

*Standards and
Assessment Guide*

**Additive
Manufacturing**

Introduction

Welcome to the Standards and Assessment Guide (SAG), a comprehensive resource designed to support excellence in assessment practices for all skills competitions hosted at the WorldSkills Competition. A key component of the SAG is the commitment to continuous improvement through ongoing review, ensuring that these guides consistently reflect the latest industry innovations and high standards of assessment in an open and transparent manner.

Purpose

The primary purpose of this guide is to provide a structured framework for the consistent and fair assessment of each skill competition. It aims to ensure that all assessments are conducted with a high degree of accuracy, reliability, validity, and reflect global industry standards. By adhering to these guidelines, assessors can maintain the integrity of the competition and uphold the high standards associated with WorldSkills.

Note: this guide is not a replacement for the Marking Scheme and should only be used as a reference when required during the assessment process. Competitors are not allowed to have a copy of this SAG in the workshop in either digital or paper form.

Scope

This document covers general assessment practices applicable to a diverse range of industry sectors including:

- Manufacturing and Engineering Technology
- Information and Communication Technology
- Construction and Building Technology
- Transportation and Logistics
- Social and Personal Services
- Creative Arts and Fashion

Each skill competition has its unique requirements and benchmarks, which are detailed within sections of this guide. The consistency of assessment across each skill is the overarching principle, ensuring a unified approach to evaluating Competitor performance to the highest standards.

Key Components

The guide is structured into several key components, each addressing critical aspects of the assessment process:

Assessment Principles and Objectives

- Emphasis on fairness, transparency, and objectivity in assessments.
- Alignment with global industry standards and best practices.

Assessment Methods and Tools

- Description of various assessment methods in Measurement and Judgement.
- Guidance on the application of appropriate assessment tools and equipment (if applicable).

Criteria and Benchmarks

- Examples of assessment criteria and aspects for each skill, outlining the expected competencies and performance standards.
- Benchmarks for different levels of proficiency i.e. Judgement award range 0, 1, 2, 3 or Yes/No criteria alongside clear measurable descriptors.

Expert assessment requirements

- Completion of the Access Programme.
- Approved Curriculum Vitae (CV).
- Reaching 100% Expert preparedness.
- Full participation of online and in-person Mandatory Assessment Training (MAT).
- Completion of practical assessment testing at the Competition.

Quality Assurance and Improvement

- Monitoring and evaluation: Ensuring assessments are carried out correctly and produce reliable results.
- Continuous improvement: Using feedback from Experts and Skill Competition Managers to enhance future assessments.
- Periodic review: Regularly updating processes to reflect current industry and WorldSkills standards.

Implementation

For effective implementation, this guide should be used for guidance purposes only and in parallel with the Technical Description for each skill. Experts are encouraged to familiarize themselves thoroughly with both the general guidelines and the particular requirements of their respective skill areas. Collaborative efforts between the Skill Management Team, Experts, and Competitors are vital for achieving the ultimate goal of global skills development.

Conclusion

The Standards and Assessment Guide embodies the commitment of the WorldSkills movement to nurturing talent and promoting the highest standards of vocational education and training worldwide. By providing clear and comprehensive guidance, we aim to empower Experts to conduct marking and assessment practices that are not only rigorous and equitable but also inspiring and transformative for all participants.

Thank you for your dedication to upholding these standards and contributing to the success of the WorldSkills Competition. Together, we can continue to champion skills excellence and celebrate the achievements of talented individuals from around the globe.

Skill 57 –Additive Manufacturing

Measurement

Measurement is used to assess accuracy, precision, and other performance that can be measured objectively. It is used where ambiguity must be avoided.

the total marks allocated to measurement marking may vary from competition to competition depending on the Test Project.

Aspect	WSOS section as per TD	Descriptor
1	7	Safe and reliable working: • Has the safety equipment been used? • Was the workplace kept tidy? • Was the equipment handled with care? • Was soiling avoided as far as possible and subsequently removed?
2	5	Communication: • Were the task parts correctly recorded and implemented? • Was the technical terminology correctly understood and used?
3	5	3D digitization • Has the equipment been calibrated correctly? • Was the equipment used correctly? • Was the equipment handled and used correctly? • Was the measurement object prepared correctly? • Was the appropriate resolution selected? • Is the data suitable for further use? • Are the dimensions correctly measured?

Aspect	WSOS section as per TD	Descriptor
4	5	Component optimization: • Was the right optimization approach chosen? • Were the correct boundary conditions set? • Has the optimization result been checked and validated? • Can the results achieved be explained? • Was the result converted into a printable model? • Have all the required aspects been considered? • Are correct loads applied?
5	5	Transfer to CAD: • Were all required steps performed? • Is the result modifiable in CAD? • Have all necessary repairs been carried out? • Were the correct tools used?
6	5	Transfer to CAD: • Were the tasks recorded correctly? • Do the print results fulfil the required task? • Are the required sizes within the required accuracy range? • Have the labelling dimensions been adhered to? • Was the orientation in the installation space selected correctly? • Was the print preparation carried out correctly? • Has the correct material been selected? • Were the correct printing parameters set?

Aspect	WSOS section as per TD	Descriptor
7	5	Finalization and post-processing: • Has all support geometry been removed? • Has the necessary chamfering/post-hardening been carried out? • Have dangerous burrs been removed? • Were the printing plates cleaned after printing? • Have the printers been restored to their original condition and prepared for a new print?
8	5	FFF-Print/DLP-Print: • Is there less number of single parts? • Is the correct material chosen? • Are the printer parameters set correctly? • Are the final dimensions, correct? • Is the post processing available with given tools? • Is the printed part free of defects?
9	5	Reachable Accuracies: • FFF-Printing: $\pm 0.2\text{mm}$ • DLP/SLA-Printing: $\pm 0.1\text{mm}$ • SLM-Printing: $\pm 0.2\text{mm}$ • Manual Measurement: $\pm 0.05\text{mm}$ • 3D-Scanning: $\pm 0.03\text{mm}$

Judgement

Judgement is used to assess the quality of performance about which there may be small differences of view when applying the external benchmarks.

The Resources column in the table below may include all kinds/formats of resources such as: a link to a YouTube video, a website link, an illustration, a photo, a reference to a book, and so on. It needs to be as detailed as possible to show the differentiation between 0, 1, 2, 3.

Generic rules:

The assessment group comprises three Experts plus one Expert who acts as the supervisor. The supervising Expert will replace an Expert in the marking group to prevent compatriot marking.

The difference of the three Experts' scores may not exceed 1. If this is the situation the Experts must re-score until there is a maximum difference of 1. As long as the three Experts judge within 1, the result can be entered into the CIS.

The total marks allocated to judgement marking may vary from competition to competition depending on the Test Project.

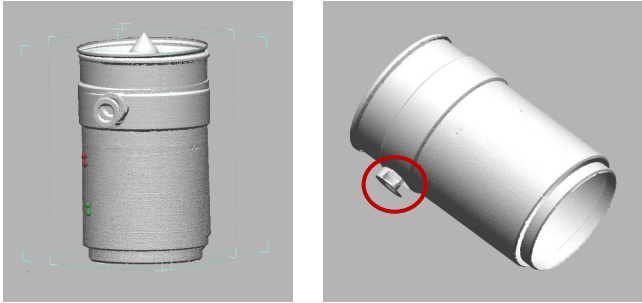
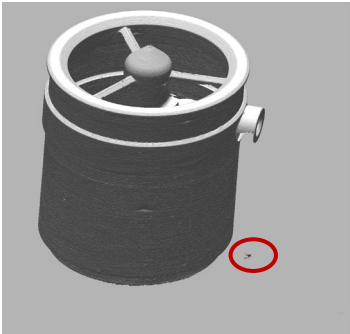
Aspect – Situation of workplace

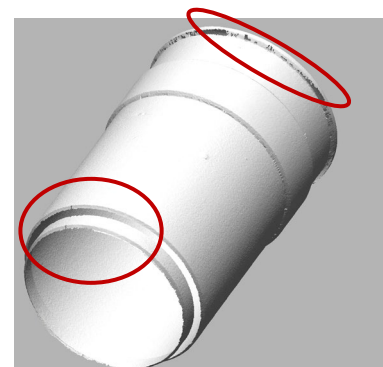
WSOS section as per TD	Score	Descriptor
1	0	- The workplace is untidy - Tools may be damaged
	1	The workplace is untidy, but the tools are stored separately according to their function
	2	The workplace is tidy, but the tools remain on the table after work
	3	The workplace is tidy, the tools are stowed away immediately after use and thus protected

Aspect – Safety equipment

WSOS section as per TD	Score	Descriptor
1	0	The safety equipment was not used at all, health risks were accepted
	1	Some safety equipment was used, but health risks and environmental damage were sometimes accepted
	2	Safety equipment was used, but environmental damage was accepted in some cases
	3	All safety equipment was fully utilized, and all risks were eliminated as far as possible

Aspect – 3D-Scanning

WSOS section as per TD	Score	Descriptor	Resource
3	0	- There are a lot of holes in the scan result - Fragments are present and difficult to remove afterwards	
	1	- There are some holes in the scan result - Fragments are present but easy to remove afterwards	

WSOS section as per TD	Score	Descriptor	Resource
	2	- There are very less holes in the scan result - Fragments are not present	
	3	The scan is error-free	

Aspect – Parts optimization

WSOS section as per TD	Score	Descriptor
4	0	The optimization result does not meet the required standards. The specified loads cannot be exceeded. If the component is used, there is a risk of danger
	1	Some specifications were not observed, not all forces can be adopted, risks in the use of the component are low
	2	All forces were correctly considered, there is no danger during use, other specifications were not taken into account in small areas
	3	All specifications were fully considered, the result can fulfil all requirements without restriction

Aspect – Regarding AM-specific design

WSOS section as per TD	Score	Descriptor
6	0	The components were designed regardless of the possibilities of the specified printing process. They could be manufactured conventionally and do not utilize the potential of AM.
	1	The utilization of AM potential can only be seen to a limited extent. Large potentials have been ignored.
	2	The potential of the specified printing process was largely utilized. However, there are other important possibilities for optimization
	3	The potential of the AM was fully utilized as far as possible in the given task

Aspect – Postprocessing

WSOS section as per TD	Score	Descriptor
6	0	Supporting material was completely dispensed with or used far too much. Further errors in the print preparation are recognizable and lead to poor printing results
	1	No support material or far too much was used. Other slicing errors are not recognizable.
	2	Support material was used, but some areas were insufficiently supported.
	3	The pressure riveting was carried out optimally. The orientation of the component and all parameters were set correctly.

Aspect – Printed parts quality

WSOS section as per TD	Score	Descriptor	Resource
	0	The surface is rough, individual layers are detached, individual areas show offsets and planes	

WSOS section as per TD	Score	Descriptor	Resource
	1	The surface is rough, the components are not suitable for industrial use and do not fulfil their purpose	

WSOS section as per TD	Score	Descriptor	Resource
	2	The surface and components are largely free of defects	

WSOS section as per TD	Score	Descriptor	Resource
	3	The surface is the best that can be achieved with the printing process, the components are otherwise largely free of defects	