worldskills

Standards and Assessment Guide

Mechatronics

v1.1

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 04 – Mechatronics

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
PLC	1, 2, 3, 4, 5,	Function to Reset the machine into a defined status like the Initial Position
		Function Quality is the proper process like required with all the Signals and Values displayed at the HMI and unknown Product selection
		Error handling in case of a Status signal or Emg. Stop process will be evaluate
Allocation	1, 2, 3, 6	I/O allocation of the wiring and checking functions and adjustments of components by using Workpieces, PLC-Simulation device and Multimeter.
Maintenance Y/N	2	Competitor took part of the Maintenance process or not. Function corrects. Time needed to maintain. Troubleshooting in Circuits
Working, Maintenance Time	3, 4, 7	Certain criteria must be fulfilled to get Marks here. Like 100% PLC and Allocation marks, 66,6 % of Judgment or special requirements must be fulfilled.
Process Time	7	Certain criteria must be fulfilled to get Marks here. Like 100% PLC, 66,6 % of Judgment or special requirements must be fulfilled
EE	4, 7	Certain criteria must be fulfilled to get Marks here. Like 100% PLC, 66,6 % of Judgment or special requirements must be fulfilled

Judgement

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 1: Cleanliness of the workplace and the station

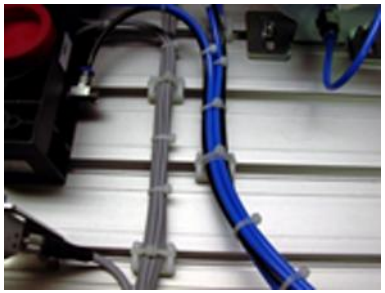
Aspect 1: Cleanliness of the workplace and the station	3 Points:	2 Points:	1 Point:	0 Points:
WSOS section as per TD: 2, 3	Ok: excellence: If all conditions below are fulfilled.	Ok: Professional / Still acceptable (~80% Solution): If there are one or a few minor deviations	Not ok: Optimization / rework necessary: If there is a major deviation or more than a few minor deviations.	Not ok: not acceptable: If the work is far from the standard specified
1.1	Tools must not be left on the stations, chairs, or the floor of workspace.			
1.2	Unused components and workpieces must be removed from the stations.			

1.3	Stations must be free of waste, off-cuts or any other debris. This also includes the inside of cable channels.	 

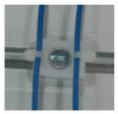
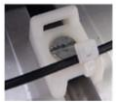
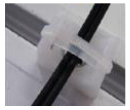
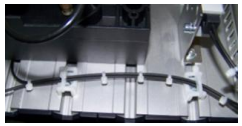
1.4	 Unused parts must be placed together on the table or in a box. Unused parts shall be separated from tools, waste, and consumables that the team has supplied. Also, Product documentation in EN have to be placed in the box	

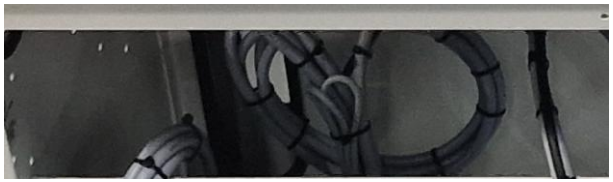
Aspect 1: Cleanliness of the workplace and the station	3 Points:	2 Points:	1 Point:	0 Points:
1.5	At the end of competition time, the workplace is tidy, including on the tables. The floor of the workspace shall be clean from waste generated from the competitor's work.			
1.6	Markings (tape, pencil, etc.) may be used during the tasks, but in that case, they must be removed completely before evaluation.			

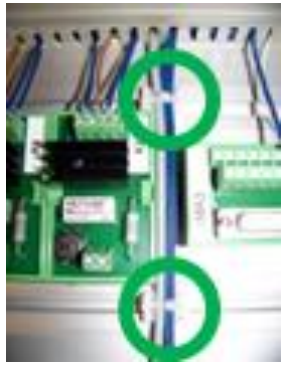
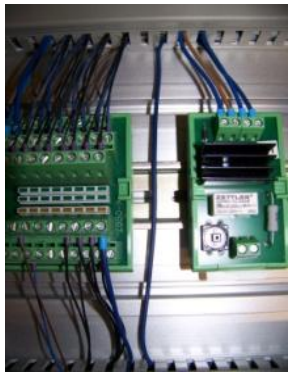
Aspect 2: Routing of tubes and cables

Aspect 2: Routing of tubes and cables	3 Points:	2 Points:	1 Point:	0 Points:
WSOS section as per TD: 3	Ok: excellence: If all conditions below are fulfilled.	Ok: Professional / Still acceptable (~80% Solution): If there are one or a few minor deviations	Not ok: Optimization / rework necessary: If there is a major deviation or more than a few minor deviations.	Not ok: not acceptable: If the work is far from the standard specified
2.1 Note Exception: when the cables and tubes are connected to a moving module. In this case routing all cables and tubes together is preferred.	Cables, tubes and water piping must be routed separately. Optical cables may be tied to electrical cables. 			

2.2	Remaining length of cut cable ties, A: A <= 1 mm 	
2.3 Cables and tube at a Module	All cables and tubes going downwards on a profile e.g. at the "Pick & Place" station have to be mounted with cable- holders and tie. Tubes and cables are allowed to combine together at a Module. 	
2.4	Distance between cable ties: <= 50 mm. This also applies to cables line under the profile plate, from modules over the profile plate to terminals on the wiring board in the visible area between the profile plate and the wiring board 	

Aspect 2: Routing of tubes and cables	3 Points:	2 Points:	1 Point:	0 Points:
2.5	     The only acceptable method for binding Cable / Wire / Optical fiber / Tubes is to use cable holders. Cables and tubes shall be tightened to the cable holder. The cable tie shall go through both sides of the holder. For single wire and for optical fiber it is allowed to use just one side.		  	 any pneumatic connector
2.6 Only to use on the basic profile plate. If limited amount on request possible to use standard cable holder.	if available velcro cable holder must be used before standard holder on the basic profile plate 			
2.7 Note: Exceptions can be announced in special cases.	 Distance between cable holders < = 120 mm Short connections between optical sensor and transmitter are also allowed.  .		   No coiling of the cables if proper cut to length is possible	

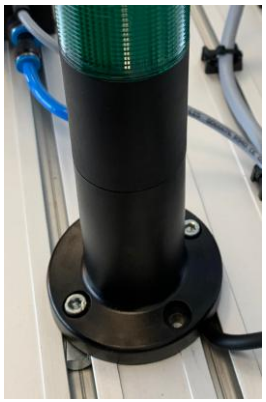
Aspect 2: Routing of tubes and cables	3 Points:	2 Points:	1 Point:	0 Points:
2.8 Exceptions apply to the winding of cables if no cable shortening is required.	Coiling cables inside the trolley, if not possible assembled at profile plates side hanging, with Velcro cable holder. Cables that are not shortened in a module must remain there.  		   	

2.9 Conductors passing over DIN rails or routed around sharp corners must be secured using 2 cable holders.		

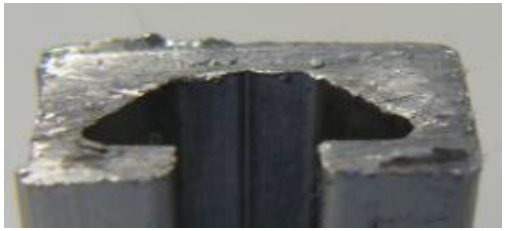
Aspect 2: Routing of tubes and cables	3 Points:	2 Points:	1 Point:	0 Points:
2.10	Airflow must not be restricted by kinks in the tubing, over-tight cable ties, etc.			
2.11	 No pneumatic tubes routed through cable channels.			
2.12	 All cables and tubes routed through a flexible cable duct / drag chain must be fixed to the end of the chain, using cable ties.			
2.13 Note: important is, that the Air Airflow must not be restricted and that there is no safety issue it the connection is bad.	  Distance from the shortest pneumatic connection to the first cable tie: 60 mm +/- 5mm. Relevant for a bundle of tubes at a valve terminal or others where multiple tube comes together and not for a single tube. Main focus to avoid bruises of tubes.			
2.14	Pneumatic and water connections must be leak-free.			

Aspect 2: Routing of tubes and cables	3 Points:	2 Points:	1 Point:
2.15	Bending radius of light conductor > 25 mm	Radius too small but sensor works 	Light conductor broken because of too small bending radius.
2.16	Cables and tubes tied together do not cross each other more than necessary. 	 	

Aspect 3: Mechanical implementation

<table>
<tr><th>Aspect 3: Mechanical implementation</th><th>3 Points:</th><th>2 Points:</th><th>1 Point:</th><th>0 Points:</th></tr>
<tr><td>WSOS section as per TD: 3</td><td>Ok: excellence:
If all conditions below are fulfilled.</td><td>Ok: Professional / Still acceptable (~80% Solution):
If there are one or a few minor deviations</td><td>Not ok: Optimization / rework necessary:
If there is a major deviation or more than a few minor deviations.</td><td>Not ok: not acceptable:
If the work is far from the standard specified</td></tr>
<tr><td>3.1</td><td colspan="2">All system components and modules must be secured.
Check by Hand of Expert
  </td><td colspan="2"></td></tr>
<tr><td rowspan="2">3.2
Note: This must be noted by PLC evaluation team</td><td colspan="2">All actors and work pieces must move without collisions</td><td colspan="2" rowspan="2">Major collision, for example if gripper crashes to the workpiece, or workpieces fall off the system.</td></tr>
<tr><td>Free movement of all actuators, cables, tubing and workpieces.</td><td>Minor collision, for example tubing touching a moving part, not affecting the function.</td></tr>
</table>

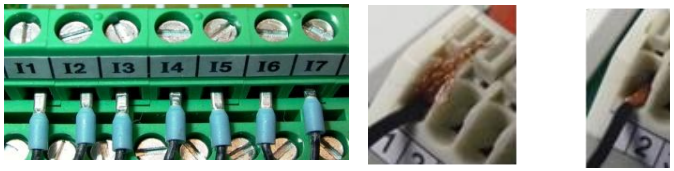
3.3	Adjoining stations must be connected with at least 2 connectors. 	
3.4	All ends of profiles must be fitted with caps 	

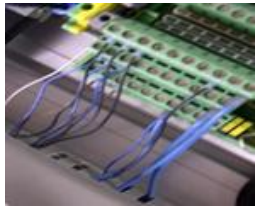
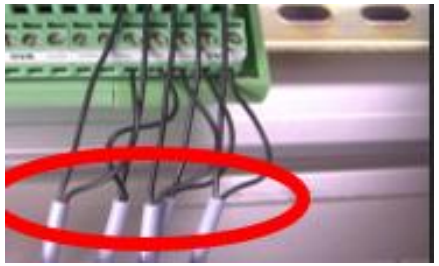
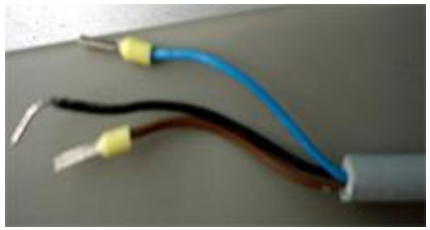
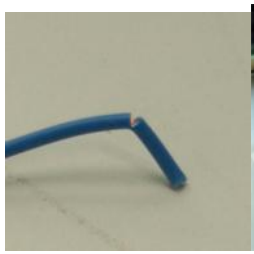
Aspect 3: Mechanical implementation	3 Points:	2 Points:	1 Point:	0 Points:
Note: Expert will open the cable channel to see that.	 Use min.at least 2 screws with washers to secure any section of cable channel.			
3.5	Screw heads must be undamaged.			
3.6	 Saw-cuts must be burr-free.			

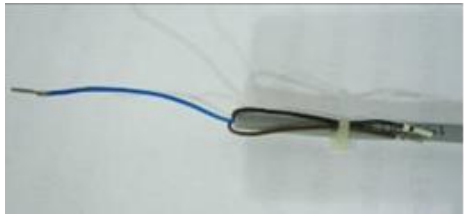
3.7 Note: Exceptions will be announced by the expert team.	Parts of devices and components should not extend beyond the profile plate.		
3.8	All components shown in the 3D sketches and photos have to be assembled and placed Approximately in the designated area on the correct MPS Station / Trolley / Profile plate - function as intended	Missing component not affecting the function of the system.	Missing component affecting the function of the system.

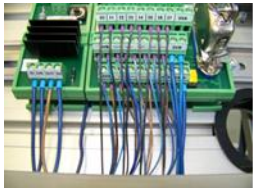
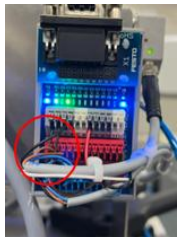
Aspect 4: Electrical installation and wiring of the components.

Aspect 4: Electrical installation and wiring of the components.	3 Points:	2 Points:	1 Point:	0 Points:
WSOS section as per TD: 3	Ok: excellence: If all conditions below are fulfilled.	Ok: Professional / Still acceptable (~80% Solution): If there are one or a few minor deviations	Not ok: Optimization / rework necessary: If there is a major deviation or more than a few minor deviations.	Not ok: not acceptable: If the work is far from the standard specified
4.1 *Note: Check by Hand of Expert*	All signal terminations must be secured		 	
4.2	 Bare conductors must not be visible at end sleeves			

4.3 Insertion of wires end sleeves into terminals	 Note: Clamp type connections may be made without the use of end sleeves end slaves are mandatory on screws.	Uninsulated portion of end sleeve / wires visible 
4.4 Note: Exceptions for clamp connections (only for screws)	 Insulated end sleeves of the correct size for the wire must be used on all screw terminals Available sizes are: 0.25, 0.5, 0.75 mm²	

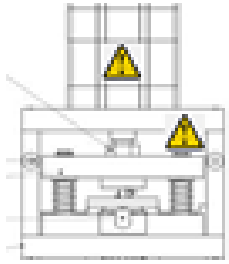
Aspect 4: Electrical installation and wiring of the components.	3 Points:	2 Points:	1 Point:	0 Points:
4.5 Note: *Expert will open the cable channel to see that.*	  Electrical cables must have a minimum of 100 mm reserve in the cable channel Unnecessary when it is a bridge in the same cable channel			
4.6	 Outer cable insulation must not extend beyond cable channel			
4.7 Note: Check by Hand of Expert	 No damage to wire insulation or exposure of bare conductors.		 	

4.8	Loose ends of wire must be tied back to cable and must have the same length as used wires.  Insulation must be left to prevent any contact being made. This applies both inside and outside of the cable channel.	 

Aspect 4	3 Points:	2 Points:	1 Point:	0 Points:
4.9	Conductors in front of Terminals must not cross. One sensor / actuator connection per cable duct slot is allowed. No wiring over components  			
4.10	No load on freely hanging cables, wires/cables not under mechanical tension			
4.11	Cable channels must be completely closed with all teeth under the cover. 			

4.12 Note: There will be no replacement of the channel Exceptions with not used open channel will be announced by the expert team	Removal of cable channel teeth and have to be used. 	

Aspect 5: Special cases, announced by experts or in the Task Description and the overall impression.

Aspect 5. Special cases, announced by experts and the overall impression	3 Points:	2 Points:	1 Point:	0 Points:
WSOS section as per TD: 3	Ok: excellence: If all conditions below are fulfilled.	Ok: Professional / Still acceptable (~80% Solution): If there are one or a few minor deviations	Not ok: Optimization / rework necessary: If there is a major deviation or more than a few minor deviations.	Not ok: not acceptable: If the work is far from the standard specified
5.1	Aspects not evaluated in previous aspects, and which have not yet influenced the overall impression			
5.2 Note: This must be noted by the timekeeper if replacements need to be supplied	No parts or components should be lost or damaged during assembly of equipment.			
5.3 Note: This must be noted by the timekeeper and verified by the ESR for H&S.	Competitors shall not work in a way where they risk injury to themselves, or other people. This includes the use of prohibited tools and cleaning with compressed air.			
5.4	All warning labels must be affixed and in the specified positions 			

5.5 Note: Exceptions will be announced by the expert team.	For the evaluation the profile plate has to be in the lowest possible position.	
5.6 Note: This must be noted by PLC evaluation team. Exceptions will be announced by the expert team.	It is not allowed to prepare workpieces with tape or similar additives.	 

Aspect 6: HMI – Design

Aspect 6: HMI – Design	3 Points:	2 Points:	1 Point:	0 Points:
WSOS section as per TD: 4, 5	Ok: excellence: If all conditions below are fulfilled.	Ok: Professional / Still acceptable (~80% Solution): If there are one or a few minor deviations	Not ok: Optimization / rework necessary: If there is a major deviation or more than a few minor deviations.	Not ok: not acceptable: If the work is far from the standard specified
6.1 Colours	The colours of all elements and background match like in the T-description			
6.2 forms	The forms match like in the T-description			
6.3 Text and Symbols	The texts and Symbols match like in the T-description and there is no overlap!			
6.4 Components required	All required components are implemented like designed in the T-description!			
6.5 Arrangement	The elements are arranged like the designed grid!			
6.6 Impression of pages	The overall impression of the HMI pages!			

Aspect 7: Workplace design, work organization and management

Aspect 7: Workplace design	3 Points:	2 Points:	1 Point:	0 Points:
WSOS section as per TD: 1	Ok: excellence: If all conditions below are fulfilled.	Ok: Professional / Still acceptable (~80% Solution): If there are one or a few minor deviations	Not ok: Optimization / rework necessary: If there is a major deviation or more than a few minor deviations.	Not ok: not acceptable: If the work is far from the standard specified
7.1 Desing all over	WP Design looks perfect. It is visible that there was put a lot of ideas in	WP Design with more potential to professional	WP Design visible but not realy profession	WP Design not realy visible
7.2 safety, sorting, tools	• Cable/hose secured to the floor • Sorting equipment available • Tools available		• No cable/hose secured to the floor • No Sorting equipment available • No Tools available	
7.3 Permitted tools and consumables	• Dangerous tools after tool check okay / partly okay • Permitted consumables after tool check okay / partly okay		• Dangerous tools after tool check partly not okay / not okay • Permitted consumables after tool check partly not okay / not okay	
7.4 Programming environment ready	• PLC functional for C1 • Programming device functional for C1 • HMI functional for C1		• PLC functional for C1 unsure • Programming device functional for C1 unsure • HMI functional for C1 unsure	
7.5 Time used for the setup	<3,0 h	3 - 3,5 h	3,5 - 4h	>4 h