T Level Technical Qualification in Manufacturing, Processing and Control – Machining & Toolmaking

Centre Standardisation Materials

Version 1.0
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For external use

Contents

Version and date	Change detail	Section
v1.0 April 2024	Publication of version	n/a

Introduction

Machining & Toolmaking Technologies (8713-33) (332)

These standardisation materials have been produced to support centre assessors when marking the Occupational Specialism assessment.

The materials are produced to support staff in the process of marking, including how to effectively use marking grids to mark using assessment themes.

The Occupational Specialism assessments for the T Level in Design and Development for Engineering and Manufacturing are externally set summative assessments which are internally marked by assessors. It is the centre's responsibility to ensure candidate's work is marked in a standard way across the centre, using the specified marking grids, in order to rank performance on a single mark scale.

The marking materials must be considered alongside the Technical Qualification Occupational Specialism assessment guide.

It is recommended that all assessors, including any unlikely to mark, are included in early discussions around the use of the marking grids, as all assessors should understand the basis of marking. This is because it could shape their teaching by helping candidates practise, bringing their skills and knowledge together to complete a problem, and helping them learn to explain and justify their choices in terms of subject knowledge in preparation for summative assessment.

Assessors must study the Technical Qualification Occupational Specialism assessment guide which provides detailed information about the assessment themes and the marking grids, to ensure they are clear about the different assessment themes and how they may show up in evidence across the range of tasks.

If there is more than one assessor carrying out marking at the centre, this process should be carried out as part of a group activity to ensure markers are clear and in agreement about what sorts of evidence are relevant for assessment and which assessment theme they fit into.

The following materials should form the basis for pre-standardisation and discussion could take place using evidence from trial runs/formative assessment activities. Standardisation should also take place using the evidence from the actual assignment set for that year, so along with utilising this tool, please ensure activities surrounding the live assignment also take place.

Thank you for accessing these support materials. Please note that the Practical Observation form has been updated since the publication of these materials. The Practical Observation form included in the live assessment materials is the version that must be used when assessing the Occupational Specialism.

Support and Guidance

Please ensure you have reviewed the information and guidance available in the Occupational Specialism assessment process guide ahead of completing internal standardisation activities.

- TQ Occupational Specialism Assessment Process Guide (PDF)

The following two recordings published on the websites provide support and guidance on student evidence requirements and the application of the Occupational Specialism assessment marking grids.

- Occupational Specialism Student Evidence Requirements
- Application of the Occupational Specialism assessment Marking Grids

This pack contains and references the following material:

- Links to the assessment materials and relevant Guide Standard Exemplification Materials
    - MPC GSEM Machining and Toolmaking Threshold Competence
    - MPC GSEM Machining and Toolmaking Distinction
- Links to the Sample Assessment Materials – Sample Assessor Pack
    - MPC Practical Assignment Machining and Toolmaking Sample Assessor Pack
- A partially completed candidate record form, reflecting marking of a number of the assessment themes within this assessment

Candidate A

Assessment details

This standardisation pack has been developed to reflect the requirements of the **Machining & Toolmaking Technologies – Sample** version. The assessment pack can be access on the City & Guilds website, here.

The evidence used for the exemplar marking in this pack is based on the **Guide Standard Exemplification** materials for this occupational specialism that can be located, here.

Task 1 - Planning

(Assessment themes: Health and safety, Planning and preparation)

For task 1 candidates need to produce the following pieces of evidence:

- a resources list with justifications for the selections and measuring equipment calibration check recorded
- a risk assessment
- a method statement with justifications
- a quality check sheet.

For task 1 candidates will be expected to produce a quality check sheet to use in task 3a during the quality inspection task. This is supporting evidence for assessors to gauge the candidate's planning skills and will not be marked.

Task 1 - Candidate evidence

Task 1 – Resources list with justifications for the selections, and measuring equipment calibration check recorded

Requirements and resources	Quantity	Justification
Tools/equipment/materials/consumables		
Writing materials (paper, ruler, pen pencil, eraser)	N/A	To plan the work and to create the quality check sheet.
Material stock for manufacture	3	Stock needed so that it could be cut and machined to size.
Bandsaw	1	Band saw will allow me to cut the bar stock to an appropriate length for manufacture measured using the steel rule.
File	1	To deburr the material.
Milling machine	1	This machine will allow production of the bearing housing.
Milling cutters	2	To use in the milling machine, for example, face cutter.
Engineer's square	1	To check the work piece is square.
Nylon mallet	1	Used to bang the bar stock to ensure that it is on the parallels.
Parallels	2	Used to set work piece in the machining vice of a milling machine.
Centre drills	1	Used prior to drilling.
Twist drills	1	To create the holes as per the drawing.
Centre lathe	1	Used to manufacture the top hat bearing.
3 jaw chuck	1	Used to hold work piece during manufacture.
Boring bar (90m/min) (0.12mm/rev)	1	Used in conjunction with the centre lathe to produce the holes in the bearing housing and top hat shaft.
Measuring equipment (steel rule, callipers etc.)	2	Used to measure during the manufacture and checking process.
Ø5mm twist drill (30m/min)	1	Used to produce the Ø5mm hole as per the drawing.
Tap	1	Used to produce threads.
Radius cutter	1	Used to produce radius.
CNC lathe	1	Used to manufacture the shoulder shaft.
Computer access	N/A	To write up the quality inspection report.
Personal Protective Equipment (PPE)		
Safety boots or safety shoes	1 pair	Needed to be worn in the workshop to prevent injury to feet.
Overalls or coat	1 pair	Needed to protect yourself and clothing form dirt and debris from the work carried out.
Safety glasses	1 pair	Needed to protect eyes from swarf and dust.
Gloves	1 pair	To protect the hands from cuts and substances.
Technical Information/documentation		
Assignment brief	For the technical drawings and requirements.	
Calibration record	To check the equipment used is within the calibration date and has been calibrated.	
User manuals	For the mill, centre lathe and CNC lathe.	

Risk assessment	To be completed before beginning the task to identify risks and hazards that may occur during the activities.
COSHH data sheets	To check user requirements of substances.
Method statement	This document sets out what I need to do and in the order in which to do things for the tasks.
Quality check sheet	To record the results of the quality review.
General workshop resources	
Waste disposal bins	Waste to be separated into recyclable and non-recyclable.
First aid kit	For any minor injuries.
Warning signage and notices	In case of a spillage, to warn others of a wet floor.
Paper towels, brushes, dustpan	To clean up any waste during and after production.
Mop and bucket	To clean up any spills of liquids, oils or substances and clean the work area.
Calibration of measuring equipment	
All measuring equipment checked. Last calibration date was November 2022.	

Task 1 – Risk assessment

Machining activities and work area

Hazard	Risk	Control	Likelihood	Severity
Revolving machinery (mills and lathes) and workpieces.	Risk of cutting and entanglement.	Carry out safety checks before use. Check guards are in place on milling machine and lathes before use. Correct PPE to be worn at all times. No loose clothing around machinery. Hair should be tied back. Comply with PUWER regulations.	2	3
Ejected swarf, cutters or workpieces.	Debris coming off the tooling during machining activities, eye injuries, cuts to fingers, minor scalds from hot swarf.	Check guards are used, use additional magnetic screen guard when machining using the lathe. Eye protection to be worn at all times with correct PPE. Use correct holding devices for securing workpieces.	3	2
Chuck keys left in.	Risk of flying out. Eye injury or hit by flying keys.	Remove chuck keys before use, check guards are in place. Set limit switch on chuck guard to stop machine from starting. Eye protection to be worn at all times along with correct PPE. Good tool management.	3	2
Fitting mating parts or general handling and tool changing.	Cuts and puncture injuries.	Turn off and isolate machine (mill or lathe) before tool removal. Any tools in tailstock chuck are removed or tailstock is moved clear, ensure any turning tools are moved clear. Wear appropriate PPE at all times.	3	2
Hazardous substances.	Eye injuries, irritation to skin, respiratory conditions (asthma), spillages	PPE worn when handling oils or fluids (non-absorbent gloves, clothing etc). Store oils and substances in correct facilities to avoid spillages. COSHH data sheets.	2	2
Moving around the workshop.	Slips, trips and falls. Musculoskeletal injuries from falls.	Keep work area and surrounding areas clean and tidy at all times. Good housekeeping. Wear correct footwear at all times. Clean up any spillages and dry floor. Dispose of waste correctly.	3	2
Hot swarf.	Burns or scalds	Wear correct PPE at all times. Use heat resistant gloves. Remove swarf carefully, using a brush or tool to avoid contact with skin.	2	2
Manual handling.	Back injuries, sprains	Ensure training has been given. Use correct manual handling techniques. Use mechanical methods to avoid handling larger and heavier materials. Follow manual handling regulations.	3	1

Likelihood		Severity	
1	Very unlikely to happen	1	Minor injury
2	Unlikely to happen	2	Major injury
3	Possible to happen	3	Loss of limb
4	Likely to happen	4	Death of an individual
5	Very likely to happen	5	Multiple deaths

Task 1 – Method statement
Bearing housing

Op No	Description	Machine, Tools and Equipment	Speeds and feeds	Process	Quality checks
1	Gather required information and conduct risk assessment	Drawings Risk assessment proforma	NA	Obtain drawings and extract the required information and perform a risk assessment on the mill and lathe in the workshop.	NA
2	Obtain material and cut to required length	Bandsaw File Steel rule	NA	Obtain material and cut to length on the bandsaw. Deburr.	Check final dimensions are correct with a steel rule.
3	Conduct machine safety checks (SOP)	Vertical Mill SOP machine set up.	NA	Reference safety checklist, tick off all boxes and hand back to the supervisor. Use the SOP to complete the machine checks.	NA
4	Box material	Vertical mill Ø50mm Face cutter	1200rpm	Place material on parallels and in the vice. Tap down job until parallels both do not move. Touch on with the face cutter and take an equal amount off each face until the block measures 60mmx60mm. Stand sawn end on parallels and use engineer's square and DTI to set block square. Face off with face cutter and take down to 50mm OAL.	Check block size with callipers and engineer's square.
5	Ream Ø14 hole for reference for setting up the 4-jaw chuck	Parallels Mallet BS3 centre drill Ø13.7 twist drill Ø14 reamer	200rpm 3418rpm (1800) 697rpm 341rpm	Lay part with 10mm protruding at the top of the vice. 60x60 face up. Use wobble bar to find the centre of the block. Centre drill, drill and then ream the hole.	Check for hole centrality with callipers
Move to Centre lathe					

6	Conduct machine safety checks (SOP)	Centre lathe SOP machine set up	NA	Reference safety checklist, tick off all boxes and hand them back to the supervisor.	NA
7	Bore Ø40-40.05 hole	4-jaw chuck DTI Ø25 twist drill		Set up part with 60x60 face facing out. Use the DTI sitting on the saddle to clock in the Ø14 reamed hole. Use the DTI on the tool post to check outside faces are correct and match the reamed hole centrality, alter if required. Drill Ø25 hole through part. Bore the Ø40 hole with the boring bar.	Check size with bore micrometer.
Move back to Vertical Mill					
8	Drill and tap 2 x M6x1 thread	Parallels Mallet		Have the top 60x50 side up and tap down onto the parallels. Find the centre. Centre drill, drill and tap the M6 holes in both positions. Deburr.	
9	Drill and tap M5x0.8 thread	Parallels Mallet Wobble bar BS3 centre drill	200rpm 3418rpm (1800) 2274rpm By hand	Have the bottom 60x50 side up and tap down onto the parallels with a mallet. Centre drill, drill and tap the M5 thread until it breaks through to the middle bore. Deburr.	
10	Mill R10 right edge	Parallels Mallet Feeler gauge R10 cutter Radius gauge	318rpm	Identify the correct edge of the block for the R10 radius, use the feeler gauge to datum the bottom and the side of the R10 cutter. Mill off in steps.	Use radius gauge to check the profile of the edge.
11	Mill 8x45°	Parallels Mallet vee block Ø50mm Face cutter	1200rpm	Mark correct edge with the 8x45° angle. Use engineer's blue and vernier height gauge for this. Place block with correct edge up on the vee block held in the vice.	Use callipers to measure the length of the angle and protractor to check the angle.

				Use face cutter to mill to the marked line.	
12	Inspect part and tidy down	Calibrated measuring equipment inspection documents	NA	Complete the inspection document and assemble the part ready for assessment handover. Fully clean down the machine. Reinstate work area.	NA

Top hat bearing

Op No.	Description	Machine, Tools and Equipment	Speeds and feeds	Process	Quality checks
1	Gather required information and conduct a risk assessment	Drawings Risk assessment proforma	NA	Obtain the drawings and extract the required information.	NA
2	Obtain material and cut to required length	Bandsaw File Steel rule	NA	Obtain material Ø60 nylon from stores. Cut to length on the bandsaw or use an offcut that is longer than 100mm in length. Deburr.	Check final overall dimensions with a steel rule.
3	Chuck material	Manual Lathe	NA	Load material into 3-jaw chuck with 65mm protruding from the chuck.	Check with steel rule
4	Centre drill and bore	BS4		Centre drill to produce a centre drilled hole, drill Ø28 hole 60mm deep.	Use probe end of calliper to check length.
5	Turn bore to Ø30mm	DTI Boring bar		Qualify tool on front face zero the DRO. Take a skim off the internal bore and qualify the size, recalibrate the DRO. Take the finished cut to final depth.	Use calliper to check size but bore micrometer to confirm final size is within tolerance.
6	Rough turn external diameter Ø40 & Ø55 to length	Rough side and face cutter		Qualify the z and x of the tool and recalibrate the DRO. Turn Ø55 diameter to 60mm, then take 2mm cuts to turn the Ø40mm to 50mm. Leave 1mm on	Check the diameters using micrometers. Use calliper to check length.

				diameter and 0.2mm on length.	
7	Produce the 1x45 chamfer the part off	Chamfer tool	238rpm	Touch on the front edge and zero the Z datum on the DRO. Move in 1mm on the Z.	Check with a steel rule.
8	Produce the 1x45 chamfer	Chamfer tool	238rpm	Touch on the front edge and zero the Z datum on the DRO. Move in 1mm on the Z.	Check with a steel rule.
9	Inspect and clean down	Measuring equipment Inspection documents	NA	Complete the inspection document and assemble the part ready for assessment handover. Fully clean down the machine. Reinstate area.	NA

Shoulder shaft

Op No.	Description	Machine, Tools and Equipment	Speeds and feeds	Process	Quality checks
1	Gather required information and conduct a risk assessment	Drawings Risk assessment proforma	NA	Obtain the drawings from supervisor and extract the required information and perform a risk assessment on the XYZ SLX in the workshop.	NA
2	Obtain material and cut to required length	Bandsaw File Steel rule	NA	Obtain material from store and cut to length on the bandsaw. Deburr.	Check final dimensions with a steel rule.
3	Conduct machine safety checks (SOP)	Centre lathe SOP machine set up.	NA	Reference safety checklist, tick off all boxes and hand back to the supervisor.	NA
4	Load material	XYZ SLX	NA	Load material in chuck with 70mm protruding from the face of jaws.	Steel rule to verify.
5	Check tools	Pre-programmed CNC lathe Check tools are in		Manually use the machine to verify the front of the part is at zero and the	NA

		the magazine.		diameter is set correctly.	
6	Simulate program		NA	Call up the program and run the visual simulation.	NA
7	Run program in tracking mode			To verify the program, run it in tracking mode as a first instance. Check the tool will not hit the chuck at the furthest extent.	NA
8	Full run on CNC			When confident change to full run CNC, make sure the coolant is running.	NA
9	Finish part	File		Retrieve the part from the coolant box and file off pip.	Check diameters using a micrometer. Check length with digital calliper.
10	Inspect part and tidy down	Calibrated measuring equipment Inspection documents		Complete the inspection document and assemble the part ready for assessment handover. Fully clean down the machine putting and reinstate area.	NA

Task 1 - Quality check sheet

Bearing housing

Drawing Size	Tolerance	Equipment Used	Actual Size	Learner Inspection	
				Satisfactory	Unsatisfactory
60mmx60 mm	±0.25	Calliper			
50mm		Calliper			
ø40	+0.1 -0.0	Bore Micrometer			
M5x0.8-6H		M5x0.8 - 6H thread gauge			
M6x1 - 6H		M6x1 - 6H thread gauge			
8x45°	±0.25	Steel rule			
R10	±0.25	R10 gauge			

Top hat bearing

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection	
				Satisfactory	Unsatisfactory
5mm	±0.25	Calliper			
55mm	+0.0 -0.2	Calliper			
ø30	+0.1 -0.0	Bore Micrometer			
ø40	+0.0 -0.1	Micrometer			
ø55	±0.25	Micrometer			
1x45°	±0.25	Steel rule			

Shoulder shaft

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection	
				Satisfactory	Unsatisfactory
4mm	±0.25	Calliper			
1.6mm	+0.14 -0.0	Calliper			
55mm	+0.2 -0.0	Calliper			
63mm	±0.25	Calliper			
ø28.6	+0.0 -0.21	Blade micrometer			
ø30	+0.0 -0.1	Micrometer			
ø45	±0.25	Micrometer			
1x45°	±0.25	Steel rule			
R1	±0.25	R1 gauge			

Task 2 – Production

(Assessment themes: Health and safety, Production (measuring and marking out, cutting components, techniques and methods, tools and equipment).

For task 2, candidates need to produce the following pieces of evidence:

- bearing assembly consisting of:
    - bearing housing
    - top hat bearing
    - shoulder shaft.

For task 2, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
    - set up and use of manual and pre-programmed computer numerical control (CNC) workshop machinery
    - the production of the individual bearing assembly components
    - tool skills, application and usage
    - checks carried out before, during and after production
    - work area prior to, during and on completion of tasks.

Note: For the purpose of this GSEM, the assessor observation has been captured on one form. In delivery, assessors may choose to capture their observations on more than one form.

Photographic evidence required:

- photographic evidence of the prepared work area - *Illustrated in task 2 photographic evidence section below (photographs 1 - 2)*
- photographic evidence showing the construction of the bearing assembly including
    - marking out of materials
    - setting up and application of machinery to remove material
    - final finish removal of material and result of tool section for accuracy and the finish of the component parts
    - application of the surface treatment to component parts

  - Illustrated in task 2 photographic evidence section below (photographs 3 - 17)
- photographic evidence of the completed bearing assembly - *Illustrated in task 2 photographic evidence section below (photographs 18 - 20)*

Note: Additional photographs may be used to capture other elements of the machining processes.

Photographs in this GSEM demonstrate the full process that the candidate has undertaken to complete the bearing assembly. Commentary sections detail where performance is considered to be at a level reflective of a threshold competence grade. Note, due to the nature of this process, not all individual work activities would provide opportunity to demonstrate a defined level of differentiation beyond a pass – but these images are shown in order to show the cohesiveness of the process being undertaken, and to draw out where differentiation is possible.

Task 2 – Candidate evidence

Task 2 – Photographic evidence – Production

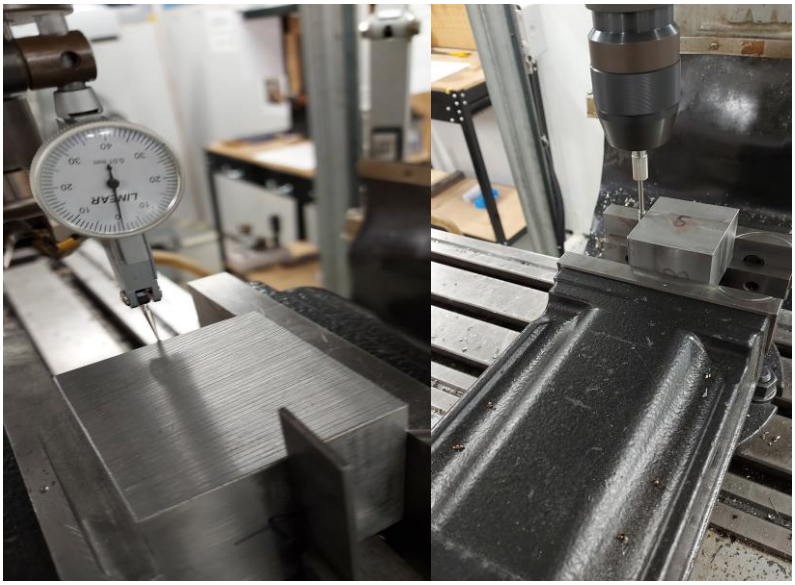
Preparation of the work area (Photographs 1 and 2)

Photograph 1 – showing the prepared mill work area.

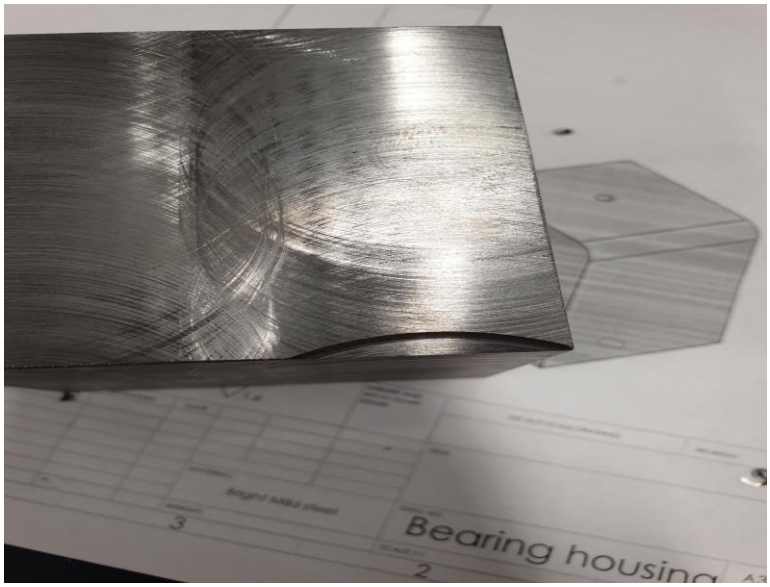
Photograph 2 – showing the lathe area, clear of debris and all tools and equipment are correctly stored on the shadow board next to the machining area.

Production of bearing housing (Photographs 3 – 11)

Photographs 3 and 4 – showing the application of a DTI gauge to prepare for the machining of the 4 faces using a face cutter.

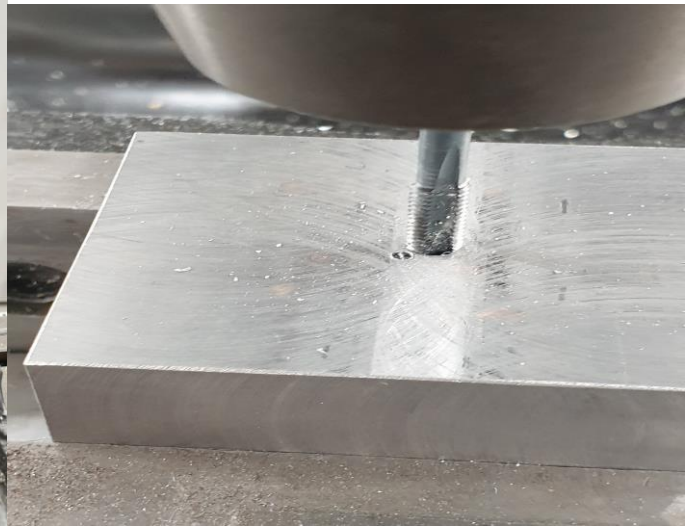


Photograph 5 – showing a fault. When machining this face a false cut was made and stopped in time. The part was then machined to the correct size.

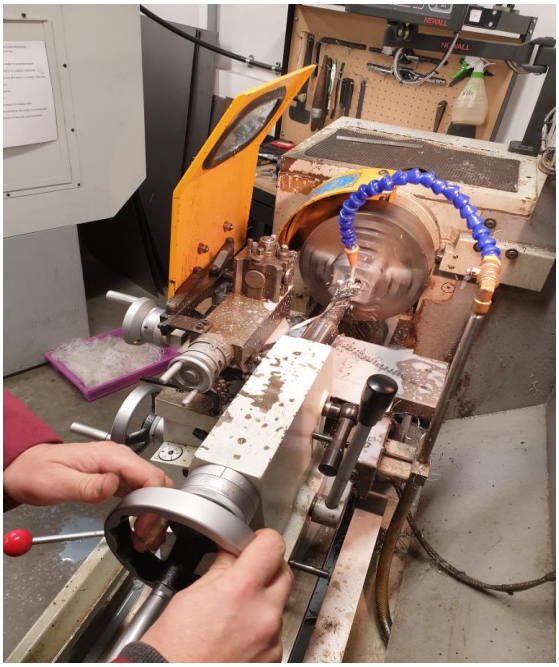


Photograph 6 and 7 – showing the wobble bar into the centre and centre drilled, 13.7 drill and 14 reamer. The wobble bar was used to find the centre of the block.

Note: The wobble bar offset was not taken into account creating the original centre drill to be placed incorrectly, this was rectified before drilling and tapping the M5 tapped hole.



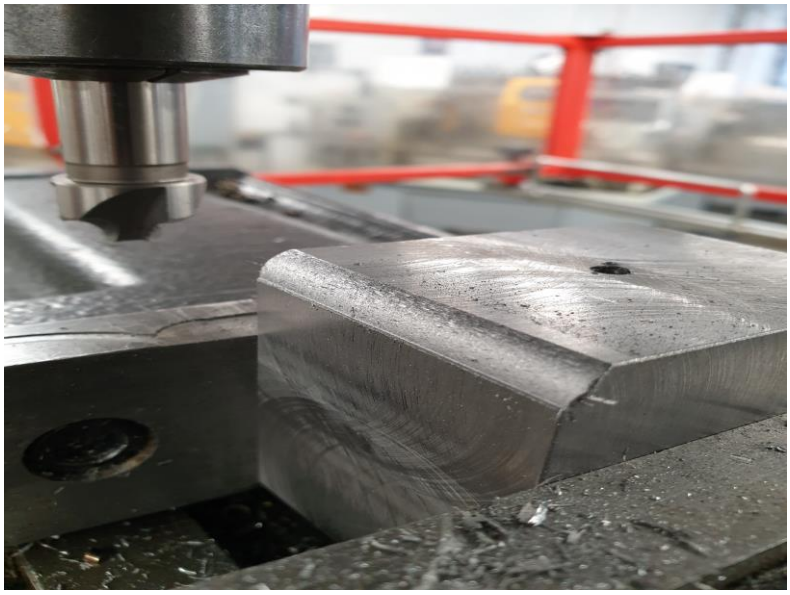
Photograph 8 – showing the drilled out hole to 28mm, swarf was removed using safe methods.



Photograph 9 – showing the bored out bearing housing, some additional adjustment was required until the nylon top hat was a push fit.

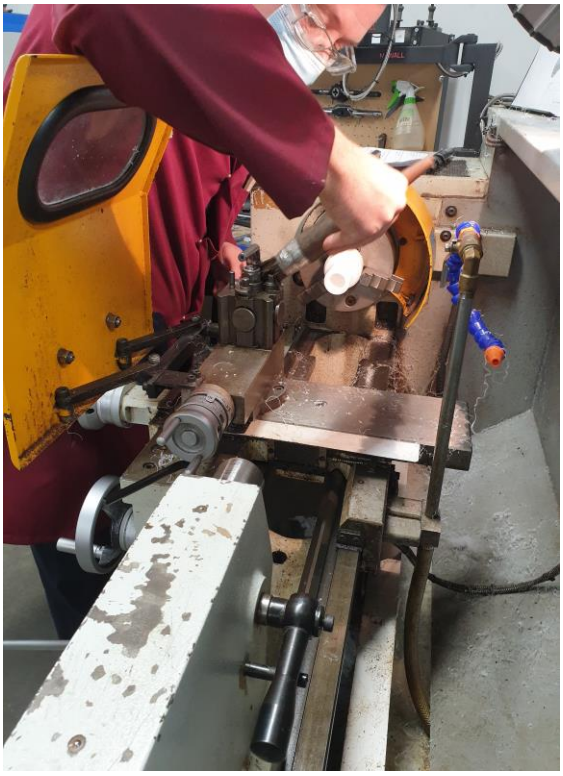
Photograph 10 - showing 8mm chamfer blued and marked with the vernier height gauge.

Photograph 11 – showing the chamfer machined using a 45-degree setting piece and a carbide tipped 16mm end mill. The R10 has cut in too deeply on the X axis. This means the form is too far in the block and has created a step.

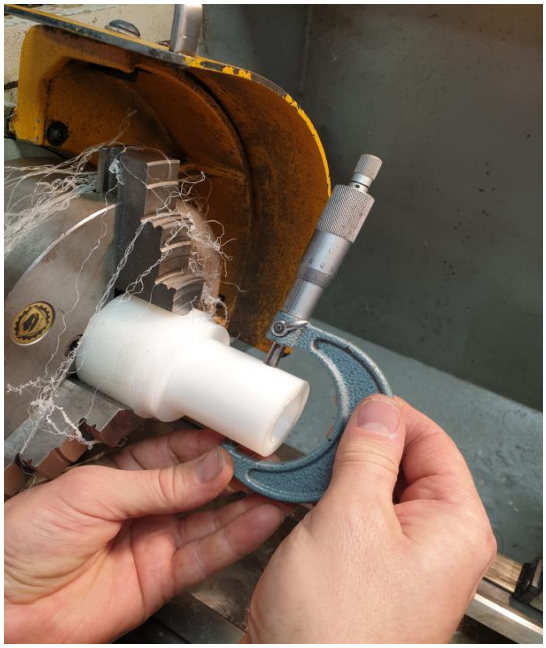


Nylon top hat bush (Photographs 12 – 14)

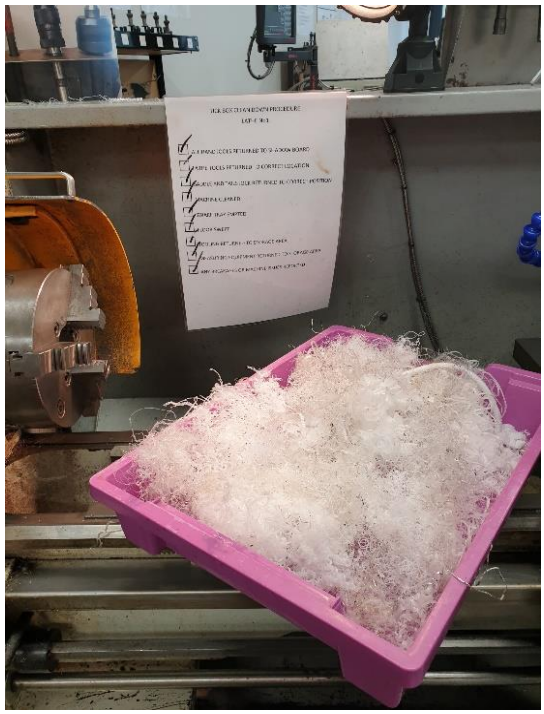
Photograph 12 – showing cleanliness of tool change over maintained throughout manufacturing.



Photograph 13 – showing the candidate checking the external bore with a micrometer. The candidate ensured the excess swarf was cleared from the moving parts most of the time. The swarf was collected in a different bin to the metal swarf.



Photograph 14 – showing collection of nylon swarf, separated waste for correct disposal.



Shoulder shaft (Photographs 15 – 17)

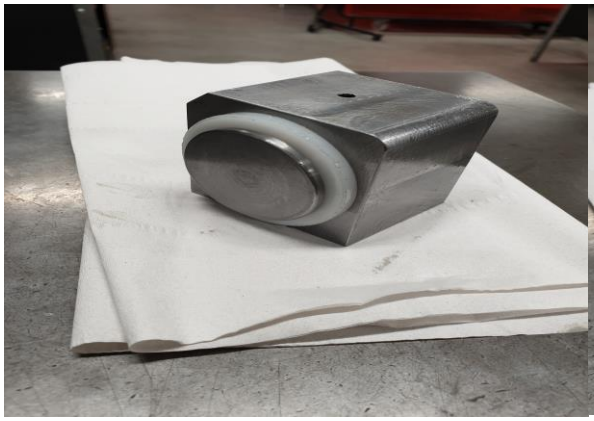
Photographs 15, 16 and 17 – showing the use of the CNC lathe including a tip change.

The tool tip had wear and was changed, the bar was chucked into the right distance from the chuck. The program simulation was run to see the general outlook of the part. The program was then run but in tracking mode to start with to prove first pass. The part was then changed to CNC mode. Coolant was turned on and part run with the 4 tools being changed at the right time.

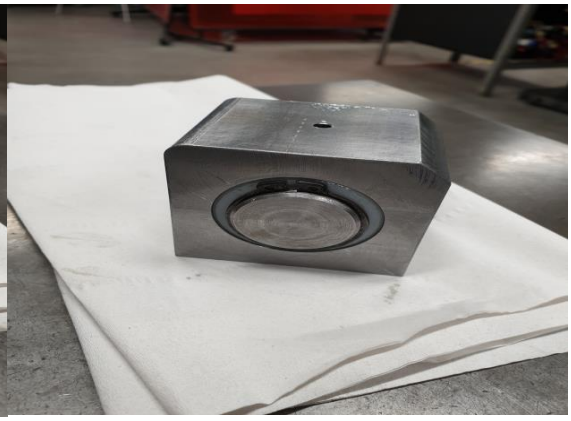
Completed bearing assembly (Photographs 18 – 20)

Photographs 18 and 19 - showing the completed bearing assembly, before and after adjustment. The candidate had to make several adjustments to the fit before the components were sufficiently seated in the bearing housing.

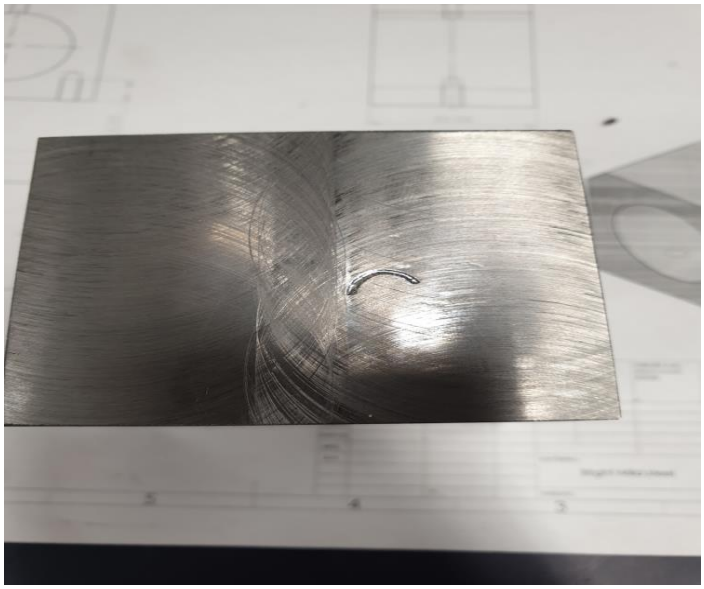
Before adjustment



After adjustments



Photograph 20 – showing a surface defect caused by a piece of swarf caught in the vice, embossing the face with a swarf mark.



Task 2 - Practical observation form - Production

Assessment ID	Qualification number
8713-332	8713-332
Candidate name	**Candidate number**
Candidate A	CG12345
Centre name	**Assessment theme**
City & Guilds	Preparation, Production, Health & safety, Assembly

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

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Production **The assessor observation should include consideration of:** • the stages of production • tool application and usage • application of hand skills • set up and use of manual and pre-programmed CNC workshop machinery • checks carried out before, during and after production • performance of safety critical commissioning checks	The candidate prepared their work area at the beginning of the session, following their risk assessment. The standard workshop SOP was followed to prepare the manual milling machine, manual lathe and CNC lathe for use. Some of the measuring tools were checked for calibration and a quick reference check to a slip gauge or zero was made. Visual checks completed on the tools and tooling selected, not all tools were checked for cleanliness prior to use. Materials were prepared and made ready for the next process; work deburred effectively. They completed some inspection of the work, but this was brief. They proceeded to machine each component, starting with the bearing housing. The part was prepared and squared on the mill. The four faces were cut using a face cutter and checked with a DTI gauge. During the machining, a false cut was made but the candidate stopped in time and the part was machined to size. The wobble bar was used to find the centre of the block, then the centre was drilled. The wobble bar offset was not taken in account, causing the original centre drill to be placed incorrectly. The candidate rectified this before drilling and tapping the M5 hole. The candidate cleared swarf away from the moving parts of the lathe but some material was caught between the workpiece and the hard jaws causing noticeable indentations on the workpiece. The bearing housing was bored out, adjustments were required to achieve the push fit. Chamfers on the workpiece were correctly blued and marked with a vernier height gauge to create the chamfers then machined using a 45-degree setting piece and a carbide tipped 16mm end mill. The R10 cut in too deeply on the X axis, with the form too far in the block, creating a step.

	When machining the top hat bearing, the candidate identified a problem with the amount of swarf produced by the nylon material, correctly stopping the machine before clearing the swarf wrapped around the holding device. This was done with care. This was repeated when the swarf built up. They noticed that the nylon left noticeable tool marks but initially carried on before realising that shim was to be used, but the end piece showed evidence of tool marks. In-production checks of the workpieces were completed, adjustments to both speed and feeds were made. The candidate completed the SOP safety checks before the use of the CNC lathe. They encountered a worn tool tip and needed to perform a change, taking longer than expected to change over the tooling. They ran the machine in tracking mode to check the set up before changing to CNC mode and machine the part. Some in-production monitoring was observed. Coolant was turned on and the 4 tools were changed at the appropriate time. On completion of the task, the lathe was cleaned down and left ready for the next use, some waste was left around the CNC machine. During the use of each machine the work holding devices were cleaned of debris and all waste segregated for disposal. This was good. On completion of the machining each machine was cleaned down, remaining swarf and waste removed. Some excess waste was observed on the floor. All tools were stored away correctly, no post use checks were observed before storage. They showed a basic understanding of the optimum method to use with each tool to achieve the best results. Additional adjustments made during production to correct both the speed and feed in order to achieve an acceptable surface finish. The 4-jaw chuck did leave surface marks. The tools selected were appropriate for the task. The candidate was unsure of the speeds to be used with the mill which caused residual tool marks. Measuring tools were applied effectively and regularly throughout the production process to check the dimensions of the machined components, checking against the drawings to adjust the machining parameters to ensure the correct dimensions were achieved. This was good practice but accuracy could have been better. On completion of the machining of the three components, the fit was checked, some additional machining adjustments required to achieve an acceptable fit. They finished the bearing assembly with a coating of an anti-corrosive surface treatment. They wiped off excess surface treatment which had been over saturated. Health and safety was followed throughout all tasks. Correct PPE was worn, one reminder was given to the candidate to wear their safety glasses, after they had briefly removed them in-between tasks.

	Machine guards were utilised throughout. A standard operating procedure for machine isolation was followed when changing the tooling and when cleaning down the machinery. The work area was adequately reinstated, most tools and equipment were briefly checked and all were returned to their shadow board or to the appropriate cupboard.

Assessor signature	**Date**
Assessor A	**17.12.2022**

Task 3a – Quality review

(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover)

For task 3a, candidates need to produce the following piece of evidence:

- completed quality check sheet.

For task 3a, assessors will need to produce the following pieces of supporting evidence:

assessor observation:

- use of measuring equipment
- checks for tolerances and accuracy

Photographic evidence required:

- the quality review being undertaken, with consideration of
    - checking of tolerances and application and use of appropriate measuring tools and equipment
- photographic evidence of the bearing assembly components and fully assembled bearing assembly – *Illustrated in task 3 photographic evidence section below (photographs 21 – 22)*

The following task 3a supporting evidence has not been included for this version of the GSEM:

- the quality review being undertaken, with consideration of
    - checking of tolerances and application and use of appropriate measuring tools and equipment.

Video evidence required:

- video evidence demonstration showing the fit of the components to form the bearing assembly

The following task 3a supporting evidence has not been included for this version of the GSEM:

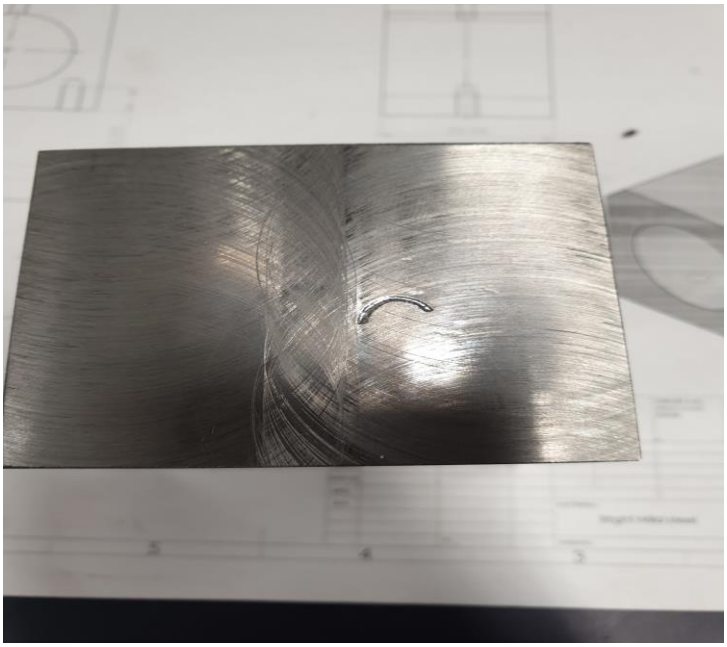
Video evidence

- video evidence showing the fit of the components to form the bearing assembly.

Task 3a – Photographic evidence – Quality review

Photograph 21 - showing the completed bearing assembly, all components correctly seated. The candidate had to make several adjustments to the fit before the components were sufficiently seated in the bearing housing.

Photograph 22 – showing a defect within the face of the bearing housing, caused by swarf. Some tooling marks also noticeable.



Task 3a - Candidate evidence

Completed quality review check sheet

Bearing housing * Digital callipers used throughout.

Drawing Size	Tolerance	Equipment Used	Actual Size	Learner Inspection		Comments
				Satisfactory	Unsatisfactory	
60mmx60mm	±0.25	Digital Calliper*	60x59.75	✓		Within tolerance. Tool marks noticeable on surface. Swarf mark.
50mm	±0.25	Calliper	50.29		✓	Out of tolerance
Ø40	+0.1 -0.0	Bore Micrometer	40.025	✓		used digital micrometer
M5x0.8-6H	Gauge	M5x0.8 - 6H thread gauge	Gauge all through	✓		
M6x1 - 6H	Gauge	M6x1 - 6H thread gauge	Gauge depth 13.97	✓		
8x45°	±0.25	Steel rule	7.9x7.9	✓		
R10	±0.25	R10 gauge	R10	✓		

Top hat bearing

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		Comments
				Satisfactory	Unsatisfactory	
5mm	±0.25	Calliper	5.30		✓	Out of tolerance – material difficult to machine
55mm	+0.0 -0.2	Calliper	54.93	✓		
Ø30	+0.0 -0.1	Bore Micrometer	29.95	✓		
Ø40	+0.0 -0.1	Micrometer	39.97	✓		
Ø55	±0.25	Micrometer	55.12	✓		
1x45°	±0.25	Steel rule	1x1	✓		

Shoulder shaft

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		Comments
				Satisfactory	Unsatisfactory	
4mm	±0.25	Calliper	4.35		✓	Out of tolerance
1.6mm	+0.14 -0.0	Calliper	1.7	✓		
55mm	+0.2 -0.0	Calliper	55.15	✓		
63mm	±0.25	Calliper	62.99	✓		
Ø28.6	+0.0 -0.21	Blade micrometer	28.5	✓		
Ø30	+0.0	Micrometer	29.91	✓		

	-0.1					
Ø45	±0.25	Micrometer	44.97	✓		
1x45°	±0.25	Steel rule	1X1	✓		
R1	±0.25	R1 gauge	R1	✓		

Task 3a – Practical observation form – Quality review

Assessment ID	Qualification number
8713-332	**8713-332**
Candidate name	**Candidate number**
Candidate A	**CG12345**
Centre name	**Assessment theme**
City & Guilds	**Quality review and evaluation**

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

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Quality inspection and application of measuring equipment	Measuring tools were selected. Each was used with acceptable accuracy however the candidate did not carry out a full calibration check on the measuring equipment before use. Some measurements were checked more than once. Reference was made back to the brief and drawings to check the required dimensions and tolerances. Missing tolerance information was added to the quality check sheet. They first completed checks for dimensional compliance. Most tolerances were met but some component dimensions were out of tolerance. These were recorded on the quality check sheet. The candidate made an addition to their quality check sheet, adding a column for comments.
The completed bearing assembly	They assembled the bearing housing in the correct order and orientation. Some tool marks were present. The fit although slightly loose was acceptable. The candidate completed a surface inspection. They noted some defects to the surface of the component, citing tool and swarf marks as the cause but this did not affect the operation of the assembly. This was recorded on their quality check sheet. Not all surface defects were accounted for or justified, the chamfer fault was not recorded.

Assessor signature	**Date**
Assessor A	**18.12.2022**

Task 3b – Evaluation and recording

(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover)

For task 3b, candidates need to produce the following piece of evidence:

- completed quality inspection report.

Task 3b – Candidate evidence

Task 3b – Quality inspection report

Quality Inspection Report

Introduction

The assignment was to create a bearing assembly to be used in a roller assembly of a bespoke conveyor system. The bearing assembly was to be manufactured and when completed, quality checked.

Production process

The bearing assembly was made up of three main components: the bearing housing, shoulder shaft and top hat bearing. The bearing housing and shoulder shaft were manufactured using low carbon mild steel and the top hat bearing was to be manufactured out of nylon. The bearing housing was manufactured using the milling machine and a manual lathe. The stock material was first prepared and squared on the milling machine. A face cutter was used to cut all four sides which was then checked with a DTI gauge. A wobble bar was used to find the centre of the block. The holes were bored on the lathe to the required sizes. Adjustments were made until the nylon top hat bearing was a push fit. A chamfer was machined using a 45-degree setting piece and a carbide tipped end mill.

The shoulder shaft was manufactured using the CNC lathe. The CNC lathe was set up to machine the part and the tooling on the lathe was changed at intervals to achieve the dimensions and finish as required in the specification. The top hat bearing was manufactured from nylon using the manual lathe. The nylon was machined using a range of tooling to remove the material. This created a lot of excess swarf which had to be cleared from the moving parts. The external bore was checked with a micrometer to ensure a good fit into the bearing housing. Some in-production checks were carried out to check the dimensions were correct during the machining of the components. The components were adjusted accordingly to ensure the fit met the specification. The final assembly was treated with an anti-corrosion spray treatment.

Quality inspection

I carried out a full quality inspection on the completed bearing assembly. This included a visual check; dimensional accuracy check and functionality test. I prepared my work area and collected my tools and equipment. I selected a digital Vernier calliper to measure the finished dimensions of the individual components. The Vernier calliper was checked and calibrated.

Firstly I completed a visual check of the complete bearing assembly. There were some noticeable marks on the surface of the bearing housing. These were caused during the production of the components and were not removable by polishing. There were some marks caused by the jaws and the top hat bearing showed some tooling marks.

To check the functionality, I checked the fit of the components by spinning the assembly to check the bearing operated correctly. The fit was a little loose but was acceptable.

I disassembled the bearing assembly and used the vernier digital callipers and micrometers to carry out dimensional checks on the individual component parts. All components were measured. The finished dimensions were recorded on the quality check sheet. I repeated this process for each component part. I checked the brief and the technical drawings to confirm the required tolerances.

Some of the finished dimensions were within the tolerances given and conformed to the dimensional requirements of the brief and technical drawings. The components that were out of tolerance included the 50mm bore of bearing housing, the 5mm thickness of the top of the top hat bearing and the 4mm top of the shoulder shaft.

Both of these components both failed on their material sizes. If I was to repeat this assignment, I would improve my level of accuracy and perform more thorough accuracy checks during the production process. I would also check that the work piece is correctly seated in the vice to ensure the correct dimensions are obtainable.

A copy of my quality check sheet is included below:

Bearing housing * Digital callipers used throughout.

Drawing Size	Tolerance	Equipment Used	Actual Size	Learner Inspection		Comments
				Satisfactory	Unsatisfactory	
60mmx60mm	±0.25	Digital Calliper*	60x59.75	✓		Within tolerance. Tool marks noticeable on surface. Swarf mark.
50mm	±0.25	Calliper	50.29		✓	Out of tolerance
Ø40	+0.1 -0.0	Bore Micrometer	40.025	✓		used digital micrometer
M5x0.8-6H	Gauge	M5x0.8 - 6H thread gauge	Gauge all through	✓		
M6x1 - 6H	Gauge	M6x1 - 6H thread gauge	Gauge depth 13.97	✓		
8x45°	±0.25	Steel rule	7.9x7.9	✓		
R10	±0.25	R10 gauge	R10	✓		

Top hat bearing

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		Comments
				Satisfactory	Unsatisfactory	
5mm	±0.25	Calliper	5.30		✓	Out of tolerance – material difficult to machine
55mm	+0.0 -0.2	Calliper	54.93	✓		
Ø30	+0.0 -0.1	Bore Micrometer	29.95	✓		
Ø40	+0.0 -0.1	Micrometer	39.97	✓		
Ø55	±0.25	Micrometer	55.12	✓		
1x45°	±0.25	Steel rule	1x1	✓		

Shoulder shaft

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		Comments
				Satisfactory	Unsatisfactory	
4mm	±0.25	Calliper	4.35		✓	Out of tolerance
1.6mm	+0.14 -0.0	Calliper	1.7	✓		
55mm	+0.2 -0.0	Calliper	55.15	✓		
63mm	±0.25	Calliper	62.99	✓		
Ø28.6	+0.0 -0.21	Blade micrometer	28.5	✓		
Ø30	+0.0 -0.1	Micrometer	29.91	✓		
Ø45	±0.25	Micrometer	44.97	✓		
1x45°	±0.25	Steel rule	1x1	✓		
R1	±0.25	R1 gauge	R1	✓		

Evaluation

If I was to remake this bearing assembly again, I would like to improve:

- the accuracy of my work by spending longer checking the setup of the machine and workpiece. I would like to be nearer the 0.25mm tolerance in all areas. I would also carry out more in-production checks to ensure the correct amount of material is removed reducing the amount of time needing to make adjustments to the fit.

- improve my attention to detail when setting up the workpiece in the milling machine and lathe. To avoid getting swarf caught in the jaws which left an embossed mark in the surface of the bearing housing.

I was happy with the surface finishes I was able to achieve, however, I could have taken the time to achieve a better surface finish. Some surface marks could have been improved by a more thorough polish and extra care taken during the production of the components could have prevented the embossed tool mark on the finished assembly, by thoroughly cleaning the machinery before use and disposing of the swarf.

Conclusion

The design of the bearing assembly is good and would be suitable for the purpose it was intended but I would suggest the bearing material is changed from nylon to another material, such as brass as the nylon was difficult to machine and created a lot of excess swarf which had to be regularly cleared away to prevent damaging the rotating parts of the lathe. It was also difficult to get a good surface finish on the nylon which detracted from the finish.

Task 3c – Handover meeting

(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover)

For task 3c, candidates must provide the following evidence for handover:

- quality inspection report
- the completed spacer block assembly.

For task 3c, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
    - handover meeting.

Video evidence required:

- video evidence of the handover meeting being undertaken.

The following task 3c supporting evidence has not been included for this version of the GSEM:

Video evidence

- video evidence showing the handover meeting.

Task 3c – Practical observation form – Handover meeting

Assessment ID	Qualification number
8713-333	8713-333
Candidate name	**Candidate number**
Candidate A	CG12345
Centre name	**Assessment theme**
City & Guilds	Quality review and evaluation

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

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Handover meeting	The handover meeting was brief. The candidate handed over the completed moulding and their quality inspection report. The candidate demonstrated a basic knowledge of most of the manufacturing processes undertaken. They briefly described their brief and the processes they had undertaken to manufacture the assembly. The responses were brief and lacking in depth. The candidate briefly described the quality inspection process undertaken and the recording of the final dimensions. They described the problems they encountered during the production of the components. They described how they had not cleaned the mould tile thoroughly enough at the start which became a problem during the consolidation stage when the peel ply would not adhere to some areas of the tile, due to the old residue. The candidate said that in future they would be more thorough, so this did not reoccur. The candidate also mentioned the defects that the final spacer block had, describing how they would make sure to select their tools more carefully, referencing the lifting tool used in demoulding. The candidate described how the tool selected was too thick which caused a small crack to one corner when too much pressure was applied. Some preventative measures were offered but this was not detailed. The candidate did not detail all the defects within the spacer block, the issues around bridging of the material over the core, the lack of consistent bonding of the two sections and the area that had resin impregnated into the “A” surface as a result of not cleaning the mould properly were not mentioned. The candidate spoke clearly and mostly used the correct technical terminology, but their meaning was understandable.

Assessor signature	**Date**
Assessor A	**18.12.2021**

Guidance on the exemplar marking

Marking Grids for each assessment theme are found within the Assignment Assessor Pack and gives guidance on banding descriptors, marks available within each band as well as indicative content that provides guidance on knowledge, understanding and skills within the assessment theme.

For the purposes of these materials the Marking Grids used can be found in the Sample Assessment Materials here.

Within this standardisation pack, a partially completed CRF form has been provided that outlines how an assessor has awarded marks against the candidate evidence for a number of the assessment themes using the Marking Grid included in the Sample Assessment Materials.

For exemplification purposes, an explanation of how the marker has determined the mark to be awarded is provided, this exemplary document showing

- How the marker has first considered the marking bands available and determined within which band the evidence best fits
- Subsequently, consideration within the determined band and justification for the mark to be awarded within that band.

Candidate Record Form (CRF) – Machining & Toolmaking Technologies (8713-332)

Health and safety												
	Band 1				**Band 2**				**Band 3**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mark 6	**Notes and justification** **Band Justification. Band 2** The candidate has produced a risk assessment which is mostly complete, and which identifies some of the major hazards and associated risks. The candidate did not cover noise or electricity within the risk assessment, both of which should have been taken into consideration in an engineering machine shop. The candidates risk mitigation methods have been identified for some of the potential risks but not all. The risk mitigations lack detail, although the candidate does not identify specific items of PPE. There is no reference to who may be harmed in the risk assessment produced by the candidate. The candidate references the use of a standard operating procedure in their method statement, in consideration of machine safety checks which included safe isolation of all machine tools. The assessor did note that the candidate had to be reminded to wear their PPE on one occasion. The candidate left the work area clear and tidy with most tools and equipment being checked and returned to the correct storage facilities. Overall, the evidence largely meets band 2, however elements within the descriptor have not been securely met. **Mark Justification. 6 Marks** Overall, the evidence mostly aligns, however some elements within the descriptor have not been securely met. The candidate risk mitigations were limited and lacked specific detail, therefore, a middle mark within band 2 of 6 marks is awarded.											

Planning and preparation									
Preparation									
	Band 1			**Band 2**			**Band 3**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mark 4	**Notes and justification** **Band Justification. Band 2** The candidate has identified a limited range of materials, components and resources. Reference is made to the use of SOP's for preparatory checks. In consideration of technical documentation, the candidate has identified the assignment brief, calibration records, user manuals, risk assessments and COSHH data sheets, however, no justification is given relating to quality, accuracy and completeness. Some tolerances are missing on the quality control sheet produced by the candidate.								

	The candidate prepared the work area safely following the risk assessment, some of the measuring equipment was checked for calibration. The candidate followed a SOP to ensure safe isolation when preparing the machine tools for operation. The evidence supplied by the candidate partially aligns with band 2 with some characteristics within band 1. Therefore band 2 has been awarded. **Mark Justification. Marks 4** As the evidence supplied by the candidate partially aligns with clear gaps with performance, the lowest mark in band 2 is awarded. 4 marks

Production												
Assembly												
	Band 1				**Band 2**				**Band 3**			
	1	**2**			**3**		**4**		**5**		**6**	
Mark 2	**Notes and justification** **Band Justification. Band 1** The candidate carried out assembly and re-assembly of the components in a logical sequence some of the time. There is no candidate evidence to confirm reference to engineering drawings when carrying out the assembly. The candidate carried out additional machining operations to achieve a fit which was slightly loose, though acceptable. The candidate applied a surface treatment to the finished assembly, however they had to wipe off an excess due to over saturation. The evidence provided by the candidate largely meets band one with the exception of reference to engineering drawings some of the time. The candidate did, however, make adjustments to the components to achieve an acceptable fit. Band 1 has been awarded to the candidate. **Mark Justification. Marks 2** The evidence quality mostly aligns, however one element of the descriptor has not been securely met, as there is no middle of the band, 2 marks have been awarded to the candidate.											
Tools and equipment												
	Band 1				**Band 2**				**Band 3**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mark 6	**Notes and justification** **Band Justification. Band 2** The candidate used the standard workshop SOP to prepare the manual milling machine and the centre lathe to ensure that correct parameters had been applied most of the time. Photographic evidence of the milling machine and the lathe before commencement of											

	machining support this. The candidate did, however, make a false cut when setting cutting depths on the milling machine, this was stopped in time to allow the candidate to machine to the correct size. The candidate set up and operated the CNC lathe with the correct parameters applied all of the time. The candidate used a SOP when setting the CNC lathe. The candidate demonstrated a basic understanding of the industrial standards to be met by carrying out pre-use checks on machine tools and equipment. There were no post use checks carried out on tools used by the candidate when they were returned to storage. The candidate returned the machines to a ready state sometimes, the CNC lathe still had some waste left around the machine. This was also the case with the manual machines with some excess waste on the floor. Overall, the candidate showed a basic application of tool skills, this is evidenced with components having an acceptable finish with some surface defects being present such as the swarf mark on a machined face. The candidate evidence has some characteristics within bands 1, 2 and 3. The band awarded for the candidate is band 2. **Mark Justification. Marks 6** The candidate is awarded 6 marks as the evidence quality mostly aligns with band 2.

Quality review and evaluation									
Quality review									
	Band 1			**Band 2**			**Band 3**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mark 3	**Notes and justification** **Band Justification. Band 1** The candidate has checked that some dimensions and components are checked for accuracy against the dimensions and tolerances within the specification. The quality check sheet produced by the candidate was updated with handwritten tolerances and the addition of a column to record their justifications for missed tolerances and defects incurred during manufacturing. Some detectable defects such as swarf marks on the surface of components which were attributed to preparation for machining. A step on the chamfer of the bearing housing was not recorded by the candidate in the quality check. Defect rectification strategies were suggested by the candidate some of the time with particular reference to swarf and tooling marks as the cause. The candidate did not, however, account for all surface defects on components. The evidence produced by the candidate is securely in band 1, therefore band 1 has been awarded.								

	Mark Justification. Marks 3 The evidence quality fully aligns with performance described in the descriptor, therefore the highest mark in band 1 has been awarded. 3 Marks.

Internal assessor signature	Date

Total
***/90**

* Please Note that the Total Mark (90) applies to the full assignment including all Assessment Themes

Candidate B

Assessment details

This standardisation pack has been developed to reflect the requirements of the **Machining & Toolmaking Technologies Sample** version. The assessment pack can be access on the City & Guilds website, here.

The evidence used for the exemplar marking in this pack is based on the **Guide Standard Exemplification** materials for this occupational specialism that can be located, here.

Task 1 - Planning

(Assessment themes: Health and safety, Planning and preparation)

For task 1 candidates need to produce the following pieces of evidence:

- a resources list with justifications for the selections and measuring equipment calibration check recorded
- a risk assessment
- a method statement with justifications
- a quality check sheet.

For task 1 candidates will be expected to produce a quality check sheet to use in task 3a during the quality inspection task. This is supporting evidence for assessors to gauge the candidate's planning skills and will not be marked.

Task 1 - Candidate evidence

Task 1 – Resources list with justifications for the selections, and measuring equipment calibration check recorded

Requirements and resources	Quantity	Justification
Tools/equipment/materials/consumables		
Pen and paper	N/A	So that I can plan my work and add any notes needed for the job.
Material stock required to produce bearing housing: (Mild steel rectangular bar 55 x75) Shoulder shaft: (Low carbon steel bar 60 mm Dia) Top hat bearing: (Nylon bar 70 mm Dia)	3	Stock needed so that it could be cut and filed to size as per specification, and the correct holes drilled and threaded as per drawing specification.
Band saw	1	Band saw will allow me to cut the bar stock to an appropriate length for manufacture measured using the steel rule.
File	1	The file will allow me to deburr the material.
Steel rule	1	To use when determining the sizes of the material stock and cutting to size on the band saw.
Vertical mill	2	This machine will allow production of the bearing housing.
Ø50mm Face cutter	1	Used to produce square faces and machining the block to size.
Engineer's square	1	This will allow me to set the work piece square in the vice and to check the work piece is square.
DTI	1	This dial test indicator will allow the work piece to be set concentric in the 4 jaw chuck.
Digital callipers	1	Used to measure workpiece during the production and to check the finished dimensions of the workpiece during the quality check upon completion.
Nylon mallet	1	Used to produce an impact force to the bar stock to ensure that it is sat firmly on the parallels.
Parallels	2	Used to set work piece in the machining vice of a milling machine.
Wobble bar	1	Used to find the edge of the work piece prior to machining.
BS3 centre drill (30m/min)	1	Used prior to drilling to create an accurate start for the twist drill.
Ø13.7 twist drill (30m/min)	1	Used to create a Ø13.7 mm hole as per the drawing.
Ø14 reamer (15m/min)	1	Used to create a Ø14 reamed hole.
Centre lathe	1	Used to manufacture the top hat bearing.

3 jaw chuck	1	Used to hold work piece during manufacture.
4 jaw chuck	1	Used to hold the rectangular work piece during manufacture of the bored hole.
Ø25 twist drill (30m/min)	1	Used to produce a Ø25 hole.
Boring bar (90m/min) (0.12mm/rev)	1	Used in conjunction with the centre lathe to produce the holes in the bearing housing and top hat shaft.
Bore micrometer	1	Used to measure holes in the bearing housing and top hat bearing.
Shim to protect surface finish	1	Used to protect the component when using work holding device during manufacture.
Ø5mm twist drill (30m/min)	1	Used to produce Ø5mm hole as per the production drawing.
M6 Tap	1	Used to produce an M6 thread as per the production drawing.
M6x1-6H thread gauge	1	Used to check the M6 threads produced.
Ø4.2mm twist drill (30m/min)	1	Used to produce a Ø4.2mm hole as per the production drawing.
M5 Tap	1	Used to produce an M6 thread as per the production drawing.
M5x0.8-6H thread gauge	1	Used to check the M6 threads produced.
Feeler gauge	1	Used to measure gap widths.
R10 cutter	1	Used to produce 10mm radius as per production drawing.
Radius gauge	1	Used to check the machined radius.
Vee block	1	Used as a work holding device to set block for machining of chamfer.
Engineer's blue	1	Used to blue the surface of the stock so that the scribed lines are more visible. Can also be used during assembly of the bearing to check for high spots.
Computer access	N/A	Needed to write up the report and to note all of the measurements once I have quality checked the workpiece to ensure it is in line with the drawing specification.
Personal Protective Equipment (PPE)		
Gloves	1 (+spares)	To protect the hands from cuts and skin irritation when handling substances. Disposable gloves to be used when handling consumables. Loose fitting gloves must not be worn during machining activities due to entanglement risk. Need to have at least spare one pair in case of replacement.
Barrier cream	1	Needed to protect hands from harmful substances and to protect against dermatitis and other skin irritations. For example, when handling workpieces coated with engineer's blue or working with consumables (oils, liquids, spray lubricants).

Safety boots or safety shoes	1 pair	Needed to be worn in the workshop to prevent injury to feet if any objects are dropped.
Overalls or coat	1 pair	Needed to protect yourself and clothing form dirt and debris from the work carried out. Ensure no loose clothing is worn around the machinery due to risk of entanglement.
Safety glasses	1 pair	Needed to protect eyes from swarf and dust. To be worn at all times.
Technical Information/documentation		
Assignment brief	Needed for technical drawings and tolerances and assessment information.	
Calibration record	Needed to check that the equipment used is within calibration and up to date.	
User manuals	Needed for the vertical miller, centre lathe and CNC lathe. To check operation instruction, safety information and maintenance instructions to check for suitable oils and lubricants.	
Risk assessment	This is a document that I will prepare to record the risks and hazards that may present during the creation of the bearing assembly. I will mitigate against the risks to reduce the likelihood of injury.	
COSHH data sheets	Needed for the hazardous substances which need to be used to ensure correct safety precautions can be followed e.g. engineer's blue, anti-corrosion spray treatment.	
Method statement	This will be used during the tasks to ensure the correct sequence of operations is followed to ensure the quality requirements can be met.	
Quality check sheet	Needed to record measurements of finished workpiece to check it is within drawing specification.	
General Workshop resources		
Waste disposal bins	Waste to be segregated to ensure all waste is disposed of correctly and to ensure materials can be recycled and hazardous substances are disposed of with registered waste carriers.	
First aid kit	Needed in the case of any minor injury when carrying out the task.	
Eye wash station	In case of emergencies, access to an eye wash station to treat any eye incidents to minimise injury before seeking medical treatment.	
Warning signs and notices	To inform people of required PPE requirements, fire exits, first aid information and any hazards in the workshop such as wet floors spillages etc.	
Dust pan and brushes and spill kits	Needed to clean work area and to clear up any spillages that may occur.	
Mop and bucket	To clean up any spillages and clean the work area once job has been completed.	

Calibration of measuring equipment
All measuring equipment has been checked for calibration against the workshop record. Last calibration date was November 2022.

Task 1 – Risk assessment

Machining and work area

Hazard	Risk	Control	Likelihood	Severity
Revolving machinery (mills and lathes) and workpieces.	Risk of cutting, crushing, shearing and entanglement.	Carry out all safety checks prior to use. Guards in place on milling machine and lathes, all guarding checked before use, including fixed and removable guards and protection devices. Correct fitting PPE to be worn at all times. No jewellery to be worn. Long hair should be tied back. Ensure the machinery (mill or lathe) being used has stopped or is turned off and isolated before working inside the machine. Comply with PUWER regulations.	2	3
Ejected swarf, cutters or workpieces from machinery (mills and lathes).	Ejected debris coming off the drill or tooling, from working materials. Getting swarf in your eyes or cutting your hands when removing. Minor burns or scalds from hot swarf.	When using mills or lathes, instruction should be given on correct set up techniques, adequate supervision from trained staff/personnel. Guards are used and checked, use additional magnetic screen guard when machining. Eye protection to be worn at all times with correct PPE. Areas kept clean and tidy; shadow boards provided. Use correct work holding devices to secure workpieces to prevent them being ejected and damaged.	3	2
Chuck keys left in chucks.	Risk of flying out when lathe started causing eye or bodily injuries.	Always check for and remove chuck keys before use, guards are checked, limit switch on chuck guard stops machine from starting unless guard is closed stopping the chuck key from being left in chuck. Eye protection to be worn at all times along with correct PPE, first aid available at all times.	3	2

Fitting mating parts or measure workpiece whilst workpiece is in the chuck, or general handling and tool changing.	Cuts and puncture injuries. Eye injuries.	Machines (mills and lathes) must be turned off and isolated before tool removal, ensure any tools in tailstock chuck are removed or tailstock is moved clear, ensure any turning tools are moved clear, fully trained staff to monitor and offer help when required, PPE available at all times, first aid available at all times.	3	2
Hazardous substances.	Injuries to eyes, skin conditions by absorption (dermatitis), respiratory conditions by inhalation (asthma), spillages (slips and falls)	All oils, lubricants, fluids and substances (engineer's blue) used in the machining process are COSHH assessed and stored in correct facilities and locked away when not in use. PPE to be worn when handling oils or substances (non-absorbent gloves, clothing etc), use masks to avoid inhaling any fumes or irritants. First aid is available if required. New operators supervised when using hazardous substances.	2	2
Moving around the workshop and work areas.	Slips, trips and falls resulting in bodily or musculoskeletal injuries or disorders.	Painted pedestrian walkways are marked out adequate lighting exists, correct footwear worn at all times, spillages cleared asap – signage available, no trailing cables in the area, keep areas clean and tidy, ensure good standard of housekeeping around equipment and local area, no material or equipment placed in pathways. Manage and dispose of all waste to avoid build up in the work area.	3	2
Hot swarf.	Burns and scalds	PPE worn at all times, adequate supervision, use of guarding to avoid damage to eyes. First aid available at all times. Use a brush to clean swarf away from the moving parts of the machine avoiding contact with fingers or hands.	2	2

Noise	Hearing damage	If noise levels are beyond the safe workshop limit, ear protection should be worn. Refer to Noise at Work Regulations.	3	1
Manual handling	Musculoskeletal injuries	Ensure training has been given. Use correct manual handling techniques are used by everyone in the workshop and ensure there is mechanical assistance available if required for larger and heavier materials per the manual handling regulations.	3	1

Likelihood		**Severity**	
1	Very unlikely to happen	1	Minor injury
2	Unlikely to happen	2	Major injury
3	Possible to happen	3	Loss of limb
4	Likely to happen	4	Death of an individual
5	Very likely to happen	5	Multiple death

Task 1 – Method statement

Bearing housing

Operation No.	Description	Machine, Tools and Equipment	Speeds and feeds	Process	Quality checks
1	Gather required information and conduct a risk assessment	Drawings Risk assessment proforma	NA	Obtain the brief and drawings from supervisor and extract the required information and perform a risk assessment on the mill and lathe in the workshop.	NA
2	Obtain material and cut to required length	Bandsaw File Steel rule	NA	Obtain material 63.5mmX3.5mm mild steel from stores. Cut to 55mm in length on the bandsaw. Deburr.	Check final overall dimensions are correct with a steel rule.
3	Conduct standard workshop machine safety checks (SOP)	Vertical Mill SOP machine set up	NA	Reference safety checklist, tick off all boxes and hand them back to the supervisor.	NA
4	Box material to 60mmX60mmX50 mm	Vertical mill Ø50mm Face cutter Engineer's square DTI Digital callipers Mallet Parallels	1200rpm	Place material with stock faces on parallels and fixed jaw of vice. Tap down job until parallels both do not move. Touch on with the face cutter and take an equal amount off each face until the block measures 60mmx60mm. Stand sawn end on parallels and use engineer's square and DTI to set block square. Face off with face cutter and take down to 50mm OAL.	Check block size with digital callipers and engineer's square.
5	Ream Ø14 hole for reference for setting up the 4-jaw chuck.	Parallels Mallet Wobble bar BS3 centre drill	200rpm 3418rpm	Lay part with 10mm protruding at the top of the vice. 60x60 face up. Use wobble bar to find the centre of the block.	Check for hole centrality with digital callipers

		(30m/min) Ø13.7 twist drill (30m/min) Ø14 reamer (15m/min) Digital callipers	(1800) 697rpm 341rpm	Centre drill, drill and then ream the hole.	
Move to Centre lathe					
6	Conduct standard workshop machine safety checks (SOP)	Centre lathe SOP machine set up.	NA	Reference safety checklist, tick off all boxes and hand them back to the supervisor.	NA
7	Bore Ø40-40.05 hole	4-jaw chuck DTI Ø25 twist drill (30m/min) Boring bar (90m/min)(0.12mm/rev) Shim to protect surface finish Bore Micrometer	382rpm 716rpm Feed (0.12 mm/rev)	Set up part with 60x60 face facing out. Use the DTI sitting on the saddle to clock in the Ø14 reamed hole. Use the DTI on the tool post to check the 4 outside faces are correct and match the reamed hole centrality, alter if required. Drill Ø25mm hole through part. Bore the Ø40mm hole with the boring bar.	Check size with bore micrometer. Adjust accordingly.
Move back to Vertical Mill					
8	Drill and tap 2 x M6x1 thread	Parallels Mallet Wobble bar BS3 centre drill (30mm/min) Ø5mm twist drill (30m/min) M6 Tap M6x1-6H thread gauge	200rpm 3418rpm (1800) 1910rpm by hand	Have the top 60x50 side up and tap down onto the parallels. Use the wobble bar to index the hole positions 44mm about the centre. Centre drill, drill and tap the M6 holes in both positions. Deburr.	Check positions of the thread with a digital calliper and the thread with a M6x1 - 6H thread gauge.
9	Drill and tap M5x0.8 thread	Parallels Mallet Wobble bar	200rpm	Have the bottom 60x50 side up and tap down onto the parallels with a mallet.	Check positions of the thread with a digital calliper

		BS3 centre drill (30mm/min) Ø4.2mm twist drill (30m/min) M5 Tap M5x0.8-6H thread gauge	3418rpm (1800) 2274rpm By hand	Use the wobble bar to index into the middle of the block. Centre drill, drill and tap the M5 thread until it breaks through to the middle bore. Deburr this area fully.	and the thread with a M5x0.8 - 6H thread gauge.
10	Mill R10 right edge	Parallels Mallet Feeler gauge R10 cutter Radius gauge	318rpm	Identify the correct edge of the block for the R10 radius, use the feeler gauge to datum the bottom and the side of the R10 cutter. Mill off in steps.	Use the R10 radius gauge to check the profile of the edge.
11	Mill 8x45°	Parallels Mallet vee block Vernier height gauge Engineer's blue Digital callipers Protractor Ø50mm Face cutter	1200rpm	Mark the correct edge with the 8x45° angle. Use the engineer's blue and the vernier height gauge for this. Place the block with the correct edge up on the vee block which will be held in the vice. Use the face cutter to mill to the marked line.	Use the digital callipers to measure the length of the angle and protractor to check the angle.
12	Inspect part and tidy down	Calibrated measuring equipment Inspection documents	NA	Complete the inspection document and assemble the part ready for assessment handover. Fully clean down the machine putting hand tools and measuring equipment back into designated places and cleaning all swarf of machine and placing it in swarf bin. Reinstate area.	NA

Top hat bearing

Operation No.	Description	Machine, Tools and Equipment	Speeds and feeds	Process	Quality checks

1	Gather required information and conduct a risk assessment	Drawings Risk assessment proforma	NA	Obtain the drawings from lecturer and extract the required information and perform a risk assessment on the XYZ mill and lathe in workshop.	NA
2	Obtain material and cut to required length	Bandsaw File Steel rule	NA	Obtain material ø60 nylon from stores. Cut to 120mm in length on the bandsaw or use an offcut that is longer than 100mm in length. Deburr.	Check final overall dimensions are correct with a steel rule.
3	Conduct standard workshop machine safety checks (SOP)	Centre lathe SOP machine set up.	NA	Reference safety checklist, tick off all boxes and hand them back to the supervisor.	DTI ensures chuck is not running out and will affect the overall specification of the part.
4	Chuck material	Manual Lathe Steel rule 3 jaw chuck	NA	Load material into 3 jaw chuck with 65mm protruding from the chuck.	Check with steel rule
5	Face to clean	Carbide side and face cutter (80m/min)	1320 rpm 0.2 feed	Touch on zero DRO wind off and place a 0.2mm cut on and face to clean.	NA
6	Centre drill and process drill	BS4 ø28mm jobber drill (30m/min)	1500rpm 340 rpm	Centre drill to produce a BS4 centre drilled hole, drill ø28 hole 60mm deep.	Use the probe end of the digital calliper to check length.
7	Turn bore to ø30mm	DTI Boring bar (80m/min) Digital vernier Bore Micrometer	636rpm (0.12 mm/rev)	Qualify tool on front face zero the DRO. Take a skim off the internal bore and qualify the size, recalibrate the DRO. Take the finished cut to final depth.	Use the digital calliper to check size but bore mic to confirm final size is within tolerance. +0.1/-0
8	Rough turn external diameter ø40 & ø55 to length	Rough side and face cutter (80m/min) 25-50 micrometer 50-75 micrometer	ø55 463rpm ø40 636 rpm	Qualify the z and x of the tool and recalibrate the DRO. Turn ø55 diameter to 60mm, then take 2mm cuts to turn the ø40mm to 50mm.	Check the diameters using the relevant micrometers. Use the digital

		digital calliper		Leave 1mm on diameter and 0.2mm on length.	calliper to check the length.
9	Finish turn external diameter ø40 & ø55 to length	Finish side and face cutter (100m/min) 25-50 micrometer 50-75 micrometer digital calliper	ø55 579rpm ø40 796rpm	Qualify the z and x of the tool and recalibrate the DRO. Turn ø55 diameter to 60mm, then take 0.5mm cuts to turn the ø40mm to 50mm. Fit the bearing housing to the ø40mm to create a push fit.	Check the diameters using the relevant micrometers. Use the digital calliper to check the length. Paying attention to the tolerances.
10	Produce the 1x45 chamfer	Chamfer tool (30m/min) Steel rule	238rpm	Touch on the front edge and zero the Z datum on the DRO. Move in 1mm on the Z.	Check with a steel rule.
11	Part off to length	Parting tool (30m/min) Digital calliper	238rpm	Qualify the parting tool and part off to 55.2mm. Leaving 0.2 for finishing.	Check overall length with digital callipers.
12	Face to length 55mm	Finish side and face cutter (100m/min) Shim	579rpm	Using shim to protect the faces, face to length.	Check overall length with digital callipers.
13	Produce the 1x45 chamfer	Chamfer tool (30m/min) Steel rule	238rpm	Touch on the front edge and zero the Z datum on the DRO. Move in 1mm on the Z.	Check with a steel rule.
14	Inspect and clean down	Calibrated measuring equipment Inspection documents	NA	Complete the inspection document and assemble the part ready for assessment handover. Fully clean down the machine putting hand tools and measuring equipment back into designated places and cleaning all swarf of machine and placing it in swarf bin. Separate the nylon waste. Reinstate area.	NA

Shoulder shaft

Operation No.	Description	Machine, Tools and Equipment	Speeds and feeds	Process	Quality checks
1	Gather required information and conduct a risk assessment	Drawings Risk assessment proforma	NA	Obtain the drawings from lecturer and extract the required information and perform a risk assessment on the XYZ SLX in the workshop.	NA
2	Obtain material and cut to required length	Bandsaw File Steel rule	NA	Obtain material ø50 mild steel from stores. Cut to 120mm in length on the bandsaw. Deburr.	Check final overall dimensions are correct with a steel rule.
3	Conduct standard workshop machine safety checks (SOP)	Centre lathe SOP machine set up.	NA	Reference safety checklist, tick off all boxes and hand them back to the supervisor.	NA
4	Load material	XYZ SLX 3 jaw chuck Steel rule	NA	Load material in chuck with 70mm protruding from the face of jaws.	Steel rule to verify.
5	Check tools	Tools are in the magazine	NA	Manually use the machine to verify the front of the part is at zero and the diameter is set correctly.	NA
6	Simulate program	NA	NA	Call up the program and run the visual simulation.	NA
7	Run program in tracking mode	Safe mode	NA	To verify the program, run it in tracking mode as a first instance. Make sure the tool will not hit the chuck at the furthest extent.	NA
8	Full run on CNC	NA	NA	When confident change to full run CNC, make sure the coolant is running.	NA
9	Finish part	File	NA	Retrieve the part from the coolant box and file off pip.	Check the diameters using the relevant micrometers.

					Use the digital calliper to check the length.
10	Inspect part and tidy down	Calibrated measuring equipment Inspection documents	NA	Complete the inspection document and assemble the part ready for assessment handover. Fully clean down the machine putting hand tools and measuring equipment back into designated places and cleaning all swarf from the machine and placing it in the swarf bin. Reinstate area.	NA

Task 1 – Quality check sheet

Bearing housing

Drawing Size	Tolerance	Equipment Used	Actual Size	Candidate Inspection		Comments
				Satisfactory	Unsatisfactory	
60mmx60mmm	±0.25	Digital calliper				
50mm	±0.25	Digital calliper				
ø40	+0.1 -0.0	Digital bore micrometer				
M5x0.8-6H	Gauge	M5x0.8 - 6H thread gauge				
M6x1 - 6H	Gauge	M6x1 - 6H thread gauge				
8x45°	±0.25	Steel rule				
R10	±0.25	R10 gauge				

Top hat bearing

Drawing Size	Tolerance	Equipment Used	Actual size	Candidate Inspection		Comments
				Satisfactory	Unsatisfactory	
5mm	±0.25	Digital calliper				
55mm	+0.0 -0.2	Digital calliper				
ø30	+0.1 -0.0	Bore micrometer				
ø40	+0.0 -0.1	Micrometer				
ø55	±0.25	Micrometer				
1x45°	±0.25	Steel rule				

Shoulder shaft

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		Comments
				Satisfactory	Unsatisfactory	
4mm	±0.25	Digital calliper				
1.6mm	+0.14 -0.0	Digital calliper				

55mm	+0.2 -0.0	Digital calliper				
63mm	±0.25	Digital calliper				
ø28.6	+0.0 -0.21	Blade micrometer				
ø30	+0.0 -0.1	Micrometer				
ø45	±0.25	Micrometer				
1x45°	±0.25	Steel rule				
R1	±0.25	R1 gauge				

Task 2 – Production

(Assessment themes: Health and safety, Production (measuring and marking out, cutting components, techniques and methods, tools and equipment).

For task 2, candidates need to produce the following pieces of evidence:

- bearing assembly consisting of:
  - bearing housing
  - top hat bearing
  - shoulder shaft.

For task 2, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - set up and use of manual and pre-programmed CNC workshop machinery
  - the production of the individual bearing assembly components
  - tool skills, application and usage
  - checks carried out before, during and after production
  - work area prior to, during and on completion of tasks.

Note: For the purpose of this GSEM, the assessor observation has been captured on one form. In delivery, assessors may choose to capture their observations on more than one form.

Photographic evidence required:

- photographic evidence of the prepared work area – *illustrated in task 2 photographic evidence section below (photographs 1 - 7)*
- photographic evidence showing the construction of the bearing assembly including
  - the work area prior to, during and on completion of tasks
  - marking out of materials
  - setting up and application of machinery to remove material
  - final finish removal of material and result of tool section for accuracy and the finish of the component parts
  - application of the surface treatment to component parts

Illustrated in task 2 photographic evidence section below (photographs 8 - 27)

- photographic evidence of the completed bearing assembly – *illustrated in task 2 photographic evidence section below (photograph 28).*

Note: Additional photographs may be used to capture other elements of the machining processes.

Photographs in this GSEM demonstrate the full process that the candidate has undertaken to complete the bearing assembly. Commentary sections detail where performance is considered to be at a level reflective of a distinction grade. Note, due to the nature of this process, not all individual work activities would provide opportunity to demonstrate a defined level of differentiation beyond a pass – but these images are shown in order to show the cohesiveness of the process being undertaken, and to draw out where differentiation is possible.

Task 2 – Candidate evidence

Task 2 – Photographic evidence – Production

Work area, prior to, during and on completion of production activities (photographs 1 – 7)

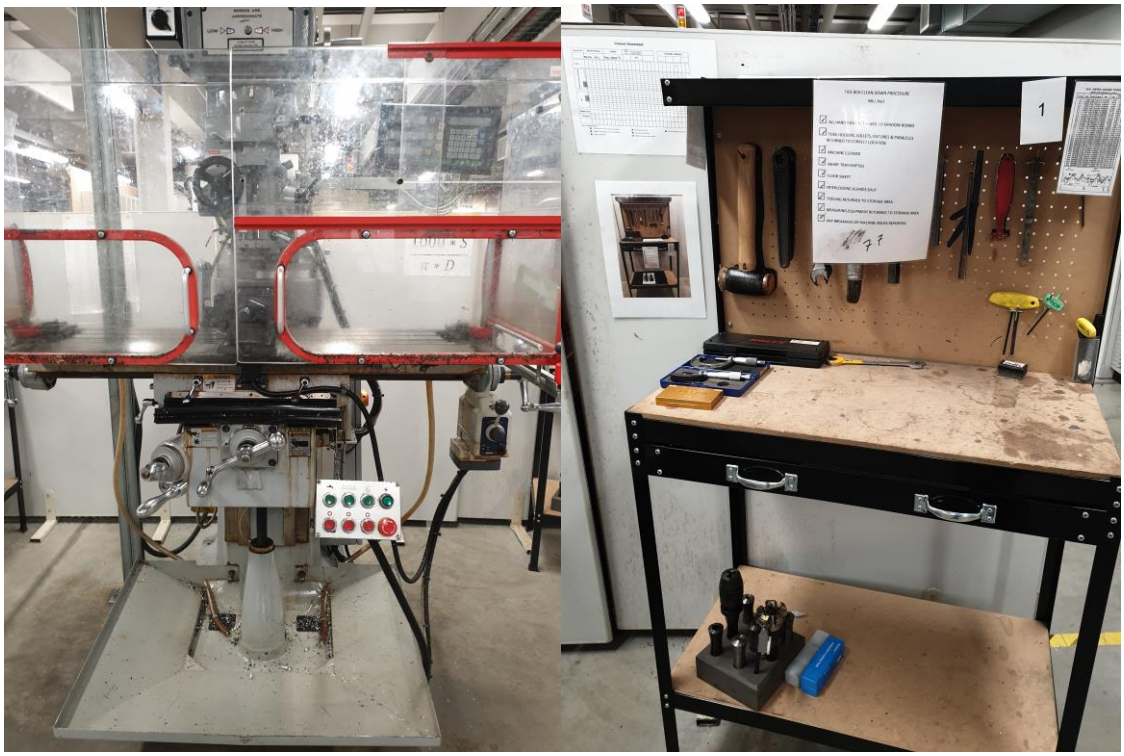
Photograph 1 – showing the mill area prepared.

Photograph 2 – showing the lathe area cleaned of all metal swarf to enable nylon swarf to be collected and disposed of separately. Work station showing all tools and equipment stored.

Photograph 3 - showing the CNC lathe prior to machining.

Photograph 4 and 5 – showing the work area on completion of activities, reinstated.

Mill area -



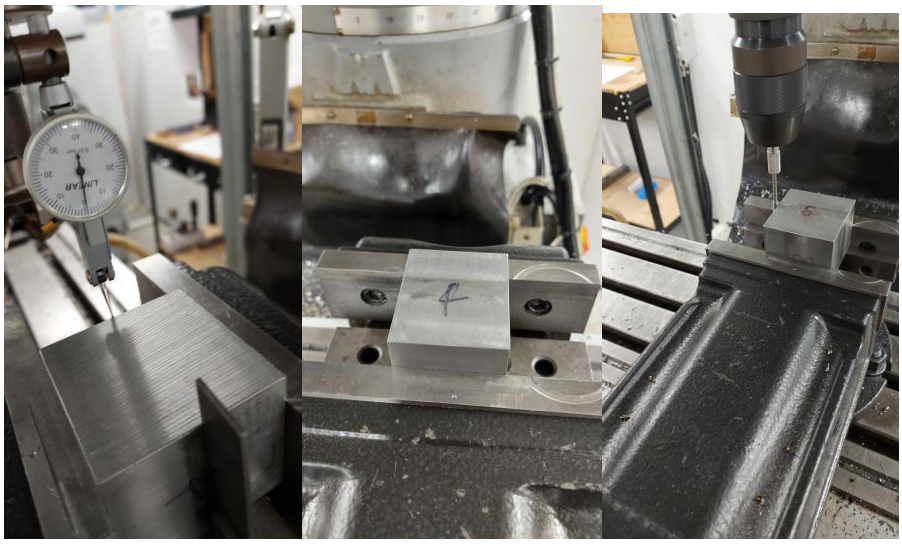
Photograph 6 and 7 – showing the removal, correct material segregation and disposal of waste.

Manual Lathe CNC Lathe

Production of bearing assembly components (photographs 8 – 27)

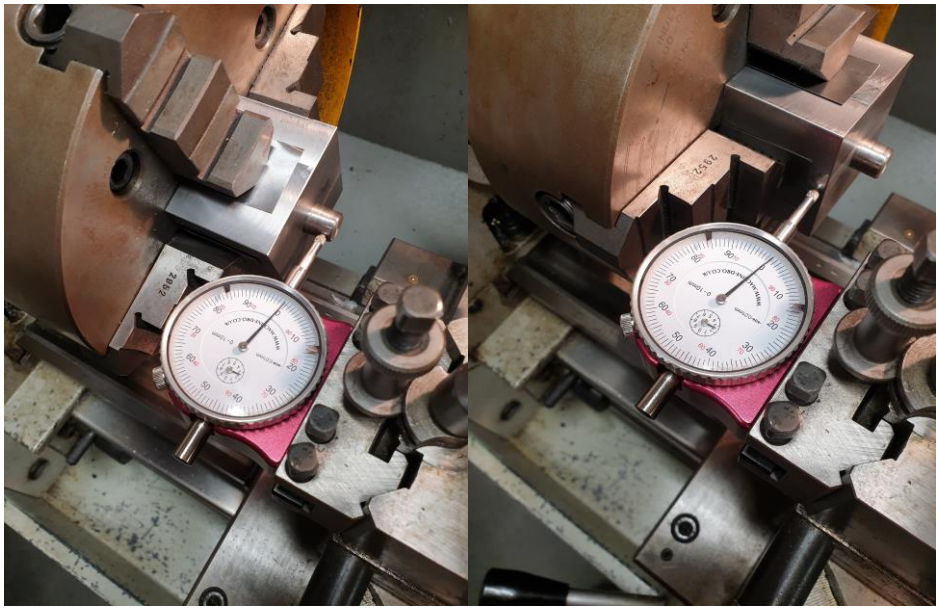
Bearing housing

Photograph 8, 9 and 10 – showing the machining of the 4 faces using a face cutter.

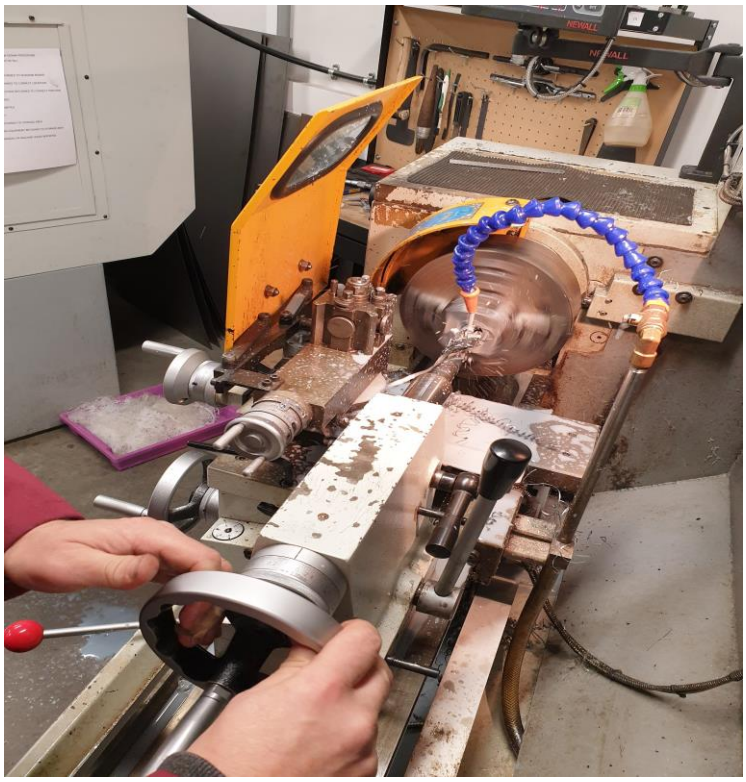


Photograph 11, 12 and 13 – showing the wobble bar into the centre and centre drilled, 13.7 drill and 14 reamer.

Photographs 14 and 15 – showing a small plug was made that fitted into the 14mm reamed hole, this gave a gauge to get it clocked in centrally, it was then rechecked with the plunger dial test indicator (DTI) on the 4 faces and minor adjustment made to make sure it was central.

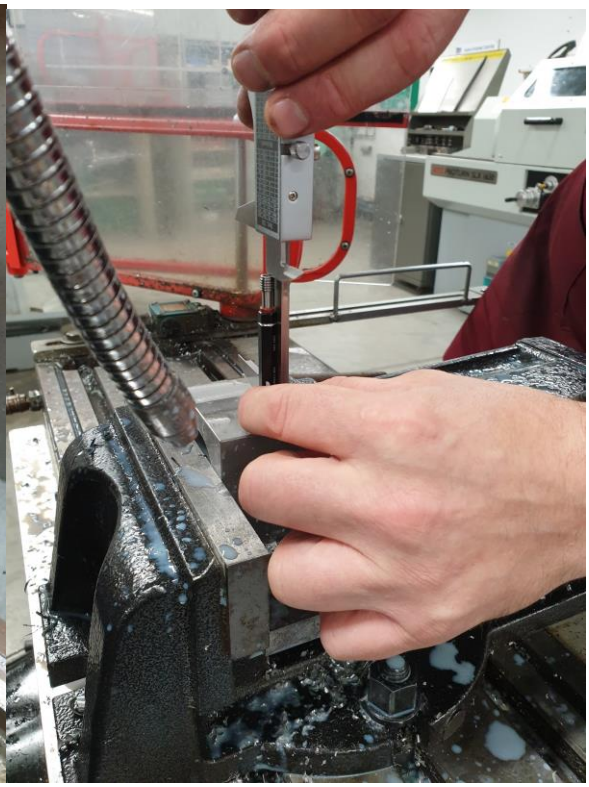


Photograph 16 – showing the drilled out hole to 28mm, swarf was consistently removed using safe methods. Boring bar tip was replaced before using it as it was worn.



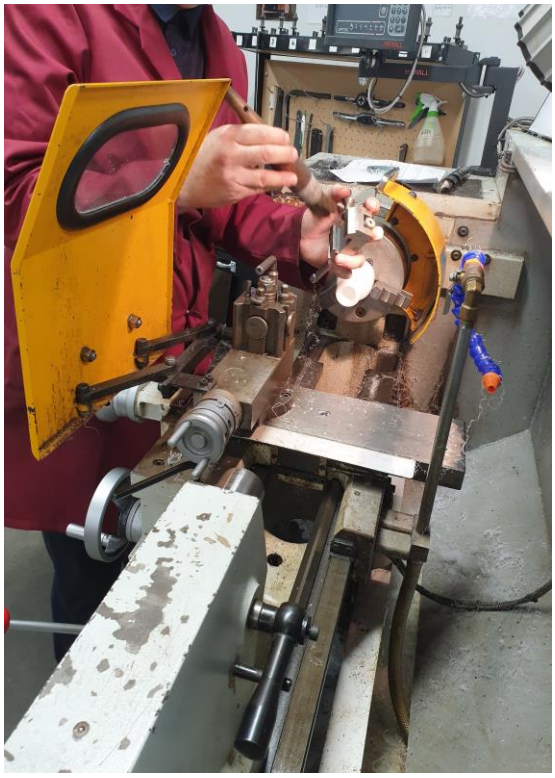
Photographs 17, 18 and 19 – showing the bored out bearing housing until nylon top hat was a push fit. Using the bore micrometer to help get close to the size before using the component as a final fit.

The thread gauge was bottomed out in M6 holes, digital calliper was used to determine depth of the thread. R10 gauge was used to confirm the radius was cut correctly.

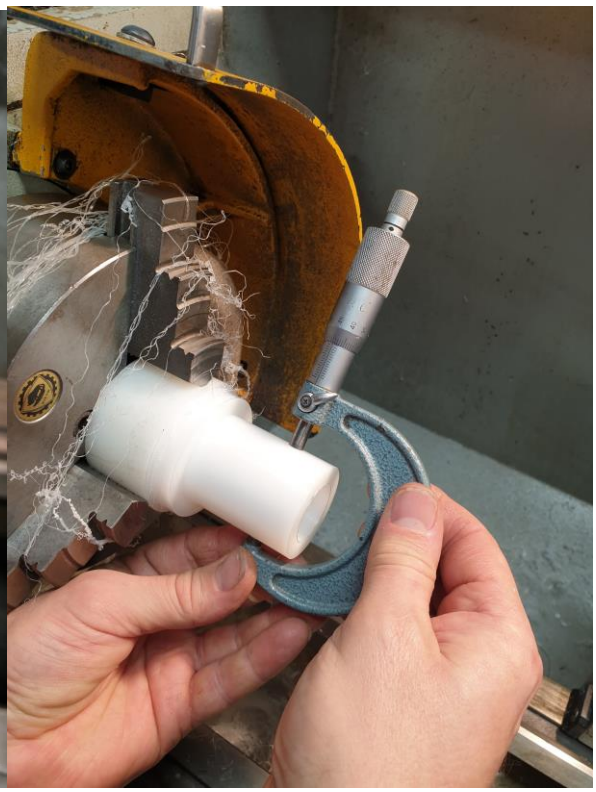


Nylon top hat bearing

Photograph 20 – showing cleanliness of tool change over maintained throughout manufacturing.



Photograph 21 and 22 – showing in-production accuracy checks being taken. Measuring the internal diameter with a bore mic and the external with an external micrometer.



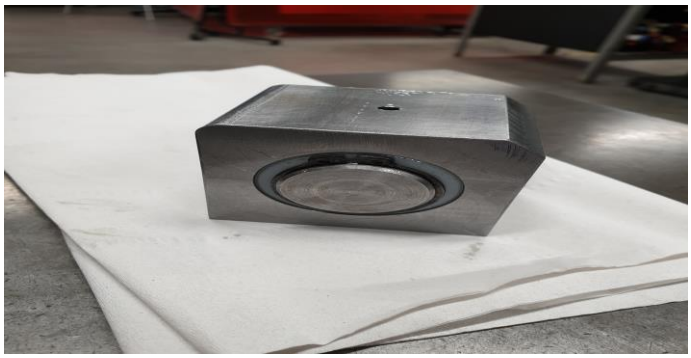
Shoulder shaft (CNC machined)

Photographs 23 and 24 – showing a tool change, the tool tip had wear and the tip was changed, the bar was chucked into the right distance from the chuck.

Photographs 25, 26 and 27 – showing the preparation of the CNC lathe. The program simulation was run to see the general outlook of the part. The program was then run but in tracking mode to start with to prove first pass. The program was then changed to CNC mode. Coolant was turned on and part run with the 4 tools being changed at the right time.

Completed bearing assembly

Photograph 28 - showing the completed bearing assembly, all components correctly seated.



Task 2 - Practical observation form – Production

Assessment ID	Qualification number
8713-332	**8713-332**
Candidate name	**Candidate number**
Candidate A	**CG12345**
Centre name	**Assessment theme**
City & Guilds	**Planning & preparation, Production, Health & safety, Assembly**

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

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Production **The assessor observation should include consideration of:** • the stages of production • tool application and usage • application of hand skills • set up and use of manual and pre-programmed CNC workshop machinery • checks carried out before, during and after production • performance of safety critical commissioning checks	The candidate prepared their work area at the beginning of the session. Attention was particularly paid to the manual centre lathe when setting up for the nylon top hat as all waste needed to be kept separate. All tools and measuring equipment referenced in the operation sheet were located and placed locally so footfall around the workshop was minimised. The standard workshop SOP was followed to make the milling machine and lathes ready for use. All measuring tools were calibrated, a quick reference check to a slip gauge or zero was made. All machine guarding was in place. They inspected and prepared the material ready for the next process. All work was deburred effectively. The candidate worked confidently when using processes to remove material from each workpiece; they followed their operation plan and consistently altered the speed and feed rate as dictated in the plan. When boxing up, indexing to the stated position or proving out a tool; they used the correct process to produce the correct parameters for the task. The bearing housing part was prepared and squared on the mill. All faces machined using a face cutter. A wobble bar used to find and drill the centre. Moving to the manual lathe, the candidate used a small plug within the 14mm reamed hole to give a gauge to clock in

• work area prior to, during and on completion of tasks.	centrally, which was checked using the plunger DTI on all four faces. A minor adjustment made to make it central. The hole was drilled out to 28mm, swarf consistently removed. Boring bar tip was worn and replaced. The bearing housing was bored out until the nylon top hat was a push fit. A bore micrometer was used to check the size before using the component to check the final fit. Thread gauge was bottomed out in M6 holes, digital calliper used to determine depth of thread. R10 gauge used to confirm radius was cut correctly. The top hat bearing was machined on the manual lathe. The internal diameter was measured with a bore micrometer and the external with an external micrometer. In-production checks of the workpieces were continual in order to ascertain whether parameters required altering. The candidate set the shoulder shaft stock up correctly on the CNC lathe. Tooling was selected and changed over at the allocated times. The roughing tool required a tip change; this was safely changed. The program simulation was run in tracking mode, checking the setup of the part. The program was then changed to CNC mode and monitored. Coolant was turned on; all four tools were safely changed during the program. On completion, the CNC machine was cleaned of all swarf and left in a ready state for the next user. All debris was disposed of in accordance with waste procedures and waste management regulations. The candidate completed thorough checks of all the tools and equipment used. All tools and equipment were checked for cleanliness and serviceability. A damaged tip was replaced, the old tip was placed in the broken tooling section. Cleaning of the tip bed area was thorough. Candidate checked the tip was correctly seated. A workshop SOP was followed to set up the machinery, all safety and serviceability checks completed before the use of each machine. Particular attention was paid to the run out of the 3-jaw chuck, the centrality of the bore when setting up the bearing housing in the 4-jaw chuck and the parallelism of the vice on the mill. Work holding devices were cleaned of debris in between operations, no swarf trapped in the vice. All machines were thoroughly cleaned after use and reinstated the work area. All swarf removed and placed in a designated bin for safe disposal. Nylon swarf was disposed of separately. No contamination with the metal disposal. All tools and measuring equipment were wiped

	clean, checked and returned to the shadow board and designated storage areas. The candidate demonstrated the optimum method to use for each tool, using the correct speeds and feeds to achieve a good surface finish. The internal bore was to the desired surface finish and tolerance; however this could have been improved. The 4-jaw chuck left a few surface marks; a shim was used to protect this which was the corrective action used to avoid marks in the industry. All measuring tools calibrated effectively. Used a range of measuring tools continually throughout the production process to check the dimensions of the machined components. Dimensions checked against the drawings; adjustments were made to the machining parameters to achieve the correct dimensions. On completion of the machining for the three components, the candidate completed checks on the final fit of the components, no additional adjustments were required. The bearing assembly was finished with an even coating of an anti-corrosive surface treatment. This completed the task. Health and safety was followed throughout all tasks, all control measures and a safe system of work were in place. Correct PPE was worn throughout. Machine guards were utilised throughout. The candidate followed a SOP for machine isolation when changing tooling and cleaning down the machinery. The work area was reinstated, all tools and equipment were cleaned, checked and returned to their shadow board or to the appropriate storage location. All waste correctly segregated and disposed of according to the type of waste.
Assessor signature	**Date**
Assessor A	**17.12.2022**

Task 3a – Quality review

(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover)

For task 3a, candidates need to produce the following piece of evidence:

- completed quality check sheet.

For task 3a, assessors will need to produce the following pieces of supporting evidence:

assessor observation:

- use of measuring equipment
- checks for tolerances and accuracy

Photographic evidence required:

- the quality review being undertaken, with consideration of
    - checking of tolerances and application and use of appropriate measuring tools and equipment
- photographic evidence of the bearing assembly components and fully assembled bearing assembly – *Illustrated in task 3 photographic evidence section below (photographs 29 – 32)*

The following task 3a supporting evidence has not been included for this version of the GSEM:

- the quality review being undertaken, with consideration of
    - checking of tolerances and application and use of appropriate measuring tools and equipment

Video evidence required:

- video evidence demonstration showing the fit of the components to form the bearing assembly – Illustrated in task 3 video evidence section below (video 1)

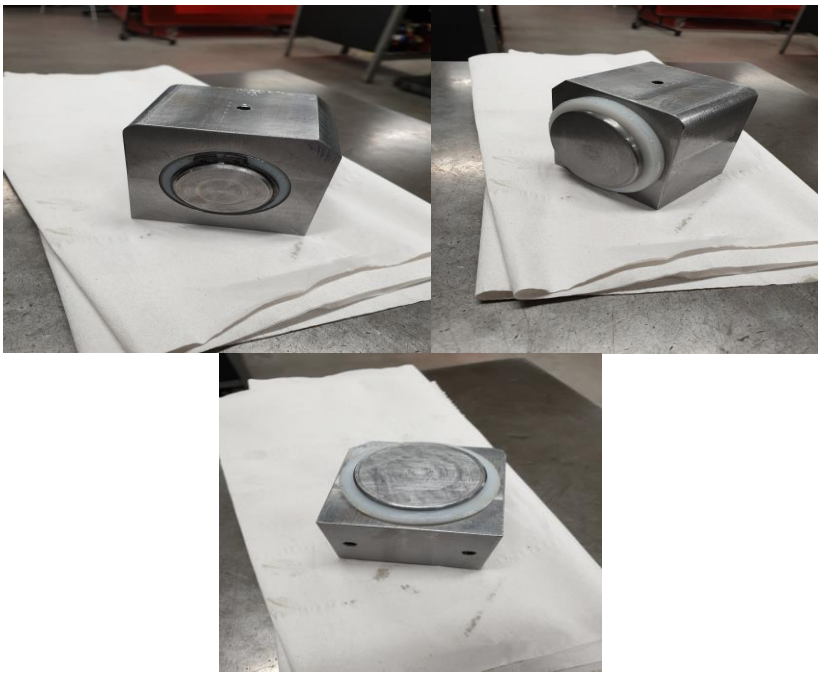
The following task 3a supporting evidence has not been included for this version of the GSEM:

Video evidence

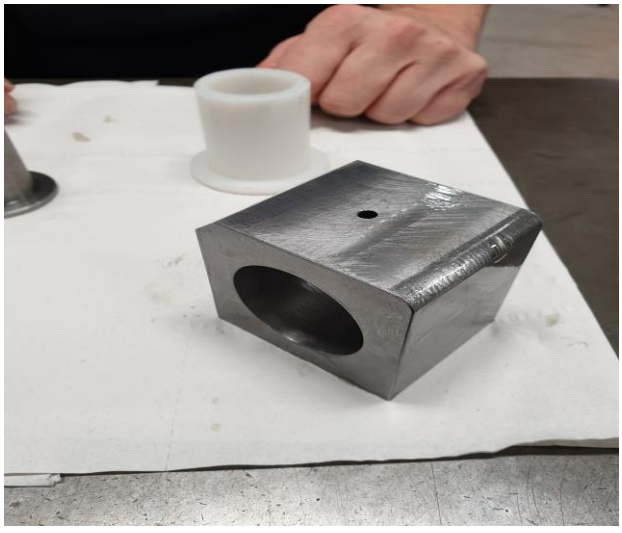
- video evidence showing the fit of the components to form the bearing assembly.

Task 3a – Photographic evidence – Quality review

Photograph 29 - 31 showing the completed bearing assembly consisting of the three parts (bearing housing, shoulder shaft and top hat bearing).



Photograph 32 - showing the completed bearing housing with minimal tool marks achieved.



Candidate evidence

3a. Completed quality check sheet

Bearing housing

Drawing Size	Tolerance	Equipment Used	Actual Size	Learner Inspection		
				Satisfactory	Unsatisfactory	Comment
60mmx60mm	±0.25	Digital calliper	60x60.03	✓		within tolerance – some minor tool marks to surface
50mm	±0.25	Digital calliper	50.03	✓		within tolerance
ø40	+0.1 -0.0	Bore micrometer	40.025	✓		within tolerance
M5x0.8-6H	Gauge	M5x0.8 - 6H thread gauge	Gauge all through	✓		NA
M6x1 - 6H	Gauge	M6x1 - 6H thread gauge	Gauge depth 13.97	✓		within tolerance
8x45°	±0.25	Steel rule	7.9x7.9	✓		within tolerance
R10	±0.25	R10 gauge	R10	✓		within tolerance

Top hat bearing

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		
				Satisfactory	Unsatisfactory	Comment
5mm	±0.25	Digital calliper	4.87	✓		within tolerance unable to remove all surface tool marks due to nature of material (nylon)
55mm	+0.0 -0.2	Digital calliper	54.93	✓		within tolerance
ø30	+0.0 -0.1	Bore micrometer	29.95	✓		within tolerance
ø40	+0.0 -0.1	Micrometer	39.97	✓		within tolerance

ø55	±0.25	Micrometer	55.12	✓		within tolerance
1x45°	±0.25	Steel rule	1x1	✓		within tolerance

Shoulder shaft

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		
				Satisfactory	Unsatisfactory	Comment
4mm	±0.25	Digital calliper	3.8	✓		within tolerance
1.6mm	+0.14 -0.0	Digital calliper	1.7	✓		within tolerance
55mm	+0.2 -0.0	Digital calliper	55.15	✓		within tolerance
63mm	±0.25	Digital calliper	62.99	✓		within tolerance
ø28.6	+0.0 -0.21	Blade micrometer	28.5	✓		within tolerance
ø30	+0.0 -0.1	Micrometer	29.91	✓		within tolerance
ø45	±0.25	Micrometer	44.97	✓		within tolerance
1x45°	±0.25	Steel rule	1X1	✓		within tolerance
R1	±0.25	R1 gauge	R1	✓		within tolerance

Task 3a - Practical observation form – Quality review

Assessment ID	**Qualification number**
8713-332	**8713-332**
Candidate name	**Candidate number**
Candidate A	**CG12345**
Centre name	**Assessment theme**
City & Guilds	**Quality review and evaluation**

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

Task	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Quality inspection and application of measuring equipment	Measuring tools were selected, calibration checks were completed on the measuring equipment before use. Each component part was measured using the appropriate measuring tool. The candidate checked the dimensions against the technical drawing and checked the adherence to the given tolerance. All dimensions and findings were recorded on their quality check sheet. Visual checks were completed, the final surface finish was closely examined.
The completed bearing assembly	The candidate assembled the bearing housing, in order and correct orientation. The circlip was added and the CNC shaft was still able to rotate freely due to the fact the unilateral tolerances were adhered to when manufacturing the parts. The bearing assembly was correctly assembled, no free play in the assembly which was good. All tolerances within the specification were met. The unilateral tolerance was adhered to, the candidate had stayed close to the nominal size in order to create the push fit for the nylon top hat into the bearing housing. The CNC shaft had a slightly looser fit, but still a running fit was achieved as the difference in parts was just 0.14mm. Overall an excellent part with excellent dimensional accuracy and a good surface finish.

	There were very few defects, but those visible were identified and a solution offered. The defects did not affect the operation of the assembly or go outside the specified tolerances.

Assessor signature	**Date**
Assessor A	**18.12.2022**

Task 3b – Evaluation and recording

(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover)

For task 3b, candidates need to produce the following piece of evidence:

- completed quality inspection report.

Task 3b – Quality inspection report

Quality Inspection Report

Introduction

The assignment was to create a new bearing assembly to be used in a roller assembly of a bespoke conveyor system. Technical drawings were provided within the brief. The bearing assembly was to be manufactured and when completed, quality inspected.

Production process

The bearing assembly was made up of three main components: the bearing housing, shoulder shaft and top hat bearing. The bearing housing and shoulder shaft were manufactured using low carbon mild steel and the top hat bearing was to be manufactured out of nylon.

The bearing housing was manufactured using the milling machine and a manual lathe. The stock material was first prepared and squared on the milling machine. A face cutter was used to cut all four sides which was then checked with a DTI gauge for squareness. A reference hole was added to the middle of the workpiece to be able to clock it when it was transferred to the lathe and it also give the drill some relief. A wobble bar was used to find the centre of the block to enable the hole to be drilled centrally. The holes were bored on the lathe to the required sizes. In-production checks were carried out to check the amount of material removed and to ensure the internal and external bore measurements were accurate. This was achieved using micrometers. Minor adjustments were made to the bearing housing to enable the required push fit for the nylon top hat bearing. A chamfer was machined using a 45-degree setting piece and a carbide tipped end mill.

The top hat bearing was manufactured from nylon using the manual lathe. The nylon was machined using a range of tooling to remove the material. Due to the properties of the material it created a lot of excess swarf when machined which had to be cleared from the moving parts to prevent damage to the lathe. The external bore was checked with a micrometer to ensure a good fit into the bearing housing.

The shoulder shaft was manufactured using the CNC lathe. The CNC lathe was set up to machine the part and the tooling on the lathe was changed at intervals to achieve the dimensions and finish as required in the specification. The program simulation was run first to check the general outlook of the part, then run in tracking mode before being changed to full CNC mode to machine the part. Coolants were used during the machining and 4 tools were changed during the manufacture. In-production checks were made to ensure the required dimensions had been met.

The individual components were adjusted accordingly to ensure the fit met the specification. The final assembly was treated with an anti-corrosion spray treatment.

Quality inspection

I carried out a full quality inspection on the completed bearing assembly. This included a visual check; dimensional accuracy check and functionality test of the bearing assembly.

I prepared my work area and collected my tools and equipment. I selected a digital Vernier calliper to measure the finished dimensions of the individual components. The Vernier calliper was checked and calibrated.

I completed a visual check of the completed bearing assembly. There were some surface marks on the bearing housing from the jaws of the vice. These were caused during the production of the component and were not removable by polishing. The nylon top hat bearing showed some residual tooling marks. A shim was used to minimise this during the manufacture but this was not able to remove all tooling marks.

To check the functionality, I checked the fit of the components by spinning the assembly to check the bearing operated correctly. The fit was good, the bearing was free running and there was no free play in the assembly.

I disassembled the bearing assembly and used the vernier digital callipers and micrometers to carry out dimensional checks on the individual component parts. All components were measured. The finished dimensions were recorded on the quality check sheet. I repeated this process for each component part. I checked the brief and the technical drawings to confirm the required tolerances. All tolerances were met. A copy of my quality check sheet is included below:

Bearing housing

Drawing Size	Tolerance	Equipment Used	Actual Size	Learner Inspection		
				Satisfactory	Unsatisfactory	Comment
60mmx60mm	±0.25	Digital calliper	60x60.03	✓		within tolerance – some minor tool marks to surface
50mm	±0.25	Digital calliper	50.03	✓		within tolerance
ø40	+0.1 -0.0	Bore micrometer	40.025	✓		within tolerance
M5x0.8-6H	Gauge	M5x0.8 - 6H thread gauge	Gauge all through	✓		NA
M6x1 - 6H	Gauge	M6x1 - 6H thread gauge	Gauge depth 13.97	✓		within tolerance
8x45°	±0.25	Steel rule	7.9x7.9	✓		within tolerance
R6	±0.25	R6 gauge	R6	✓		within tolerance

Top hat bearing

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		
				Satisfactory	Unsatisfactory	Comment
5mm	±0.25	Digital calliper	4.87	✓		within tolerance unable to remove all surface tool marks due to nature of material (nylon)
55mm	+0.0 -0.2	Digital calliper	54.93	✓		within tolerance
ø30	+0.0 -0.1	Bore micrometer	29.95	✓		within tolerance
ø40	+0.0 -0.1	Micrometer	39.97	✓		within tolerance
ø55	±0.25	Micrometer	55.12	✓		within tolerance
1x45°	±0.25	Steel rule	1x1	✓		within tolerance

Shoulder shaft

Drawing Size	Tolerance	Equipment Used	Actual size	Learner Inspection		
				Satisfactory	Unsatisfactory	Comment
4mm	±0.25	Digital calliper	3.8	✓		within tolerance
1.6mm	+0.14 -0.0	Digital calliper	1.7	✓		within tolerance
55mm	+0.2 -0.0	Digital calliper	55.15	✓		within tolerance
63mm	±0.25	Digital calliper	62.99	✓		within tolerance
ø28.6	+0.0 -0.21	Blade micrometer	28.5	✓		within tolerance
ø30	+0.0 -0.1	Micrometer	29.91	✓		within tolerance
ø45	±0.25	Micrometer	44.97	✓		within tolerance
1x45°	±0.25	Steel rule	1X1	✓		within tolerance
R1	±0.25	R1 gauge	R1	✓		within tolerance

Evaluation

If I was to remake this bearing assembly again, I would like to improve the overall finish on the bore by spending longer checking the setup of the machine and workpiece before committing to removing material. For example, by doing more trial cuts before boring down to size. I ran out of time to do this as I had already removed the required material before I could improve the finish. I would like to improve my adherence to tolerances and be exact or within 0.2mm for all dimensions, as the design of the assembly is dependent upon accuracy in order to achieve the required push fit of the nested components. I could also manipulate the speeds and feeds more to get a better finish.

I would also change the order in which I created the components. I would produce the top hat bearing first as it would be easier to pair with the bearing housing and the nylon material is cheaper than mild steel, so any mistakes or reworking of the component would be cheaper and less time consuming to reproduce. Any adjustments to the fit could be made to the shoulder shaft on the CNC lathe if needed.

I was happy with the surface finishes I was able to achieve, however, I could improve the finish of the top hat bearing by using a thicker shim to prevent the teeth marks from the jaws which would allow a better surface finish.

Conclusion

The design of the bearing assembly is good and would be suitable for the purpose it was intended but I would suggest the designers consider making a test piece or setter which could be made up to the same size to get it near to clocking first of all before you put the first one in, minimising the jaw marks.

I would also consider replacing the bearing material to another material, such as brass as the nylon was difficult to machine and the nylon created a lot of excess swarf which had to be regularly cleared away from the moving parts to prevent damage to the lathe.

Task 3c - Handover meeting

(Assessment themes: Health and safety, Quality review and evaluation (quality review, reporting, recording and handover)

For task 3c, candidates must provide the following materials:

- completed bearing assembly
- quality inspection report (from task 3b).

For task 3c, assessors will need to produce the following pieces of supporting evidence:

- assessor observation:
  - handover meeting.

Video evidence required

- video evidence showing the handover meeting – *Illustrated in task 3 video evidence section below (video 2)*

The following task 3c supporting evidence has not been included for this version of the GSEM:

Video evidence

- video evidence showing the handover meeting

Task 3c – Candidate evidence

Practical observation form – Handover meeting

Assessment ID	**Qualification number**
8713-332	**8713-332**
Candidate name	**Candidate number**
Candidate A	**CG12345**
Centre name	**Assessment theme**
City & Guilds	**Quality review and evaluation**

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

Task - Handover	**Notes –** *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*
Handover meeting	The candidate showed a comprehensive knowledge and understanding of all the operating procedures to manufacture the parts for the bearing housing assembly. Each component and process was described in detail and the candidate explained why the component parts were manufactured in that order (bearing housing, top hat bearing then shoulder shaft). The component parts were well manufactured and when assembled, the bearing was free running. They reiterated the need to produce each component to the given tolerances and how the design of the assembly is dependent upon accuracy, stating that this would determine the fit of the components and the completed assembly. They explained the assembly and explained how each component was machined to meet the tolerance, specifically describing the order in which the components were machined and the need to achieve the push fit in the bearing housing. They demonstrate how the components fitted together and how the limits were met. They said if they were to do it again, they would change the order, producing the top hat bearing first as this would be easier to pair with the bearing housing and cheaper and easier to remake if needed. The shoulder shaft could then be tweaked on the CNC lathe if needed.

	The candidate identified two elements that they would like to improve and explained how they would remedy this if they were to manufacture the components again. They would use a thicker shim to prevent the teeth marks from the hard jaws and would attempt a better bore finish by manipulating the speeds and feeds to get the better finish. They also suggested using brass or bronze in place of the nylon due to the excess swarf it created when machined and the unsatisfactory finish they were able to achieve on the top hat bearing. The candidate displayed good communication skills, using positive body language and conducted themselves with professionalism whilst in the handover meeting. They spoke clearly and used the correct industrial terminology to discuss the manufacturing processes and the limits and fits achieved.

Assessor signature	**Date**
Assessor A	**17.12.2022**

Guidance on the exemplar marking

Marking Grids for each assessment theme are found within the Assignment Assessor Pack and gives guidance on banding descriptors, marks available within each band as well as indicative content that provides guidance on knowledge, understanding and skills within the assessment theme.

For the purposes of these materials the Marking Grids used can be found in the Sample Assessment Materials here.

Within this standardisation pack, a partially completed CRF form has been provided that outlines how an assessor has awarded marks against the candidate evidence for a number of the assessment themes using the Marking Grid included in the Sample Assessment Materials.

For exemplification purposes, an explanation of how the marker has determined the mark to be awarded is provided, this exemplary document showing

- How the marker has first considered the marking bands available and determined within which band the evidence best fits
- Subsequently, consideration within the determined band and justification for the mark to be awarded within that band.

Candidate Record Form (CRF) – Machining & Toolmaking Technologies (8713-332)

<table>
<tr><th colspan="13">Health and safety</th></tr>
<tr><td></td><td colspan="4">Band 1</td><td colspan="4">Band 2</td><td colspan="4">Band 3</td></tr>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>Mark
10</td><td colspan="12">Notes and justification
Band Justification. Band 3
The candidate has produced a risk assessment which demonstrates a thorough knowledge and understanding of the different types of risks associated with machining activities. Detailed risk mitigation methodology has been applied to identify most potential risks including hazardous substances. The candidate also recognized the importance of floor marking to minimise the risk of harm to personnel in the workshop, reflecting industry practices. The candidate did not, however cover the major hazards associated with electricity in the risk assessment.
The candidate ensured that safety issues were fully taken into account when planning and as part of preparatory checks with the identification of the correct PPE with justification of the selection of the equipment.
Health and safety was followed by the candidate during preparation and throughout tasks ensuring that work was completed safely.
The candidate returned all tools and equipment to their correct location after carrying out cleaning and visual checks. All waste produced was correctly segregated and disposed of.
The evidence produced by the candidate largely meets band 3, however, some elements of the descriptor were not met, however the evidence exceeds the band below. Therefore band 3 has been awarded.

Mark Justification. 10 Marks
The evidence quality provided by the candidate largely meets with the performance described in the descriptor for Band 3 therefore a mark in the middle of band 3 has been awarded.</td></tr>
</table>

Planning and preparation									
Preparation									
	Band 1			**Band 2**			**Band 3**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mark 8	**Notes and justification** **Band Justification. Band 3** The candidate prepared a comprehensive range of materials, components and resources, carrying out visual and dimensional checks. The materials were deburred effectively. Thorough checks of all tools and equipment were carried out. This resulted in the identification of a damaged tip which was replaced following industry procedures, and the damaged tool was placed in the correct area. The candidate has prepared a good range of relevant technical documentation. This includes a quality check sheet which accounts for accuracy of components within specified tolerances. The method statement also details verification of the CNC program to support completeness in the manufacturing process. Candidate evidence which includes a comprehensive risk assessment and method statement and supported by photographic evidence demonstrated that the work area was prepared safely for machining operations. The candidate followed an SOP to ensure safe isolation of the machine tools in preparation for machining activities. Calibration checks of precision measuring equipment were carried out by the candidate. The evidence produced by the candidate largely meets band 3, however, some elements of the descriptor were not met, however the evidence exceeds the band below. **Mark Justification. 8 Marks** The evidence quality provided by the candidate largely meets with the performance described in the descriptor for band 3 therefore a mark in the middle of band 3 has been awarded.								

Production						
Assembly						
	Band 1		**Band 2**		**Band 3**	
	1	**2**	**3**	**4**	**5**	**6**
Mark 5	**Notes and justification** **Band Justification. Band 3** The candidate followed a logical sequence in the assembly and re-assembly of the bearing housing, the shaft was able to rotate freely due to adherence to tolerance. There is no evidence of referencing of drawings during the assembly.					

	All components in the bearing housing fitted together with no adjustments required. The candidate worked close to nominal sizes with minimal deviation, meeting the required specification. The candidate applied surface treatment to all components evenly upon completion. Whilst carrying out assembly operations the candidate evidence is largely within band 3, hence band 3 is awarded. **Mark Justification. Marks 5** There is no evidence of referencing of drawings during the assembly process, however there is inferred evidence through meeting dimensional specification. The evidence provide therefore mostly aligns so a mark of 5 is awarded to the candidate.

Tools and equipment

	Band 1				Band 2				Band 3			
	1	2	3	4	5	6	7	8	9	10	11	12

Mark 11	**Notes and justification** **Band Justification. Band 3** The candidate uses industry standard methodologies when setting up the machinery to ensure that parameters and settings are correct all of the time. This is evidenced through photographs of setting up procedures and candidate performance. When setting the CNC machine, the candidate used program simulation to verify CNC operations and ensured that correct parameters and setting were applied all of the time using the tracking facility prior to commencing machining. Machine tools were handled in a way which promoted longevity by ensuring that they were checked before and after machining operations. Machine tools were returned to a state of readiness after operations were completed. This is evidenced through the candidate carrying out cleaning operations during and after use and prevention of any issues with moving parts from any build up of swarf. Components were produced with good quality finish and some minor defects (marks from 4 jaw chuck) however, this did not detract from detract from the finished appearance of the assembly. With regard to tools and equipment the candidate evidence is largely within band 3, hence band 3 is awarded. **Mark Justification. Marks 11** With the exception of the marks produced from the use of the 4 jaw chuck affecting surface finish, the evidence mostly aligns so a mark of 11 is awarded to the candidate.

Quality review and evaluation									
Quality review									
	Band 1			**Band 2**			**Band 3**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Mark 8	**Notes and justification** **Band Justification. Band 3** The candidate checked all dimensions on all components for accuracy. All tolerances were met. The candidate produced all components with very few defects, those which were identified, a solution was offered by the candidate. A concern noted was the choice of nylon as the material for the top hat bearing, which resulted in surface tool marks. The candidate had strategies in place for the rectification of any defects most of the time. The evidence produced by the candidate largely meets band 3, however, as some elements of the descriptor were not met, with the evidence exceeding band 2. **Mark Justification. 8 Marks** The evidence quality provided by the candidate largely meets with the performance described in the descriptor for Band 3 therefore a mark in the middle of band 3 has been awarded.								

Internal assessor signature	Date

Total
*/90

* Please Note that the Total Mark (90) applies to the full assignment including all Assessment Themes