

# WORLDSKILLS SINGAPORE 2023

## Technical Description



### ADDITIVE MANUFACTURING

#### 1. Skills Competition

- This competition covers the important aspects of Additive Manufacturing skills.
- Conducted as an individual event, competitors are given 15 hours over 3 days to complete all test projects.
- The test project is structured into modules covering, 3D CAD modelling, design optimisation, build preparation for 3D printing, reverse engineering and post-processing activities.

#### 2. Scope of Work

Competitors must be able to demonstrate competencies in the following areas:

<b>Section</b>	<b>Relative importance (%)</b>
<b>2.1 3D CAD Modelling</b>	<b>15</b>
<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• 3D CAD modelling, parametric feature creation tools</li> <li>• Principles of measuring instruments and their accuracy</li> <li>• Fundamentals of engineering drawing notations, symbols and annotations</li> <li>• Interpretation of orthographic views of engineering drawings</li> </ul> <p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Visualize and translate a physical part into 2D drawing.</li> <li>• Use metrology instruments to measure physical models.</li> <li>• Read 2D engineering drawings.</li> <li>• Create 3D models using NX CAD software.</li> </ul>	
<b>2.2 Design Optimisation (Metal)</b>	<b>20</b>
<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Principles of topology optimization</li> <li>• Constraints, Links and boundary conditions</li> <li>• Stress, Strain and Safety factor</li> </ul>	

*The organisers reserve the right to update the Technical Description whenever necessary*

<b>Section</b>	<b>Relative importance (%)</b>
<p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Create mass optimised models.</li> <li>• Select design space non design space.</li> <li>• Apply load cases, boundary conditions and constraints.</li> <li>• Reconstruction of 3D model from optimised shape</li> <li>• Verification of optimised and reconstructed shapes</li> <li>• Prepare 3D models for printing.</li> <li>• Support structure parameters</li> </ul>	
<b>2.3 Functional Design (Polymer)</b>	<b>20</b>
<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Functional design principles</li> <li>• Component operational functionality (Design fit for purpose)</li> <li>• Model preparation, simulation and analysis</li> <li>• Model and support material properties</li> <li>• Preparation of and setup of AM machine</li> </ul> <p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Prepare 3D models for printing.</li> <li>• Support structure parameters</li> <li>• Simulate and analyse printing processes.</li> <li>• Prepare built platform and establish parameters.</li> <li>• Calibration of print quality</li> <li>• Post process final part</li> <li>• Deliver the part to the appropriate location and/or personnel as required by the organization.</li> </ul>	
<b>2.4 3D Scanning</b>	<b>15</b>
<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Principles of equipment operation for 3D digitizing</li> <li>• Technical characteristics of equipment for accuracy and speed of optical 3D digitizing</li> </ul> <p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Perform equipment's adjustment and calibration.</li> <li>• Perform 3D digitizing for various objects (different materials, surface characteristics and difficulty of geometry)</li> <li>• Create editable CAD models from scan data (polygonal models)</li> <li>• Create water-tight scan image for reverse engineering.</li> </ul>	

<b>Section</b>	<b>Relative importance (%)</b>
<b>2.5 Reverse Engineering</b>	<b>20</b>
<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Scan-to-CAD software applications; CAD, CAE and optimization software</li> <li>• Techniques for efficient reverse engineering</li> <li>• Knowledge on conversion from 3D Scan to 3D CAD model</li> </ul> <p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Re-create 3D CAD models from scan files.</li> <li>• Create editable CAD models from scan data (polygonal models)</li> <li>• Create 2D engineering drawings from 3D CAD model.</li> </ul>	
<b>2.6 AM Theory</b>	<b>5</b>
<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Range of available industrial AM technology.</li> <li>• Limitations of the different AM technologies.</li> <li>• Benefits of AM for industrial design</li> </ul> <p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Answer series of theoretical questions</li> </ul>	
<b>2.7 Work Organisation and Management</b>	<b>5</b>
<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> <li>• Standards for environmental protection, safety, hygiene and accident prevention related to the use of 3D printers, 3D scanners and computer workstations.</li> <li>• The importance of planning and time management during work</li> <li>• The importance of prioritizing</li> </ul> <p>The individual shall be able to:</p> <ul style="list-style-type: none"> <li>• Maintain a safe, tidy, and efficient work area.</li> <li>• Use planning and time management during the work.</li> <li>• Estimate and plan the time, sequence, and duration of task, steps and produce work that fully meets the specifications.</li> </ul>	

### **3. Technical Support**

- Half-day familiarisation of competition venue, equipment will be provided prior to the competition. Technicians will be on site to brief competitors with the equipment functions and processes. Competitors not familiar with the competition equipment are encouraged to attend the training to reduce the risk of injury to themselves and damage to the equipment.

### **4. Assessment**

- Competitors will be assessed based on measurement (objective) and judgement (subjective) marking.
- The Marking Scheme developed by the Independent Test Project Expert will comprise Aspects with clear calculations and/or added detail.
- The assessment criteria and relative weighting of marks are as follows:

<b>Module</b>	<b>% of total marks</b>
<b>3D CAD Modelling</b>	<b>15</b>
<ul style="list-style-type: none"> <li>• Correct position of features</li> <li>• Correct size (measurements) of features</li> <li>• Parametric features</li> <li>• Correct volume of model</li> <li>• Absence of noise objects and errors</li> <li>• Create 2D engineering drawings while adhering to engineering standards e.g. layout, annotations etc....</li> </ul>	
<b>Design Optimisation (Metal)</b>	<b>20</b>
<ul style="list-style-type: none"> <li>• Correct design space non design space</li> <li>• Correct load cases, boundary conditions and constraints</li> <li>• Best optimised models</li> <li>• Best reconstructed of 3D model from optimised shape</li> <li>• Prepare part of printing (DfAM)</li> <li>• Final Printed part</li> </ul>	
<b>Functional Design (Polymer)</b>	<b>20</b>
<ul style="list-style-type: none"> <li>• Design functional component based on industrial problem statement.</li> <li>• Ensure critical design features are included.</li> <li>• Ensure dimensioning is correct.</li> <li>• Design is fit for purpose.</li> <li>• 3D print prototype.</li> <li>• Ensure printed part is post-processed adequately.</li> </ul>	
<b>3D Scanning</b>	<b>15</b>
<ul style="list-style-type: none"> <li>• Final scanned component includes all critical features.</li> <li>• Ensure critical features are clear.</li> <li>• Final scanned component to be watertight.</li> <li>• Scanned file optimised.</li> <li>• The absence of defects and mistakes in stitching (there are</li> </ul>	

<b>Module</b>	<b>% of total marks</b>
<p>not any duplications, shifts, offsets, skews of surfaces of the polygonal model)</p> <ul style="list-style-type: none"> <li>• Data sufficiency for the geometry restoration (the data must allow determining the shape and mutual placement of all surfaces)</li> <li>• Properness of alignment of a polygonal model</li> </ul>	
<b>Reverse Engineering (Scan file and physical part)</b>	<b>20</b>
<ul style="list-style-type: none"> <li>• Ensure critical features are clear.</li> <li>• Ensure dimensions are accurate.</li> <li>• Create 2D engineering drawing for validation.</li> </ul>	
<b>AM Theory</b>	<b>5</b>
<ul style="list-style-type: none"> <li>• Range of available industrial AM technology.</li> <li>• Limitations of the different AM technologies.</li> <li>• Benefits of AM for industrial design</li> </ul>	
<b>Work Organisation and Management</b>	<b>5</b>
<ul style="list-style-type: none"> <li>• Maintain a safe, tidy, and efficient work area.</li> <li>• Use planning and time management during the work.</li> <li>• Estimate and plan the time, sequence, and duration of task, steps and produce work that fully meets the specifications</li> </ul>	

## **5. Major Tools and Materials**

The following tools and materials will be used in the competition:

### **Measuring Tools**

- Vernier calliper (0~150 mm).
- Post processing finishing tools.

### **Equipment/Accessories**

- Computer.
- 3D Printer FDM (Fused Deposition Modelling), Raise 3D E2 with “ideaMaker” Slicer software.
- Portable Handheld scanner, EinScan Pro HD with industrial pack (tripod & electrical turntable). All competitors will bring their scanner. To use a different brand/ model, the competitor must seek approval from the TWG prior to the competition.
- CAD application software, Siemens NX12 with Topology optimization module.
- Reverse Engineering software, Geomagic Design X.
- Slicer software, GrabCAD.

### **Print Materials**

- ABS (Acrylonitrile butadiene styrene).