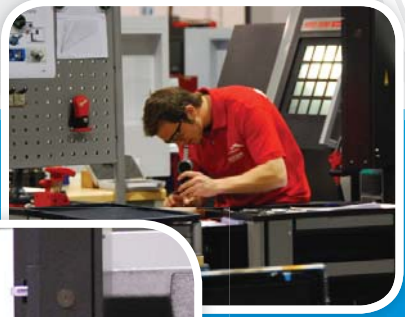


TECHNICAL DESCRIPTION

CNC Turning

TD06 v3.0 – WSC2011

WorldSkills International, by a resolution of the Technical 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:

Effective 31.03.10

Liam Corcoran
Technical Committee Chair

1. INTRODUCTION

1.1 Name and description of skill

1.1.1 The name of the skill is CNC Turning.

1.1.2 Description of skill
CNC Turning covers the processing of metal work pieces with CNC lathes, including simple work with Life Tooling or driven tools.

From a technical drawing, the machinist must program the software controlled manufacturing machine and select, mount and offset the needed cutting tools, to fabricate the desired customer part to an accuracy of 0,01mm. (This is a human hair split approx. 8 times).

Programming of the CNC lathe takes place through the machine control unit and/or Computer-Aided Machining software (CAM).

CNC Turning, when combined with live tooling (driven tools) covers one of most important global industry needs. This technology covers many possibilities in metal cutting needs for the modern Industry.

Such parts are used everywhere in metal Industries, such as Automotive, Tool and Die, Aviation and even in the Aerospace industries.

1.2 Scope of application

1.2.1 Every Expert and Competitor must know this Technical Description.

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

1.3 Associated documents

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

- WSI - Competition Rules
- WSI - Competition Manual
- WSI - Online resources as indicated in this document
- Host Country - Health and Safety regulations

2. COMPETENCY AND SCOPE OF WORK

The Competition is a demonstration and assessment of the competencies associated with this skill. The Test Project consists of practical work only. No written exam about theoretical knowledge will be conducted.

The Test Project covers practical work related to modern manufacturing industry tasks, completed on CNC lathes.

Competitors will be given raw material, (ferrous and non-ferrous material) and technical drawings. The desired work pieces shall be worked on all sides, so that the Competitor carries out tasks that reflect run-out, perpendicularity, parallelity and other set-up challenges.

The programming of the CNC lathe must be carried out on commercially available CAM systems (such as MASTER-CAM) and Machine Controls (such as FANUC).

For the Competition the use of live tooling is desired. However, this depends on the availability of sponsors of the CNC machines of the Host country.

2.1 Competency specification

Underpinning knowledge and understanding

- Quality standards of manufacturing, engineering and machining processes
- Standards of environment, safety, hygiene and prevention in machine shops
- Computer operating systems
- Mathematics (Geometry)
- Metrology (Properties of Materials)
- Technical design (Mechanical Engineering)

Advanced knowledge

- Blueprint reading (Mechanical Engineering)
- Machining technology.
- CNC equipment technology
- Tooling and cutting technology
- Inspection technology

Execution of skills

- Professional interpretation of technical drawings, charts and tables
- Selection and proper use of trade specific inspection instruments
- Selection and proper use of adequate cutting tools
- Set-up of cutting tools, support tools and machine-accessories
- Advanced knowledge of chip removal properties, stability of tools, material, support and clamping devices.
- Programming techniques for CNC lathes (including CAM)

Main goal

The Competition does not reflect the typical mass-production on CNC machines. The aim is to display the correct set-up of CNC lathes. The Competitor will be confronted with a “Customer meets Machinist” situation, meaning that a customer (panel of Experts) approaches the machinist with a paper-drawing and stock material. The Competitor is for the first time confronted with this customer part and must now decide his/her actions to fulfil the customer needs.

2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.

- Professional interpretation and execution of manufacturing drawings according to ISO-A or ISO-E standard
- Knowledge of the materials used and their correct processing.
- Experienced with tool-offsets and tool-parameters
- DIN ISO programming, as well as knowledge of the programming language of the provided software(s)
- Data transfer
- Knowledge of trigonometry or other mathematical means of calculating tangent and intersection points.

2.2.2 Knowledge of rules and regulations is not examined.

2.3 Practical work

The Competitor has to carry out independently the following tasks:

- Prepare, based on the paper drawing, the desired CNC programs
- Calculate the points of intersection on profiles if not shown on the drawings by means of any kind of calculator or the provided CAM system or the machine control.
- Select the proper tools and independently mount, set-up and measure them.
- Machine and measure the test project. Use any type of analysis and correction to complete the desired task.
- Comply with the safety instructions by the machine manufacturer and with the national safety regulations, as well as WorldSkills regulations.
- The tool data (offsets) have to be found and entered at the machine. No external tool-setting equipment will be provided. (touch up)
- The provided CNC programming software shall be known and used worldwide, ideally Fanuc - Master-CAM
- All components may be programmed using the full capacity of the provided control and CAM system.

3. THE TEST PROJECT

3.1 Format / structure of the Test Project

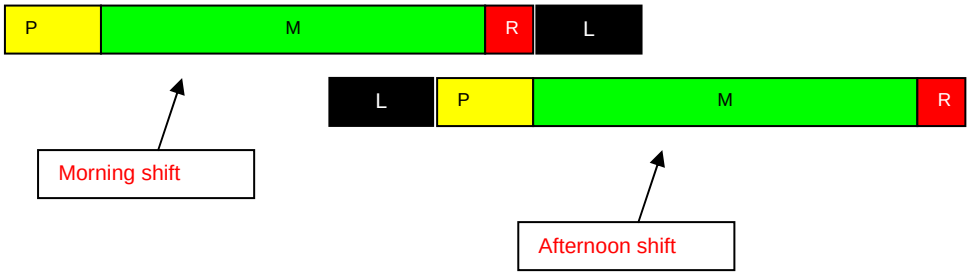
The format of the Test Project is a series of three or four standalone modules.

The modules are comprised of programming, set-up and actual machining work.

One module covers the tasks for a complete Competition day 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 each Competitor has a CNC machine totally at his/her 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
P = CAM programming
M = Machine (and CAM) is at competitors disposal
R = Reset time of machine
L = Lunch



Considering that 1 hour of CAM programming can lead to approximately 3 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 will be cleared, machine parameters will be reset to original stage and tools and tool holders will be taken out. The machine will be clear and ready for the next shift to start the job.

3.2 Test Project design requirements

Prior to the Competition the Chief Expert is to assign participating Experts for Test Project designing. The Chief is to assign material, sizes and desired feature and has to coordinate the modules to avoid missing competences like “face grooving, threading etc”.

Such a Test Project is one complete module. One module is the work of a full Competition day. Upon arrival to the Competition site, Experts will submit their proposals to the panel of Experts. Selection of the modules is by vote of the Experts.

A module may consist of a maximum two (2) parts.
The modules must be designed in metric and to the standards described in the document “Project Design Criteria Skill 06”. This document will be updated and developed prior to each competition taking into consideration the infrastructure. It will be posted on the Discussion Forum.

The Test Project design criteria were developed to:

- Ensure features on modules reflect modern industry
- Minimise the amount of cutting tools for the Competitor to bring
- Minimise the amount of inspection tools for the Competitor to bring

Only Test Projects meeting the following criteria will be available for selection.

- Project features according to assignments by Chief Expert
- Project design to criteria of document “Project Design Criteria Skill 06“
- The Test Project drawings have to be available in ISO-E and ISO-A. Drawings shall have as little text as possible. In the project design the focus is on “technical language” only, like dimensions and international symbols.
- Drawing available in digital format (for supply to WSI) and hard copy – source file, PDF and printout.
- Each Expert shall bring a machined sample part of his/her design. This is needed to program the CMM (Coordinate Measuring Machine). It is also supportive in the voting for the Test Project to have a “real” machined part available.
- Proposed marking scheme has been developed.

In the situation where voting of Test Projects results in a tie of two or more projects, the Chief Expert will settle the tie with his vote.

Once the modules were selected, material preparations, marking possibilities and selection of marking groups will be conducted.

In the situation where the panel of Experts find the selected Test Project not suitable because of machining or marking scheme errors, the Test Project will be eliminated and a new vote takes place.

All Test Projects proposals are made available to Experts on the WSI website at the conclusion of the Competition.

The Chief Expert coordinates the desired material requirements and the saw cutting possibilities with the Workshop Supervisor.

The aim of this Test Project selection method is:

- Every member has equal input in Test Project design.
- This method ensures a balance of competences and industry needs from all Experts’ countries.
- Through the coordination by the Chief Expert it is ensured that all features and competences are tested. This shall reflect a mix of the global training and/or manufacturing practices.
- Coordination of tooling needs to minimise the amount of tools shipped by Competitors.
- Coordinate material needs with the Host. Every member knows what material and sizes to expect.
- Each of the Test Project modules is validated by the machined sample brought by the Expert.

- This ensures the machinability has been tested, the information on the blueprint is sufficient, and most important of all, there are sample parts for the programming of the coordinate measuring machine.
- The non-voted projects (blueprints and sample parts) may serve as display parts for the general public visiting the venue.

3.3 Test Project development

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

3.3.1 Who develops the Test Project / modules

The Test Project / modules are developed as follows:
The Chief Expert is to assign project design to participating Experts prior to the Competition. Each participating Expert is to design a Test Project and selection of the project will take place on site.

3.3.2 How and where is the Test Project / modules developed

The Test Project / modules are developed independently.

3.3.3 When is the Test Project developed

The Test Project is developed before the current Competition and brought to the Competition for selection.

3.4 Test Project marking scheme

Each Test Project must be accompanied by a marking scheme proposal based on the assessment criteria defined in Section 5.

3.4.1 The marking scheme proposal is developed by the person(s) developing the Test Project. The detailed and final marking scheme is developed and agreed by all Experts at the Competition.

3.4.2 Marking schemes should be entered into the CIS prior to the Competition.

3.5 Test Project validation

Each Expert shall bring a machined sample part of his/her design.

3.6 Test Project selection

The Test Project is selected as follows by vote of Experts at the current Competition.

Project selection will be conducted by the Experts from drawings and sample parts that they have brought to the Competition in one of the three official languages.

The drawings must correspond to the determined marking criteria and to the desired project features assigned by the Chief Expert.

3.7 Test Project circulation

The Test Project is circulated via WorldSkills International website as follows:

- Not circulated

3.8 Test Project coordination (preparation for Competition)

Coordination of the Test Project will be undertaken by Chief Expert.

3.9 Test Project change at the Competition

Not applicable

3.10 Material or manufacturer specifications

The Host Country is to provide the technical specifications of the provided equipment to the Technical Delegates of the participating countries at least eight (8) months before the WorldSkills Competition.

Free training on machine and software 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 Competitor or his/her sponsor.

The Host Country is obligated to schedule this training at least four (4) months before the Competition, and notify the participants at least six (6) months before the Competition.

Participating in the provided training is the choice of the Competitors and/or their sponsor.

The Sponsors must supply specialists and service staff for the software and the CNC machines in adequate numbers to ensure that the competition runs smoothly. These specialists will be available at all times before and during the competition, as well as during the marking of the test projects.

4. SKILL MANAGEMENT AND COMMUNICATION

4.1 Discussion Forum

Prior to the Competition, all discussion, communication, collaboration and decision making regarding the skill must take place on the skill-specific Discussion Forum (http://www.worldskills.org/forums). All 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 moderator for this forum. Refer to Competition Rules for the timeline of communication and competition development requirements.

4.2 Competitor information

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

This information includes:

- Competition Rules
- Technical Descriptions
- Test Projects
- Other Competition-related information

4.3 Test Projects

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

4.4 Day-to-day management

The day-to-day management is defined in the Skill Management Plan that is created by the Skill Management Team led by the Chief Expert. The Skill Management Team comprises the Jury President, Chief Expert and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalised at the Competition (agreed by Experts and submitted to the Chair/Vice Chair of the Technical Committee). The Chief Expert is to regularly share updates of the Skill Management Plan via the Forum.

5. ASSESSMENT

This section describes how the Experts will assess the Test Project / modules. It also specifies the assessment specifications and procedures and requirements for marking.

5.1 Assessment criteria

This section defines the assessment criteria and the number of marks (subjective and objective) awarded. The total number of marks for all assessment criteria must be 100.

Section	Criterion	Marks		
		Subjective (if applicable)	Objective	Total
A	Conformity to drawing	10		10
B	Surface finish		10	10
C	Main dimensions		50	50
D	Secondary dimensions		25	25
E	Use of materials		5	5
F				
G				
H				
	Total =	10	90	**100**

5.2 Subjective marking

Scores are awarded on a scale of 1 to 10.

5.3 Skill assessment specification

A) Conformity to drawing – 10 marks (10% of the total score)
Total marks per module depends on the allocated duration of the module, and shall be approx. 10% of the total marks of the module.

- Visual check if features and characteristic of the test part according to print, if features are missing, or if additional features (unwanted) are on the part.
- Check for corner break and chamfers and for burrs on the part.
- Check for damage to part (scratches, clamp-imprints, crash-marks etc.)
- Visual check of surface finishes not specified for measuring.

B) Surface finish – 10 marks (10% of the total score)
Total marks per module depends on the allocated duration of the module, and shall be approx. 10% of the total marks of the module.

- Maximum 5 marking aspects per module.
- Measure specified locations (marked on print).

C) Main dimensions – 50 marks (50% of the total score)
Total marks per module depends on the allocated duration of the module, and shall be approx. 50% of the total marks of the module.

Each main dimension shall carry the same weight in points.
There shall not be more than 10 marking aspects per Module.

D) Secondary dimensions – 25 marks (25% of the total score)
Total marks per module depends on the allocated duration of the module, and shall be approx. 25% of the total marks of the module.

There shall not be more than 15 marking aspects per Module.
Each dimension equals less points then a main dimension (not more than 80% of a main dimension).

E) Use of material – 5 marks (5% of the total score)
Award marks only if no additional material is used by the competitor.

Award per module = 5 marks divided by number of modules
Example : 4 modules = 1.25 marks per module

Depending on the amount of modules, a rounding of allocated marks may apply.
Example : 3 modules - Module 1 = 1.66 marks, Module 2 = 1.66 marks and Module 3 = 1.68 marks

Competitor may only receive ONE extra material per test part.

5.4 Skill assessment procedures

- The Experts participating in the Competition will be divided into marking groups to deal with the assigned sections of the marking criteria.
- Marking of the Test Project modules will take place on a daily basis.
- ONLY the machined test part will be evaluated.

6. SKILL-SPECIFIC SAFETY REQUIREMENTS

Refer to Host Country Health & Safety documentation for Host Country regulations.
There are no skill-specific safety requirements.

7. MATERIALS & EQUIPMENT

7.1 Infrastructure List

The Infrastructure List lists all equipment, materials and facilities provided by the Host Country.

The Infrastructure List is online (http://www.worldskills.org/infrastructure/).

The Infrastructure List specifies the items & quantities requested by the Experts for the next Competition. The Host Country will progressively update the Infrastructure List specifying the actual quantity, type, brand/model of the items. Host Country supplied items are shown in a separate column.

At each Competition, the Experts must review and update the Infrastructure List in preparation for the next Competition. Experts must advise the Technical Director 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.

7.2 Materials, equipment and tools supplied by Competitors in their toolbox

- The Competitor must bring all equipment not provided for machining, measuring and testing as required.
- Competitors are to bring their own measuring tools.
- To allow for innovation and learning from each other, the Competitor has no restrictions in bringing any equipment or accessories.
- Restriction of tools is limited to data transfer devices, as well as equipment that allows for presetting and programming of tooling and offsets.

7.3 Materials, equipment and tools supplied by Experts

Not applicable

7.4 Materials & 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 will be confiscated. This could be for example a special sleeve that was manufactured specifically for the Test Project.
- Individual data storage and data transfer devices are prohibited. Only the provided data-storage-devices will be allowed.

7.5 Sample workshop and workstation layouts

The general layout of the Workshop will be as below, with sufficient space for the workstation, toolboxes and for the Competitor's working area.

Please note that the following is an example of the layout, and is not definitive.
Approx. space for 20 Competitors = 1000m²

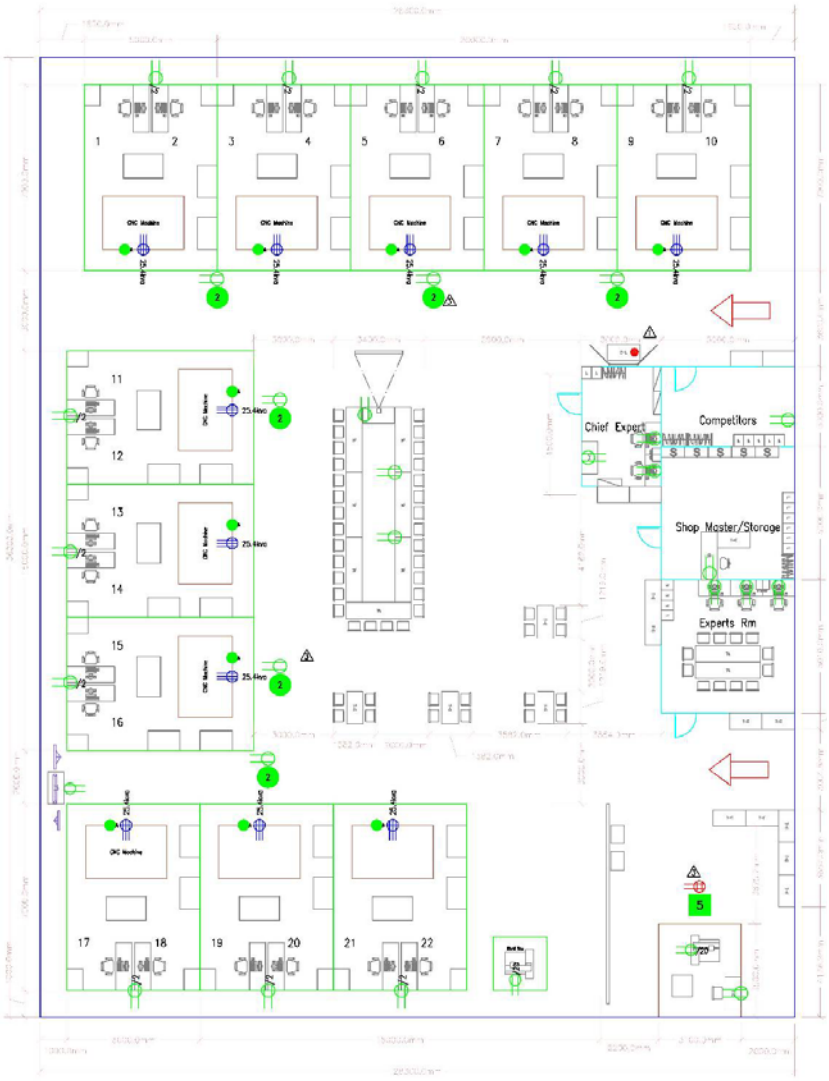
Space requirements:
For 2 competitors, 1 machine, 2 workbenches 7m x 5m = 35m²

Number of machines:
Number of competitors divided by 2 PLUS 1

Expert Room: 9m x 9m = 81m²
Space for Inspection equipment: 9m x 15m = 135m²
Walking and working space between machines: Approx. 15m² per Competitor workstation
Add in some space for columns as well as Competitors toolboxes.
Based on 20 Competitors, 20 Experts, Workshop Supervisors, Equipment Technicians and some Translators, the space would be approx. 1000 m² for the Competition.

Workshop layouts from Calgary are available at:
http://www.worldskills.org/index.php?option=com_halls&Itemid=540

Workshop layout from previous Competition:



8. MARKETING THE SKILL TO VISITORS AND MEDIA

8.1 Maximising visitor and media engagement

The following ideas may be considered to maximise visitor and media engagement.

- The additional CNC machine could have a "phantom part" running so the audience can easily see what CNC Turning does.
- A display of industry parts where an industry professional provides explanation. The CNC machine supplier could bring sample parts which they use at trade shows. Such display parts are easily recognized and draw much attention.

8.2 Sustainability

- Recycling
- Use of 'green' materials
- Use of completed Test Projects after Competition