# WorldSkills Malaysia (WSM) University Challenge 2021

# TECHNICAL DESCRIPTION

# 05-Mechanical Engineering CAD

(Adopted from WSC2019_TD05_EN with modification)

**ORGANIZED BY:**
**JABATAN PEMBANGUNAN KEMAHIRAN, KEMENTERIAN SUMBER MANUSIA**
**UNIVERSITI KUALA LUMPUR – MALAYSIA FRANCE INSTITUTE (UNIKL MFI)**

The Technical Description consists of the following:

# 1. INTRODUCTION

## 1.1. NAME AND DESCRIPTION OF THE COMPETITIONS

### 1.1.1 The name of the skill trade 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 competition.

### 1.1.4 Age limit of Competitors

The Competitors must not be older than 25 years in the year of the competition.

# 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 competition is intended to reflect international best practice as described by the WSSS, and to the extent that it can. The Standards Specification is therefore a guide to the required training and preparation for the competition. In the 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 competition. However, section 5 (with remark ‘*5’) will not be tested in this competition.

## 2.2 **STANDARDS SPECIFICATION**

| SECTION | | RELATIVE IMPORTANCE (%) |
|---|---|---|
| **1** | **Work organization and management** | **10** |
| | The individual needs to know and understand:<br>• The various purposes and uses for CAD designs<br>• Current internationally recognized standards (ISO)<br>• Standards currently used and recognized by industry<br>• Health and safety legislation and best practice including specific safety precautions when using a visual display unit (VDU) and in a workstation environment<br>• Relevant theory and applications of mathematics, physics, and geometry<br>• Technical terminology and symbols<br>• Recognized IT systems and related professional design software<br>• The importance of accurate and clear presentation of designs to potential users<br>• The importance of effective communications and inter-personal skills between co-workers, clients, and other related professionals<br>• The importance of maintaining knowledge and skill in new and developing technologies<br>• The role of providing innovative and creative solutions to technical and design problems and challenges | |
| | The individual shall be able to:<br>• Apply consistently the internationally recognized standards (ISO) and standards currently used and recognized by industry<br>• Apply and promote health and safety legislation and best practice in the workplace<br>• Apply a thorough knowledge and understanding of mathematics, physics and geometry to CAD projects<br>• Access and recognize standard component and symbol libraries<br>• Use and interpret technical terminology and symbols used in preparing and presenting CAD drawings<br>• Use recognized IT systems and related professional design software to consistently produce high quality designs and interpretations<br>• Deal with systems problems such as error messages received, peripherals which do not respond as expected, and obvious faults with equipment or connecting leads<br>• Produce work that consistently meets high standards of accuracy and clarity in the design and presentation of designs to potential users<br>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<br>• Explain complex technical images to trainers and non-trainers, highlighting key elements<br>• Maintain proactive continuous professional development in order to maintain current knowledge and skill in new and developing technologies and practices<br>• Provide and apply innovative and creative solutions to technical and design problems and challenges<br>• Visualize the desired product to fulfil the client's brief accurately | |
| 2 | **Materials, software, and hardware** | **5** |
| | The individual needs to know and understand:<br>• Computer operating systems to be able to use and manage computer files and software correctly<br>• Peripheral devices used in the CAD process<br>• Specific specialist technical operations within design software<br>• The range, types and uses of specialist product available to support and facilitate the CAD process<br>• The production process for designs<br>• The limitations of design software<br>• Formats and resolutions<br>• The use of plotters and printers | |
| | The individual shall be able to:<br>• Power up the equipment and activate the appropriate modelling software<br>• Set up and check peripheral devices such as keyboard, mouse, 3D mouse, plotter, and printer<br>• Use computer operating systems and specialist software to create and manage and store files proficiently<br>• Select correct drawing packages from an on-screen menu or graphical equivalent<br>• Use various techniques for accessing and using CAD software such as a mouse, menu, or tool bar<br>• Configure the parameters of the software<br>• Plan the production process effectively to produce efficient work processes<br>• Use plotters and printers to print and plot work | |
| **3** | **3D modelling** | **30** |
| | The individual needs to know and understand:<br>• Software Programmed in order to be able to configure the parameters of the software<br>• Computer operating systems to use and manage computer files and software<br>• Mechanical systems and their functionality<br>• Principles of technical drawing<br>• How a component is assembled | |

| | | |
|---|---|---|
| | The individual shall be able to:<br>• Model components, optimizing the constructive solid geometry<br>• Create families of components<br>• Ascribe characteristics to the materials (density)<br>• Ascribe colors and textures to the components<br>• Produce assemblies from 3D models of components<br>• Structure assemblies (sub-assemblies)<br>• Review base information to plan work effectively<br>• Access information from data files<br>• Model and assemble base components of project pieces<br>• Estimate approximate values for any missing dimensions<br>• Assemble modelled parts into sub-assemblies as required<br>• Apply graphics decals such as logos as required onto images<br>• Save work for future access | |
| **4** | **Create photo rendered images (2D) and creation of animations** | **10** |
| | The individual needs to know and understand:<br>• The use of lighting, scenes, and decals to produce photo rendered images<br>• How to demonstrate the working of an image | |
| | The individual shall be able to:<br>• Save and label images to access for further use<br>• Interpret source information and accurately apply to the computer-generated images<br>• Apply material properties using information supplied from source drawings<br>• Create photo rendered images of components or assemblies<br>• Adjust colors, shading, backgrounds, and camera angles to highlight key images<br>• Use camera settings to show better angles of the project<br>• Print completed images for presentation purposes<br>• Create functions relative to the operation of the system being designed using industry programmes.<br>• Create animations that demonstrate how different parts work or are assembled | |
| ***5** | **Reverse engineering of part models** | **15** |
| | The individual needs to know and understand:<br>• Materials and processes for obtaining unprocessed work pieces:<br>• Castings<br>• Welding<br>• Machining<br>• Simulation<br>• The process to transfer a real object to a 3D image/3D model and then to a technical drawing | |

| | | |
|---|---|---|
| | The individual shall be able to:<br>• Determine dimensions on physical parts by using industry accepted instruments<br>• Create freehand sketches<br>• Use measuring instruments to produce accurate replicas • 3D Scanning of models | |
| **6** | **Technical drawing and measuring** | **30** |
| | The individual needs to know and understand:<br>• Working drawings in ISO standard together with any written instruction<br>• Standards for conventional dimensioning and tolerancing and geometric dimensioning and tolerancing appropriate to the ISO standard<br>• Rules of technical drawing and the prevailing latest ISO standard to govern these rules<br>• The use of manuals, tables, list of standards, and product catalogues | |
| | The individual shall be able to:<br>• Generate working drawings in ISO standard together with any written instructions<br>• Apply standards for conventional dimensioning and tolerancing and geometric dimensioning and tolerancing appropriate to the ISO standard<br>• Apply the rules of technical drawing and the prevailing latest ISO standard to govern these rules<br>• Use manuals, tables, lists of standards, and product catalogues<br>• Insert written information such as explanation balloons and parts lists with more than one column using annotation styles that meet ISO standards<br>• Create 2D detail technical drawings<br>• Create exploded isometric views | |
| | **Total** | **100** |

# 3. THE TEST PROJECT

## 3.1. GENERAL NOTES

The Test Project will not cover areas outside the Standards Specification or affect the balance of marks within the Standards Specification other than in the circumstances indicated by Section 2.

The Test Project will enable knowledge and understanding to be assessed solely through their applications within practical work. The Test Project will not assess knowledge of WorldSkills rules and regulations. This Technical Description will note any issues that affect the Test Project's capacity to support the full range of assessment relative to the Standards Specification. Section 2.1 refers.

## 3.2. FORMAT/STRUCTURE OF THE TEST PROJECT

The Test Project is a series of TWO standalone modules.

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

- Sheet metal parts;
- Frame structures and assemblies;
- Welded parts and assemblies;
- Mechanical parts and assemblies;
- Detail and/or Fabrication drawing;
- Functional animation and photo rendering;

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

## 3.3. TEST PROJECT DESIGN REQUIREMENTS

The Competition is divided into TWO (2) modules covering the following categories:

**(Six hours)** – Mechanical Assembly, detailed drawing, and Design Challenge:

**Data:**

- Finished drawings / layout of components of assemblies;
- 3D models of components or assemblies;
- Technical specifications for the design change to be applied;
- Design brief;
- Nomenclature;
- All necessary additional information.

**Work requested:**

- To produce models of components from detail drawings;
- Produce detail drawing(S) for manufacture;
- Produce functional assembly(s) from given data;
- To input components from Inventor Content Centre;
- 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:**

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

**(Six 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.
- One animation showing full exploded or collapsing view sequence in file format .avi or other formats by request;

**Results expected:**

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

**General information:**

- Use of Autodesk Inventor Professional 2022.
- PDF Print are required to all Drawing for online marking.
- Drawing plotted on sizes A1 and smaller;
- Charts, table and documents printed on paper sizes A3;
- Screenshots, rendering to a maximum size of A3;
- Files, components, assemblies, etc. according to the instructions for the test;

## 3.4. TEST PROJECT CIRCULATION

The Test Project is not circulated.

# 4. MATERIALS AND EQUIPMENT

## 4.1. INFRASTRUCTURE LIST

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

The detail of Infrastructure List is show in Appendix, items 6.3.

The Infrastructure List specifies the items and quantities required for participant to participate in this competition. 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.

## 4.2. MATERIALS, EQUIPMENT, AND TOOLS PREPARED BY COMPETITORS

- Compendium of standards;
- Technical manuals;
- Instruments for freehand sketching (plastic tools such as rulers, set square, angle protractor, etc.) if needed

## 4.3. MATERIALS AND EQUIPMENT PROHIBITED IN THE SKILL AREA

All materials and equipment brought by Competitors to competition area will have to be presented to the chief judges/judges using cameras.

## 4.4. PROPOSED COMPETITOR WORKSTATION LAYOUTS

The detail of proposed competitor workstation layout is show in Appendix, item 6.4.

# 5. SKILL-SPECIFIC RULES

Skill-specific rules cannot contradict or take priority over the competition Rules. They do provide specific details and clarity in areas that may vary from competition to competition. This includes but is not limited to personal IT equipment, data storage devices, internet access, procedures and workflow, and documentation management and distribution.

| TOPIC/TASK | SKILL-SPECIFIC RULE |
|---|---|
| Use of technology – USB, memory sticks | • No external memory devices are to be connected to the Competition computer unless under the supervision of the Chief judge and Deputy Chief judge.<br>• Competitors are not allowed to load any digital data to their Competition computers others than stated in IL. |
| Communication and contact between compatriot Trainer, Digital Workshop Manager and Competitor | • Trainer can be in the workshop or at home.<br>• Digital Workshop Manager and competitor must be in workshop Area (excl. workshop area is a competitor home, in this case there are no Digital Workshop Manager and Competitor bears all responsibility for workplace, cameras etc.)<br>• No communication between Workshop Manager/trainer/coach and Competitor all the time unless required.<br>• No communication during breaks or lunch time between Workshop Manager/trainer/coach and Competitor. |

# 6. APPENDIX

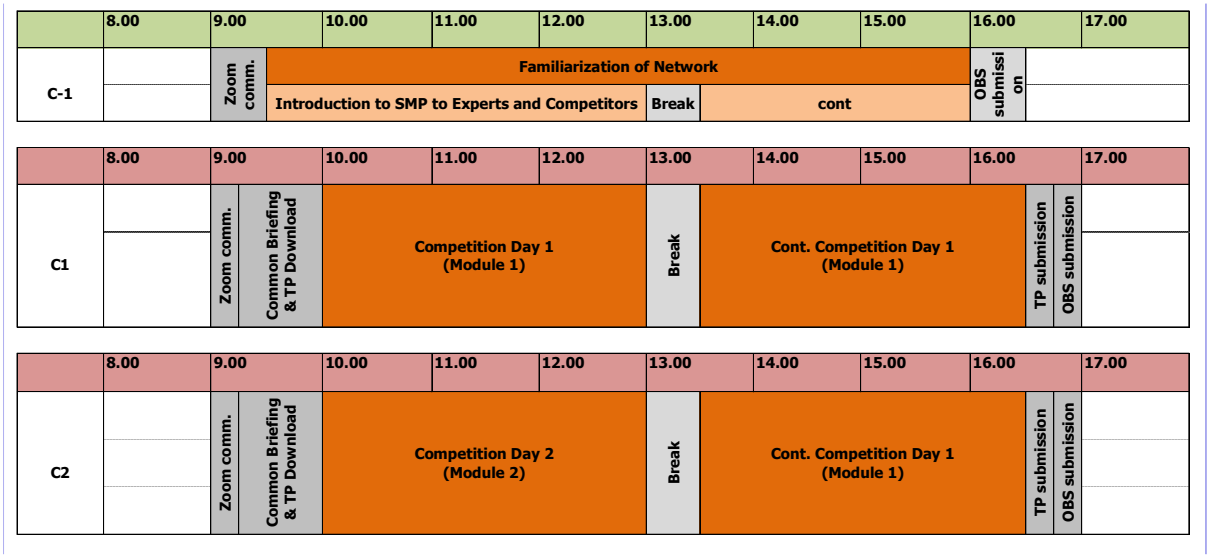
## 6.1. MODULES DISTRIBUTION OF MARK.

Each Test Project module with be worth as follows:

| Section | Criterion | Marks | | |
|---|---|---|---|---|
| | | Judgement (if applicable) | measurement | Total |
| A | Module 1 – Mechanical Assemblies, Detail Drawing for Manufacture and Design Challenges. | 5 | 45 | 50 |
| B | Module 2 – Mechanical Fabrication | 5 | 45 | 50 |
| | Total | 10 | 90 | 100 |

## 6.2. PROPOSE SKILL MANAGEMENT PLAN (SMP) – TIMETABLE

(Instruction details will be supply separately by agreement of all trainers)

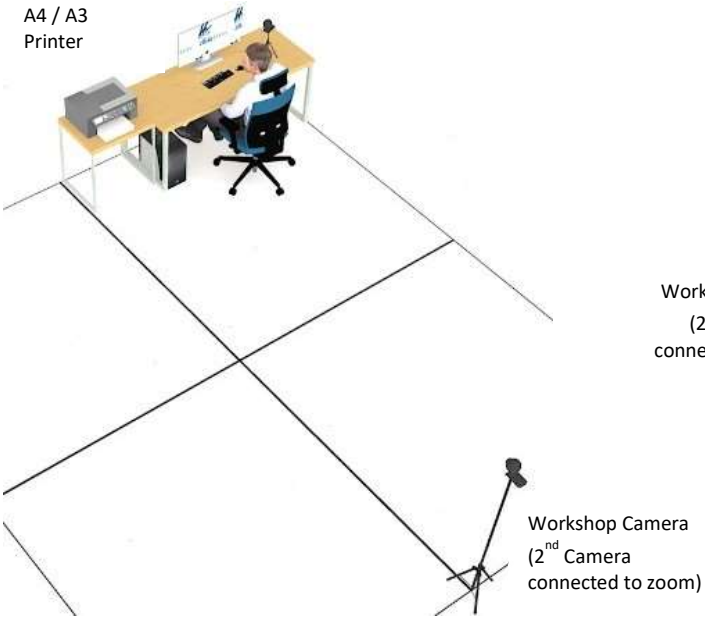


## 6.3. **INFRASTURCTURE LIST**

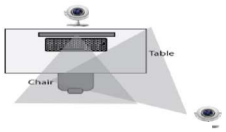
| Skill Work Area | Category | Quantity | Description |
|---|---|---|---|
| **Competitors Work Area** | **Work Area** | 1 for workplace | 2.5m x 2.5m or higher |
| | **Power requirements** | 4 sockets for workplace | 220 V (2 kW) |
| | **Furniture** | 1 pcs per Competitor | Desk Lamp |
| | | | Side Table (850x670x750) |
| | | | Computer Table (1400x600x750) |
| | | | Chair (650x720x1120) |
| | | 1 pcs for Workshop Digital Manager | Table (Workshop manager) |
| | | | Chair (Workshop manager) |
| | | | Dustbin (sharing) |
| | **IT (Equipment)** | 1 pcs per Competitor | Computer - refer spec for detail |
| | | | Keyboard (QWERTY) |
| | | | Mouse (Wireless) Logitech |
| | | | Network / Internet (Stable internet connection of competitor's PC and 2nd cameras) |
| | | | UPS (2000w) |
| | | | 2 pc's of Cameras (One camera for workshop, one camera for competitor workplace) |
| | | | Cable HDMI (5 m) |
| | | | A4 / A3 Printer if needed for printing. |
| | | 1 pcs For Workshop Digital Manager | Desktop Computer C/W Monitor 24" (dual monitor is recommended) |
| | | | Network / Internet (Stable internet connection of competitor's PC, 1st camera and 2nd cameras) |
| | | 1 pcs per Skill (on competitor demand) | Clock (Analog) |
| | **IT (Software)** | 1 pcs per Competitor | Autodesk Inventor Professional 2022 (English Version) |
| | | | Microsoft Office (doc/docx, xls/xlsx) |
| | | | Acrobat Reader / PDFViewer |
| | | | Autodesk Design Review |
| | | | Screen capture software (OBS Studio or equivalent) |
| | | | Zoom Software for web meetings |
| | | | WinRAR (or WinZip, 7zip etc.) |
| | | 1 pcs For Workshop Digital Manager | Zoom Software for web meetings |
| | **Stationery (as request by competitor if needed)** | 1 pcs per Competitor | Steel ruler |
| | | | 80g A3 Paper / 80g A4 Paper |
| | | | Calculator |
| | | | Pencil 2B - Staedtler (c/w sharpener) |

| | | | |
|---|---|---|---|
| **Computer Workstation (Recommended Specification)** | **IT Software** | 1 unit per competitor | **CPU TYPE**<br>3.0 GHz or greater, 4 or more cores |
| | | | **MEMORY**<br>16GB RAM or higher / HDD/SDD 256Gb or higher |
| | | | **GRAPHICS**<br>4 GB GPU with 106 GB/S Bandwidth and DirectX 11 compliant |
| | | | **HARD DRIVE**<br>1 TB 7200 rpm SATA |
| | | | **Monitor** LED **x 2** (Dual Monitor is recommended) |
| | | | **Display Resolution**<br>3840 x 2160 (4K); Preferred scaling: 100%, 125%, 125% or 200% |
| | | | **OS**<br>64-bit Microsoft® Windows® 10 Semi-Annual Channel |
| | | | **Spreadsheet**<br>Full local install of Microsoft® Excel 2010, 2013, 2016 or 2019 for iFeatures, iParts, iAssemblies, Global BOM, Parts Lists, Revision Tables, spreadsheet-driven designs and Studio animation of Positional Representations. |

## 6.4. **PROPOSED COMPETITOR WORKSTATION LAYOUTS**



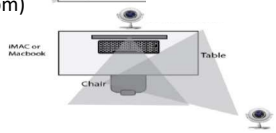

**1 Competitor**




Workshop Camera
(2nd Camera
connected to zoom)

**2 Competitors**

Workshop Camera
(2nd Camera
connected to zoom)




Workshop Camera
(2nd Camera
connected to zoom)

Note:

1. The main communication platform will be Zoom.
2. Google drive will be used for data transfer.
3. Competitor can be in the workshop or at home.
   3.1. **Main Equipment's** for competitor (as listed in IL):

*(How to prepare OBS Studio for capturing 2 displays:*
*https://www.youtube.com/watch?v=KhX7lj6CDvo)*

3.2. ***Competitor's camera***; Camera (Web-camera/camera of laptop/smartphone camera etc.) workplace of competitor (table, keyboard, PC box, screens, printer). It is better to place camera in the side and a little bit back and up from competitor.

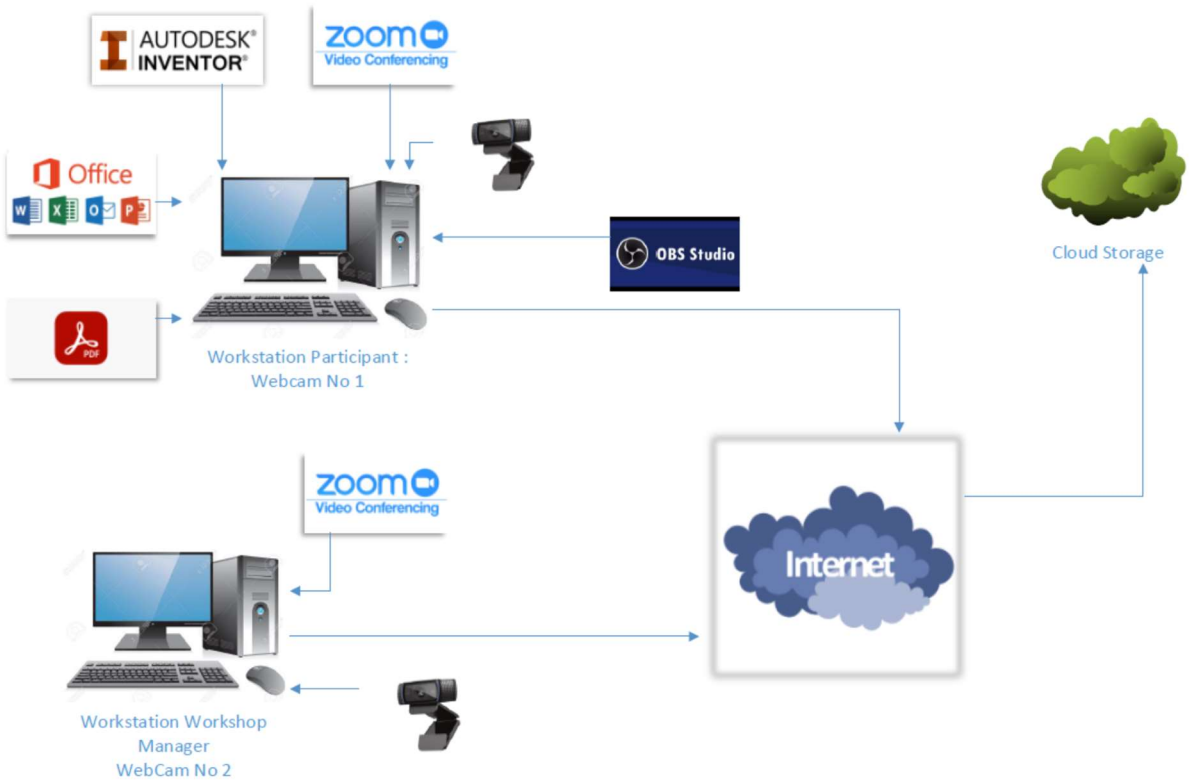
3.3. ***Workshop camera;*** 1 PC / laptop / smartphone with camera and internet connection.

Camera view setup: –

Workshop camera Competitor's camera

It is recommended to check camera positions and screen recording software before competitions. Software needs to produce records for all day (in one file or number of files). Temporary personal cloud storage required (can be erased after competitions).

## 6.5. VIRTUAL CONNECTION SETUP



## 6.6. 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 behaviour;
  - Autodesk Exchange App Manager;
  - Custom command aliases;
  - Custom shortcut keys;
  - Customize info tips in Inventor

- **Parts**
  - 2D sketches;
  - 3D sketches;
  - Dimensions;
  - Constraints;
  - Work geometry and work features;
  - Part modelling overview;
  - Part features;
  - Plastic Features;
  - I-Features and iParts;
  - Part faces and bodies;
  - Solid modelling;
  - Representations;
  - Part Analysis;
  - Repair Environment;
  - Construction Environment;
  - Sheet metal parts

- **Assemblies**
  - Build assemblies;
  - Bills of materials:

- Bills of materials overview;
- Manage item numbers in bills of materials;
- Structure of bills of materials;
- Bill of Materials Editor;
- Parts lists and BOMs in iAssemblies
- Representations
- Functional design

- **Design Accelerator**
  - Bolted Connection;
  - Shaft;
  - Involute Splines;
  - Parallel Splines;
  - Key Connection;
  - Disc Cam;
  - Linear Cam;
  - Spur Gears;
  - Bevel Gears;
  - Worm Gears;
  - Bearing;
  - V-Belts;
  - Synchronous Belts;
  - Roller Chains;
  - Clevis Pin;
  - Joint Pin;
  - Secure Pin;
  - Cross Pin;
  - Radial Pin;
  - O-ring

- **Component Generators**
  - Bolted Connection Component Generator;
  - Shaft Component Generator;
  - Parallel Splines Component Generator;
  - Involute Splines Component Generator;
  - Parallel Key Connection Generator;
  - Cam Component Generators;
  - Spur Gears Component Generator;
  - Bevel Gears Component Generator;
  - Worm Gears Component Generator;
  - Bearing Component Generator;
  - Plain Bearing Calculator;
  - Compression Spring Component Generator;
  - Extension Spring Component Generator;
  - Torsion Spring Component Generator;
  - Belleville Spring Component Generator;
  - V-Belts Component Generator;
  - Synchronous Belts Component Generator;
  - Roller Chains Generator;
  - Clevis Pin Component Generator;
  - Pin Component Generators;
  - O-Ring Component Generator
  - Calculators;

- **Content Centre:**

- Configuration of Content Centre libraries;
- Manage libraries on the server;
- Migrate or synchronize user libraries;
- Navigate in Content Centre;
- Search in Content Centre;
- Content Centre Consumer;
- Auto Drop;
- Refresh Standard Components;
- Content Centre Editor;
- Publish parts and features in Content Centre
- Build structural frames with Frame Generator
- Frame Generator;
- Apply or Modify End Treatments;
- BOMs and Cut Lists;
- Structural Shape Authoring;
- Tips for generating frames;
- Frame Generator browser
- Weldments;

- **Weldments environment**
  - Templates for weldments;
  - Strategies for designing weldments;
  - Weld bead feature types;
  - Weld feature groups;
  - Welding symbols on models

- **Drawings**
  - Create drawing views
  - Develop drawings for large assemblies;
  - Design view representations in drawing files;
  - Drawing views;
  - Alignment, orientation, and rotation of drawing views;
  - Sketches in drawings;
  - Project geometry to drawing sketches;
  - Section views;
  - Detail Views;
  - Overlay Views;
  - Break Operations;
  - Crop Operations;
  - Slice Operations;
  - Create drawing views of surfaces;

- **Drawing annotations**
  - Suppressed annotations;
  - Dimensions in drawings;
  - Centre lines and centre marks;
  - Symbols, sketched symbols, and blocks;
  - Tables;
  - Hole notes;
  - Hole tables;
  - Balloons;
  - Parts lists;
  - Text in drawings;

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

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