T-LEVELS | Institute for Apprenticeships & Technical Education

T Level Technical Qualification in Engineering, Manufacturing, Process and Control (8713-32)

Machining and Toolmaking Technologies (332)

Guide Standard Exemplification Material

Threshold Competence - Sample

First teaching from September 2022
Version 1.1

City & Guilds | eal

Version and date	Change detail	Section
1.1 Jan 2023	Minor typographical amendments	Through document

Contents

Introduction

The sample assessment materials within this document refers to the Machining and Toolmaking Technologies sample occupational specialism assignment. The aim of these materials is to provide centres with examples of knowledge, skills and understanding that attest to **minimal threshold competence**.

The examples provided do not reflect all evidence from the sample assignment as the focus of this material is the quality and standards that need to be achieved rather than the volume of exemplar evidence provided. However, the examples provided are representative of all tasks in the sample assignment. The evidence presented here has been developed to reflect **minimal threshold competence** within each task but is not necessarily intended to reflect the work of a single candidate. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and the standard of performance will vary across tasks. The minimal threshold competence grade boundary will be based on a synoptic mark across all tasks.

The materials in this Guide Standard Exemplification Material (GSEM) are separated into the sections as described below. Materials are presented against a number of tasks from the assignment.

Task

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

In this GSEM there is candidate evidence from:

Task 1 - Planning

Task 2 - Production

Task 3 – Quality review and evaluation.

Candidate evidence

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

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.

Commentary

This section includes detailed comments to demonstrate how the candidate evidence attests to the performance standard of **minimal threshold competence** by directly correlating to the grade descriptors for this occupational area. Centres can compare the evidence against the performance indicators in the marking grid descriptors within the assessor packs, to provide guidance on the standard of knowledge, skills and understanding that need to be met for **minimal threshold competence.**

It is important to note that the commentary section is not part of the evidence or assessment but are evaluative statements on how and why that piece of evidence meets a particular standard.

Grade descriptors

To achieve a pass (threshold competence), a candidate will typically be able to:

Interpret information, plan, assess risk and follow safe working methods when applying practical skills to an acceptable standard in response to the requirements of the brief.

Adequately prepare working areas, acknowledging potential risks and applying acceptable housekeeping techniques during tasks.

Demonstrate the basic technical practical skills in machining materials to produce components and products using a range of manual and automated equipment and machinery, which are in line with industry standards and meet the requirements of the brief.

Demonstrate basic knowledge and understanding of the principles and processes required for machining and toolmaking activities.

Work safely showing an understanding in the selection and use of relevant tools and equipment and demonstrate a basic awareness of straightforward preparation and application processes within the working environments for machining and commissioning activities.

Identify causes of problems or common issues related to production control, operating procedures and quality control and have some knowledge and skills in how to rectify them.

Mostly use general industry and technical terminology accurately across different communication methods with some consideration of technical and non-technical audiences.

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.

Candidate evidence

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.		

Commentary

The candidate has interpreted the requirements of the brief and applied some understanding to produce an adequate list of the resources required, demonstrating technical knowledge of the requirements required for producing the bearing housing assembly but has omitted some resources. The candidate could have developed their response further if they had considered more resources. For example, the candidate has not listed a vee block which they will need to use as a work holding device to set the block for machining the chamfer and the engineer's blue which they will use to colour the surface of the stock so scribed lines can be seen and high spots can be seen.

The candidate has listed amounts of each resource that they have planned to use but their justification is brief and not detailed. The candidate could have given more detailed justifications for their choice, giving an indication of the intended use. The candidate has indicated the task in which the listed resources will be used. The candidate has also included consideration for other resources that should be available in the workshop, for example, access to a first aid kit. They could have also included an eye wash station.

The candidate has recognised the need to refer to supporting technical documentation in order to complete the task. This is not detailed. The candidate could have provided more detail in order to develop their response.

The candidate has demonstrated planning for safe working by identifying appropriate PPE and stating why each piece should be used, but some areas lack additional detail, for example, the type of gloves to be worn and why they are the preferred type. The candidate

could have developed their response by listing additional pieces, including ear protection and the use of barrier cream.

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,	2	2

		using a brush or tool to avoid contact with skin.		
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

Commentary

The candidate has demonstrated an adequate knowledge and understanding of the different types of risks and hazards associated with machining activities. The candidate has identified some of the major hazards and the associated risks. The candidate could have developed their response if more hazards had been identified, for example, working with electricity or noise, both important in a workshop and when using machinery.

The candidate has demonstrated an acceptable understanding of the mitigations required that can minimise the risks and hazards however this is brief and not detailed, more detail could have been given. For example, specific PPE has not been listed for all control measures. The response could have been developed if the candidate had provided more detail for the controls, for instance they could have expanded on how to handle spillages by use of a spill kit.

The likelihood and severity has been identified for those listed in respect of the major hazards and risks occurring based on machining operations the candidate will be using for the task. The candidate has shown an understanding of the need to attribute a rating to each hazard, these are appropriate for the environment in which the assessment is to be taken, for instance, a college workshop.

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

Commentary

The candidate has carried out a limited analysis of the brief, this is shown here by the level of detail provided in the description column. The candidate has missed some information on the tools, speeds and feeds. The response could have been developed if the candidate had included this information and a higher level of detail.

The candidate has displayed a good understanding of the order the activities should take place, however the level of detail in some of the processes and quality checks is lacking depth. The activities are sequenced and some detail given in terms of what machine should be operated. Some information is missing which may lead to potential machining inaccuracies or defects in the finished product if the candidate doesn't correct them during the machining of the components.

The method statement has been developed into an operation sheet, which is typical of a machining environment; it is logical and gives most of the sequential steps for the three parts. Some resources are listed here but with no justification. It is expected that a resources list would also be produced where their choices will be justified. The candidate could have developed their response if they had provided the missing information, for example, the speeds and feeds for the different tooling. Calculations could also have been added.

The candidate has used a standard workshop standard operating procedure (SOP) checklist to identify how to set up the machinery, showing an awareness of health and safety within the process.

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.

2. Photographic evidence – Production

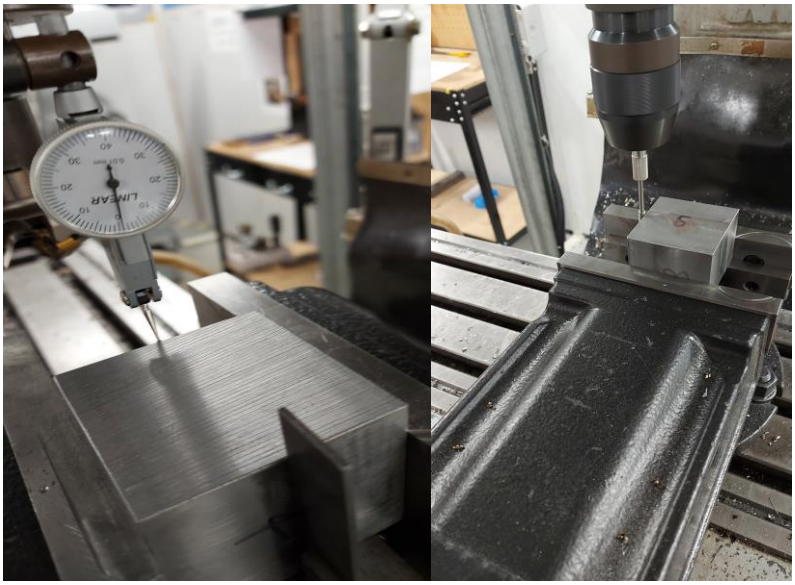
Preparation of the work area (Photographs 1 and 2)

Photograph 1 – showing the prepared mill work area.

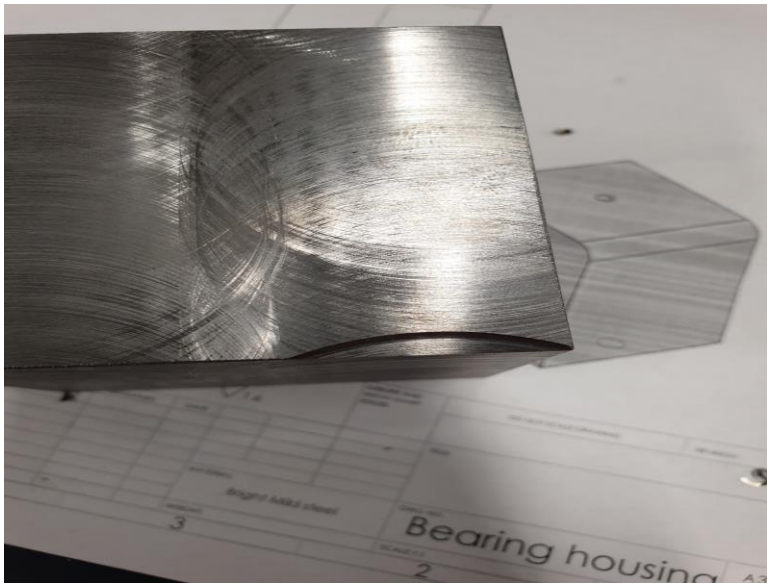
Photograph 2 – showing the lathe area, clear of debris and all tools and equipment are correctly stored on the shadow board next to the machining area.

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.

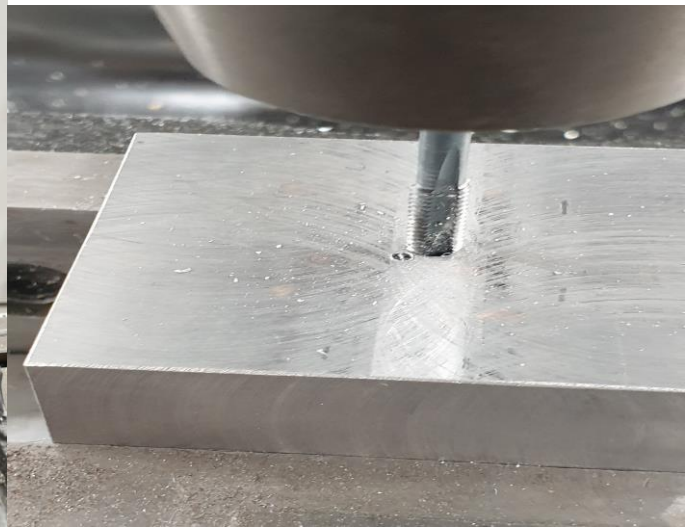


Photograph 5 – showing a fault. When machining this face a false cut was made and stopped in time. The part was then machined to the correct size.

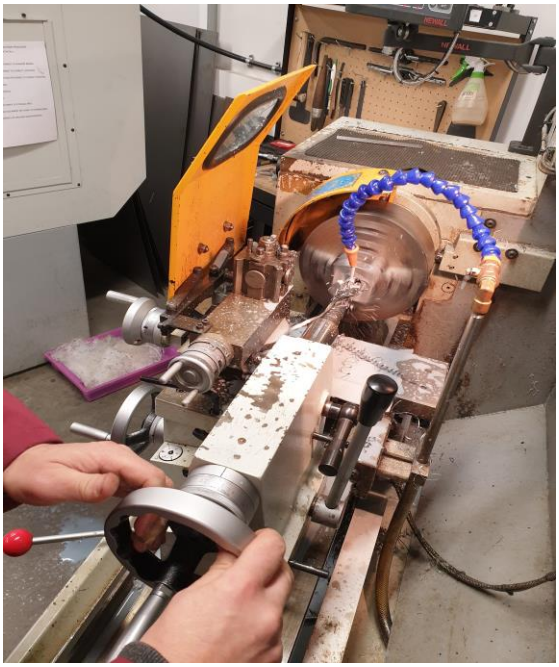


Photograph 6 and 7 – showing the wobble bar into the centre and centre drilled, 13.7 drill and 14 reamer. The wobble bar was used to find the centre of the block.

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.



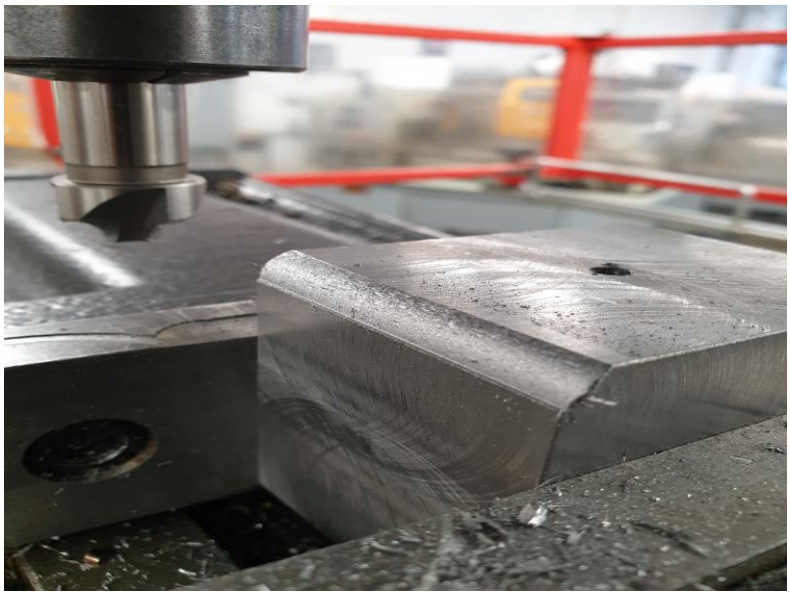
Photograph 8 – showing the drilled out hole to 28mm, swarf was removed using safe methods.



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

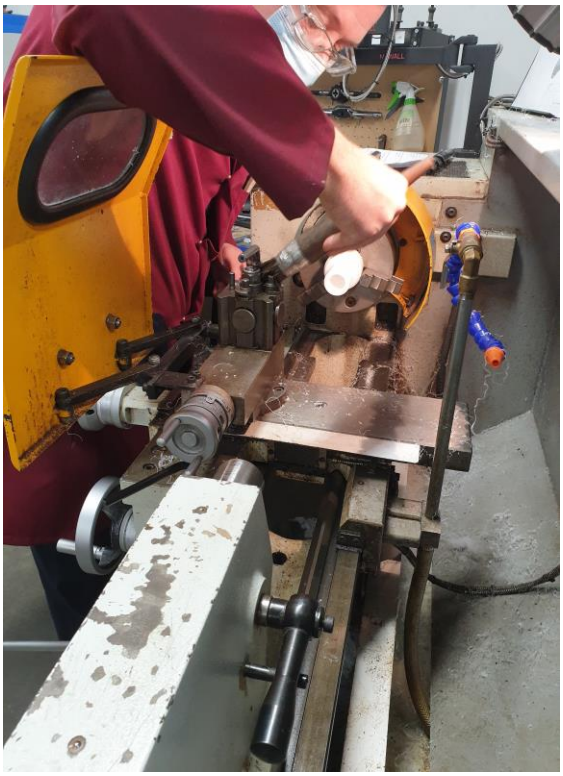
Photograph 10 - showing 8mm chamfer blued and marked with the vernier height gauge.

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.

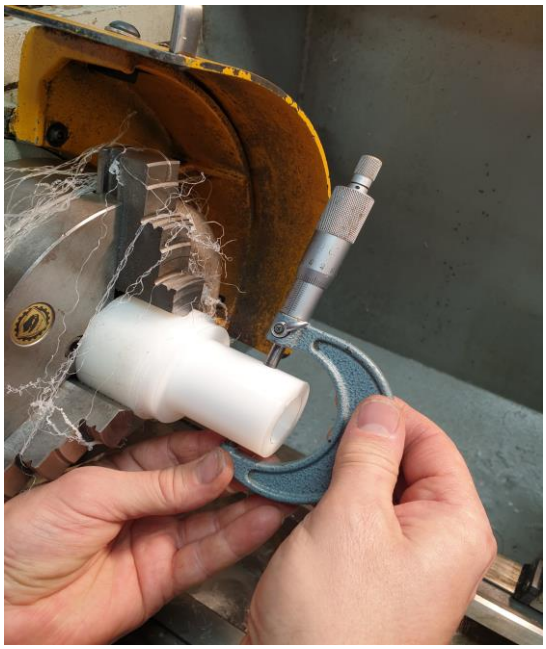


Nylon top hat bush (Photographs 12 – 14)

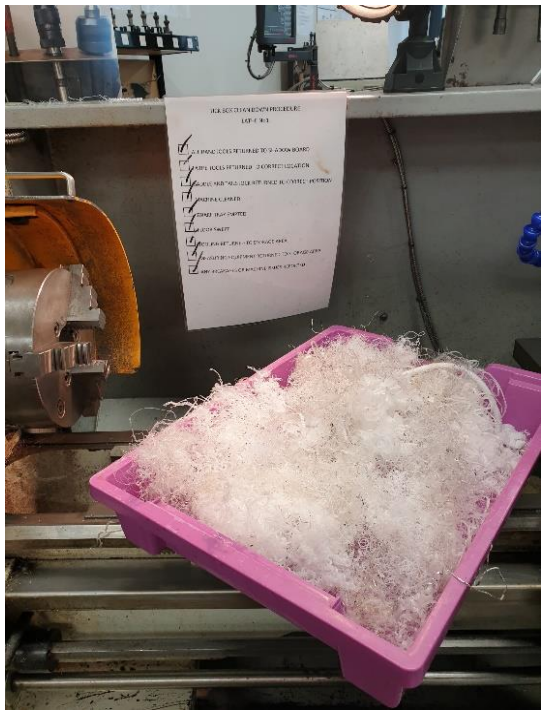
Photograph 12 – showing cleanliness of tool change over maintained throughout manufacturing.



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)

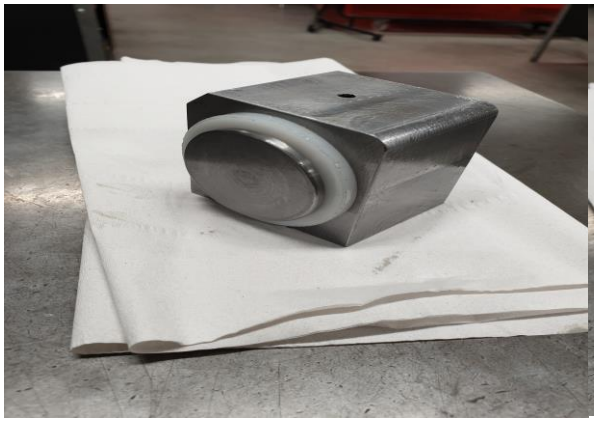
Photographs 15, 16 and 17 – showing the use of the CNC lathe including a tip change.

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.

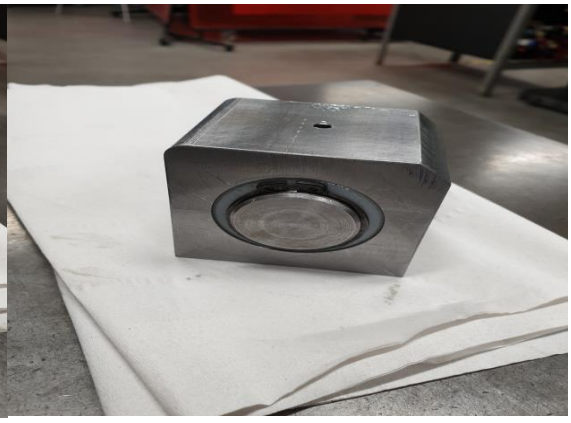
Completed bearing assembly (Photographs 18 – 20)

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.

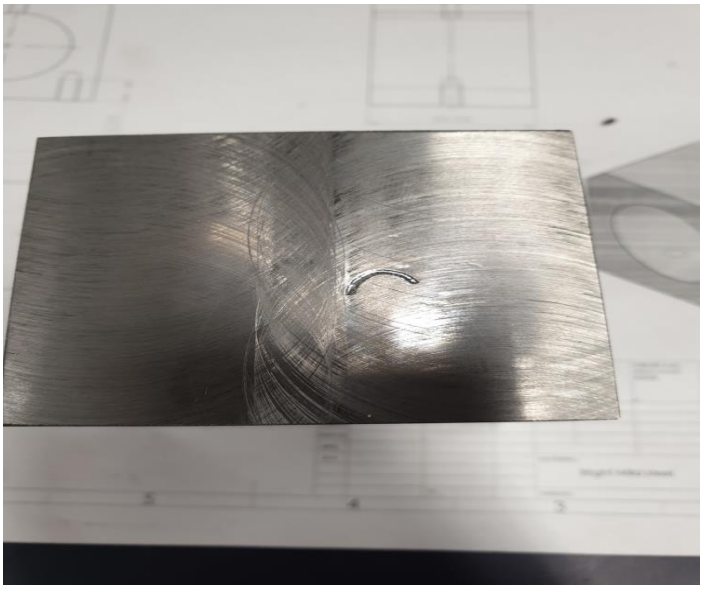
Before adjustment



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.



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**

Commentary

The observation evidence shows that the candidate has demonstrated an acceptable understanding and knowledge of planning and preparation to prepare for the activities. They have demonstrated a good understanding of health and safety when preparing the work area, mitigating potential risks prior to commencing tasks by following their risk assessment.

The candidate demonstrated an ability to follow procedures to produce or maintain working components. For example, by following the standard workshop standard operating procedure (SOP) and by applying their basic knowledge and understanding to safely set up the work area to enable machining activities to commence safely.

The candidate made some informed decisions regarding the selection and application of tools. For example, the candidate selected the tooling but did not always perform the pre-use checks including cleanliness, particularly during selecting the tooling which could have compromised the standard of the finished bearing assembly. Additional marks could have been gained if the candidate had carried out more thorough pre-use and cleanliness checks. The level of cleanliness during machining was not consistent, for example, the jaws of the lathe were not thoroughly cleaned resulting in a piece of swarf remaining in the jaws and marking the workpiece, see photograph 20 in the photographic evidence section.

The candidate demonstrated a basic knowledge, understanding and practical techniques and methods to remove material both using a manual mill, lathe and a computer numerical control (CNC) lathe. For example, the materials were initially prepared by the deburring and edge preparation. The selection and use of specific tooling showed a basic knowledge, for example, the candidate was initially not using a shim to remove the tooling marks from the nylon top hat, showing a lower comprehension. The candidate could have developed their response by carefully selecting tooling to be used for the material to achieve the best quality finish possible. All material removal was carried out with a basic understanding of the need for accuracy, for example, the candidate did not take into account the wobble bar offset causing the original centre drill to be placed incorrectly and the candidate needing to rectify before continuing. See photographs 6 and 7 in the photographic evidence section.

The candidate demonstrated a basic understanding of measurement terminology and the need for accuracy. For example, through performing in-production checks to check for accuracy. However, improvement could be made in respect of conducting more thorough calibration of the measuring equipment prior to use.

The candidate demonstrated they could set the parameters of both a manual mill and lathe and a CNC lathe, showing a basic understanding of parameter setting. Some parameters

needed to be adjusted during the machining of each component. The candidate demonstrated some care towards the longevity of the machinery, for example, by removing excess swarf from the moving parts. See photograph 14 in the photographic evidence section, this shows the build-up of swarf that the candidate had to remove. The candidate showed a basic understanding of the application of feeds and speeds, for example, using an incorrect speed on the mill resulting in residual tool marks left on the workpiece.

The candidate demonstrated their ability to work safely and to follow safe operating practices throughout the machining, showing an acceptable knowledge and understanding of health and safety. They demonstrated an acceptable regard for safety and for the machinery used, through safe use and ensuring their work did not affect the machinery which could then affect others, including reinstating the work area. The candidate could have developed their response if they had checked their tooling before returning to storage.

The candidate demonstrated a basic application of tool skills, for example, their machining resulted in an acceptable finish, with some surface defects present and the final fit needed some additional work to successfully seat all components.

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:

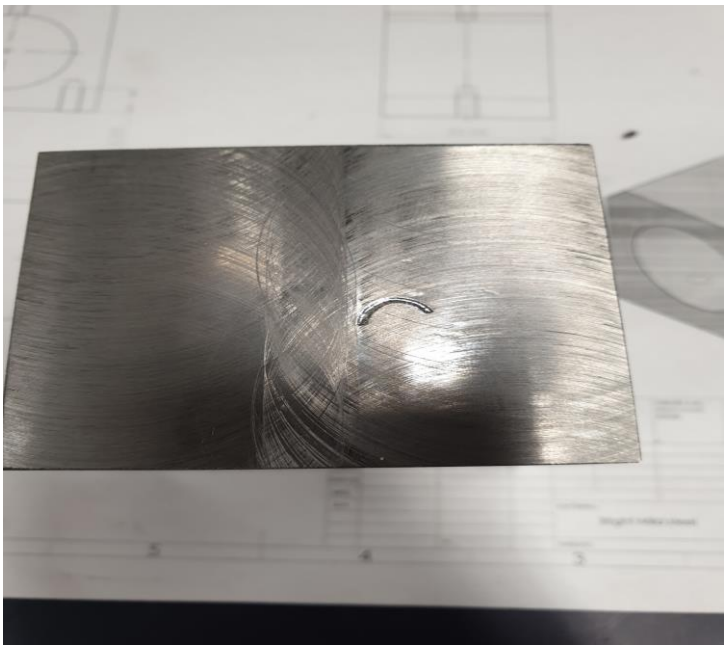
Video evidence

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

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.



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 -0.1	Micrometer	29.91	✓		
Ø45	±0.25	Micrometer	44.97	✓		
1x45°	±0.25	Steel rule	1X1	✓		
R1	±0.25	R1 gauge	R1	✓		

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**

Commentary

This commentary also covers the completion of the quality check sheet.

The observation evidence has captured that the candidate undertook the quality inspection of the machined bearing assembly components and the completed assembly, demonstrating a basic understanding of measurement and the need for accuracy.

They utilised measuring equipment to perform the checks on each of the components to record the final dimensions and to check for compliance with tolerances against the brief. The candidate did not thoroughly check the calibration of the equipment or perform cleanliness checks on the equipment prior to use, which could result in inaccurate readings being recorded.

The candidate demonstrated a basic understanding of the need to perform a range of quality checks. They performed some dimensional checks, a basic fitting check and a surface check for defects, recording their findings on their quality check sheet (from task 1). The candidate made a change to their original template, adding a column for comments to record their justifications for the missed tolerances and defects incurred. The quality check sheet is set out clearly and shows the candidate has recorded their findings but has not provided detailed comments.

Some detectable defects were identified, recorded and briefly attributed to a process or procedural deficiency. These were recorded on the quality check sheet.

Candidates could have developed their response further if they had undertaken a more thorough calibration of the measuring equipment and by completing more thorough checks on the equipment prior to use. The candidate could have developed their response if they had recorded all defects and inaccuracies with the completed bearing assembly and provided more detail regarding the defects found and how the process or procedural deficiency occurred and how it could be prevented in the future. For example, explaining the stepped fault within the chamfer on the bearing housing, attributing it to a machining fault and inaccurate parameters being used.

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.

Candidate evidence

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.

Commentary

The candidate has given a brief description of the methods and techniques undertaken to produce the bearing assembly and the process of performing the quality inspection. To develop their response, the candidate could have provided more detail, for example, they could have included reference to the types of in-production checks that were carried out during the production of the components. For example, checking the internal and external bores using micrometers to determine the correct amount of material had been removed.

The evaluation is basic and the candidate has identified some improvements to their own performance but has only provided a list with brief justifications.

The candidate has identified some areas for their improvement in their performance and has recorded their concessions and some difficulties encountered during the production of the components. They provided a brief reasoning for why the concessions had occurred; this was lacking in detail. They did not mention the fault with the machining of the chamfer, why this had occurred and how it could be prevented in the future.

The candidate could have developed their response if they had provided more detailed justifications and had given further consideration to preventative measures. For example, the candidate stated that the nylon material was difficult to machine and it was difficult to get a good surface finish. They could have explained how they could have prevented the marks from occurring by using thicker shims and soft jaws.

The candidate has suggested an improvement for the design which is to replace the nylon material due to the amount of waste it produces and the hazard to the machinery but has not considered the impact of the change on the costs of the manufacturing process.

The report is structured appropriately with an introduction, overviews for the production and quality inspection, evaluation and conclusion. The inclusion of the completed quality check sheet gives the finished sizes of the components and has captured the key data showing whether the component met the required dimensions.

A basic level of industry terminology has been used consistently throughout.

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.

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

Video evidence

- video evidence showing the handover meeting.

3c. 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	**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 demonstrated a basic knowledge of most of the operating procedures to manufacture the parts for the bearing housing assembly. Each process was briefly described, some reasoning was given to the order in which the parts were manufactured. The bearing assembly was manufactured to an acceptable standard. They identified two parts to improve, leaving out others. They described how they would remedy the problems if they were to manufacture the components again but this was not detailed. They explained how a piece of swarf had been caught between the workpiece and the jaws causing the mark on the surface of the bearing housing. They said this could have been prevented if they had cleaned the lathe more thoroughly between activities. The candidate mentioned they had forgotten to replace their safety glasses after removing them after machining the bearing assembly, acknowledging that health and safety was important. The candidate displayed some good communication skills, using some positive body language and conducted themselves with professionalism during the meeting. They spoke clearly, using a basic level of industrial terminology to discuss the manufacturing processes, some inaccuracies were noted especially when discussing determining speeds and feeds. The candidate presented their completed bearing assembly and quality inspection report on completion of the handover.

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

Commentary

The observation evidence covers the requirements of the handover assessment themes.

The account of the handover is good, indicating the candidate had shown basic subject knowledge and understanding in order to describe the processes they have undertaken and how to achieve the push fit of the bearing assembly.

They gave brief summaries of the activities undertaken and only mentioned some of the issues they encountered. The candidate did not fully explain the reasons for all the surface defects and did not attribute them to a process or state any remedial action. The candidate did not make reference to the defect created when creating the chamfer on the bearing housing.

The report states that the candidate demonstrated some good communication skills, presented themselves professionally and used industry terminology at a basic level throughout with some inaccuracies.

The candidate could have developed their response further if they had given more detailed explanations for the problems and defects incurred during the production process and how they could prevent them in future production runs and by using correct industry terminology more consistently and with fewer errors when presenting their work to the supervisor.

The T Level is a qualification approved and managed by the Institute for Apprenticeships and Technical Education.