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

8714-321 Mechanical Occupational Specialism

Grade Standard Exemplification Material

Distinction - Summer 2025

Version 1.0

Version and date	Change detail	Section	Question
v1.0 31st October 2025	First published		

Contents

Introduction

Summer 2025 Results

This document is aimed at providers and learners to help understand the standard that was required in the summer 2025 assessment series to achieve a distinction grade for the 8714-321 Design and Development in Mechanical engineering Occupational Specialism (OS).

The Grade Standard Exemplification Material (Grade SEM) evidence provided for the distinction grade displays the holistic standard required across the tasks to achieve the distinction grade boundary in the summer 2025 series.

The aim of these materials is to provide examples of knowledge, skills and understanding that attested to distinction competence in summer 2025 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 (https://www.gov.uk/government/publications/ofqual-guide-for-schools-and-colleges-2025/ofqual-guide-for-schools-and-colleges-2025#grading), 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:

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

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

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

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.

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.

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.

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

Task 1 Design

Assessment number (eg 1234-033)	8714-321
Assessment title	Mechanical 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 Selected design for development with justifications Selection and use of materials and components needed for the proposed design with justifications All design calculations, including all workings Engineering drawings of the proposed design Outcomes of the virtual modelling of the proposed design, either as screen captures or printouts Bill of materials, with justifications Any notes produced of research undertaken including citation of sources and internet search
Date submitted by candidate	dd/mm/yy

Task 1

Assessment themes:

- Health and Safety
- Design and Planning

You must:

a) produce a detailed design specification that builds on the design criteria given in the assignment brief and Technical Drawing Pack DD321, including references to any research used
b) sketch and annotate three potential designs for the mobile crane
c) select one appropriate mobile crane design for development with justifications
d) select and justify the use of the materials and components needed for the proposed design
e) carry out 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 mobile crane design using CAD software
g) produce a virtual model of the proposed mobile crane design using CAD software
h) create a bill of materials (BoM) listing all of the parts required in your final design proposal, with justifications.

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

none

Candidate evidence

Task 1 Design Specification

Introduction:

After reading through the design criteria I have identified three main design criteria points that my design must be able to meet, these are:

- It must be manually powered and operated
- Rotate 180 degrees
- Lift in and upwards motion

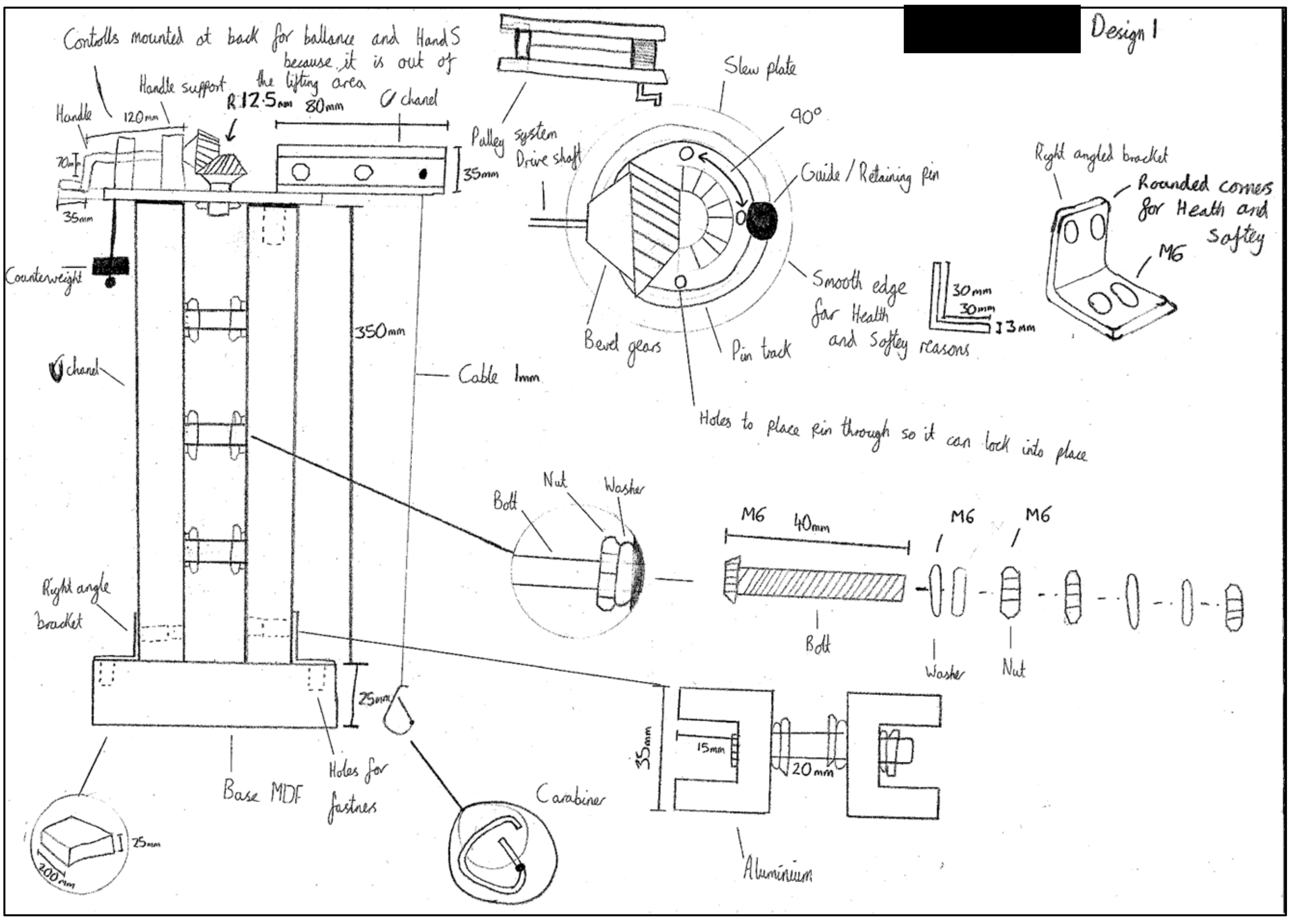
I have also decided to scale down my design to a 1:5 scale.

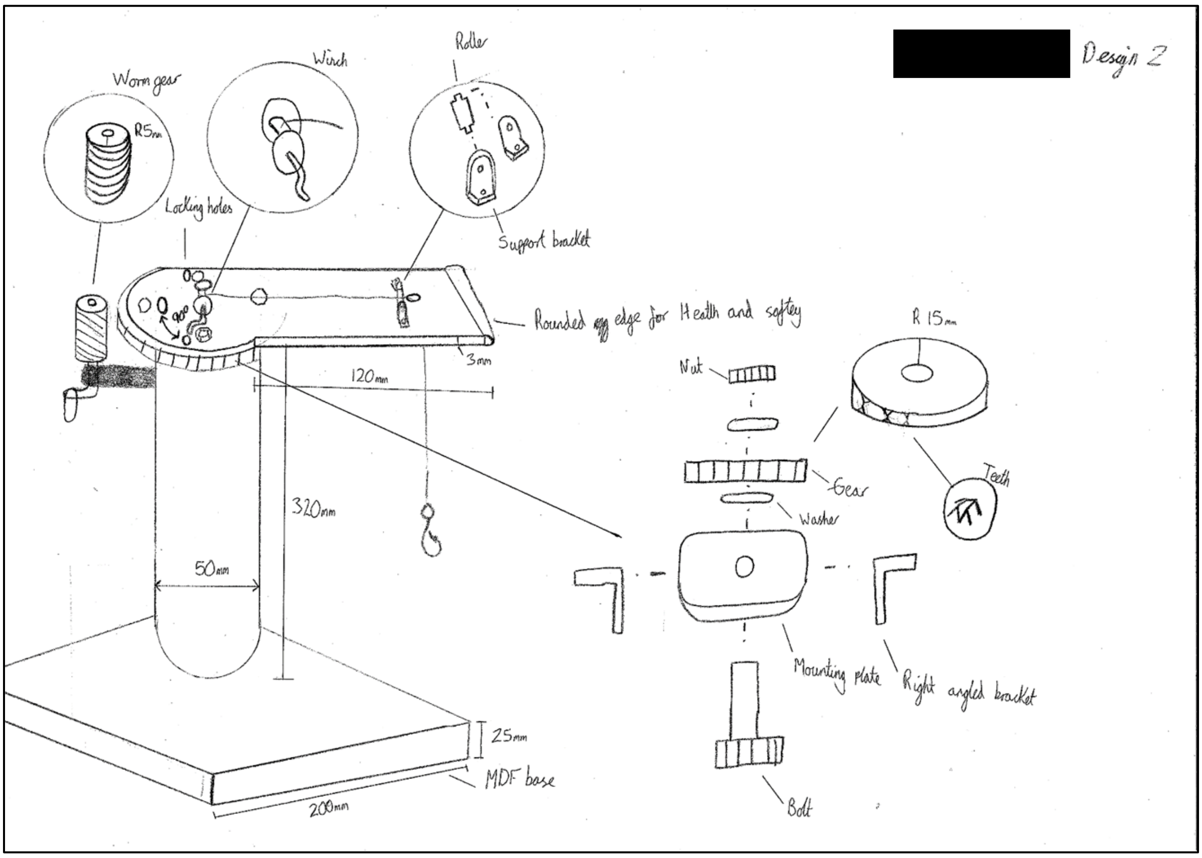
Design criteria	**Solutions**	**Justification**
Manually powered and operated	**Solution 1:** Use components that have to be physically interacted with for them to move such as a rack and pinion or pulley system. **Solution 2:** A series of gears could be used to make something turn or pull something in.	**Solution 1:** By using components like a rack and pinion or a pulley system a handle can be attached allowing them to be manually powered by someone turning it. **Solution 2:** By using gears, they can be used to change the direction of movement such as bevel gears which can covert the movement in a 90-degree angle.
Be able to rotate 180 degrees	**Solution 1:** To allow the crane to rotate 180 degrees a slew ring could be used. **Solution 2:** A component that allows for 180 degrees of movement is spur gear which drive a larger gear.	**Solution 1:** By using a slew ring, it allows for a smooth 360-degree movement by using ball bearing housed inside it. **Solution 2:** A spur gear which drives a larger gear allows for very precise movement and is very powerful.

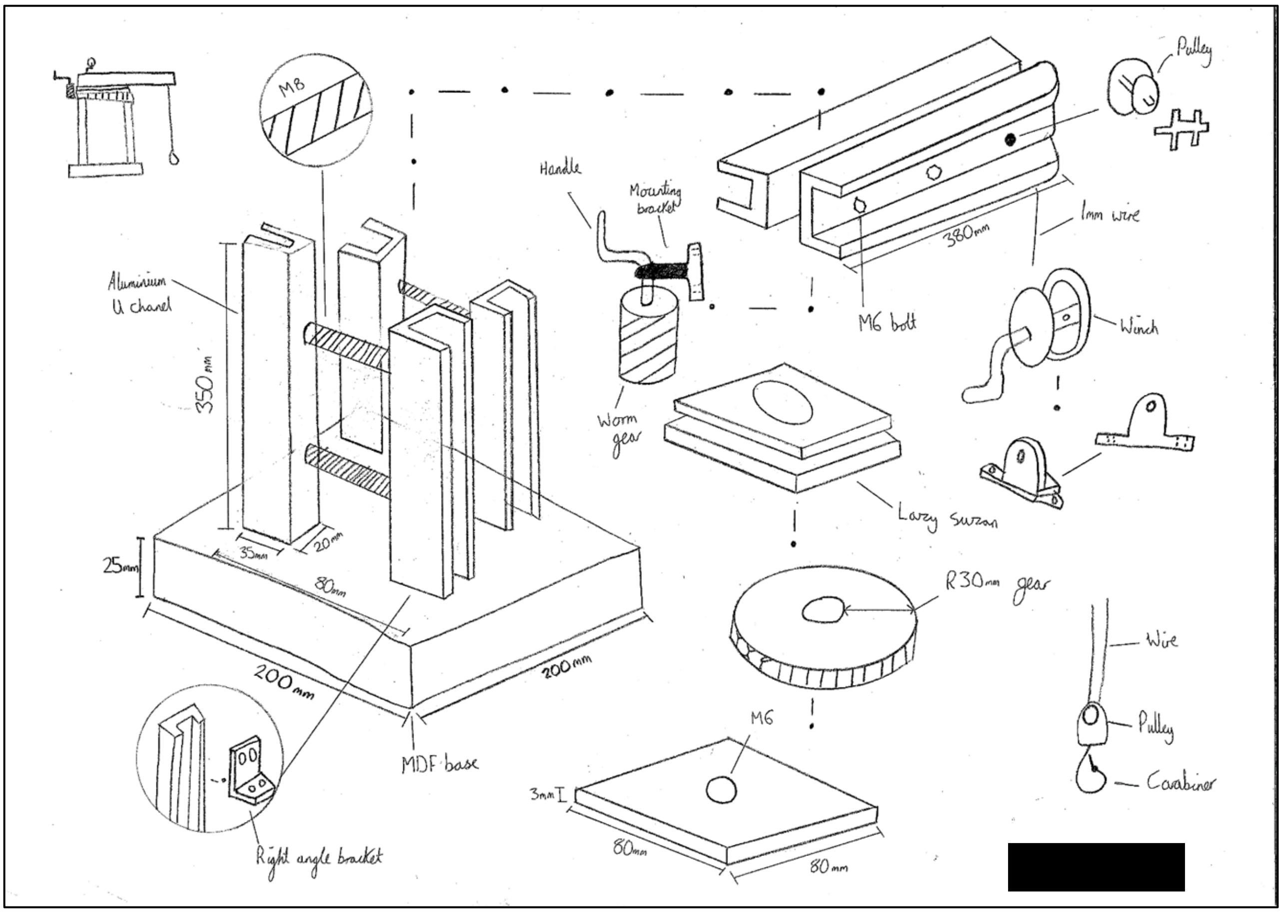
Design criteria	Solutions	Justification
Include a locking mechanism to restrict movement to 90 degrees intervals	**Solution 1:** A locking mechanism that could be used is a worm gear and a pinion. **Solution 2:** To allow for the crane to be locked every 90 degrees of movement a gear with holes could be used so that when it gets to 90 degrees a bar can be placed through the hole to stop if from moving.	**Solution 1:** By using a worm gear and pinion it allows for rotational movement when the worm gear is wound a certain way but once it stops being wound then it will self-lock allowing no back drive in that position because of the friction. **Solution 2:** By using a gear with holes in it which a bar is place through to lock it into position it allows for easy operation and is a very simple design which is affective.
Lift a minimum mass of 5.2kg	**Solution 1:** Make sure the product is secured strongly so nothing breaks off by using the correct sized fasteners for that part of the product. **Solution 2:** Make sure that appropriate brackets are being used to join two separate pieces together.	**Solution 1:** By using the appropriately sized fasteners it means that they will sustain less stress when the mass is lifted meaning they are less likely to fail. **Solution 2:** By using appropriate style of bracket, it means they are more affective of holding two pieces of material together.
Be able to lift a maximum of 300mm from the ground	**Solution 1:** To lift 300mm from the ground the product must use a durable mechanism such as a pulley system. **Solution 2:**	**Solution 1:** By using a pulley mechanism, it is durable and is very affective because it can create a big mechanical advantage if it run through a series of pulleys. **Solution 2:**

Design criteria	Solutions	Justification
	Use a strong construction so that the weight can be lifted up without breaking the jib off when lifted.	By making the construction of the jib strong it allows a better chance for the mass to be lifted without causing damage to any part of the crane.
Free standing	**Solution 1:** Securely fasten the base of the crane to a heavy base. **Solution 2:** Incorporate a counter weight into the crane.	**Solution 1:** By mounting the crane to a heavy base, it reduces the chance of it tipping over when the mass is lifted up. **Solution 2:** By using a counter weight is take stress of the components when the mass is being lifted as the unbalance caused by the mass is balanced due to the weight of the counterweight.
Lifting must be carried out safely	**Solution 1:** Mount the controls out of the lifting area.	**Solution 1:** By mounting the controls that the operator uses of the way of the lifting arear it allows the lifting operation to be carried out more safely.
Assembled as a non-permanent product	**Solution 1:** Use components such as nuts and bolts and brackets.	**Solution 1:** By using nuts, bolts and brackets it allows the crane to easily be disassembled and reassembled.

Task 1 Proposed designs







M8
Handle
Mounting bracket
Pulley
Aluminium U chanel
350mm
Worm gear
380mm
1mm wire
M6 bolt
Winch
Lazy Suzan
25mm
35mm
20mm
80mm
R30mm gear
200mm
200mm
Wire
MDF base
Pulley
M6
Carabiner
3mm
80mm
80mm
Right angle bracket

[redacted]

Task 1 Design Justification

Scoring chart	
1	Unsatisfactory
2	Poor
3	Acceptable
4	Good
5	Excellent

Design criteria	Design 1	Design 2	Design 3
Manually powered and operated	This design uses a handle which rotates a worm gear as well as a winch with a handle, a carabiner and a locking pin. Score = 5	This design uses a worm gear with a handle a winch with a handle as well as a carabiner and a locking pin. Score = 5	This design uses a worm gear and handle, a winch and a carabiner. Score = 5
Rotates 180 degrees	To allow the crane to rotate 180 degrees this design uses a pair of bevel gears mounted to a circular plate which is mounted on a bearing so when the gears are wound it spins freely. Score = 5	This design uses a worm gear which when spun moves a larger round gear and this allows it to rotate as it is mounted onto a bearing. Score = 5	This design uses a worm gear mounted onto a lazy Susan which meshes with a fixed flat gear to easily rotate. Score = 5
Locking mechanism every 90 degrees	To allow for the crane to be locked every 90 degrees holes have been added every 90 degrees on the swivel plate so that when it is moved 90 degrees the holes line up with a cut out which then a pin is placed through to lock it. Score = 4	This design uses a worm gear and larger flat gear so when the crane moves 90 degree and the worm gear has stop being spun it will automatically lock its self, I have also added a locking pin mechanism so that when the platform is in line with the locking pin hole a pin can be placed I it preventing rotation. Score = 3	This design uses a worm gear and larger gear so this means when the crane is moved 90 degrees and the worm gear has stop being wound then it will automatically lock due to how the gears mesh. Score = 5

Design criteria	Design 1	Design 2	Design 3
Lift a 5.2Kg mass	All of these crane designs use the same mechanism to lift the 5.2kg mass and this is by using a pulley system which is connected to a winch. Score = 5		
Lift a maximum of 300mm off the ground	To do this the crane has been designed so that it is taller than 300mm in height so that the weight can be lifted off the ground. Score = 5		
Free standing	To make this design free standing it will be relying on a counterweight to help balance it and the whole crane will be mounted onto a base. Score = 4	To make this device free standing the main structure will be securely attached to the base by using right angle brackets. Score = 3	This device is free standing by using 4 legs which will be securely mounted to the base and the worm gear and winch are mounted near the back to act as a counterweight. Score = 4
Lifting carried out safely	To carry out the lifting safely a durable mechanism is being used which is a winch and pulley system and it is mounted securely with adequate fixings. Score = 5		
Non-permanent product	To make all of these designs a non-permanent product nuts and bolts have been used since they can come undone again. Score = 5		
Score **/40	**38**	**36**	**39**

Justification

My chosen design is **Design 3.**

The reason for deciding to choose design 3 over the other ones is for many different reasons such as structural integrity, because this design uses four posts it makes it a lot stronger than just one or two posts that are mounted closely each other like the other designs. Another reason is for ease of manufacturing, this design uses simply shaped parts and this is good because they only require a few manufacturing processes to be carried out on them such as holes being drilled or bending unlike the other designs which need specially shaped brackets to fit around a tube-like design 2 or like a circular platform that requires precise cutting.

Even though design 2 and 3 are very similar they work slightly different such as design 2 having to locking mechanisms, the worm gear being mounted the other way and having a tubular upright structure.

By having two locking mechanisms it will require more manufacture time because more parts have to be made, be more complicated for the operator to use and adds unnecessary weight.

Task 1 Material Justification

I have identified some key points that the materials must meet in order for it to work with my design, these points are:

- Good machinability
- Available in a wide variety of different supply forms
- Have a high yield strength
- High strength to weight ratio
- Lightweight

Main structure and jib of the crane					
Material Name	**Advantages**	**Disadvantages**	**Supply forms**	**Yield strength**	**Density**
6063 – T6 Aluminium	- Excellent machinability - Heat treatable - Good corrosion resistance -	- Difficult to weld - Susceptible to fracturing when bent	- U channel - Round bar - Sheet - Box section - Angle bar	214 MPA	2700 kg/m3
EN3B Mild Steel	- Can be case hardened - Good machinability - Good weldability	- Not heat treatable - Fatigues under high stress - Corrosive	- Round bar - Flat bar - Square bar - Sheet - Plate	215 MPA	7850kg/m3

Justification

My chosen material to manufacture the main structure and jib from is, **6063 – T6 aluminium**.

While 6063 – T6 aluminium and EN3B mild steel do have some similar properties, I believe aluminium is more suitable for my compact mobile crane design.

The main reasons for choosing aluminium is because it is easier to manufacture components out of since it is less hard which will allow for it to be manufacture quicker. Another reason is because it offers a better strength to weight ratio since it is less dense and offers a similar yield strength, this is good because the crane can be made to light offering easier mobility while still retaining a high yield strength stopping it from deforming under high stress.

Since aluminium can be heat treated the mechanical properties can be altered to make it more suited to the application such as making it harder or more ductile.

Because aluminium also comes in a variety of supply forms less manufacturing will need to be done to produce components unlike with mild steel which comes in fewer supply forms.

Components

To fasten together piece of material I will be using different sized hex head bolts paired with washers and nuts.

Task 1 Citation of sources

Material information for 6063 – T6 aluminium found on: ASM aerospace

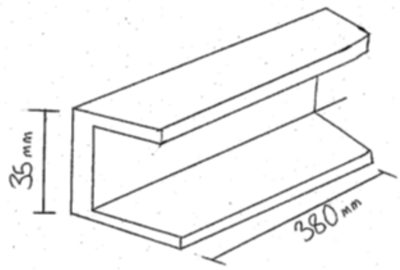
6063 – T6 aluminium source:

https://www.fictiv.com/articles/cnc-materials-series-pros-and-cons-of-different-aluminum-alloys#:~:text=Disadvantages%20of%206061-T6%20aluminum%3A%201%20Experiences%20a%20reduction,%28brittle%20fracturing%29%20when%20bent%204%20Lower%20fatigue%20strength

EN3B mild steel information found on: Smiths metal

Task 1 Calculations

Stress calculations on the Jib



Aluminium 6063
yield strength = 214 MPa

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

Force = Mass × Gravity

= 5·2 Kg × 9·81 N = 51·012 N

Area = Base × Height

= 380mm × 35mm = 13300 mm^2

Force = 51·012 N
Area = 13300 mm^2

$$\frac{51{\cdot}012}{13300} = 0{\cdot}0038 \text{ MPa}$$

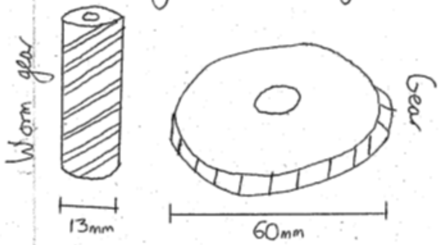
$$\frac{\text{Stress}}{\text{Yield strength}} = \frac{0{\cdot}038}{214} = 56315$$

56315 = Factor of saftey

On the crane there are two Jibs so this Factor of saftey is halfed because it is shared across both of them.

This calculation above shows my workings out for calculating how much stress the jib is undergoing when the 5.2kg mass is being lifted and what the factor of safety was. I calculated that the stress it is under going is 0.0038MPa and the factor of safety is 56315, this means it is more than capable of lifting 5.2kg by 56315 times.

[redacted] Velocity Ratio of Worm gear and gear



Velocity Ratio = Diameter of driven gear / Diameter of driver gear

Driven gear = 60mm

Driver gear = 13mm

$$VR = \frac{60}{13} = 4.6$$

This means it takes 4.6 turns / revolutions of the driver gear (worm gear) to rotate the driven gear (gear) 1 revolution.

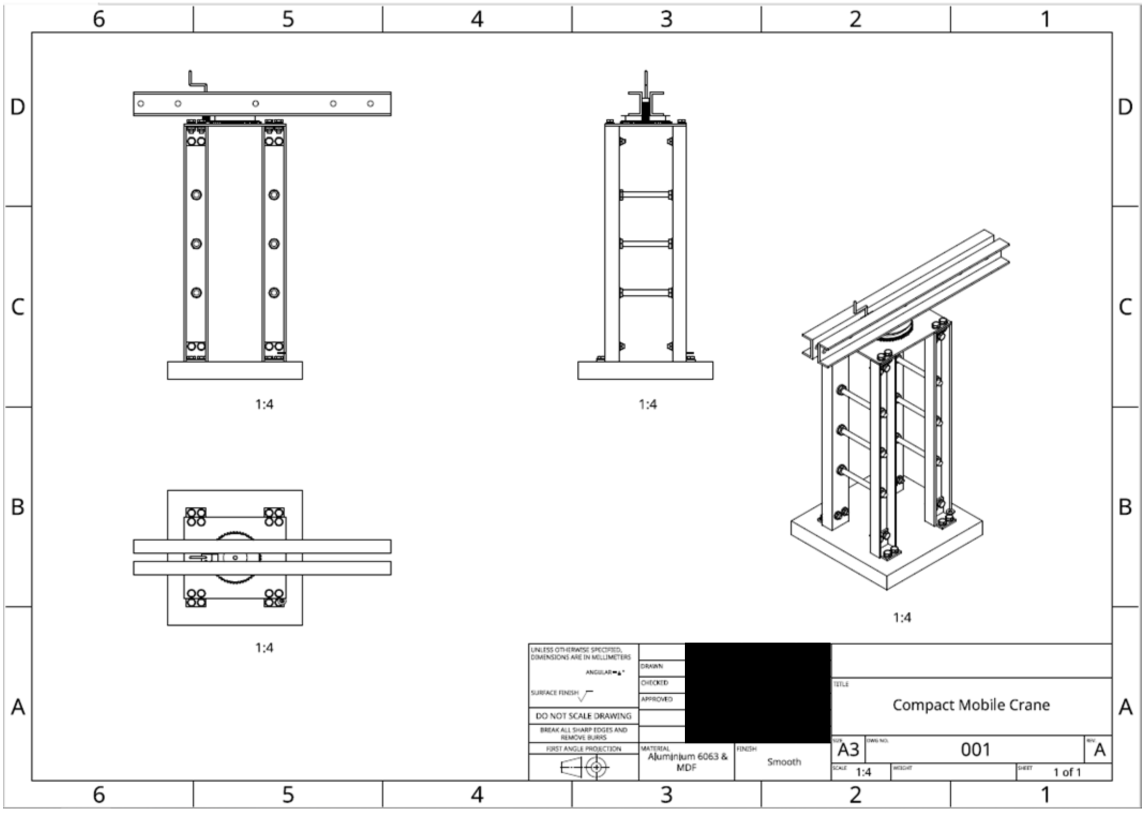
This means the gear ratio is 1 : 4.6

In the application where it will be used it only requires for it to do half of this because it is only rotating 180° meaning the worm gear will have to complet a maximum of 2.3 revolutions to get the gear to move half a revolution.

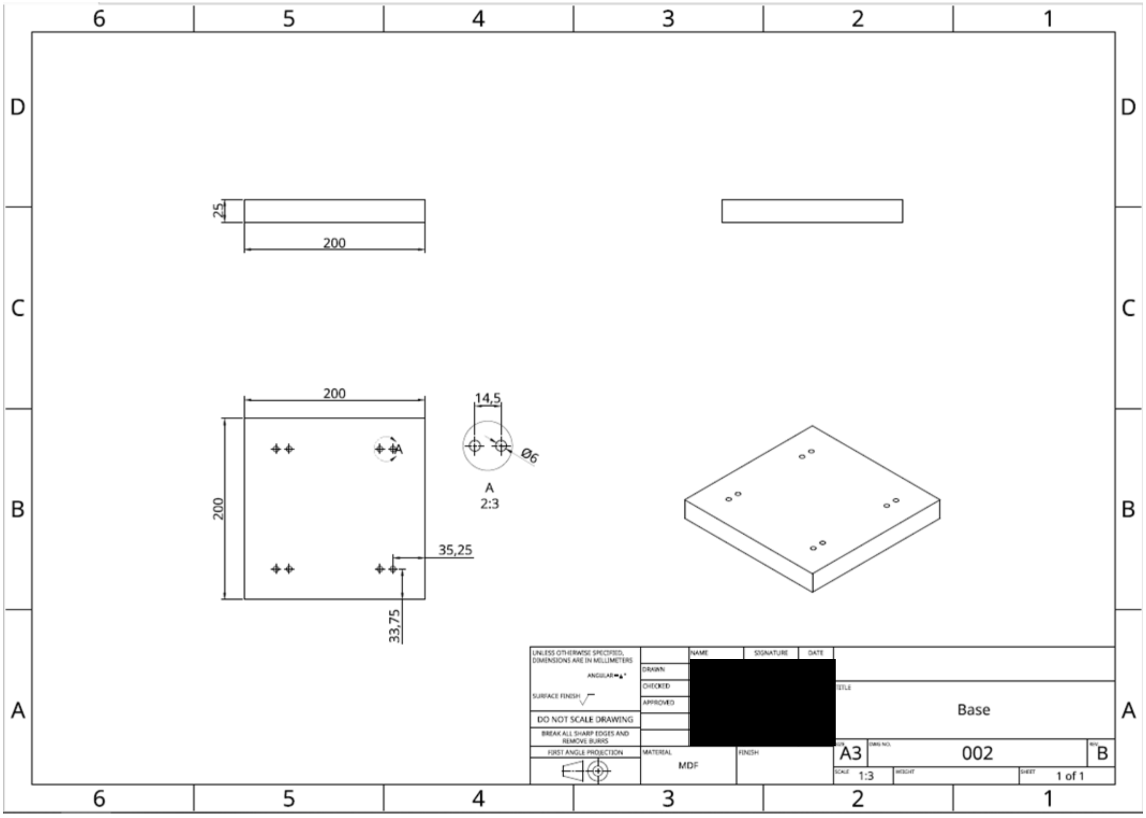
The calculation above shows the workings out to find the mechanical advantage of the worm gear and gear by using a Velocity Ratio (VR) formula. To find out the answer I divided 60 which is the diameter of the gear by 13 which is the diameter of the worm gear and this gave me an answer of 4.6 this means for every 4.6 revolutions of the worm gear the gear moves 1 revolution making it have a gear ratio of 1:4.6, because the cane only has to turn 180 degrees it would only take 2.3 revolutions to move the gear half a revolution.

Task 1 Engineering drawings

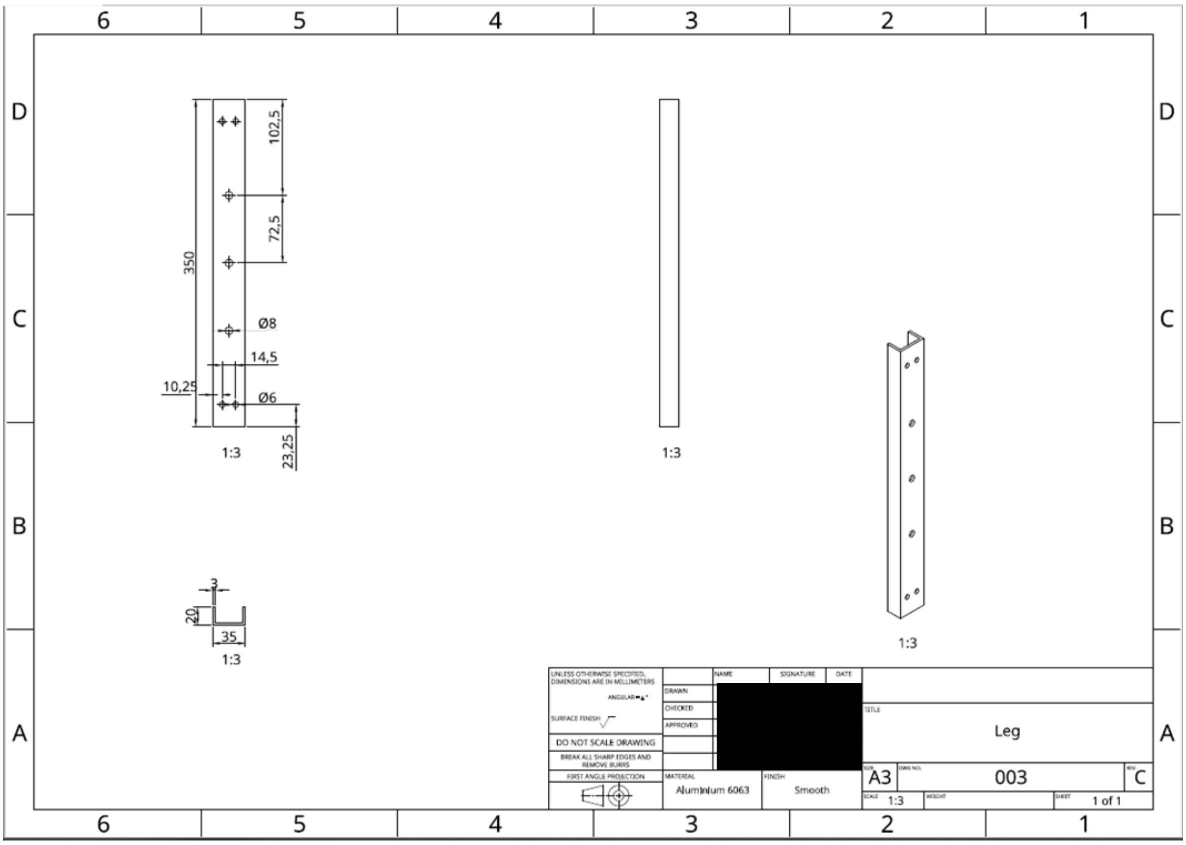
Compact Mobile Crane Whole assembly



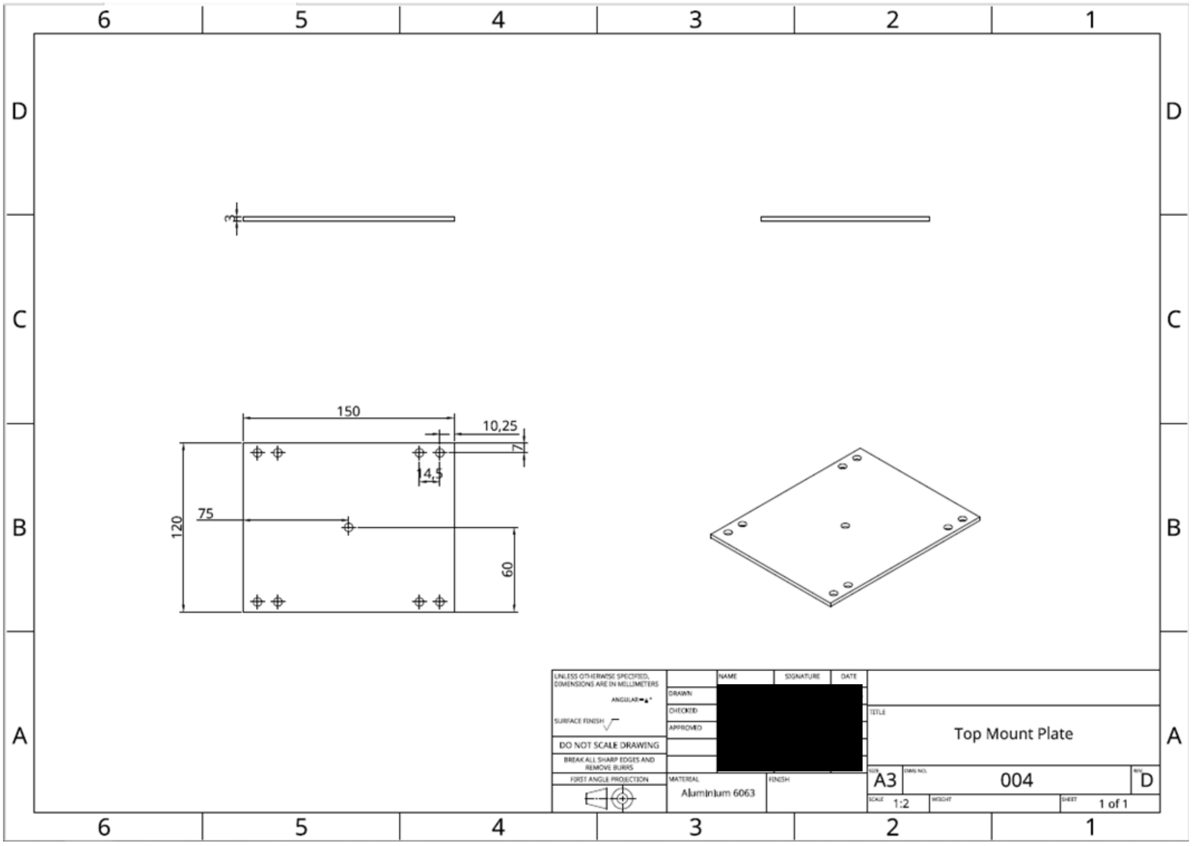
Base



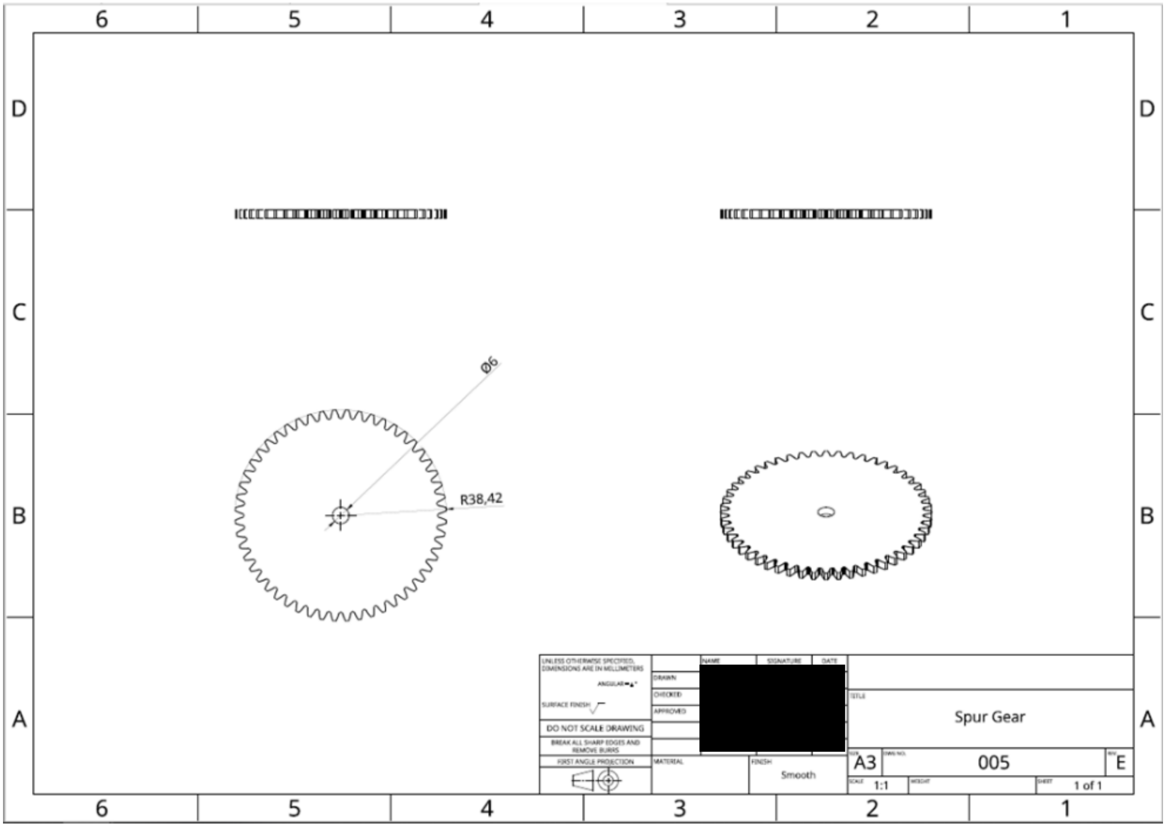
Leg



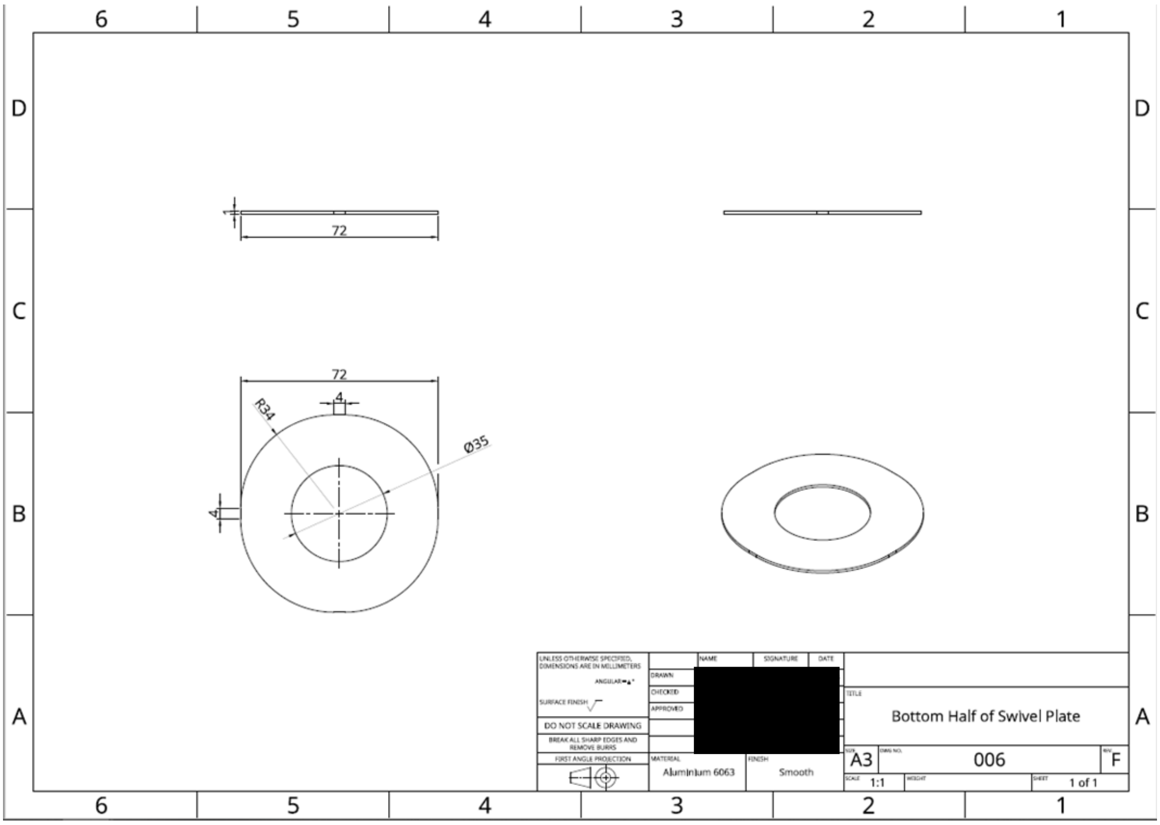
Top Mount Plate



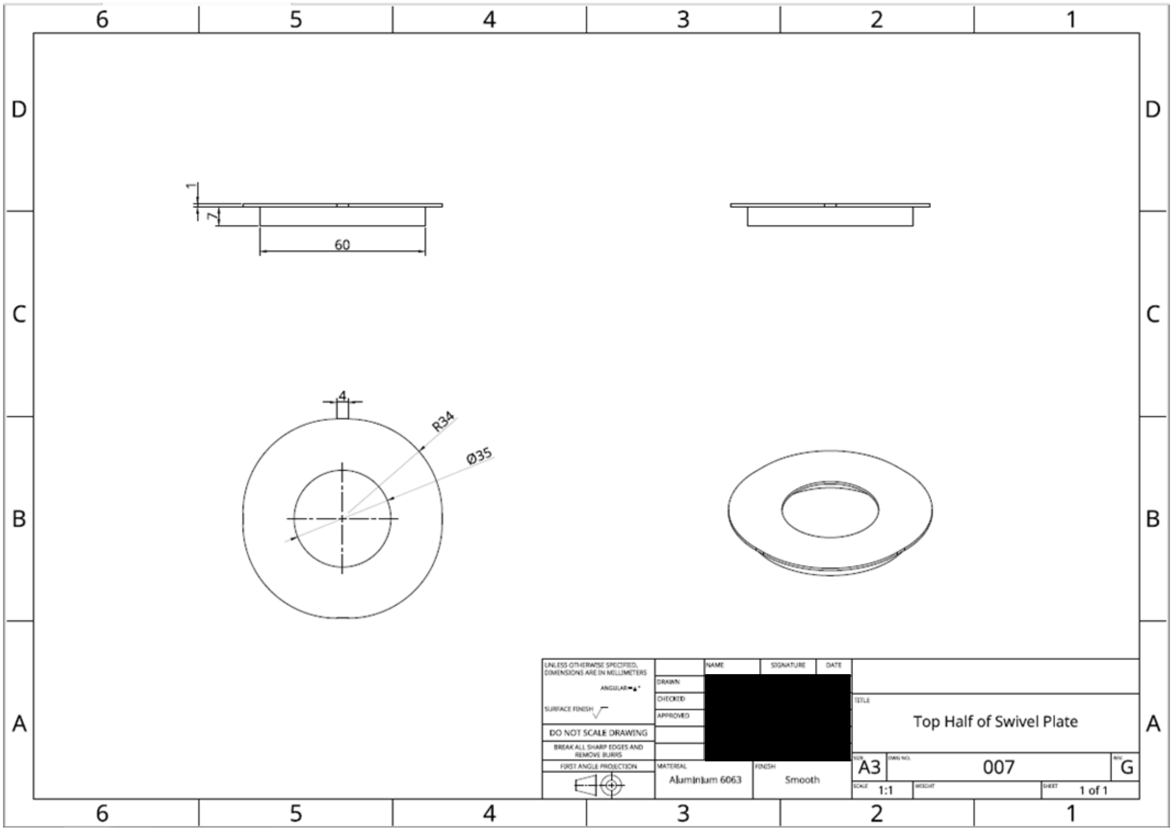
Spur Gear



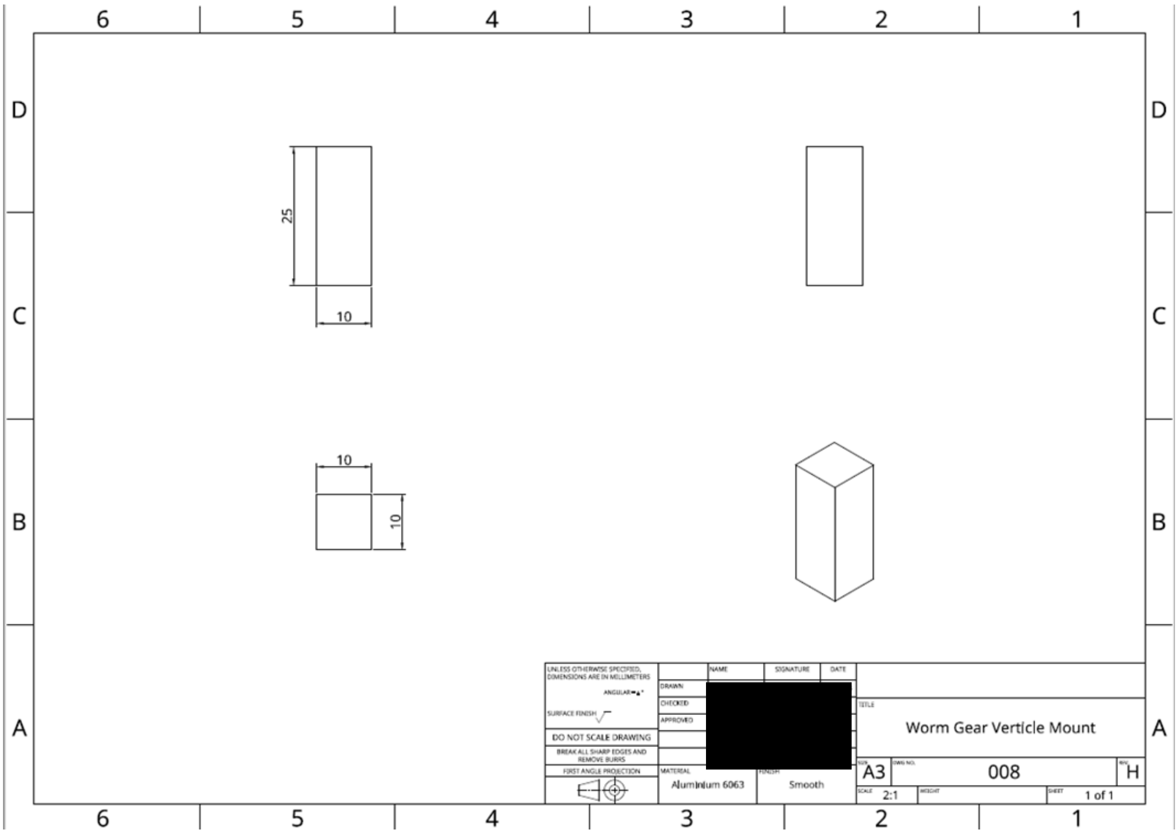
Bottom Half of Swivel Mount



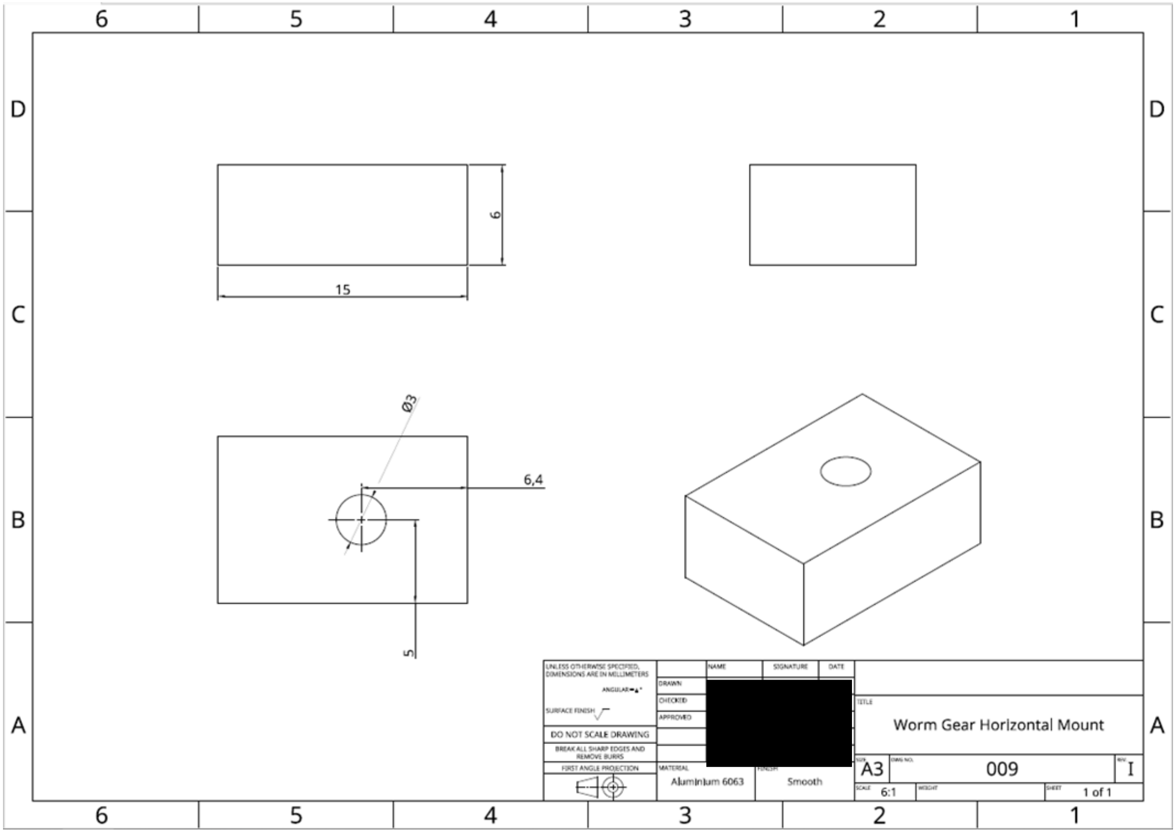
Top Half of Swivel Plate



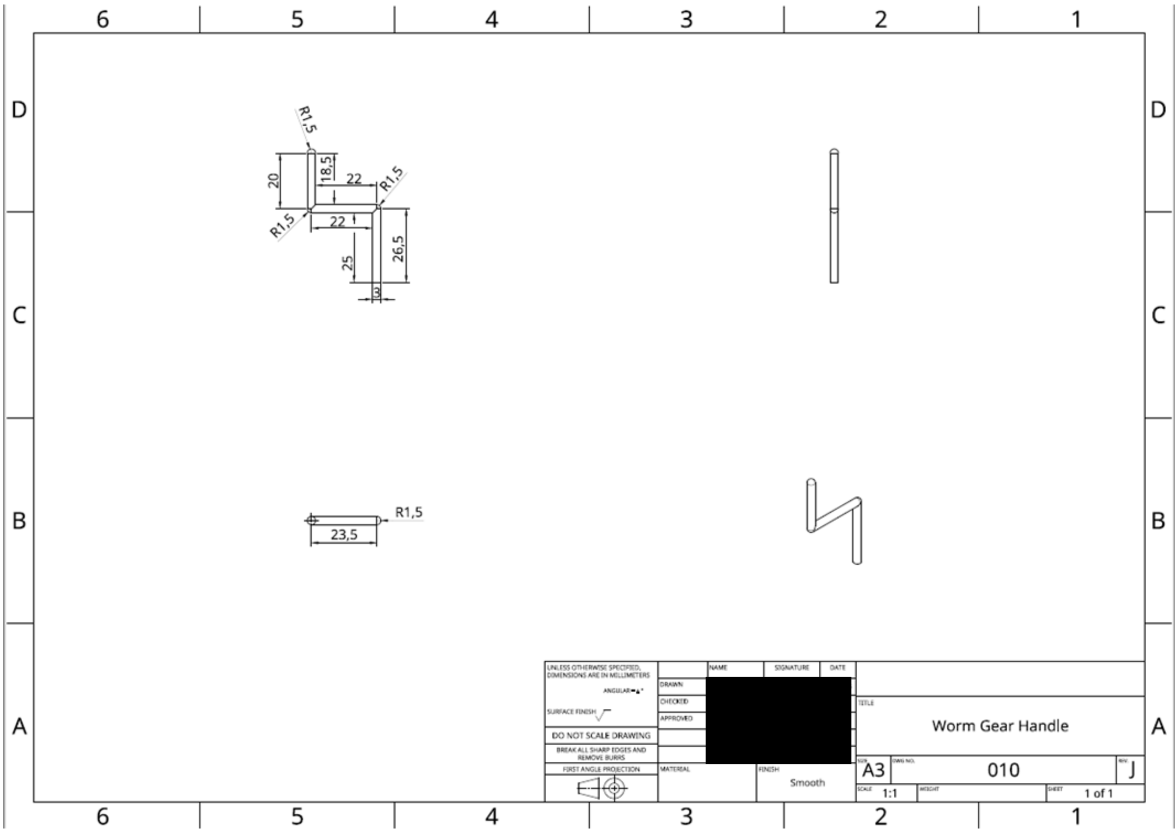
Worm Gear Vertical Mount



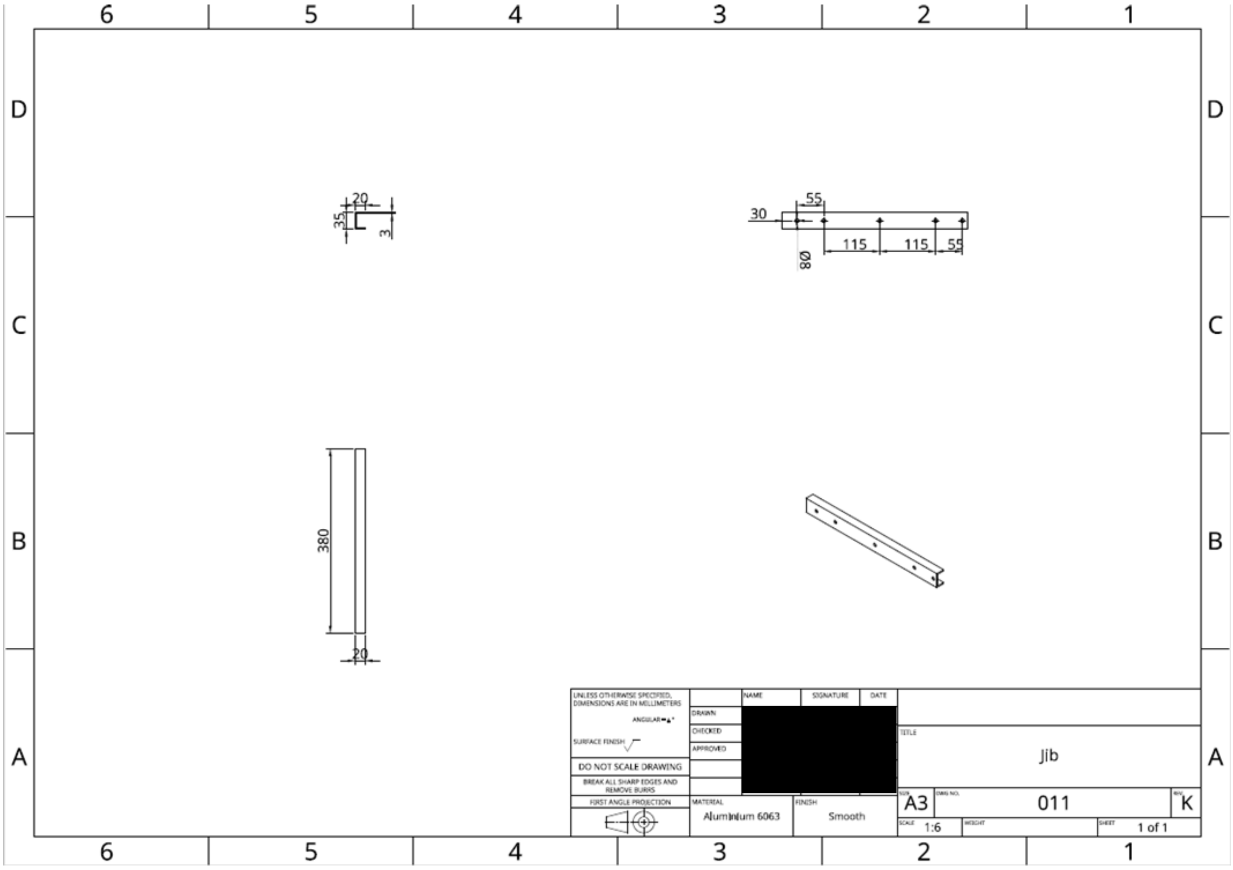
Worm Gear Horizontal Mount



Worm Gear Handle



Jib



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UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH
DO NOT SCALE DRAWING
BREAK ALL SHARP EDGES AND REMOVE BURRS
FIRST ANGLE PROJECTION
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DATE
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Aluminium 6063
FINISH
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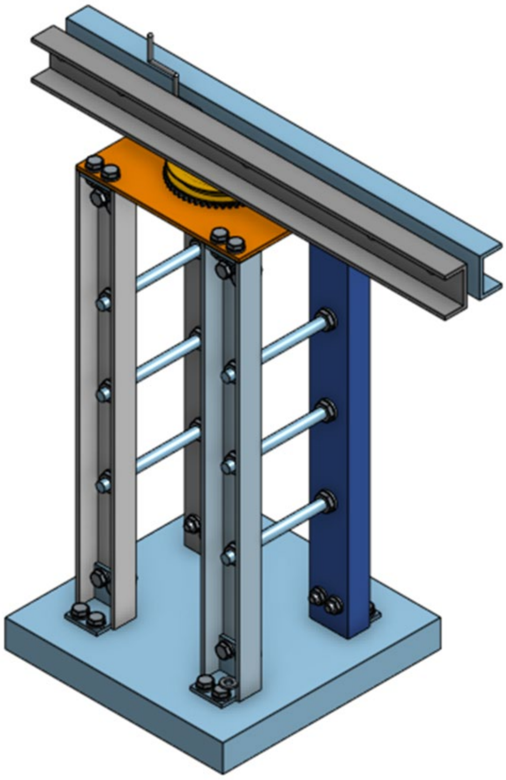
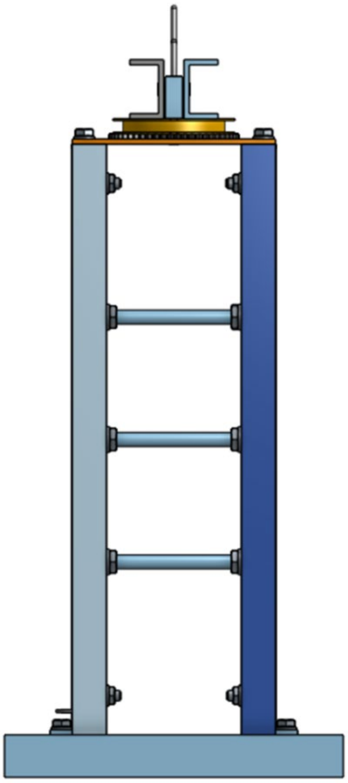
1 of 1

Task 1 Virtual model

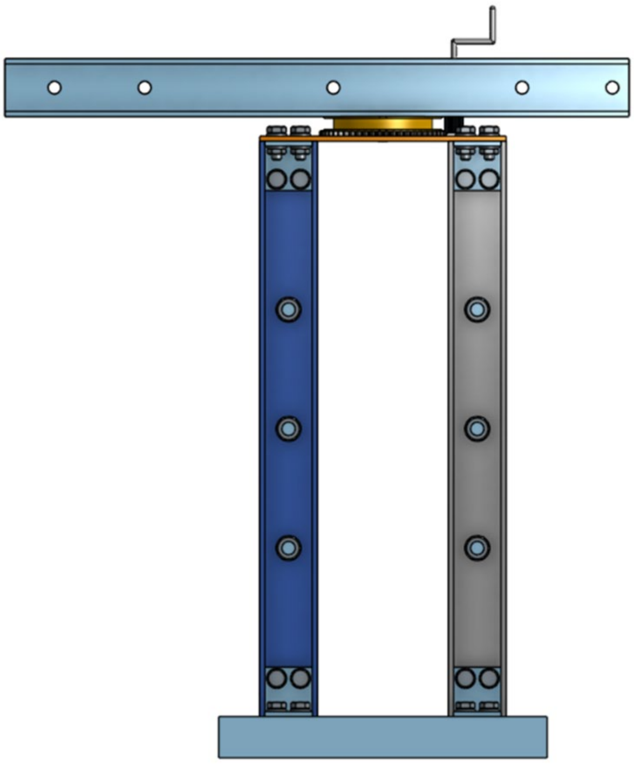
Isometric View



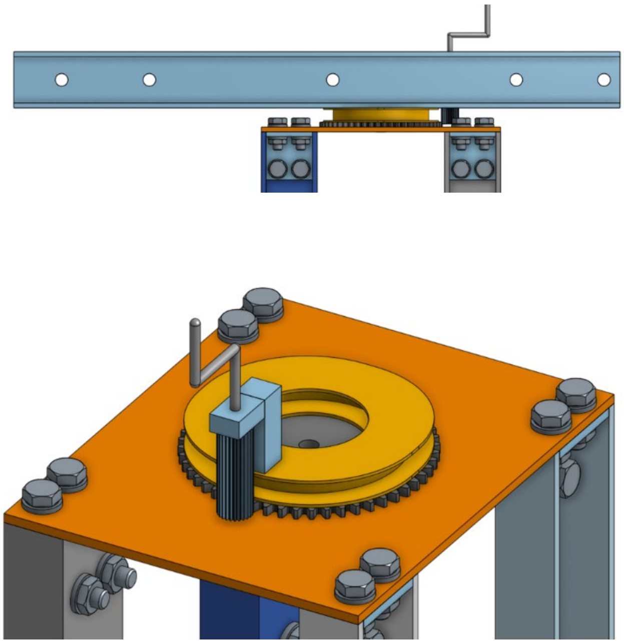
Front View



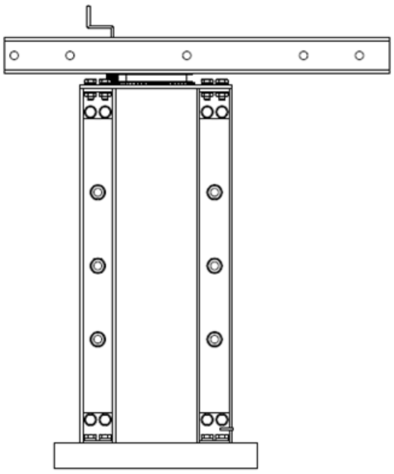
Side View



Close up View of Mechanism



Task 1 Bill of Materials



Item	Quantity	Description	Material
1	1	Back Left Leg	Aluminium 6063
2	1	Back Right Leg	Aluminium 6063
3	1	Base	Medium Density Fiberboard (MDF)
4	1	Swivel Platform	Aluminium 6063
5	1	Short 90 Degree Bracket	Aluminium 6063
6	1	Short 90 Degree Bracket	Aluminium 6063
7	1	Gear	
8	1	Top Mount Plate	Aluminium 6063
9	4	Long 90 Degree Bracket	Aluminium 6063
10	4	Short 90 Degree Bracket	Aluminium 6063
11	57	Clevis pin plain washer M6 Stainless Steel	Stainless Steel
12	24	Clevis pin plain washer M8 Stainless Steel	Stainless Steel
13	24	Hex thin nut grade A & B M8 Stainless Steel	Stainless Steel
14	6	M8 Threaded Bar	
15	24	Hex thin nut grade A & B M6 Stainless Steel	Stainless Steel
16	32	Hex head screw grade A & B M6x1.00 x 16 Stainless Steel	Stainless Steel
17	1	Top Half Of Swivel Platform	Aluminium 6063
18	1	Worm Gear Vertical Mount	Aluminium 6063
19	1	Worm Gear Horizontal Mount	Aluminium 6063
20	1	Worm Gear Handle	Aluminium 6063
21	1	Worm Gear	
22	1	Left Jib	Aluminium 6063
23	1	Right Jib	Aluminium 6063

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN MILLIMETERS
ANGULAR: ±°
SURFACE FINISH
DO NOT SCALE DRAWING
BREAK ALL SHARP EDGES AND REMOVE BURRS
FIRST ANGLE PROJECTION

NAME | SIGNATURE | DATE
DRAWN
CHECKED
APPROVED
[redacted]
MATERIAL | FINISH

TITLE: Compact Mobile Crane BOM
SIZE: A3 | DWG NO. | REV
SCALE: 1:3 | WEIGHT | SHEET 1 of 1

Task 2 Manufacture and test

Assessment number (eg 1234-033)	8714-321
Assessment title	Mechanical 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	Completed risk assessment Test Report Practical observation form Photographic evidence
Date submitted by candidate	dd/mm/yy

Task 2

Assessment themes:

- Health and Safety
- Manufacturing
- 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 prototype can be manufactured to be full size or a scale model (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.
- 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.

Candidate evidence

Task 2 Completed risk assessment

Severity						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	**2**	**3**	**4**	**5**
Occurrence Probability						

Score	Meaning
15-25	Unsafe
8-12	Likely to get injured
4-6	Chance of Injury
1-3	Safe

Name	Risk	Hazard	Severity	Occurrence Probability	Score	Mitigation Measures	severity	Occurrence Probability	Overall Score
Hacksaw	Hot work piece from cutting	Could cause burns	2	3	6	Allow time for the work piece to cool down	1	2	2

Name	Risk	Hazard	Severity	Occurrence Probability	Score	Mitigation Measures	severity	Occurrence Probability	Overall Score
File	Slipping of work piece	Could cut your skin	2	3	6	Use the correct technique and make sure to hold the file correctly	1	1	1
File	Sharp metal filings	Cause metal splinter	2	2	4	Make sure to clean up the work area after filing	1	1	1
Cordless Drill	Drill bill not secure in chuck	Could become a projectile and cause damage to body parts and work environment	4	2	8	Make sure the drill bit is straight in the chuck and tighten it tightly	1	1	1
Cordless Drill	Drill snatching when drilling material	Cause damage to wrist and shoulder	2	3	6	Use the inbuilt torque setting to stop it snatching	1	1	1
Pillar Drill	Swarf when drilling	Could cause damage to eyes	4	2	8	Wear the appropriate PPE such as	1	1	1

Name	Risk	Hazard	Severity	Occurrence Probability	Score	Mitigation Measures	severity	Occurrence Probability	Overall Score
						protective eyewear			
Pillar Drill	Work piece not secure	When drilling it could become a projectile and damage body parts or the work environment	4	3	12	Make sure to use a vice and wear appropriate PPE such as protective eyewear and safety boots	2	1	2
Hammer	Hitting fingers	May break, fracture or bruise fingers	2	3	6	Make sure fingers are out of the way of where the hammer is hitting and make sure the work piece is secure	2	1	2
Junior Hacksaw	Sharp edge	Cause damage to skin				Don't put fingers near the blade when cutting and			

Name	Risk	Hazard	Severity	Occurrence Probability	Score	Mitigation Measures	severity	Occurrence Probability	Overall Score
			2	1	2	make sure the workpiece is secured so it doesn’t slip	1	1	1
Raw Material	Sharp edges	Damage skin and cause metal splinters	1	3	3	Make sure to de-bure all the edges by using a deburring tool or a file	1	1	1

Task 2 Test Report

Testing Criteria	Testing Method	Pass or Fail	Justification
Manually Powered and operated	Visual inspection that all the tasks are being carried out by hand.	Partially	My crane is manually powered because it uses a pulley system made from a big wheel which is hand powered by using a crank which when wound winches up the mass. Another manually powered component is the gear with a handle attached which is supposed to be used to make the crane swivel but didn't function because the two gears wouldn't mesh together.
Able to rotate 180 degrees	Visual inspection	Yes	My crane was able to rotate the full 180 degrees by using the lazy Susan it was mounted on top of.
Locking mechanism to lock every 90 degrees	Visual inspection	Yes	My crane was successfully able to lock into place every 90 degrees by using a locking pin which secured the top swivel plate to the bottom fixed plate. This was done by having a hole drilled through the top plate and bottom plate allowing the pin to slide through.
Lift a maximum mass of 5.2Kg	Using a designated weighed out mass.	Yes	My crane was successful of lifting a mass of 5.2kg by using a winch and pulley system which had steel wire fixed to the pulley and on the other end a D shackle allowing the mass to be securely attached.
Lift a maximum of 300mm off the ground	Using a tape measure	Partially	My crane failed to lift the mass a maximum of 300mm off the ground however it did lift it 280mm which is very close.
Free standing	Visual inspection	Yes	My crane is fully free standing and is attached to a base.
Carried out safely	Visual inspection	Partially	The crane carries out the majority of the task safely but others not so well. The tasks it carries out well are:

			The lifting of the mass and the locking mechanism for both the winching system and swivel mechanism. However, the lowering of the mass is carried out not as safely because if the crank is let go then the mass will freefall causing the crank to go around very quickly and unsafely.
Non-permanent product	Visual inspection	Yes	My crane is assembled using nut, bolts, washers and a few screws, all of these components can be removed easily and be reused.

Summary

After testing my crane, it carried out all of the tests without breaking, with a few off the tests such as lifting the mass a maximum of 300mm of the ground and being carried out safely it partially failed because of flaws in my design. But overall it did very well and to a good standard. It also met my top three most important points that I set out for it to do, these were it must be manually powered and operated, rotate 180 degrees and lift in an upwards motion which it was able to do.

Task 2 Practical observation form (and photographic evidence)

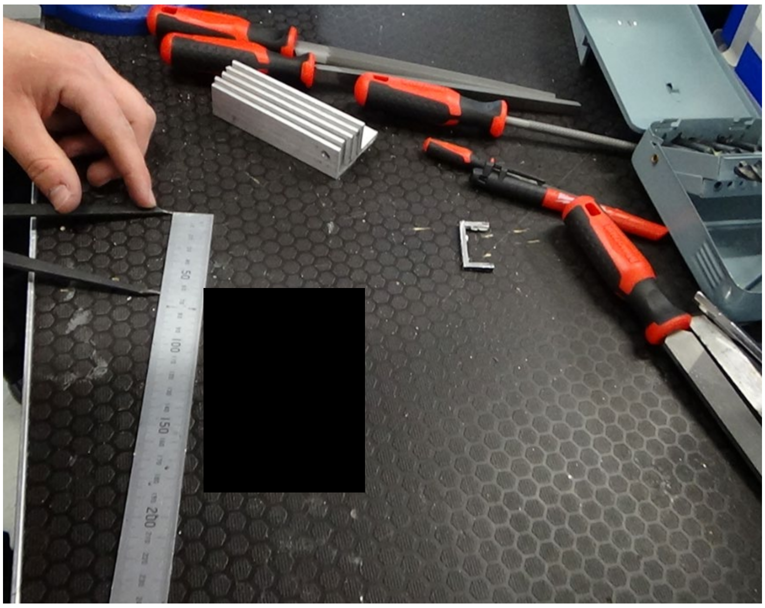
8714-321 Design and Development: Mechanical - Summer 2025

Candidate name	Candidate number
Provider name	**Date**

Complete the table below referring to the relevant marking grid, found in the assessment pack.
Do not allocate marks at this stage.

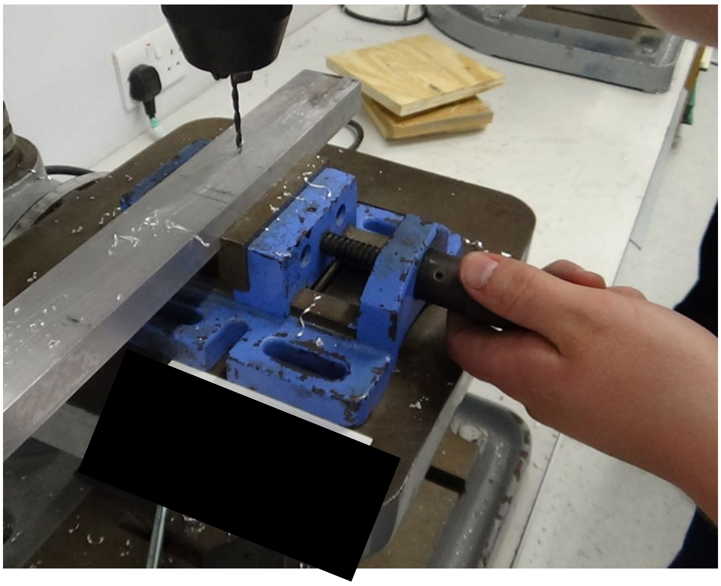
This observation must cover	Assessor observation should include:	Assessment Themes
Manufacture of the prototype	• manufacture of the prototype.	• Health and Safety • Manufacturing
Testing of the prototype	• testing of the prototype.	• Health and Safety • Manufacturing

Manufacture of the prototype



During the initial set up of the task, the candidate checked the components against the Bill of Materials (BoM).

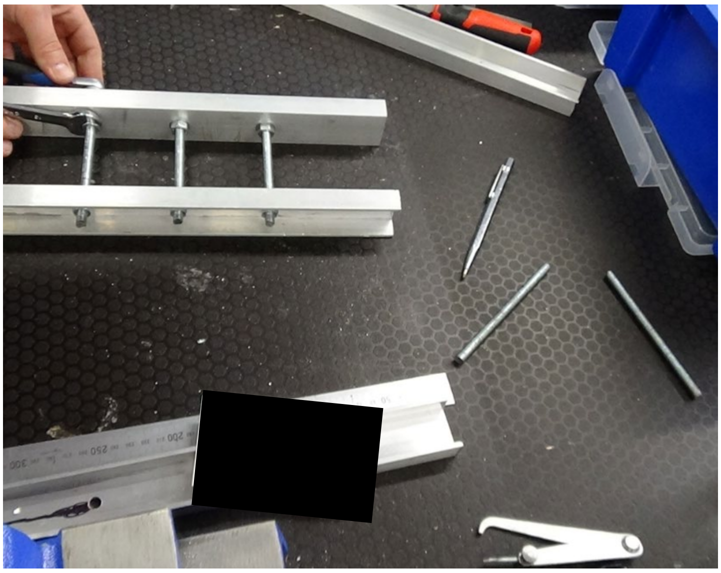
An example of using dividers accurately with the steel rule laced down, ready for marking and checking a series of brackets.



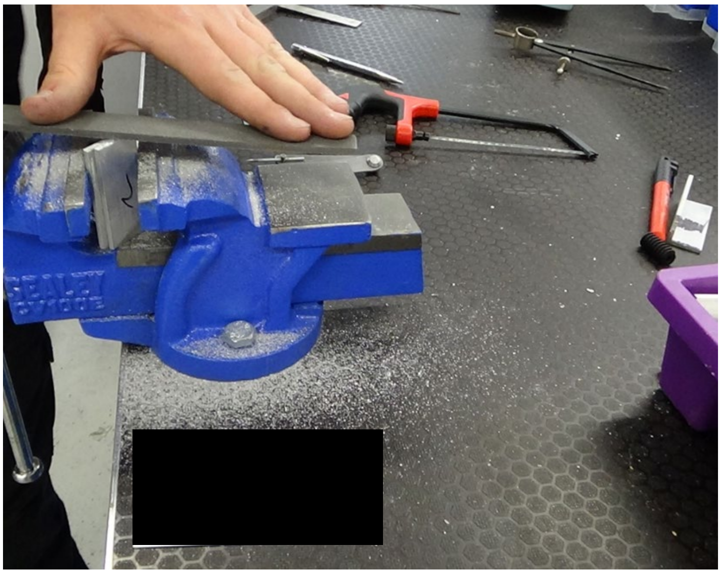
The candidate set up and used the pillar drill competently.

In this image, the work is secured in a hand vice, which has been turned for the photograph.

In addition, the guard has been raised to see the task more clearly.



Assembling the vertical supports using a wrench and ratchet on the M8 nuts and threaded bar. The candidate locked the nuts against each other for a secure fix.



The candidate opted to clamp two brackets together to be filed as a pair to save time and improve consistency.

A good filing technique can be observed from the image.

Here the candidate can be seen wearing appropriate PPE when setting up a pillar drill.

Safety goggles, workwear and safety boots.

The work area has been kept clean and tidy.

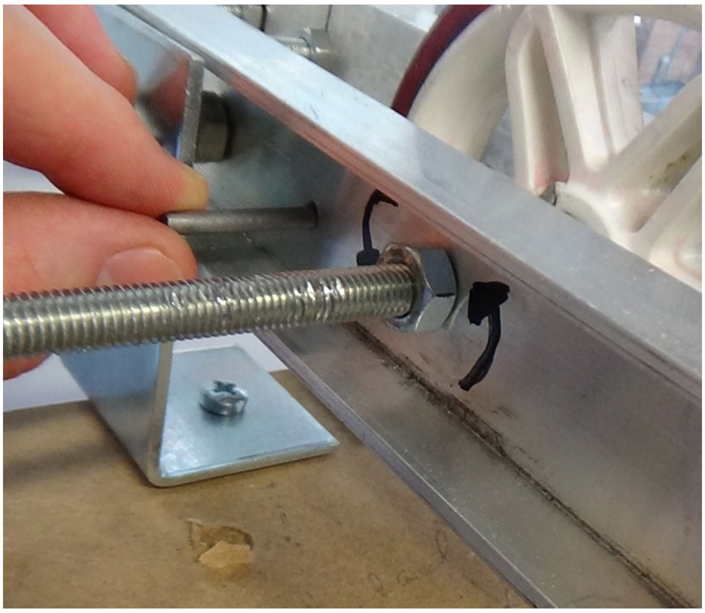
A hand vice was used to secure the workpiece.

The guard is shown raised purely for the convenience of clearer photographic evidence.

Assembly of the tower structure.

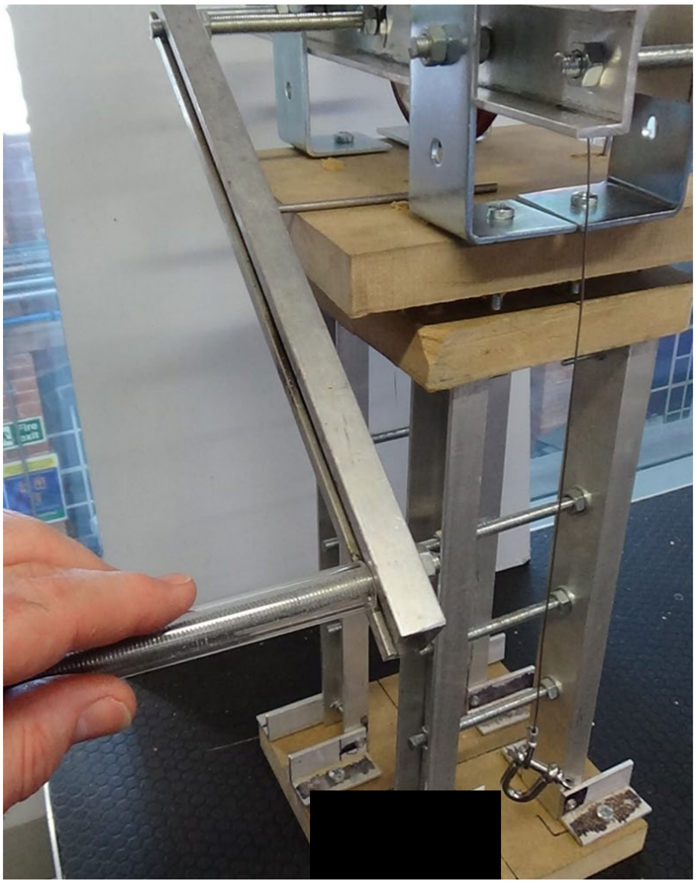
It would have been better for the marking ink to be removed prior to assembly.

From a design for manufacture point of view, it would be better if the eight single small brackets were replaced with two longer ones.

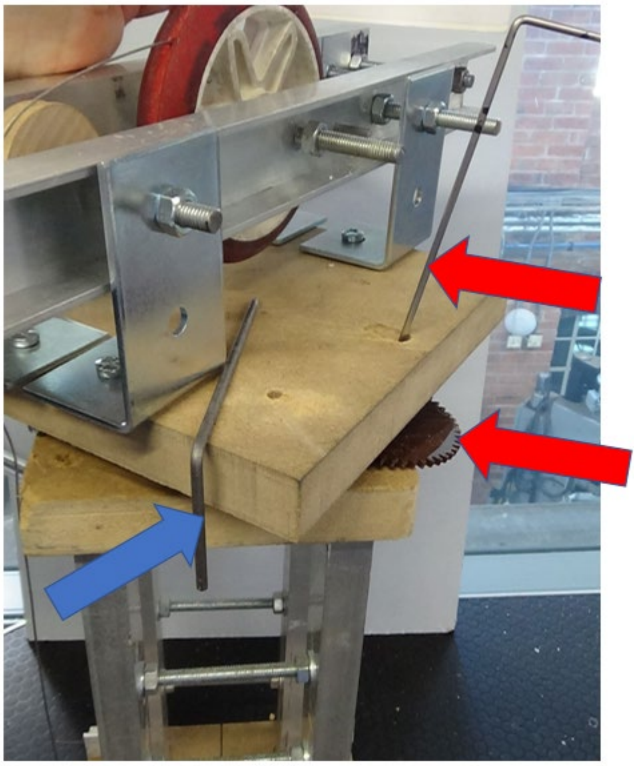


This shows the load lift locking pin being inserted through the wheel.

It also shows how a little more care could be taken when holding the threaded bar for cutting.

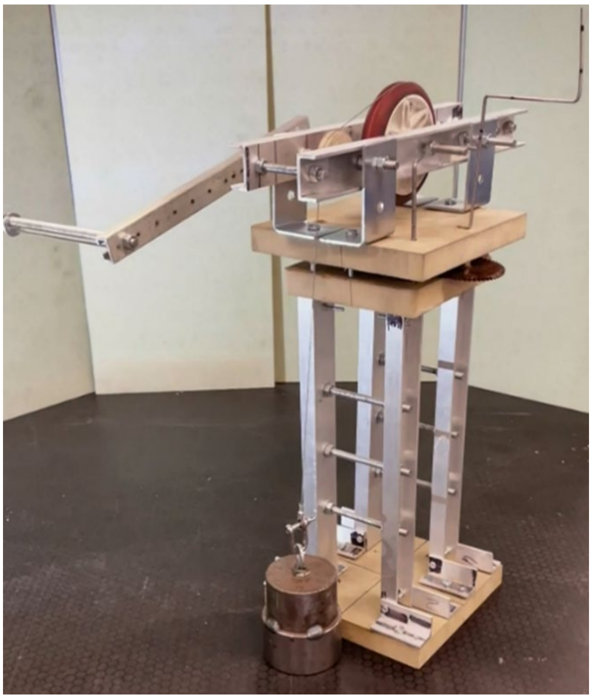


Quality – trialling the feel of the lifting crank. The candidate was observed on a number of times checking various stages of the performance of the crane as it was built.



Work on the rotation mechanism can be seen here (red arrows) but time is running low for the candidate. This does not reflect the solid style of the rest of the build and I feel that given time, the candidate would make a more robust fix. This might be an area for improvement in the evaluation.

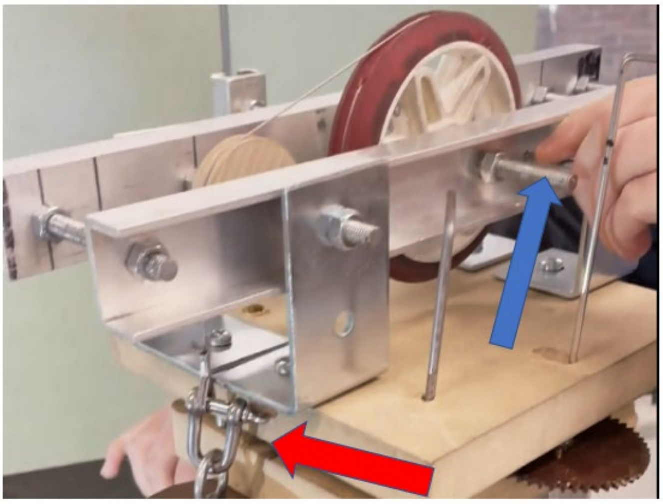
Testing of the prototype



The device is manufactured at 5th scale and successfully lifted the 5.2kg test mass to 278mm.

It is of a sturdy construction which presented no problems with stability. In addition, there were no noticeable issues with deflection in the structural elements.

The load was raised by turning a large crank handle which made very light work of the test load, due to the length of the crank. A large wheel and tyre was used to reel in the steel cable and this was locked into position using a pin through the spokes of the wheel as detailed on the next slide. The locking peg can be seen (blue arrow) and this requires careful alignment to use as the operator cannot easily see the hole alignment.

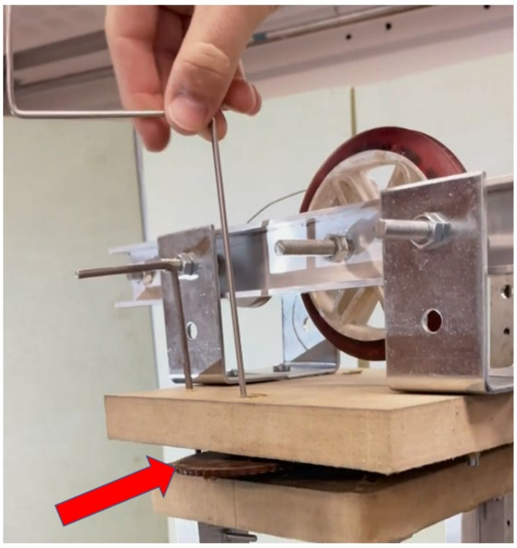


The location of the locking pin to secure the load is shown on the video, this is an image showing its location (see blue arrow).

Also in the image, you can see how the test mass D coupling clashes with the structure as it raises to the maximum height (see red arrow).The locking peg can be seen (blue arrow) and this requires careful alignment to use as the operator cannot easily see the hole alignment.

The crane rotation mechanism did not function as the candidate ran out of time to align and adjust it to work effectively, therefore, the crane was rotated manually.

This image shows how the rotation was locked into place using a peg after aligning two holes in the base structure (see red arrow).



At the end of the video, the candidate shows the incomplete stage of the slew gearing idea that was proposed to turn the crane.

There is no reason to doubt that this concept would work if further time was spent in making adjustments to the device.

The slew gear can be seen (see red arrow) and the meshing gear is mounted under the top plate.

Internal assessor signature	Date
x	Dd/mm/yy

Task 3 Peer review

Assessment number (eg 1234-033)	8714-321
Assessment title	Mechanical 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 forms Feedback record form
Date submitted by candidate	dd/mm/yy

Task 3

Assessment themes:

- Reports

You must:

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

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

none

Candidate evidence

Task 3 Peer Review Form 1

Assessment ID	Qualification number
	8714-321
Candidate name	**Candidate number**
<candidate>	ABC1234
Provider name	**Provider number**
<provider>	
Date	**Series**
dd/mm/yy	Summer 2025

Question	Feedback
Explain how well the diagrams/drawings meet the design criteria.	The candidate has met a variety of different points in the design criteria. This includes: • The prototype is a free-standing structure • The device rotates using a worm gear which also aids in the full 180-degree rotation and the 90-degree intervals. • The device is manually operated and powered • It can also lift the load to a max height of 300mm above the ground. This shows that the candidate has understood what the design criteria is asking and has demonstrated clearly in their drawings.
Explain how well the diagrams/drawings meet the specification criteria.	The candidate has met the specification and has clearly shown their level of understanding via their drawings/diagrams. • The device is assembled as a free sanding product and is fixed together using a variety of standard fixings including nuts and bolts • The candidate has also considered health and safety in their drawings
Explain how well the diagrams/drawings conform to the relevant conventions.	The candidate has shown the appropriate amount of relevant conventions throughout their drawings. • There are plenty of dimensions clearly shown out throughout their drawings indicating that they have thought about how their design would be built • The candidate has also provided a number of different drawing views including isometric, exploded views and zoomed in views.

Explain how the system could be optimised/improved.	One improvement that the candidate could consider is adding in rounded corners to further their health and safety considerations for their prototype when it is in use. Another improvement that the candidate could consider is adding another gear next to the other gear sat on top of the platform so it will allow the gears to interlock and to allow it to have 90-degree intervals.

Task 3 Peer Review Form 2

Assessment ID	Qualification number
	8714-321
Candidate name	**Candidate number**
<candidate>	ABC1234
Provider name	**Provider number**
<provider>	
Date	**Series**
dd/mm/yy	Summer 2025

Question	Feedback
Explain how well the diagrams/drawings meet the design criteria.	Your designs and diagrams that have been presented shows that the design has been designed so that it can be disassembled by the use of the fixings nuts and bolts making it a 'non-permanent product.' Your design also show that the design is manually powered by the use of a winch and gears. The self-locking mechanism that you have decided to used is a pawl which allows for the pulley to lock in place when the rotation of the handle is stopped. You have also shown that you use gears that stop rotating when the handle is turned.
Explain how well the diagrams/drawings meet the specification criteria.	After looking at your design specification I can see from your drawings that your design is free standing due to it being mounted to an MDF block. Components like nuts and bolts have also been used which shows that it can be disassembled showing the criteria of being 'non-permanent' has been met. The design also shows that the product is strong enough to lift the 5.2kg weight.
Explain how well the diagrams/drawings conform to the relevant conventions.	All drawings have the appropriate dimensions allowing for a third-party person to manufacture the product from the drawings. Your drawings also show different views. Your CAD drawings shows different parts allowing sub-assemblies to be noticed and allowing for details to be seen. All drawings show different views and details that are required. One improvement that can be made is adding a title to your sketches to allow peers to tell which designs are which for example design 1, design 2 and design 3. Having titles will also allow the product name to be known and will allow for the drawings to be easily recognised. Health and safety considerations are clear and all your drawings and diagrams are clear and presentable. Your design sketched are well annotated and presented.
Explain how the system could be optimised/improved.	An improvement to your design that I think will be a good adaptation will be to add degree markers this will allow for the 90-degree mark to be shown.

Task 3 Peer Review Form 3

Assessment ID	Qualification number
	8714-321
Candidate name	**Candidate number**
<candidate>	ABC1234
Provider name	**Provider number**
<provider>	
Date	**Series**
dd/mm/yy	Summer 2025

Question	Feedback
Explain how well the diagrams/drawings meet the design criteria.	I believe that the candidate has a good understanding of the design criteria, in particular the idea of using a self-locking mechanism to ensure that the design can be locked to 90-degree intervals. I also believe that they have considered the idea of allowing all designs to fully slew, having an unrestricted slewing motion from point A to point B
Explain how well the diagrams/drawings meet the specification criteria.	I believe that the candidate's designs use a heavy base as was detailed within their specification to ensure that the design stays down at ground level, without toppling over and potentially injuring any user. I also believe that all of their designs allow for at least 300mm of vertical movement, as detailed within their specification, to allow for the design to meet another key point listed by the candidate.
Explain how well the diagrams/drawings conform to the relevant conventions.	I think that the candidate's drawings have good detailed views, which they are using to show intricate components and fixings clearly, allowing any user or third party to easily see the design flow and ideology of their designs. I also think that the candidate uses a good use of orthographic views to show their design idea in a variety of different ways, allowing for the users to visualise their product more clearly.
Explain how the system could be opsed/improved.	Whilst the candidate's chosen design uses a weighted base already, I believe that it could benefit from having a larger base. This larger base would allow for the design to have a larger surface area for it to distribute the load across, providing stability and ensuring that the design will not begin to topple over during situations where the load might be higher than that specified to be used by the client. I also believe that the candidate's design will need a counterweight to be added to the pulley system used to pick up the 5.2kg mass. I believe this as it will improve the centre of gravity of the design, once more improving the overall stability of the design, as well as allowing the user to much more easily pick up the mass, without having to strain too much, or without having to put excessive force in to move the load.

Task 3 Feedback record form

Assessment ID	Qualification number
	8714-321
Candidate name	**Candidate number**
<candidate>	ABC1234
Provider name	**Provider number**
<provider>	
Date	**Series**
dd/mm/yy	Summer 2025

Candidate's notes
To optimise/improve my crane design instead of using a worm wheel and gear a planetary gear mechanism could be used for more reliability and simplicity. Another way it could be optimised/improved is by using two legs instead of four to save manufacturing time and weight.

Task 4 Evaluation and implementation

Assessment number (eg 1234-033)	8714-321
Assessment title	Mechanical 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 Peer review feedback report Design and development Report
Date submitted by candidate	DD/MM/YY

Task 4

Assessment themes:

- Health and Safety
- Design and Planning
- Reports

You must:

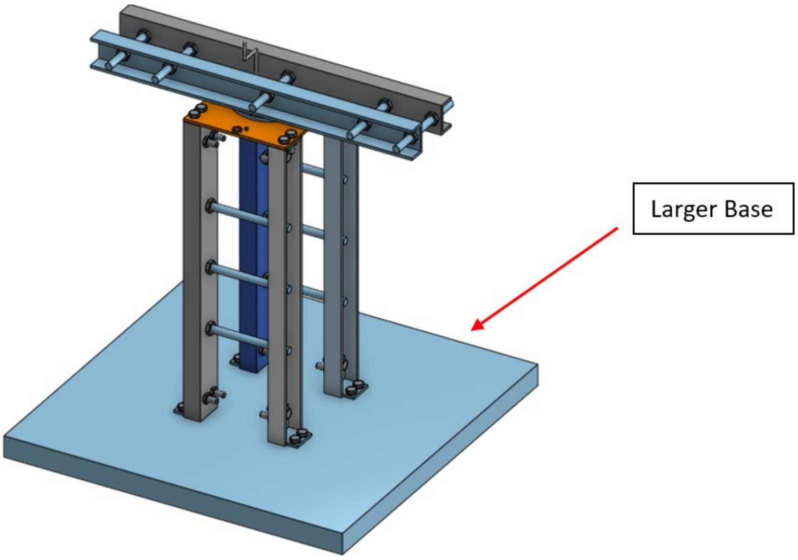
a) update the virtual model of the final design solution using appropriate software to incorporate any changes made and research completed in response to feedback or as a result of manufacturing and testing
b) produce a revision control document or report justifying why changes were made or not made as a result of the peer review feedback. This document should typically be 500 words
c) produce a report evaluating the design 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:

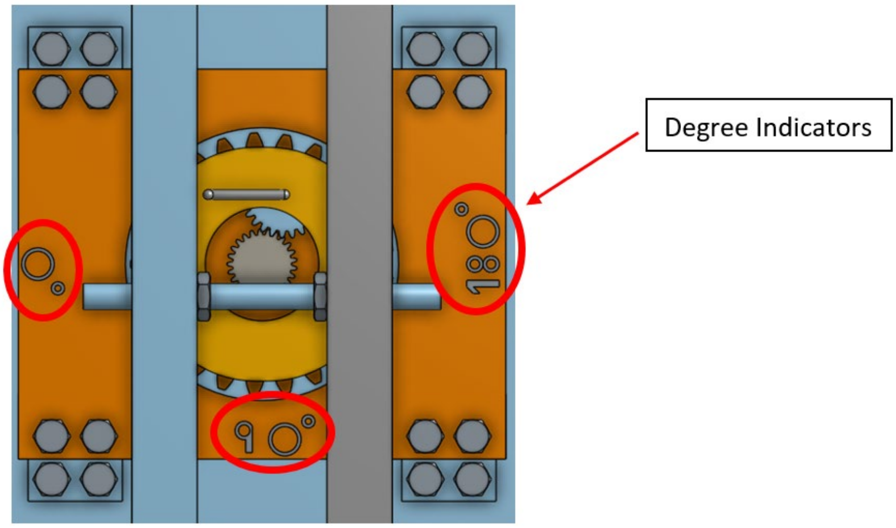
None

Candidate evidence

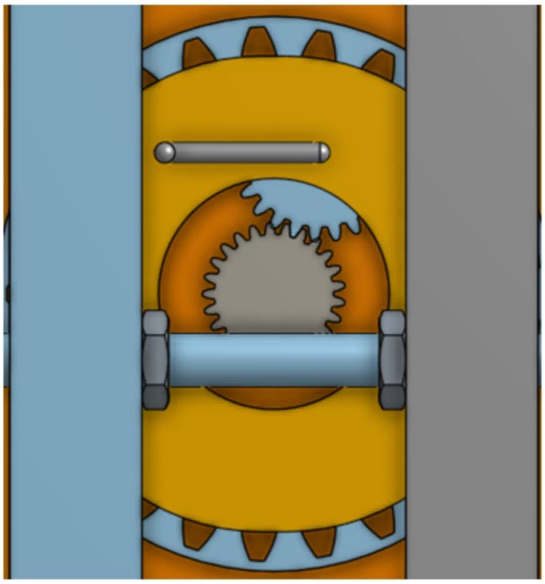
Task 4 Changes to virtual model

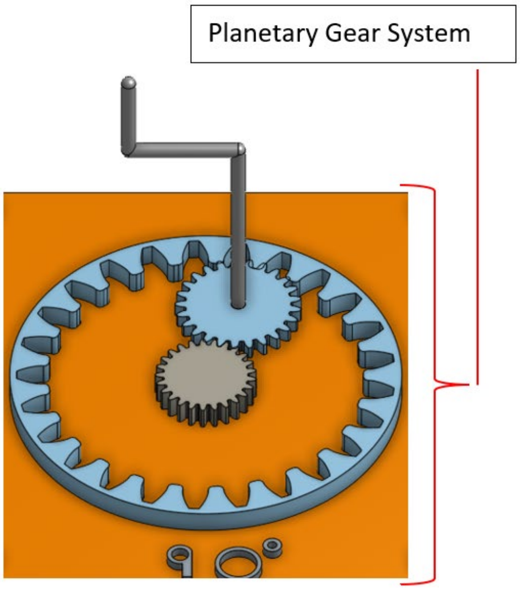


The first change I have made to my crane is by making the base that the crane is mounted on larger, by making the base larger it will provide more stability and make the centre of mass lower down because there is more weight at the bottom. The base size was originally 200mm (long) x 200mm (wide) x 25mm (thick) and it is now 400mm (long) x 400mm (wide) x 25mm (thick).



The second change I have made to my crane is adding markers to show the operator how many degrees it has moved, the markings I have added read 0 degrees, 90 degrees and 180 degrees, before these were added there was no way of telling how many degrees the crane had rotated.





The third change I have done is by using a planetary gear system instead of the swivel plate, gear and worm wheel. By using a planetary gear system, it is more reliable and durable because there are fewer components and it provides more power because less energy is being lost through other parts moving.

Task 4 Peer review feedback report

Design description

My crane is constructed to be durable and functional by using a strong construction paired with simple mechanisms, the mechanisms used are to allow it to swivel, lift the mass and lock components into place. To make sure the crane is sturdy I have used four legs as vertical supports which are securely bolted down to a large base made from MDF, these legs are also bolted in pairs for additional rigidity. Mounted on top of the legs is a top plate which is used to mount the swivel mechanism, winching mechanism and the two jibs. The winching mechanism works by a big pulley that was a large crank attached to allow for a lot of mechanical advantage and attached to the pulley is steel cable which has a D shackle on the other end which is used to attach to the mas.

Changes to the existing system

The changes that have been done to the existing system where suggested to me by my peers while doing the peer review. The first change I have made is by making the base that the crane is mounted onto larger, I thought this was a very good suggestion because it will provide more stability since it will be heavier making the centre of gravity lower down. The peer also suggested using a counterweight but I disagree with this because when the crane was being tested it didn’t experience any stability issues and this is because of how the crane is constructed and how the weight is distributed.

The second change that I have made is by adding markings every 90 degrees to show how many degrees the crane has rotated, this is a very useful as when the crane is being operated it will make it obvious when to stop rotating the crane every 90 degrees.

The third change I have done is one that I suggested myself and that was to use a planetary gear system instead of the swivel plate, worm wheel and gear mechanism which was used in the testing of the crane and failed to function properly. The main reason for using a planetary gear system is because they provide more reliability because of their simple construction. I also thought about using two vertical legs instead of four but decided against this because it will affect the structural integrity and change the overall weight of the crane which may cause it to tip over when lifting the mass.

While manufacturing I came across a few issues with my design such as mounting the two jibs, the problem was when I added the pulley wheel it stuck out further than the jibs so I had to use some large brackets to mount it on these were standard components that I used.

Changes to technical documents

Since new components have been added to the crane this means changes will have to be made to the existing technical documents, this include the BOM (Bill Of Materials), SOP (Standard Operating Procedures), risk assessment and technical drawings. The BOM will have to be changed due to some components being removed such as the swivel plate, worm wheel and gear because they are being replaced with a planetary gear system which will have to be added. The SOP has to be changed because the order in which the components are made and the order that the crane is assembled will have altered. The risk assessment will have to be carried out again if new hand tools and machines are being used to make sure the manufacturing is done safely. The technical drawings will have to be change due to the addition of new components to show where they are located as well as this the dimensions must be shown to show what size they need to be made.

Comments

Overall, I thought the peer review was a very informative task and allowed my crane to be optimised/improved by my peers suggesting new ways of things being done and it also helped me back up my idea of why I chose to design the crane that way because of questions that were being asked.

Task 4 Design and Development Report

Third party implementation

To make it easy for a third party to manufacture the design I have included a variety of views in my technical drawings and sketches these include close ups, exploded views, plan view, side view, front view, back view and views of each individual component. I also included adequate dimensions, annotations and health and safety considerations these are all very useful and important pieces of information because it shows how the finished product should look, how the product is fitted together and what parts are used to manufacture it. I have also created a highly detailed CAD (Computer Aided Design) model to help create a realistic representation of the design which will make it easier for a third party to understand my design and how it operates. I have also produced a BOM (Bill Of Materials), this clearly shows te name of the components used, the quantity of each one and what material they are manufactured out of. Additionally, some legislations may have to be followed such as PUWER (Provision and Use of Work Equipment Regulations) this makes sure the work equipment such as power tools and hand tools are in safe working order. Another one which will have to be followed is HASAWA (Health And Safety At Work Act) this is to protect all workers by making sure all the tools and work environment is safe and doesn't pose a risk to anybody health, this can be followed by providing appropriate PPE and giving the correct training.

Calculations

To calculate the operating efficiency of the device I have used the velocity ratio equation.

To first calculate this, I found the diameter of the driven gear which was 60mm, then I found the diameter of the driver gear which was 13mm. I then divided the diameter of the driven gear by the driver gear to get an answer of 4.6. The answer 4.6 means that for every 4.6 turns of the driver gear the driven gear will do one complete rotation meaning the mechanical advantage (efficiency) is 1 : 4.6

Testing methods

To test my crane and to see how well it works against the design and specification criteria I used the most appropriate testing techniques/methods for each criteria to get the most accurate result, the testing methods for each criteria were:

Manually powered and operated – To see if the crane was able to meet these criteria the test done was a visual inspection, an example of this was to see if when a handle such as the one attached to my winch was turned the component it was attached the pulley had moved at all.

Able to rotate 180 degrees – This was done by preforming a visual inspection but it could be more accurate if an angle finder or protractor was used.

Locking mechanism in 90-degree intervals – This was done by doing a visual inspection as well as a physical inspection to make sure it didn't move when the locking mechanism was engaged.

Lift a minimum mass of 5.2kg – To do this test there was an assigned weight to use that had been weighed out prior to the test and then a visual inspection was done to see if it was lifted off the ground.

Lift a maximum of 300mm off the ground – To check this a tape measure was used to get an accurate measurement.

Free standing – This test performed by doing a visual inspection.

Lifting carried out safely – To check it could do this a visual inspection was done to make sure everything was preforming safely and wasn't going to fail.

Assembled as a non-permanent product – This was done by doing a visual inspection to check fasteners had been used since they can be removed easily.

Fit for purpose

My crane was able to complete most of the tests which showed it conformed to the specification, the crane was mostly manually powered and operated except for the swivel mechanism that was supposed to rotate when the gear was turned by a handle but there were issues with the gears meshing so it was unable to work but it would rotate by hand and for the full 180 degrees. The locking mechanism that was used to lock in 90-degree intervals worked as intended and this was done by a pin that was placed through the top swivel plate and into the bottom swivel plate which securely locked it into place. The crane was able to lift the mass which weighed 5.2kg by using a reliable winch and pulley system which also had a locking mechanism that worked by using a pin to go through the pulley to lock it into position. While the crane did lift the mass, it didn't lift it a maximum of 300mm but instead only 280mm. The crane is free standing because is its mounted onto a base that is not fastened down allowing it to be moved. The lifting operation was carried out safely because the crane was stable due to its construction and reliable mechanisms such as the winch, pulley and locking mechanism. The crane is assembled as a non-permanent product by using fasteners such as nuts bolts and screws allowing it to be easily disassembled.

Improvements

Some improvements that can be done in the future are using a counterweight which is incorporated into the winching system, this would improve the lifting operation because the counterweight would help to pull the mass up taking stress off the winch crank and it would also be safer because if the operator were to let go of the handle instead of it rotating quickly and the mass falling down which would be dangerous it would only rotate slowly because the counterweight is holding back the mass from free falling.

Another improvement that could be done is by making the jibs longer, this would improve the crane because it would give more clearance for the movement of the mass because it will be further away from the main structure of the crane. This means when the mass is lifted if it starts to sway then it won’t hit the crane structure and damage it.

Principal Moderator Commentary

The candidate applied excellent knowledge and understanding when analysing a range of health and safety considerations as part of the design specification, referring to the stability of the crane. The risk assessment was detailed and identified a range of potential risks and hazards with consideration of the work area, tools and equipment to produce the prototype and control measures.

The candidate demonstrated the ability to work safely with well-founded and informed decisions when selecting tools, materials and equipment to manufacture the prototype of the crane. This was evident during preparation and throughout tasks. A comprehensive range of health and safety considerations were included as part of the design evaluation and implementation report, with reference to relevant legislation and standards.

The candidate interpreted information with comprehensive technical knowledge considering all points required in the specification with consideration of most key materials and design calculations. The candidate demonstrated excellent use of software and technologies to model, evaluate and produce mechanical engineering drawings and simulations that met the requirements of the brief. Drawings and diagrams were clear and contained most of the appropriate information needed for a third party to reproduce them. Use of virtual modelling was comprehensive, meeting all requirements of the design criteria, including any changes and modifications as suggested in the evaluation and implementation report.

The candidate demonstrated excellent knowledge and technical skills when selecting and using appropriate tools and equipment to manufacture the prototype model of the crane. The crane met all requirements of the design criteria and was functional. However, the candidate was unable to complete the crane rotation mechanism in the time given, therefore, the crane was rotated manually. The candidate applied comprehensive knowledge and understanding of testing processes, resulting in a prototype that was functional to a high degree of accuracy.

The candidate used accurate industry and technical terminology consistently in written contexts. Their implementation report contained comprehensive information that would allow a third party to reproduce their design, with screen shots clearly displaying modifications and changes to the design proposal following peer feedback. Reports and records were detailed and accurate throughout with correct industry terminology, with a detailed evaluation of testing outputs against the design criteria.

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

T: 0300 303 53 52

E: **technicals.quality@cityandguilds.com**

W: **http://www.cityandguilds.com/tlevels**

Web chat available **here**.