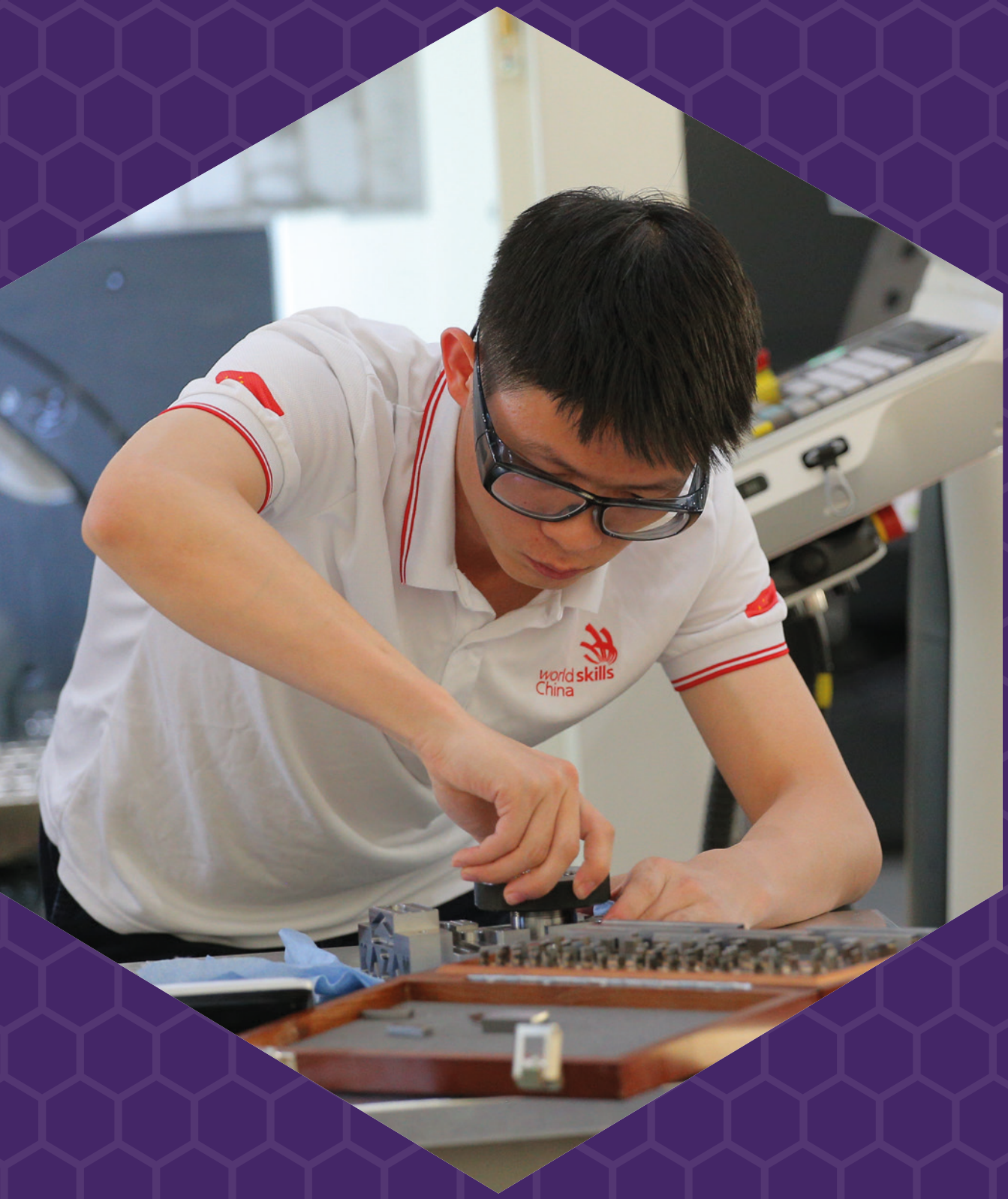
MANUFACTURING AND ENGINEERING TECHNOLOGY

CNC Milling



WorldSkills Occupational Standards

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WorldSkills Occupational Standards (WSOS)

Occupation description and WSOS

The name of the occupation is

CNC Milling

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

Computer Numerical Control (CNC) technology has become omnipresent. Most people cannot imagine how important these technologies are in their lives. There is nothing that we use that hasn't in its manufacturing utilized CNC technology. It is present in products and objects of everyday life, such as cars, airplanes, components of machines of all types, moulds for tools used for household machines, medical prosthetics, cell phones, and toys.

CNC milling machines are machine tools used for the shaping of metal and other solid materials. These machines exist in two basic forms: horizontal and vertical. This refers to the orientation of the cutting tool spindle. Early milling machines were manually or mechanically automated, but technological advances have led to the development of Computer Numerical Control, such as the CNC machining centre. CNC refers to a computer-controlled device to read and store instructions. This numerical information, generally "G and M" codes (a programming language) is then used to control and drive a machine tool which is a powered mechanical device ("machining centre"). A machining centre is used to fabricate components using cutting tools for removing the material.

To form the finished part, the cutting process can be started from a solid block, pre-machined part, casting, or forgings. For those scenarios, the skill requires the highly skilled CNC milling machinist must read and interpret complex technical drawings and specifications, and work to a high degree of precision and detail. They must be proficient in metal work and understand how metals react to various processes. They must be a skilled computer operator and machine operator. The programs can be generated manually or using Computer Aided Design/Computer Aided Manufacture (CAD/CAM) software.

To achieve the finished part, the CNC milling machinist undertakes a sequence of essential activities, from interpreting engineering drawings to optimizing the machining process:

- Interpreting engineering drawings and following the specifications
- Generating the processes and programs with the CAD/CAM system and/or G and M-codes
- Setting up the tools, work holding devices, and work pieces on the CNC milling centre
- Manipulating cutting conditions, based on the properties of the material and tools
- Operating, inspecting, and maintaining the accuracy of dimensions within the specified tolerances
- Optimizing the process, taking into account the production type: whether large quantities of one part, small batches, or one-of-a-kind items. Today a wide range of industries require CNC milling machinists to program, operate, and keep sophisticated machining centre's running in an efficient and reliable way. Large enterprises such as automobile plants, medium sized enterprises such as mould making, and small enterprises in the maintenance field, are some of many environments in which the CNC milling machinist plays a key, integral role to the success of the metalwork industries.

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**	**10**

The individual needs to know and understand:

- The extent and impact of CNC-milling on modern life and industry
- Quality standards for materials and quality of metals
- Standards for the environment, safety, hygiene, and prevention of accidents at work
- Computer operating systems
- Mathematics, especially accurate and detailed calculations, and trigonometry
- Properties of materials, especially steel and aluminium
- Principles of technical design and process planning
- CNC equipment technology (Vertical and Horizontal Machining Centre)
- Programming by hand or CAM system software
- Cutting technology according to the parameters, material, equipment and cutting tools
- Health and safety regulations, legislation, and best practice
- The importance of adhering to manufacturers' operating instructions
- Ways to ensure the maintenance of sophisticated milling machines to promote efficient and reliable working
- The importance of effective communications and teamwork
- The importance of effective working methods with other professionals related to the CNC milling process

The individual shall be able to:

- Use computer related professional software
- Interpret and apply quality standards and regulations
- Promote and apply health and safety regulations and best practice
- Use IT and related professional software
- Apply mathematical and geometrical principles accurately for the preparation and programming processes for CNC milling
- Develop creative solutions to complex design or technology challenges

2	**Interpret engineering drawings and follow the specification**	**10**

The individual needs to know and understand:

- ISO 1 and/or ISO 3 (European and American) drawing representation
- Technical terms and symbols used in drawings and plans
- Standards, standards symbol, and tables
- Technical drawing legends

Section		Relative importance (%)
	The individual shall be able to: • Interpret and apply engineering drawings and follow specifications • Locate and identify main dimensions and secondary dimensions • Locate and identify ISO standards for surface finishes Locate and identify ISO standards for geometrical form and positional tolerances • Locate and identify ISO standards for geometrical form and positional tolerances	
3	**Process planning**	**15**
	The individual needs to know and understand: • The importance of good planning for the successful execution of programming and operation/machining • How to plan, based on the type of operation and the sequence (machining strategy) of the data that must be specified • Types of machining tools used in CNC technology including lathes, multi-axis spindles, wire electrical discharge machines, and milling machines • Methods of work holding according to the shape of the base material	
	The individual shall be able to: • Identify and set the different machining features • Identify the most efficient work holding solution to clamp the base material into the machine • Select the right cutting tools for machining • Define the cutting parameters as a function of the operation sequence, material type, and type of operation	
4	**Programming**	**20**
	The individual needs to know and understand: • Programming as the creation of a logical process plan • Different methods and techniques to generate the programs (CAM/CAD or manual) • CAM system programming • Skill related software	
	The individual shall be able to: • Select the best methods according to the production type and part specification • Use skill specific software and related hardware • Generate programs by using the CAD/CAM system with the format of the initial data • Start with drawings in paper format to create the geometry in wireframe and/or surface and/or solid	

Section		Relative importance (%)
5	**Metrology**	**10**
	The individual needs to know and understand: • The ranges of tools and gauging instruments and their applications • Main measuring techniques	
	The individual shall be able to: • Select and use appropriate measuring tools and instruments • Make measurements on threaded elements	
6	**Operating**	**15**
	The individual needs to know and understand: • The different steps that lead to setup machines • The different modes of machine operation	
	The individual shall be able to: • Prepare measurements and cutting tools • Identify and design the functional parameters for operation on the CNC milling machine	
7	**Machining**	**20**
	The individual needs to know and understand: • The different types of machine features • The machining sequence	

Section	Relative importance (%)

The individual shall be able to:
• Identify and designate the different machining processes on a CNC milling machine
• Optimize the machining strategy
• Define and adjust the cutting parameters as a function of the operation sequence, material type, type of operation, and CNC machine tool
• Start the cutting process from the raw material
• Solid block
• Perform the following machining operations:
  • Facing
  • Roughing and finishing
  • External contours
  • Island milling
  • Milling channels
  • Pocket (figurative)
  • Pocket (circular and rectangular)
  • Taper ribs
  • Thread milling
  • Internal
  • External
  • Canned cycles
  • Through hole boring
  • Blind hole boring
  • Reaming
  • Tapping
  • Drilling
  • 3D machining operations
  • Roughing
  • Finishing
• Tapping
• Drilling
• 3D machining operations
• Roughing
• Finishing	

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 WorldSkills Occupational Standards on a two-yearly cycle.

In parallel to this, WSI consults three international occupational classifications and databases:

- 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/)

The WSOS appears most closely to relate to: *Milling and Planing Machine Setters, Operators and Tenders*: https://www.onetonline.org/link/summary/51-4035.00

or *Milling Machine Operator*:
http://data.europa.eu/esco/occupation/a1c9f8b7-c4ce-4b15-ac3c- 3378c300d8f2

These links also enable a review of adjacent occupations.

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
GBR Mechanico Pte Ltd, (Asia)	Davizon Yee Khe Khum, Director
Hamilton Bonaduz AG, (Global)	Enrico Bellasi, Team Leader, Prototyping and Apprentices Mechanics
Prototyp-Werke GmbH (Global)	Wolfgang Lehmann, Team Leader Vocational Education
Sick Stegmann GmbH (Germany)	Stefan Mueller, Vocational Trainer
Siemens AG (Global)	Karsten Schwarz, Head of Training