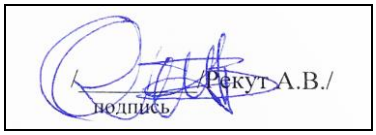
Approved by

A.V. Rekut



TECHNICAL DESCRIPTION
Reverse Engineering

WorldSkills Russia "Young Professionals" Union (hereinafter referred to as WSR) in accordance with the charter of the organization and rules of the competition has

established the following minimum professional skill command requirements for participation in the skill competitions.

The Technical Description includes the following sections:

1. INTRODUCTION

1.1. PROFESSIONAL SKILL NAME AND DESCRIPTION

1.1.1 Professional skill name:

Reverse Engineering

1.1.2 Professional skill description.

The area of activity of specialists in reverse engineering is the establishment of industrial projects on the basis of existing products, with a goal to analyze, improve, repair, or copy.

Reverse Engineering uses state-of-art computer technologies of 3D scanning (optical, laser, ultrasonic, contact and magnetic resonance) and computer simulation and research of materials.

Reverse Engineering is required when:
- new production needs to be started,
- any scientific research and design works are conducted,
- unique equipment is being repaired or in case of restoration,
- lost technical documentation is being re-created.

Reverse Engineering specialists are sought for in different spheres ranging from commercial production and R&D to mechanical restoration of rare equipment, museum items and architectural objects of cultural heritage.

The objective of WS Competition Competitors is to create a design suitable for further production based on defective parts. Competition Competitors use proximity 3D digitization systems (3D scanners), specialized software and computer aided design (CAD) systems.

1.2. RELEVANCE AND SIGNIFICANCE OF THIS DOCUMENT

This document contains information about the standards required to compete in the skill competition, the assessment principles, methods, and procedures that govern the competition. WSR hereby acknowledges the WorldSkills International (WSI) copyright. Furthermore, WSR acknowledges WSI intellectual property rights regarding scoring principles, methods, and procedures.

Each Expert and Competitor shall be familiar with and understand this Technical Description.

1.3. ASSOCIATED DOCUMENTS

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

- WSR, Competition Standing Orders
- WSR, online resources specified in this document;
- WSR, policy and statutory regulations;
- Skill-specific OHSE Instruction.

2. WORLDSKILLS STANDARDS SPECIFICATION (WSSS)

2.1. GENERAL INFORMATION ON WORLDSKILLS STANDARDS SPECIFICATION (WSSS)

The WSSS 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.

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

In skill competitions, knowledge and understanding will be checked through assessment of the performance of practical work. There will be no separate theoretical tests of knowledge and understanding.

The WSSS is divided into clearly-defined sections with numbers and headings.

Each section is assigned a percentage of the total marks to indicate its relative importance within the WSSS. The sum of all the percentage marks is 100.

The Marking Scheme and the Test Project will assess only those skills that are set out in the WSSS. They will reflect the WSSS as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme and the Test Project will reflect the allocation of marks within the WSSS to the maximum possible extent. A variation of 5% is allowed, provided that this does not distort the weightings assigned by the WSSS.

Section		Importance (%)
1	**Work organization and management**	**10**
	A specialist shall know and understand: Purpose and sphere of application of Reverse Engineering Importance of and the need in technical specifications for performance of works Existing international standards (ISO) and standards currently used in industry Technical terminology and designations of relevant spheres Theoretical and applied sections of mathematics, geometry and physics related to the skill Universally accepted computing systems and special professional software for Reverse Engineering and CAD Importance of accurate and clear understanding of project by a potential user Importance of effective information exchange in a professional community between employees, customers and other specialists involved in production process Importance of ensuring high level of awareness of new and evolving technologies The role of applying innovative and creative solutions to technical and design problems and challenges Health and safety legislation and best practice including specific safety precautions when using a visual display unit (VDU) and in a work station environment and proximity digitization devices	
	A specialist shall be able to: Consistently use existing international standards (ISO) and standards currently used in industry Apply and promote health and safety legislation and best practice in the workplace Use the Reverse Engineering knowledge in the sphere of applied mathematics, physics and geometry Use terminology and special designations corresponding to the subject area Use universally accepted computing systems and special professional software for Reverse Engineering and CAD Handle the system problems, such as: false messages, absence of expected response from periphery devices, availability of evident defects in equipment or connecting wires	

	Perform the work that fully corresponds to technical specifications and standard requirements Ensure efficient communications between specialists involved in the project and customer that would guarantee compliance of Reverse Engineering with requirements of specifications and standards Explain the role and practical applications of Reverse Engineering to customers and other professionals Explain complex technical issues of Reverse Engineering to experts and non-experts, highlighting key elements Maintain continuous professional development to ensure compliance of knowledges and skills with new and evolving Reverse Engineering technologies and practices Clarify the specifications to ensure maximum accuracy of compliance with client's requirements	
2	**3D digitization**	**25**
	A specialist shall know and understand: 3D digitization equipment operation principles; Strong and weak points of different types of equipment for 3D digitization and underlying processes; Technical specifications of 3D optical digitization equipment, i.e. accuracy and speed, and requirements for work environment ensuring required accuracy (constant temperature, absence of dust, vibrations, stray light, draughts, stability of digitization object, etc.) Significance of calibration equipment and requirements for calibration process Required characteristics of object surface for 3D digitization (looseness, smoothness, transparency, translucency, reflecting capacity, etc.) Ways and methods for preparation of surfaces for 3D digitization (washing, degreasing, matting, etc.) • Types of rejected works during optical 3D digitization and methods for their elimination	
	A specialist shall be able to: Adjust and calibrate the equipment; Use PPE; Make a decision on possibility of 3D digitization and compliance of its results with specifications (possible/impossible for implementation, what accuracy can be secured for a certain object and available digitization conditions);	

	Make decisions regarding the need for and content of preliminary works (dismantling, washing, painting, etc.) Perform preliminary works to apply matting coatings; Apply matting coatings; Apply optical tags; Secure the object for digitization; Perform 3D digitization for different objects (different materials, surface characteristics and complexity of geometry) • Obtain the models resulting from optical 3D digitization suitable for further Reverse Engineering	
3	**3D digitization data processing and analysis**	**15**
	A specialist shall know and understand: Software for 3D digitization data processing (e.g. GOM Inspect etc.) Methods of work with 3D digitization data • Requirements for polygon models obtained as a result of 3D digitization and intended for further Reverse Engineering	
	• A specialist shall be able to: • • Process clouds of points in specialized software • Create polygon models with optimum polygonization based on point clouds with all information required for Reverse Engineering available • Straighten the polygon model obtained as a result of 3D digitization in a certain coordinate system • Compare the polygon model obtained based on 3D digitization with CAD model, define the deviations and dimensions on polygon model, create reports.	
4	**Hand tool measurements**	**5**
	A specialist shall know and understand: Types and functions of hand measurement tools Measurement methods using hand measurement tools • Level of achievable measurement accuracy using hand measurement tools	
	A specialist shall be able to: • Select a measurement tool corresponding to the task • Use hand measurement tools	

	• Make a decision regarding supporting of blind zone data of 3D digitization with the data taken with hand measurement tools and make corresponding measurements • Use the tools correctly • • Transfer the dimensions measured by hand tools to CAD	
5	**Reverse Engineering**	**45**
	A specialist shall know and understand: Conversion software 3D SCAN-TO-CAD (e.g., PowerShape, GeoMagic Dezign X) CAD software (e.g., Inventor, SolidWorks, ProE) Requirements for polygon models for possible extraction/plotting of elementary items from/based on these models for the purpose of Reverse Engineering The methods for extraction of elementary items from polygon models for the purpose of Reverse Engineering Mechanical systems and their operation principles Basics of plotting technical sketches and drawings Basics of component assembly Methods for comparison of CAD model and polygon models obtained as a result of 3D digitization Requirements for CAD models intended for CNC processing • Properties of materials applied in mechanical engineering	
	A specialist shall be able to: Create editable CAD models based on digitization data (polygon models); Replenish missing data on individual elements of the facility being designed based on the object data available in polygon model (e.g. only 1 tooth remaining on pinion, or 1 turn on a work, or only 1/3 of flange is available) Restore missing data on individual elements of designed facility based on the data taken from companion parts Restore missing data on individual elements of designed facility based on the data taken by hand tools from an available objects (e.g. definition of the depth of blind hole with depth gage or diameter with inside caliper) Introduce changes to computer models according to specifications Analyze deviation of designed facility from 3D digitization results Analyze and optimize model grid and surface topology according to specifications	

	Create detailed drawings in ISO standard accompanied with written instructions, if required • Apply standards for nominal dimensions and tolerances and geometric dimensions and tolerances appropriate to the ISO standard	
	Total	**100**

3. ASSESSMENT STRATEGY AND TECHNICAL FEATURES OF ASSESSMENT

3.1. MAIN REQUIREMENTS

The Strategy establishes the principles and techniques to which WSR assessment and marking must conform.

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

Assessment at WSR competitions falls into two broad types: measurements and judgment. 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 WSSS. The Test Project is the assessment vehicle for the skill competition and should also follow the WSSS. The CIS enables marks to be recorded in a timely and accurate manner, which contributes to the proper organization of the competition.

The Marking Scheme, on the whole, is a critical factor for the Test Project development process. During further development, the Marking Scheme and the Test Project will be designed and developed through an iterative process to ensure their joint optimization within the framework of the WSSS and the Assessment Strategy. They will be submitted to the Skill Competition Manager for approval together to demonstrate their quality and conformity with the WSSS.

4. MARKING SCHEME

4.1. GENERAL GUIDANCE

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

The Marking Scheme is the main tool of WSI competitions and determines the compliance of the Test Project assessment with the WSSS. It is designed to allocate marks for each assessed aspect of performance, which refers to just one WSSS module.

By reflecting the weightings specified in the WSSS, the Marking Scheme sets out the Test Project development parameters. Depending on the nature of the skill and its assessment requirements, it can be helpful to develop the Marking Scheme in detail early on so that it can be used as a guide for development of the Test Project. Otherwise, the Test Project shall be developed based on the generalized Marking Scheme. Further development of the Test Project is accompanied by the development of assessment criteria.

Section 2.1 specifies the maximum acceptable variation percentage and the Test Project Marking Schemes based on the weightings provided in the Standards Specification.

The Marking Scheme and the Test Project may be developed by one person, or a group of experts, or a third-party developer. The detailed and final Marking Scheme and Test Project shall be approved by the Skill Competition Manager.

Furthermore, all experts are encouraged to submit their proposals for the development of Marking Schemes and Test Projects to the Discussion Forum for further review by the Skill Competition Manager.

In all cases, a complete Marking Scheme approved by the Skill Competition Manager shall be entered into the CIS at least two days prior to the competition, with the use of a standard CIS spreadsheet or other agreed-upon methods. The Chief Expert is responsible for this process.

4.2. ASSESSMENT CRITERIA

The main headings of the Marking Scheme are the assessment criteria. In some skill competitions, the assessment criteria may be similar to the section headings in the WSSS; in others, they may be completely different. There are usually from five to nine assessment criteria; that said, there should be at least three assessment criteria. Whether or not they match the headings, the Marking Scheme must reflect the weightings specified in the WSSS.

The Assessment Criteria are created by the person(s) developing the Scoring Scheme, who is free to define the criteria they consider most suited to the assessment of the Test Project performance.

The Mark Summary Form generated by the CIS will comprise a list of the assessment criteria.

The marks allocated to each criterion will be calculated by the CIS. This will be the cumulative sum of marks given to each aspect within that assessment criterion.

4.3. SUBCRITERIA

Each assessment criterion is divided into one or more subcriteria. Each subcriterion becomes a heading in the Marking Scheme.

Each marking form (subcriteria) specifies a certain date on which it will be filled.

Each marking form (subcriteria) contains the aspects to be assessed. Each marking method is assigned to a special marking form.

4.4. ASPECTS

Each Aspect defines in detail a single item to be assessed and marked together with the marks or instructions for how the marks are to be awarded.

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 skill in the WSSS. It will be displayed in the Mark Allocation Table of the CIS in the following format:

Criteria										Total points for the WSSS section	WSSS MARKS PER SECTION	VARIANCE
WorldSkills Standard Specification (WSSS) Sections		A	B	C	D	E	F	G	H			
	1	10								10	10	0
	2			4					1	5	5	0
	3		13							13	13	0
	4			6						6	6	0
	5		7		5	15	15			42	42	0
	6		5						9	14	14	0
	7							10		10	10	0
Total marks for criterion		10	25	10	5	15	15	10	10	100	100	0

4.5. JURY'S OPINION (JUDGMENT MARKING)

Decisions are made using a scale of 0–3. To apply the scale with rigor and consistency, judgment must be carried out using:

- Benchmarks (criteria) for detailed guidance for each aspect
- 0–3 scale, where:
    - 0: performance does not meet the industry standard,
    - 1: performance meets the industry standard,
    - 2: performance meets and in some aspects exceeds the industry standard,
    - 3: performance wholly exceeds the industry standard and is judged as excellent.

Each aspect is assessed by three experts, each expert must perform assessment, after which the allotted marks will be compared. If the expert assessments vary by more

than 1 point, they must discuss the assessment of this particular aspect and eliminate the difference.

4.6. ASSESSMENT BY MEASUREMENT

Each aspect will be assessed by three experts. Unless otherwise specified, only the maximum mark or zero points will be awarded. If within some aspect it is possible to award marks below the maximum, it shall be described in the Marking Scheme with the measurable parameters specified.

4.7. USE OF MEASUREMENT AND JUDGMENT

The final concept of measurement and judgement assessment will become available after the approval of the Marking Scheme and the Test Project. The table provided contains approximate information and is intended for the development of the Marking Scheme and the Test Project.

Criteria		Points		
		Jury's opinion	Measurable	Total
A	Reverse design of a part based on polygon model with partially distorted or incomplete data and joined elements;		28	28
B	Reverse design of a part of complex geometrical shaped based on polygon model only (possible with partially distorted or incomplete data)		32	32
C	Reverse design of a part using manual measurement data		11	11
D	Creation of assemblies, analysis of conflicts and deviations		11	11
E	Digitization of 3 parts of different materials (blocking, partially translucent and non-transparent)	3	15	18
Total		3	97	100

4.8. SKILL ASSESSMENT SPECIFICATION

The Test Project assessment will be based on the following criteria (modules):

A. Name + description + check method.

B. Name + description + check method.

C. Name + description + check method.

D. Name + description + check method.

E. Name + description + check method

4.9. ASSESSMENT STANDING ORDERS

The Chief Expert and Deputy Chief Expert shall discuss and divide the experts into groups (each group is composed of at least three people) for marking. Each group shall include at least one experienced expert. An expert shall not assess any competitor from their own organization.

4.9.1 For the purpose of unification of test project work procedure, proceed from the following provisions:

1). For assessment of compliance with criteria related to accuracy of reproduction of source item dimensions in the built mode, use specialized software (currently, GOM Inspect program is used for comparison of CAD model with source polygon model in STL format).

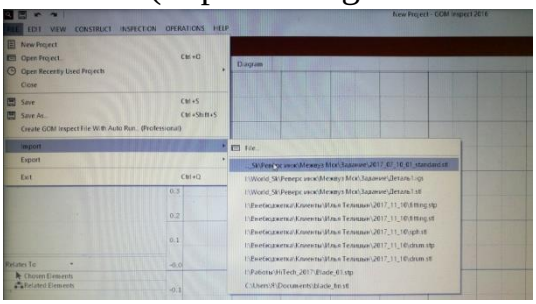
2). When source model has elements with deviation of original geometry (breaks, wear, etc.), a reference polygon model created earlier can be used for assessment, and if such model absent, the assessment can be based on compliance of CAD model dimensions with the values approved in advance for this purpose by experts.

To compare CAD model with source polygon model (STL) in GOM Inspect, proceed as follows:

1). Install this program from developer's official web-site (http://www.gom.com/3d-software/gom-inspect/download.html)

2). Prepare the files for comparison (CAD in STP format or IGS and source STL)

3). Start the program on PC.



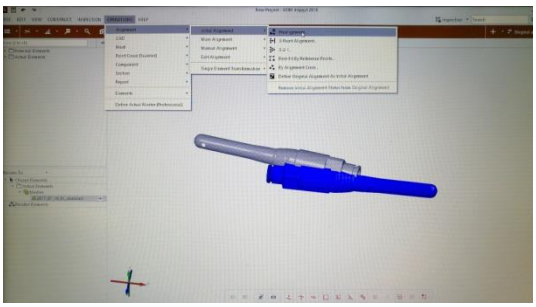
4). In "File" menu, click on "Import" line and click on the required CAD file in drop-down menu.

5). Click OK in opened top left corner. After that, CAD model shall upload and appear on screen. If this did not happen, find the cause and load the model.

6). Repeat steps 4. and 5. In "File" menu, click on "Import" line and click on the required STL file in drop-down menu.

7). Click OK in opened top left corner. After that, the source polygon model shall upload and appear on screen. If this did not happen, find the cause and load the model.

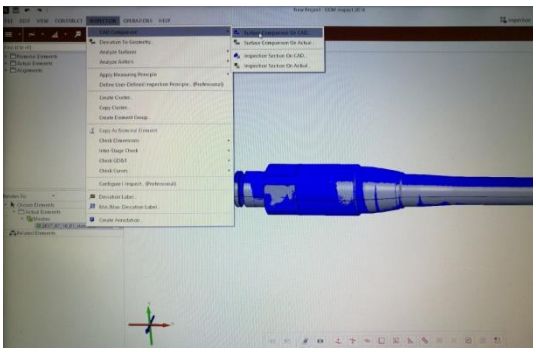
8). To align the polygon model with CAD model, click "Alignment" in "OPERATIONS" menu and click "Initial Alignment" in the opened menu and click "Prealignment" in the next menu. If the models aligned, further steps may be made. If they did not align:

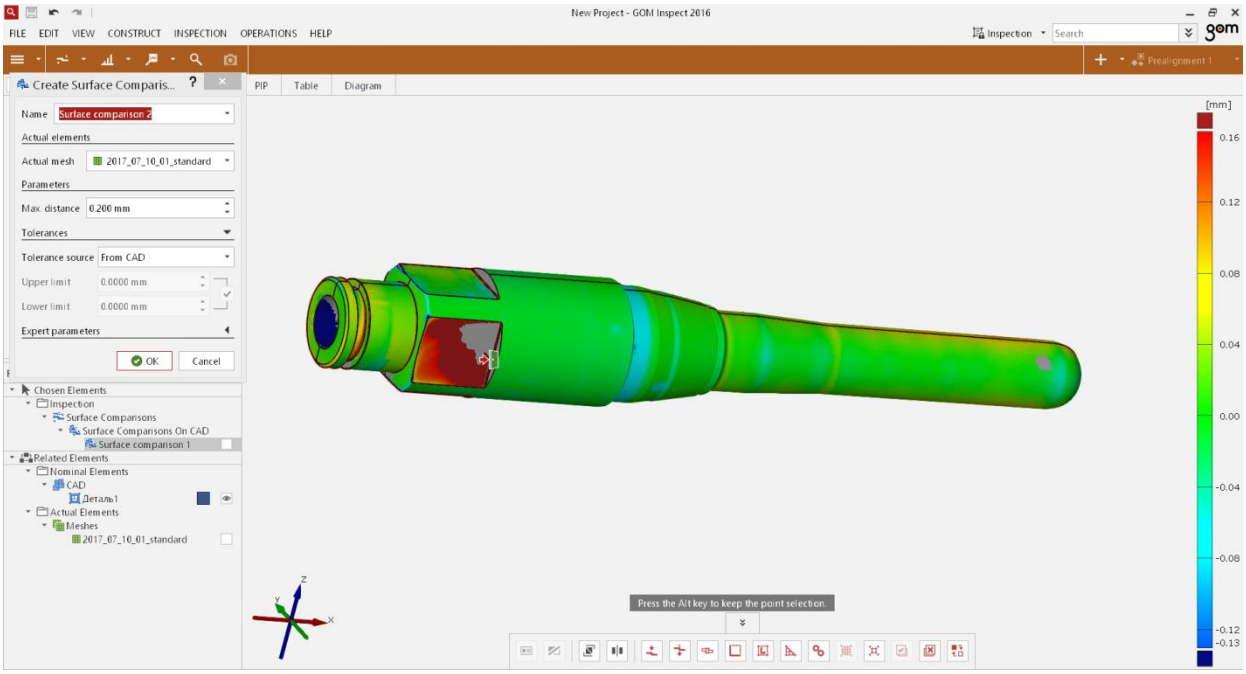


a) perform the above procedure using the polygon model aligned by competitor (he/she must have saved it) and parametric model plotted by him/her. If alignment is not achieved after this, that Competitor plotted to model completely incorrectly and it can not be further assessed;

b) there was an error in alignment and the procedure must be repeated.

9). Click "CAD Comparison", "Surface Comparison on CAD" in "INSPECTION" menu.





10). Set the required value in "Max. distance" line of the window that opened in top left corner. A color map of deviations will appear on the model and the legend of correspondence between colors and deviations – on the right scale.

11). After that, check conformity of sizes with assessment criteria and enter corresponding values into form (to turn the model in work field, hold left mouse button, and turn the mouse wheel to zoom in/out),

12. If any disputable situations appear, compare the model dimensions with the dimensions measured manually.

4.9.2. Assessment of test projects shall be based on:

Module 1 – Reverse design of a part based on polygon model (3D scan of broken part) and the elements being joined.

- 22-27 aspects defining availability and dimensions of particular elements of the part and work performance period.

Module 2 – Reverse design of a part based on polygon model only (3D scan of broken part).

- 22-27 aspects defining availability and dimensions of particular elements of the part and work performance period.

Module 3 – Reverse design of a part based on manual measurement data only;

- 6-8 aspects defining availability and dimensions of particular elements of the part and work performance period.

Module 4 – Creation of assembly and analysis

- Analyzed the deviations of designed parts from polygon models
- Created visual color maps of deviations
- Created all required assembly elements
- Correctly plotted the assembly model
- Correctly set all immovable links
- All parts ensure assembling capacity of a unit
- The parts do not cross

Module 5 – Digitization of 3 parts of different materials (blocking, partially translucent and non-transparent);

- Quality of coating applied on a glittering part;
- Quality of coating applied to a part of partially translucent material;
- Quality of coating applied to a part of non-transparent and not glittering material;
- Type of surfaces of polygon model matches the source part of glittering material (i.e. they have corresponding curvature and contain no new formations except "holes");
- Absence of surfaces duplication on polygon model of a part of glittering material;
- Absence of displacements of generatrices at different frames (shifts and turns) of a model of a part of glittering material;
- The available data allow restoration of source geometry of the part of glittering material.

- Type of surfaces of polygon model matches the source part of partially translucent material (i.e. they have corresponding curvature and contain no new formations except "holes");
- Absence of surfaces duplication on polygon model of a part of partially translucent material;
- Absence of displacements of generatrices at different frames (shifts and turns) of a model of a part of partially translucent material;
- The available data allow restoration of source geometry of the part of partially translucent material.

- Type of surfaces of polygon model matches the source part of non-transparent material (i.e. they have corresponding curvature and contain no new formations except "holes");
- Absence of surfaces duplication on polygon model of a part of non-transparent material;
- Absence of displacements of generatrices at different frames (shifts and turns);
- The available data allow restoration of source geometry of the part of non-transparent material;
- Work completion time.

4.9.3.

- Assessed parameters and distribution of assessments – upon decision of Experts made before commencement of Competition.
- To ensure openness, each competitor shall receive a list identical to those used by Experts.
- Chief Expert and Deputy Chief Expert shall distribute all Experts to groups to give scores taking into account an Expert's experience in previous Competitions, his/her cultural background and language.
- If Experts can perform measurements with a digital measurement instruments, to ensure their unbiased scoring, they need to make a corresponding decision and arrange this before Competition commencement. In this case, the measurements shall be performed by a professional assistant well familiar with this equipment.
- When a module is assessed based on subjective and objective criteria, the subjective assessment is made first (each day when the scores are given).
- Each completed module shall be assessed using a progressive scoring system.

4.9.4. Measurement for skill assessment

Objective assessment

The points are accrued on a scale from 0 to 2; depending on the equipment used, the dimension tolerance may be changed.

2 = ±0 to ±0.2

1.5 = ±0.21 to ±0.3

1= ±0.31 to ±0.4

0.5 = ±0.41 to ±0.5

0.25 = ±0.51 to ±1.0

0.1 = above ±1.0

0 = not completed

Angles

+/- 30’ = 2 points

+/- 1º = 1 point

Above 1º = 0 points

Rounding and radii

+/-0.2mm = 2 points

Above 0.2 mm = 0.75 points

Not performed = 0 points

5. TEST PROJECT

5.1. MAIN REQUIREMENTS

Sections 2, 3, and 4 govern the development of the Test Project (TP). The recommendations in this section provide additional explanation for the TP content.

The Test Project performance shall take not less than 15 and no more than 22 hours.

In order to qualify for the performance of this Test Project the competitors must be from 17 to 23 years old.

Regardless of the number of modules, the TP shall include the scoring for each of the WSSS sections.

The Test Project shall not fall outside of the WSSS.

The participant's knowledge shall be assessed and marked exclusively in the practical performance of the Test Project.

The Test Project will not assess knowledge of WSR rules and regulations.

5.2. TEST PROJECT STRUCTURE

The test project consists of the following modules:

1. Reverse design of a part based on polygon model with partially distorted or incomplete data and joined elements;
2. Reverse design of a part of complex geometrical shaped based on polygon model only (possible with partially distorted or incomplete data)
3. Reverse design of a part using manual measurement data
4. Creation of assemblies, analysis of conflicts and deviations
5. Digitization of 3 parts of different materials (blocking, partially translucent and non-transparent)

5.3. TEST PROJECT DEVELOPMENT REQUIREMENTS

General requirements:

Test Project shall represent a well known object for specialists around the world who studied or are studying mechanics and CAD engineering.

Competitors shall received polygon models, real world objects and Technical Description of Test Project on site.

The Test Project is not published and is secret.

Competition workshop requirements:

- graphic stations (I7, at least 16 GB, 3x video outs with a possibility of connection of 2 displays and a scanner projector);
- CAD, CAM, receiver software;
- manual measurement instruments – as set for Experts (electronic vernier caliper, radius gages, thread gages, angle gages);
- electronic digitizing devices (stationary 3D scanners corresponding to the number of competitors; if Test Project contains any objects requiring other digitizing devices, they must be provided to competitors);
- adjustable individual lighting source;
- furniture (electrical installation desk);
- partitions or cabins for competitors preventing the possibility of observing the work of competitors;
- common transparent wall of a booth (for exhibition halls only);
- PPE (gloves, breathing masks, goggles);
- box for flaw detection spray application (or a dedicated area/room);
- cleaning devices and sanitary and hygienic agents (brushes, rags, napkins, wiping liquids);
- CNC machine tool with required outfit, tools and billets and/or industrial 3D printers with plotting speed of 15 cm3/h minimum that can operate with structural materials;
- Cutting coolant in required amount;
- compressed air main line;
- 380 V connection
- equipment for analysis and inspection of properties (spectrometers, durometers, hardness gauges);
- presentation equipment (plasma panels, projectors, screens);
- electronic presentations;
- floor characteristics and coating (concrete floor excluding vibration, the coating should be dry, non-greasy, clean and dustless);
- illumination (illumination shall be at least 500 lux, the sources of scattered light, direct sunlight or directional light sources are unacceptable);
- temperature mode (19-22 deg. C, abrupt fluctuations, for example, because of an adjacent exit door, are unacceptable);
- air movement requirements (constant and temporary drafts are unacceptable);

- requirements for ceilings (industrial concrete ceilings of at least 3.2 m, eliminating leaks of any liquids and intrusion of dust to the competition area);
- requirements for absence of dust sources (around the competition area and in the area itself, the presence of dust sources is unacceptable);
- availability of supply and exhaust ventilation (it is necessary to have a ventilation, but air flows should not fall into the competition area);
- Requirements for the absence of strong vibrations (around the competition area and in the area itself, the presence of vibration sources is unacceptable: sound, especially low-pitch, jumps, etc.);

Competitor's workstation arrangement:

2 detached desks (for workstation and for digitizing object).
Graphic station,
2 monitors
3D scanner,
Chair, on wheels, with backrest.

5.4. TEST PROJECT DEVELOPMENT

The Test Project is developed based on the samples provided by the Skill Competition Manager on the WSR forum (http://forum.worldskills.ru). The Test Project samples provided shall be changed once a year.

5.4.1. WHO DEVELOPS THE TEST PROJECT/MODULES

The Skill Competition Manager is responsible for the overall management and approval of the Test Project. The following individuals may be involved in the Test Project development:

- Certified WSR experts
- Third-party design engineers;
- Other concerned parties.

If 30% changes are made to the Test Project, the following individuals shall participate in the preparation process for each competition:

- Chief Expert
- Certified Skill Expert (if present at the competition)
- Experts taking part in assessment (if required to be involved by the Chief Expert)

The introduced 30% changes to the Test Project must be approved by the Skill Competition Manager.

When 30% changes are made to the Test Project, the above mentioned persons shall be guided by the principles of objectivity and impartiality. The changes shall not affect the complexity of the Test Project or relate to other professional areas not described in the WSSS or exclude any WSSS units. Furthermore, the changes introduced shall be performable using the approved Infrastructure List for the competition.

5.4.2. HOW THE TEST PROJECT IS DEVELOPED

Test Projects for each competition shall be developed based on the unified Test Project approved by the Skill Competition Manager and posted on the Discussion Forum. Test Projects can be developed both as a whole or in modules. The Discussion Forum is the main tool for developing the Test Project.

5.4.3. WHEN THE TEST PROJECT IS DEVELOPED

The Test Project is developed in accordance with the following schedule that defines the documentation preparation periods for each competition type.

Time frames	Local competition	Qualifying competition	National competition
Test Project template	The Test Project from the previous National Competition shall be taken from the Discussion Forum in unmodified form	The Test Project from the previous National Competition shall be taken from the Discussion Forum in unmodified form	Developed based on the previous competition taking into account the skill competition experience and the industry standards 6 months prior to the competition
Approval of the Chief Competition Expert responsible for TP development	2 months prior to the competition	3 months prior to the competition	4 months prior to the competition
TP publication (if applicable)	1 month prior to the competition	1 month prior to the competition	1 month prior to the competition
Introduction of 30% changes made to the TP and approval by the Skill Competition Manager	On Day C-2	On Day C-2	On Day C-2
Submission of suggestions on the Discussion Forum for updating the TP, BD, IL, TD, EN, and GR	On Day C+1	On Day C+1	On Day C+1

5.5 TEST PROJECT APPROVAL

The Chief Expert and the Skill Competition Manager shall decide whether all modules can be performed and, if necessary, prove their feasibility. Time and materials shall be taken into consideration.

The Test Project can be approved in any form convenient for the Skill Competition Manager.

5.6. PROPERTIES OF MATERIALS AND MANUFACTURER INSTRUCTIONS

If it is necessary for the competitor to study a particular material user manual or manufacturer's equipment manual to perform the Test Project, they will receive this/these in advance by decision of the Skill Competition Manager and the Chief Expert. If necessary, the Technical Expert may organize an on-site demonstration.

Materials selected for the modules that are to be used by the competitors (except where materials are brought by the competitors themselves) shall be available from a variety of manufacturers and able to be bought freely in the region of the competition.

6. SKILL MANAGEMENT AND COMMUNICATION

6.1 DISCUSSION FORUM

All precompetition discussions take place on the special forum (http://forum.worldskills.ru). Decisions on skill development shall only be made after a preliminary discussion on the forum. In addition, information on all important skill related events shall be provided on the forum. This forum is moderated by an International Expert and/or a Skill Competition Manager (or an Expert nominated by them).

6.2. INFORMATION FOR COMPETITORS

The information for competitors is published in accordance with the Standing Orders for the competition. Information may consist of:

- Technical Description
- Test Projects
- Mark Summary Form;
- Infrastructure List
- Occupational Health and Safety instructions
- Additional information

6.3. ARCHIVE OF TEST PROJECTS

The Test Projects are available at http://forum.worldskills.ru.

6.4. SKILL MANAGEMENT

General skill management is carried out by the International Expert and the Skill Competition Manager with the potential involvement of the expert community.

Skill management within a specific competition is carried out by the Chief Skill Expert in accordance with the Competition Standing Orders.

7. OHSE REQUIREMENTS

7.1 OHSE REQUIREMENTS AT THE COMPETITION

See the occupational health and safety documentation provided by the Skill Management Team.

7.2 SKILL-SPECIFIC OCCUPATIONAL HEALTH, SAFETY, AND ENVIRONMENTAL REQUIREMENTS

1.1 The persons admitted to individual work with personal computer and optical 3D scanner (operators) shall pass:

- a preliminarily medical examination. The persons directly admitted to work with personal computers shall have no medical counter indications. Women from the time when pregnancy is established and during nursing period are not admitted to all types of works related to use of a personal computer;
- initial workplace induction, and persons having electrical safety qualification group I.

1.2 Hazardous and harmful production factors that may affect an employee during performance of work on a personal computer and when using a 3D scanner include:

a) physical:

- increased electromagnetic radiation levels;
- increased X-ray radiation levels;
- increased UV radiation levels;
- increased IR radiation level;
- increased radiation level of visible spectrum;
- increased level of static electricity;
- increased dust levels in work booth;
- increased content of positive air ions in work booth air;
- reduced content of negative air ions in work booth air;

- reduced or increased air humidity in work booth;

- reduced or increased air humidity in work booth;

- increased noise level;

- reduced or increased illumination level;

- increased level of direct glare;

- increased blindness level;

- irregular distribution of brightness in the field of view;

- increased brightness of light image;

- increased level of light flux pulsations;

- increased voltage in the electrical circuit, the resulted short circuit can pass through a human body;

b) chemical:

- increased content of carbon dioxide, ozone, ammonia, phenol, formaldehyde and polyphenylchloride biphenyls in work booth air;

c) psycho-physiological:

- eye strain;

- attention strain;

- intellectual loads;

- emotional loads;

- prolonged static loads;

- routine work;

- large amount of information processed per time unit;

- irrational workstation arrangement;

d) biological

- increased content of microorganisms in work booth air.

1.3 All personal computers shall have a hygienic certificate including, without limitation, an assessment of visual parameters.

1.4. The Area of a single workstation with a personal computer for adult users shall be 6 sq.m minimum, and the volume – 20 cu.m minimum.

1.5 Workstations with personal computers shall be located relative to light openings so as to make sure that natural light falls from the side, mostly from the left.

1.6 Work (arm-) chair shall be lifting and rotary with adjustable height and backrest and seat tilt angle and adjustable distance from backrest to front edge of the seat, while adjustment of each parameter must be independent, easy and secure.

1.7 Video screen shall be located at an optimum distance of 600-700 mm from user's eyes, but not closer than 500 mm, considering the dimensions of alphanumeric signs and symbols.

1.8 Wet cleaning shall be performed in rooms with personal computers on a daily basis.

1.9 Rooms with personal computers shall be fitted with a first aid kit and CO2 fire extinguishers.

1.10 Desk height for adult users shall be adjustable in the range of 680-800 mm; or, if such opportunity is unavailable, the height of desk work surface shall be 725 mm.

1.11 Desk shall have a space for feet, at least 600 mm high, 500 mm wide, and at lest 450 mm deep at knee level and 650 mm at the level of stretched feet.

1.12 Workstation shall be equipped with a foot stand, at least 300 mm wide, at least 400 mm deep, with adjustable height within the limits of 150 mm and with angle of supporting surface adjustable within the range up to 20 degrees. Support surface shall be ribbed and have a 10 mm high curb on the front edge.

1.13 Workstation with a personal computer shall be fitted with an easily removable stand for documents.

1.14 Keyboard shall be located at desk surface at a distance of 100-300 mm from the edge directed towards user, or at a special work surface with adjustable height detached from main tabletop.

1.15 Duration of work with personal computer without regulated breaks shall not exceed 2 hours.

1.16 In order to reduce nervous and emotional stress, eye strain, eliminate the effect physical inactivity, prevent development of fatigue, it is feasible to perform sets of special exercises during regulated breaks.

1.17 If the persons operating a personal computer experience eye discomfort or other adverse subjective feelings despite of compliance with sanitary and hygienic and economic requirements, work and rest modes, then an individual approach shall be applied to limitation of the time of work with personal computer to adjust the duration of rest breaks or to change the activity to that not related to use of a personal computer.

2. Occupational Health and Safety Requirements before Work Commencement

2.1 Prior to commencement of work, operator shall:

- wash his/her face and hands with soap;

- examine and arrange workstation;

- adjust illumination level at workstation, make sure that illumination is sufficient, there are no reflections on the screen and there is no counter light flux;

- check correct connection of equipment to mains;

- wipe the surface of the screen and protective filter with a special napkin;

- check correct installation of the desk, chair, position of equipment, screen tilt angle, position of keyboard and (if required) adjust the desk and chair and location of computer elements to avoid uncomfortable positions and prolonged stresses according to ergonomic requirements.

2.2 When turning the computer on, operator shall follow the sequence described below:

- turn power supply unit on;
- turn periphery devices (printer, monitor, scanner, etc.) on;
- turn the system unit on.

2.3 Operator shall never start the work, if:

- any equipment faults are found;
- PC protective earthing is missing.

The following is recommended to avoid impact of harmful factors:

- prepare the workstation so as to avoid inconvenient positions and long-term strains;
- prevent screen glare;
- do not use fluorescent lamps, if they are noticed to be blinking;
- wall or any other surface behind the screen shall have the same illumination level as the screen;
- display image center shall be at a height of 0.7 - 1.2 m from floor level.

2.4 Inspect the work place and remove non-required objects.

3 Occupational Health and Safety Requirements during the Work

3.1 During the work, operator shall:

- perform only the work assigned to him/her and the work, he/she was instructed on;
- keep the workstation clean and in order;
- keep all ventilation openings of devices open;
- use the mouse, only if a special pad is available;

- if the work needs to be stopped for some time, correctly close all active tasks;

- turn the power off, only if operator must stay near (less than 2 meters) the video terminal during the break; otherwise the power does not have to be turned off;

- follow sanitary norms and work and rest modes;

- follow the computer operation rules according to operation manuals;

- observe the breaks regulated by working schedule and perform recommended exercises for eyes, neck, hands, body and legs;

- observe the distance from eyes to screen in the range of 60-80 cm.

3.2 During the work, operator shall never:

- look directly at light source of 3D scanner;

- direct the light of 3D scanner to the eyes of people or animals;

- touch the screen and keyboard simultaneously;

- touch the rear panel of system unit with power on;

- switch the connectors of interface cables of periphery devices with power on;

- stack paper and unwanted objects on top panels of devices;

- allow debris of paper at workstation to avoid accumulation of organic dust;

- turn the power off during performance of an active task;

- frequently switch power on and off;

- allow any moisture on the surface of system unit, monitor, keyboard working surface, disc drives, printer and other devices;

- turn a significantly cooled equipment on (brought from outside in winter);

- open and repair the equipment individually.

3.3. During continuous operation, the screen shall be in the center of view, documents shall be located on the left of the desk or on a document stand in the same plane with the screen.

4 Occupational Health and Safety Requirements after Work Completion

4.1 After work completion, operator shall follow the sequence described below to shut down the computers:

- close all active tasks;
- turn off the power of all periphery devices;
- turn power supply unit off;

4.2 Upon completion of work, operator shall examine the workstation and bring it in order and wash his/her hands and face with soap.

5 Occupational Health and Safety Requirements in Case of Emergency Situations

5.1 Operator shall:

- any time a wire rupture or earthing fault or other electrical equipment damages are found, or if burning smell appears, immediately turn the power off and inform direct manager about the emergency situation;
- if a person affected by electrical shock is found, immediately release him/her by power shutdown and provide first medical aid to the affected person before a doctor arrives;
- in any case of hardware or software failure, immediately call a technical representative of IT support service;
- in case of smarting eyes, rapid deterioration of visibility, inability to focus or make the eyesight sharp, or if pain appears in fingers and palms,

or if heartbeat intensifies, immediately leave the workstation and inform the work manager about the matter and visit a doctor;

- in case of equipment inflammation, turn the power off and take measures to extinguish fire source using CO2 or dry chemical fire extinguisher, call fire crew and inform the direct manager about the incident.

5.2 In case of power outage, stop the work and inform the manager thereof. Do not attempt to clarify and eliminate the cause without assistance. Remember that voltage may re-appear just as unexpectedly as it disappeared.

5.3 In case of inflammation or fire, remember that electrical units must be extinguished with CO2 or dry chemical fire extinguishers or dry sand to avoid electrical shock.

8. MATERIALS AND EQUIPMENT

8.1. INFRASTRUCTURE LIST

The Infrastructure List includes all the infrastructure, equipment, and consumables needed for the Test Project. The Infrastructure List must contain an example of such equipment and a clear description of the corresponding features if it is possible to acquire equivalent equipment.

During development of the Infrastructure List for a specific competition, the process must be guided by the Infrastructure List posted on the Discussion Forum by the Skill Competition Manager. All changes made to the Infrastructure List must be agreed upon by the Skill Competition Manager.

At each competition, the Technical Expert should maintain a record of infrastructure elements. The list should not include elements that were asked to be included by the experts or the competitors or prohibited elements.

Following the competition results, if required, the Technical Expert and the Chief Expert must provide recommendations for changes to be made to the

Infrastructure List to the Competition Organizing Committee and the Skill Competition Manager.

8.2. MATERIALS, EQUIPMENT, AND TOOLS SUPPLIED BY COMPETITORS IN THEIR TOOLBOX

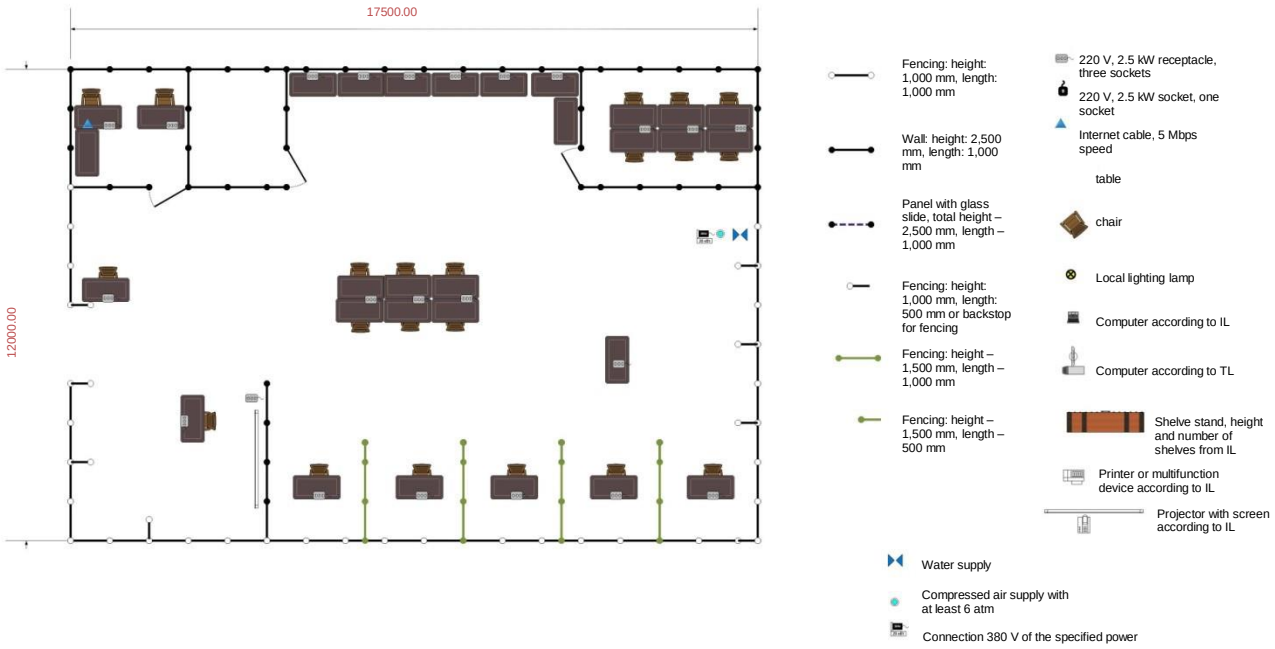
The required tools in Competitor's toolbox include: vernier caliper and a set of thread gages. The Competitor's toolbox may also include other manual measurement instruments that the competitor will deem necessary for the Test Project, for example: inside caliper, depth gage, angle gage, set of angle gages, set of radius gages, etc.

A Competitor is also entitled to carry along and use printed reference tables on site, including those included in engineering reference books.

8.3. MATERIALS AND EQUIPMENT PROHIBITED IN THE WORKSHOP

No storage media or information transfer and writing tools are allowed on site without a special permission of Chief Expert or his/her deputy.

8.4. PROPOSED COMPETITION WORKSHOP LAYOUT



Competition workshop layout (*see the illustration*).

9. SPECIAL RULES FOR THE 14-16 AGE GROUP

The test project performance time shall not exceed 5 hours per day.

During the development of the Test Project and Marking Scheme, it is required to consider the specific features and limitations of the applied OHSE rules for this age group. It is also necessary to take into account the anthropometric, psychophysiological, and psychological characteristics of this age group. In this way, the Test Project and Marking Scheme may cover not all the WSSS units and areas depending on the specific features of the skill.