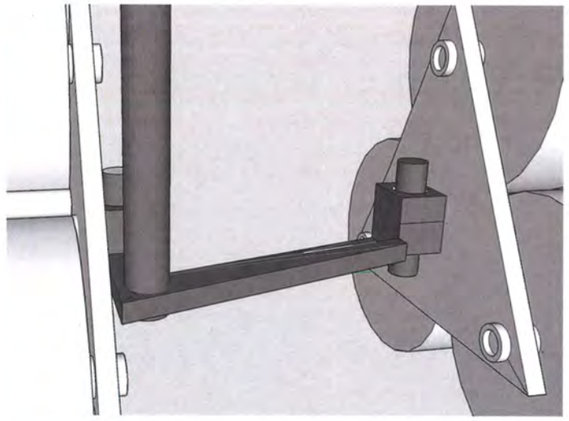
If I was to look at making a second prototype I would look to develop a quick release mechanism. This way it could be easily manufactured and would benefit the user greatly. Apart from this fault I believe the client had no other major issues that I hadn't addressed.

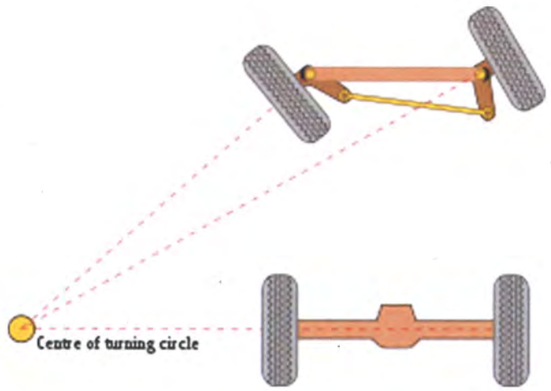
Improvements based on client feedback/evaluation



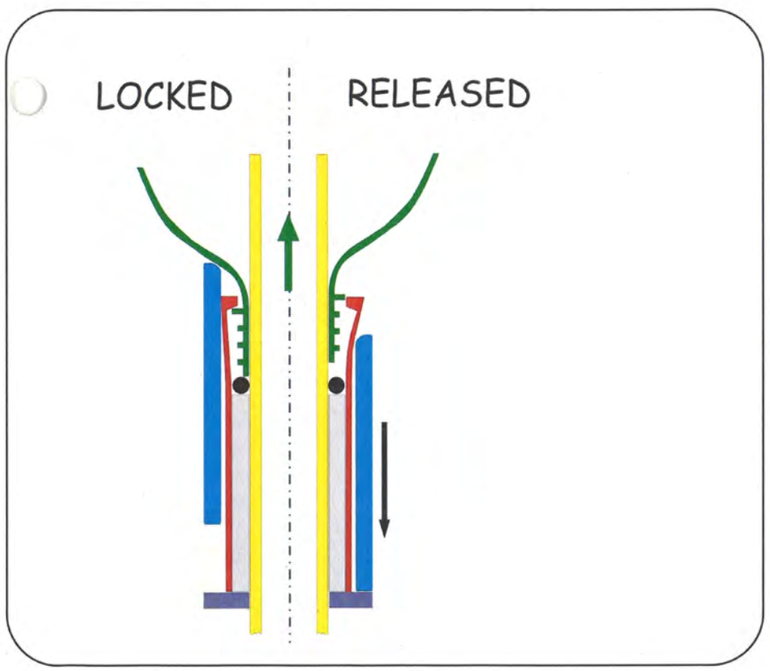
One point I received from the evaluation of my product was that I could increase further the capacity of logs that could be carried. The way in which I could achieve this would be to add another mesh frame further up the product. As seen by the diagram. My prediction is that this design would increase the capacity of the logs that can be carried by 50%. This added mesh frame would also mean that when the product is in its second mode the logs would be able to be stacked higher, further increasing the volume of the logs.

If I were to make this mesh frame for a second prototype I think I would make it an attachment that can be taking of depending on how many logs you want2 to carry and what weight you can carry.





Another improvement I think I could make to my prototype would be it ability to turn on the spot. I looked at a few possibilities to do this and decided that running an axel rod below the base frame would be the best idea. The axel would be off centred so the turning rod could be replaced as a handle for one side of the product. This would allow the product to turn a lot easier under the weight of the logs. This mechanism would not interfere with the three-wheel system and so they could combine each feature to improve the product.



Whilst searching for solutions to my quick release mechanism problem I found one that could be applied to my crutch mechanism. Pulling the two green sliders apart allows the outside part (red) to slide up and down. This mechanism would be perfect for quickly changing the heights of the adjustable crutch mechanism.

I believe this mechanism could also be applied to the angle adjuster on the product with some redevelopment built still using the same concept, pulling to spring loaded handles apart.

The last change I would make to my product would be to slightly change the wrist support. I would either chose an alternative more flexible material to allow bend in the wrist support to fit the user or I would use attachable sliders to the inverted wrist support apart allowing it to open up and fully close around the user's wrist.

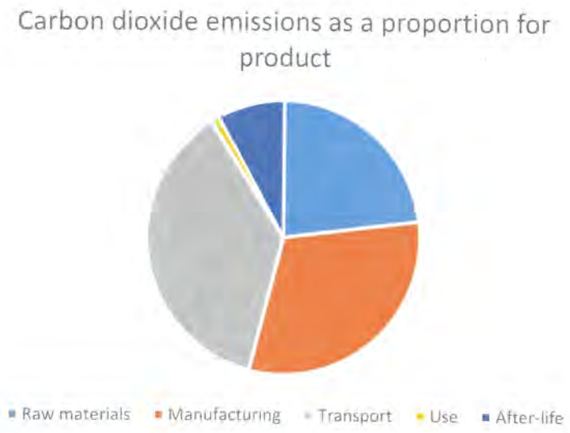
Life cycle analysis

Raw materials

Birch plywood- Plywood is obviously a wood material and therefore is not a finite resource. However, birch plywood takes a long time to grow and therefore can be energy intensive. As well as this using birch plywood for manufacture is likely to contribute to deforestation which has many environmental impacts such as increased level of CO_2

Aluminium- Aluminium originates as bauxite ore. This ore is difficult to extract and is energy intensive to do so. However, Aluminium can be recycled multiple times without much effect to its properties. Therefore, these two aspects almost cancel each other out.

Mild steel- Mild steel is a mix of iron and carbon. Iron come from iron ore and is extracted using a blast furnace. This process is energy intensive. It is then mixed with a specific amount of carbon to make it into mild steel. Steel can be recycled over and over again without losing any of its properties and therefore makes it a good raw material to use over and over



Plastics/Polymers-
Plastics/Polymers originate from crude oil. Oil is a finite resource and so we will eventually run out of it. Crude oil is an energy intensive material to extract and can also cause many environmental issues like oil spills therefore it must be used sparingly

Manufacturing

During manufacture, I limited my use of electronic machinery where I could. The use of pop riveting and using nuts and bolts would have reduced my energy usage dramatically. However, I obviously did use some machines, such as the pillar drill and metal band saw. When I did use machines, I made sure it was absolutely necessary to use them. This way my energy consumption during the manufacture period should be relatively low.

Transport

If my product where to be batch produced I would have to consider how I would distribute my product to the wider community. Firstly, I would use bulk transport to reduce the number of journeys needed to distribute my product. I would also, where possible use "greener" transport methods. This could include the use of electric vehicles or bio-diesel vehicles. If I were to distribute international I would use the UK's freight train infrastructure to reach Europe and Asia, whereas I would use cargo ships to reach the Americas.

Use

The use of my final product has very little if no impact on the environment. It has no parts that require a fuel source. The only area I can think where my product may contribute to emissions is if a part needs to be replaced such as the wheels.

After life

Most of my product is joined using temporary methods. Therefore, it can be disassembled easily making recycling easier and less energy intensive. This way the emissions from end of life are low. All the materials I used can be recycled at the end of life, therefore this aspect of the product has low carbon emissions.

Social, moral and ethical

Social, moral and ethical impacts

Social- The social impacts of this product are minimal, but there are a few. By designing my product for the elderly and a wide range of ages the design has become more inclusive. Whilst designing and manufacturing I always looked at how I could include as many people as possible. Whether this was through the range of adjustable heights or by making the product easier to use for people who struggle.

Moral- Throughout the design and manufacturing process I always tried to do the morally right thing. This was mainly done by using sustainable methods and reputable suppliers for materials. By doing this you can be assured the employees have been paid a fair wage and have been treated fairly. I also attempted to produce a project that was as inclusive as possible to all kinds of people. One slight moral issue with my product would be the use of my paint finish which contains VOCs. These can affect the environment in a negative way. In the future, I should use a paint that does not have VOC as they are now readily available. Another positive of my product is that it can easily be recycled, that way the user can feel better about themselves and that they are doing their bit for the environment. Another moral issue with my product is whether it is safe to use. Due to its stability and safe carrying of logs I would say it is. However, it is not suitable for ages under 18 due to the possibility of catching your finger in the mechanism.

Ethical- Throughout manufacturing and designing I always considered how the product might be interpreted by different ethnicities. I tried to use neutral materials and colours in the hopes to not offend anyone. By doing this I believe I have achieved a neutral product. I was careful to avoid bright colours such as red which can represent both luck and death depending on what country you are in. I would say my product is culturally neutral meaning it shouldn't offend any cultures or people in different countries.