

# TECHNICAL DESCRIPTION

## MECHANICAL ENGINEERING DESIGN - CAD



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TD05 v4.0 – WSC2013

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

The Technical Description consists of the following:

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Effective 11.10.11



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## 1. **INTRODUCTION**

### 1.1 **Name and description of skill**

1.1.1 The name of the skill is

Mechanical Engineering Design – CAD

1.1.2 Description of skill

Mechanical Engineering Design covers the use of Computer Aided Design (CAD) technology in the preparation of graphical models, drawings, paperwork and files containing all the information necessary for manufacture and documentation of parts and components typical of solutions to mechanical engineering problems facing workers in industry. Solutions will comply with appropriate industry and ISO standard, latest issue.

### 1.2 **Scope of application**

1.2.1 Every Expert and Competitor must know this Technical Description.

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

### 1.3 **Associated documents**

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

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

## 2. **COMPETENCY AND SCOPE OF WORK**

The Competition is a demonstration and assessment of the competencies associated with this skill. The Test Project consists of practical work only.

### 2.1 **Competency specification**

The following competencies will be tested within one or more of the individual modules listed below

#### **3D modelling of part**

Knowledge and understanding of 3D modelling of part:

- Have sufficient knowledge of Autodesk Inventor to be able to configure the parameters of the software
- Have sufficient knowledge of computer operating systems to be able to use and manage computer files and software correctly

The competitor shall be able to:

- Perform the modelling of the components, optimizing the constructive solid geometry.
- Create families of components (a maximum of 3 variables)
- Ascribe characteristics to the materials (density)
- Ascribe colours and textures to the components

### **3D modelling of assemblies**

Knowledge and understanding of 3D modelling of assemblies:

- Understand mechanical systems and their functionality

The competitor shall be able to:

- Produce an assembly from 3D models of components.
- Structure an assembly (sub-assemblies)

### **Create photo rendered images**

Knowledge and understanding of rendering:

- Understand the use of lighting, scenes and decals to produce photo rendered images

The competitor shall be able to:

- Create photo rendered images of components or assemblies

### **Creation of simulations**

Knowledge and understanding of creating simulations:

- Understand mechanical systems and their functionality

The competitor shall be able to:

- Create functional simulations relative to the operation of the system being designed using Autodesk Inventor Studio.

### **Reverse engineering of a physical model**

Knowledge and understanding of reverse engineering of a physical model:

- Knowledge of materials and processes for obtaining unprocessed workpieces (casting, welding, machining, simulation, etc)

The competitor shall be able to:

- Determine dimensions on a physical part by means of the instruments described under paragraph 3.2 Test Project design requirements
- Creating freehand sketches

### **Technical drawings and dimensioning**

Knowledge and understanding of technical drawings and dimensioning:

- Understand working drawings in ISO standards together with any written instruction.
- Knowledge of standards for conventional dimensioning and tolerancing, and geometric dimensioning and tolerancing appropriate to the ISO standards.
- Thorough understanding of the rules of technical drawing and the prevailing latest ISO standards that govern those rules
- Using the manuals, tables, lists of standards and product catalogues
- Using plotters and printers

The competitor shall be able to:

- Interpret and execute drawings and diagrams
- Create freehand sketches
- Produce print outs of drawings in sizes A0 to A4

### **Materials**

Knowledge and understanding of materials:

- Knowledge of materials and processes for obtaining unprocessed workpieces (casting, welding, machining, simulation, etc)

### **Software and hardware**

Knowledge and understanding of software and hardware:

- Understanding of how to configure the parameters of the software
- Knowledge of computer operating systems to be able to use and manage computer files and software correctly
- Working knowledge to use plotters and printers

## **2.2 Theoretical knowledge**

2.2.1 Theoretical knowledge is required but not tested explicitly.

2.2.2 Knowledge of rules and regulations is not examined.

## **2.3 Practical work**

Practical tasks will be given in the form of sketches, drawings and electronic data files, individual physical components and assemblies. Collection of information from these sources will require reading of prints, sketches, drawings, engineering tables, charts, and manuals. Additional information will be obtained from direct measurement of actual parts supplied and/or from scaled drawings. Problems will require solutions in the form of graphical and textual descriptions, sufficient to communicate successfully the information necessary for manufacturing of these components and assemblies in industry.

Only the English version of the chosen software is to be used during the Competition.

## **3. THE TEST PROJECT**

### **3.1 Format / structure of the Test Project**

The Test Project is a series of 4 standalone modules.

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

- Sheet Metal parts and
- Frame structures and assemblies
- Welded parts and assemblies
- Mechanical parts and assemblies
- Detail drawing
- Functional Simulation and photo rendering
- Reverse engineering from a physical model
- Modification of a product to fulfil and design brief.

A combination of the above skills is allowed in each module.

### 3.2 Test Project design requirements

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

#### **Day 1 (6 hours) – Mechanical assemblies and detail drawing for manufacture:**

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)

#### **Day 2 (6 hours) – Mechanical Fabrication:**

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

Results expected:

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

#### **Day 3 (6 hours) – Mechanical Design Challenge:**

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
- Animation showing full exploded view sequence of design change in file format .avi
- Animation showing full physical simulation of design change in file format .avi
- Photo Rendered images of design change up to a maximum of A3 size
- Nomenclature

#### **Day 4 (4 hours) – Reverse Engineering from a Physical Model:**

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 will be produced using measuring instruments in Annex 1 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) will be given to the Competitors for 2 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
- Manufacturing drawing(s) of components or assemblies

#### **Output format**

Use of Autodesk Inventor Professional. The version will be determined by the Chief Expert 6 months before the Competition.

- Drawing plotted on sizes A1 and smaller
- Charts, table and documents printed by laser printers on paper sizes A3.
- Screenshots, rendering on colour printer to a maximum size of A3
- Files, components, assemblies, etc according to the instructions for the test
- During the competition, each competitor is allowed no more than 2 checking prints of each drawing. The final printing will take place at the end of each competition day..
- PDF prints may be asked to reduce the paper waste

### **3.3 Test Project development**

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

3.3.1 Who develops the Test Project / modules  
The Test Project / modules are developed by:

An External Enterprise (Autodesk)

3.3.2 How and where is the Test Project / modules developed

The external enterprise is to produce 6 Test Projects (Modules), 4 to use in the Competition and 2 more as a backup plan.

The external enterprise is to produce 1 extra Test Project, 3 months before Competition, to be published to all experts. Like this we can check the quality of the project and still have time to propose changes to the format. This project won't be used in the Competition.

The Test Project must be developed in Autodesk Inventor, and all files must come along with the Test Project.

All the physical models to Module 4 (one for each Competitor), must be provided by the External Enterprise to WS International, one month before Competition.

The presence of a Technical/Support Team from Autodesk, during all pre-competition and Competition period (if possible the presence of the TP designer).

3.3.3 When is the Test Project developed  
The Test Project is developed:

By 3 months before the current Competition.

One month before the Competition the Test Project must be submitted to WorldSkills for validation

### 3.4 Test Project marking scheme

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

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

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

### 3.5 Test Project validation

At the Competition all Experts will be divided into 4 groups. Each group will be given the task to verify the validity of one of the finally selected Test Projects. The group will be 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
- If, after examination, the selected Test Project is found incomplete or unfeasible, it shall be discarded and replaced with the backup Test Project.

### 3.6 Test Project selection

The Test Project is selected as follows:

Not applicable.



### 3.7 Test Project circulation

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

Not circulated.

### 3.8 Test Project coordination (preparation for Competition)

Coordination of the Test Project will be undertaken by:

The Chief Expert and the Technical Director.

### 3.9 Test Project change at the Competition

Not applicable.

### 3.10 Material or manufacturer specifications

Not applicable.

## 4. **SKILL MANAGEMENT AND COMMUNICATION**

### 4.1 Discussion Forum

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

### 4.2 Competitor information

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

This information includes:

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

### 4.3 Test Projects

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

### 4.4 Day-to-day management

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

## 5. ASSESSMENT

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

### 5.1 **Assessment criteria**

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

Section	Criterion	Marks		
		Subjective (if applicable)	Objective	Total
<b>A</b>	Module 1 – Mechanical Assemblies & Detail Drawing for Manufacture Name	1	24	25
<b>B</b>	Module 2 – Mechanical Fabrication Name	1	24	25
<b>C</b>	Module 3 – Mechanical Design Challenge	5	20	25
<b>D</b>	Module 4 – Reverse Engineering from a Physical Model Name	1	24	25
<b>Total =</b>		<b>8</b>	<b>92</b>	<b>100</b>

### 5.2 **Subjective marking**

Scores are awarded on a scale of 1 to 10.

### 5.3 **Skill assessment specification**

#### Module 1 - Mechanical Assemblies & Detail Drawing for Manufacture

- Part Modelling
- Assembly Modelling
- Dimensioning inc GDT
- Drawing Views & Presentation (part subjective)

#### Module 2 – Mechanical Fabrication

- Sheet Metal Parts and Assemblies
- Frame Parts and Assemblies
- Fabrication Drawing Details
- Drawing Views & Presentation (part subjective)

#### Module 3 – Mechanical Design Challenge

- Fulfilment of the Design Brief (part subjective)
- Physical Simulation (part subjective)
- Exploded view (simulation) (part subjective)
- Photo Rendering (part subjective)

#### Module 4 – Reverse Engineering from a Physical Model

- Presence of part features
- Accuracy of dimensions
- Tolerances
- Surfaces
- Presentation (subjective)

#### 5.4 Skill assessment procedures

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

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

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

Each Expert will mark exactly 25% of the total marks assessed.

At the end of each day the marks will be entered into the CIS.

Blind marking will be applied whenever possible.

There are no special processes to be followed during marking.

### 6. **SKILL-SPECIFIC SAFETY REQUIREMENTS**

Refer to Host Country Health & Safety documentation for Host Country regulations.

None

### 7. **MATERIALS & EQUIPMENT**

#### 7.1 Infrastructure List

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

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

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

At each Competition, the Experts must review and update the Infrastructure List in preparation for the next Competition. Experts must advise the Technical Director of any increases in space and/or equipment.

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

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

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

- Compendium of standards
- Technical manuals
- Instruments for freehand sketching
- Measuring instruments (Appendix 1 Tool List).
- The Competition Organiser must supply identical tools during the Competition for all Competitors.
- Personal keyboard and mouse (including drivers), if different than the ones supplied by Host Member
- "Space Mouse" (3D Mouse) will be permitted if the brand is approved by the Experts on the Discussion Forum if different from the one provided in the Infrastructure List.

## 7.3 Materials, equipment and tools supplied by Experts

Not applicable

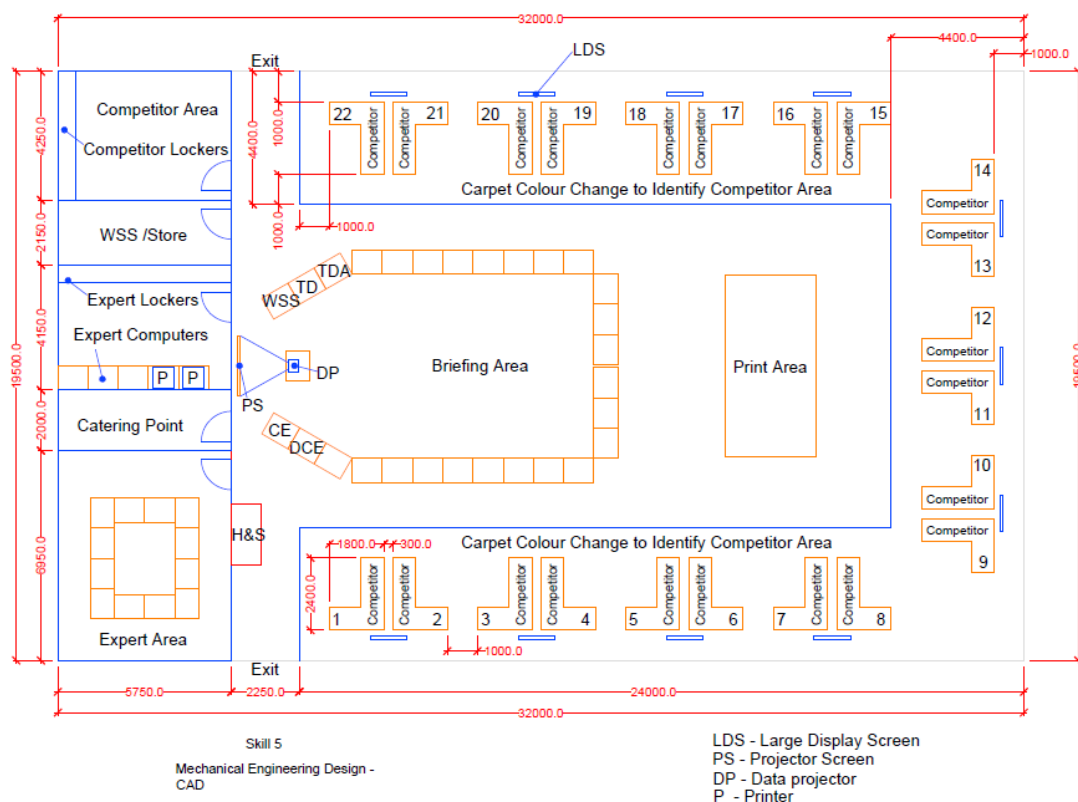
## 7.4 Materials & equipment prohibited in the skill area

All materials and equipment brought by Competitors will have to be presented to the Experts. The Jury 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.

## 7.5 Proposed workshop and workstation layouts

Workshop layouts from London are available at:  
[http://www.worldskills.org/index.php?option=com\\_halls&Itemid=540](http://www.worldskills.org/index.php?option=com_halls&Itemid=540)

Workshop layout:



## **8. MARKETING THE SKILL TO VISITORS AND MEDIA**

### **8.1 Maximising visitor and media engagement**

Below is a list of possible ways to maximise visitor and media engagement for this skill:

- Try a trade
- Display screens
- Test Project descriptions
- Enhanced understanding of Competitor activity
- Competitor profiles
- Career opportunities
- Daily reporting of competition status

### **8.2 Sustainability**

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

## 9. APPENDICES

### 9.1 Appendix 1 – Tool list



### Radius Gages (0,4 to 25mm)



### External Metric Thread Pitch Gage (0.35 to 6mm)



### Internal Metric Thread Pitch Gage (0.35 to 6mm)

Use of screws/thread plugs is allowed

### Surface comparator gauges (Ra)



### Metalic Ruler (0-300mm)

