Virtual Skills Competitions
Technical Description

05-Mechanical Engineering CAD (MECad)

MANUFACTURING AND ENGINEERING TECHNOLOGY

(Adopted from WSC2019_TD05_EN with modification)

WorldSkills Malaysia, 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 Malaysia (WSM) Competition.

The Technical Description consists of the following:

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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).

Computer aided design 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 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 the 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

Refer to World Skill Malaysia (WSM) – Competition Rules.

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 organizer, test center, Judge 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:

- WSM – Competition Rules
- WSM – Standards Specification framework if any

2 THE WORLDSKILLS STANDARDS SPECIFICATION (WSSS)

2.1 GENERAL NOTES ON THE 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 (www.worldskills.org/WSSS).

The skill competition is intended to reflect international best practice as described by the WSSS, and to the extent that it is able to. The Standards Specification 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 Standards Specification 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 Specification. This is often referred to as the “weighting”. The sum of all the percentage marks is 100.

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

The Marking Scheme and Test Project will follow the allocation of marks within the Standards Specification to the extent practically possible. A variation of five percent is allowed, provided that this does not distort the weightings assigned by the Standards Specification.

2.2 **WORLDSKILLS STANDARDS SPECIFICATION**

SECTION		RELATIVE IMPORTANCE (%)
1	**Work organization and management**	**15**
	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	

	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 obvious 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 • Demonstrate effective communications and inter-personal skills between 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 Judges and non-Judges, 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 the desired product in order to fulfil the client's brief accurately	
2	**Materials, software, and hardware**	**15**
	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 and printers	

	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 the production process effectively to produce efficient work processes • Use plotters and printers to print and plot work	
3	**3D modelling and Creation of Animation**	**30**
	The individual needs to know and understand: • Programs in order to be able 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 colors 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	
	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 colors, 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 or are assembled	
5	**Technical drawing and measuring**	**30**
	The individual needs to know and understand: • Working drawings in ISO standard together with any written instruction • 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	
	The individual shall be able to: • Generate working drawings in ISO standard together with any written instructions • Apply standards for conventional dimensioning and tolerance and geometric dimensioning and tolerance 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**

2.3 COMPLETION OF SKILL ASSESSMENT SPECIFICATION

This Skill Competition is classed as "fault finding" on all days, therefore no Instructor, Coach and Competitor communication during the competition time will be allowed.

Module – Mechanical Assembly, Fabrication and Design Challenge

- Part Modelling;
- Assembly Modelling;
- Sheet Metal Parts and Assemblies;
- Dimensioning, Tolerances including GDT;
- Surface Texture
- Fabrication Drawing Details;
- Fulfilment of the Design Brief (part judgement);
- Physical Simulation (part judgement);
- Exploded view (simulation) (part judgement);
- Photo rendering (part judgement);
- 3D Printing (part judgement).
- Drawing Views and Presentation (part judgment);

3 THE TEST PROJECT

3.1 FORMAT/STRUCTURE OF THE TEST PROJECT

Use of Autodesk Inventor Professional Version 2020.

Test project will be divided into **Two (Project 1 and Project 2).** Skills that could be tested in the Project module could cover:

- Sheet metal parts;
- Frame structures and assemblies;
- Welded parts and assemblies;
- Mechanical parts and assemblies;
- Detail drawing;
- Functional animation and photo rendering;
- Modification of a product to fulfil and design brief;
- 3D printing
- 3D scanning file

A combination of the above skills is allowed in each projects with different standards to be tested in each projects.

3.2 TEST PROJECT DESIGN REQUIREMENTS

The Competition could covering the following:

(six hours) – Mechanical Assembly, Fabrication and Design Challenge:

Data:

- Finished drawing of components or assemblies;
- 3D models of components or assemblies;
- Nomenclature;
- Layout (assemblies and components);

- Technical specifications for the design change to be applied;
- Design brief;
- All necessary additional information.

Work requested:

- To Produce models of components from detail drawings;
- Produce functional assembly(s) from given data;
- Implement the design change;
- Autodesk Inventor Design Accelerator may be used to generate parts and assemblies;
- Produce detail drawing(s) for manufacture;
- Input components from Inventor Content Centre;
- Produce assembly drawing(s);
- Produce exploded views;
- Produce physical simulations using Autodesk Inventor Studio;
- Produce photo rendered images using Autodesk Inventor Studio.
- 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;
- 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.

General information:

- Drawing plotted on sizes A1 and smaller;
- Charts, table and documents printed by laser printers on paper sizes A3;
- Screenshots, rendering on color printer to a maximum size of A3;
- Files, components, assemblies, etc. according to the instructions for the test;
- The final printing will take place after the end of competition and will done by Experts;
- Submission file in format PDF, may be asked to reduce the paper waste;

4 SKILL MANAGEMENT AND COMMUNICATION

4.1 COMPETITOR INFORMATION

- Other Competition-related information will be informed by Worldskills Malaysia.

5 MATERIALS AND EQUIPMENT

5.1 INFRASTRUCTURE LIST

The Infrastructure List details all equipment, materials and facilities provided by the Competition Organizer.

The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Items supplied by the Competition Organizer are shown in a separate column.

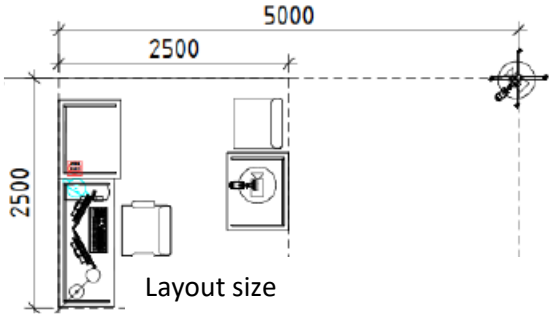
At each Competition, the chief Judge must review, audit, and update the Infrastructure List in partnership with the Technical Observer in preparation for the Competition. The chief Judge must advise the Director of Skills Competitions of any requests for increases in space and/or equipment.

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

5.2 PROPOSED WORKSHOP AND WORKSTATION LAYOUTS

Propose Competitor working layouts for participation institution. Refer to Infrastructure list for detail.

Competitor Working Area



Layout size

6 APPENDIXES

6.1 APPENDIX ONE – CAD SOFTWARE (AUTODESK INVENTOR) BASE FUNCTIONALITY LIST

- **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 behavior;
  - 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