MANUFACTURING AND ENGINEERING TECHNOLOGY

CNC Turning

Technical Description

 TD06 v8.0 WSC2021

worldskills

WorldSkills International, by a resolution of the Competitions Committee and in accordance with the Constitution, the Standing Orders, and the Competition Rules, has adopted the following minimum requirements for this skill for the WorldSkills Competition.

The Technical Description consists of the following:

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1 Introduction

1.1 Name and description of the skill competition

1.1.1 The name of the skill competition is

CNC Turning

1.1.2 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.

1.1.3 Number of Competitors per team

CNC Turning is a single Competitor skill competition.

1.1.4 Age limit of Competitors

The Competitors must not be older than 22 years in the year of the Competition.

1.2 The relevance and significance of this document

This document contains information about the standards required to compete in this skill competition, and the assessment principles, methods and procedures that govern the competition.

Every Expert and Competitor must know and understand this Technical Description.

In the event of any conflict within the different languages of the Technical Descriptions, the English version takes precedence.

1.3 Associated documents

Since this Technical Description contains only skill-specific information it must be used in association with the following:

- WSI – Code of Ethics and Conduct
- WSI – Competition Rules
- WSI – WorldSkills Occupational Standards framework
- WSI – WorldSkills Assessment Strategy
- WSI online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations.

2 The WorldSkills Occupational Standards (WSOS)

2.1 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.

2.2 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 (how to use, when to use, etc.)
- Different types of energy supplies for the CNC Lathe (electric, hydraulic, pneumatic)
- Basic Machine maintenance (Coolant-Maintenance, Machine-Lubrication, settings etc.)
- Machine Accessories such clamping devices, tailstock, part-catching devices, etc.
- The use and care of the available computer operating systems
- Programming, setting operating of CNC lathe with live tooling
- CNC-programming Systems (Din-ISO (G-Code writing), CAM software)
- Principles of technical design and process planning
- Mathematics, especially calculations in trigonometry
- Principles of cutting- and chip-removal technology
- The importance of effective communications and teamwork
- The importance of machinery-handbooks, datasheets, and tables
- 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
- Use computer related professional software effectively
- Consistently apply mathematical and geometrical principles for the programming processes of CNC Turning
- Select and apply appropriate cutting technology for the provided material, equipment and cutting tools
- Interpret and apply manufacturers' instructions
- Find appropriate data in a handbook, tables, or 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 drawings and plans
- Standards, symbols, and tables
- Technical data sheets
- Drawing legends

The individual shall be able to:

- Interpret engineering drawings and follow 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)

3	**Process planning**	**10**

The individual needs to know and understand:

- The importance of good planning for reliable machining operation
- Successful timing of the selected sequences
- Identification of critical sections
- How material, tools and machine accessories will react in different cutting processes
- How material and clamping devices will react in the clamping process
- Methods of work holding techniques
- Methods to avoid crash or collision 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: • Imagine solutions with reference to the capacities of the workshop environment and the required work (size of batch, complexity) • Identify the features of work pieces and the appropriate machining and measuring processes • Identify and prepare the best work holding methods • Identify, prepare, and calibrate the correct measuring tools • Identify and prepare the correct cutting tools • Identify critical sections (with a high possibility of damage or unsafe practice) and consider alternatives • Imagine innovative ways of using the environment to solve technical issues • Check if the potential solutions will be reliable until the end of the process • Weigh each solution and choose the best (considering speed, safety, and price) • Make a final choice and lock the strategy • 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 tool-modelling and profile drawing • Cutting effects on temperature, bending, force etc. • Geometric complex constructions in work piece design • Work holding devices • Tool holding devices • Machine-accessories • How to select the cutting tools for machining the required materials and operations • Mathematics (especially trigonometry) • Speeds and feeds for different materials and tools and work holding devices • How to choose the correct postprocessors • Generating G-Code • Dialoguing with the CNC Lathe • How to use canned cycles to program work piece features (classic 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 specification • Use skill specific software and related hardware • Generate programs using CAD/CAM systems • Create CNC programs using the provided drawings and software • Create or edit programs directly on the control (without CAD/CAM)	
5	**Metrology**	**5**
	The individual needs to know and understand: • Chip removal behaviour of provided materials and tools • Temperature behaviour of provided materials, tools, and accessories • Effects of cutting forces on material, tools, and accessories • The range of tools and gauging instruments and their applications • How temperature may influence measurements	
	The individual shall be able to: • Select appropriate measuring- or gauging instruments • Calibrate measuring tools • Use selected tools to make measurements on all components on drawings • The properties, uses, and handling of ferrous and non-ferrous materials	
6	**Setting and operating CNC lathe**	**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 power up sequence • How to initialize CNC lathes • How to manipulate CNC lathes • Mounting tools and setting tool parameters • How to modify clamping devices, such as jaws, etc. • How to transfer a CNC program to a CNC lathe, using provided software, cable, memory devices, or wireless technology • How to test a programme, simulate, do a dry run etc. • How to clamp a part correctly, and safely • How to set a work shift and offset system • How to run a programme safely • How to stop and restart cycles • How to make an emergency stop	

Section		Relative importance (%)
	The individual shall be able to: • Follow their selected process strategy • Follow a given process- strategy (external CNC programme) • Upload generated CNC programmes 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, Partscatcher, etc.) • Avoid vibration in the machining sequences • Apply burr-removal techniques on work pieces • Optimize machining strategies • Quickly react if anything goes wrong (making emergency stops) • obtain dimensions, geometries, surface roughness by interacting with CNC lathes • Make the final parts conform to blueprints • Report health, safety, and environmental issues to the appropriate personnel • Report equipment failure to the appropriate personnel	
7	**Finalize and deliver work piece**	**5**
	The individual needs to know and understand: • The procedures and calculations required for scheduling time with software and machinery • The importance of completing work pieces to the required standard within the given resources and capabilities • The circumstances in which referral should be made to other appropriate personnel	
	The individual shall be able to: • Clean the parts • Deliver the parts, drawings and digital memory devices to the appropriate location and/or personnel as required by the organization • Dismount tools, clamping, accessories • Clean the machines • Set the environment to its initial state, ready for the next job	
	Total	**100**

3 The Assessment Strategy and Specification

3.1 General guidance

Assessment is governed by the WorldSkills Assessment Strategy. The Strategy establishes the principles and techniques to which WorldSkills assessment and marking must conform.

Expert assessment practice lies at the heart of the WorldSkills Competition. For this reason, it is the subject of continuing professional development and scrutiny. The growth of expertise in assessment will inform the future use and direction of the main assessment instruments used by the WorldSkills Competition: the Marking Scheme, Test Project, and Competition Information System (CIS).

Assessment at the WorldSkills Competition falls into two broad types: measurement and judgement. For both types of assessment, the use of explicit benchmarks against which to assess each Aspect is essential to guarantee quality.

The Marking Scheme must follow the weightings within the Standards. The Test Project is the assessment vehicle for the skill competition, and therefore also follows the Standards. The CIS enables the timely and accurate recording of marks; its capacity for scrutiny, support, and feedback is continuously expanding.

The Marking Scheme, in outline, will lead the process of Test Project design. After this, the Marking Scheme and Test Project will be designed, developed, and verified through an iterative process, to ensure that both together optimize their relationship with the Standards and the Assessment Strategy. They will be agreed by the Experts and submitted to WSI for approval together, in order to demonstrate their quality and conformity with the Standards.

Prior to submission for approval to WSI, the Marking Scheme and Test Project will liaise with the WSI Skill Advisors for quality assurance and to benefit from the capabilities of the CIS.

4 The Marking Scheme

4.1 General guidance

This section describes the role and place of the Marking Scheme, how the Experts will assess Competitors' work as demonstrated through the Test Project, and the procedures and requirements for marking.

The Marking Scheme is the pivotal instrument of the WorldSkills Competition, in that it ties assessment to the standard that represents each skill competition, which itself represents a global occupation. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards.

By reflecting the weightings in the Standards, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill competition and its assessment needs, it may initially be appropriate to develop the Marking Scheme in more detail as a guide for Test Project design. Alternatively, initial Test Project design can be based on the outline Marking Scheme. From this point onwards the Marking Scheme and Test Project should be developed together.

Section 2.1 above indicates the extent to which the Marking Scheme and Test Project may diverge from the weightings given in the Standards, if there is no practicable alternative.

For integrity and fairness, the Marking Scheme and Test Project are increasingly designed and developed by one or more independent people with relevant expertise. In these instances, the Marking Scheme and Test Project are unseen by Experts until immediately before the start of the skill competition, or competition module. Where the detailed and final Marking Scheme and Test Project are designed by Experts, they must be approved by the whole Expert group prior to submission for independent validation and quality assurance. Please see the Rules for further details.

Experts and Independent Assessors are required to submit their Marking Schemes and Test Projects for review, verification, and validation well in advance of completion. They are also expected to work with their Skill Advisor, reviewers, and verifiers, throughout the design and development process, for quality assurance and in order to take full advantage of the CIS's features.

In all cases a draft Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition. Skill Advisors actively facilitate this process.

4.2 Assessment Criteria

The main headings of the Marking Scheme are the Assessment Criteria. These headings are derived before, or in conjunction with, the Test Project. In some skill competitions the Assessment Criteria may be similar to the section headings in the Standards; in others they may be different. There will normally be between five and nine Assessment Criteria. Whether or not the headings match, the Marking Scheme as a whole must reflect the weightings in the Standards.

Assessment Criteria are created by the person or people developing the Marking Scheme, who are free to define the Criteria that they consider most suited to the assessment and marking of the Test Project. Each Assessment Criterion is defined by a letter (A-I). *The Assessment Criteria, the allocation of marks, and the assessment methods, should not be set out within this Technical Description. This is because the Criteria, allocation of marks, and assessment methods all depend on the nature of the Marking Scheme and Test Project, which is decided after this Technical Description is published.*

The Mark Summary Form generated by the CIS will comprise a list of the Assessment Criteria and Sub Criteria.

The marks allocated to each Criterion will be calculated by the CIS. These will be the cumulative sum of marks given to each Aspect within that Assessment Criterion.

4.3 Sub Criteria

Each Assessment Criterion is divided into one or more Sub Criteria. Each Sub Criterion becomes the heading for a WorldSkills marking form. Each marking form (Sub Criterion) contains Aspects to be assessed and marked by measurement or judgement, or both measurement and judgement.

Each marking form (Sub Criterion) specifies both the day on which it will be marked, and the identity of the marking team.

4.4 Aspects

Each Aspect defines, in detail, a single item to be assessed and marked, together with the marks, and detailed descriptors or instructions as a guide to marking. Each Aspect is assessed either by measurement or by judgement.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it. The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the Standards. This will be displayed in the Mark Allocation Table of the CIS, in the following format, when the Marking Scheme is reviewed from C-8 weeks. (Section 4.1 refers.)

		CRITERIA								TOTAL MARKS PER SECTION	WSSS MARKS PER SECTION	VARIANCE
STANDARDS SPECIFICATION SECTION		A	B	C	D	E	F	G	H			
	1	5.00								5.00	5.00	0.00
	2		2.00					7.50		9.50	10.00	0.50
	3								11.00	11.00	10.00	1.00
	4			5.00						5.00	5.00	0.00
	5				10.00	10.00	10.00			30.00	30.00	0.00
	6		8.00	5.00				2.50	9.00	24.50	25.00	0.50
	7			10.00				5.00		15.00	15.00	0.00
TOTAL MARKS		5.00	10.00	20.00	10.00	10.00	10.00	15.00	20.00	100.00	100.00	2.00

4.5 Assessment and marking

There is to be one marking team for each Sub Criterion, whether it is assessed and marked by judgement, measurement, or both. The same marking team must assess and mark all Competitors. Where this is impracticable (for example where an action must be done by every Competitor simultaneously, and must be observed doing so), a second tier of assessment and marking will be put in place, with the approval of the Competitions Committee Management Team. The marking teams must be organized to ensure that there is no compatriot marking in any circumstances. (Section 4.6 refers.)

4.6 Assessment and marking using judgement

Judgement uses a scale of 0-3. To apply the scale with rigour and consistency, judgement must be conducted using:

- benchmarks (criteria) for detailed guidance for each Aspect (in words, images, artefacts or separate guidance notes)
- the 0-3 scale to indicate:
  - 0: performance below industry standard
  - 1: performance meets industry standard
  - 2: performance meets and, in specific respects, exceeds industry standard
  - 3: performance wholly exceeds industry standard and is judged as excellent

Three Experts will judge each Aspect, normally simultaneously, and record their scores. A fourth Expert coordinates and supervises the scoring, and checks their validity. They also act as a judge when required to prevent compatriot marking.

4.7 Assessment and marking using measurement

Normally three Experts will be used to assess each aspect, with a fourth Expert supervising. In some circumstances the team may organize itself as two pairs, for dual marking. Unless otherwise stated, only the maximum mark or zero will be awarded. Where they are used, the benchmarks for awarding partial marks will be clearly defined within the Aspect. To avoid errors in calculation or transmission, the CIS provides a large number of automated calculation options, the use of which is mandated.

4.8 The use of measurement and judgement

Decisions regarding the choice of criteria and assessment methods will be made during the design of the competition through the Marking Scheme and Test Project.

4.9 Skill assessment strategy

WorldSkills is committed to continuous improvement. This particularly applies to assessment. The SMT is expected to learn from past and alternative practice and build on the validity and quality of assessment and marking.

Assessment	% of total score
A. Conformity to drawing a) All features optically finished and optically on the right place and optically without damage (clamp marks, scratches, crash marks, etc.) and no unwanted feature on the part b) Product is free of burrs and free of chips (cleaned)	10%
B. Surface finish Surface inspection on different features	10%
C. Main dimensions Measurements of critical and 'difficult to produce' features	50%
D. Secondary dimensions Measurements of all other features	25%
E. Use of material Award marks only if no additional material is used by the Competitor	5%

4.10 Skill assessment procedures

Assessment and marking are an intense process that depends upon skilful leadership, management, and scrutiny.

There shall be a clear understanding that ONLY the finished result (the machined part(s)) are evaluated. Not the process or any written documentation.

The marking of the Test-Projects will take place daily.

After the Competitors finished a module, the Test Projects are collected, and the CE and DCE will permanently mark the collected Test Projects with the secret number. From now on nobody in the assessment teams will have any reference of the "secret number" to any of the Competitors.

The CE will divide the Experts into teams of three and assign the teams to specific criterion to evaluate. Having three Experts in an assessment team (EACH Expert must measure the aspect) shall ensure that no errors are made in assessment.

Besides the Expert teams there will also be selected criterion which is inspected by measurement machines and an independent technician of the sponsor of such machines. For these criteria a minimum of one Expert must witness the process of each assessment.

5 The Test Project

5.1 General notes

Sections 3 and 4 govern the development of the Test Project. These notes are supplementary.

Whether it is a single entity, or a series of stand-alone or connected modules, the Test Project will enable the assessment of the applied knowledge, skills, and behaviours set out in each section of the WSOS.

The purpose of the Test Project is to provide full, balanced, and authentic opportunities for assessment and marking across the Standards, in conjunction with the Marking Scheme. The relationship between the Test Project, Marking Scheme, and Standards will be a key indicator of quality, as will be its relationship with actual work performance.

The Test Project will not cover areas outside the Standards, or affect the balance of marks within the Standards other than in the circumstances indicated by Section 2. This Technical Description will note any issues that affect the Test Project's capacity to support the full range of assessment relative to the Standards. Section 2.1 refers.

The Test Project will enable knowledge and understanding to be assessed solely through their applications within practical work. The Test Project will not assess knowledge of WorldSkills rules and regulations.

Most Test Projects (and Marking Schemes) are now designed and developed independently of the Experts. They are designed and developed either by the Skill Competition Manager, or an Independent Test Project Developer, normally from C-12 months. They are subject to independent review, verification, and validation. (Section 4.1 refers.)

The information provided below will be subject to what is known at the time of completing this Technical Description, and the requirement for confidentiality.

Please refer to the current version of the Competition Rules for further details.

5.2 Format/structure of the Test Project

The Test Project is a series of three (3) standalone modules.

Each module is comprised of programming, set-up, and actual machining work.

5.3 Test Project design requirements

The Document "Project Design Criteria Skill 06", which is made available by the Skill Competition Manager on the WorldSkills Discussion Forum after CPW describes a variety of material, sizes, and desired features. The Skill Competition Manager must coordinate and ensure that all features are included in the Test Project.

Such a Test Project is one complete module. One module is the work of a full Competition day.

The modules must be designed in metric and to the standards described in the document "Project Design Criteria Skill 06 – competition year XXX".

The Test Project design criteria are developed to:

- Ensure features on modules reflect modern industry;
- Minimize the amount of cutting tools for the Competitor to bring;
- Minimize the amount of inspection tools for the Competitor to bring;
- Project design must meet criteria of document "Project Design Criteria Skill 06";
- The drawings of the Test Projects shall have as little text as possible. In the project design the focus is on "technical language" only, like dimensions and international symbols, there shall be no need for translation;
- The Independent Test Project Designer must bring a machined sample part of the design;
- This is needed to programme the CMM (Coordinate Measuring Machine);
- The Independent Test Project Designer includes the proposed Marking Scheme for each module.

5.4 Test Project development

The Test Project MUST be submitted using the templates provided by WorldSkills International (www.worldskills.org/expertcentre). Use the Word template for text documents and DWG template for drawings.

5.4.1 Who develops the Test Project or modules

The Test Project/modules are developed by an Independent Test Project Designer in collaboration with the Skill Competition Manager.

5.4.2 When is the Test Project developed

The Test Project/modules are developed according to the following timeline:

Time	Activity
Ten (10) months prior to the Competition	An Independent Test Project Designer is appointed.
Nine (9) months prior to the Competition	The WSI Director of Skills Competitions enters into an agreement with the Independent Test Project Designer.
Five (5) months prior to the Competition	After this, no Expert is allowed to communicate directly with the Independent Test Project Designer. The Independent Test Project Designer starts to develop TP in accordance with the TD and IL. IL must be finished to accomplish smart design.

Time	Activity
No later than one (1) month prior to the Competition	The Independent Test Project Designer completes the design of the Test Project and Marking Scheme. The Test Project documents are sent to the WorldSkills International Skills Competitions Administration Manager.
At the Competition at the beginning of each module	The Test Project/modules are presented to Competitors.

5.5 Test Project initial review and verification

The purpose of a Test Project is to create a challenge for Competitors which authentically represents working life for an outstanding practitioner in an identified occupation. By doing this, the Test Project will apply the Marking Scheme and fully represent the WSOS. In this way it is unique in its context, purpose, activities, and expectations,

To support Test Project design and development, a rigorous quality assurance and design process is in place (Competition Rules sections 10.6-10.7 refer.) Once approved by WorldSkills, the Independent Test Project Designer is expected to identify one or more independent, expert, and trusted individuals initially to review the Designer's ideas and plans, and subsequently to verify the Test Project, prior to validation.

A Skill Advisor will ensure and coordinate this arrangement, to guarantee the timeliness and thoroughness of both initial review, and verification, based on the risk analysis that underpins Section 10.7 of the Competition Rules.

5.6 Test Project validation

The Skill Competition Manager coordinates the validation and will ensure that the Test Project/modules can be completed within the material, equipment, knowledge, and time constraints of Competitors.

The Independent Test Project Designer shall bring machined sample parts of their design for each day.

5.7 Test Project selection

The Test Project/modules are selected by the Independent Test Project Designer in collaboration with the Skill Competition Manager.

5.8 Test Project circulation

If applicable, the Test Project is circulated via the website as follows:

The Test Project/modules are not circulated prior to the Competition. The Test Project/modules are presented to Competitors at the beginning of each module.

5.9 Test Project coordination (preparation for Competition)

Coordination of the Test Project/modules is undertaken by the Skill Competition Manager.

5.10 Test Project change

There is no 30% change required to be made to the Test Project/modules at the Competition. Exceptions are amendments to technical errors in the Test Project documents and to infrastructure limitations.

5.11 Material or manufacturer specifications

Specific material and/or manufacturer specifications required to allow the Competitor to complete the Test Project will be supplied by the Competition Organizer and are available from www.worldskills.org/infrastructure located in the Expert Centre. However, note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These such items may include those for fault finding modules or modules not circulated.

The Competition Organizer is to provide the technical specifications of the provided equipment on the Infrastructure List at least eight (8) months prior to the Competition.

Free training on machine and software, where possible, must be provided at least four (4) months prior to the Competition. Travel, lodging, and food expenses for this training are to be carried by the Competitors or their sponsor. The scheduling of the training is to be done by the Competition Organizer. The Competitors are notified about the training at least six (6) months prior to the Competition. Participating in the provided training is the choice of the Competitors and/or their sponsor.

Sponsors of CNC machines, inspection equipment, and CAM-software must supply specialists and service staff in adequate numbers to ensure that the competition runs smoothly. These specialists should be available at any time prior to and during the competition, as well as during the marking of the Test Projects.

6 Skill management and communication

6.1 Discussion Forum

Prior to the Competition, all discussion, communication, collaboration, and decision making regarding the skill competition must take place on the skill specific Discussion Forum (http://forums.worldskills.org). Skill related decisions and communication are only valid if they take place on the forum. The Chief Expert (or an Expert nominated by the Chief Expert) will be the moderator for this Forum. Refer to Competition Rules for the timeline of communication and competition development requirements.

6.2 Competitor information

All information for registered Competitors is available from the Competitor Centre (www.worldskills.org/competitorcentre).

This information includes:

- Competition Rules
- Technical Descriptions
- Mark Summary Form (where applicable)
- Test Projects (where applicable)
- Infrastructure List
- WorldSkills Health, Safety, and Environment Policy and Regulations
- Other Competition-related information

6.3 Test Projects [and Marking Schemes]

Circulated Test Projects will be available from www.worldskills.org/testprojects and the Competitor Centre (www.worldskills.org/competitorcentre).

6.4 Day-to-day management

The day-to-day management of the skill during the Competition is defined in the Skill Management Plan that is created by the Skill Management Team led by the Skill Competition Manager. The Skill Management Team comprises the Skill Competition Manager, Chief Expert, and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalized at the Competition by agreement of the Experts. The Skill Management Plan can be viewed in the Expert Centre (www.worldskills.org/expertcentre).

6.5 General best practice procedures

General best practice procedures clearly delineate the difference between what is a best practice procedure and skill-specific rules (section 9). General best practice procedures are those where Experts and Competitors CANNOT be held accountable as a breach to the Competition Rules or skill-specific rules which would have a penalty applied as part of the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System. In some cases, general best practice procedures for Competitors may be reflected in the Marking Scheme.

Topic/task	Best practice procedure
Release of Test Project	• Step 1 Competitors in a Group get a general verbal instruction of the expectations. This is done by the SCM and the Independent Test Project Designer – typically 5-10 minutes. Competitors, Experts, and Interpreters are present in this session. The Test Project is NOT shown at this point! NO documentation allowed! • Step 2 After clarification of expectations, ONLY the Competitors (no Expert and no interpreter) receive the Test Project to study and plan their work. Duration 15 minutes. During this time the SCM and the Independent Test Project Designer are present to clarify any possible discrepancies. • Step 3 At the given time the Competitors start their work. Now a designated team of Experts (team leaders of the marking teams) get the Test Project to study and clarify the inspection plan the Independent Test Project Designer and the SCM prepared. This is to clarify the marking methods, possibilities, and prepare a timetable for inspection. • Step 4 Now the designated Inspection Teams [Experts and independent marking people (such as Mitutoyo)] review the Test Project and their marking tasks assigned by the team leaders. • Step 5 SCM shares the TP with the entire group of Experts after the marking is finished.
Marking teams	• The Skill Management Team defines a sufficient amount of marking teams based on WorldSkills experience and mixture of cultures. Each group has a team leader assigned by the SMT and rotates their duties in the course of the different modules.
Use of digital memory devices	• The Skill Management Team will use specific software to check if banned memory devices have been used on Competitor's computers

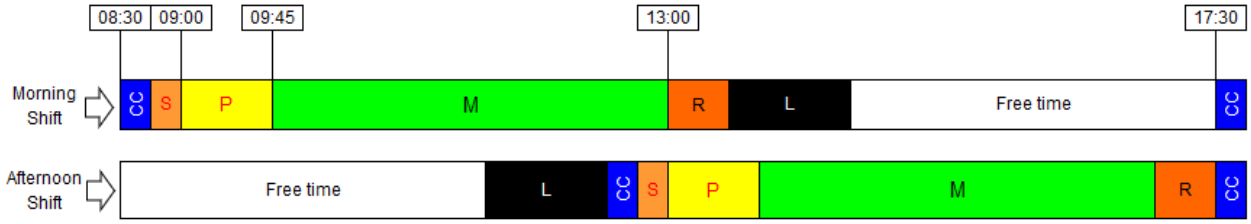
Topic/task	Best practice procedure
Equipment failure	• If equipment or tools which are brought by the Competitor fail, no extra time is allowed. • If equipment or tools supplied by the Competition Organizer fail extra time may be allowed only if the technician of the sponsor or supplying company specifies and proves it is not a "user error", but truly an equipment failure without the fault of the user, e.g. power outage … this is in most cases is NOT the fault of the user.

One module covers the tasks for a complete Competition day (or a shift) and shall not be interrupted with work from other modules.

The floor-space and the CNC machine requirements are so intensive, that it is impossible to get a working situation where Competitors have a CNC machine totally at their disposal.

Therefore, the shift rotation basis will apply, meaning Competitors have to share the CNC machine in a shift rotation (morning shift/afternoon shift). This reflects common industry situations.

Sequences example:



Considering that one hour of CAM programming can lead to approximately three hours of uninterrupted machining (set-up and turnaround included), it is desired to keep the scheduled machining time at the maximum.

It is important to have the reset-time between shift changes. During this reset-time the control-unit is cleared, machine parameters are reset to original stage, and tools and tool holders are taken out. The machine is cleaned by the Competitor and made ready for the next shift to start their Test Project.

The sequence of a module is (example morning shift):

1: 8:30 Compatriot Communication (without Test Project)

Includes explanation of expectations with independent Test Project Designer (Experts and Interpreters present)

2: 8:45 Competitors receive drawings and materials (including data transfer equipment e.g. memory stick) and have 15 minutes for planning their work (without any other person except the Independent Test Project Designer for clarification).

3: 9:00 Buzzer will indicate the beginning of the programming time.

Competitor can use the provided computer for writing the CNC programme, no action at the machine is allowed.

4: 9:45 Buzzer will indicate beginning of the machining time.

At this point the Competitor is allowed to use both, the computer and the CNC machine.

5: 13:00 Buzzer will indicate the finishing of the module.

The reason that during the programming time (CAM, indicated above in yellow) the Competitor is only allowed to use the computer and not the machine, is the shift rotation system. (equal situation for both shifts)

7 Skill-specific safety requirements

Refer to WorldSkills Health, Safety, and Environment Policy and Regulations for Host country or region regulations.

Task	Safety glasses with side protection	Cut protection gloves (without breakage)	Safety shoes with protective cap	Sturdy shoes with closed toe and heel	Tight fitting work clothes	Hair net, hat or cap, or any other means to hold long hair out of the Danger Zone
General PPE for safe areas				√		
Operating machine	√ (only if machine has door open)		√		√	√ (only if Competitor has long hair)
Handling chips from the chip-bin and/or raw material that is not deburred (Sharp corners)	√	√	√		√	

8 Materials and equipment

8.1 Infrastructure List

The Infrastructure List details all equipment, materials, and facilities provided by the Competition Organizer.

The Infrastructure List is available at www.worldskills.org/infrastructure.

The Infrastructure List specifies the items and quantities requested by the Skill Management Team for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These such items may include those for fault finding modules or modules not circulated.

At each Competition, the Skill Management Team must review and update the Infrastructure List in preparation for the next Competition. The Skill Competition Manager must advise the Director of Skills Competitions of any increases in space and/or equipment.

At each Competition, the Technical Observer must audit the Infrastructure List that was used at that Competition.

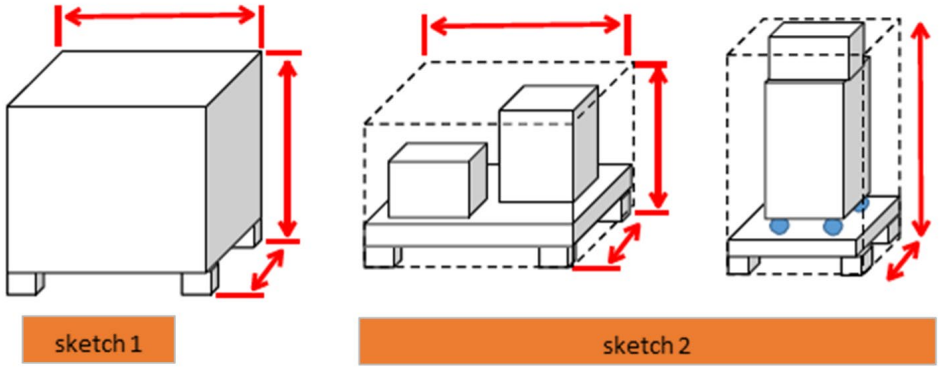
The Infrastructure List does not include items that Competitors and/or Experts are required to bring and items that Competitors are not allowed to bring – they are specified below.

8.2 Competitors toolbox

Competitors may bring more than one toolbox with a total external volume not exceeding 2.8 m³ including pallet or transportation box.

(Volume = Length x Height x Width, or V = L x H x W)

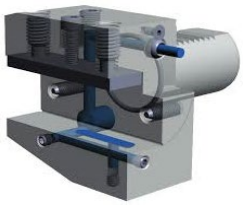
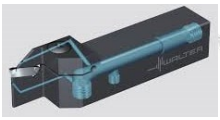
- Other than forbidden tools, the limitation of tools to bring is also dictated by "Shipping Crate Volume";
- Everything a Competitor brings, must fit in the shipping volume. (See sketch 1)
- The dimension is taken on the OUTSIDE of the shipping crates, including the pallet;
- In the case of shipping toolboxes like in sketch 2, an imaginary box is applied, like indicated in the sketch;
- The CE will assign Expert Teams to measure each crate size upon delivery of toolboxes;
- If Competitors bring more than the allowed volume, he/she (not the Expert, or Interpreter, or any other "helper") will have to use familiarization time, to reduce the tools to the allowed volume;
- The assigned Expert team will oversee this process until an agreement is found.



8.3 Materials, equipment, and tools supplied by Competitors

- To allow for innovation and learning from each other, the Competitor has no restrictions in bringing any equipment or accessories, as long as it conforms to the provided equipment and WSI-duplication rules. Of course, it must be within reasonable limits, for example: Competitors shall not bring their tailstock or a control-unit. In any debatable case the Skill Competition Manager shall make the final decision.
- Competitors must bring their own tooling, cutting tools, and measurement Instruments to the Competition. The Competition Organizer will not be providing these infrastructure items for the Competitors, the items described and available in Infrastructure List are only spares.
- The Competitors must supply their own cutting tools; these must be compatible with the clamping system of the machine (Specifications of the machine to be supplied are to be considered – example tool shank metric/standard.)
- The Competitors are allowed to bring additional tools in relation to the list described in the project design criteria which is published on the WorldSkills Discussion Forum (be aware of the maximum diameter permitted by the machine tool manufacturer).
- The quantities and type of cutting tools to bring is a decision of participating country/region or Competitor only. (The IL is a good source of inspiration.)
- VDI holders that allow for internal coolant will not be supplied by the Competition Organizer. Such holders are expensive, and there are so many different systems available, and they must correspond with each other. Therefore, a limited amount (4) of such VDI Holders shall be allowed by the Competitor to bring to the Competition.

See Pictures for clarification.


Competitors are required to supply their own Personal Protective Equipment as specified in section 7 skill-specific safety requirements.

8.4 Materials, equipment, and tools supplied by Experts

Experts are required to supply their own Personal Protective Equipment as specified in section 7 skill-specific safety requirements.

8.5 Materials and equipment prohibited in the skill area

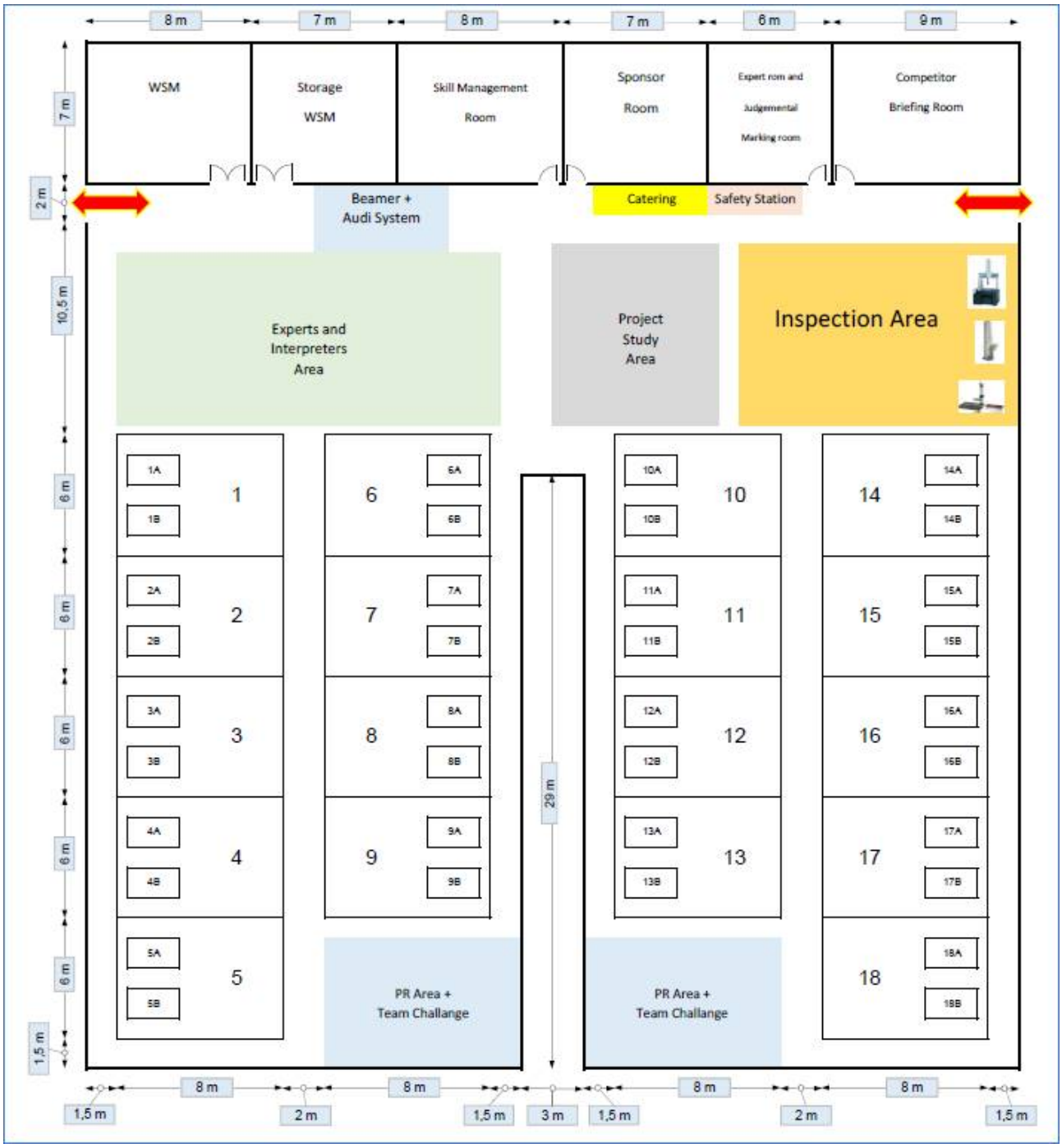
- Tools and holders that allow for pre-programmed offsets are NOT allowed;
- Any device that clearly reflects prior knowledge of the Test Project is confiscated. This could be for example a special sleeve that was manufactured specifically for the Test Project;
- See section 9 skill-specific rules for further information

8.6 Proposed workshop and workstation layouts

Workshop layouts from previous competitions are available at www.worldskills.org/sitelayout.

Example workshop layout

Description of the Workshop (example of previous page)



Space requirements for 32 Competitors (subject to space availability) include:

- Number of Workstations: 18
  - A workstation consists of one machine, one workbench, two programming stations and has an approx. size of 6 m x 8 m = 48 m²
  - For 24 Competitors or less: Number of Competitors divided by two PLUS ONE
  - For 25 Competitors or more: Number of Competitors divided by two PLUS TWO
  - The PLUS-Workstations are used when a competitor gets in trouble and needs time-extension.
- Expert and judgmental marking room: approx. 40 m²
  - This room is needed for Experts meetings, storage and for judgmental marking
- Competitor briefing room: approx. 70 m²
  - This room is needed to brief the Competitors as a group on each of the Test Project modules.
  - This room is extremely important when briefing the 2nd shift competitors on the test module, while the 1st shift competitors are still working on the shared workplaces
- Sponsor room: approx. 50 m²
  - Sponsors need a place to store their tools, spare parts, their personals and a place to work on their laptops, have meetings in a quite environment to communicate with their company to find solutions for troubleshooting.
  - We have four major sponsors (CNC Machine, CAD-CAM System, Inspection Tools, tools and holders)
- Workshop manager room: approx. 55 m²
  - Serves also as storage room for Test Project raw material
- Material storage room: approx. 50 m²
  - Materials, Pallets, Boxes, Tools etc. need a place to be stored
  - Also a place where Sponsors can store bulky items and tools.
- Skill management room: approx. 50 m²
  - Serves also as a room for storage and lockup of test projects from all competitors
- Inspection area: approx. 120 m²
- Expert work area: approx. 200 m²
- Project Study Area: approx. 80 m²
- Space for PR and the CNC Team Challenge: approx. 80 m²

Add in some space for columns as well as Competitors toolboxes.

Add in minimum of 1.5 m clearance around the visitor-barrier

Very important – we need to keep in mind the evacuation route, as well as pathways to drive with the pallet jacks.

Based on 32 Competitors, 32 Experts, Workshop Managers, equipment technicians and some Interpreters, the required space is approx. 2050 m².

This is of course based on the footprint available and can be changed based on the layout of the workstation arrangement (Especially the supply channels on the floor. CNC Machines must be placed on a stable underground and can NOT be placed on a supply channel-cover)

9 Skill-specific rules

Skill-specific rules cannot contradict or take priority over the Competition Rules. They do provide specific details and clarity in areas that may vary from skill competition to skill competition. This includes but is not limited to personal IT equipment, data storage devices, Internet access, procedures and workflow, and documentation management and distribution. Breaches of these rules will be solved according to the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System.

Topic/task	skill-specific rule
Use of technology – digital memory devices (such as memory stick, CD or DVD Rom, Bluetooth or Wi-Fi devices, media players etc.)	• Competitors are only allowed to use digital memory devices provided by the Competition Organizer. No other memory devices are to be inserted into or connected with the Competitor computers or machines. • All provided digital memory devices are to be submitted to the Chief Expert at the end of each module (day) for safe keeping and must not be taken out of the workshop. • The Skill Management Team, Competition Organizer IT team, and technicians from sponsors are allowed to insert their devices for checking or installation of software. • Headphones, wireless earbuds, or similar devices that would allow music, communication, or any other distraction are not allowed for the Competitors.
Use of technology – personal laptops, tablets, and mobile phones	• Competitors are not allowed to bring personal laptops, tablets, or mobile phones into the workshop, including other communication devices such as smartwatches. In the event that Competitors do bring these to the competition they shall be locked in the personal locker and shall not be taken to the workstation. These can only be removed at the completion of the module for that day. This rule is valid for C-2 until the end of C4. • No Wi-Fi or Bluetooth is allowed at the workstations for Competitors • Skill Competition Manager, Chief Expert, Deputy Chief Expert, Experts and Interpreters are allowed to use personal laptops, tablets, and mobile phones in assigned areas only from C-6 until C+1.
• Use of technology – personal photo and video taking devices	• Skill Competition Manager, Chief Expert, Deputy Chief Expert, Competitors, Experts, Workshop Managers, and Interpreters are allowed to use personal photo and video taking devices in the workshop. Restrictions may be set by the Skill Management Team in situations where sensitive information is in the area. Any photos or videos must be approved by the SMT prior to taking. • This rule is valid for C-6 until C+1.

10 Visitor and media engagement

Following is a list of possible ways to maximize visitor and media engagement:

- Organize an area that has local instructor, apprentice or industry explaining the CNC turning machinist role in industry, local opportunities for training, career details etc.
- Display screens (video of CNC Turning Machining);
- Display a complete Test Project (description, parts, and drawings) from past Competitions
- Display Competitor profiles - national flag, name of Competitor and a brief description of their studies;
- A display of industry parts, measuring tools, drawings, MasterCam running on a laptop. The CNC machine supplier could bring sample parts which they use at trade shows.
- The Try-a-Skill (where audience gets to try a hands-on an activity that reflects CNC Machining) option is a valuable way to draw interest, sample keychains where they programme their name and it becomes a take-away.
- Competitions should try to capitalize on the visitor experience, in addition to running the competition, plan the media engagement in the process. (spare machine, volunteers in this trade to help engage audience), software running, sample parts, exposure of CMM measuring activity so audience see's the technology applied to trade.
- In CNC Turning we run our "Team-Challenge" on C4. This is usually very good for Visitors and Media Engagement.

Possible text for Media and Marketing

CNC Turning is a branch of engineering. Engineers have to find mechanical solutions that make complex designs possible.

There are many different single parts in things that you see or use on a daily basis. Just like in cars, Smartphones, aircraft, Aero-Space, and so on; the possibilities are endless. For example, there are about 10.000 parts in just one car. Engineers create assemblies of many parts and using a variety of different materials.

But who will build these parts? The CNC machinist…. we have to decide the best way to produce each part.With a CNC Lathe we can build very complex parts. Computer-controlled tools are moved to cut away excessive material and shape the material to the form we want.

You, as the machinist receive the blueprint and must then develop a strategy to build the desired part. Which tools to use? Which clamping method without destroying the part? What sequence to develop? Are there alternatives? Faster, better or cheaper ways? Can you produce the desired quality, in the desired time, to the desired price. with the method's you developed?

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 times thinner than a human hair.

The CNC Turning machinist has to use a computer to tell the Lathe how to move the tools and cut the part. He/she also has to set up the Lathe with all the cutting tools. These tools can cut almost every material (stainless steel, plastic, soft steel, aluminium, bronze and so on) but we have to choose well.

When the machine starts cutting material, the machinist makes sure that the dimensions exactly fit the blueprint specifications. For this, very accurate inspection tools are used. A smart machinist will get the part to fit the specifications at the first attempt, which not only gives you good quality, but a better price. Have you finished the part? Quality control ok? Now send it to the assembly line, where in the end all parts must fit together.

And in the end, if everyone has done their job well, the finished assembly will meet expectations and the car can drive, the plane can fly, and the rocket can fly into space

11 Sustainability

This skill competition will focus on the sustainable practices below:

- Use of shift rotation system (i.e. shared workstations) to reduce floorspace.
- Recycling and waste management
- Smart management of Infrastructure List to safe resources
- Multiple use of offices to reduce needed floorspace (Expert-room is also Judgement Marking room, Competitor-room is also briefing room)
- Use of Team-Challenge outcome as present to the Competition Organizer of the competition.
- Better use of digital technology to reduce paper

12 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.onetonline.org/)

This WSOS (section 2) 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 2021.

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