

TECHNICAL DESCRIPTION

SKILL “Reverse Engineering”

Upon the agreement of Technical Committee and in accordance with the Charter and Competition Rules, WorldSkills Russia (WSR) has adopted the following minimal requirements for this skill required for the participation in competition.

The Technical Description consists of the following sections:

1. INTRODUCTION
2. QUALIFICATION AND VOLUME OF WORK
3. TEST PROJECT
4. SKILL MANAGEMENT AND COMMUNICATION
5. ASSESSMENT
6. SKILL-SPECIFIC SAFETY REQUIREMENTS
7. MATERIALS AND EQUIPMENT
8. VISITOR AND MEDIA ENGAGEMENT
9. APPENDIX

Effective date:

_____ Alexey Tymchikov, WSR Technical Director

_____ Full name, WSR Expert

1. INTRODUCTION

1.1. Name and description of the skill

1.1.1 The name of the professional skill:
Reverse Engineering

1.1.2 Description of the skill

Reverse engineering specialists create manufacturing projects based on existing products in order to analyze, improve, repair or copy them.

Reverse engineering is required:

- to launch new production processes,
- to conduct R&D as well as design and experimental processes,
- to repair unique equipment,
- to recreate missing technological documentation.

Reverse engineering specialists perform 3D scanning, design, computer modelling and analysis in a wealth of fields ranging from industrial production and R&D to mechanical restoration of rare equipment, museum pieces and architectural objects of cultural heritage.

Reverse engineering is based on digitization and computer modelling, but it also requires knowledge of mechanics, materials and industrial technologies.

Reverse engineering requires application of computer technologies, such as different technologies used for 3D digitization (optical, laser, ultrasound, contact and magnetic resonance), as well as computer modelling and material research.

1.2. Scope of application

1.2.1 Every Expert and Competitor must familiarize themselves with this Technical Description.

1.3. Associated documents

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

- WorldSkills Russia – Competition Rules;
- WorldSkills International, WorldSkills Russia: on-line resources specified in this document;
- Competition Regulation
- Code of Ethics
- Health and Safety Regulations.

2. QUALIFICATION AND VOLUME OF WORK

Competition is held in order to demonstrate and assess qualification in this skill. The Test Project includes only practice-oriented tasks.

2.1. *Qualification requirements*

The Competitor should be able to:

- Work with 3D CAD systems;
- Prepare 2D and 3D drawings and 3D models;
- Process a point cloud using special software;
- Configure non-contact measuring equipment and perform measuring (digitization);
- Use manual measuring tools;
- Disassemble and assemble parts of mechanisms

The Competitor needs to know and understand the following areas:

- Calibration of non-contact measuring tools;
- Definition of a “point cloud”;
- Methods for extracting primitives and curvilinear surfaces from a point cloud;
- Vector method of reverse engineering;
- Basics of mechanical engineering;
- Comparative methods for current and nominal data;
- Design;
- 3D-CAD software (for example, Inventor, SolidWorks, ProE, etc.);
- Characteristics, risks and methods of creating control software for CNC machines;
- Unified system for design documentation;
- Creation of parts, assembly and preparation of drawings using 3D-CAD software including the determination of dimensions;
- Risks and applications of aerosol cans;
- Use of measuring tools;
- Safety precautions for handling digitization equipment;
- Safety and health standards of the host country.

2.2 *Theoretical knowledge*

2.2.1 Knowledge of theory is necessary, but is not explicitly monitored.

2.2.2 Knowledge of rules and regulations is not monitored.

2.3 *Practical work*

Competitors should complete the following practical assignments by themselves:

- Creation of a CAD model of the product from a point cloud (Competitors cannot see the product itself);
- Creation of drawings based on a 3D-model;
- Digitization of products out of different materials;

- Combined reverse engineering (manual measuring tool + non-contact measuring tools);
- Modification of a created 3D model in accordance with the Test Project;
- Control of design accuracy and analysis of assembly conflicts.

3 TEST PROJECT

3.1 Form and structure of the Test Project

The Test Project consists of 5 Modules.

Module "A": Digitization of a housing part and its reverse engineering;

Module "B": Reverse engineering of a part for gyration transmission;

Module "C": Reverse engineering of a part based on a point cloud and matching parts and elements;

Module "D": Analysis of an assembly conflict;

Module "E": Creation of drawings;

3.2 Requirements to the draft of a Test Project

The Test Project should be in the form of an object well recognized by global specialists who have studied or are studying mechanics.

The Competitors receive point cloud, product and technical description of the Test Project.

The Test Project is not published and is confidential.

3.3 Development of the Test Project

The Test Project should be prepared based on templates provided by WorldSkills Russia (<http://forum.worldskills.ru/>). Please use Word template for text documents and DWG or PDF template for drawings.

3.4.1 Persons authorized to develop Test Projects / Modules
Chief Experts develop Test Projects. In doing so they cannot represent their Competitors at the Competition, therefore, they act as independent persons.

3.3.3 Time period for Test Project development

Test Project is developed prior to the start of a current Competition in accordance with the Competition Regulation.

3.4 *The Marking Scheme for the Test Project*

Each Test Project should be accompanied with the draft of a Marking Scheme based on the assessment criteria established in Section 5.

3.4.1 The draft of Marking Scheme is developed by person(s) preparing the Test Project. A final detailed Marking Scheme is developed and approved of by all Experts involved in the competition.

3.4.2 Marking Schemes should be submitted to the CIS prior to the start of the competition in accordance with the Competition Regulation.

3.5 *Adoption of the Test Project*

At the competition all Experts are divided into groups. Each group is tasked with reviewing the feasibility of a task chosen for the competition. Such group should:

- Check the presence of all documents
- Check the compliance of the Test Project with project criteria
- Confirm that the Test Project is feasible within the assigned time limit
- Confirm the adequacy of the proposed Marking Scheme
- In case the Test Project is deemed incomplete or infeasible, it is canceled and replaced with a back-up Test Project.

3.6 *Publication of the Test Project*

Test Project is not to be published.

3.7 *Approval of the Test Project (preparation for competition)*

The Test Project is approved of by: Chief Expert and Technical Director.

3.8 *Variation of the Test Project during the competition*

During the Competition (preparation days) all Experts agree on a 30% change for each chosen module of the Test Project. A professional assistant makes respective changes (in case of prior disclosure of Test Project).

3.10 *Materials or instructions from a manufacturer*

The Competition Organizer should inform the Expert about any specifications for materials required for the Test Project via the Infrastructure List provided to WorldSkills 6 months prior to the commencement of the Competition.

4. SKILL MANAGEMENT

4.1 *Discussion Forum*

Prior to the Competition, all discussions, communications, collaboration, and decision making regarding the skill competition must take place in the skill-dedicated Discussion Forum (<http://forum.worldskills.ru/>). Skill-related decisions and communications are only valid if they take place in such 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.

4.2 *Information for Competitors*

All information for registered Competitors is available on the website (<http://www.worldskills.ru>).

The information includes:

- Competition Rules
- Technical Descriptions
- Test Projects
- Other information regarding the Competition.

4.3 *Test Projects*

Circulated Test Projects are available on the website [worldskills.ru](http://www.worldskills.ru) where such circulation has been approved of.

4.4 Day-to-day management

Day-to-day management is regulated by “Competition Management Road Map” prepared by the Skill Management Team led by the Chief Expert. The Skill Management Team consists of Jury President, Chief Expert and Deputy Chief Expert.

5. ASSESSMENT

This Section describes how Test Projects / Modules are assessed by the Experts. It also includes the description of marks, assessment procedures and requirements.

5.1 *Assessment criteria*

This Section provides an example of assignment of assessment criteria and the number of given marks (judgement and measurement). A total of 100 marks are available for all assessment criteria.

Module "A";

Module "B";

Module "C";

Module "D";

Module "E";

Section	Criterion	Marks		
		Judgement marking (if applicable)	Objective	Total
A	Module A - Reverse engineering of a part for gyration transmission	0	20	20
B	Module B - Digitization of a housing part and its reverse engineering	0	35	35
C	Module C - Reverse engineering of a part based on a point cloud, matching parts and elements	0	20	20
D	Module D - Assembly and analysis of assembly conflicts	0	15	15
E	Module E - Creation of drawings	0	10	10

Total =	0	100	100
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5.2 *Judgement marking*

Marks are assigned at a scale 1-10.

5.3 *Skill assessment criteria*

Module 1 - Reverse engineering of a part for gyration transmission Speed of the adjustment of equipment;

- Deviation at the end of the calibration;
- Integrity of a point cloud for the part;
- Correctness of a point cloud "collection";
- Presence of artifacts in a point cloud;
- Processing and aligning the point cloud;
- Elimination of digitization defects;
- Extraction of surfaces and primitives;
- Possibility of variation of the designed part;
- Accuracy of dimensions;

Module 2 - Digitization of a housing part and its reverse engineering

- Deviation at the end of the calibration;
- Integrity of a point cloud for the part;
- Correctness of a point cloud "collection";
- Presence of artifacts in a point cloud;
- Processing and aligning the point cloud;
- Elimination of digitization defects;
- Extraction of surfaces and primitives;
- Accuracy of dimensions;
- Possibility of variation of the designed part;
- Accuracy of dimensions;

Module 3 - Reverse engineering of a part based on a point cloud

- Processing and aligning the point cloud;
- Elimination of digitization defects;
- Extraction of surfaces and primitives;
- Accuracy of dimensions;
- Possibility of variation of the designed part;
- Accuracy of dimensions;

Module 4 - Assembly and analysis of assembly conflicts or

- Creation of an assembly;
- Creation of an assembly diagram;
- Conflict analysis;
- Modification of the model (if necessary);
- Comparison of the constructed models with the original polygonal models and determination of deviations;

Module 5 – Creation of drawings

- Creation of a pack of drawings for a unit's production.

5.4 Skill assessment rules

- Assessed criteria and mark assignment are based upon the decision of the Experts, adopted prior to the Competition.
- To ensure the transparency each Competitor receives an Marking Form identical to the one used by the Experts.
- Chief Expert and Deputy Chief Expert divide all Experts into groups for assessment taking into account their participation in past Competitions, cultural affiliation, language and continent.
- If Experts have an opportunity to measure with the help of a digital measuring tool to ensure objectivity of assessment, they should reach a respective decision and take all necessary measures prior to the commencement of the Competition. In this case, a professional assistant, who is competent to deal with such equipment, makes measurements.
- When a module is marked by both judgement and measurement, judgement marking will be completed first (each day of assessment).
- Each completed module is assessed through a progressive mark assignment system.

5.5. Assessment of excellence

Measurement

Marks are assigned at a scale 0-2, dimensions margin may be changed depending on the used equipment.

2 = from ± 0 to ± 0.2

1.5 = from ± 0.21 to ± 0.3

1 = from ± 0.31 to ± 0.4

0.5 = from ± 0.41 to ± 0.5

0.25 = from ± 0.51 to ± 1.0

0.1 = more than ± 1.0

0 = not finished

Angles

+/- 30' = 2 points

+/- 1° = 1 point

More than 1° = 0 points

Radii and rounds

+/- 0.2mm = 2 points

More than 0.2 mm = 0.75 points

Not performed = 0 points

6. SKILL-SPECIFIC SAFETY REQUIREMENTS

Please refer to the documentation on health and safety requirements of the Competition.

7. MATERIALS AND EQUIPMENT

7.1 *Infrastructure List*

The Infrastructure List contains the list of all equipment, materials and devices provided by the Competition Organizer.

You may find the Infrastructure List on the website: <http://www.worldskills.ru>

The Infrastructure List contains the name and quantity of all materials, as well as the number of devices requested by the Experts for the next Competition. The Competition Organizer updates the Infrastructure List by indicating required quantity, type, brand / model of items. Items provided by the Competition Organizer are indicated in a separate column.

At each competition the Experts consider and clarify the Infrastructure List to prepare for the next competition. The Experts provide recommendations to the Technical Director in relation to the expansion of workstations or change of equipment lists.

At each Competition the WSR Technical Director reviews the Infrastructure List used at the previous Competition.

The Infrastructure List does not include those items that Competitors or Experts should bring with them, as well as items, which Competitors are not allowed to bring with them. These items are listed below.

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

- List of Standards
- Technical Guides
- Tools for hand drawing
- Measuring tools (minimal set is indicated in the Infrastructure List)
- The Competition Organizer should provide all Competitors with identical tools

7.3 *Materials, equipment and instruments supplied by Experts*

Not applicable.

7.4 *Materials and equipment prohibited in the skill area*

All materials and equipment brought by Competitors will have to be presented to the Experts. The Jury is entitled to forbid the use of any items that may be deemed unrelated to automated engineering and CAD, that will give any Competitor an unfair advantage.

8. VISITOR AND MEDIA ENGAGEMENT

8.1. The utmost engagement of visitors and media

The following ideas enhance engagement of visitors and media in the process:

- Demonstration area for material analysis (hardness measuring equipment, durometer, spectral analysis);
- Display screens;
- Test Project descriptions;
- Career opportunities;

- Daily reporting of competition status.

8.2. Sustainability

- Recycling;

Appendix to the Technical Description of Skill

Functional Information List

Skill "Skill Name"

1	Skill name	Reverse Engineering
2	Number of Modules	5
3	Number of WSI Modules	-

5	Module	Skills required to complete the Module
5.1	A Reverse engineering of a part for gyration transmission	Working with an optical device for non-contact digitization, calibration of equipment, partial digitization of the product, "collection of points" into a single point cloud, point cloud processing, aligning with global coordinate system, eliminating artifacts of digitization, extracting curvilinear surfaces and matching them, extracting primitives. Construction of a CAD-model of the unit, preparation of drawings.

5.2	<p>B</p> <p>Digitization of a housing part and its reverse engineering</p>	<p>Digitization of the unit, "collection of points" into a single point cloud, point cloud processing, aligning with global coordinate system, eliminating artifacts of digitization, extracting curvilinear surfaces and matching them, extracting primitives. Construction of a CAD-model of the unit, preparation of drawings.</p>
5.3	<p>C - Reverse engineering of a part based on a point cloud, matching parts and elements</p>	<p>Point cloud processing, aligning with global coordinate system, eliminating artifacts of digitization, extracting curvilinear surfaces and matching them, extracting primitives. Construction of a CAD-model of the unit, preparation of drawings.</p>
5.4	<p>D</p> <p>Assembly and analysis of assembly conflicts</p>	<p>Creation of a computer assembly; Check the assembly for absence of conflicts; Creation of an assembly diagram; Comparison of the constructed models with the original polygonal models, determination of deviations.</p>
5.5	<p>E</p> <p>Creation of drawings</p>	<p>Creation of drawings for the unit.</p>