T Level Technical Qualification in Engineering and Manufacturing - Design and Development

8714-321 Mechanical

Grade Standard Exemplification Material

Distinction - summer 2024

Version 1-0

Version and date	Change detail	Section	Question
v1-0 Oct 2024			

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Introduction

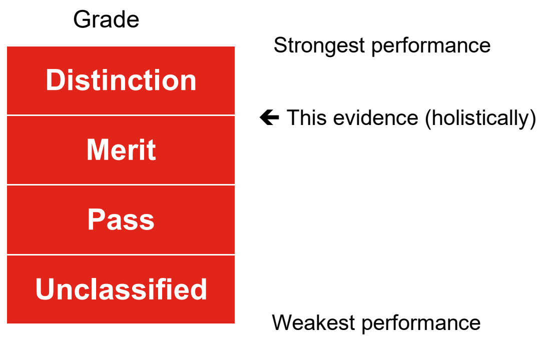
Summer 2024 Results

This document is aimed at providers and learners to help understand the standard that was required in the summer 2024 assessment series to achieve a distinction grade for the 8714-321 Design and Development in Mechanical engineering Occupational Specialism (OS).

The grade standard exemplification evidence (Grade SEM) provided for the distinction grade displays the holistic standard required across the tasks to achieve the distinction grade boundary in the summer 2024 series.

The aim of these materials is to provide examples of knowledge, skills and understanding that attested to distinction competence in summer 2024. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and standard of performance will vary across tasks.

The Occupational Specialism is graded Distinction, Merit, Pass or Unclassified.



The distinction grade boundary is based on a synoptic mark across all tasks. The materials in this Grade SEM are separated into two sections as described below. Materials are presented against a number of tasks from the assignment.

Tasks

This section details the tasks that the candidate has been asked to carry out. What needs to be submitted for marking and any additional evidence required including any photograph/video evidence. Also referenced in this section are the assessment themes the candidates were marked against when completing the tasks within it. In addition, candidate evidence that has been included or not been included in this Grade SEM has been identified within this section.

In this Grade SEM there is candidate evidence from:

Task 1 Design
Task 2 Manufacture and Test
Task 3 Peer Review
Task 4 Evaluation and implementation

Candidate evidence

This section includes exemplars of candidate work, photographs of the work in production (or completed) and practical observation records of the assessment completed by centre assessors. This was evidence that was captured as part of the assessment and then internally marked by the centre assessor.

The Occupational Specialism brief and tasks can be downloaded from here .

Important things to note:

- We discussed the approach to standard setting/maintaining with Ofqual and the other awarding organisations before awarding this year. We have agreed to take account of the newness of qualifications in how we award this year to recognise that students and teachers are less familiar with the assessments (grading-arrangements-for-vtqsand-technical-qualifications-within-t-levels-in-the-academic-year-2023-to-2024), whilst also recognising the standards required for these qualifications.

- The evidence presented, as a whole, was sufficient to achieve the distinction grade. However, performance across the tasks may vary (i.e. some tasks completed to a higher/lower standard than distinction grade).

Grade descriptors

To achieve a distinction, a candidate will be able to:

A. Demonstrate a comprehensive use of software/technologies to model, evaluate and produce mechanical engineering diagrams and simulations that meets the requirements of the brief.

B. Demonstrate excellent technical skills when developing models and prototypes, resulting in a prototype that is fully functional.

C. Apply comprehensive knowledge and understanding of testing processes, resulting in a prototype that has been tested against all of the design criteria.

D. Critically interpret information to plan, assess risk, follow safe working practices and apply the technical skills to practical tasks and procedures to an exemplary standard in response to the requirements of the brief, producing an excellent quality of work.

E. Apply comprehensive knowledge and understanding of the design principles required for mechanical engineering resulting in proposals and solutions that meet all requirements of the brief.

F. Work safely and make well founded and informed decisions on the selection and appropriate use of tools, materials and equipment within the environments that they are working in, resulting in tasks that are carried out to a high degree of accuracy.

G. Use accurate industry and technical terminology consistently in both written and verbal contexts.

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Task 1 - Design

Assessment number (eg 1234-033)	8714-321
Assessment title	Mechanical Engineering Occupational Specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	1
Evidence title / description	Design specification Annotated sketches Justification of the choice of one design for further development Justification of selection of the materials and components Design calculations, including all workings Engineering drawings of the proposed design Outcomes of virtual modelling of the proposed design, either as screen captures or printouts Bill of materials Any notes produced of research undertaken including citation of sources and internet search history
Date submitted by candidate	DD/MM/YY

Task 1

Assessment themes:

- Health and Safety
- Design and Planning
    - Documents
    - Drawings and diagrams
    - Virtual modelling

You must:

a. produce a detailed design specification that builds on the design criteria given in the assignment brief, including references to any research used
b. sketch and annotate three potential designs for the lifting device
c. select one appropriate design for development with justifications
d. select and justify the use of the materials and components needed for the proposed design
e. carry out the following calculations to support the proposed design:
    - the loading applied to any components of the design that are subject to stress.
    - the mechanical advantage afforded by the design
f. create engineering drawings of the proposed design using CAD software
g. produce a virtual model of the proposed design using CAD software
h. create a bill of materials (BoM) listing all of the parts required in your final design proposal.

You must complete the design activity prior to carrying out Tasks 2, 3 and 4

If you provide a design plan that is not fit for purpose it is expected that your tutor/assessor will intervene and provide necessary feedback that will be commented on in the marking documentation and reflected in marks awarded.

Additional evidence of your performance that must be captured for marking:
none

Candidate evidence

Task 1

PDS

Aesthetics

The customer is a hazardous materials lab so the design will be coated in white protective paint to match the aesthetic already in the lab and also protect the piece in case of accidental chemical spillage

Cost

There is no set cost limit in the brief so to make it as economical as possible for the laboratory I have used hollow steel pipes as high strength is not required and where possible used faster processes like 3d printing and laser cutting

Customer

This product is being designed for use in a chemical experimentation laboratory so should be designed to be operated by their employees

Ergonomics

The handles on the device should be fitted for average human hand size so that they are useable by all of the employees.
The device should also be lightweight to be easily lifted with little effort to reduce possible strain in the wrist or a possibility of an employee dropping the sample and causing a spill

Safety

The device should be easily operated from the side of the glass that the laboratory assistant is on an they should not have to reach around the glass to manually correct something on the design when moving the beaker.
The design should also be very stable to reduce risk of it falling over and spilling hazardous materials

Sustainability

Where possible in the design I will use recycled materials for the structure such as recycled stainless steel for the arm or recycled abs for any 3d printed parts. Since the design is manually powered there will be no carbon output during use after manufacture

Function

- Must be able to lift a beaker with liquid totalling 200g
- Must be able to move the beaker 100mm twice
- Must be able to pick up and put down beaker twice
- Must be manually powered
- Must be operated from behind a glass barrier
- Must not spill beakers contents
- Must not damage the beaker

Material

The portion of the device behind the glass must be able to resist any possible chemical spills so a non reactive metal or painted in specialized coating such as an epoxy resin (see source list(11)).
The material used for the load bearing portions of the structure must also be able to hold up the weight of itself and the beaker during operation

PDS-

Aesthetics-

the exterior of the arm will be coated in a corrosion resistant and chemical resistant paint to prevent any spill from damaging the equipment, The arm is designed to reach over the glass barrier to keep the operator's hand as far away from the chemicals as possible

Cost-

there is no specified budget for this project, but the design is made to use as little material as possible with small limbs and a hollow frame

Customer-

mechanical design company designing lifting device for hazardous material laboratory

Ergonomics-

the design I have chosen uses two handles on the other side of the barrier to keep hands faraway from the hazardous material. These handles each have a lever that when pulled will operate the beaker grips or the wheel leg mechanisms

Safety-

the glass barrier is placed between the lab worker and the hazardous materials so they cannot be harmed by spills, the product will either go over the top of the screen or around it so that the worker does not need to place their arms in the vicinity of the chemicals

sustainability-

where possible, materials will be sourced from renewable sources or recycling facilities. The lift is manually powered so emissions are not produced at all after production

Function-

must be manually powered, must lift a beaker off the counter twice, must be able to move the beaker a total of 200mm. must eb able to slowly lower the beaker twice, must be operated from behind a protective screen.

Material-

the arm of the grabber will be made with stainless steel tube due to its high corrosion resistance, high tensile strength and its relatively cheap price compared to other similarly performing materials

Initial design one

Pros

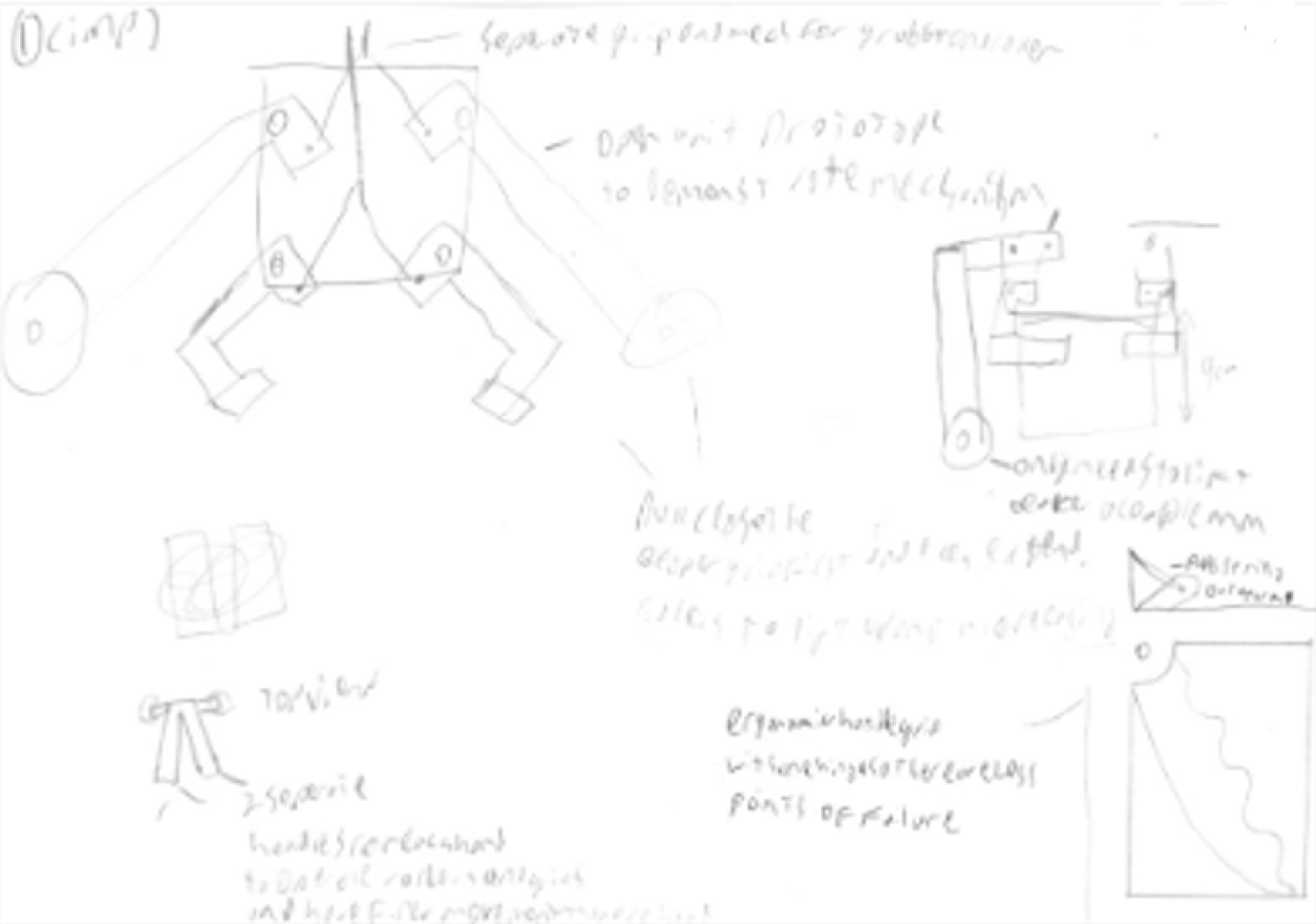
- Uses less material (cheaper)
- User has precise movements with hands
- Can move forwards and backwards not just left and right
- Little effort to lift with the handles
- Smaller form factor
- Easier to store
- Simple operation procedure
- Easier to manufacture

Cons

- User has to line up beaker instead of it being on rails
- I user slips sample may fall
- User has to hold the lifting device the fullt ime its moving
- Wheels cannot deploy seperately to the grips
- This initial design features a mechanism that reaches over the glass and grasps around the beaker, the arms to grasp the beaker also feature a set of wheels so that when the beaker is grabbed at the same time wheel swill deploy, raising the beaker of the ground ald allowing it to move without putting any strain on the wrists and arms of the operator in the lab

Initial design 1 - improvements

- This design has most of the same pros and cons of design one but instead of the whelles being attached to the beaker gripping arm, they are on an entirely separate mechanism making operation smoother as the second handle allows the user to extend and retract both of the mechanisms at the same time or separately depending on what is needed



Initial design 2

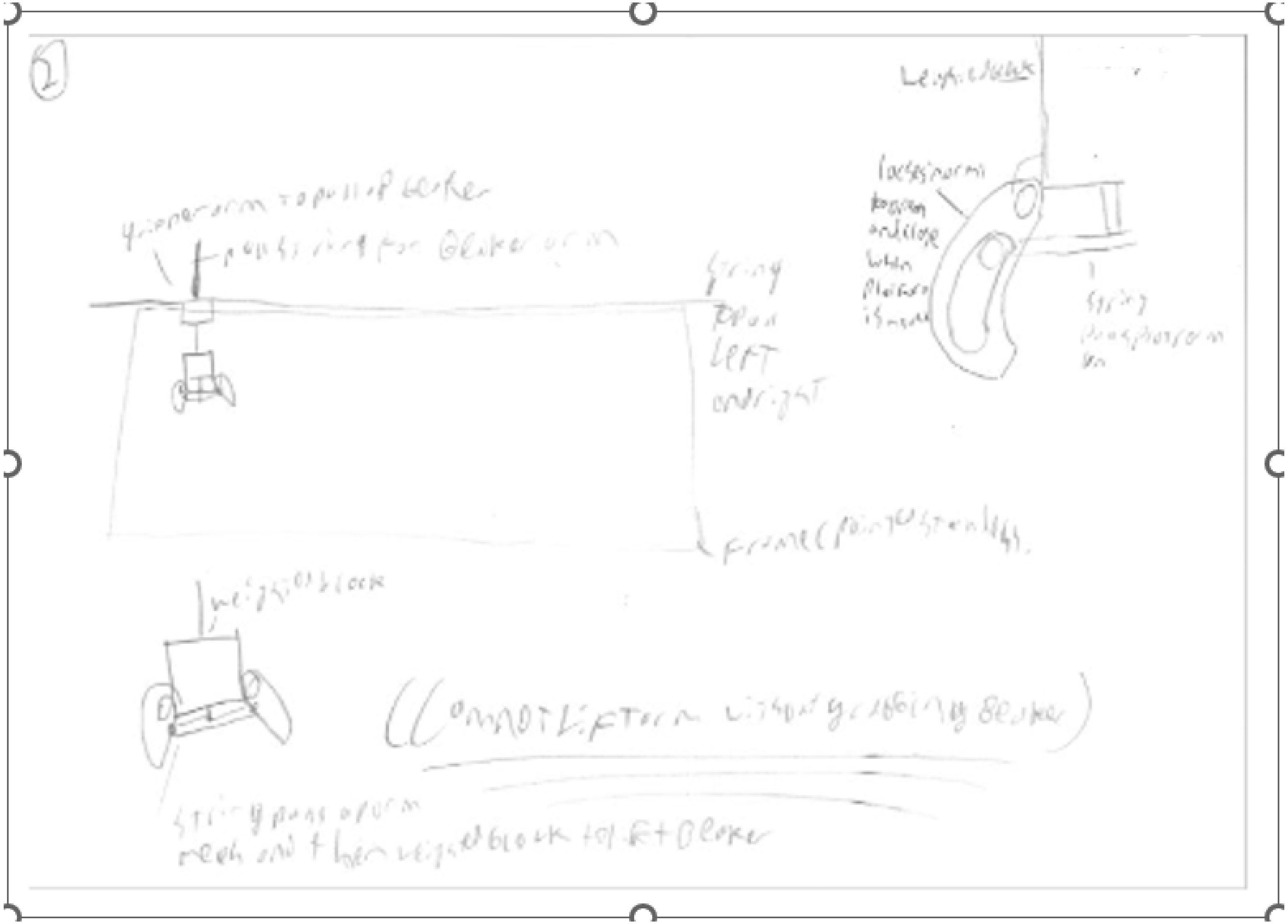
Pros

- Use just uses turns pulleys to operate
- Rails make positioning more accurate
- Beaker will not drop if operator makes mistake

Cons

- Lots of materials used (more expensive)
- Harder to store and move because of size
- Needs much finer tolerances than other design
- Harder to operate than other design (3 knobs vs 2 handles)
- Cannot move backwards and forwards, only left to right
- Cannot move crane head without grabbing beaker (in the way)
- Many more parts (longer manufacture)
- Not as good a grip with no cupped arms

This design features a full stand setup that will be placed behind the glass screen and operated from the front side. The design uses rails to move a head that would pick up the beaker an then move it to the next point. The design would be operated by 3 crank handles on the operators side of the glass that pull stell cables that operate the claw, the height of the claw and the movement left or right on the rail system. This design would be much more complicated to make and operate than the first design and also cost more due to the increased amount of material for the stand and rail system.


(Cannot Lift arm without grabbing Beaker)

Legislation(COSHH, Ioler)

- According to coshh: two or more people must be present to move hazardous chemicals due to the risk of injury so 2 operators need t be present during use.
- For chemicals that need to be moved in a fumination cupboard this design could also be used at the top of the glass section without putting limbs in the cupboard because of its small size
- This also reduces risk assessment size for coshh reports as it does not feature any electrical components that may cause a reaction In certain vapours or in liquids
- Due to its exposed mechanism the device is easily cleaned in case of a spillage with coshh standard cleaning equipment.
- The device follows Ioler regulation on lifting devices as it is more than strong enough to lift itself and the full beaker it is designed for

Mechanism

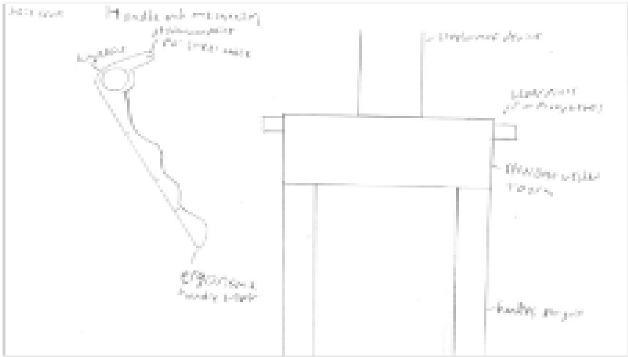
- There will be an arm that reaches own over the sheet to the beaker and on the end of the arm there wil be two mechanisms. One will grip the glass and one will fold down the wheels to raise the glass beaker and make it easier to roll across the desk and lower it by lifting the wheels and letting go of the beaker
- These mechanisms will be operated by handles that pull stainless steel cables through the arm to pull these mechanisms open and elastics that pull them shut to lower the beakers.

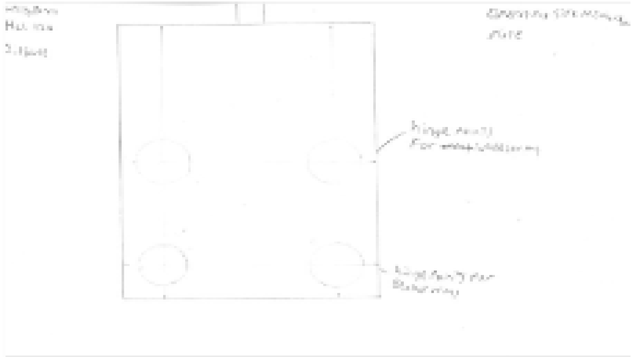
Final design

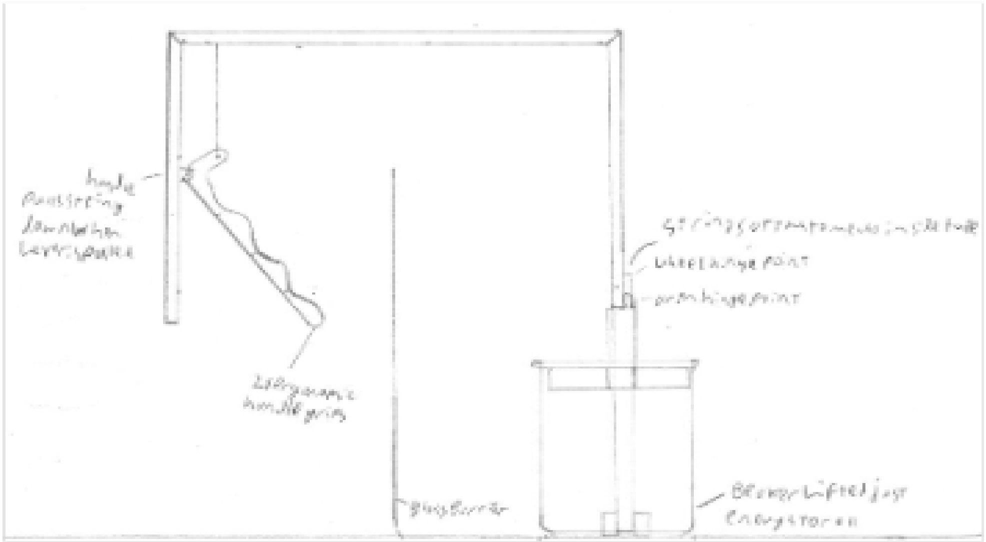
- I have chosen design one for my final design due to its robustness and small size as it features many less points of failure than the design 2 and it is a fraction of the size reducing cost of the manufacture and making it easier to operate for the laboratory employees.
- I chose not to use the second design due to its large size, it’s restricted movement compared to design one, its inability to move the claw without picking up the beaker and its large rails as they would be much more expensive to buy or produce than anything in the first design

Final design

- This design is based on the improved design one and features mostly the same design points.
- The operators end of the device will feature a plate laser cut from 5mm stainless stell with 100mm handles below it. On both sides it will have a hinge points for the levers to attach as the control point of the mechanism.
- The end near the chemicals will also feature a plate for attaching the arms with four prongs friction welded onto the steel plate to act as hinge points for the beaker arm and wheel arm.
- There will be 2 steel cables that run through the tube to attach the mechanisms to the levers, one will attach to the left lever and the beaker arms on the other end an the other wire will attach to the right handle lever and the wheel arms at the other end to actuate them
- The arms will have hooks that will attach to springs on the body of the arm to act as a return mechanism so the arms will open again.







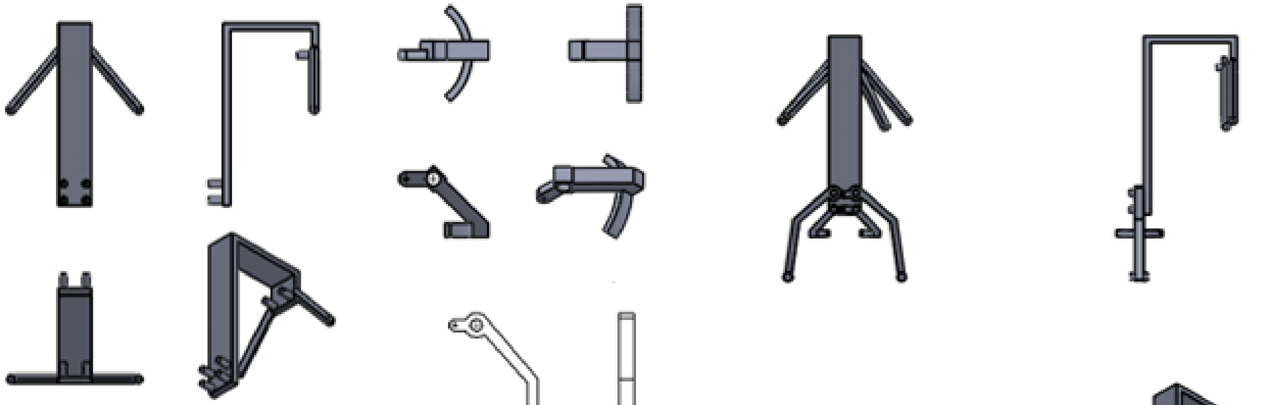
Manufacture

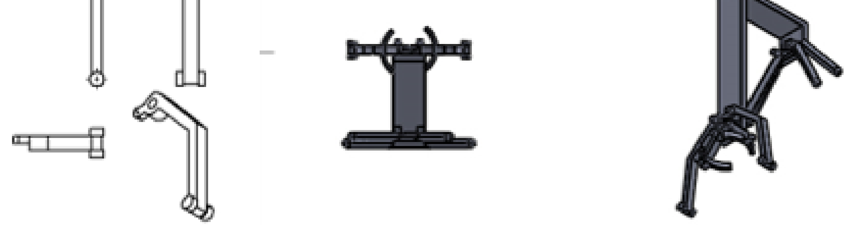
- First the main arm will be constructed by cutting 3 150 mm pieces out of the 6 mm tube, these will be cut to 45 degrese at each end to improve srtrength.
- These pieces will then be welded together via TIG welding as it is easier to attain detail on smaller scale with it vs MIG.
- A 60*80 mm plate will be laser cut and 4 prongs friction welded on as attachment points for the arms
- The 60*80 mm plate that holds the mechanism will then be welded to the bottom of one of the tubes
- Another plate will be cut with 2 handles and hinge points for the 2 levers
- The levers to activate the mechanism will be 3d printed and attached to the hinge points with hinge pins
- Arms for the operating end of the device will be laser cut by an external company due to the cost of the machinery
- The laser cut arms for the beaker grips and the wheel mechanisms will be put onto the prongs and fastened by an end cap to prevent them from sliding off
- The 2 steel wires will then be run through the tube and attached to the pulleys on their respective handles and the mechanisms on the other end(beaker arm on th eleft handle and wheel mechanism on the right)

Cad model

The cad model I have designed is the correct size and shape for the prototype in the workshop being one to one of the final design, and the beaker grips are sized correctly for a standard 70 mm diameter 250ml beaker but can be scaled up or down for the prototype if needed

The cad model also uses off centre parts so two identical parts can be made and fit instead of two different ones simplifying the production process





The real design will use string and elastics to pull the arms but this would take too much time to accurately represent in solidworks

Calculations

((pi*6^2)-(pi*5^2))*200=

6911mm^3 of steel above wheels

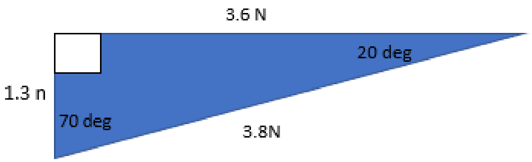
Steel dense =0.01g/mm^3

Weight of steel above wheels =69 g

Weight of beaker + weight of arm =269g

269 g =~2.6 g

half on each wheel = 1.3N each



Arm does not push straight down so the force required to push the full device up is actually 3.8 n

Mechanical advantage of arm is 17/130

3.8/(17/130)= 29 N of force is on the wire operating the wheels.

Steel cable is 0.9 mm in diameter so an area of ~0.64 mm^2

Stainless steel UTS is 520n/mm^2 so rope can handle 520*0.64 = 333 N before breaking

This means the rope has a safety factor of around 11 making it more than strong enough to lift the full device and beaker

0.9 mm stainless steel rope was chosen as even though smaller rope would have held, it becomes increasingly more expensive and hard to work with and produce the smaller it gets

materials

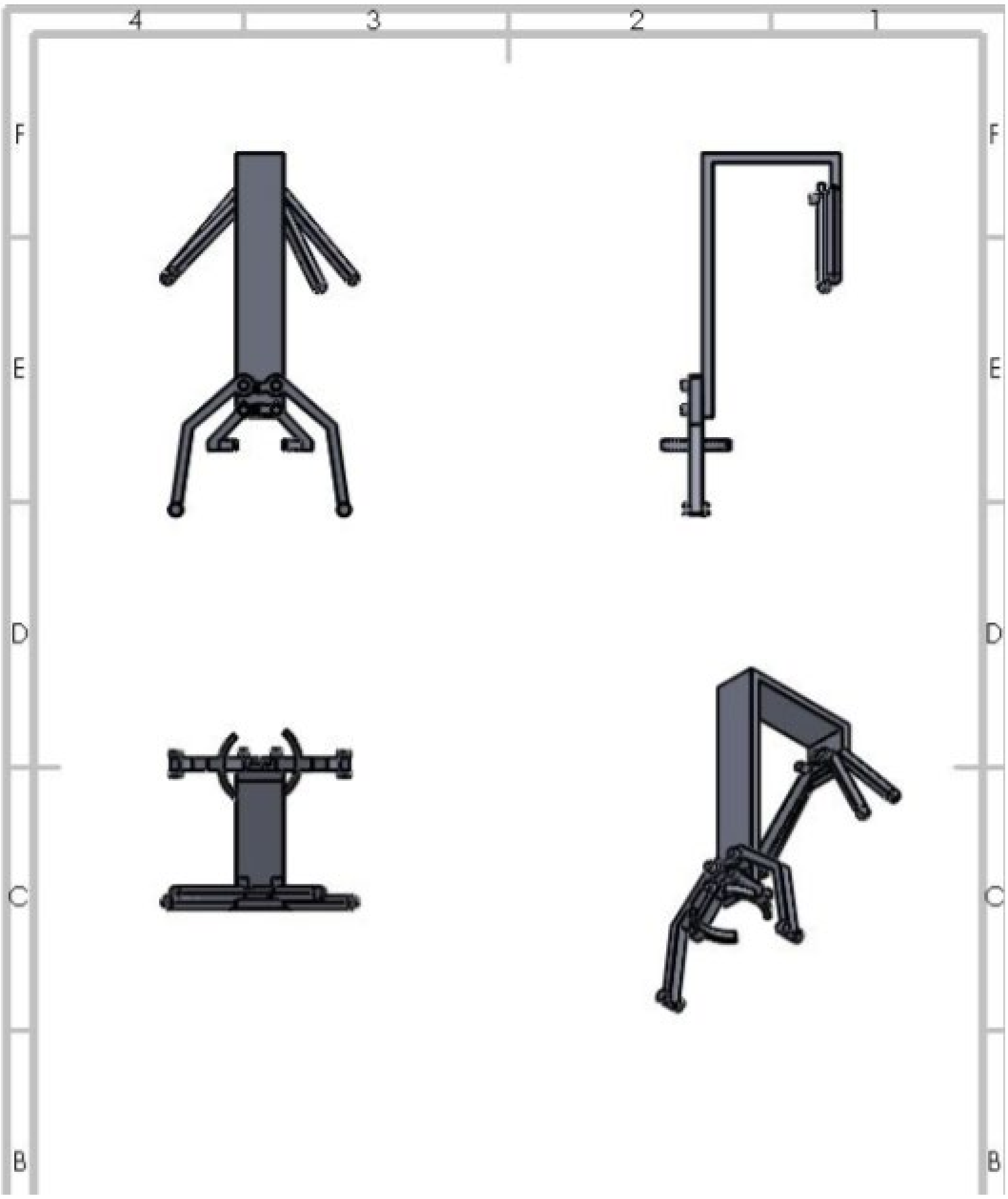
	properties	Machineability	weldability	Malleability / ductility	Strength to weight ratio	Price (1kg) (source list (11))	sources
Stainless steel	• 205 HB hardness • 500 MPa UTS • 7980kg/m^3	Can be cut by most standard power tools with little to no warping or changes in properties	Prone to cracking at high temperatures but is strong with right equipment	Very high ductility and malleability	Very high	£0.80	Number 4
Aluminium	• 75 HB • 310 MPa UTS • 2710 Kg/m^3	Is easily cut by most standard power tools but is prone to grabbing the edge on lower rpm tools	Much harder than alloys of other metals but certain alloys such as: 5083, 5454 and 6061 have a high weldability	Second most malleable and sixth most ductile metal	Extremely high	£0.95	Number 5
Mild steel	• 120HB • 400MPa UTS • 8000kg/m^3	Easily cut by most standard bits, but due to the softness of the metal, long problematic chips form in the machine more often than other metals	Great weldability but can warp easier than other alloys under the intense heat	Very high ductility and malleability due to the low carbon content	good	£1.40	Number 6
Titanium alloys	• 70HB • ~800MPa UTS • 4420KG/M^3	Can be cut by most diamond bit tools but has a tendency to friction weld onto the bit and cause tool failure	Requires high temp welding gear due to its high melting point and releases dangerous gasses when welded	Excellent malleability and ductility but requires much more force than steels or aluminium	Much lower than steels	£66.38	Number 7

Bill of material

Key
Black- material choice
Red- reason
Green-cost

- My final design will use around 0.8 m of 6 mm (1mm wall) chemical grade stainless steel due to its high corrosion resistance and very low price of around £10 per meter (see source list (2))
- The design will also use laser cut components for the arms as they are precision cut to specification and have high tolerances. they will be ordered from an external company due to the cost of machinery and will be around £130 for all laser cut components (see source list(8))
- The design will also use around 2.5 metres of 0.9 mm steel cable due to it's high tensile strength and low price at around 50 pence per metre (see source list(3))
- The handles will be made of 3d printed abs due to its high strength to weight ratio, cheap price and ease of manufacture. 3D printing Is the cheapest production method for abs for this scale as injection moulding has an extremely high upfront cost £1000 and upwards for the mould whereas a 3d printer only costs around £300-700 (see source list(9,10))

Full CAD Assembly



Task 2 - Manufacture and Test

Assessment number (eg 1234-033)	8714-321
Assessment title	Occupational Specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	2
Evidence title / description	Risk assessment Test records for the results of testing the prototype Prototype
Date submitted by candidate	DD/MM/YY

Task 2

Assessment themes:

- Health and Safety
- Manufacturing
  - Prototype/model
  - Developing
  - Testing
- Reports
  - Implementation
  - Record/reports

You must:

a. produce and complete a risk assessment for the manufacture of the prototype
b. manufacture the prototype
c. test the operation of the completed prototype.

Note: The physical prototype can be full size or a scaled prototype (the minimum acceptable size is 1:5 scale).

Additional evidence of your performance that must be captured for marking:

- assessor observations:
  - manufacture of the prototype
  - testing of the prototype.

To support the comments made within the Practical Observation the assessor must capture the following photographs and videos that must be submitted as supporting evidence for each candidate.

Photographic evidence which shows:

- sequence of photos during the construction of the prototype, to include:
  - results of tool selection and usage
  - the fit and relative orientation of the mechanical parts
  - final prototype.

Video evidence which shows:

- functionality of the prototype.

Candidate evidence

risk assesment								
hazard	who is at risk	severity	risk	controlls in place	controls needed	do by	completed by	finished (Y/N)
band saw	operator		cut hands or arms while in operation, throw the workpiece off the table at the user, sawdust flung into eyes of user	guard on the saw to keep hands as far away as possible when in use, pushrod to keep hands further away	floor markings around saw to prevent other students bumping operator or becoming a distraction	37/04/2024		
hand saw	operator		cut hands or arms while in operation, could rip piece out of hands of the user and cause injury	vice grips used to prevent piece from moving reducing risk of injury	vice grips horizontally on th workbenches to fasten down wood to be cut safely by the students	37/04/2024		
laser cutter	full workshop		high powered beams could harm eyes or burn skin of users, fumes from material could be inhaled and damage lungs	uv blocking plastic hood is over the cutter preventing the beams from toughing the user, fitted with ventilation fans	extra ventillation kit to pull smoke or fumes out of the room to stop inhilation	37/04/2024		
drills (pillar and hand)	operator		could fling material from the vice at the user, could slip off of piece and injure users hand	both drills can be used with a fixed position vice to reduce risk of piece moving and reducing risk of injury	cut resistant gloves to be available to studednts, guards for woodchips on the pillar drill	37/04/2024		
3d printer	full workshop		could burn hands on hot extrusion tip , could inhale harmfull chemicals from melted abs	doors on machine to prevenrt accidental contact while in use	lockable doors on machine and ventillation system added	37/04/2024		
beakers	full workshop		could smash beaker when testing and have glass shards put in hands or on workshop floor and be stepped on	using plastic beakers in prorotyping phase	use mats in final test so if bbeaker is dropped then it will land on the padded surface preventing it from shattering or cracking	37/04/2024		

Safety

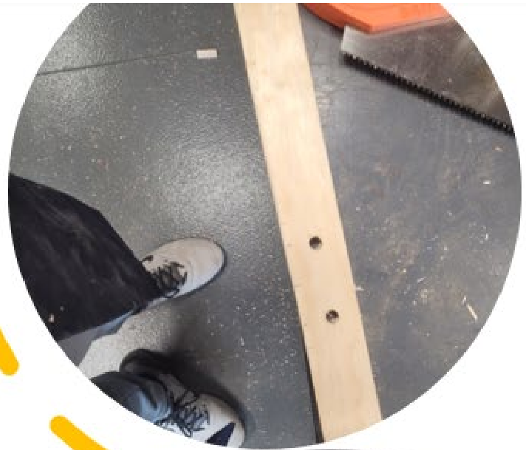
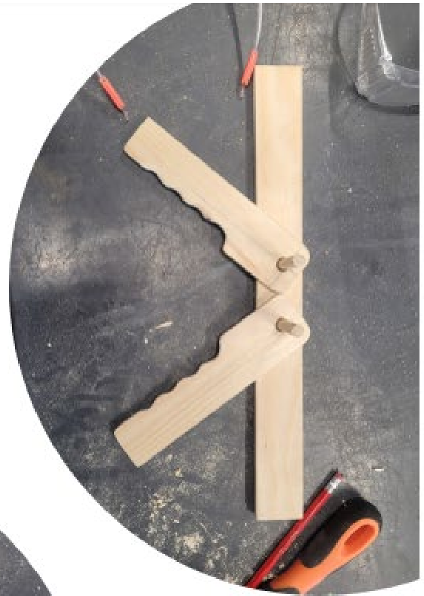
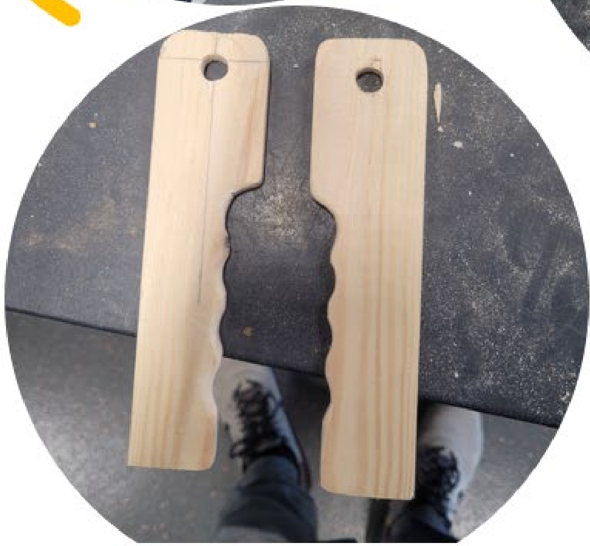
- During this practical, every time I was in the workshop a protective overcoat was worn to prevent cuts or snags on regular clothing or skin
- While using any powered tools such as the drill or band saw, eye protection was worn to prevent wood chips or metal shards chipping out and damaging eyes.

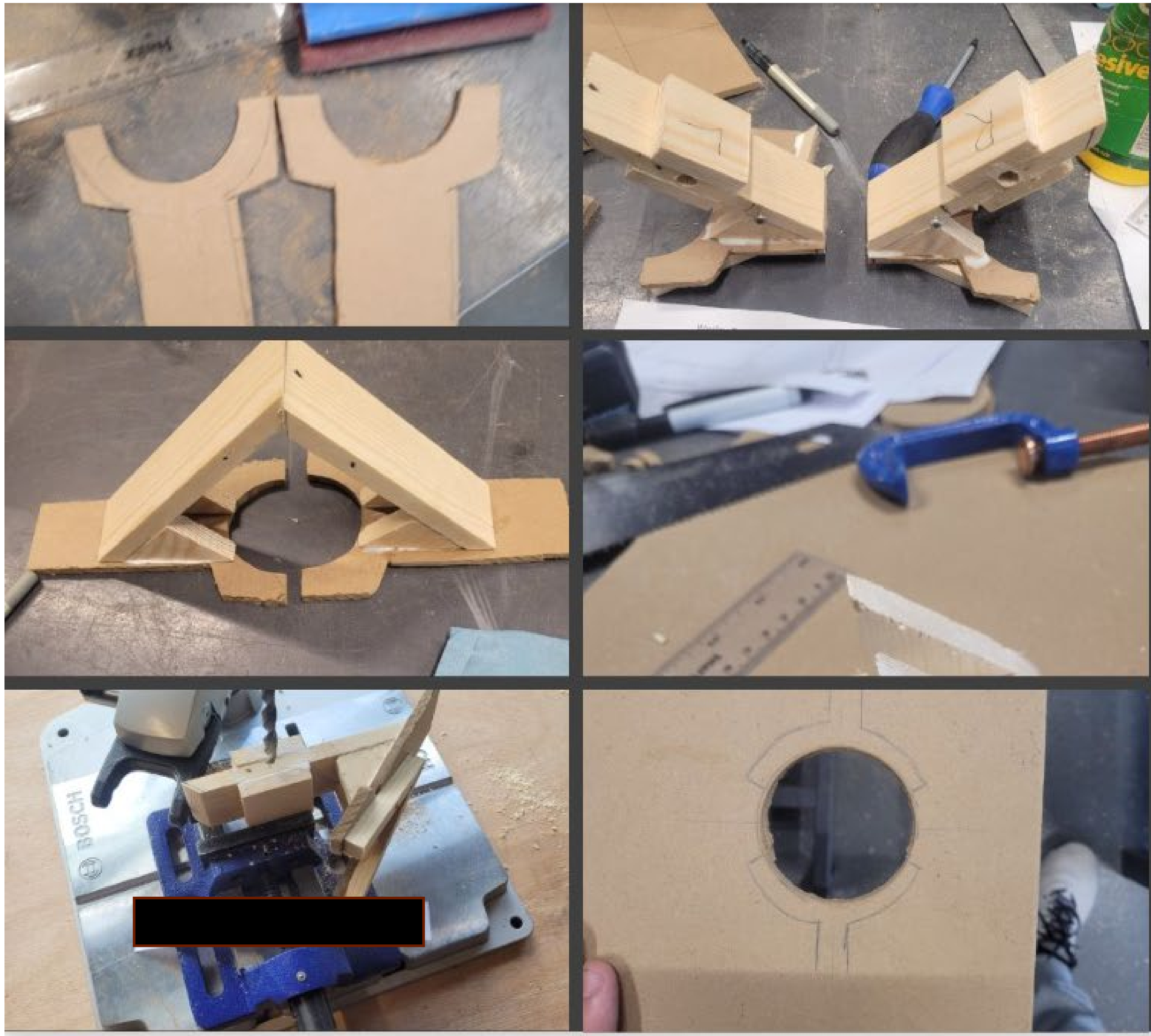
Tools

- For this design I used mostly wood due to its robustness and strength
- To cut the pieces I used mostly band saw and the hand saw after marking out the cuts
- To attach the pieces, I used mostly wood glue but I also used staple gun in parts that needed extra strength such as joints between large pieces
- To make the holes in the pieces I used the pillar drill and if there was not an exact diameter drillbit a circular file was used to bore them out

handle

- The handle on this piece is made of three main parts, the base and the left and right handle
- A piece of 36 cm long 12 mm thick wood was used for the handles
- To make the base more ergonomical the piece was thinned by cutting a sliver off with the band saw
- Holes were drilled in the base 2.5 cm away either side of the centre of the piece to allow for room when the handles are moving
- 9 mm wooden dowels were then fitted in these holes to act as hinge points for the handles
- The handles basic shape was cut from 9 mm wood and 10 mm holes were drilled as the hinge point of the handle and a 4 mm hole was cut closer to the user's hand to pull the cable.
- The base and the two levers were the sanded down with sanding sheets to increase ergonomics

Beaker arms

- To make the beaker arms , I used 6 mm mdf as the grabbers, I used a hole cutter so drill a hole the exact size of the beaker to get a better grip with more surface area and cut the shape out of the mdf
- I used 12 mm wood as a frame for the grabber arms and cut the bottom to 45 degrees to attach to the grabbers, I then cut reinforcements to increase stability of the arms.
- This was all fastened together with wood glue to make the final shape of the arm.
- To make the hinge point of the arm, the wood was too thin, so extra 12 mm wood was cut to use as reinforcement around this area and a 10 mm hole was drilled through the wood
- To make an attachment point for the sting to pull the arms shut, a 4 mm hole was drilled 10 mm form the end of the wood to allow it to be attached
- A screw was put in the side of the arm to allow for a spring to be attached to make the arms automatically return to the open position

Wheel legs

- To manud=facture the wheel legs a 350 mm piece of 9 mm wood was cut at a 20 degrees angle 15 cm from the top and the one side was flipped and glued together again wo make a 40 degrees angle.
- These pieces were then reinforced with 3 mm hardboard over the joining point to reduce risk of breaking when in use.
- The wheels of the legs were cut form 6 mm mdf with a 45 mm hole saw on a drill, the holes were then bored out to 9 mm and attached to a piece of wooden dowel.
- 2 10 mm holes were drilled both 15 mm from the bottom and 40 mm from the top of the piece and a 4 mm hole was drilled 10 mm from the top of the piece to attach the string to
- The wheels there then put into the arm and then had the other side attached to prevent them coming off the arm

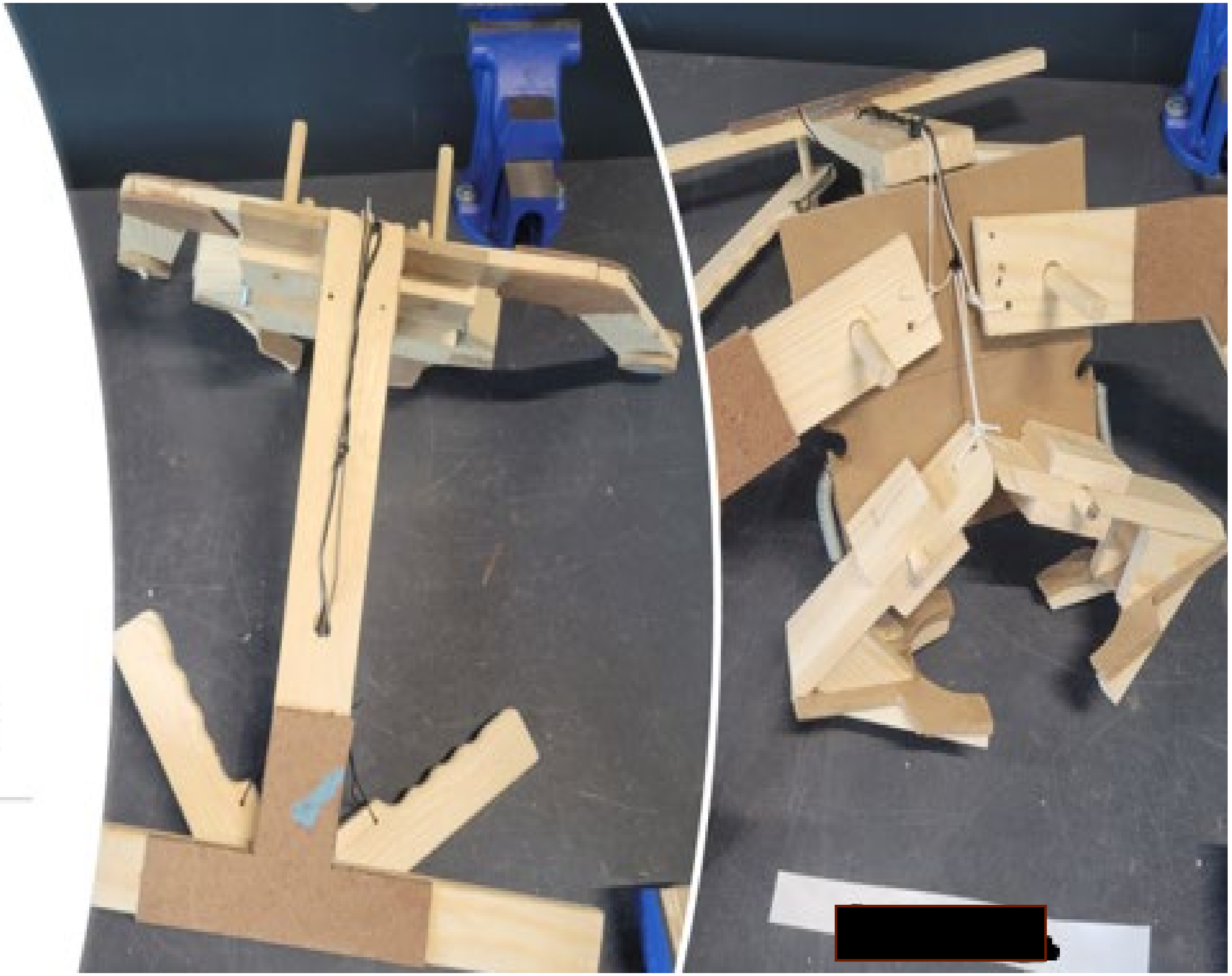
faceplate

- To make this faceplate, I used 6 mm mdf as a base, cut to a 150 mm square.
- For reinforcement on the face pins, I used a 12 mm wood backing for the places where the pins would be attached to the board
- to make the pins for the grabber arms I drilled 9 mm holes , 2.5 mm from the bottom and sides of the faceplate and then glued the wooden dowel into them.
- To make the pins for the wheel legs I drilled 9 mm holes 2.5 mm fom the sides of the plate and the horizontal middle of the plate
- I then used a saw and circular file to cut out attachment points for the beaker arm springs

assembly

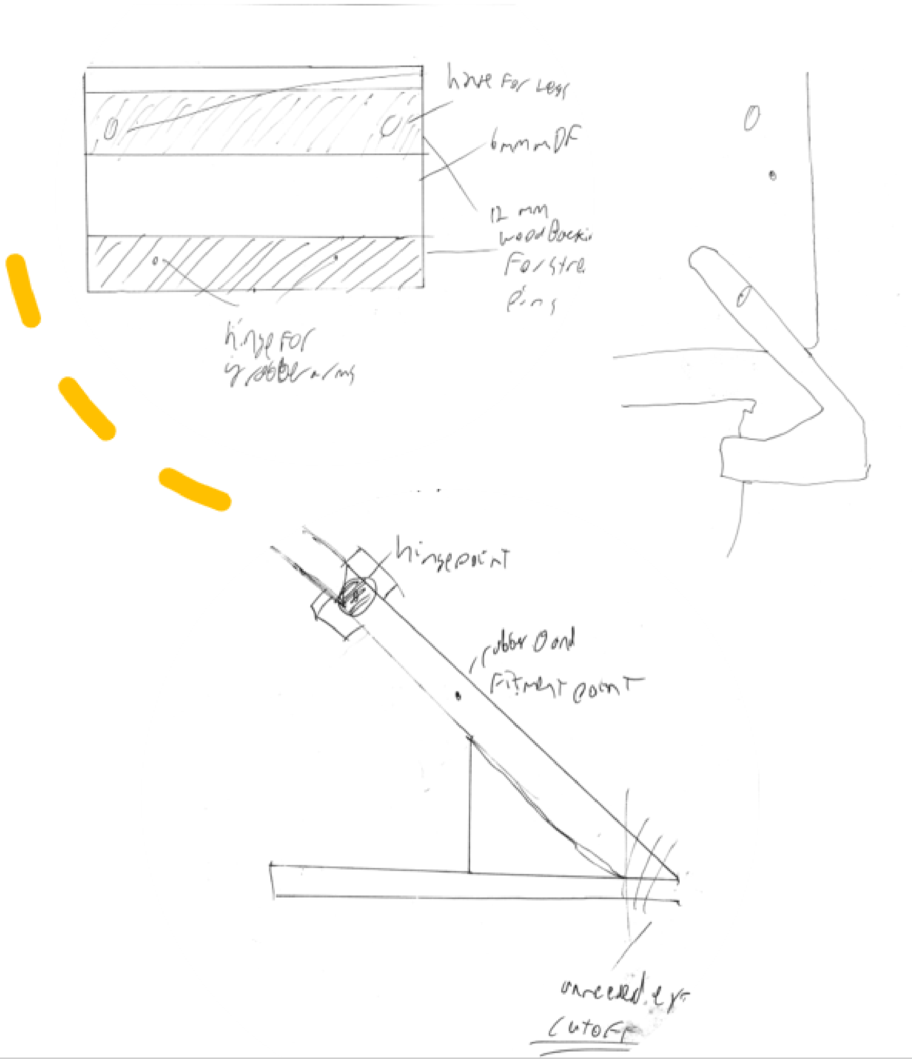
- First, I attached the main beam to the handle base with 3 mm hardboard backing on either side to increase strength
- Because the faceplate has limited surface area to attach to the main beam of the final design , brackets were cut from 12 mm wood, these brackets are 150 mm long to cover the whole back of the piece and have cutouts for the wood on the backing to make the fitment better
- I then attached the main beam to the faceplate brackets with wood glue and staples to increase the strength of these pieces,
- All of the legs, arms and handles were then attached to their relative pins and the arms were attached with cable to the right handle and the legs attached to the left handle

Final prototype



stencils

- In the workshop I used tracings of the pieces I had made as a stencil to check all of the pieces are in tolerance



Testing grid

criteria	Test method	Outcome
Must pick up and drop 200g beaker	Recorded process	Pass
Must move 200 mm left and right	Recorded process	Move freely any distance
Must reach over a 200 mm tall guard sheet	ruler	Can reach over up to 250 mm
Beaker must remain undamaged	Visual inspection	No visible damage to the beaker
Free standing	Visual inspection	No parts are nailed or screwed to the testing table

Ergnomics and ease of use

- The handle bars of the design all have chamfered edges to reduce scatching on the hand of the user
- The handles on the design are cut around my hands personally so have personal fit for me as a user but will be useable by most lab techs
- The design uses simple two lever design so that the user only has to pull the handles in the right order and pull the arm left or right

Task 2 Practical observation form

8714-321 Design and Development: Mechanical - summer 2024

Candidate name	Candidate number
<first name> <surname>	ABC1234
Provider name	**Date**
<provider name>	26th April 2024

Complete the table below referring to the relevant marking grid, found in the assessment pack.

Do not allocate marks at this stage.

This observation must cover	Assessor observation should include:	Assessment Themes
Construction of the prototype	• The construction of the prototype.	• Health and Safety • Manufacturing
Testing and verification of the prototype	• The testing and verification of the prototype.	• Health and Safety • Manufacturing

Notes – *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*

Construction of the prototype:

Appropriate assembly and fixing devices have been used to join/assemble all of the individual components ensuring the overall quality of finish and accuracy reflect an appropriate understanding of the requirements of the design brief.

Overall the prototype model is excellent and meets the requirements of the design brief in its ability to grasp the beaker.

The manufacturing tasks where machinery was used were conducted safely at all times with the appropriate PPE worn.

All hand tools were used in a safe and appropriate manor from initial inspection to safe storage and good housekeeping.

In respect to manufacturing of the model I could clearly observe that strong industry standard practise had taken place in the cutting and forming of the individual components for the prototype as it was mainly appropriate requiring little to no modification to meet the requirements of the brief.

The level of quality produced in the manufacturing of the prototype do consistently align to that expected in industry for example:

[redacted] confidently constructed his model and is at home within the workshop. [redacted] quickly manufactured a successful grabbing device.

Where there are material cuts applied to create the product these have been suitably planned for, marked out and cut out by hand or by laser cutting machine with an excellent level of accuracy.

The testing and verification of the prototype:

[redacted] has a strong understanding through the selection of tests. [redacted] has checked that his prototype meets the criteria. The release function was successful and the handles control the mechanism on the correct side of the screen.

In respect to testing during the manufacturing of the model I could clearly observe that [redacted] had a strong amount of understanding shown through selection of tests.

[redacted] has used the test to check the prototype/ model functionality meets the design criteria. The prototype successfully meets the criteria.

The model has been tested against all of the design criteria and meets all of the requirements. Use of testing and measurement equipment is appropriate and carried out accurately.

Within [redacted] model he moved successfully right to left on a wheel system and the mechanical grabber picked up the glass beaker to the correct weight with ease. As well as this

the prototype successfully moved up and down and side to side controlled but handles on the correct side of the screen. The overall prototype was successful and does not require further modification when testing.

Internal assessor signature	Date
X ______________________________	26/4/24

If completing electronically, double-click next to the ‘X’ to add an electronic signature once the record is **finalise**

Task 3 – Peer Review

Assessment number (eg 1234-033)	8714-321
Assessment title	Mechanical Engineering Occupational specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	3
Evidence title / description	Peer review feedback form Feedback record form
Date submitted by candidate	DD/MM/YY

Task 3

Assessment themes:

- Reports – for consideration only

As part of the development and design process it is critical that engineers can work constructively with others and consider feedback to inform designs to ensure they meet their purpose and requirements.
The assessor will set up the groups and make sure that candidates have access to copies of their design.

You are required to present your design;

a. Prepare to present your design verbally using annotated sketches and diagrams.
b. Present and explain your design.
c. Peer reviewers will now have time to reflect on your design.
d. Discuss feedback from the group on your design presented in part b.
e. Peer reviewers will now complete the peer review feedback form.

For parts a), b) and d) **you** must:

- proactively participate in the discussion
- manage your time
- seek any clarity in the feedback given and be prepared to ask questions
- record any feedback notes on the feedback record form provided.

For parts c), d) and e) **peer reviewers** must:

- proactively engage in the discussion
- respond constructively and fairly
- ensure the peer review feedback form is completed fully and handed to the assessor.

Additional evidence of your performance that must be captured for marking:
none

Candidate evidence

Peer review form - reviewer 1

Feedback Record Form

Assessment ID	Qualification number
	8714-31
Candidate name	**Candidate number**
[redacted]	
Provider name	**Provider number**
[redacted]	[redacted]
Date	**Series**
08/05/2024	Summer

Candidate's notes
The design is well brought out accounting for how much load ~~to~~ it is supposed to carry with all structural parts having reinforcements. ~~Having~~ The model has 2 different components ~~which~~ where one is ~~f~~ responsible for lifting the entire mechanism and the other to grab the beaker. The design also has an easy to use interface that ~~it~~ has ergonomic handels. For improvements, have the same lifting structure mechanism on the other side to aid it lifting up evenly. Make the pins smaller and have caps on the end or use nuts and bolts instead of pine dowels.

Peer Review Form – Reviewer 2

Feedback Record Form

Assessment ID	Qualification number
8714	8714-31
Candidate name	**Candidate number**
[redacted]	[redacted]
Provider name	**Provider number**
[redacted]	[redacted]
Date	**Series**
8/05/24	Summer

Candidate's notes
positives: Fix point on string – ensures jaws don't become uneven. ergonomics – hand grips on handles – more comfortable to operate. everything carefully measured and considered e.g. diametre of holes for to reduce stiffness. Can be manually powered and operated; Can lift and move beaker; Jaws open and close; Strong enough to support beaker → meet design specification and criteria leading to a successful product.
negatives: make pins smaller (length) and have caps.

Candidate feedback form

Peer Review Form

Assessment ID	Qualification number
8714-31	
Candidate name	**Candidate number**
[redacted]	[redacted]
Provider name	**Provider number**
[redacted]	[redacted]
Date	**Series**
8th May 2024	summer

Question	Feedback
Explain how well the diagrams/drawings meet the design criteria.	ergonomic, simple design (only 2 handles
Explain how well the diagrams/drawings meet the specification criteria.	
Explain how well the diagrams/drawings conform to the relevant conventions.	all cad drawings are correctly scaled and follow all standards and regulations
Explain how the system could be optimised/improved.	use same lifting mechanism on other side to keep beaker level, make pins smaller and cap off arms/use bolts/hinges. reduce size of arms

Task 4 – Evaluation and Implementation

Assessment number (eg 1234-033)	8714-321
Assessment title	Mechanical Engineering Occupational specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	4
Evidence title / description	Outcomes of virtual modelling Revision control document Evaluation and implementation report
Date submitted by candidate	DD/MM/YY

Task 4 – Evaluation and implementation

- Assessment themes
- Health and Safety
- Design and Planning

You must:

a. update the virtual model of the final design solution using appropriate software to incorporate any changes made and research completed in response to feedback or as a result of manufacturing and testing

b. produce a revision control document or report justifying why changes were made or not made as a result of the peer review feedback. This document should typically be 500 words

c. produce a report evaluating the design and development work completed. The report should typically be 800 words. This must include:

   - the information necessary for a third party to manufacture the design, including health and safety considerations
   - calculations of the operating efficiency of the device
   - an explanation of the test methods used, reasons for their use and their limitations.
   - an evaluation of the fitness for purpose of the device and its conformance to the specification
   - any further improvements or adaptions required to the design, including any reasoning and justifications if adaptions or improvements are not required.

Additional evidence of your performance that must be captured for marking:
none

Candidate evidence

Task 4 - Report evaluation

Manufacture

- To make the basic shape of the device, the user would tig weld 2*250 mm stainless steel tube sections (15 mm outer diameter and 2 mm walls) together at a 90-degree angle in a t with the weld being in the middle of one of the tubes
- The bottom of the back tube would be milled 1 mm from the bottom to give it a flat surface for the handles and a hole drilled into the bottom of the top tube to allow for the cable to move through
- the faceplate would then be laser cut by an external company from 5mm stainless steel and welded onto the end of the tube section at the top-middle of the plate.
- A pin welder would then be used to weld on 5mm diameter 15 mm pins to the handlebars for the levers and the front and back of the faceplate for the lever arms and legs
- The handle levers will be 3d printed by an external company in solid ABS plastic with holes for the hinge points and to pull the string 25mm apart
- The arm grips for the beaker will be cut from 5 mm steel to the diameter of the beaker and then the arms to attach to the hinge points will be cut from the same steel and welded together on site
- the section of the grip that touches the beaker will be coated in a rubberised coat that will increase grip and reduce the risk of the beaker falling
- the wheel legs will be cut on site from 6 mm steel at a 20-degree angle 60 mm from the top and then flipped and welded together to stop interference with the beaker arms and will be 130 mm long
- the holed will then be drilled for the wheels and pins in the beaker arms and wheel legs at 5.1 mm for the pins and 9 (threaded hole) for the wheels
- the wheels will be made of 2 parts these will be assembled by taking a 9 mm steel rod and threating either end, one of these ends will be attached to a rubber coated bearing as the wheel and the other end will be threaded into the wheel leg, one on either side to increase stability
- in final assembly all the parts will be slotted onto their pin and cable will be attached from the wheel legs to the left handle and the beaker arms to the right, the springs will then be attached, and end caps screwed onto the end of all the pins to stop parts falling off

Calculations

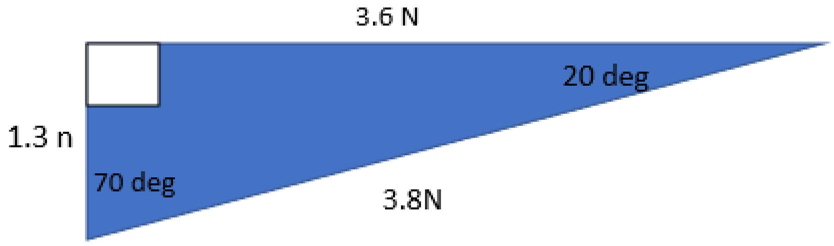
Pressure to grab beaker

The spring used in the beaker arm return mechanism requires around 30 n to pull open and is 20 mm away from the pivot, this means It is the same distance as the pull string attachment point so no lever advantage Is produced here.

The string attachment point for the handle lever is 20 mm away from the pivot and the centre of force from the user's hand is 50 so the lever advantage gained is 2.5 * force so it only requires 12 g of grip strength to grab the beaker

pressure to lift assembly with handle

the weight of the full load the wheels will bear will be estimated at around 69 g of steel (as calculated in task one PowerPoint) and 200g for the beaker so around 130 g per wheel or 1.3 N. The force will to be put straight down then pulling the legs due to the angle of the legs at 20 degrees so the legs will need to pull 3.8 N inwards



This means that the bottom of the arm needs to pull 3.8 n and the lever advantage of the arm is 20/130 so the cable needs to pull 24.7N. the lever advantage of the handle is 2.5 so the force the user needs to pull the handle with is 9.88 N which is much lower than even the average older persons grip strength being around 230N, so could comfortably be used by any lab technician with little effort

Test methods

The main test that was used in this prototyping stage was the final test for the actual final assembled product, so the device had to grip and lift a beaker, move it 100mm and put it down and repeat a second time as it is a 1:1 prototype and that is what is required from the final device

The pieces of the arms and legs were also tested during production to make sure they were fit for purpose such as controlled weight bend tests to make sure it can handle the weight of the beaker

Purpose and spec conformity

This product has passed all tests used during prototype as a 1:1 scale prototype so I believe that it would perform more than well enough as the final steel product with increased strength when compared to the wood and MDF used in prototyping.

The final prototype is more than tall enough to reach over the glass barrier and keep the hands of users away from the chemicals, the prototype can pick up a beaker weighing 200g and move it any distance left and right (due to the use of wheels instead of rails), it can place down the beaker gently and repeat the process too

Any further needed improvements

As far as I or the peer reviewers are aware, there are no large issues with this design and all changes to the final cad model are small such as changing diameter of pins used and slightly moving the location of the wheel pins to prevent interference between the wheel legs and beaker arms

Implementation

For this design as it is purely manually powered, little training is needed as it only requires two levers to use, it also requires little maintenance other than visual inspection and occasional lubrication of moving parts.

However, the legislation cited in task one must be considered as COSHH and LOLER are legal requirements in the workplace when lifting or interacting with dangerous chemicals, so protective hand and eyewear must be worn while using this design and the full faceplate assembly must be washed after each use

Task 4 - Revision control documentation

Peer review	Add or ignore	reason	reviewer
Smaller pins	added	I have reduced the diameter and length of the pins due to steels high strength	Umair Ahmed
hinges	ignored	I believe that normal pins as the pivots is a more robust and straightforward design with less points of failure	Umair Ahmed
Caps on pin ends	added	Will prevent handles or arms coming loose from the main structure during use and fall off dropping the beaker	Marcus Barnes

Revision document

As a result of peer review feedback, I have decided to keep the base design like the prototype, but I have made some minor changes to my final design, these include:

Lifting legs

I have decided to move the pins for the lifting legs onto the rear of the faceplate instead of the front as when they are in use, they can interfere with the beaker arms preventing the device from being lifted via these arms without moving the arms and knocking or picking up the beaker accidentally

I have also decided to increase the length of the wheel axel on the lifting legs as there is some interference currently with rolling over stations a, b and c and hitting equipment in the lab so these wheels being further apert means that they can roll over these parts without touching them. This will also increase stability on the design as the wider wheelbase will allow for less tilt from the user on the beaker and reduce spillages when in use

I will also add inward facing springs to pull the legs together to reduce the effort required from the user to lift the beaker as someone with under average grip strength may struggle to pull the handles and lift the assembly

Pins

I will be reducing the length of the pins on this final design as most of the length in the prototype was unused and un-needed leading to a bulkier design and catching o parts of the beaker when in use

I will change the pins currently used to a smaller 5 mm diameter as the larger pins are not needed in a metal design due to the increased strength of the material and the reduced length puts the design at less risk of breaking at these parts during routine use

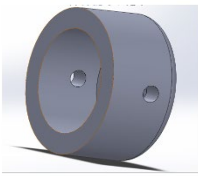
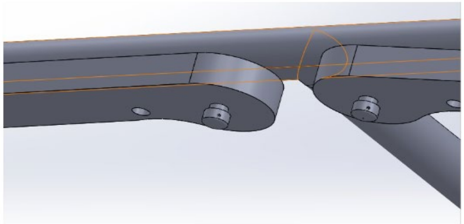
The end of the pins will also be threaded with attachable end caps as in my prototyping I found parts would come off the frame lots during manufacture without stoppers on the pins

Handles

I have chosen to rotate the handles of the cad model to match the prototype more closely and during real life manufacture it felt more natural to have the parallel handlebar style design than the angled design that was initially designed as it allows for more control over the angle of the assembly.

Most of these design changes are small tweaks to the initial design as the prototype worked with little issue and only serve to increase stability and efficiency of the final design that would be produced for the chemical laboratory

Task 4 – Revision CAD models

End caps	End caps will be pun on the end of all pins to prevent them from falling off and be attached by clips that run through the hole in the cap and the pin similar ro an rc car body retaining clip design	  
legs	The only change I have made with the wheel legs are that the length of the wheel axel has been increased so instead of the wheels touching the leg they are offset around 100 mm to make the device more stable as it reduces how easily it can rock or tilt	
Main body	Main differences in the main body of the arm is that cad model has been desifned around the stell tubing instead o wood beams, the plate on the front is much smaller than the prototype, the top beam is much longer and the pins for the wheels have been moved to the rear to lessen interference	

Get in touch

The City & Guilds Quality team are here to answer any queries you may have regarding your T Level Technical Qualification delivery.

Should you require assistance, please contact us using the details below:

Monday - Friday | 08:30 - 17:00 GMT

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