Cambridge Nationals in Engineering Manufacture

NAME:

CENTRE NUMBER:

CANDIDATE NUMBER:

Project overview

In this project, I aim to make a small, aluminium billet- combining several engineering tools and methods of manufacture – of cylindrical shape with a chamfer and a ⌀5mm hole drilled on one pole of it, with flat, faced ends, based off of a production drawing given to us. This piece has to be to scale as well as to the given dimensions within allowed tolerances. I plan to perform methods of drilling, facing, turning and milling in order to achieve this.

The equipment I will use will be:

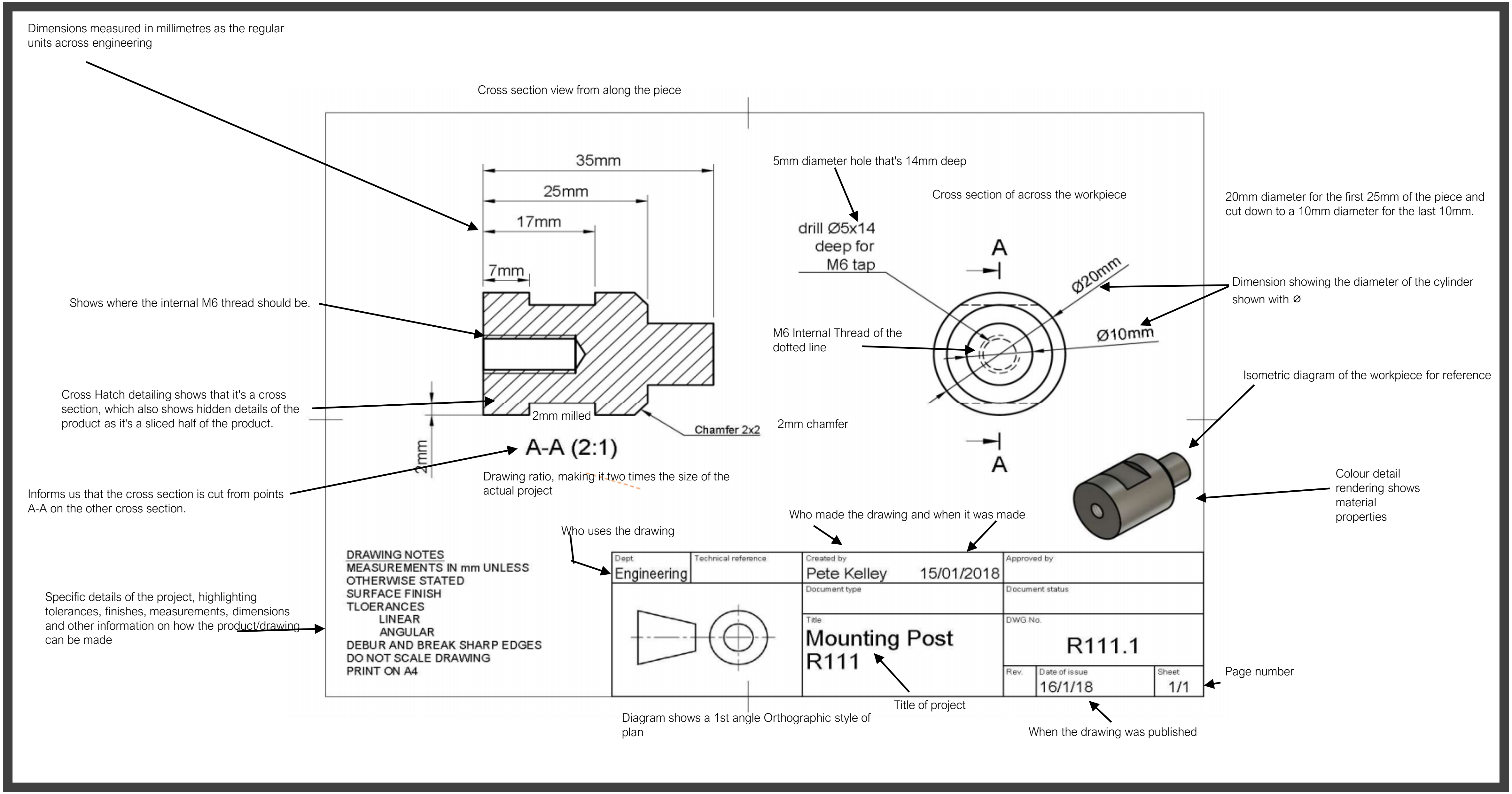
- Metal Lathe
- Vernier Callipers
- Milling Machine
- Facing, parting, chamfering and drilling tool
- Tap and die

The main safety rules I must consider during this production are:

- Wear correct PPE
- Put away dangling items and jewellery
- No running
- Don't put hands near the machine in operation

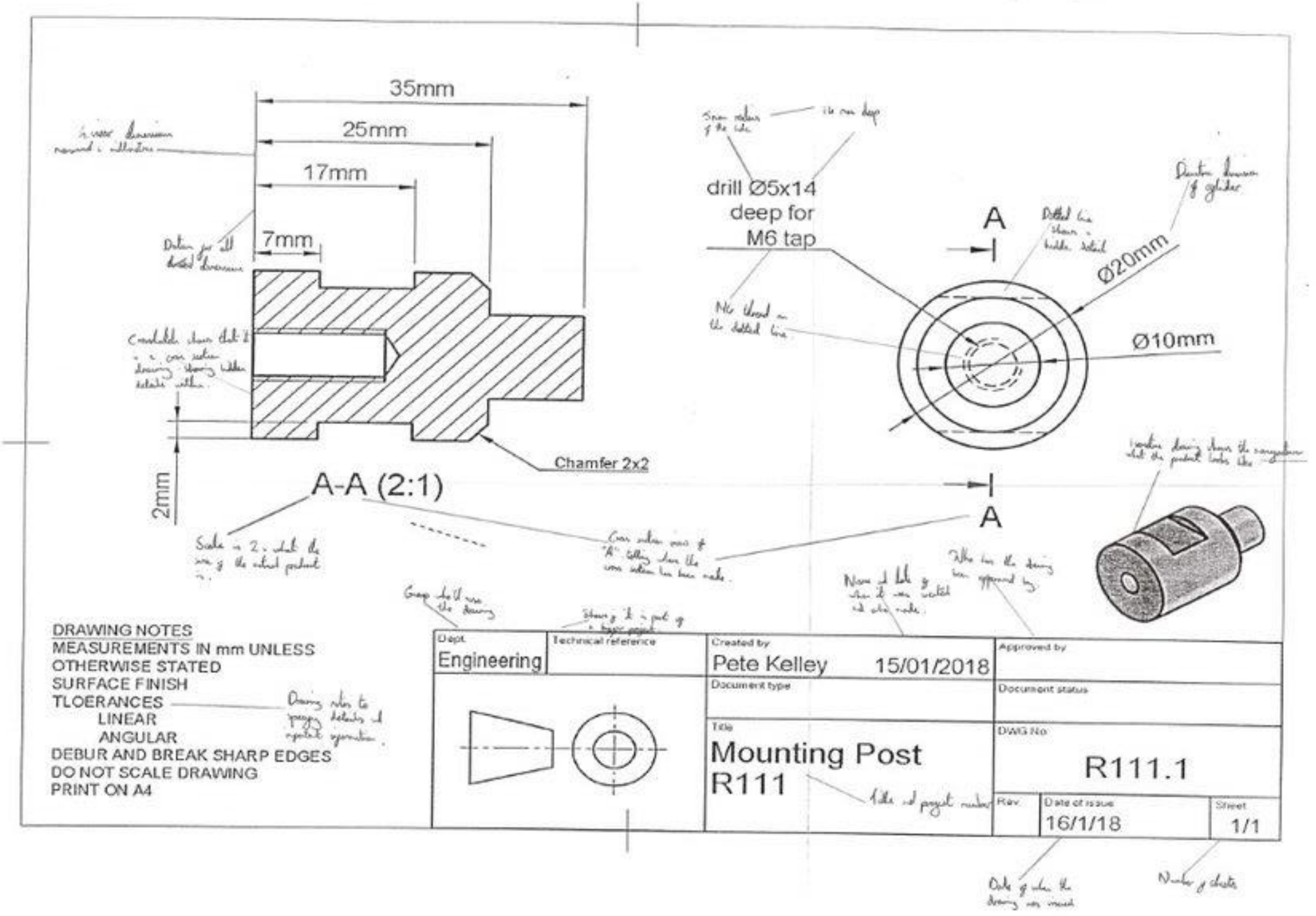
The PPE I will use will be:

- Goggles
- Safe shoes
- Protective overcoat



Dimensions measured in millimetres as the regular units across engineering
Cross section view from along the piece
35mm
25mm
17mm
7mm
Shows where the internal M6 thread should be.
Cross Hatch detailing shows that it's a cross section, which also shows hidden details of the product as it's a sliced half of the product.
2mm milled
2mm
Chamfer 2x2
2mm chamfer
A-A (2:1)
Informs us that the cross section is cut from points A-A on the other cross section.
Drawing ratio, making it two times the size of the actual project
5mm diameter hole that's 14mm deep
drill Ø5x14 deep for M6 tap
Cross section of across the workpiece
A
A
Ø20mm
Ø10mm
M6 Internal Thread of the dotted line
20mm diameter for the first 25mm of the piece and cut down to a 10mm diameter for the last 10mm.
Dimension showing the diameter of the cylinder shown with Ø
Isometric diagram of the workpiece for reference
Colour detail rendering shows material properties
Who made the drawing and when it was made
Who uses the drawing
DRAWING NOTES
MEASUREMENTS IN mm UNLESS OTHERWISE STATED
SURFACE FINISH
TLOERANCES
LINEAR
ANGULAR
DEBUR AND BREAK SHARP EDGES
DO NOT SCALE DRAWING
PRINT ON A4
Specific details of the project, highlighting tolerances, finishes, measurements, dimensions and other information on how the product/drawing can be made
Dept. Engineering
Technical reference
Created by Pete Kelley 15/01/2018
Approved by
Document type
Document status
Title Mounting Post R111
DWG No. R111.1
Rev.
Date of issue 16/1/18
Sheet 1/1
Page number
Title of project
Diagram shows a 1st angle Orthographic style of plan
When the drawing was published

Adam


35mm
25mm
17mm
7mm
2mm
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drill Ø5x14
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A
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Ø10mm
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Types of lines used in engineering drawings

(see fig 1 for reference)

Construction lines: Used to outline the edges of the drawing and therefore have to be bold, outstanding and continuous.

Centre line: Refer to circular features on a 2D drawing.

Hidden lines: Show hidden or invisible edges of a design.

Phantom line: Indicate a part or edge that isn't incorporated into the final product.

Break line: To show breaks within the drawing

Dimension lines: Demonstrates the measurement value of a line.

Leader: Connects an important feature to text

Cutting Line: Bisects the shape and shows the inside of the project

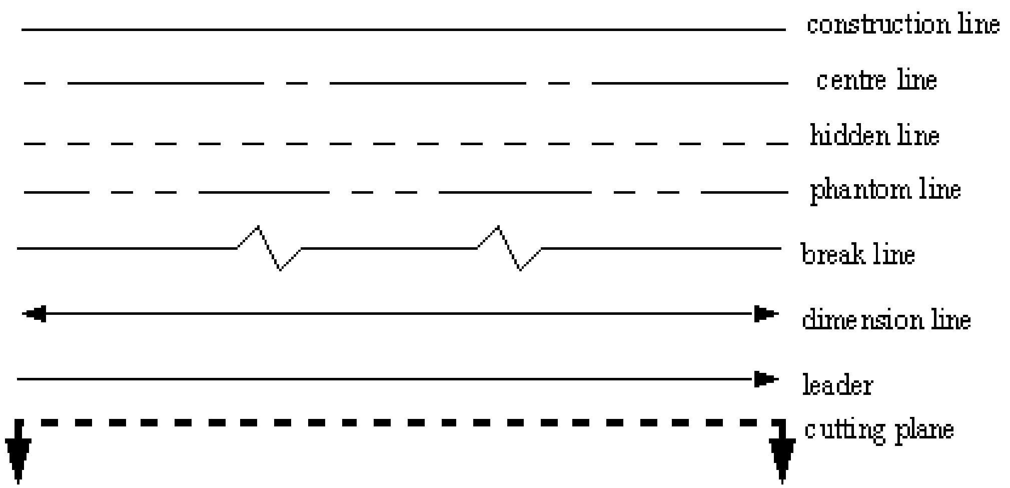


Fig 1: mhhstechnology.wordpress.com

Orthographic projections

Orthographic drawing is a method of which designers can demonstrate a 3D product onto a 2D presentation, showing a front view, a side view and a plan (top) view- every angle of a product

1st angle projection, represented by is a method of presenting where the object is located between the observer and the plane of projection, and the plan view is beneath the front view, whilst the side view is parallel to the front and to the left. This method is used in the UK

3rd angle projection, represented by contradicts the layout of 1st angle, by having the plane of projection lie in between the observer and the object, as well as having the plan view above the front, and the side be parallel and to the right of the front view. This method is used in the US.

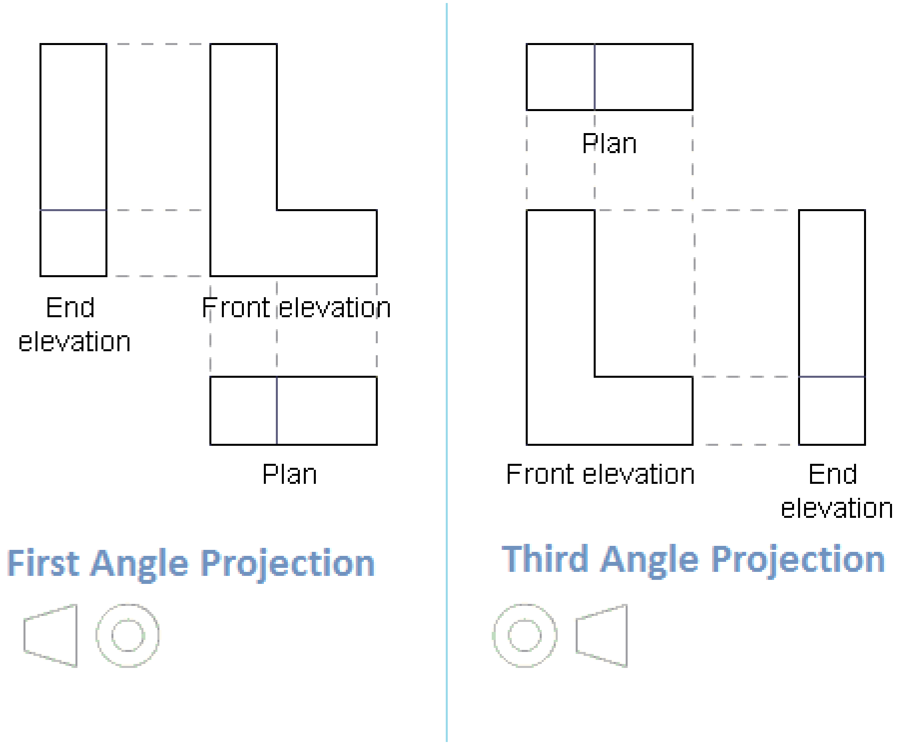


Fig 2: basiccivilengineering.com

Isometric drawings

Isometric is a method of 3D projection where every vertical edge is presented as parallel and true, however horizonal edges are off at an angle of 30 degrees from a normal horizontal axis giving a 3 dimensional effect.

Compared to an orthographic drawing, isometric shows a 3D form of the finished product as one drawing, with one or more views from an orthographic drawing presented. Because of this, orthographic and isometric drawings often are used in conjunction with one another on an engineering drawing, as it presents the full product.

3D and 2D drawings

3D DRAWINGS

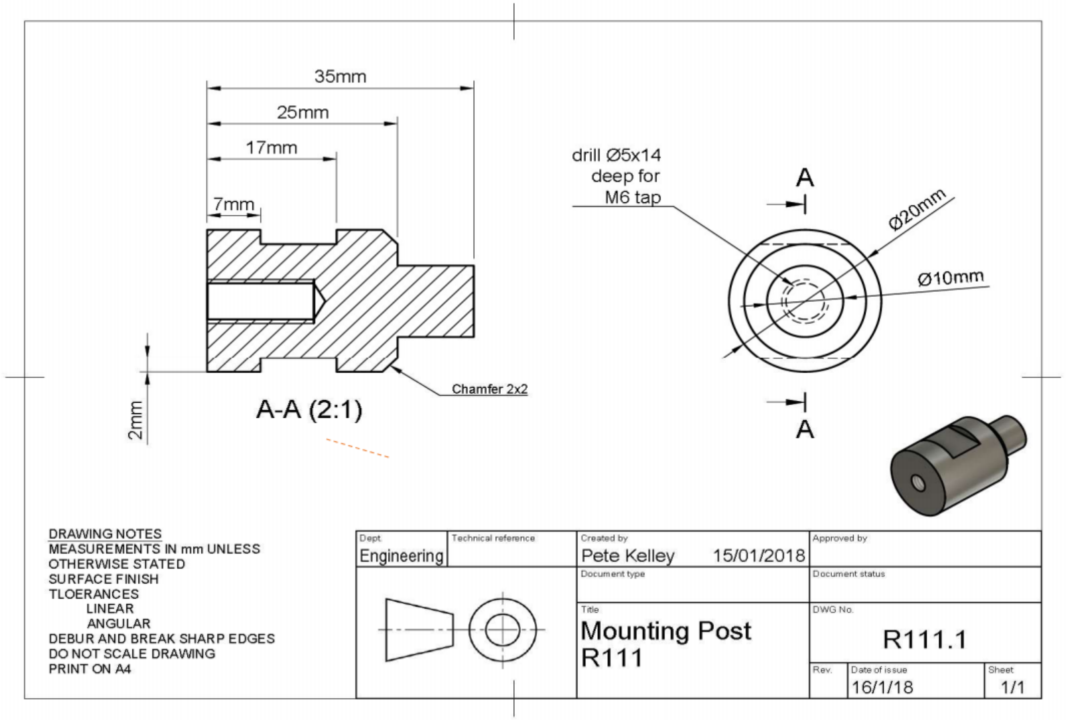
3D drawings are used in design to get a clearer understanding of the finished product as a whole- understanding tolerances, function and spacing in between individual parts of the product. Examples such as isometric drawings and exploded diagrams can assist majorly in understanding a product's assembly and processes in a project. The extra dimension when compared to 2D drawings help when it comes to textured or extra features within the product such as drilled holes and millings.

2D DRAWINGS

2D drawings are easier to produce than 3D ones, however they are more often used for individual parts rather than the product due to their simplicity. These are always to scale and present length and width but lack depth. Orthographic projections are used in order to get a full understanding of a product, as despite it losing perspective, it can still represent every face and detail.

British Standard BS8888

BS8888 is the document dictating the standard that all engineering drawings, layouts and specifications are required to meet within the United Kingdom. As well as that, it covers exactly how technical drawings should be presented, including defining symbols, lines and information which have to be included in technical documents- replacing the former B308 national standard.



Tolerances in engineering

Tolerances are allowances for products or parts to not fully meet the required sizing. This variation is done in order to limit the amount of wastage, as it is incredibly difficult to get an exact size in manufacturing, for both manual and automated manufacturing. In drawings the tolerance symbol is represented by ±, and next to it will describe the allowed variation of the dimension.

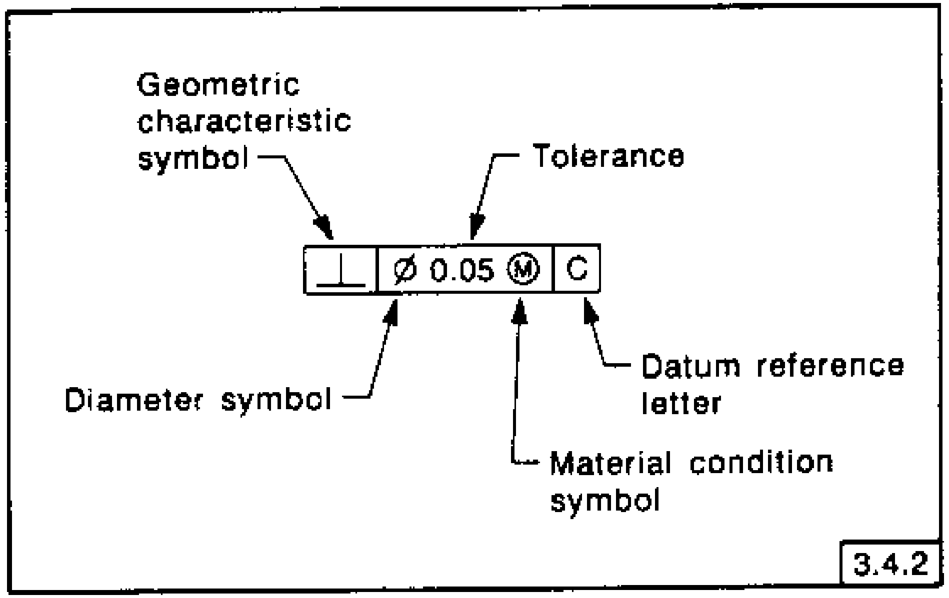


Fig 3: joshuanava.biz

Material specification

Material specifications are a given requirement of product testing, storage, appearance, etc, for the materials you would be using in the manufacture. Using a material specification means that the product will have its properties uniformly and not have different levels of functionality from product to product; as well as that, it should go hand in hand with the technical drawing for maximum clarity before manufacture.

TABLE 1 CHEMICAL COMPOSITION OF ALLOYS AND PHYSICAL PROPERTIES OF ALUMINIUM ALLOY PISTONS

(*Clause* 3.1)

(Values are in percent *Max*, unless shown otherwise)

*Alloy Designation		Chemical Composition, Percent												Physical Properties†			
Casting	Forging	Cu	Mg	Si	Fe	Mn	Ni	Zn	Ti	Sn	Pb	Cr	Al	Hardness (HB)	Tensile Strength N/mm² (kgf/mm²) Chill casting	Tensile Strength N/mm² (kgf/mm²) Forging	Coefficient of Thermal Expansion (20-200°C) cm/cm°C×10⁻⁶
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
2285	24850	3·5-4·5	1·2-1·8	0·6	0·7	0·2	1·7-2·3	0·2	0·2	0·05	0·05	—	Remainder	90-130	225-275 (23-28)	345-410 (35-42)	23-24
4658	49582	0·8-1·5	0·8-1·3	11·0-13·0	0·8	0·2	1·5‡	0·35	0·2	0·05	0·05	—	Remainder	90-140	195-245 (20-25)	295-365 (30-37)	20·5-21·5
4928-A	49285	0·8-1·5	0·8-1·3	17·0-19·0	0·7	0·2	0·8-1·3	0·2	0·2	0·05	0·05	—	Remainder	90-125	175-215 (18-22)	225-295 (23-30)	18·5-19·5
4928-B	—	0·8-1·5	0·8-1·3	23·0-26·0	0·7	0·2	0·8-1·3	0·2	0·2	0·05	0·05	0·3-0·6	Remainder	90-125	165-205 (17-21)	—	17-18

*Alloys have been designated in accordance with IS : 6051-1970 'Code for designation of aluminium and aluminium alloys'.

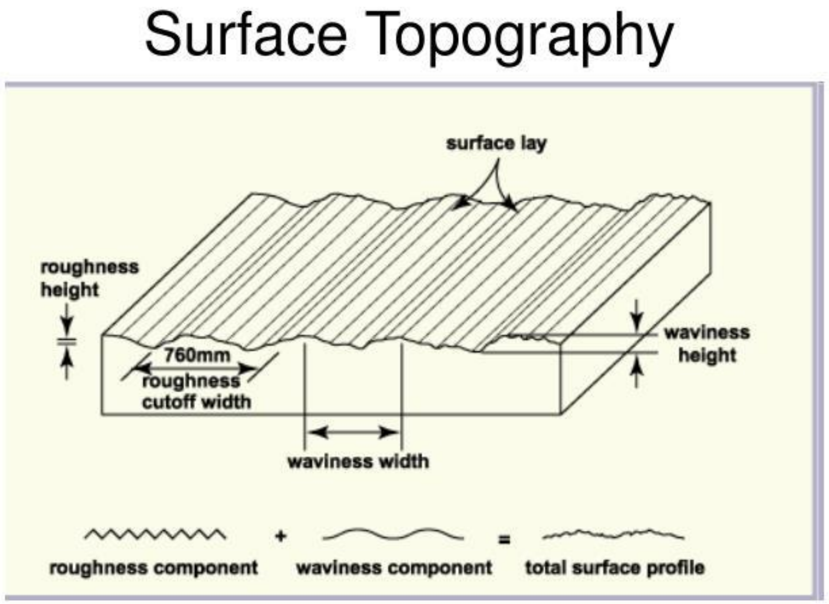
†Physical properties are attainable after suitable heat-treatment.

‡The purchaser may specify a minimum nickel content, if so desired.

Fig 4: Quora.com

Surface topography

Surface topography defines the overall finish of a material, it's variation of deviations across a perfectly flat plane of material. This defines its aesthetic but more importantly its friction, which makes it quintessential in the development of parts and components when it comes to establishing their roughness and thickness

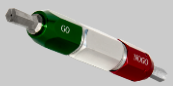
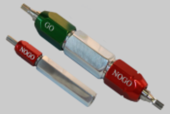
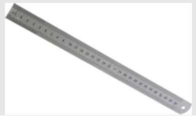


http://www.ami.ac.uk/courses/topics/0122_mos/index.html

Tools and Equipment

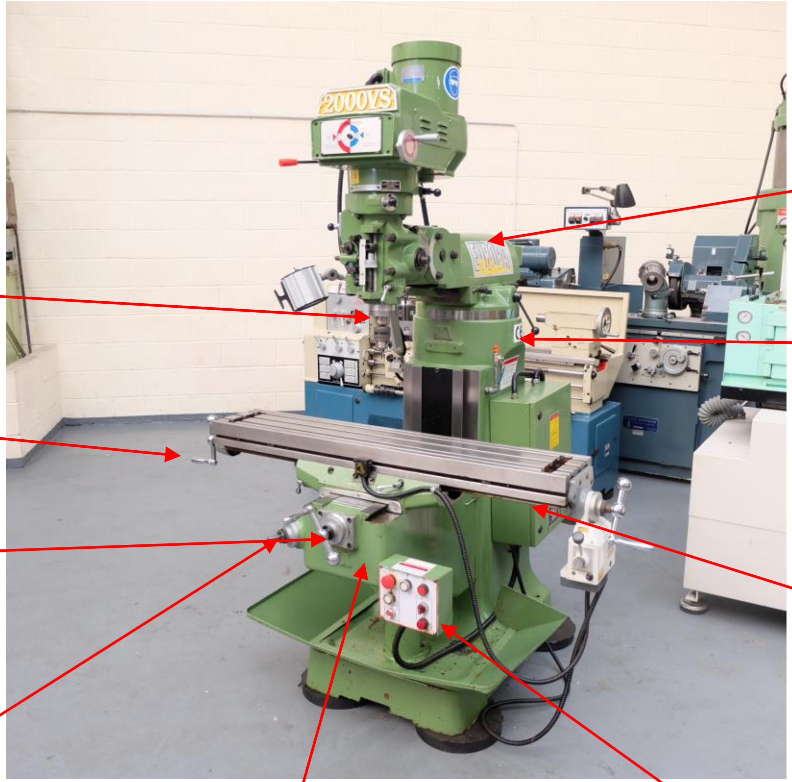
Here I will state the equipment, the apparel and the tools which I'm going to use during the manufacturing process

Tool	**Image, Diagram for reference**	**Purpose and function**
Personal Protective Equipment (PPE)		
Overcoat	 	The workshop safety overcoat (Interchangeable with a thick lined apron) is worn by manufacturers in the workshop to protect their entire body, their arms and lower body from physical harm. Such a piece of gear is recommended to be worn whilst operating any sort of machinery or tooling. It is thickly lined and shouldn't be loose fitting in case of catching.
Safety Goggles	 	Safety goggles are intended to protect the user from potential impact and chemical hazards within a workshop environment which could harm the eyes such as sawdust, fragments of metal, plastic etc. Goggles have been designed to fit around the eyes, forming a small protective seal- which prevents objects from flying in from your surroundings.
Gloves	 	Workshop gloves should be worn on most situations where you are operating a machine. They come in variations, specialised for chemical resistance, abrasion resistance, maximising dexterity, et cetera. However the use of gloves with revolving machinery, such as lathes, drills and some sanders are examples of where gloves make it more hazardous to operate since loose fibre and fabrics can catch and then drag the wearer into precarious situations.
Steel capped shoes/boots	 	Steel capped workshop boots are safety shoes worn in the workshop with steel either at the end of the foot or on the rims in order to protect the wearers' feet from dropped tooling, equipment, accidents, etc.
Lathing machinery, tooling and components		
Metal Lathe	 	A metal lathe is a machine lathe specialised in shaping hard materials such as, obviously, metal. It functions on several axis by rotating a cylindrical workpiece at high velocity into a stationary cutting tool. Cutting tools' functions can vary from threading, cutting, turning, facing et cetera.
Lathe chuck	 	The lathe chuck is a specialised clamp which is used to hold the rotating workpiece as it goes toward the cutting tool . They possess varying amounts of jaws which can be tightened or loosened to grab the workpiece, using either a chuck key or manually for simplicity.
Facing tool	 	A facing tool is a small cutting tool used for lathes in order to face off, or "flatten", workpieces. This operation is performed by bringing the tool- at a centre level- across the workpiece until by observation the workpiece is flat faced.

Tool	Image, Diagram for reference	Purpose and function
Chuck key	 	The chuck key is used with the chuck by tightening or loosening its jaws over a workpiece; it also, in some, more modern machines, can function as a safety feature- as if the chuck key remains inside the chuck, it poses a risk as it could end up being launched across the room if the machine turns on- and if the chuck key remains inside the chuck, the lathe will not turn on.
Emergency Stop	 	The emergency stop feature on a lathe is a safety requirement on all lathes and can come in several forms to easily and rapidly close the machine's operation : In pedals, buttons, levers and switches to be prepared for any emergency or accident.
Mounting Post	 	The cutting tool is mounted onto this and tightened to keep it steady as it
Measurement Tooling		
Go/No go- gauge	 	A go/No- go gauge is a tool used to inspect an object against it's allowed tolerances, making sure that a cut or a radius is done to a set accuracy via a "go" signal and a "no-go" signal.
Vernier Callipers	 	Metric vernier callipers detail the dimensions of small (as in <1cm) measurements up to larger (>10cm) projects precisely in either digital or non-digital format. The Vernier scale determines the distance between two points, markings, on a linear scale.
Calliper		Callipers come in many variations, vernier callipers being one of them, which can measure the internal distance between two points and the external distance between a pair of points. However the older versions of callipers require manual adjustment before use. An example of the usage of exterior callipers would be using them to measure the diameter of a pipe.
Steel Rule	 	A steel rule is a simple, straight measuring tool used to measure lengths accurately in either metric or imperial measurements.


Toolpost
Headstock
Chuck
Compound Handwheel
Emergency Stop
Tailstock
Lathe bed
Cross slide
Motor Lever
Saddle Handle
Saddle
Colchester
Student
2500

Metal Lathe



Milling Machine

The piece

The piece I'm going to be making is a 35mm x ⌀20mm piece of bar, which diameter becomes thinner (via a 2mm chamfer) to ⌀10mm 25mm into the piece. It also has 2mm milled into it, as well as a ⌀5mm x 14mm deep hole on the opposite end.

Pre-Production Plan

This is the pre-production plan, where I assess and predict the production process- its hazards, time, etc.

Stage no.	Stage name/ summary	Operation	Equipment Required	Time estimate (minutes)	Health and Safety	Quality Control
1	Gather materials	Obtain the round bar from the equipment storage or from a teacher as well as any protective equipment needed	Round bar of >70mm length	1	Have a tight grip to not drop, be aware of surroundings whilst holding the bar.	Ensuring that the workpiece is initially greater length than the end product stops it from cutting too short.
2	Cut the piece	By using a hacksaw, cut the bar down to the required length, being 70mm x 20mm round bar.	Power hacksaw machine, round bar	5	Wear the correct protective gear, not put hands near the blade, clamp the piece steady.	Marking it clearly makes it accurate, the length and with being greater than the product allows tolerances
3	Put the piece in place	Clamp the workpiece in a 3-jaw chuck, tighten it using a chuck key	Lathe, Chuck Key, Round bar	3	Tightening it prevents it from coming loose during the cut, remove the key, close the chuck guard and double check the tightening to ensure safety.	By checking that it is tight within the chuck, it prevents the piece from coming loose and ruining any cut you perform.
4	Collect cutting tool	Gather a facing tool from storage and mount it onto the machine, tightening and altering its place getting it as close to the centre of the piece as possible from eyes.	Lathe, Quick release mounting post, facing tool	5	Check that the tool's tip isn't broken, make sure that it is tight, get rid of any dangling lanyards or long hair which can catch.	Make sure the cutting tool is dead centre. Making sure that the speed is at the recommended amount (800 rpm)
5	Start the lathe	By turning the lever right and then down, it initiates the lathe in the correct working direction for the cut.	Lathe, round bar	0.2	Make sure the chuck key isn't present, clearing any swarf from the machine stops it from flying from the chuck towards you	By making sure the lever is pushed in the correct direction, it prevents the cutting tool from breaking upon contact

Stage no.	Stage name/ summary	Operation	Equipment Required	Time estimate (minutes)	Health and Safety	Quality Control
5	Face-off the piece at both ends	Once the lathe has started, bring the cutting tool to the circumference of the piece, then go forward a minute amount, then across slowly until the tip of the piece is at the centre- then bring the toll backward. Check that no nipple is left after a cut: if it's high, the nipple will be a cone shape, if it's low, the nipple will be rectangular or square-shaped. Repeat the step until no nipple is present- the piece will have a flat face on both poles	Lathe, chuck, workpiece	3	Make sure your hands are away from the machine. Making sure the machine goes in the correct direction makes sure that the cutting tool won't break and send a sharp, metal tip across the workshop. PPE equipment stops me from injuring myself from flying shrapnel.	Make sure the machine is going in the correct direction. Locking the tool in place prevents it from wobbling during the cut. Facing the piece makes sure that any measurement is accurate. Cutting a small bit as you face makes sure that you don't cut it too far down.
6	Measure and prepare for a parallel cut	Put the tip of the cutting tool just on the edge of the workpiece and stop the machine: wind the piece back, then- holding the outer ring still- turn the measurement ring to a ≤0.5 mm cut.	Lathe, chuck, cutting tool, workpiece	2	Make sure your hands are away from the machine and cutting tool as you finish	Going at a slow and steady pace, time the machine's stop correctly, doing it to ≤0.5mm makes sure that the finish is good and accurate
7	Perform a parallel cut	After, turn the machine back on and bring the piece forward toward the chuck- performing a parallel cut slowly and measure the cut piece afterward.	Lathe, Vernier callipers, workpiece, chuck	5	PPE equipment stops me from injuring myself from flying shrapnel. Make sure your hands are away from the machine. Making sure the machine goes in the correct direction makes sure that the cutting tool won't break and send a sharp, metal tip across the workshop. By cutting the piece in slower increments it prevents the tool from breaking by going too far into the piece.	Instead of downright doing the cut of 2mm, doing slow increments; measuring after each cut ensures that the piece is of upmost accuracy throughout the process

Stage no.	Stage name/ summary	Operation	Equipment Required	Time estimate (minutes)	Health and Safety	Quality Control
8	Repeat the last step x4	Perform the parallel cut four more times until the 22mm piece becomes 20mm diameter. At each repetition, measure the diameter of the workpiece to ensure you don't cut too far and adjust accordingly.	Lathe, Vernier callipers, chuck, workpiece	15	Stopping the machine before measuring the workpiece stops accidents from happening. Going slowly at every cut prevents either the workpiece or the cutting tool from breaking.	Performing each cut to the exact same method minimises the chances of going off or making mistakes.
9	Cut the first 10mm length of the piece to 10mm diameter in accordance with the production diagram.	Put the tip of the cutting tool just on the edge of the workpiece and stop the machine: wind the piece back, then-holding the outer ring still- turn the measurement ring to a ≤0.5 mm cut. After, turn the machine back on and bring the piece forward toward the chuck- by revolving the compound handwheel by 2.5mm four times, and measure the cut piece afterward. Repeat this operation, measuring after, until the diameter is 10mm.	Lathe, Vernier callipers, chuck, billet	20	PPE equipment stops me from injuring myself from flying shrapnel. Make sure your hands are away from the machine. Making sure the machine goes in the correct direction makes sure that the cutting tool won't break and send a sharp, metal tip across the workshop. By cutting the piece in slower increments it prevents the tool from breaking by going too far into the piece.	With identical increments at consistent speeds, we ensure that the piece has a shiny finish and is done to the correct dimensions
10	Apply a 2mm chamfer to the piece at 45 degrees	Apply the 45-degree chamfer tool to the edge of the 20mm diameter and push it inward at a slow speed for 2mm	Lathe, chamfer tool	3	PPE equipment stops me from injuring myself from flying shrapnel. Make sure your hands are away from the machine.	By applying the chamfer at a slow speed, it ensures that the chamfer is accurate and has a good finish as well as avoids chipping to the workpiece and chamfer too itself
11	Part off the piece to 35mm length	Remove the billet from the 3 jaw chuck and measure its length, which should be >35mm, and mark the 35mm requirement. Accounting for the saw blade width, clamp the workpiece in a	Hacksaw	5	Using goggles prevents bits of the aluminium entering your eyes and causing potential damage. By using gloves and avoiding the blade it prevents accidents.	By accounting for the blade width and clamping it in a vice, it makes the cut as precise as possible.

Stage no.	Stage name/ summary	Operation	Equipment Required	Time estimate (minutes)	Health and Safety	Quality Control
12	Set up centre drill piece into the drill chuck on the tailpost-then apply cutting fluid onto the drill bit- reel it in close to the aluminium workpiece	Insert the drill into the tailstock turn to lock it. Then insert the centre drill bit and tighten. Apply a few drops of cutting fluid onto the centre drill bit, and then slide the tailstock up the ways	Tailstock, lathe, drill chuck, centre drill piece	2	Making sure to avoid the activation lever as you fit it avoids accidents.	Tightening the drill bit ensures that during the cut it won't wobble. Using a centre drill makes sure that the actual hole remains accurate and on course with the centre of the piece. Using cutting fluid also ensures a smooth and accurate hole.
13	Perform a centre drill cut	Bring the tailstock forward and perform a small hole in the centre of the aluminium piece.	Tailstock, centre drill	2	PPE equipment stops me from injuring myself from flying shrapnel. Make sure your hands are away from the machine. Using cutting fluid makes sure that the drill bit doesn't break and the cut is smooth.	Using a centre drill makes sure that the actual hole remains accurate and on course with the centre of the piece. Using cutting fluid also ensures a smooth and accurate hole.
14	Change the drill piece to a 5mm and perform a cut that's 14mm deep	Bring the drill chuck back to the ends of the ways and turn the lathe off. Remove the centre drill bit and replace with a 5mm diameter drill bit and apply cutting fluid. Bring the tailstock forward and perform another cut to 14mm deep before bringing the tailstock backwards on the ways.	Tailstock, drill chuck, 5mm drill piece, lathe, ways.	9	PPE equipment stops me from injuring myself from flying shrapnel. Make sure your hands are away from the machine.	By having made a centre hole before performing the main cut, it ensures that the hole is straight, quick and won't waver from the desired cut. Using cutting fluid also ensures a smooth and accurate hole.
15	Thread the hole with an M6 thread using a tap and die	Remove the piece from the chuck and clamp it in a vice. To begin tapping, rotate the taper bit clockwise until you feel resistance from the threads cutting into the material. From there, for every full rotation clockwise, make a half rotation counterclockwise to break any chips.	Tap wrench, Tap, vice	5		Taps are very brittle, so accumulation of chips or any other extra stress on the tap could cause it to break in your material. By clamping the piece lightly but firmly, it prevents it from biting into the material.

Stage no.	Stage name/ summary	Operation	Equipment Required	Time estimate (minutes)	Health and Safety	Quality Control
16	Mill one side of the workpiece to a depth of 2mm, with a 10mm width	Set the workpiece in a vice on the milling table, and then perform a cut to 1mm deep slowly at 1860RPM. This is done by zeroing the milling machine using a piece of paper, then setting it to 1mm deep, before switching the machine to forwards and bringing it left across the piece. Then repeat the cut again to get the desired 2mm depth, this time in the inverse direction- right in this case.	Milling machine, vice, Milling bit	5	PPE equipment stops me from injuring myself from flying shrapnel. Make sure your hands are away from the machine.	By only performing the mill in 1mm deep increments, it avoids any potential damages to the milling bit by going in too deep. By taking time to line up the measurement it makes sure that it is accurate.
17	Repeat stage 16 on the opposite side of the billet.	Set the workpiece in a vice on the milling table, and then perform a cut to 1mm deep slowly at 1860RPM. Then repeat the cut again to get the desired 2mm depth	Milling machine, vice, Milling bit	5	PPE equipment stops me from injuring myself from flying shrapnel. Make sure your hands are away from the machine.	By only performing the mill in 1mm deep increments, it avoids any potential damages to the milling bit by going in too deep. By taking time to line up the measurement it makes sure that it is accurate.

Reproducing the product by batch & mass.

In order to reproduce this product in our lathe workshop, which has 8 lathe machines, 1 bandsaw and 2 milling machines, set up like the diagram to the right.

The bandsaw is going to cut every piece, as the first step to ≥60mm length either as automation or as manual work for a single workman.

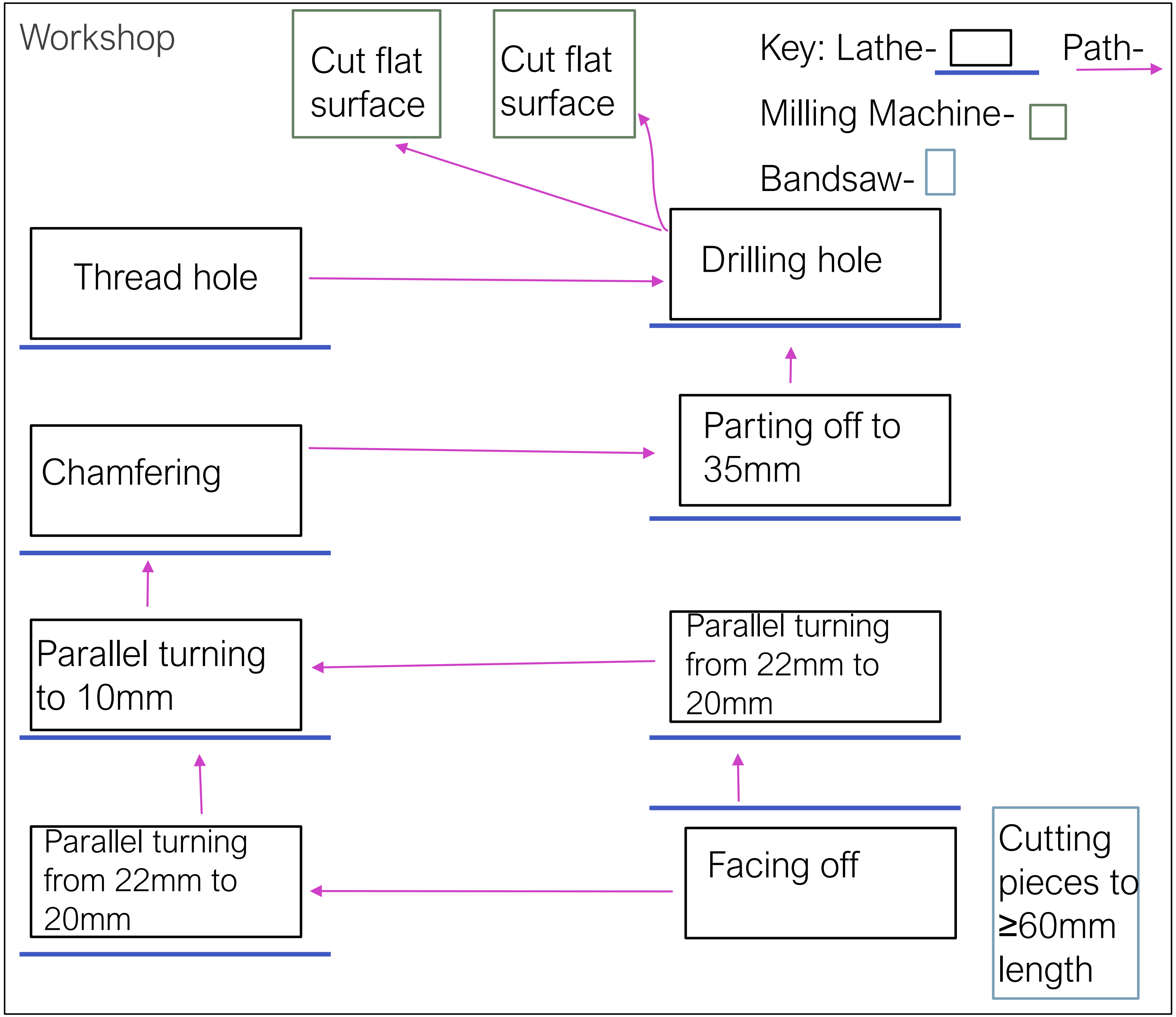
On the eight lathes, I'll plan for having the first task of the workpiece being done until all eight pieces on the machines are down to 20mm diameter. Then each machine runs their own operation of each step of the production chronologically- including the initial first step on new pieces. The milling machines run their operations at the same time. The chamfering is completed using a chamfering tool on a manual lathe as step 5.

This reduces the amount of time taken by each product on the machines, as only a single measurement needs to be taken, adjusted and repeated per machine- therefore no time is spent measuring and preparing every operation.

By allowing some processes to be done on two machines instead of one, this allows quicker production as the division of labour per batch is on two machines for parallel turning to the two dimensions.

However, potentially, on the slight chance that there could be an error, one in 50 items produced has to be checked and measured precisely to ensure that all of the products are correct in the batch.

I would attempt to implement CNC automation in the mass production process, as it reduces the amount of cost for workers' wages, insurance, breaks etc. and can run 24/7 without breaks. By using CNC automation, I also reduce human error and fatigue- so long as the coding is correct- however the pieces must be moved from one machine to another rapidly.



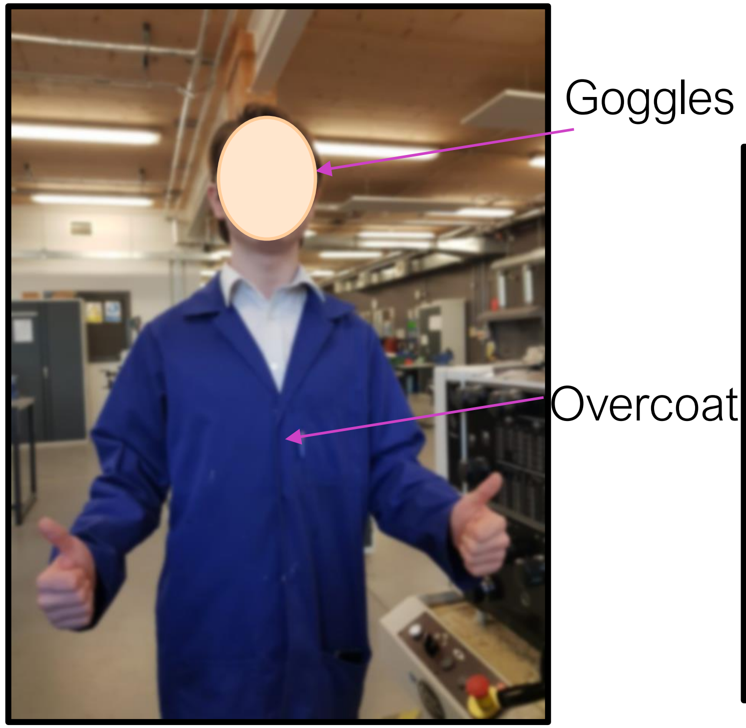
Diary of make

In this, I annotate, in detail, every step I took during the production process including any safety precautions and operations.

1. This is the aluminium piece before we performed any operations on it, measuring 100mm length and 22mm diameter. I then compare this piece to the desired measurements of the drawing, it being 35mm length and 20mm (10mm diameter along the first 10mm).

2. In this picture, I fitted the small aluminium rod into the 3-jaw chuck using a chuck key, ensuring that the grip wasn't loose nor too tight. I checked that there wasn't any fault with the lathe itself, as well as fitted the cutting tool onto the tool post tightly and securely, to prevent it flying out. I make sure to steer very clear from the operating lever.

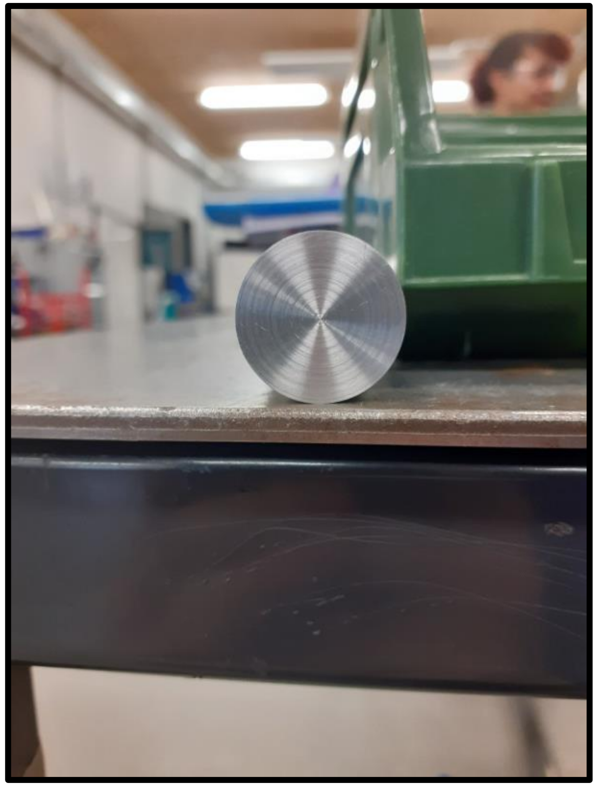
3. Then I ensured that the gears were tuned to the correct speed in order to perform operations on aluminium efficiently and safely, which was 800RPM. If the gears were on the wrong setting, it would damage to cutting tool, the workpiece and even the lathe, as it will be going too fast.



4, This is me wearing the personal protection equipment before starting the lathe- goggles and an overcoat. As you can see, I removed my tie, blazer and lanyard in order to prevent them from catching and causing severe accidents.

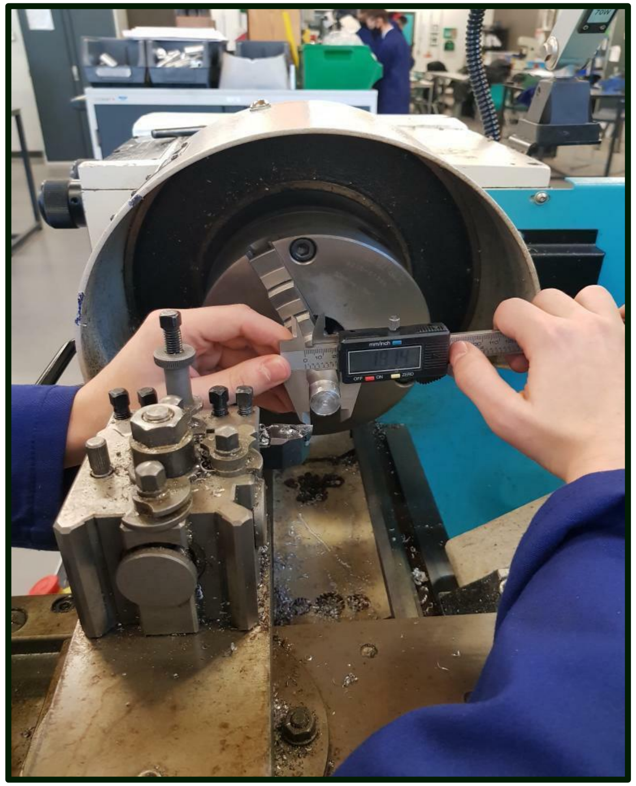
5. I then do observational checks that the facing tool is as close to the centre of the workpiece as possible, before initiating a facing cut.

6. After, I perform a facing operation on the workpiece- where I bring the cutting tool across the workpiece at a shallow depth to get a flat "face". I then check that no nipple is left after a cut: if it's high, the nipple will be a cone shape, if it's low, the nipple will be rectangular or square-shaped. If there is no material left over after the cut, I have the piece flat and the tool is central.



7. As you can see, the piece is now flat faced at the front end. After, I face off the opposite face.

8. I then measure and carry out a parallel turning operation. I do this by putting the tip of the cutting tool at the edge of the workpiece and reel it out, measure the ≤0.5mm depth on the cross slide and bring the cutting tool forward. I repeat this 4 times to get the 20mm required diameter.



9. I measure after every parallel cut in order to ensure optimal accuracy and precision during the manufacture process.

10. Then I measure the first 10mm of the workpiece, and then perform a cut of 0.5mm depth several times until the piece measures 10mm diameter, with a ±0.5mm tolerance, for the first centimetre.

11. This is the parallel turned piece before parting it off to 35mm length.

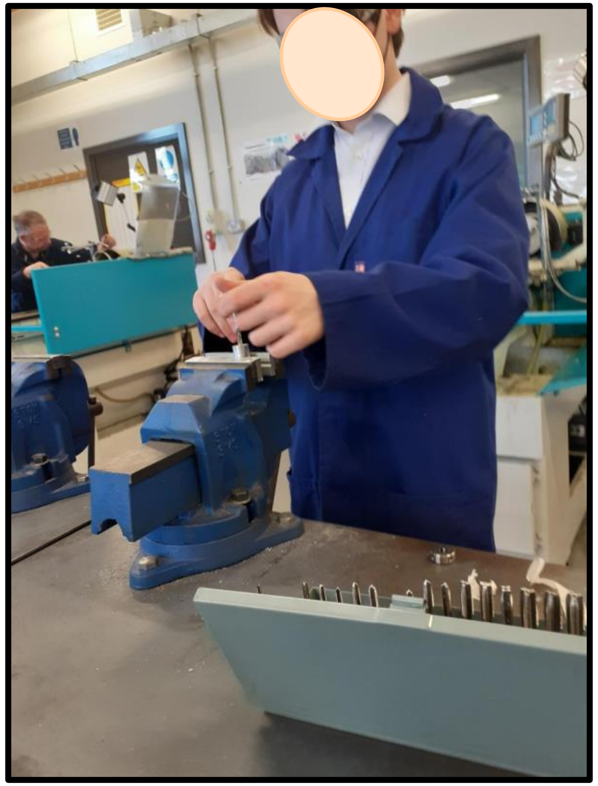
12. I then parted off the turned piece to the 35mm length requirement

13. I then performed a 2mm chamfering operation on the workpiece

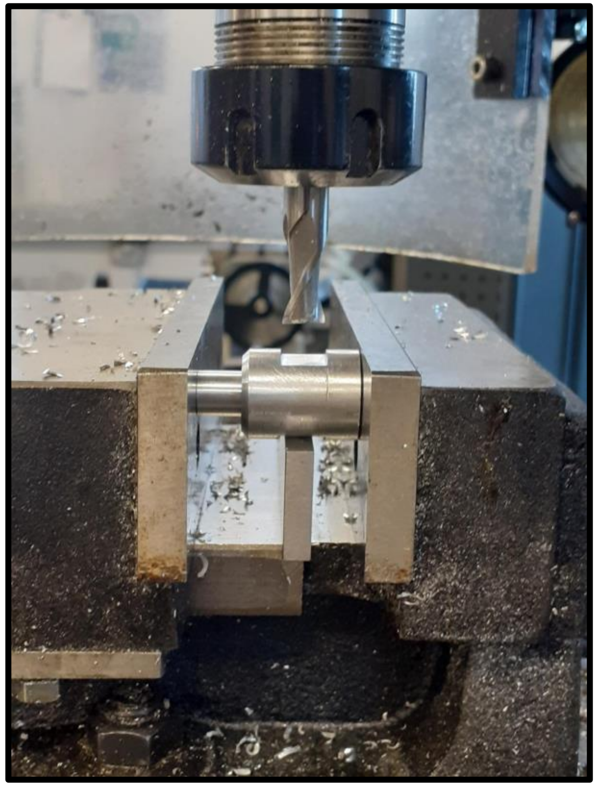
14. I then measure each dimension to ensure that the product has been accurate up to this point, however I discover that the overall length is out of tolerance by 1.87 mm, and quickly perform the operation to correct it.

15. After correcting the fault, I then fit the drill chuck and drill bit onto the tailpost, tightening the drill in preparation for the hole to be cut.

16. After, I perform the cut of the ⌀5mm x 14mm deep hole on the billet



17. Then I use a tap and die set to thread an internal M6 thread into the hole.



18. I then tighten the piece within a vice on the bed of the milling machine to perform the final 2mm mill cuts on the piece.

This is the finished product, measured against the production plan.

Evaluation

Overall, the product in my opinion came out well- it had a decent finish applied to it on the 20mm diameter, and the more delicate operations came out with accurate dimensions too. The length was done within a tolerance of <0.5mm, as was most other parts of the piece. The task was originally rather difficult, however that was due to a lack of practical experience on lathe machines, and once I repeated it with my partner's workpiece I grasped the basic operations quickly and I could repeat them without fault easily. During the practical however, the lathe and cutting tools we used kept having faults and performed poorly- so that limited progression on the initial stages of the work, however we overcame them by rapidly performing the operations accurately once the machine was sorted. A big flaw within my practical was the marks caused by the jaws of the chuck on the exterior of the piece, this is due to my prior inexperience working with lathes, making me tighten the jaw too much and indenting the workpiece. Fortunately I reacted to this, and sanded out the rough marks using increasingly finer grit sandpaper, which too gave it a shinier finish.

Dimension	Planned/labelled measurement (Mm)	Actual Measurement (mm)	Difference between measurements (mm)	Within allowed tolerances? Y/N	Reason for accuracy/ inaccuracy
Overall length of piece	35	35.35	0.35	Y	Didn't face it off enough after parting
Outer diameter	20	20.00	0	Y	Exact 2mm turn
Diameter of second diameter	10	9.95	-0.05	Y	Inaccuracy with wheel on final step
Length of second diameter	10	10.24	+0,24	Y	Slightly too long
Depth of drilled hole	14	14.09	+0.09	Y	Drill chuck extended slightly too much into piece, or tap caused extra depth
Diameter of drilled hole	5	5	0	Y	Exact drill hole
Width between mills	16	15.96	-0.04	Y	Mills were more automated, however I adjusted the depth with a wheel
Distance between base and mill	7	7.18	+0.18	Y	Overall length was too long, a stopper was set at the base of the piece before the mill
Length of 20mm diameter	25	25.11	+0.11	Y	Overall piece is slightly too long, should have faced the base off slightly more.
Depth of mill	2	2.01 / 2.03	+0.01/ +0.03	Y	Slight human error
Length of mill	10	10	0	Y	Automated