MANUFACTURING AND ENGINEERING TECHNOLOGY

CNC Turning

WorldSkills Occupational Standards

 WSC2022_WSOS06_CNC_Turning

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WorldSkills Occupational Standards (WSOS)

Occupation description and WSOS

The name of the occupation is

CNC Turning

Description of the associated work role(s) or occupation(s)

CNC Machining has become one of the most important current machining processes in modern industry. Parts are made for household-equipment, telecommunications, cars, ships, aeroplanes, oil rigs, bridges, aerospace etc. Customers come from virtually every sector.

In CNC Machining the movements of the machine through computers and servomotors are dictated by the programmer. Once correctly programmed and set up, these machines can produce almost any shape and can repeat the process many times. This offers great advantages for quality and efficiency.

CNC Machining covers a broad variety of machining processes, such as grinding, welding, electrical discharging, milling and also turning.

Some may think that lathes (turning machines) are built to make round parts; however, CNC lathes are capable of producing almost any shape and any part.

Every customer has different requirements and demands and therefore each part is made of different materials, and needs different geometries, dimensions and surface qualities. To explain all the desired requirements to the machinist, the customer produces a technical drawing.

Machining starts with deciding how best to produce the part. There are many ways of doing this, like welding, milling, casting, and 3D Printing. One very important method is CNC Turning.

A CNC lathe is a very accurate computer-driven machine, where cutting tools, controlled by a program, are moved to cut away excessive material to result in the expected customer part. The CNC Turning machinist receives the technical drawing and uses the lathe in many ways to find solutions to build the part. These machines are very expensive, because they can do remarkable things. To have an idea of this, think what it means to achieve accuracy below ten microns, which is six to10 times thinner than a human hair.

The CNC Turning machinist uses a computer to tell the lathe how to move the tools and cut the part to the desired shape. They must also set up the lathe with all the necessary clamping devices, support devices, and cutting tools. These tools can cut almost every material (stainless steel, plastic, soft steel, aluminium, bronze, and so on). But the machinist has to choose well to avoid temperature variations, tool wear or vibration. Those factors influence the product and it can result in poor quality.

When the machine starts cutting material, the machinist makes sure that the dimensions exactly fit the customer specifications. For this, very accurate inspection tools are used. Once the machine is set up, the CNC-Turning machinist also monitors and optimizes the processes, to achieve even faster and better results for all the following parts.

General notes on the WSOS

The WSOS specifies the knowledge, understanding, and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSOS).

The skill competition is intended to reflect international best practice as described by the WSOS, and to the extent that it is able to. The Standard is therefore a guide to the required training and preparation for the skill competition.

In the skill competition the assessment of knowledge and understanding will take place through the assessment of performance. There will only be separate tests of knowledge and understanding where there is an overwhelming reason for these.

The Standard is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total marks to indicate its relative importance within the Standards. This is often referred to as the "weighting". The sum of all the percentage marks is 100. The weightings determine the distribution of marks within the Marking Scheme.

Through the Test Project, the Marking Scheme will assess only those skills that are set out in the Standards Specification. They will reflect the Standards as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme will follow the allocation of marks within the Standards to the extent practically possible. A variation of up to five percent is allowed, provided that this does not distort the weightings assigned by the Standards.

WorldSkills Occupational Standards

Section		Relative importance (%)
1	**Work organization and management**	5

The individual needs to know and understand:

- The scope and limits of the workshop and the workspace
- Standards for the environment, safety, hygiene, and prevention of accidents
- Safety equipment, such as First aid kits, fire extinguishers (when and how to use)
- Types of energy supplies for the CNC Lathe (electric, hydraulic, pneumatic) and their sustainable management
- Basic Machine maintenance (Coolant-Maintenance, Machine-Lubrication, settings etc.)
- Machine Accessories such as clamping devices, tailstock, and part-catching devices
- The use and care of the available computer operating systems
- Programming, setting, and operating of CNC lathe with live tooling and multiple axes
- CNC-programming Systems (Din-ISO (G-Code writing), CAM software)
- Principles of technical design and process planning
- Properties of ferrous and nonferrous materials
- Mathematics, especially calculations in trigonometry
- Principles of cutting- and chip-removal technology
- The importance of effective communications and teamwork
- The use of machinery-handbooks, datasheets and manufacturers' operating instructions
- The calibration, accuracy and use of measurement- and gauging tools.

The individual shall be able to:

- Organize the workspace for optimal safety and performance
- Check the condition and functionality of the workspace, equipment, tools and materials
- Interpret and apply quality standards and regulations
- Promote and apply health and safety regulations and best practice
- Set up and operate CNC lathes safely and environmentally well managed (e.g. in use of energy)
- Use computer related professional software
- Apply mathematical and geometrical principles for programming processes
- Select and apply appropriate cutting technology for the material, equipment and cutting tools provided
- Interpret and apply manufacturers' instructions
- Find appropriate data in handbooks, tables, and charts.

Section		Relative importance (%)
2	**Interpret engineering drawings**	**10**
	The individual needs to know and understand: • ISO E and/or ISO A (European and American) drawing representation • Technical terms and symbols used in engineering drawings and plans • Standards, symbols, and datasheets • Technical drawing-legends.	
	The individual shall be able to: • Interpret engineering drawings and apply to specifications • Locate and identify dimensions of features • Locate and identify surface finish requirements • Locate and identify geometric specifications • Make 3D mental representations of the parts • Identify the materials that parts are made of • Identify critical sequences (with a high possibility of damage or unsafe practice) and develop appropriate approaches.	
3	**Process planning**	**10**
	The individual needs to know and understand: • The importance of good planning for reliable machining operations • The procedures and calculations required for scheduling time with software and machinery • Successful timing of selected sequences • Identification of critical sections • The behavior of machines, clamping devices, materials, tools and machine accessories in different cutting processes • Methods and techniques for work holding • Methods to avoid crashes or collisions for the selected sequences • The identification of work piece features and the appropriate machining and measuring processes.	

Section		Relative importance (%)
	The individual shall be able to: • Find solutions using the capacities of the workshop nvironment, and according to the required work (size of batch, complexity) • Identify the appropriate machining and measuring processes for each feature of each work-piece • Identify and prepare the best work holding methods • Identify, prepare, and calibrate appropriate measuring tools • Identify and prepare appropriate cutting tools • Identify critical sections (with a high possibility of damage or unsafe practice) and identify alternatives or safe practice to avoid accidents or damage • Find innovative ways of using the environment to solve technical issues • Find alternatives which will be reliable until the end of each process • Weigh each solution and choose the best (considering context, speed, safety, price, and sustainability) • Make a final choice and lock the strategy accordingly • Plan the operations and sequences (machining strategy) based on specified data • Create awareness actions for critical operations where no alternative is available.	
4	**Programming**	**10**

	The individual needs to know and understand:
	• CNC Programming as the creation of a logical process plan
	• Different methods and techniques to generate programs (manual, CAM etc.)
	• CAM system programming and the techniques of part- and tool-modelling
	• Cutting-effect (temperature, bending, force etc.) on:
	  • Geometry of the work piece design
	  • Work holding devices
	  • Tool holding devices
	  • Machine-accessories
	• The selection of cutting tools for machining required material and features
	• Mathematics (especially trigonometry)
	• Speeds and feeds for different materials and tools and work holding devices
	• The basis for choosing correct postprocessors
	• The generation of G-Code
	• Dialoguing with the CNC Lathe
	• The proper use of canned cycles to program work piece features (classical turning features as well as driven-tool features).	

Section		Relative importance (%)
	The individual shall be able to: • Select the best methods according to the production type and part specifications • Use skill specific software and related hardware • Generate programs using CAD/CAM systems • Create or edit programs directly on the machine-control • Edit running programs in CAD/CAM and reload to the machine-control.	
5	**Metrology**	**5**
	The individual needs to know and understand: • Chip removal behaviour of provided materials and tools • The temperature-related behaviour of provided materials, tools and machine-accessories • The effects of cutting force on material, clamping-devices, tools, and machine-accessories • The range of tools and gauging instruments and their applications • The influence of temperature on measurements.	
	The individual shall be able to: • Select appropriate measuring or gauging instruments • Calibrate measuring tools • Use selected tools to make measurements on all features of the products • The properties, uses, and handling of ferrous and non-ferrous materials.	
6	**Setting and operating CNC lathes**	**55**
	The individual needs to know and understand: • The different steps that lead to the setup of the machine • The different modes of machine operation • The appropriate power up and Initializing sequence of CNC lathes • The proper manipulating of CNC lathes • Mounting tools and setting tool parameters • The modification of clamping devices, such as jaws, dual spindle etc. • The transfer of CNC programs to machine control, using provided software, cables, memory devices, or wireless technology • The testing of programs (simulation, dry run etc.) • The correct, efficient and safe clamping of work-pieces • Settings of work shift and tool shift offsets • The safe running of CNC procedures • Stopping and restarting cycles • Emergency stopping.	

Section		Relative importance (%)
	The individual shall be able to: • Follow their selected process strategies • Appraise and follow a given process-strategy when using External CNC-programs • Upload generated CNC programs to CNC lathes and perform test runs • Identify and designate the different machining processes on CNC lathes • Mount and align selected tools • Mount and align selected work holding devices • Mount and align selected accessories (Tailstock, Parts-catcher, etc.) • Set measures to avoid vibration in machining sequences • Apply efficient burr-removal techniques on work pieces • Optimize machining strategies • Quickly react to problems and emergencies • Obtain dimensions, geometries, surface roughness etc. • Make all necessary corrections to get the final part to conform to the blueprint • Report health, safety, and environmental issues to the appropriate personnel • Report equipment failures to the appropriate personnel.	
7	**Finalize and deliver work pieces**	**5**
	The individual needs to know and understand: • Appropriate procedures with documentation for re-using jobs • The importance of completing work pieces to the required standard within their capabilities • The circumstances in which referral should be made to other appropriate personnel.	
	The individual shall be able to: • Clean and deburr products • Make final optical and measurement checks • Deliver parts, drawings and digital memory devices to the appropriate locations and/or personnel as required by the organization • Dismount tools, clamping devices and machine accessories • Clean the machinery • Set each environment to their initial state, ready for the next job • Document and save CNC Programs, work-holding and tooling information etc. for each organization's re-use.	
	Total	**100**

References for industry consultation

WorldSkills is committed to ensuring that the WorldSkills Occupational Standards fully reflect the dynamism of internationally recognized best practice in industry and business. To do this WorldSkills approaches a number of organizations across the world that can offer feedback on the draft Description of the Associated Role and

- ISCO-08: (http://www.ilo.org/public/english/bureau/stat/isco/isco08/) ILO 7223
- ESCO: (https://ec.europa.eu/esco/portal/home)
- O*NET OnLine (www.**onet**online.org/)

This WSOS appears most closely to relate to *"lathe and turning machine tool setters, operators, and tenders, metal and plastic"*:
https://www.onetonline.org/link/summary/51-4034.00,

and/or *"lathe and turning machine operator"*:
http://data.europa.eu/esco/occupation/63042e8f-dd59- 47fe-87f3-3b2ce21f196a

Adjacent occupations can also be explored through these links.

The following table indicates which organizations were approached and provided valuable feedback for the Description of the Associated Role and WorldSkills Occupational Standards in place for WorldSkills Shanghai 2022.

Organization	Contact name
ABZ Braunau GmbH (Austria)	Dieter Geisberger, CEO
DMG MORI (Global)	Joerg Harings, Head of Training
DMG MORI Singapore PTE. LTD.	Kevin Goh, Technical Director
EMCO, GmbH (Austria)	Leopold Zerz, Sales Director
Siemens AG (Global)	Karsten Schwarz, Head of Training centre