MANUFACTURING AND ENGINEERING TECHNOLOGY

Mechanical Engineering CAD

Technical Description

 TD05 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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Stefan Praschl
Board member – Competitions

Michael Fung
Board member – Competitions

1 Introduction

1.1 Name and description of the skill competition

1.1.1 The name of the skill competition is

Mechanical Engineering CAD

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

Mechanical engineering computer aided design (CAD) is the use of computer systems to assist in the creation, modification, analysis, or optimization of an engineering design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communication through documentation, and create a database for manufacturing. CAD output is often in the form of electronic files for print, manufacturing documentation, or other manufacturing processes.

The technical and engineering drawings and images must convey information such as materials, processes, dimensions and tolerances according to application-specific conventions. CAD may be used to design curves and figures in two-dimensional (2D) space or curves, surfaces and solids in three-dimensional (3D) space. CAD is also used to produce computer animation for the special effects used in, for example, advertising and technical manuals.

CAD is an important industrial art and is the way projects come true. It is extensively used in many applications, including automotive, ship building and aerospace industries, and in industrial design. The CAD process and outputs are essential to successful solutions for engineering and manufacturing problems.

CAD software helps us explore ideas, visualize concepts through photorealistic renderings and movies, and simulates how a design project will perform in the real world.

1.1.3 Number of Competitors per team

Mechanical Engineering CAD 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**	**10**

The individual needs to know and understand:

- The various purposes and uses for CAD designs
- Current internationally recognized standards (ISO)
- Standards currently used and recognized by industry
- Health and safety legislation and best practice including specific safety precautions when using a visual display unit (VDU) and in a work station environment
- Relevant theory and applications of mathematics, physics, and geometry
- Technical terminology and symbols
- Recognized IT systems and related professional design software
- The importance of accurate and clear presentation of designs to potential users
- The importance of effective communications and inter-personal skills between co-workers, clients and other related professionals
- The importance of maintaining knowledge and skill in new and developing technologies
- The role of providing innovative and creative solutions to technical and design problems and challenges

Section		Relative importance (%)
	The individual shall be able to: • Apply consistently the internationally recognized standards (ISO) and standards currently used and recognized by industry • Apply and promote health and safety legislation and best practice in the workplace • Apply a thorough knowledge and understanding of mathematics, physics and geometry to CAD projects • Access and recognize standard component and symbol libraries • Use and interpret technical terminology and symbols used in preparing and presenting CAD drawings • Use recognized IT systems and related professional design software to consistently produce high quality designs and interpretations • Deal with systems problems such as error messages received, peripherals which do not respond as expected, and faults with equipment or connecting leads • Produce work that consistently meets high standards of accuracy and clarity in the design and presentation of designs to potential users • Effectively communicate and use interpersonal skills with co-workers, clients, and other related professionals to ensure that the CAD process meets requirements • Describe to clients and other professionals the role and purposes for CAD designs • Explain complex technical images to experts and non-experts, highlighting key elements • Maintain proactive continuous professional development in order to maintain current knowledge and skill in new and developing technologies and practices • Provide and apply innovative and creative solutions to technical and design problems and challenges • Visualize desired products in order to fulfil clients' briefsaccurately	
2	**Materials, software, and hardware**	5
	The individual needs to know and understand: • Computer operating systems to be able to use and manage computer files and software correctly • Peripheral devices used in the CAD process • Specific specialist technical operations within design software • The range, types and uses of specialist product available to support and facilitate the CAD process • The production process for designs • The limitations of design software • Formats and resolutions • The use of plotters, printers, 3D printers and 3D scanners.	

Section		Relative importance (%)
	The individual shall be able to: • Power up the equipment and activate the appropriate modelling software • Set up and check peripheral devices such as keyboard, mouse, 3D mouse, plotter, and printer • Use computer operating systems and specialist software to create and manage and store files proficiently • Select correct drawing packages from an on-screen menu or graphical equivalent • Use various techniques for accessing and using CAD software such as a mouse, menu, or tool bar • Configure the parameters of the software • Plan production processes effectively to produce efficient work processes • Use plotters and printers to print and plot work	
3	**3D modelling**	**30**
	The individual needs to know and understand: • Programmes in order to configure the parameters of the software • Computer operating systems in order to use and manage computer files and software • Mechanical systems and their functionality • Principles of technical drawing • How a component is assembled	
	The individual shall be able to: • Model components, optimizing the constructive solid geometry • Create families of components • Ascribe characteristics to the materials (density) • Ascribe colours and textures to the components • Produce assemblies from 3D models of components • Structure assemblies (sub-assemblies) • Review base information to plan work effectively • Access information from data files • Model and assemble base components of project pieces • Estimate approximate values for any missing dimensions • Assemble modelled parts into sub-assemblies as required • Apply graphics decals such as logos as required onto images • Save work for future access	
4	**Create photo rendered images (2D) and creation of animations**	**10**
	The individual needs to know and understand: • The use of lighting, scenes and decals to produce photo rendered images • How to demonstrate the working of an image	

Section		Relative importance (%)
	The individual shall be able to: • Save and label images to access for further use • Interpret source information and accurately apply to the computer-generated images • Apply material properties using information supplied from source drawings • Create photo rendered images of components or assemblies • Adjust colours, shading, backgrounds and camera angles to highlight key images • Use camera settings to show better angles of the project • Print completed images for presentation purposes • Create functions relative to the operation of the system being designed, using industry programmes • Create animations that demonstrate how different parts work are assembled	
5	**Reverse engineering of physical models**	**15**

	The individual needs to know and understand:
	• Materials and processes for obtaining unprocessed work pieces:
	  • Castings
	  • Welding
	  • Machining
	  • Simulation
	• The process to transfer real objects to 3D images/3D models and then to technical drawings	

	The individual shall be able to: • Determine dimensions on physical parts by using industry accepted instruments • Create freehand sketches • Use measuring instruments to produce accurate replicas • Perform 3D Scans of models	
6	**Technical drawing and measuring**	**30**
	The individual needs to know and understand: • Working drawings in ISO standard together with any written instructions • Standards for conventional dimensioning and tolerancing and geometric dimensioning and tolerancing appropriate to the ISO standard • Rules of technical drawing and the prevailing latest ISO standard to govern these rules • The use of manuals, tables, list of standards, and product catalogues	

Section	Relative importance (%)
The individual shall be able to: • Generate working drawings in ISO standard together with any written instructions • Apply standards for conventional dimensioning and tolerancing and geometric dimensioning and tolerancing appropriate to the ISO standard • Apply the rules of technical drawing and the prevailing latest ISO standard to govern these rules • Use manuals, tables, lists of standards, and product catalogues • Insert written information such as explanation balloons and parts lists with more than one column using annotation styles that meet ISO standards • Create 2D detail technical drawings • Create exploded isometric views	
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
		A	B	C	D	E	F	G	H			
STANDARDS SPECIFICATION SECTION	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.

This skill competition is classed as "fault finding" on all days, therefore no Expert and Competitor communication during the competition time including breaks and lunch period is allowed.

Module 1 – Mechanical Design Challenge

- Fulfilment of the Design Brief (part judgement);
- Physical Simulation (part judgement);
- Exploded view (simulation) (part judgement);
- Photo rendering (part judgement);
- 3D Printing (part judgement).

Module 2 – Mechanical Fabrication

- Sheet Metal Parts and Assemblies;
- Frame Parts and Assemblies;
- Fabrication Drawing Details;
- Drawing Views and Presentation (part judgement).

Module 3 – Mechanical Assemblies and Detail Drawing for Manufacture

- Part Modelling;
- Assembly Modelling;
- Dimensioning including GDT;
- Drawing Views and Presentation (part judgement);

Module 4 – Reverse Engineering from a Physical Model

- Presence of part features;
- Accuracy of dimensions;
- Tolerances;
- Surface Texture;
- Presentation (judgement).
- 3D Scanning

4.10 Skill assessment procedures

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

The Chief Expert will divide the Experts into four (4) groups. They will make sure to have Experts with WorldSkills experience and first Competition Experts in the same group.

Each group is responsible to mark every aspect in one of the four Test Project modules.

Each marking team will mark all the aspects in the day that their group is responsible.

If possible, at the end of each day, digital marking is done, and the marks are entered into the CIS. The rest of the marking is processed the following day, except day four.

There are no special processes to be followed during marking.

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 four (4) standalone modules.

Skills that could be tested in the different modules could cover:

- Sheet metal parts;
- Frame structures and assemblies;
- Welded parts and assemblies;
- Mechanical parts and assemblies;
- Tubes, pipes, and wires;
- Detail drawing;
- Functional animation and photo rendering;
- Reverse engineering from a physical model;
- Modification of a product to fulfil and design brief;
- 3D printing
- 3D scanning

A combination of the above skills is allowed in each module, but different standards must be tested in each module.

5.3 Test Project design requirements

The Competition is divided into four (4) modules covering the following categories:

Day 1 – Module 1: Mechanical Design Challenge (6 hr)

Data:

- Assemblies (3D models);
- Layout (assemblies and components);
- Technical specifications for the design change to be applied;
- Design brief;
- All necessary additional information.

Work requested:

- Produce functional assembly(s) from given data;
- Implement the design change;
- Autodesk Inventor Design Accelerator may be used to generate parts and assemblies;
- Produce assembly drawing(s) of design change;
- Produce exploded views;
- Produce physical simulations using Autodesk Inventor Studio;
- Produce photo rendered images using Autodesk Inventor Studio.

Results expected:

- Modified files (components and assemblies);
- Assembly drawing of design change;
- One Animation showing full exploded and/or collapsing view sequence and physical simulation of design change in file format .avi, or other formats by request;
- Photo Rendered images of design change up to a maximum of A3 size;
- Nomenclature;
- 3D printed parts as solution.

Day 2 - Module 2: Mechanical Fabrication (6 hr)

Data:

- Finished drawings of components;
- 3D models of components or assemblies;
- Nomenclature;
- All necessary additional information.

Work requested:

- To produce sheet metal parts and assemblies;
- To produce metal frame parts and assemblies using Autodesk Inventor Frame Generator;
- To add welded connections to parts and assemblies;
- To add bolted connections to parts and assemblies;
- To produce sheet metal and welding detail drawings.
- One animation showing full exploded or collapsing view sequence in file format .avi or other formats by request;
- To produce tubes, pipes, cabling, and wires.

Results expected:

- Part and Assembly file(s);
- Assembly drawing(s);
- Detail drawings for manufacture;
- Nomenclature.

Day 3 – Module 3: Mechanical assemblies and detail drawing for manufacture (6 hr)

Data:

- Finished drawings of components or assemblies;
- 3D models of components or assemblies;
- Nomenclature;
- All necessary additional information.

Work requested:

- To produce models of components from detail drawings;
- To produce an assembly;
- To produce detail drawing(s) for manufacture;
- To input components from Inventor Content Centre.

Results expected:

- Part and Assembly file(s);
- Assembly drawing(s);
- Detail drawings for manufacture;
- Nomenclature;
- Exploded view(s).
- One animation showing physical simulation in file format .avi or other format as requested;

Day 4 – Module 4: Reverse Engineering from a Physical Model (4 hr)

Data:

- Physical component(s) and assembly(ies);
- File of parts and assemblies;
- All the necessary additional information.

Work requested:

- Making files and layout from dimensions taken from a physical component;
- The scaled drawing is produced using measuring instruments in Appendix one Tool List;
- The use of systems enabling the memorization of scaled drawings or shapes is prohibited (Photographs, malleable putty, ink pad, etc.);
- The Competitor may produce sketches on paper which will serve as the basis for producing the 3D modelling of the components or assemblies;
- The physical component(s) is given to the Competitors for two hours and then confiscated. The Competitor will then continue his task on the basis of the sketches and information collected previously.
- The use of the computer is allowed during all the competition time.

Results expected:

- 3D models of components or assemblies;
- 3D Annotation;
- Manufacturing drawing(s) of components or assemblies.

Results expected:

- Detail drawings for manufacture;
- Volume specifications
- Rendered images.

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
Six (6) months prior to the Competition	The Test Project/modules are developed.
No later than one (1) month prior to the Competition	The Test Project must be submitted to the WorldSkills International Skills Competitions Administration Manager.
At the Competition from C-4 to C1	Four Expert groups are responsible to validate one of the four modules according to section 5.6.
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 will ensure that the Test Project/modules can be completed within the material, equipment, knowledge, and time constraints of Competitors.

At the Competition all Experts are divided into four (4) groups. Each group is given the task to validate one (1) of the four (4) modules of the Test Project. The group is required to:

- Verify that all documents are present;
- Verify that Test Project is within the design criteria;
- Ensure that the Test Project can be completed within the time frame;
- Ensure that proposed marking aspects are adequate;
- Verify that there are two versions of drawings, first angle, and third angle projection method;
- Verify that there's a Marking Scheme;
- If, after examination, the selected Test Project is found incomplete or unfeasible, it shall be modified the Independent Test Project Designer based on the Expert teams' feedback.

If the Test Project is developed by the Skill Competition Manager, the validation of the Test Project by the Experts could be dismissed and all Experts will have knowledge of the Test Project during the brief 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.

The presence of the Independent Test Project Designer is mandatory during all pre-competition and the Competition period.

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 Experts on C-4 and to Competitors every morning of each Competition day.

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.

All necessary changes are made by the Independent Test Project Designer based on the Expert teams' feedback.

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.

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
Marking	• For volumes marking, always check on the digital part file. • A checklist is used and signed by the Competitor to verify the requested work. • 2D Drawing printed files must comply with professional use. Mark penalty can be applied according to the Marking Scheme (part Judgement). e.g. – over dimensioning, overlapping dimensions, unnecessary views, incorrect symbols, and abbreviations, incomplete title block, etc.

7 Skill-specific safety requirements

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

Task	Sturdy shoes with closed toe and heel
General PPE for safe areas	√

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 the total external volume not exceeding 0.32 m³.

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

Volume measurement does not include a packing crate, other protective packing material, palette for transportation, wheels, etc.

8.3 Materials, equipment, and tools supplied by Competitors

Competitors may bring the following to the Competition:

- Compendium of standards;
- Technical manuals;
- Instruments for freehand sketching (plastic tools such as rulers, set square, angle protractor, etc.);
- Measuring instruments
- Personal keyboard and mouse (including drivers), if different than the ones supplied by Competition Organizer;
- "Space Mouse" (3D Mouse) is allowed. Different electronic equipment must be presented to the Expert team for validation, see section 8.5.

Following items are allowed to be carried in the toolbox:

Description	Quantity	Photo
Internal Metric Thread Pitch Gauge • 4 sizes – M6, M8, M10, and M12 • Use of screws/thread plugs is allowed		
Surface comparator gauges (Ra)		

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 not required to bring materials, equipment, or tools. All is supplied by the Competition Organizer.

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

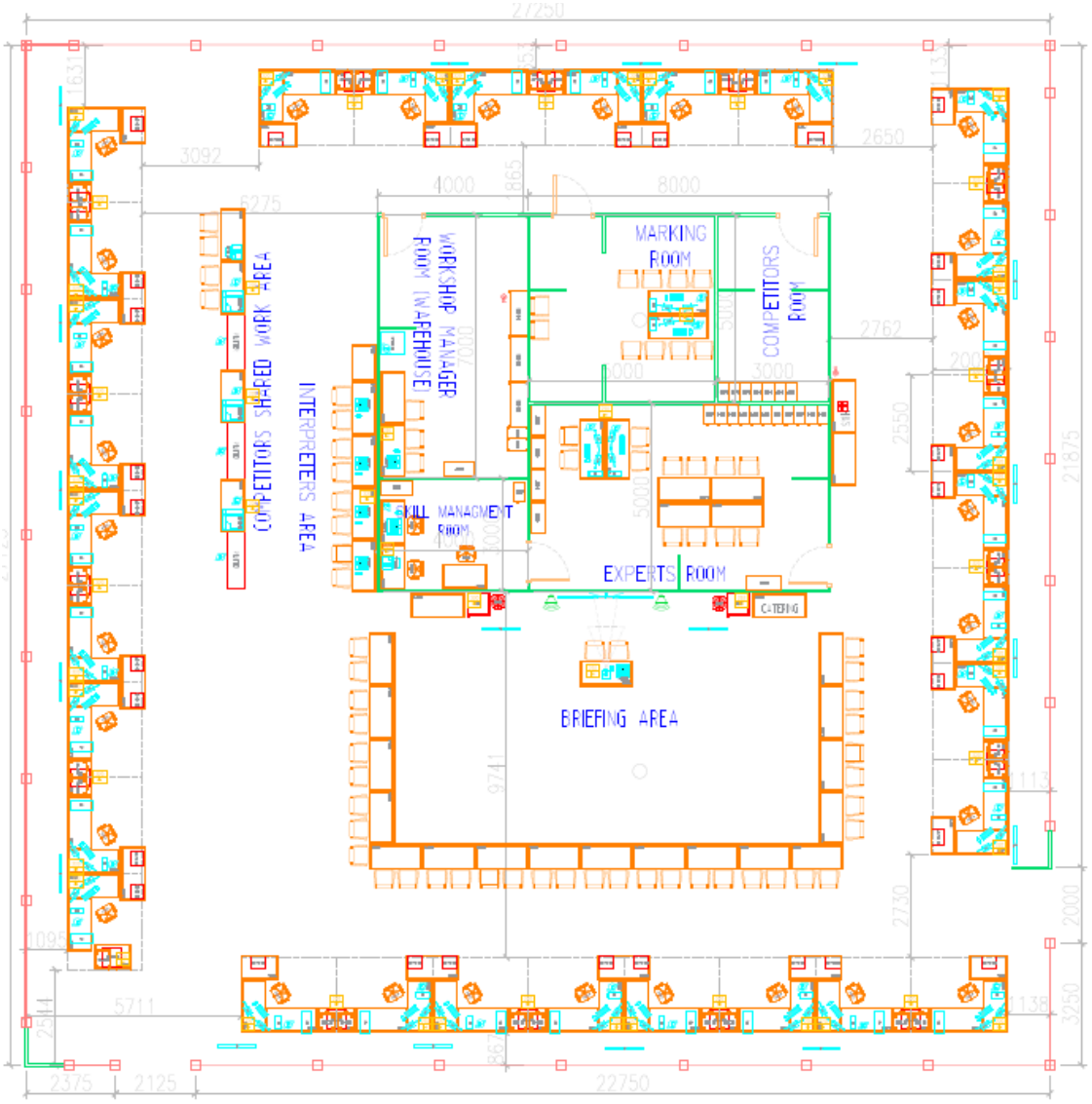
8.5 Materials and equipment prohibited in the skill area

All materials and equipment brought by Competitors have to be presented to the Experts. The Experts shall rule out any items brought to the Competition that are not considered normal Engineering Drawing and CAD related tools and equipment, that will give any Competitor an unfair advantage.

8.6 Proposed workshop and workstation layouts

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

Example workshop layout



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 – USB, memory sticks	• No external memory devices are to be connected to the competition computer unless under the supervision of the Chief Expert and Deputy Chief Expert. • Competitors are not allowed to load any digital data to their competition computers. If needed, it must be approved first by the Chief Expert. The Chief Expert will nominate an Expert or group of Experts to execute the necessary installations. • Skill Competition Manager, Chief Expert, Deputy Chief Expert, Experts, Competitors, and Interpreters are not allowed to bring and use personal memory sticks into the workshop.
Use of technology – personal laptops, tablets and mobile phones	• From C-4 to C1 Chief Expert, Deputy Chief Expert, Experts and Interpreters are allowed to use personal laptops, tablets, and mobile phones in the Expert room only. Exceptions are possible with the Skill Competition Manager approval. • The Skill Competition Manager is allowed to use his laptop, tablet and mobile phone at all times. • Competitors are not allowed to bring personal laptops, mobile phones, and tablets into the workshop. If these items are brought into the workshop, then they must be locked in the personal locker and only removed at the end of day. • Wireless headphones and smartwatches are not allowed for the Competitors. If these items are brought into the workshop, then they must be locked in the personal locker and only removed at the end of day.
Use of technology – personal photo and video taking devices	• The use of personal photo and video taking devices is forbidden in the workshop until the last break on each competition day.
Communication and contact between compatriot Expert and Competitor	• No communication during breaks or lunch time between Expert, Interpreter and Competitor from C1 to C4. • Competitor and compatriot Expert/Interpreter cannot be outside the competition area at same time unless is approved by the Chief Expert.

10 Visitor and media engagement

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

- Try-a-Skill;
- Display screens;
- Test Project descriptions;
- Enhanced understanding of Competitor activity;
- Competitor profiles;
- Career opportunities;
- Daily reporting of competition status;
- 3D Printing;
- 3D Scanning;
- Sponsors booth.

11 Sustainability

This skill competition will focus on the sustainable practices below:

- Recycling;
- Use of "green" materials;
- Use of completed Test Projects after Competition;
- Use of digital information instead of 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/)
- ESCO: (https://ec.europa.eu/esco/portal/home)
- O*NET OnLine (www.**onet**online.org/)

This WSOS (Section 2) appears to relate most closely to *Computer-Aided Manufacturing Operator*: http://data.europa.eu/esco/occupation/62979364-6fac-41f2-87ca-202bca19a6ab

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
Lockheed Martin Corporation (Canada)	Vince DiPietro, Repair Engineering Manager, Aeronautics

13 Appendix

13.1 Measuring tool list provided by the Competition Organizer for each Competitor

Description	Photo
Digital Calliper (0-200mm)	
Digital Offset Centreline Calliper (10-160 mm)	
Universal Protractor	
Radius Gauges (0.4 mm to 25.0 mm)	
External Metric Thread Pitch Gauge (0.35 mm to 6.0 mm)	
Metallic Ruler (300 mm)	
Digital Depth Gauge Calliper (0-150 mm)	

13.2 CAD software (Autodesk Inventor) base functionality list

After installation of the following file, all listed functionalities are linked to their own explanation.
Local installation file:

http://download.autodesk.com/us/support/files/inventor_2016_help/Autodesk_Inventor_2016_Help.exe

Online support:
http://help.autodesk.com/view/INVNTOR/2016/ENU/

- Fundamentals
  - File types;
  - Parts;
  - Features;
  - Assemblies;
  - Drawings;
  - Publish Designs;
  - Manage Data;
  - Print Designs;
  - Styles and Style Libraries
- Work Environment
  - Application Options settings;
  - Configure Default Templates;
  - Document Settings;
  - Measurement units;
  - Projects;
  - Command Alias input and behaviour;
  - Autodesk Exchange App Manager;
  - Custom command aliases;
  - Custom shortcut keys;
  - Customize info tips in Inventor
- Parts
  - 2D sketches;
  - 3D sketches;
  - Dimensions;
  - Constraints;
  - Work geometry and work features;
  - Part modelling overview;
  - Part features;
  - Plastic Features;
  - I-Features and iParts;
  - Part faces and bodies;
  - Solid modelling;
  - Representations;
  - Part Analysis;
  - Repair Environment;
  - Construction Environment;
  - Sheet metal parts
- Assemblies
  - Build assemblies;
  - Bills of materials:
    - Bills of materials overview;
    - Manage item numbers in bills of materials;
    - Structure of bills of materials;
    - Bill of Materials Editor;
    - Parts lists and BOMs in iAssemblies
- Representations
- Functional design

- Design Accelerator
  - Bolted Connection;
  - Shaft;
  - Involute Splines;
  - Parallel Splines;
  - Key Connection;
  - Disc Cam;
  - Linear Cam;
  - Spur Gears;
  - Bevel Gears;
  - Worm Gears;
  - Bearing;
  - V-Belts;
  - Synchronous Belts;
  - Roller Chains;
  - Clevis Pin;
  - Joint Pin;
  - Secure Pin;
  - Cross Pin;
  - Radial Pin;
  - O-ring
- Component Generators
  - Bolted Connection Component Generator;
  - Shaft Component Generator;
  - Parallel Splines Component Generator;
  - Involute Splines Component Generator;
  - Parallel Key Connection Generator;
  - Cam Component Generators;
  - Spur Gears Component Generator;
  - Bevel Gears Component Generator;
  - Worm Gears Component Generator;
  - Bearing Component Generator;
  - Plain Bearing Calculator;
  - Compression Spring Component Generator;
  - Extension Spring Component Generator;
  - Torsion Spring Component Generator;
  - Belleville Spring Component Generator;
  - V-Belts Component Generator;
  - Synchronous Belts Component Generator;
  - Roller Chains Generator;
  - Clevis Pin Component Generator;
  - Pin Component Generators;
  - O-Ring Component Generator
- Calculators;

- Content Centre:
  - Configuration of Content Centre libraries;
  - Manage libraries on the server;
  - Migrate or synchronize user libraries;
  - Navigate in Content Centre;
  - Search in Content Centre;
  - Content Centre Consumer;
  - Auto Drop;
  - Refresh Standard Components;
  - Content Centre Editor;
  - Publish parts and features in Content Centre
- Build structural frames with Frame Generator
  - Frame Generator;
  - Apply or Modify End Treatments;
  - BOMs and Cut Lists;
  - Structural Shape Authoring;
  - Tips for generating frames;
  - Frame Generator browser
- Weldments;
- Weldments environment
  - Templates for weldments;
  - Strategies for designing weldments;
  - Weld bead feature types;
  - Weld feature groups;
  - Welding symbols on models
- Drawings
  - Create drawing views
    - Develop drawings for large assemblies;
    - Design view representations in drawing files;
    - Drawing views;
    - Alignment, orientation, and rotation of drawing views;
    - Sketches in drawings;
    - Project geometry to drawing sketches;
    - Section views;
    - Detail Views;
    - Overlay Views;
    - Break Operations;
    - Crop Operations;
    - Slice Operations;
    - Create drawing views of surfaces;
- Drawing annotations
  - Suppressed annotations;
  - Dimensions in drawings;
  - Centre lines and centre marks;
  - Symbols, sketched symbols, and blocks;
  - Tables;
  - Hole notes;
  - Hole tables;
  - Balloons;

- Parts lists;
- Text in drawings;
- Text in drawing sketches;
- Weld annotations in drawings;
- Revision tables and revision tags;
- Sheet metal annotations in drawings;

- Exploded views and presentations
- Visualization
  - Render and animate with Inventor Studio
    - Studio browser;
    - Styles for rendering;
    - Rendering Images;
    - Animating in Studio