worldskills

Standards and Assessment Guide

Robot Systems Integration

v1.0

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.

Important information for Robot System Integration

- In our skill competition, the Test Project and the Marking Scheme are kept confidential and are redesigned for each edition of the Competition. This approach aligns the assessment with the evolving WorldSkills Occupational Standards (WSOS) within the context of the specific Test Project.
- Furthermore, in preparation for each WorldSkills Competition, Competitors are provided with a comprehensive background of the choice of the Test Project. This background experience explains and puts the Test Project in an industrial context and industry standards pertinent to that specific Competition.
- As a result, **the criteria provided below are generic examples and should not be expected to appear in the exact wording or context in the actual Test Project.** Relying on overly generic or broad criteria leads to excessive interpretation and variability in scoring. The aim is to tailor the assessment criteria specifically for each Competition, thereby ensuring a robust and fair evaluation of the Competitors' skills in accordance with the latest industry standards and requirements.

For effective preparation, we suggest using previous WorldSkills Test Projects and marking schemes as practice materials. These provide a good understanding of the Competition's style and requirements.

Skill 63 – Robot Systems Integration

Important information for Robot System Integration

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- Furthermore, in preparation for each skill competition, Competitors are provided with a comprehensive background of the choice of the Test Project. This background experience explains and puts the Test Project in an industrial context and industry standards pertinent to that skill competition.
- As a result, **the criteria provided below are generic examples and should not be expected to appear in the exact wording or context in the actual Test Project.** Relying on overly generic or broad criteria leads to excessive interpretation and variability in scoring. The aim is to tailor the assessment criteria specifically for each competition, thereby ensuring a robust and fair evaluation of the Competitors' skills in accordance with the latest industry standards and requirements.

For effective preparation, we suggest using previous Test Projects and Marking Schemes as practice materials. These provide a good understanding of the Competition's style and requirements.

Sub-criterion: Installation/Layout in real cell including labelling

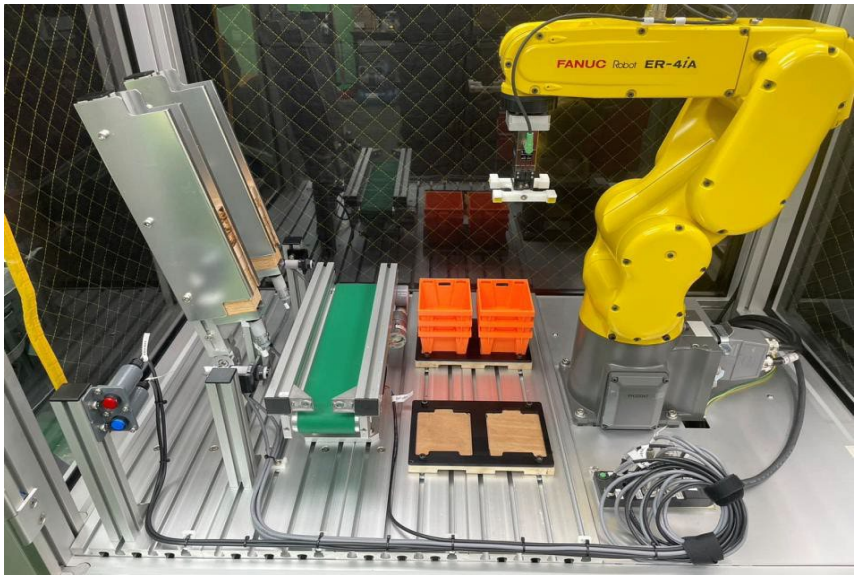
Theme: Installation/Layout

Best practice:

A wide range of factors must be considered when designing and implementing the layout of a robot application. The main criteria are:

- Available space
- Collision and singularity avoidance
- Efficiency (low cycle time or low energy consumption)
- Easy access to loading and unloading zones
- Robustness

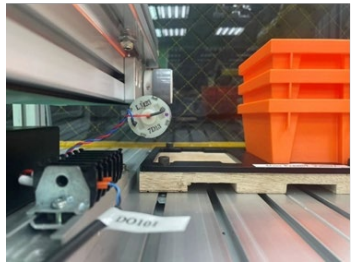
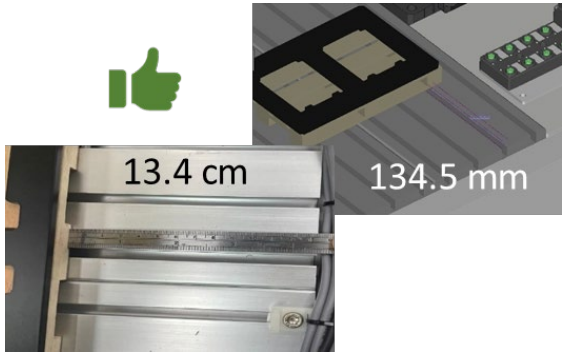
Example of a good practice:

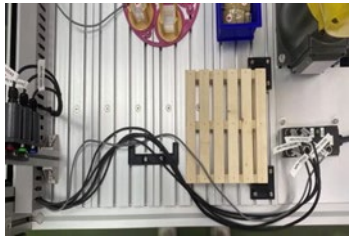


Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Peripherals installed correctly in the real cell		Preferred to be aligned with other cell components, as in an industrial installation. If peripherals are not aligned then a reason should be given. Aspect may be applied to several components depending on TP or agreed by Experts during Marking Review	Yes/No	4	
M2	Peripherals installed solidly in the real cell		With clamps or screws. Will not shift or tip over due to external force or vibration. (Any testing/pushing etc should be done by Competitors under instruction from Experts, not directly by Experts)	Yes/No	4	

M3	LED mounted with good visibility		Clearly visible from the door side of the cell, which is equivalent to the operator side of the cell in an industrial installation, so clearly visible for operators.	Yes/No	4	 

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M4	No interference between peripherals		There should be no forcing of peripherals during installation (i.e. +/- 10mm or tolerance to be agreed for the TP by Experts during MS review). Peripherals may need to be installed closely together or even touching, but there must be no forcing or bending of peripherals or other cell components during or after installation.	Yes/No	4	 
M5	Layout transferred from Roboguide to real cell		Positions within +/- XX mm (tolerance TBD for TP by Experts during MS review)	Yes/No	4	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	Cables and hoses neatly routed		Through conduit if suitable, fixed with cable ties etc. If fixed to tabletop, plastic adaptors should be used.		4	
		0	No cable or hose routing done			
		1	Some cable and hose routing done			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		2	Cable and hose routing done but not perfectly			
		3	All cables and hoses perfectly routed			

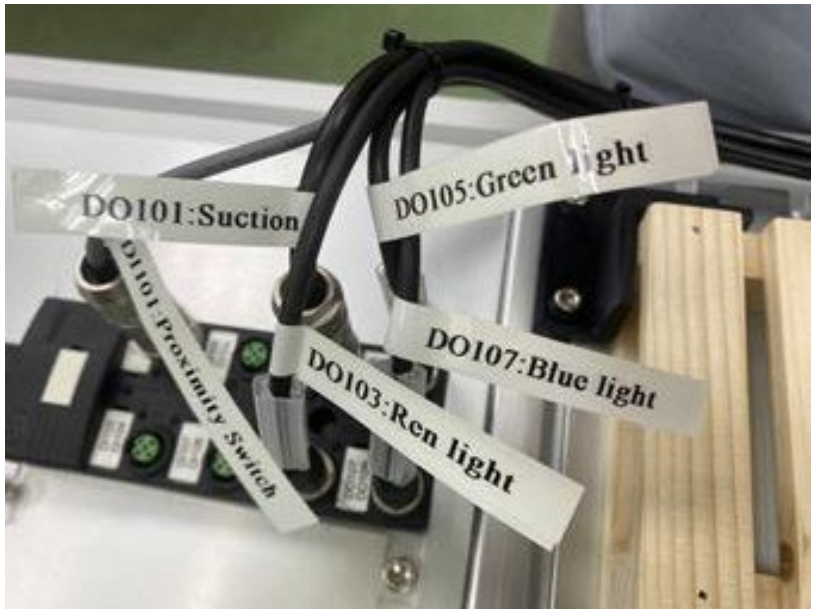
Theme: Labelling

Best practice:

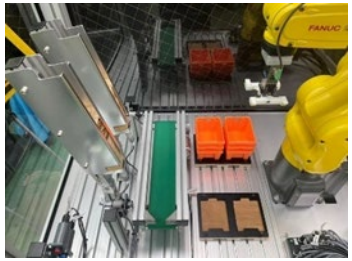
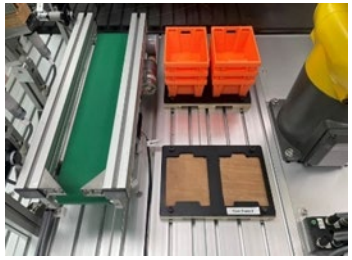
It is good practice to label cables, hoses, user tools and user frames in a cell. Cables and hoses could be labelled with a reference issued from a schematic or at least with the information where they should be connected to on both ends. A cable connecting a deburring tool to the IO block could for example be labelled on both ends with the text "DO1 (Deburring tool)".

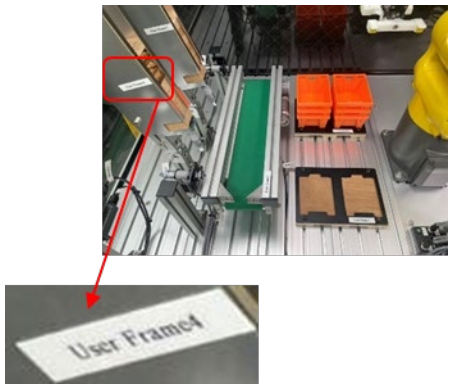
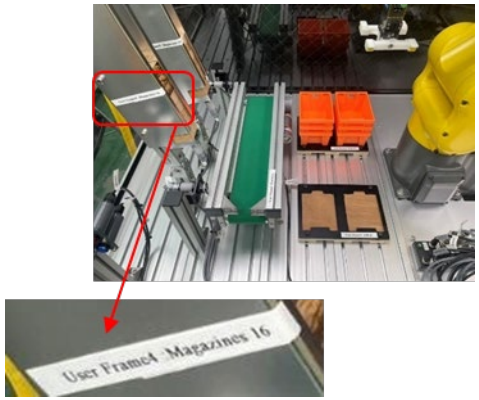
Fixtures, machines and tools should be at least labelled with the number and the name of the associated user frame or user tool, so for example "UF2 (Conveyor)".

Example of good cable labelling:



Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	
J1	Mechanical UFrame labels		User should be able to identify which UFrame to use easily during programming without having to look at documentation etc.		4	
		0	No labels			
		1	Some labels			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	
		2	All UFrames labelled but not perfectly (e.g. number but not description or vice versa)			
		3	All UFrames clearly and perfectly labelled (e.g. with number and description)			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	
J2	Electrical cable Labels to Input/Output Block		Must be clear which cable goes where on Input/Output block from labels alone, without having to refer to any other type of documentation/diagram etc.		4	
		0	No labels			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	
		1	Some labels			
		2	Good labelling but not everywhere (e.g. on I/O block end of cable but not on other end of cable)			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	
		3	All cables and hoses perfectly labelled on both ends so totally clear where every cable is connected			

Sub-criterion: Layout of cell in Roboguide, gripper animation and reachability check

Best practice:

Preparing the integration of a robot system in a simulation environment is an absolute standard. It allows efficient feasibility tests, programming and cycle time estimates. In a first stage the simulation environment should be used to find a valid cell layout and setup (see current chapter). In a second stage robot programs can be prepared offline and transferred to the real robot (see chapter "Programming"). In the final phase the cell should be developed to a complete digital twin of the real cell (see chapter "Digital Twin").

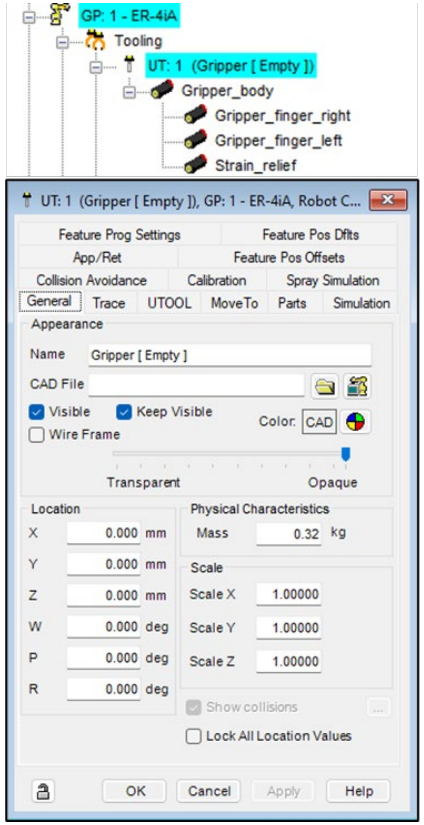
Some of the necessary CAD models may be missing, requiring the Competitors to create the model using an external software. If the Competitors are not able to make them, then the files can be provided by Experts, but the corresponding points will obviously not be awarded.

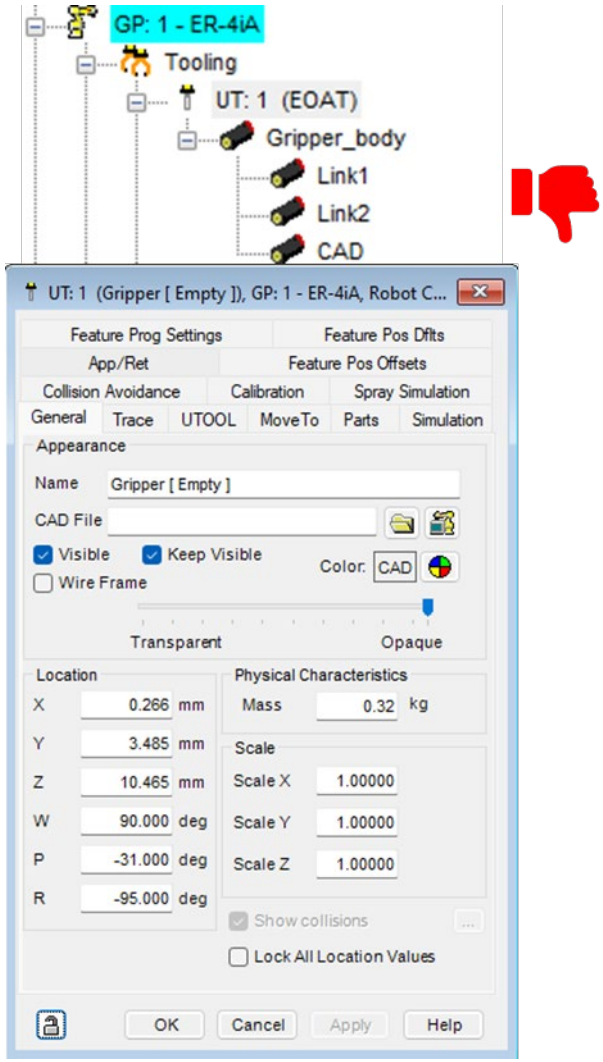
NOTE: Currently there are only two CAD model creation software's available during Competitions:

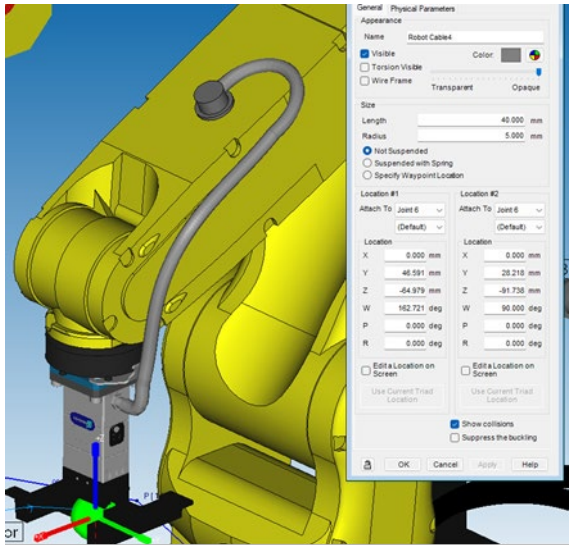
- Roboguide Modeler (Menu Tools/Modeler)
- Roboguide by lumping basic objects like boxes and cylinders together, exporting and re-importing
- In the future other CAD software could become available – e.g. Autodesk – but for now the licencing/internet connectivity requirements prevent this.

Theme: End Of Arm Tooling (EOAT) Setup

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	EOAT– CAD models imported OK		The CAD models for the different tools have been imported correctly. This includes: • Import into Roboguide as a Tool (not dress out, obstacle, fixture or machine) with unique name given to the tool. (not "EOATX" or similar) • Positions and orientations are correct relative to the mounting holes of the tool, not just dragged into position. Recommended X/Y/Z values whole or obvious fractions of mm: nnn.0, nnn.5. and rotations obviously aligned with cell/robot e.g. 0, 45, 90, 180 degrees; if possible.	Yes/No	3	

M2	EOAT – Links imported OK		The CAD models for the moving parts of the EOAT have been imported correctly. This includes: • Import as a link, not as a part, with meaningful names given (not "LinkX" or similar) • Positions and orientations as on the real tool • Motion of the moving parts as on the real tool (distance or angle) The assignment of the links to the correct outputs is not checked here.	Yes/No	3	

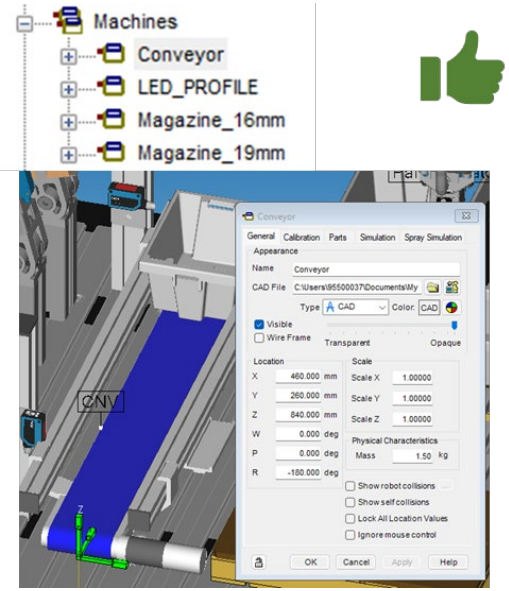
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M3	Dressouts – Setup		The dressouts in relation with the EOATs have been imported or setup correctly. These dressouts could be cables, hoses or other armloads. "Correctly" includes: • The dressouts are positioned and orientated correctly. • The cables and hoses have approximately the same length, diameter and routing as in the real cell. • The dressouts are assigned to the correct axis. *(depending on the complexity of the dress out, this aspect might have to be converted to a judgement – chapter 3.3, J1)*	Yes/No	3	

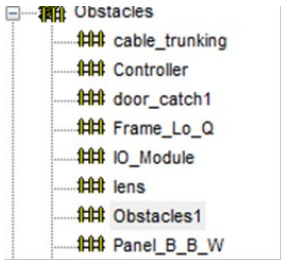
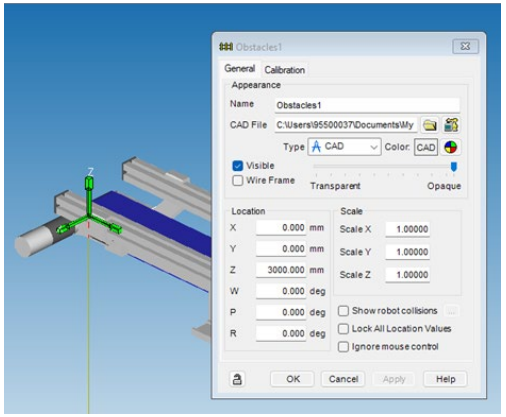
Theme: CAD Model Import

General comment:

This section covers the importing and modelling of CAD models for the RG cell.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	CAD models – imported OK		The CAD models to build the fixtures and the machines have been imported correctly. This means that the models are assigned to the correct entity (parts, fixtures, part of a fixture, machines, links, etc.). Obstacles are excluded here to avoid excessive marking time. Import of each model is a simple Yes/No measurement.	Yes/No	3	
M2	CAD models – Names		All imported fixtures, machines and obstacles have been given meaningful names. So not "FixtureX", "MachineX", "OstacleX" or similar.	Yes/No	3	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
						  
M3	Create any missing CAD models		Realistic 3D CAD models (i.e. following basic shape of the object; has intricate details; all moving parts modelled, etc.) have been created of the parts where no models were made available. These are: *(list of parts…)*	Yes/No	3	N/A – specific to each Test Project

Theme: Reachability Test

Best practise:

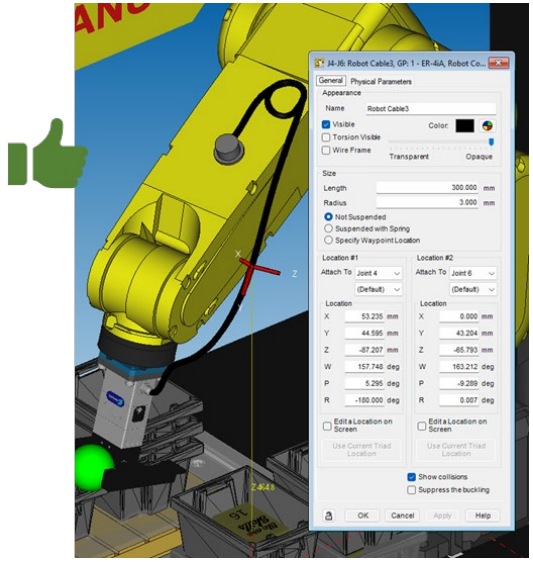
Part of a feasibility study is the reachability test to check if the robot can reach all foreseeable positions. The reachability test will rarely provide a 100% assurance that all future motions will be without errors, but there are some strategies that can avoid the most obvious problems like lack of robot reach and singularities.

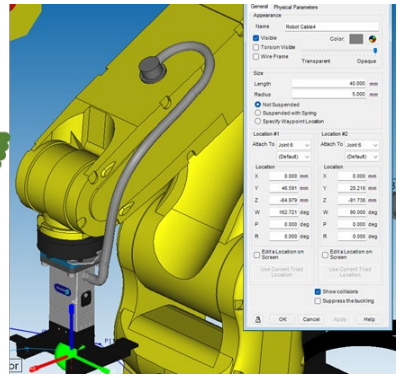
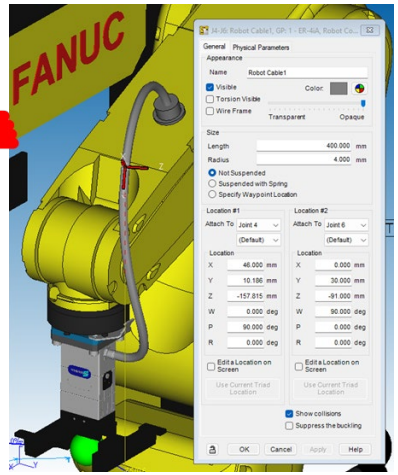
The simplest form of reach test could be to use the "Move to" button in Roboguide, which is generally sufficient to exclude a lack of robot reach. However, this approach only checks the end points of motions not the complete path and thereby often fails to detect singularities on the path.

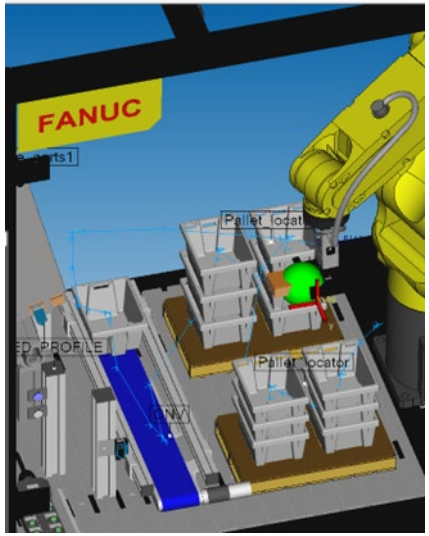
The next best method is to write a program to make the robot move to the most extreme positions. As the path of this test program is not identical to the final path, there is also a residual probability that some issues have not been detected.

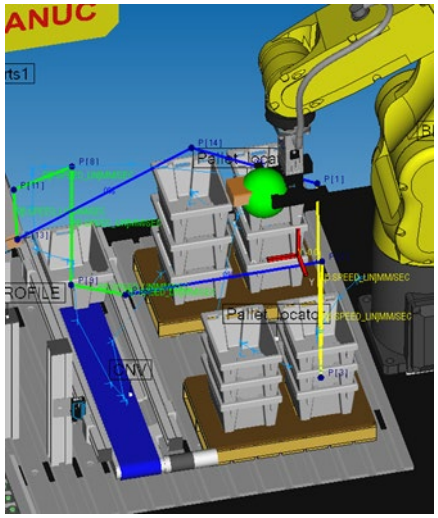
Potential marking aspects:

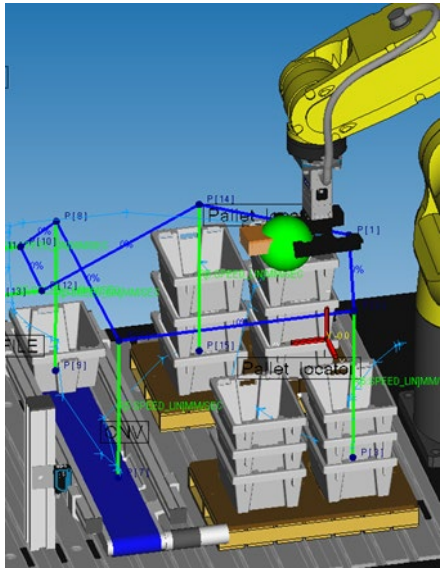
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	UTOOL(s) defined		Can be 1 or more. Not sufficient to do reach tests with faceplate (zero tool), but values used for tool can be approximate since exact tool coordinates may not be known at this stage.	Yes/No	3	

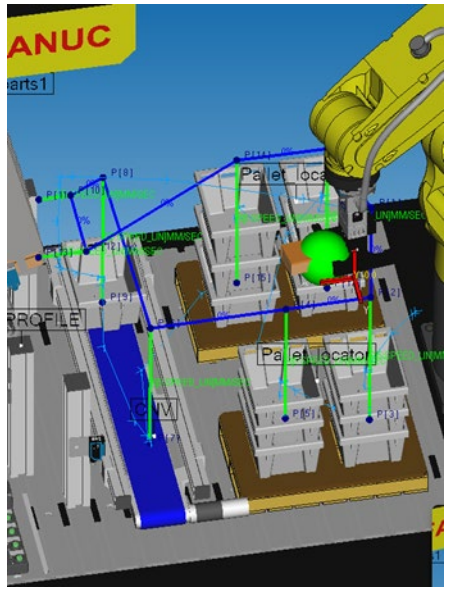
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M2	End Effector hose/cable simulation included in reach test		Only last moveable section between last clamp and EOAT required. The cable/hose won't touch or collide during reach test.	Yes/No	3	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	End Effector hose / cable length same as in real cell		Bonus for additional End Effector hose / cable simulation.		3	
		0	No hose/cable in Simulation			
		1	One (1) of following: • Hose/Cable in Simulation, incorrect length /diameter • Moving section length same +/- 50mm between last clamp and EOAT • Fixed section also included in model			
		2	Two (2) of above			
		3	Three (3) of above			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J2	Create a Roboguide program to show how the robot reaches all aspects of the "Working Area"		Competitors will need to demonstrate via a single Roboguide program how the Robot is able to reach all the required positions necessary and demonstrate this via simulation on RG. The overall goal is to have the Robot be able to reach the extremes of the "Working Area" using the correct approach/depart method. (The basic requirement should be indicated in the TP)		3	
		0	No program present/simulation does not run			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		1	Basis of a program present, but fails to reach required points/simulate properly			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		2	Program present and working with simulation, but incorrect use of approach/depart to said positions OR correct method not used for ALL **extreme** positions			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		3	Demo program present and working with simulation, as well as the correct use of approach/depart for ALL **extreme** positions			

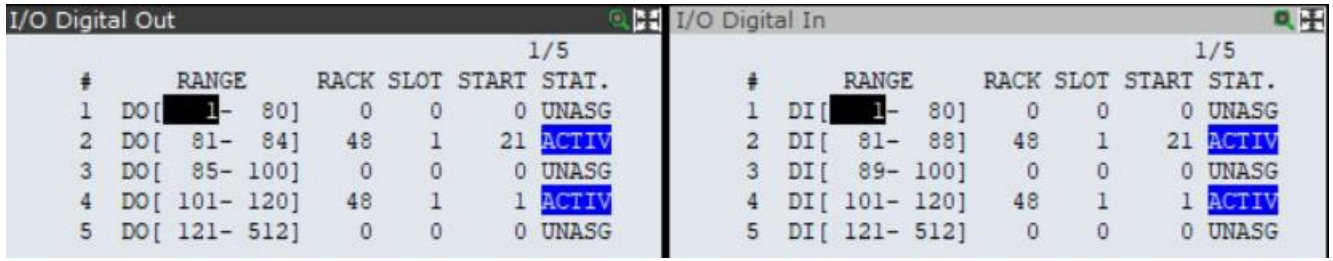
Sub-criterion: IO Setup (ranges, comments and function)

Theme: I/O Range Allocation

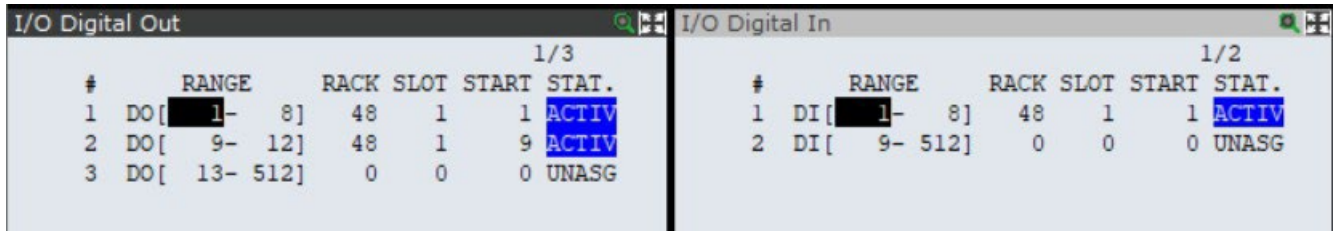
Best practice:

The standard I/O module for the Education Cell (Phoenix block) uses DI[101 – 108] and DO[101 – 108]. This is not particularly convenient as this requires an unnecessary number of manipulations to observe these inputs and outputs. It is therefore a good practice to allocate the inputs and outputs of the I/O block to DI/DO[1-8] and in case the Education Cell also has the UOP box, to allocate the DO-LEDs on the UOP-Box to DO[9-12].

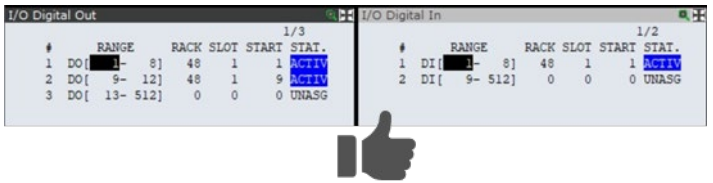
Automatic Configuration ($IO_AUTO_CFG = TRUE)



Manual Configuration (preferred $IO_AUTO_CFG = FALSE)

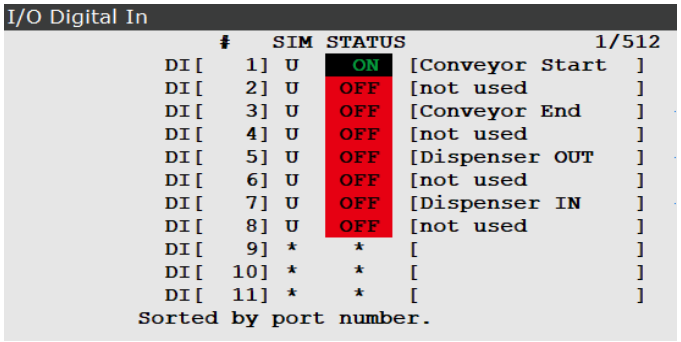


Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	
M1	I/O Allocation		I/O configuration cleaned up/reallocated to start of I/O range As specified in the Test Project – if not specified/requested then not assessed.	Yes/No	5	

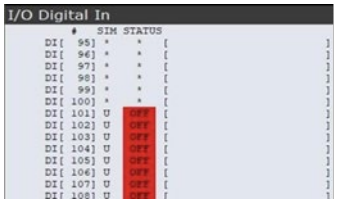
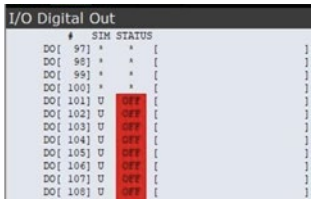
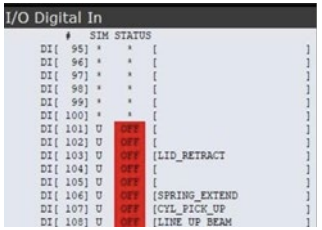
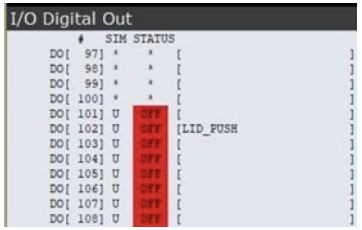
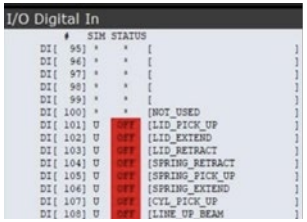
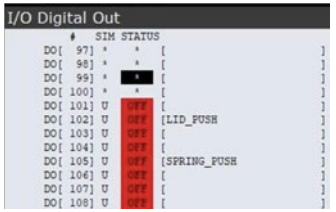
Theme: Setup I/O Comments and Function

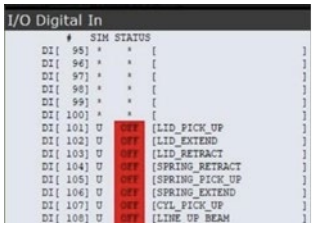
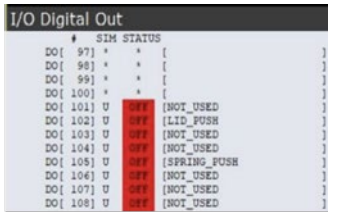
Best practice:



Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Peripheral xyz works as commented		The outputs to control the peripheral xyz are correctly commented and work as expected. Check for example by activating the outputs. (To be adapted by the Independent Test Project Designer to the Test Project. One aspect per peripheral to be checked.)	Yes/No	5	n/a
M2	Sensor xyz works as commented		The inputs to read the sensor xyz are correctly commented and work as expected. Check for example by activating the sensor. (To be adapted by the Independent Test Project Designer to the Test Project. One aspect per peripheral to be checked.)	Yes/No	5	n/a

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	Setup I/O Comments				5	
		0	No Commenting			 
		1	Some Comments			 
		2	All used Inputs and Outputs commented			 

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		3	All used and unused I/O commented consistently (i.e. “reserved”/”not used” comments added) (Non-configured I/O like DO[100] in example does not need to be commented)			 

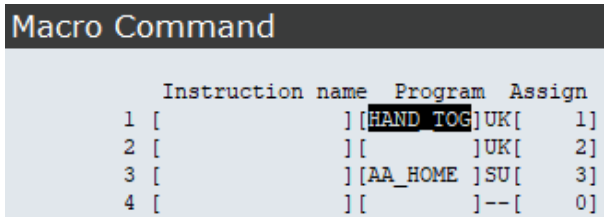
Sub-criterion: Macros and user keys

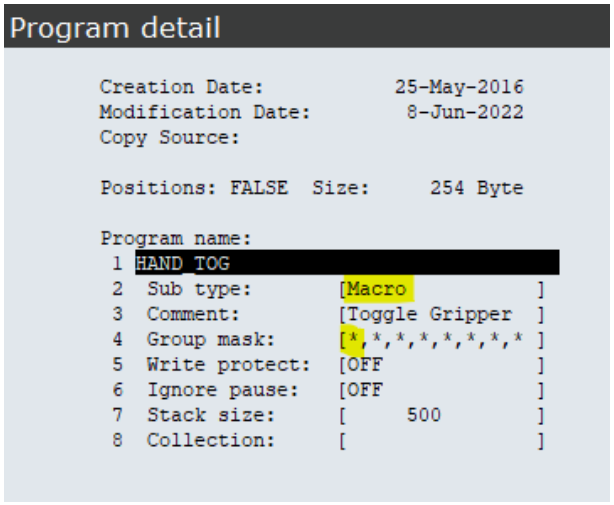
Best practice:

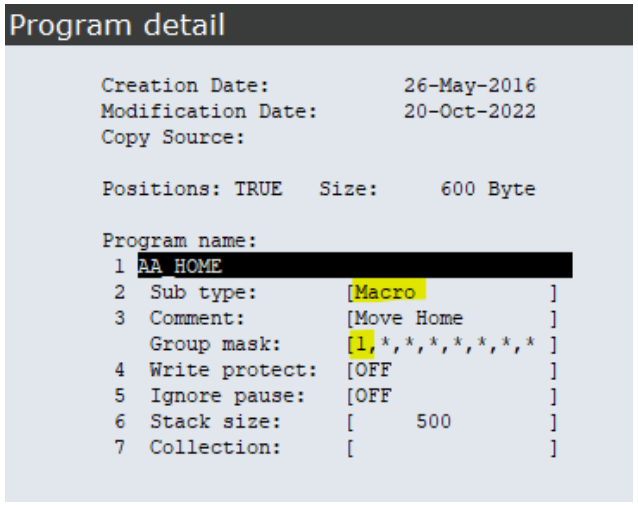
Application equipment such as EOATs, LEDs, conveyor belts, etc. should be enabled and disabled using individual programs. The sub type of these programs should be set to 'Macro'. The most used macros, like EOAT toggling or move to home, should be allocated to a user key on the teach pendant for quick start.

Programs that have been removed from all motions groups can potentially be run even if the robot is in an error condition, like a pressed emergency stop. It is part of the customers risk assessment procedure to judge if the latter is acceptable or not. Therefore, the Test Project should explicitly state which macros should be implemented, how the user keys should be used and if a macro must or must not run in error conditions.

Examples of good practice:



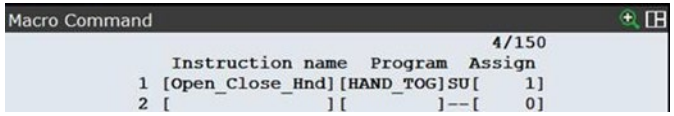
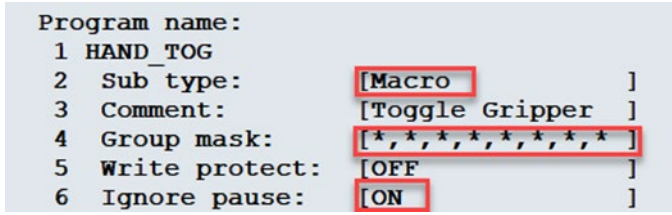




Theme: Setup Macro for equipment I/O control

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Macro to return home		A macro has been created to move the robot to its Home position AND this macro has been assigned to a user key.	Yes/No	5	n/a
M2	Control of peripheral xyz		Count the number of correct settings. List of expected settings for this peripheral: (List to be adapted by the Independent Test Project Designer to the peripheral and the requirements in the Test Project.) • One or multiple macros have been written to control IO of the peripheral. • The above macros are assigned to one or multiple user keys. • The above macros can/cannot be started while the emergency stop is pushed. • The peripherals stops if the emergency stop is pushed but can be reactivated afterwards. • The peripherals stops if the emergency stop is pushed and a reactivation would be overwritten.	0 - x	5	n/a

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	Setup Macro for equipment I/O control				5	
		0	Not attempted			n/a
		1	Macro made – Controls I/O when activated from Teach Pendant			n/a
		2	Macro made and one (1) of: • Assigned to Teach Pendant key (Fig 1) OR • Set to NO MOTION so also runs when robot is in error condition. (Fig 2)			 Fig.1  Fig.2
		3	Macro made with BOTH of: Assigned to TP and NO MOTION			

Sub-criterion: Reference positions

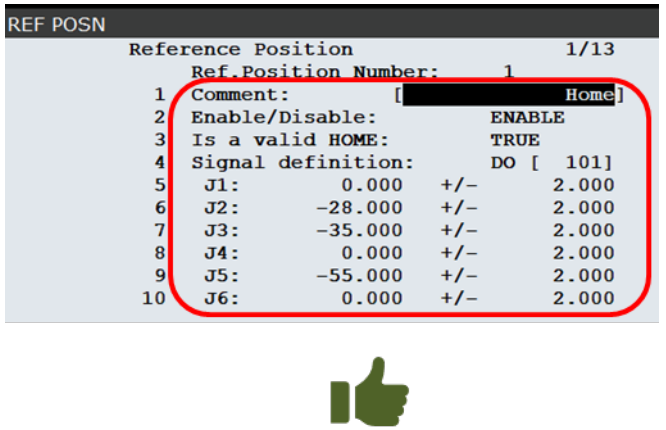
Theme: Setup of Home reference position

Best practice:

To check whether a robot is in the home position when the programme starts, it is best to define a reference position at the home position and assign a valid digital output to it so that this output can be queried when the programme starts. Typical tolerances are between 1 and 5 degrees but depend on the application. For easy readability the chosen values should be whole numbers.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	Setup Home reference position		A reference position has been set-up correctly for the chosen Home position. The following settings should be checked: Comment, Enable, Output, angles and tolerances. *Joint angles values will be defined in each Test Project brief.*			
		0	Not attempted			n/a

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		1	One (1) of the following: • Commented and Enabled and Valid Home True • Angles as defined in TP • Tolerance 1° <= Tolerance <= 5°			
		2	Two (2) of above			
		3	Three (3) of above			

Sub-criterion: User tools and user frames

Theme: Tool coordinate systems

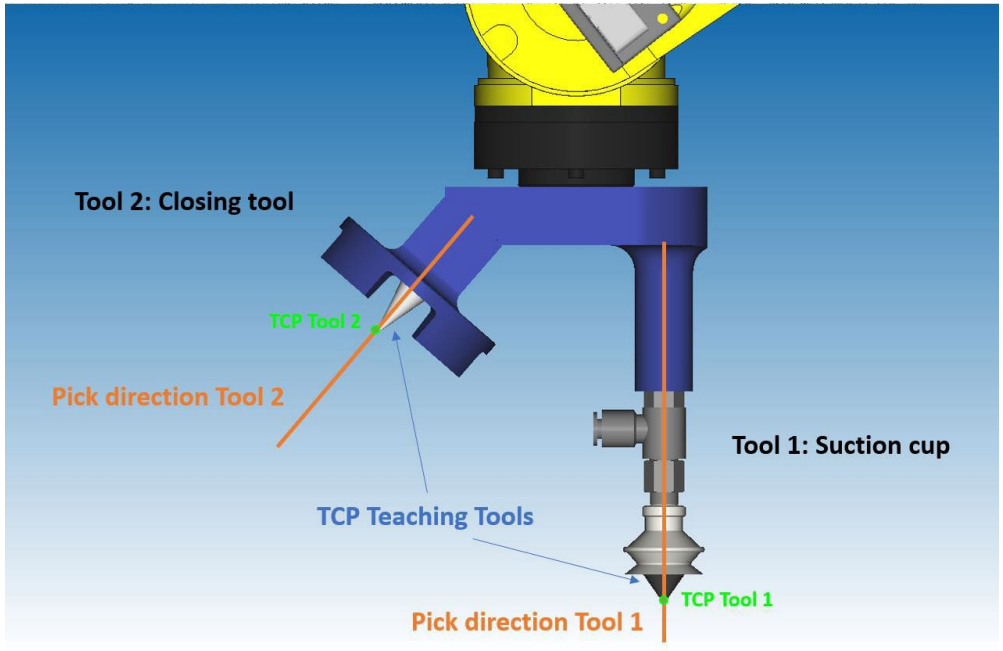
Best practice:

Tool coordinate systems (UTOOLs) must be defined such that the TCP is located at the tip of the tool.

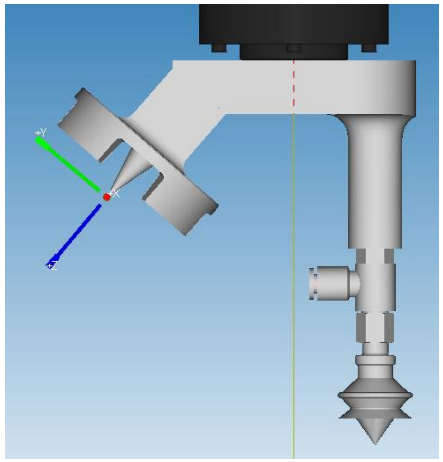
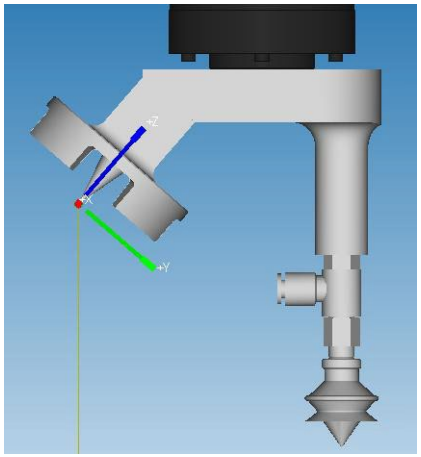
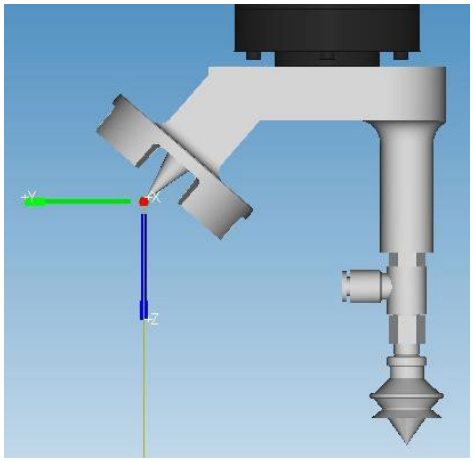
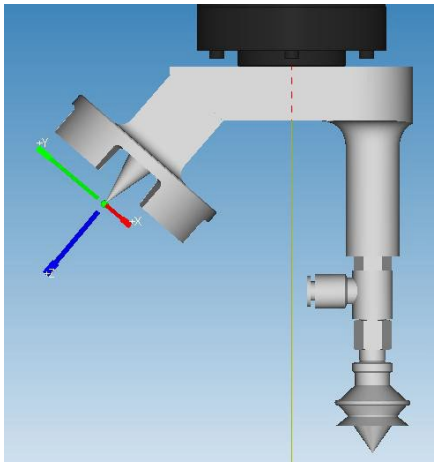
The Z-axis must be aligned with the pick direction of the tool. The positive direction of the Z-axis can be chosen to point inwards or outwards. The orientation of the X- and Y-axes of the tool coordinate system should be aligned with the main axes of the tool if there are any defined.

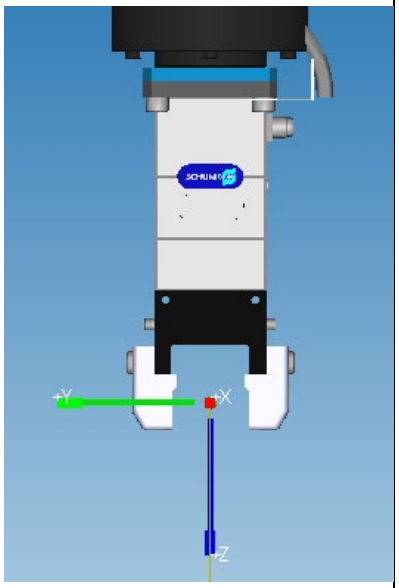
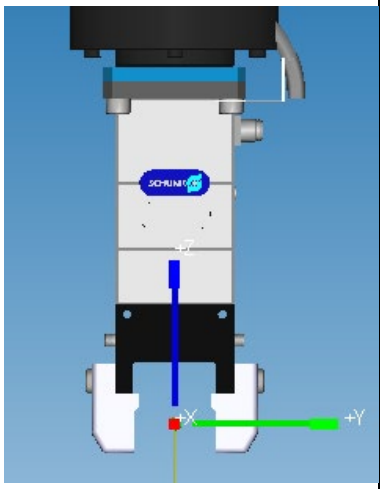
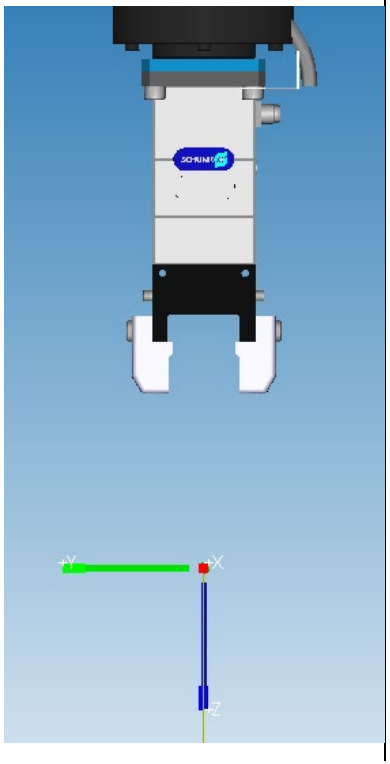
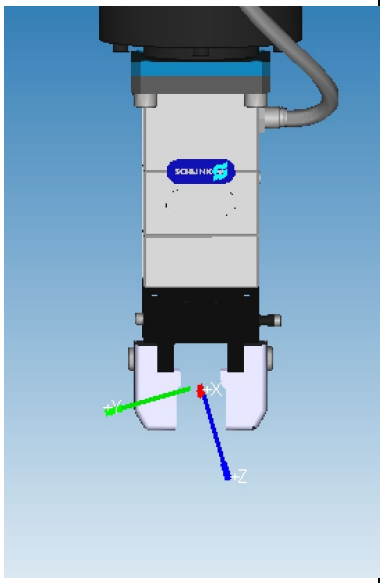
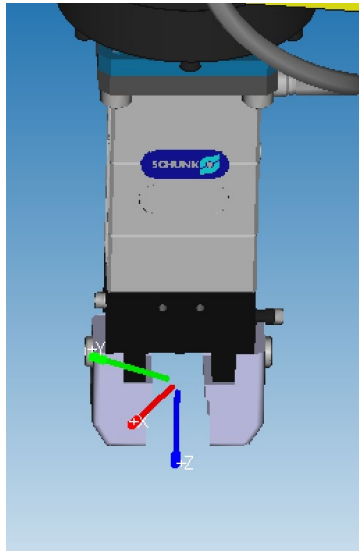
For tools that do not have a defined tip, a part must be provided that can be mounted on the tool to help teaching the TCP. For these tools more tolerance can be given to the position of the TCP in the ZTOOL direction (pick direction) than in the XTOOL and YTOOL directions.

Example of a tool assembly with two tools, their pick directions and the TCP teaching tools:



Examples of good and bad practice:

OK	OK	Not OK	Not OK
		Z-axis is not pointing into pick direction	X- and Y-axis are not aligned with the main axes of the tool
			

OK	OK	OK	NOK	NOK
		(Experts to decide on acceptable distance to tool)	Z-axis is not pointing into pick direction	X- and Y-axis are not aligned with the main axes of the tool
				

Potential marking aspects:

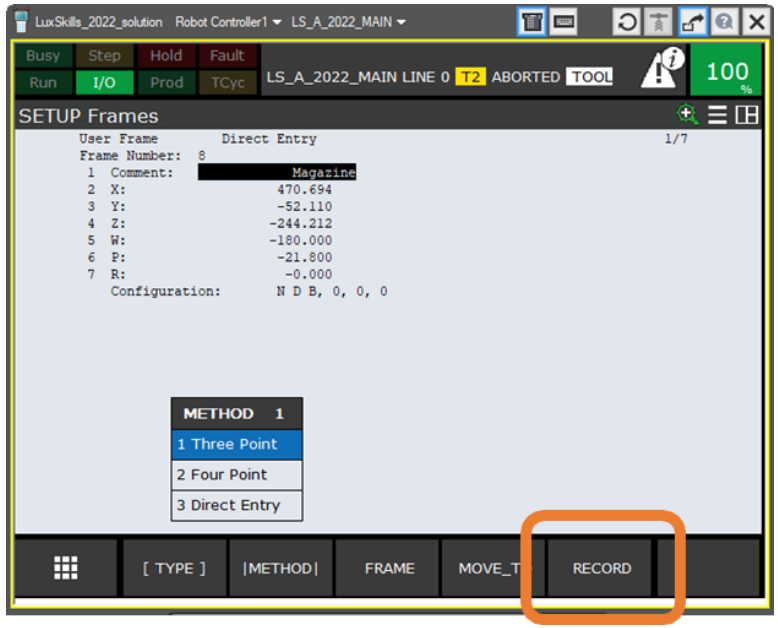
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Tool 1 (UTOOL orientation)		The Z-axis is aligned with the pick direction of the tool. The positive sense of the Z-axis is not evaluated. The orientation of the X- and Y-axes of the tool coordinate system must be aligned along the main axes of the tool. Experts decide during marking review if this is to be checked in Roboguide or the real cell.	Yes/No	4	n/a
M2	Tool 1 (TCP location)		A tool coordinate system has been defined for the tool with the TCP at the tool tip. The teaching method used is not evaluated. Experts decide during marking review if this is to be checked in Roboguide or the real cell. Expected values and acceptable deviations (to be adapted to the Test Project): xTCP = 0 mm ± 2 mm yTCP = -30 mm ± 2 mm zTCP = 123 mm ± 2 mm	Yes/No	4	n/a
M3	Tool 2 . . n		Same as Tool 1	Yes/No	4	n/a

Theme: User coordinate systems

Best practice:

A user coordinate system (UFRAME) should be defined for each fixture, machine or workpiece that a robot could move to. The orientation of the axes must match the orientation of the main axes of the fixture, machine or workpiece if they have them. The positive direction of the Z-axis should point out of the workpiece.

A controversial point is the use of the direct entry for teaching user frames or the record function to save the current TCP location as a user frame, instead of using the traditional three point or four points method. It is agreed that a user frame must be re-teachable by a technician in the real cell in case a station is moved or not perfectly positioned as in Roboguide. Therefore, a user frame must be taught such that a procedure can be written on how to teach a valid position and orientation of the user frame corresponding to the programmed path.



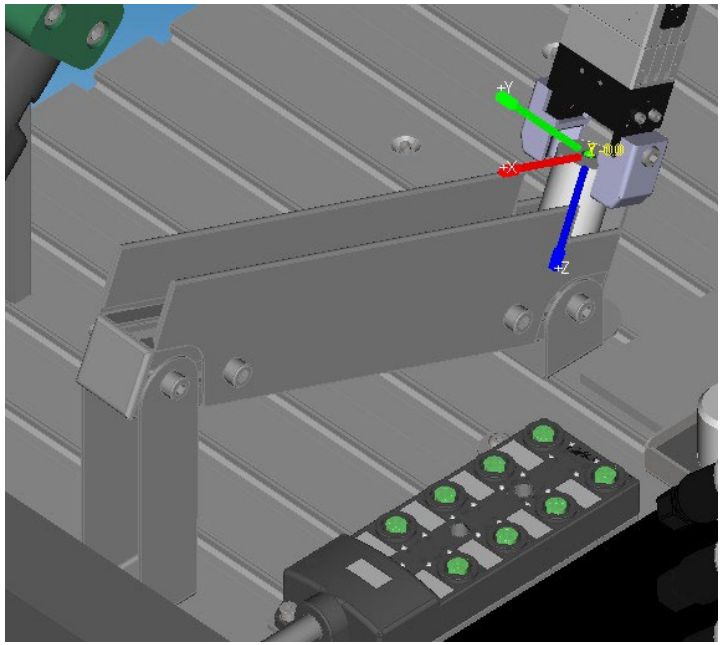
If a fixture has for example only one single point to which the robot moves to, then the record function with an appropriate tool coordinate system is a valid solution. However, if multiple points have to be addressed along an axis, then it must be ensured that the orientation of one axis of the user frame matches the orientation of the alignment of the points to be addressed, especially when using position calculations. This can in most cases only be achieved by a three or four points method.

The teaching of a user frame must not necessarily be done along edges or with teaching pins. It could for example also be done with a part in the gripper that is moved into several locator holes.

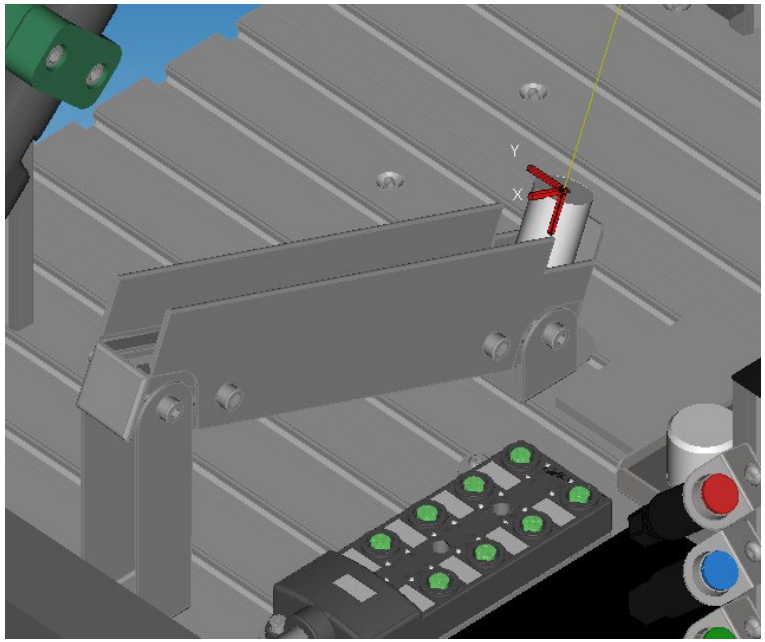
As a summary: A user frame must be taught such that a procedure can be written on how to teach a valid position and orientation of the user frame in the real cell without access to Roboguide.

Example of a situation where the "Record" button leads to a valid user frame:

Position of the TCP before pushing the Record button

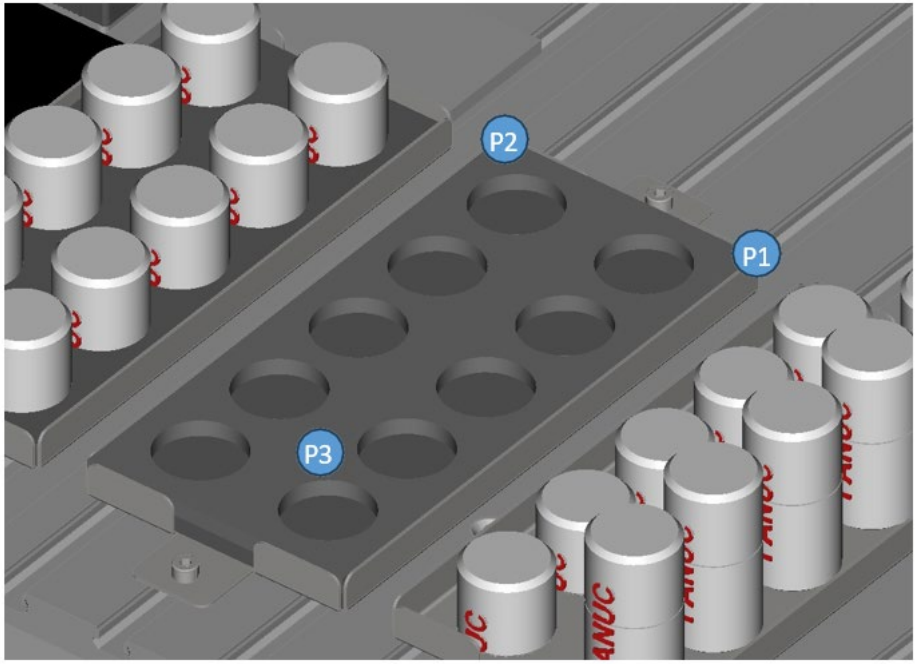


User frame generated via the record function

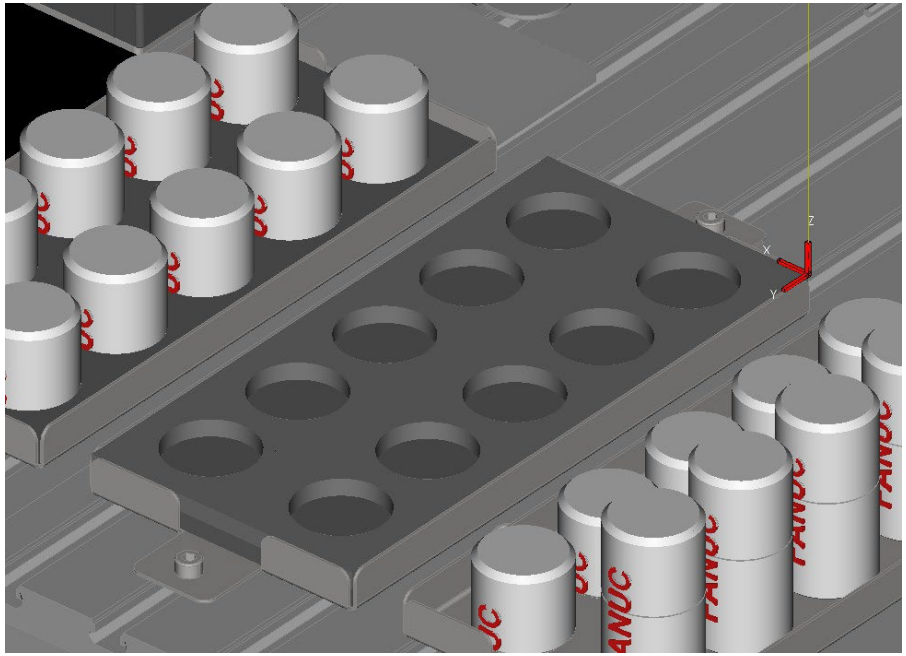


Example of a valid three-point method:

P3 is valid as it is in the XY plane (not necessary for it to be on the Y axis).

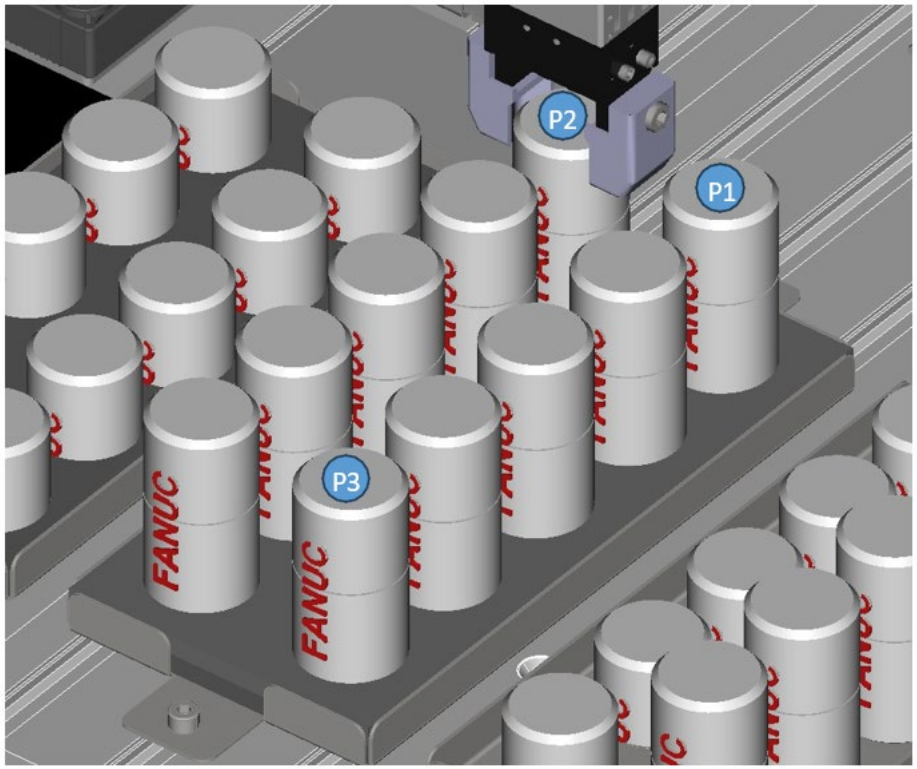


Resulting user frame

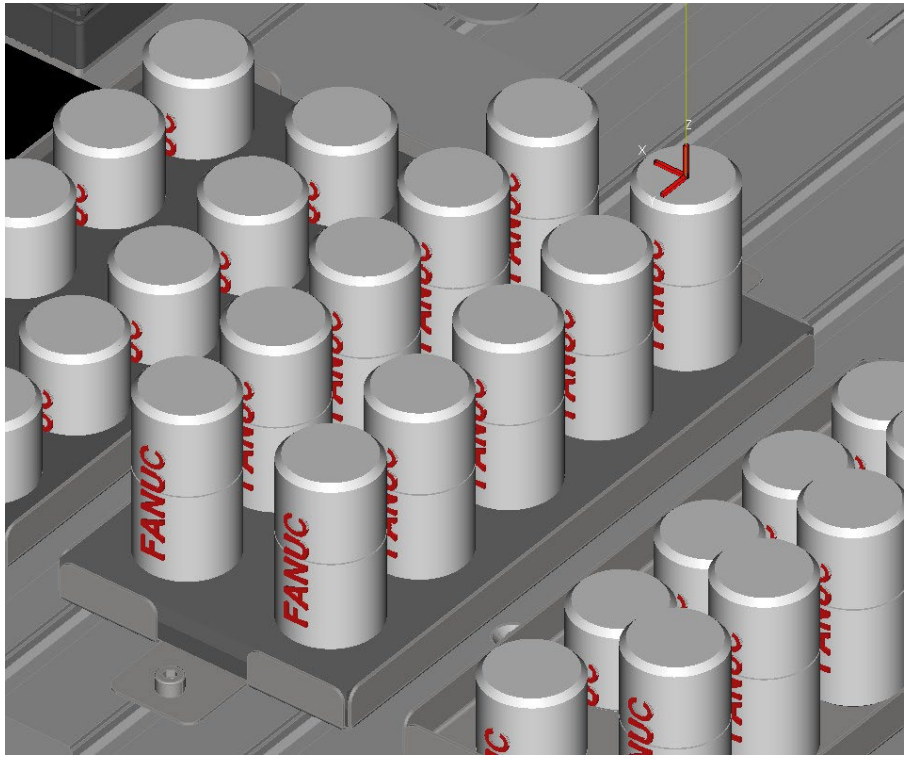


Example of a valid three-point method:

Teaching of user frame by moving a part into locator positions.

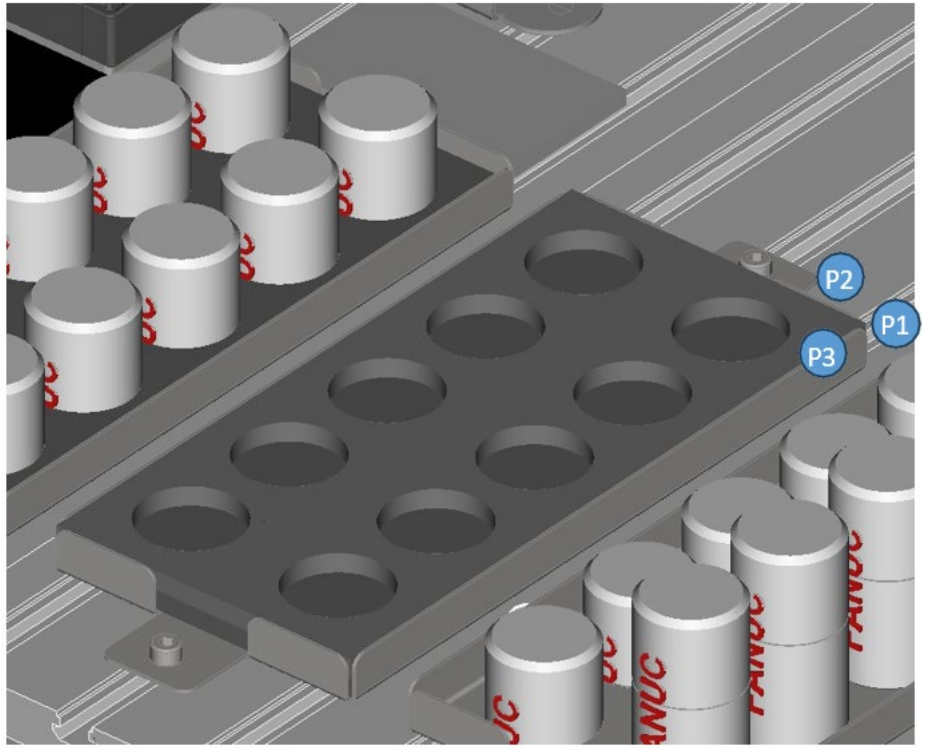


Resulting user frame

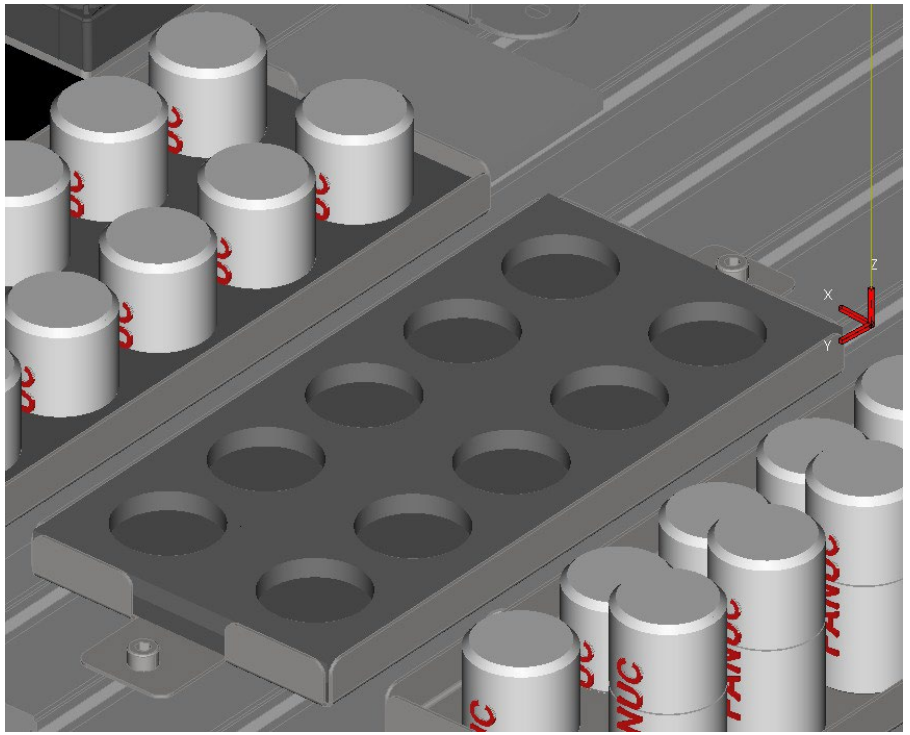


Example of an invalid three-point method:

Not valid as the position of P1 lacks precision and the distances of P2 and P3 relative to P1 are too low to result in a precise direction of the X- and Y-axis.



Resulting user frame



Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Number of UFRAMEs		The number of user frames defined is sufficient. OR The number of user frames defined is at least x.	Yes/No	4	n/a
J1	UFRAME is valid		The quality of one user frame should checked. Experts to decide during the marking review which user frame to check. Could for example be judged: • Reproducible without having access to Roboguide. • Position of the user frame origin. • Orientation of the user frame. • Appropriate choice of UFRAME teaching points		4	
		0	Not valid at all – so not related to actual position of part or fixture – no specific reference.			n/a
		1	One (1) single reference position taught.			n/a
		2	Two (2) reference positions and one (1) non-specific plane position.			n/a
		3	Perfect – precisely taught using three (3) or four (4) point method – three (3) or four (4) reference positions.			n/a

Sub-criterion: DCS

Best practice:

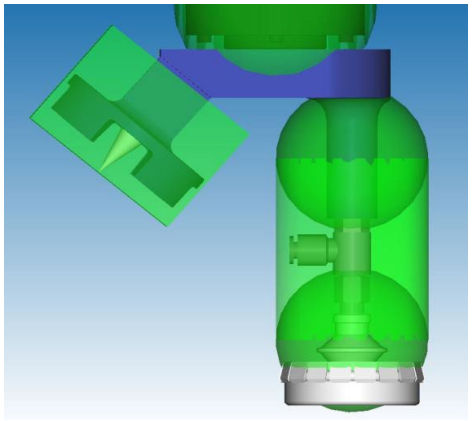
DCS (Double Check Safety) is a key component of safe operation of an industrial robot. The primary purpose of DCS is to protect humans by avoiding that any part of the robot can leave the defined working zone of the robot. The minimum setup of DCS includes the following steps:

- Definition of at least one user model for the tool. Ideally this user model should at least partially include the biggest part that will be carried, if this does not
- restrict excessively other motions.
- Definition of an appropriate working zone.
- Setup of Cartesian Position Check.

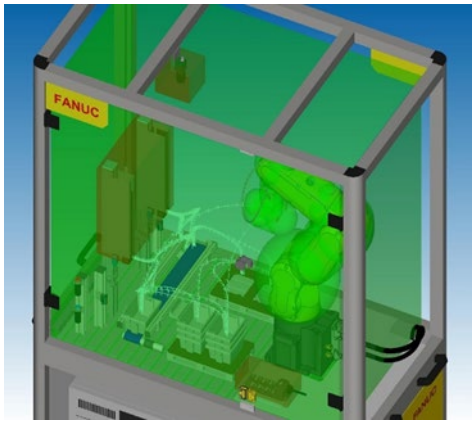
Competitors should be prepared to show matching DCS setups in Roboguide and on the real robot. Additional setups could be requested in the Test Project, as for example:

- Definition of restricted zones to avoid collisions.
- Target model collision check function to avoid the user model to collide with the robot model.

Example of a user model:

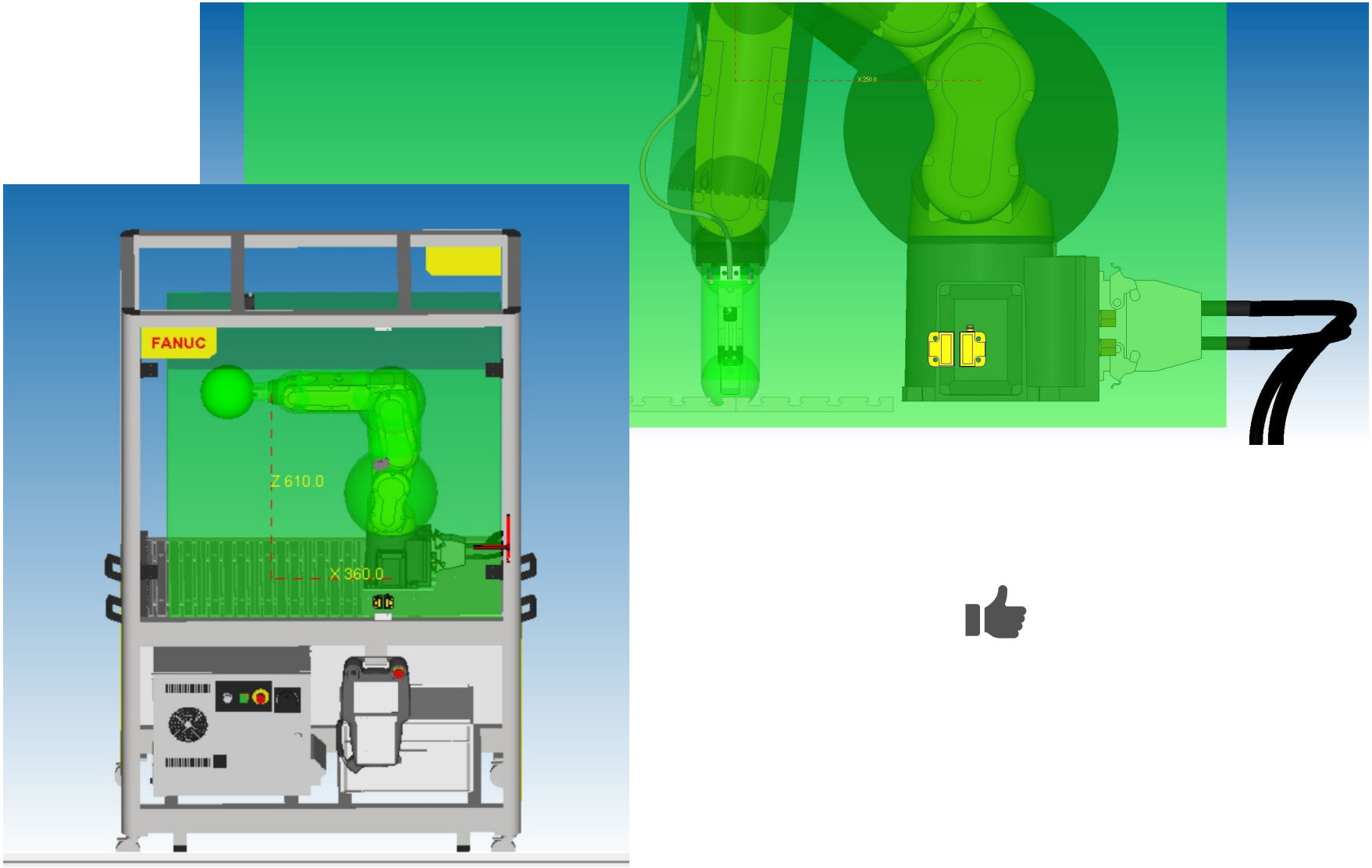


Example of the use of CPCs to define a working zone and restricted zones:

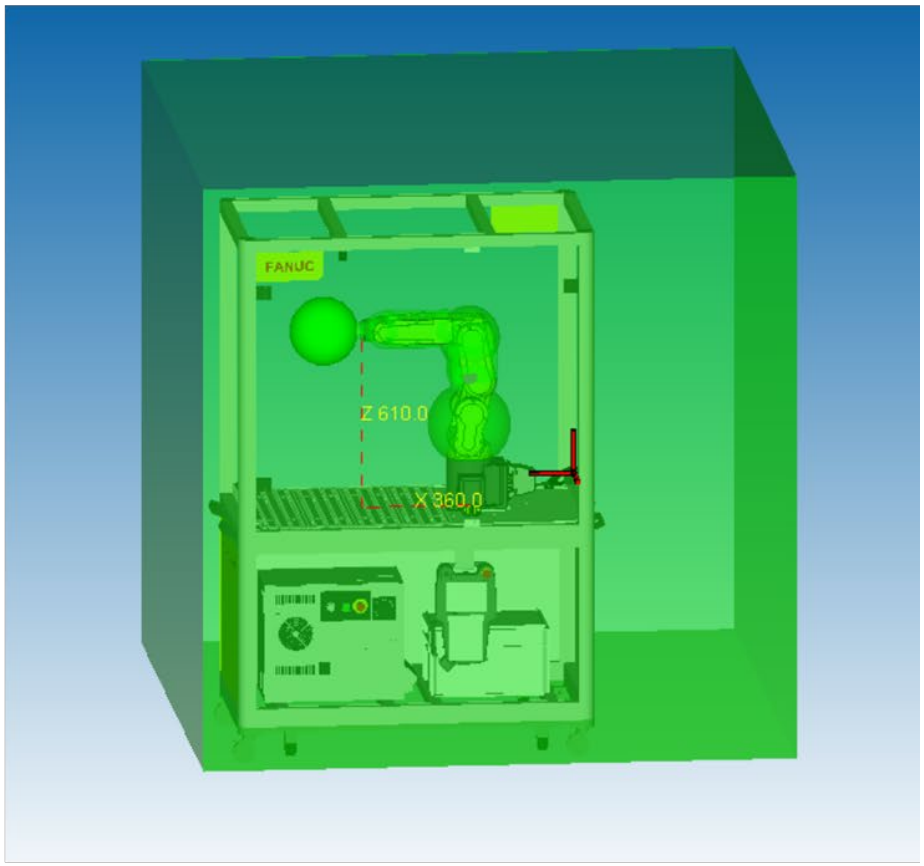


In cases where the robot runs the risk of having to pick parts near to the slotted plate, the lower plane of the working zone can be positioned moderately below the slotted plate as the robot cannot travel through the plate, though not harm a human.

Illustration:




FANUC
Z 610.0
X 360.0


FANUC
Z 610.0
X 360.0

Theme: DCS Setup

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	DCS working zone is set up correctly		The position and size of the box must be reasonable. The lower plane of the box can be set below the slotted plate to avoid DCS errors when picking close to the slotted plate. (i.e. +/- 10mm or tolerance to be agreed for the TP by Experts during MS review). Marking conditions as for the user model.	Yes/No	5	n/a
M2	DCS cartesian position check is set up correctly		The DCS setup includes at least one enabled cartesian position check with the right robot and user model. Marking conditions as for the user model.	Yes/No	5	n/a
M3	Robot Stop Test with Active DCS in T1		Competitors demonstrate that the robot actually stops when leaving the working zone in T1. Experts to decide during the marking review where exactly this is checked.	Yes/No	6	n/a
M4	Setup of restricted zones (only to be used if this topic is requested in the Test Project)		Check if one or multiple restricted zones have been configured correctly according to the description in the Test Project. Experts to decide during the marking review if checked in Roboguide, on the real robot or both.	Yes/No	5	n/a

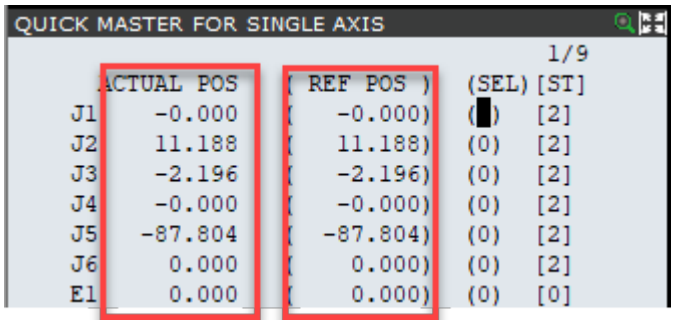
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
			If it is decided to check on both and the restricted zones in Roboguide and on the real robot do not match, then priority is to be given to the real cell for evaluation.			
M5	Setup of Target model collision (Only to be used if this topic is requested in the Test Project)		Check if Target model collision has been configured correctly according to the description in the Test Project. Experts to decide during the marking review if checked in Roboguide, on the real robot or both. If it is decided to check on both and the CPCs in Roboguide and on the real robot do not match, then priority is to be given to the real cell for evaluation.	Yes/No	5	n/a

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	DCS User Model is setup correctly and appropriately		Experts to decide during the marking review if checked in Roboguide, on the real robot or both. If it is decided to check on both and the user models in Roboguide and on the real robot do not match, then priority is to be given to the real cell for evaluation. In that situation Competitors might need to demonstrate the validity of their setup in 4D Graphics with exported CAD models.		5	
		0	Missing DCS components in 4D Teach Pendant View			n/a
		1	Robot DCS Zone is modelled correctly in 4D View			n/a
		2	DCS Tool Model appropriate in 4D View – this depends on Test Project			n/a
		3	Normally required to use at least 2-point method (preferred line seg. model) to match Roboguide.			n/a

Sub-criterion: Quick Master Reference Position

Theme: Set/Check Quick Master Reference Position

General comment:



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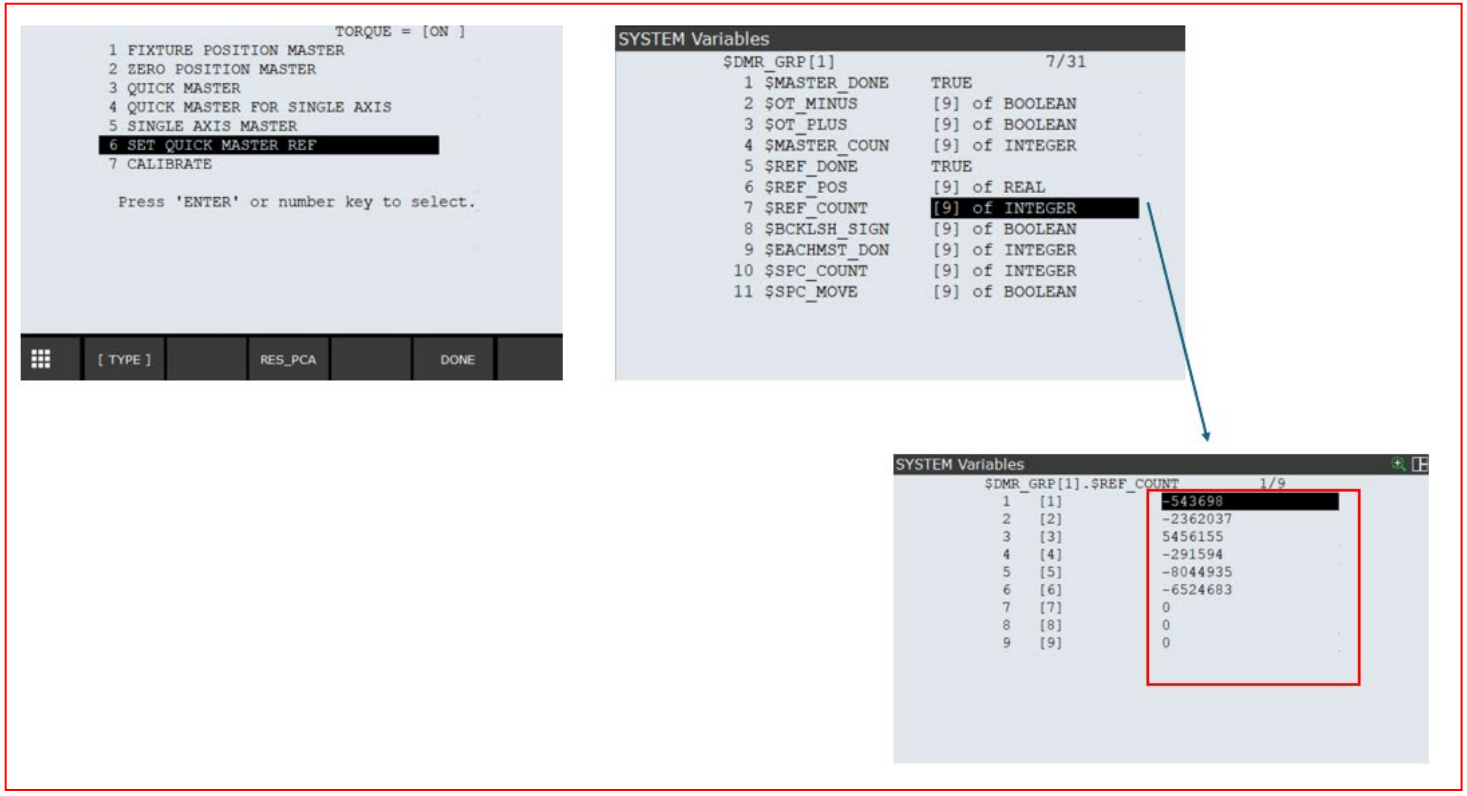
Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Quick Master Reference Position Set up Correctly		This can be checked using MENU>System>Master/Cal>Quick Master Single Axis The Ref Pos and the Actual Pos when the robot is at the Quick Master Reference Position should match. (May also need to set $MASTER_ENB = 1)	Yes/No	5
M2	Quick Master – Reference SET		This can be checked using	M2	5

			Menu > System > DMRGRP > REF COUNT > Count values. REF Count values must present in variable. This can be Set from MENU>System>Master/Cal>Set Quick Master Ref Pos		



This can be set from MENU>System>Master/Cal>Set Quick Master Ref Pos

Sub-criterion: Payload and arm load

Theme: Payload and arm load setup

General comment:

Setting up the payload of the End Of Arm Tool (EOAT) is considered each time an object is picked up or dropped, as this allows for the servos to compensate the additional weight / reduction in weight. This improves the overall efficiency and longevity of the Robot. If the EOAT can carry more than one fixture, then a payload must be setup for each device.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Payload of EOAT set up correctly from data sheet provided	Mass value of EOAT provided with tolerance. Tolerance high +/- 100 g – principle more important than exact values. E.g. Schunk gripper m = 0.42 kg tolerance +/- 100 g.	Yes/No	4
M2	At least two payloads have been defined, one with and one without	If applicable – depends on the Test Project MENU>System>Motion	Yes/No	4
M3	Payload mass is set correctly on the created payloads	Mass values for each payload provided with tolerance. Tolerance high +/- 100 g – principle more important than exact values. This aspect has to be adjusted for each Test Project with appropriate values. E.g. Gripper + tote + blocks 0.545 kg tolerance +/- 100 g etc.	Yes/No	4

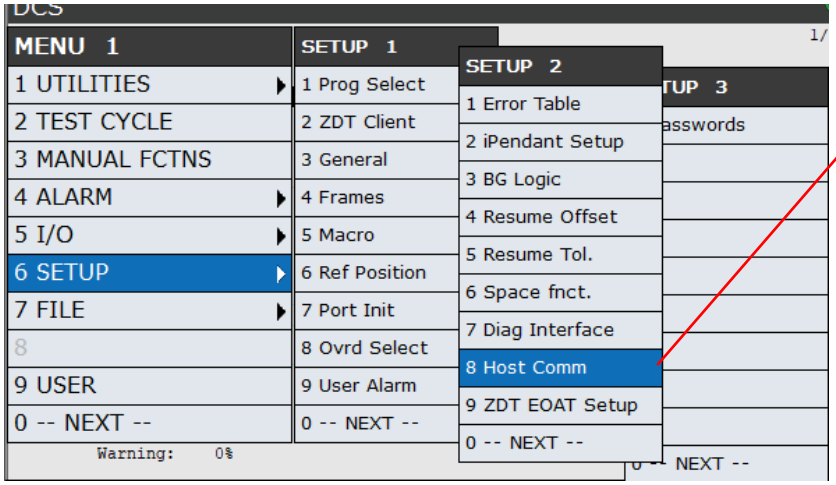
Aspect type (M or J)	Aspect Description	Extra Aspect Description	Requirement (M only)	WSOS Section
M4	Payload CofG set correctly	Payload CofG set correctly with tolerance. Tolerance high +/- n mm – principle more important than exact values. This aspect has to be adjusted for each Test Project with appropriate values.	Yes/No	4
M5	Arm load Axis 1/Axis 3 setup	Axis 1 is rarely used. Axis 3 is a small value/effect but good practice to setup. Tolerance +/-50 g E.g. 160g in TP cable – 0.16kg +/- 0.05 (In case of Complex EOAT – Cable dresspack design, values can be provided in Test Project)	Yes/No	4

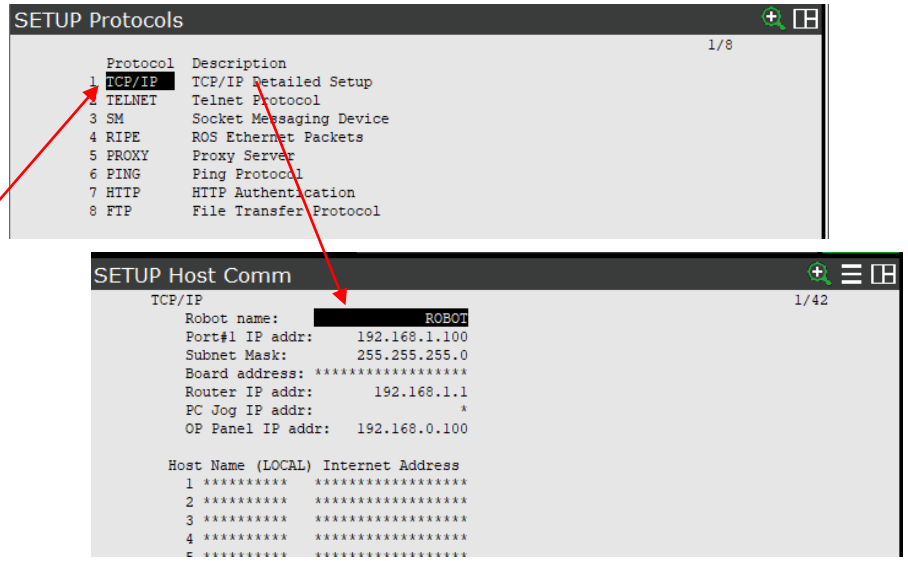
Sub-criterion: Setup host communication

Theme: TCP/IP address settings

General comment:

This section details how to setup the Robot IP address:





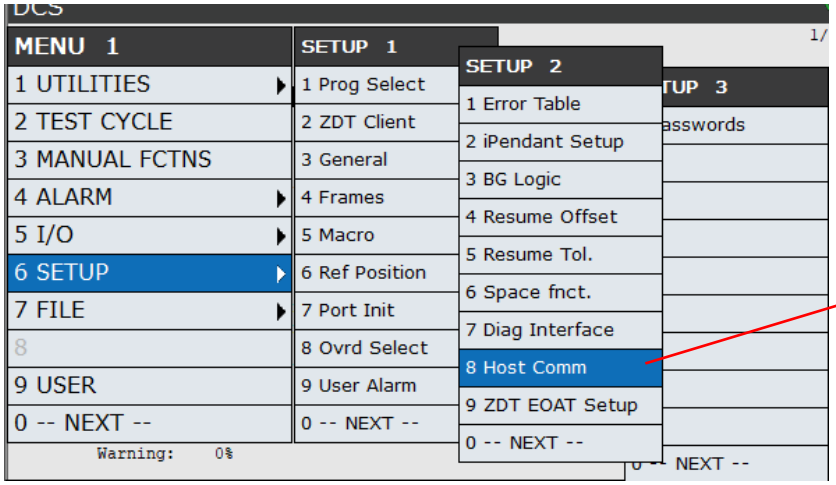
Potential marking aspects:

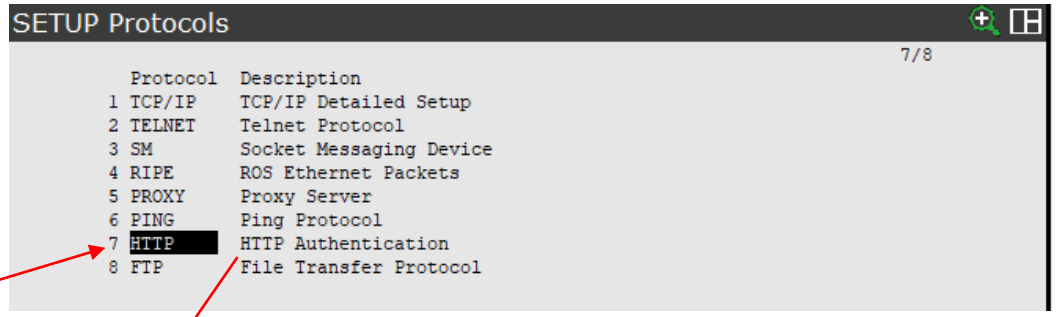
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	IP addresses of PC and Robot set up correctly		MENU>SETUP>Host Comm>TCP/IP Check it on the real Robot and call the Robot webpage on the laptop.	Yes/No	5

Theme: HTTP settings

General comment:

This section details how to set up the HTTP Authentication. For comment tool and vision, it has to be set Unlock all of it.





Potential marking aspects:

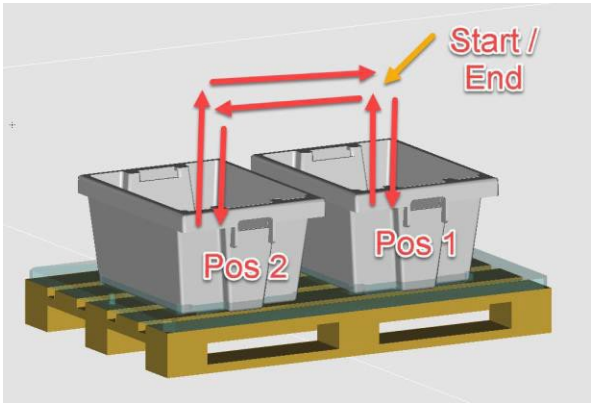
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	HTTP settings setup correctly		At least Karel and Vision setup is unlocked. MENU>SETUP>Host Comm>HTTP Check it on the real Robot and call the Robot webpage on the laptop.	Yes/No	5

Sub-criterion: EOAT (e.g. Gripper) test program

Theme: EOAT (e.g. Gripper) test

General comment:

The task has to be completed on the first day of the Test Project. The purpose is to see if the Competitors can handle the gripper, setting up the RO correctly etc. and can follow the detailed instructions. One example would be as shown: Write a Gripper test program to present the following sequence:



0 Start at HOME position
1 Open Gripper
2 Move above Position 1
3 Move down to Position 1, close gripper, move up above Position 1
4 Move above Position 2
5 Move down to Position 2, open gripper, move up above Position 2
6 Move down to Position 2, close gripper, move up above Position 2
7 Move above Position 1
8 Move down to Position 1, open gripper, move up above Position 1
9 Repeat steps 1-8 for 3 cycles.

Test conditions – number of attempts, time allowed etc are as specified in TD and TP

In some Test Projects there will be specific instructions on how to mount the EOAT – such as a required cable/hose routing.

In other Test Projects there may be no specific instructions but if standard mounting hardware -such as a dowel/location pin is used then this can be evaluated here.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	EOAT test runs correctly		Simple pick and place of one (1) part runs correctly, according to instructions and without any collisions	0-x (cycles)	6
M2	EOAT test program was run in AUTO mode		If specified in Test Project, run in AUTO ONLY, T1 or T2 will award zero (0) marks	Yes/no	6
M3	Start and finish at HOME		Program must start and finish from HOME position	Yes/No	6
M4	EOAT test program cycle time		Must complete required number of cycles and start/finish from HOME – otherwise no cycle time points awarded. Competitors should be told to move robot to home position before starting.	seconds	6
M5	Standard EOAT Mounting Hardware used		Example: Faceplate dowel/location pin installed correctly	Yes/No	6
M6	Special EOAT/Cable/ Hose Mounting Instructions followed correctly		Example: Hose routing as instructed if included in Test Project	Yes/No	6

Sub-Criterion: Run basic task

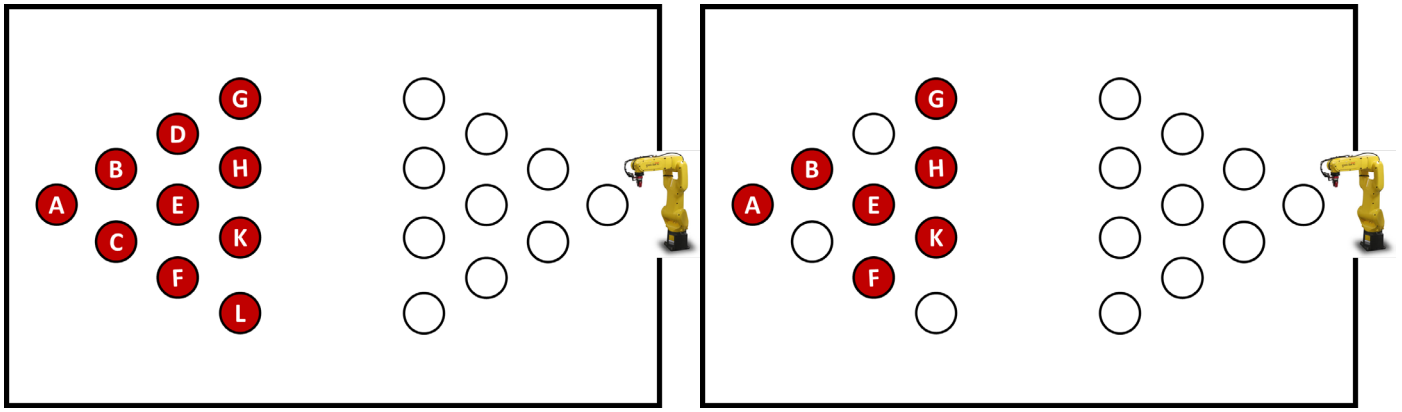
Theme: Correctly running basic task on Robot Cell

General comment:

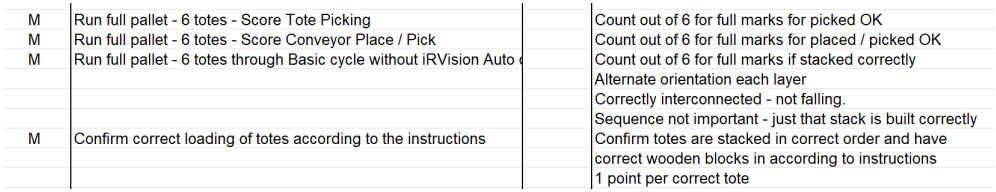
This section covers the correctness of running basic task on Robot Cell. For extension task, the items in the basic task can be used as a reference.

Example of completeness of a task is given below:

- **Requirement:** To take ten (10) cylindrical workpieces from a supplier to the designated places on the chess board.
- **Case 1:** If the Competitor can move ten (10) cylindrical workpieces from the supplier to the designated positions on the chess board, he will get full points.
- **Case 2:** If the Competitor can only move seven (7) cylindrical workpieces successfully from the supplier to the designated positions on the chess board, he should only get seven (7) out of ten (10) full points.



Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Basic task – program selection from UOP Box		Competitors must use the UOP Box – PNS/RSR input to select the Robot Program Or HMI	Yes/No	5
M2	Check the correct running of individual sections of the basic task		These aspects are very specific to the Test Project so should be determined on a case-by-case basis by the Independent Test Project Designer/SCM and Independent Test Project Validators. Example is as shown below.  Counting of successful sections is the preferred means of measurement	It depends on Test Project – Counting is preferred	6
M3	Correct running of the complete basic task		Independently of the counting of individual sections, as in M1 above, points should be given for completing the basic task completely from beginning to end. This should include for instance from Home to Home or other instructions specified in the Test Project.	Yes/No	5
M4	Cycle time test - measure time for each team for basic task		Record the cycle time in seconds, accurate to the second decimal place. Timer program should be given to Competitors and have them insert this in their program to measure cycle time. In parallel, stopwatch/ hone should be used to record manual time. In case of big difference, use of program timer should be checked.	seconds	5

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
J1	Error handling while running the basic task		Set some error situations, e.g., missing workpieces, wrong workpieces, etc. Points should be awarded for correct response, and quality of response – for instance		5
		0	Error not noticed		
		1	Program paused without message		
		2	Program paused with message		
		3	Program paused with option for user to retry etc (menu option or HMI – method not specified)		
J2	The smoothness of motion while performing the basic tasks.		If possible, the Experts should assess the fluidity of the motion while executing the basic tasks. It is clear that this is difficult assessment to do especially with limited time available for marking. In the future example videos or other means should be investigated as basis for marking training. Example Judgement criteria are shown below.		5
		0	Numerous interruptions or delays in the motion (more than five (5) instances).		
		1	Fewer than four (4) occurrences of interruptions or delays in motion.		

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
		2	Fewer than two (2) occurrences of interruptions or delays in motion.		
		3	Very smooth without any glitches or delays.		

Sub-criterion: Digital twin

Theme: Correctly running basic task on Roboguide

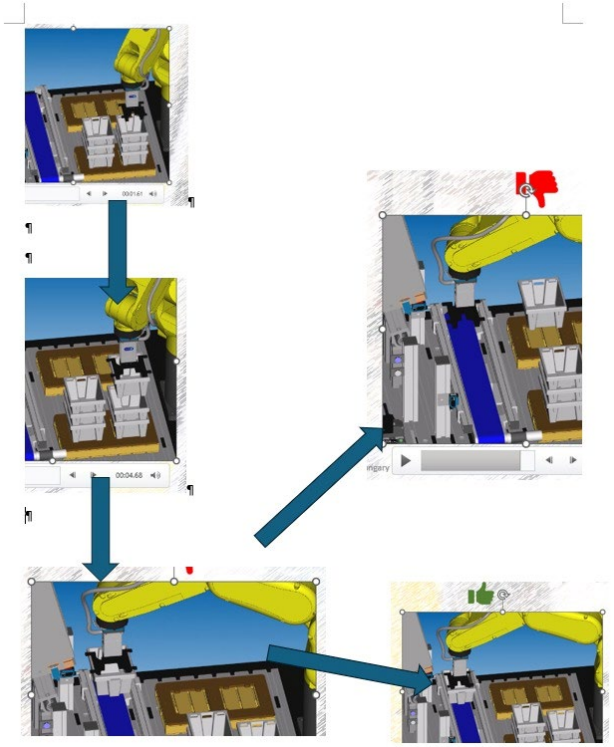
General comment:

This section covers the correctness of running basic task on offline program. For extension task, the items in the basic task can be used as a reference.

Note that many of these aspects depend on the Test Project so will have to be adjusted for each Competition.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Parts picking and placing process - Visibility		During the simulation, the visibility of the parts will accurately reflect whether they disappear or appear.	Yes/No	3	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M2	Parts picking and placing process – smoothness		The parts should appear and disappear smoothly. If they 'jump' from EOAT to Fixture or vice versa then this means part positions have not been taught well so points should not be awarded.	Yes/No	3	

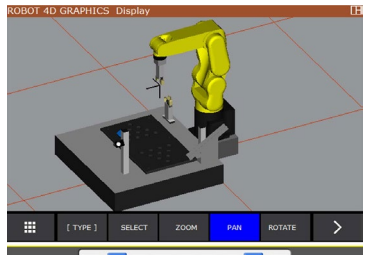
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M3	Animation of EOAT fingers implemented		The accurate opening and closing movements of the EOAT fingers can be observed in the simulation.	Yes/No	3	 
M4	Simulation on error handling		For example, missing object or robot not at home. "Not at Home" is basic/easy to simulate so can be assessed as standard. "Missing Object" is difficult to simulate and to assess, so must be specifically requested in the Test Project Instructions if it is required in a Competition.	Yes/No	3	

Theme: Correspondence of digital twin with real application

General comment:

This section covers the correspondence of the digital twin in Roboguide with the actual robot application.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Functionality used in digital twin		Demonstrating the use of 4D graphics functionality in the digital twin.	Yes/No	5	
J1	Digital Twin representation		If possible, the Experts should assess the accuracy of the digital twin in perfectly representing the real-world dynamics of the robot cell. It is clear that this is difficult assessment to do especially with limited time available for marking. Example Judgement criteria are suggested below.		5	
		0	The actions depicted in both the simulation and the actual operation conducted in the robot cell exhibit substantial differences.			

		1	Certain similarities exist alongside discrepancies, including the identification of more than three differences, between the actions depicted in the simulation and those carried out in the real operation within the robot cell.			
		2	There are few discrepancies, such as recognizing fewer than three differences between the actions depicted in the simulation and those executed in the actual operation within the robot cell.			
		3	The actions depicted in both the simulation and the actual operation conducted in the robot cell are fundamentally identical, although they demonstrate differences in operational speed.			

Sub-criterion: Working style, safety and backup

Theme: Working Style and Safety

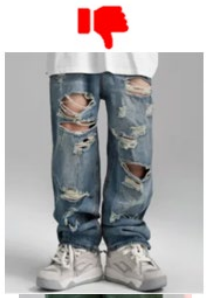
General comment:

This section covers the working style in the work area and how to ensure the safety during working.

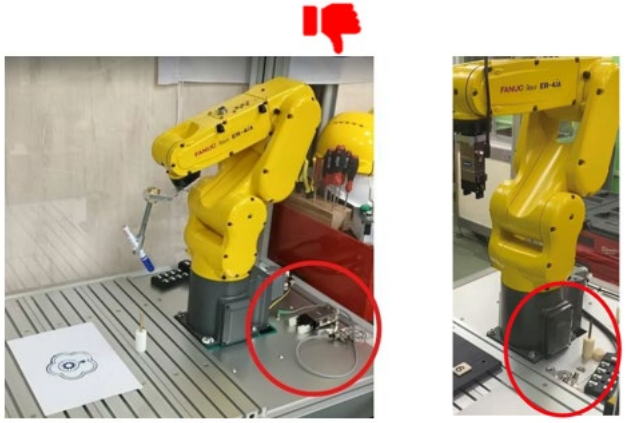
Safe conduct throughout the Competition referring to the rules in the Test Project and Technical Description

In the aspects below a "work session" is one of the half-day sessions of the Competition – i.e. the morning or afternoon session.

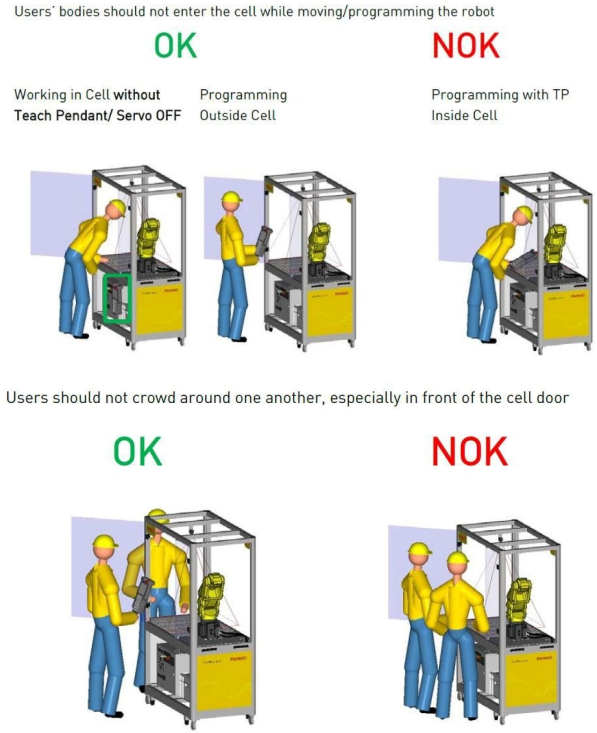
Potential marking aspects:

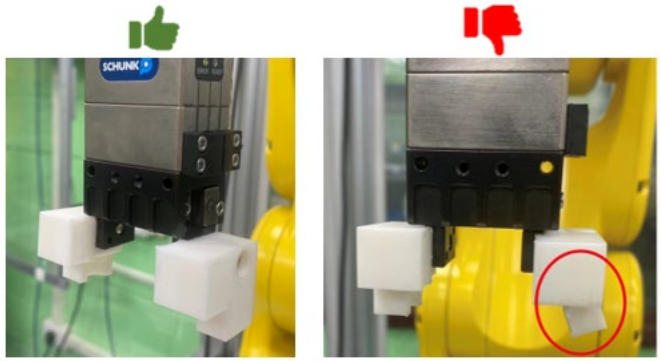
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Professional appearance		Following the WSI recommendations and PPE requirements for the Competition.	Yes/No	1	   
M2	Correct use of Auto/T1/T2 switch.		If possible, depending on human resources available, Experts should monitor the correct use of the Auto/T1/T2 switch. Good practice is for Competitors to start their work in T1 mode and then progress to testing in T2 mode or Auto mode.	Yes/No	1	N/A

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M3	Keep robot running smooth		If possible, depending on human resources available, Experts should monitor even minor collisions during programming and testing. The robot should not hit any parts of the robot cell, workpieces, or fixtures.	Yes/No	1	   

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M4	Keep robot cell tidy		At the end of each work session, no clutter in the robot cell, e.g. unused screws or nuts.	Yes/No	1	
M5	Keep work area clean		At the end of each work session, the overall work area should be neat and tidy. But there should be nothing except the monitor on the table.	Yes/No	1	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M6	Shut down		At the end of each work session, shut-down the robot and computer before leaving the workshop (unless otherwise instructed by SMT – for instance to speed up marking).	Yes/No	1	
M7	Balanced job sharing. Equitable distribution of tasks among Competitors.		Especially – one person working in the cell at a time The workload should be evenly distributed between two Competitors, ensuring that no individual remains idle while their teammate is busy. (NOTE: important but difficult to assess – suggestions on how to assess would be welcome)	Yes/No	2	N/A

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M8	Safe conduct throughout the Competition.		There are no hazardous actions permitted that could compromise safety throughout the operation, as instructed during Safety Briefing.	Yes/No	2	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M9	Ensure that everything remains undamaged.		No workpieces or fixtures are to be damaged during the Competition. Competitors have not damaged a part that needed to be replaced.	Yes/No	1	
J1	Teach pendant cable		Wound up and stored neatly – not left in a heap on the floor (during working and assessment)		1	
		0	Cable damaged or cable and TP left in uncontrolled position – on floor or table or elsewhere			

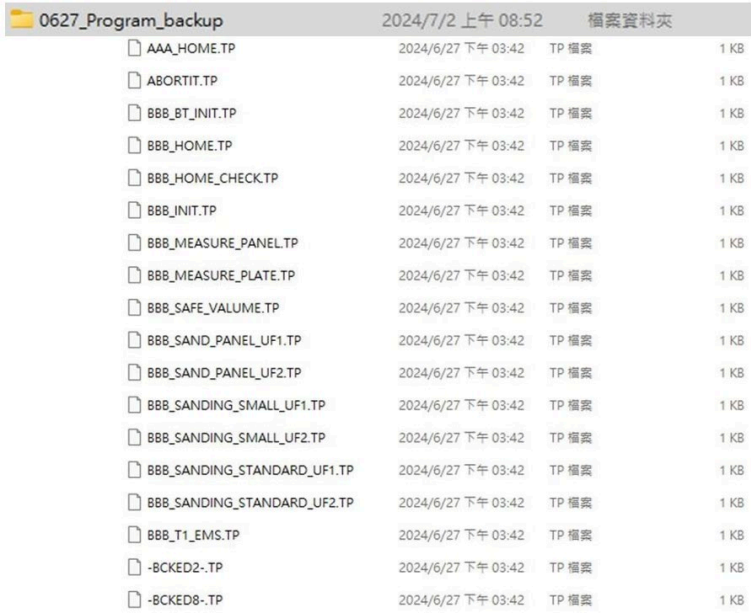
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		1	TP hung up but Cable on floor			
		2	TP hung up and Cable clearly off floor and in controlled position			
		3	TP hung up and Cable neatly coiled and stored			

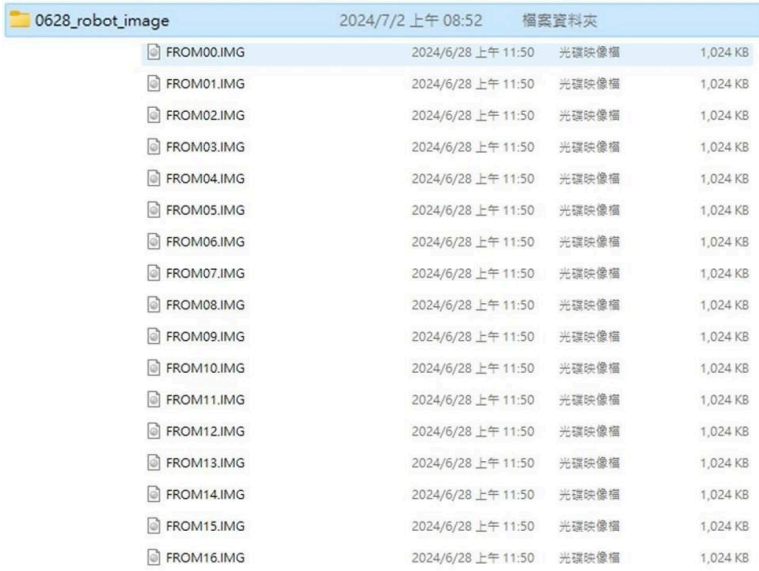
Theme: Backup

General comment:

This section covers the backup of works.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Program backup made		Program backup after session work. Check on the USB stick or computer. Check time backup made – within one (1) hour of end of session	Yes/No	2	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M2	Image backup made		Image backup after session work. Check on the USB stick or computer. Check time backup made – within one (1) hour of end of session	Yes/No	2	
M3	Roboguide backup made		Roboguide backup after session work. Check on the USB stick or computer. Check time backup made – within one (1) hour of end of session	Yes/No	2	

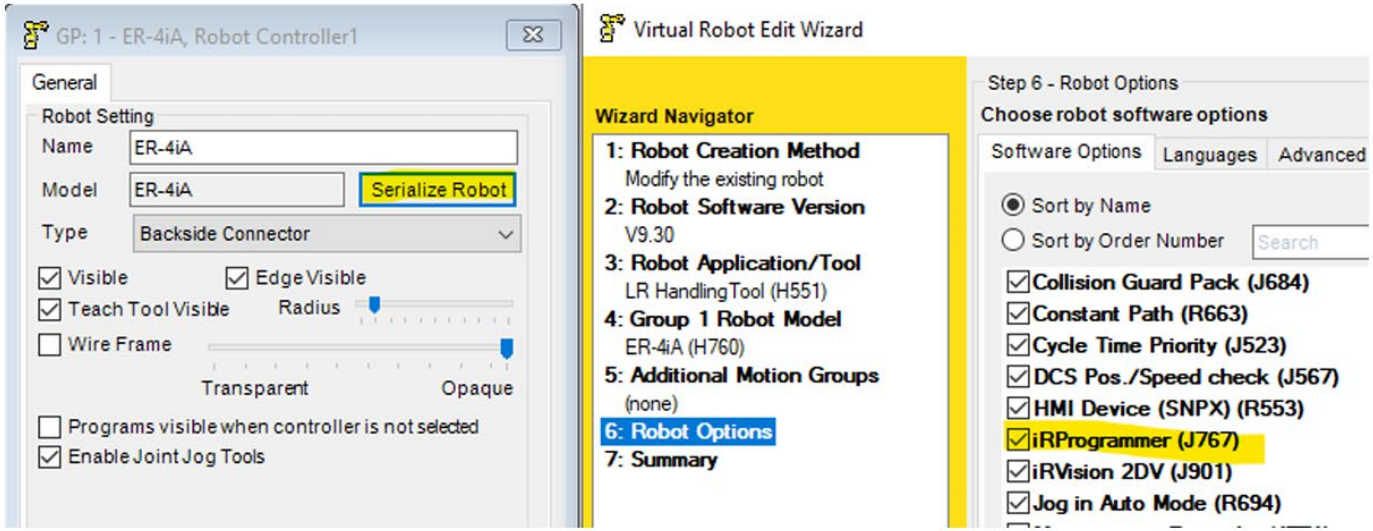
Sub-criterion: Programming

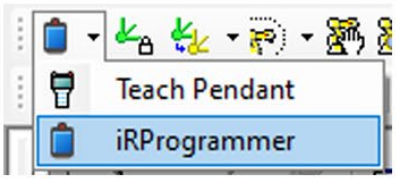
Theme: Editor in iRProgrammer

General comment:

Similar to the use of the comment tool, it seems opportune in a modern approach to use the Editor in iRProgrammer. The use should however not be imposed but Competitors should at least be able to install the iRProgrammer option in Roboguide and be aware of the location of this tool.

This is a new theme and is not mandatory for Lyon – to be discussed and added in future if agreed.





Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Installation of the iRProgrammer option		The iRProgrammer option is installed on the robot in Roboguide.	Yes/No	5
M2	Use of the iRProgrammer Editor		The Competitors can navigate to the iRProgrammer Editor.	Yes/No	5

Theme: Program files structure and naming

General comment:

The program names structure of a project should meet the following three (3) criteria:

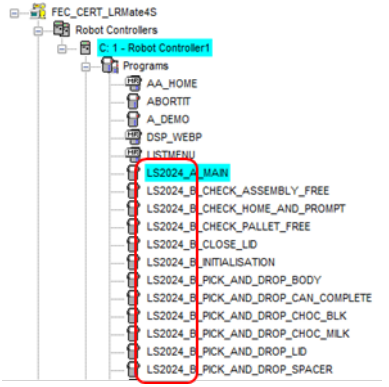
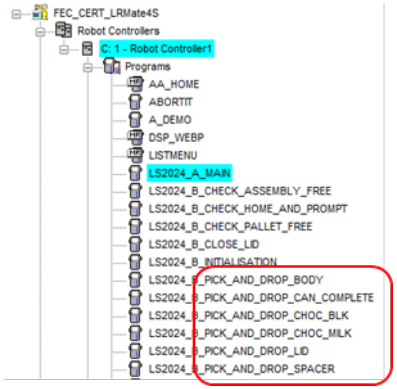
- All files of a project will group together when sorted alphabetically. Exception can only be made for the well-known program "AA_Home". Alternatively, a collection can be used for this purpose.
- Sub-programs and macros are used.
- If existing, the files should appear in the following order: Main program, sub-programs, macros, simulation programs.

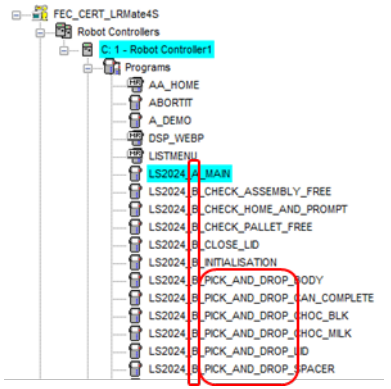
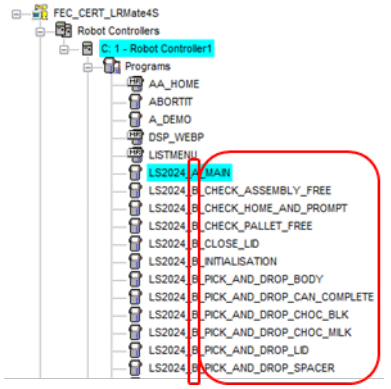
Example:

AA_Home
ES_A_main
ES_B_sub1
ES_B_sub2
ES_C_macro1
ES_D_sim_prog1

The program names or their comments indicate what the program does. Example: ES_B_PICK_CYLINDER not ES_B_sub1

Potential marking aspects:

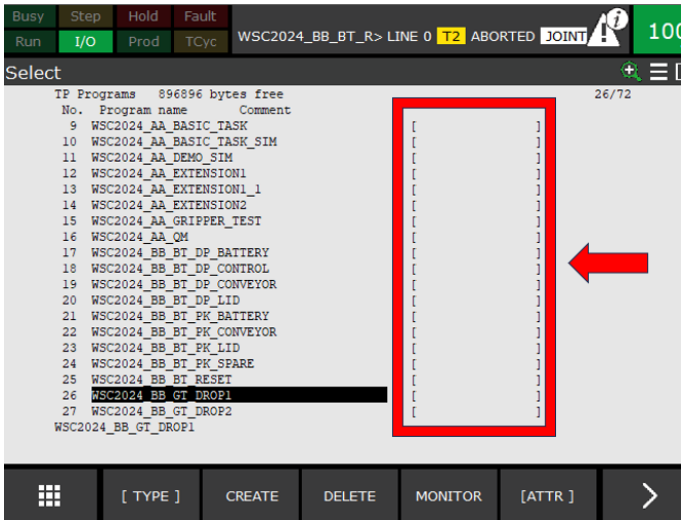
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Program names structure (grouping)		All files unique to the project are grouped together when sorted alphabetically. Alternatively, a collection can be used for this purpose.	Yes/No	5	
M2	Program names structure (sub-programs)		Sub-programs and macros are used.	Yes/No	5	

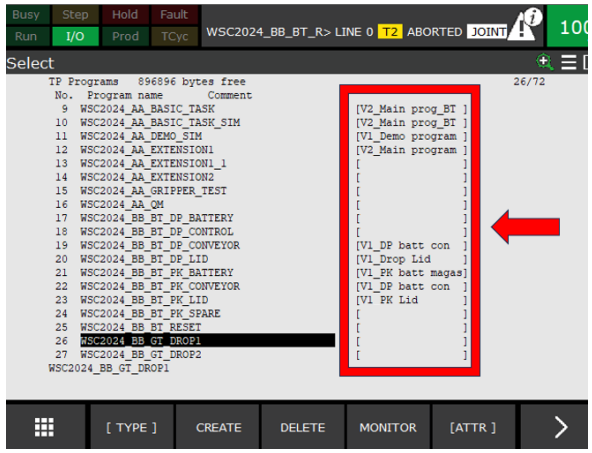
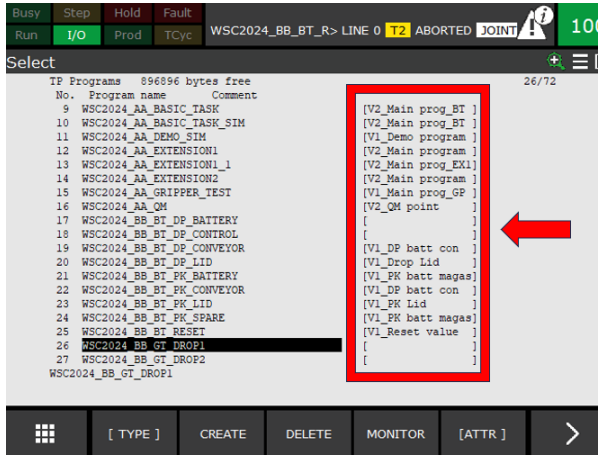
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M3	Program names structure (order)		The files appear in the following order: Main program, sub-programs, macros, simulation programs. (No point if no sub-programs or no macros are used)	Yes/No	5	
J1	Program names meaning		The program names or their comments indicate what the program does. Example: ES_B_PICK_CYLINDER not ES_B_sub1 (Suitable abbreviations are suggested)		5	
		0	Not recognisable what the programs do.			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		1	Poor program names.			
		2	Most program names indicate what the programs do.			
		3	All programs indicate very clearly what the programs do.			

Theme: Program select screen comments

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	Program comments		All programs should contain some kind of comment on the Program Select screen. It is not mandatory to show the version number in the program select screen.		5	
		0	No comments			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		1	At least one (1) program			
		2	Over than half programs are commented			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
		3	All programs are commented			

Theme: Program header and program version number

General comment:

A robot program header should at least contain the purpose of the program and the authors.

A program should also contain some kind of version number – see aspect below.

A date is not sufficient as a version number, as multiple versions can occur during one day. Indicating the version number at multiple places must be avoided.

In an industry context the header should not only contain the **authors names** but also **their company (Team Chinese Taipei, for example).**

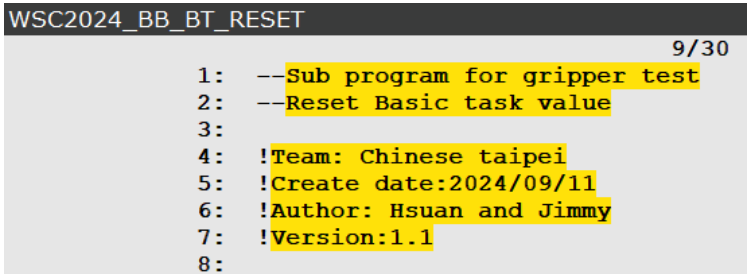
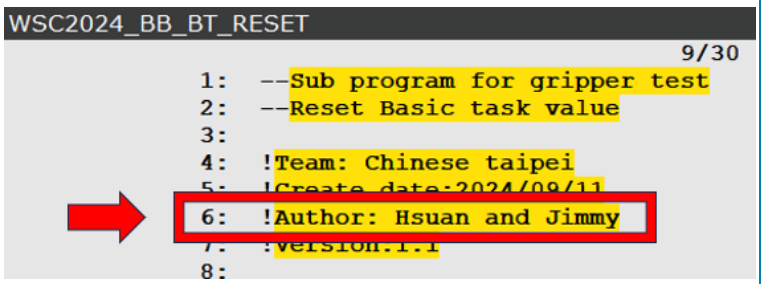
Noted: Please take care of not using long comments.

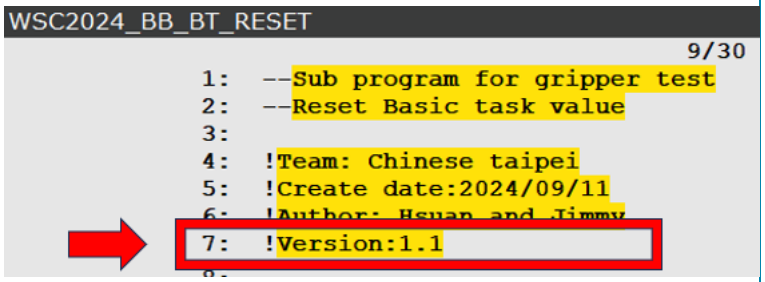
WSC2024_BB_BT_RESET

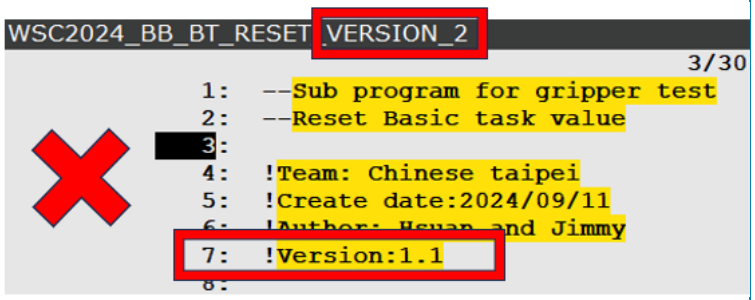
9/30

```
1:  --Sub program for gripper test
2:  --Reset Basic task value
3:
4:  !Team: Chinese taipei
5:  !Create date:2024/09/11
6:  !Author: Hsuan and Jimmy
7:  !Version:1.1
8:
```

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Purpose of the program		All programs contain in the header a comment with the description of the purpose of this program. (To be checked at least in two by the Experts randomly chosen programs.)	Yes/No	5	
M2	Authors		All programs contain in the header clear identification on the actual person who has written the program – so who to ask in case there is a problem. (To be checked at least in two by the Experts randomly chosen programs.)	Yes/No	5	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M3	Version numbers (Measurement)		All programs contain some kind of version number. This must not necessarily be in the header of the program but can also be in the program name comment or even in the program name (not recommended). A date is not sufficient as a version number. Indicating the version number in multiple places must be avoided. (To be checked at least in two by the Experts randomly chosen programs)	Yes/No	5	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
J1	Version Numbers (Judgement)		All programs should contain some kind of version number. A date is not sufficient as a version number. Indicating the version number in multiple places must be avoided. (To be checked at least in two programs randomly chosen by the Experts)		5	
		0	No Version Numbers			
		1	At least one (1) of the checked examples seen			
		2	More than half checked examples seen			
		3	All checked examples seen (see above)			

Theme: Initialisation

General comment:

It is common practise in programming to initialize variables at the beginning of a program that are not automatically set within the rest of the program. The correct execution of a robot program should not depend on the manual initialisation of a register before program start. All registers and even position registers should be set to defined initial value if this is not done by the logic. The latter is for example the case for the counter register of a for loop. Position registers [PR()] can also be initialized by assigning a position variable [P()].

It must also be ensured that the representation of position registers is correctly initialised to "cartesian" or "joint".

The initialisation can be done at the beginning of a main- or sub-program, or in a separate initialisation sub-program, or a mixture of it.

Example:

```
3   !Initialisation
4   UTOOL_NUM=2
5   UFRAME_NUM=2
6
7   PR[3:Pick Position]=P[1:LidInHolder]
8   R[4:DeltaZ]=R[1:CansOnStock]*R[25:DeltaZBetwLids]
```

```
4:
5:  --Initialisation of registers
6:  R[1:J-speed]=10
7:  R[2:L-speed]=40
8:
9:  --Initialisation of PR via P
10: PR[3:Pick Position]=P[1:Top Lid]
11:
12: --Initialisation of PR representation and values
13: PR[1:Offset]=LPOS-LPOS
14: PR[1,3:Offset]=(-40)
15:
```

Potential marking aspects:

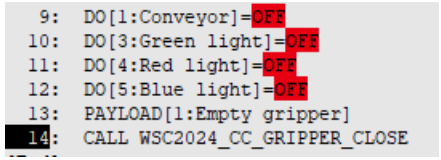
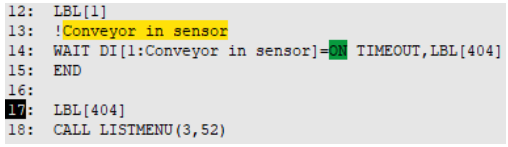
Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Initialisation of registers		All registers used in the Test Project are set to a defined value at the beginning of the main- or sub-program so that the program runs correctly regardless of the values that were stored in the used registers before the program was executed. Exception can be made for registers that are set by the logic (e.g. user defined registers as speed override, number of parts been processed, etc).	Yes/No	5
M2	Initialisation of position registers		All position registers used in the Test Project are set to a defined value at the beginning of the main- or sub-program so that the program runs correctly regardless of the values that were stored in the used position registers before the program was executed. Exception can be made for registers that are set by the logic.	Yes/No	5
J1	Initialisation of registers and position registers		The Competitors should show how and where they initialise registers and position registers by programming.		5
		0	No initialisation done by programming, only manual.		
		1	Only a few registers or position registers are initialized by programming, but not consistently.		
		2	Most registers and position registers are initialized by programming with values.		
		3	All registers and position registers are initialized by programming with their values and their representations (For example use of LPOS-LPOS, JPOS-JPOS or assignment of a position variable).		

Theme: Use of remarks

General comment:

A program should be commented in such a way that at least the logical flow is reproduceable for an outsider. It is however admitted that commenting largely depends on the qualification of the final customer, so that a sharp formulation of a marking criteria is difficult.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	WSOS Section	Resource
J1	Use of remarks		A program should be commented in such a way that at least the logical flow is reproduceable for an outsider. (To be checked at least in the main program and one sub-program.)	5	
		0	No remarks apart from the header		
		1	Some remarks		

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	WSOS Section	Resource
		2	Logical flow reproduceable (at least remarks before IF, FOR and JMP)		9: !Definition I/O 10: DO[1:Conveyor]=OFF 11: DO[3:Green light]=OFF 12: DO[4:Red light]=OFF 13: DO[5:Blue light]=OFF 14: !Definition Payload 15: PAYLOAD[1:Empty gripper] 16: !Definition Gripper 17: CALL WSC2024_CC_GRIPPER_CLOSE
		3	Detailed commenting, above expectations.		WSC2024_AA_BASIC_TASK 27: WAIT 1.25(sec) 28: ENDIF 29: WAIT .20(sec) 30: R[10:Timer]=0 31: !Pick battery during conveyor mov 32: IF (DI[1:Conveyor in sensor]=[redacted] AND R[1:BT Pick battery]<=5 AND : DI[3:Conveyor out sensor]=[redacted]),JMP LBL[1] 33: 34: !All magasine battery done 35: LBL[3] 36: CALL WSC2024_BB_BT_PK_CONVEYOR 37: !Repick battery 38: IF (R[55:out UIF select f]=1),JMP LBL[1] 39: !Control module 40: IF (R[5:Count PK batt co]=R[3:Set module]) THEN 41: CALL WSC2024_BB_BT_DP_CONTROL 42: JMP LBL[1] 43: ENDIF 44: 45: CALL WSC2024_BB_BT_DP_BATTERY

Theme: Use of UTOOLs, UFRAMEs and PAYLOADs

General comment:

Two (2) conditions should be met:

1. The right user tool, user frame and payload have been chosen before a motion command.
2. At least once per sub-program, containing motions, a user tool and a user frame have been programmed in the initialisation section to potentially allow running the sub-program independently of the main program.

```
 9:  !Definition frame
10:  UFRAME_NUM=0
11:  UTOOL_NUM=10
12:  !Definition Payload
13:  PAYLOAD[5:Teach pin]
14:  !Definition Gripper
15:  CALL WSC2024_CC_GRIPPER_CLOSE
```

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Correct choice of user tool and user frame.		The right user tool and user frame have been chosen before a motion command. (To be checked at least in two by the Experts randomly chosen pick- or place-situations.) If only one (1) user frame was configured, this should not be penalised here again but simply be checked if it was set at least once before the first motion.	Yes/No	5
M2	Correct choice of payload.		The right payload has been chosen before a motion command. (To be checked at least in two by the Experts randomly chosen pick- or place-situations.) If only one (1) payload was configured, this should not be penalised here again, simply check if it was set at least once before the first motion.	Yes/No	5

M3	Initialisation of user tool and user frame.		At least once per sub-program, containing motions, a user tool and a user frame have been programmed in the initialisation section to potentially allow running the sub-program independently of the main program. Exception can be made for the user frame if the motions are all relative to joint coordinates (see for example AA_HOME). (To be checked at least in two by the Experts randomly chosen sub-programs.) If no sub programs were used, this should not be penalised here again but simply be checked in the main program.	Yes/No	5

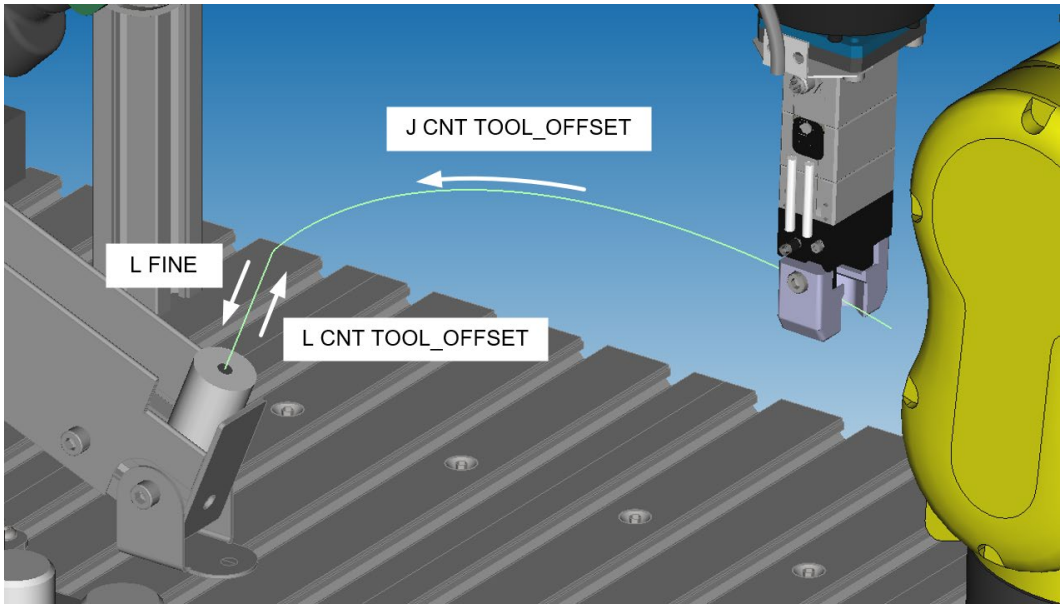
Theme: Programming of motions

General comment:

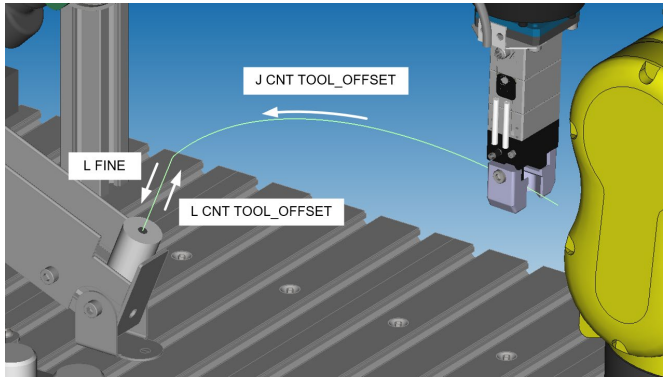
A typical pick- or place motion should follow the concept adjoining. Motion speeds should be controlled most of the time by registers that are set in the initialisation section of the main program. For example, one register per motion type could be used. Exceptions could be made in cases where individual motions require a specific speed, but most should be controlled by registers.

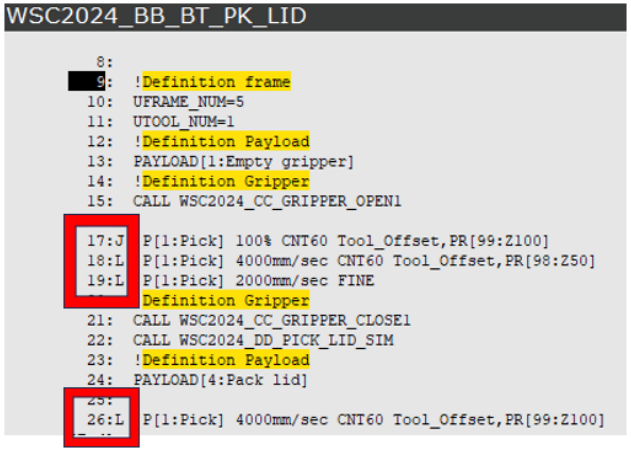
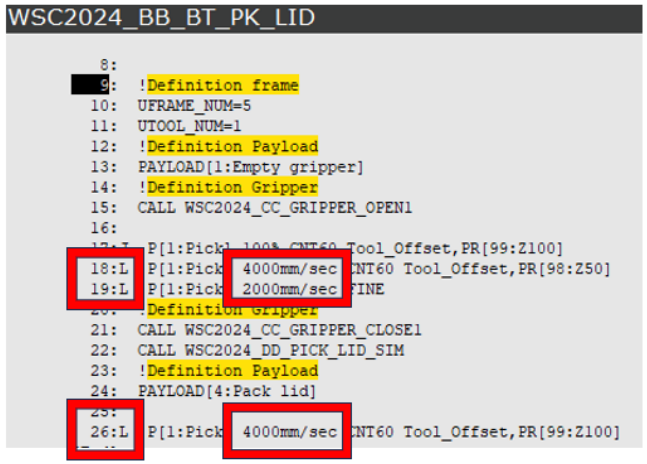
Offsetting towards the pick- or place-position is not desirable.

When using circular motions, the marking criteria risk to vary in dependency of the exact application. Below some potential criteria to be used.

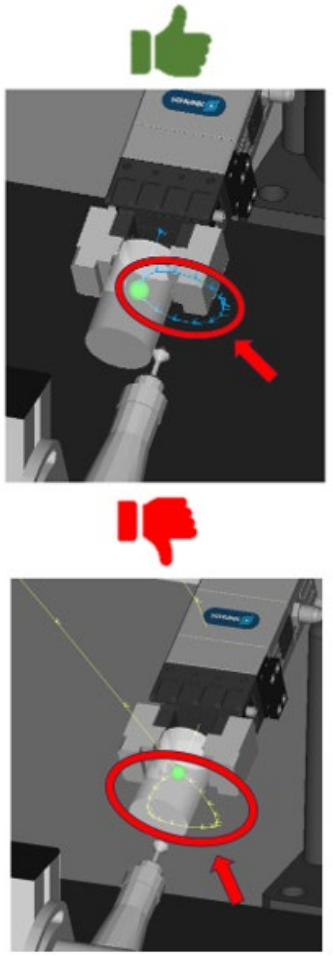


Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M1	Use of approach positions to pick and place		The robot is moved through an approach position before moving to the pick- or place-positions, no matter what technique is used to do so. (To be checked at least in two by the Experts randomly chosen pick- or place-situations.)	Yes/No	5	
M2	Use of offsets to create approach positions		The OFFSET or TOOL_OFFSET option is used relative to a pick- or place-position to make the robot move through an approach position. (To be checked at least in two by the Experts randomly chosen pick- or place-situations.)	Yes/No	5	WSC2024_BB_BT_PK_LID 8: 9: !Definition frame 10: UFRAME_NUM=5 11: UTOOL_NUM=1 12: !Definition Payload 13: PAYLOAD[1:Empty gripper] 14: !Definition Gripper 15: CALL WSC2024_CC_GRIPPER_OPEN1 16: 17:J P[1:Pick] 100% CNT60 Tool_Offset,PR[99:Z100] 18:L P[1:Pick] 4000mm/sec CNT60 Tool_Offset,PR[98:Z50] 19:L P[1:Pick] 2000mm/sec FINE 20: !Definition Gripper 21: CALL WSC2024_CC_GRIPPER_CLOSE1 22: CALL WSC2024_DD_PICK_LID_SIM 23: !Definition Payload 24: PAYLOAD[4:Pack lid] 25: 26:L P[1:Pick] 4000mm/sec CNT60 Tool_Offset,PR[99:Z100]

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M3	Use of motion types		Linear motions are used most of the time for motions to and from pick-up and drop-off positions. Joint motions are used most of the time between fixtures, approach positions and to avoid singularity issues. (To be checked at least in two by the Experts randomly chosen pick- or place-situations.)	Yes/No	5	
M4	Correct linear speed (if applicable)		The speeds of the linear motions are always as requested. (To be checked at least in two by the Experts randomly chosen situations)	Yes/No	5	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M5	Use of FINE option		FINE is used for all motions towards pick-up and drop-off positions. (To be checked at least in two by the Experts randomly chosen pick- or place-situations.)	Yes/No	5	WSC2024_BB_BT_PK_LID 8: 9: !Definition frame 10: UFRAME_NUM=5 11: UTOOL_NUM=1 12: !Definition Payload 13: PAYLOAD[1:Empty gripper] 14: !Definition Gripper 15: CALL WSC2024_CC_GRIPPER_OPEN1 16: 17:J P[1:Pick] 100% CNT60 Tool_Offset,PR[99:Z100] 18:L P[1:Pick] 4000mm/sec CNT60 Tool_Offset,PR[98:Z50] 19:L P[1:Pick] 2000mm/sec FINE 20: !Definition Gripper 21: CALL WSC2024_CC_GRIPPER_CLOSE1 22: CALL WSC2024_DD_PICK_LID_SIM 23: !Definition Payload 24: PAYLOAD[4:Pack lid] 25: 26:L P[1:Pick] 4000mm/sec CNT60 Tool_Offset,PR[99:Z100]
M6	Use of CNT option		CNT is used most of the time towards all approach positions. (To be checked at least in two by the Experts randomly chosen pick- or place-situations.)	Yes/No	5	WSC2024_BB_BT_PK_LID 8: 9: !Definition frame 10: UFRAME_NUM=5 11: UTOOL_NUM=1 12: !Definition Payload 13: PAYLOAD[1:Empty gripper] 14: !Definition Gripper 15: CALL WSC2024_CC_GRIPPER_OPEN1 16: 17:J P[1:Pick] 100% CNT60 Tool_Offset,PR[99:Z100] 18:L P[1:Pick] 4000mm/sec CNT60 Tool_Offset,PR[98:Z50] 19:L P[1:Pick] 2000mm/sec FINE 20: !Definition Gripper 21: CALL WSC2024_CC_GRIPPER_CLOSE1 22: CALL WSC2024_DD_PICK_LID_SIM 23: !Definition Payload 24: PAYLOAD[4:Pack lid] 25: 26:L P[1:Pick] 4000mm/sec CNT60 Tool_Offset,PR[99:Z100]

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M7	Check circular path		The positions are set precisely to achieve the requested motion, means the coordinates are calculated manually or by programming such that the path is perfectly what it should be. OR The complete circular motion is programmed perfectly circular relative to the requested plane.	Yes/No	5	

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resource
M8	Tool orientation during circular motion		The orientation of the tool is constant during the circular motion. (if appropriate) OR The orientation of the tool is changing as required during the circular motion. (if appropriate)	Yes/No	5	
M9	Correct circular speed (if applicable)		The speeds of the circular motions are always as requested.	Yes/No	5	

Theme: Use of register and position names - Judgement

General comment:

Most registers and positions [P() and PR()] should have a name.
If no position variables [P()] or no position registers [PR()] have been used at all, this should not be penalised here.
Easiest to be checked at in the initialization section of at least two by the Experts randomly chosen programs.

Most registers and positions [P and PR] should have a name.
Unused registers and position registers do not necessarily need to be marked as such, as there are too many.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resources
J1	Register R[] and PR[] Names				5	
		0	Not attempted			R[16:]=1 R[17:]=2 R[18:]=3 R[19:]=4
		1	At least one example seen			R[16:]=1 R[17:]=2 R[18:PIck battery]=3 R[19:]=4

		2	At least half examples seen			R[1:[redacted]]=2 R[2:BT Drop battery]=7 R[3:]=2 R[4:Conveyor status]=1 R[5:Count PK batt co]=0 R[6:Check Export]=0 R[7:Drop control]=0 R[8:Gun status]=0
		3	Done for all used Registers observed during Marking – no used Registers without names seen			R[1:BT Pick battery]=2 R[2:BT Drop battery]=7 R[3:Set module]=2 R[4:Conveyor status]=1 R[5:Count PK batt co]=0 R[6:Check Export]=0 R[7:Drop control]=0 R[8:Gun status]=0
J2	Position Names				5	
		0	Not attempted			PR[17:]=R PR[18:]=R PR[19:]=R PR[20:]=R PR[21:]=R PR[22:]=R PR[23:]=R

		1	At least one example seen			PR[17:]=R PR[18:]=R PR[19:]=R PR[20:]=R PR[21:]=R PR[22:]=R PR[23:Pick Battery]=R
		2	At least half examples seen			PR[17:]=R PR[18:]=R PR[19:]=R PR[20:]=R PR[21:Pick Battery3]=R PR[22:Pick Battery4]=R PR[23:Pick Battery5]=R
		3	Done for all Position Instructions observed during Marking - no Positions without names seen			PR[1:Magazine Batt1]=R PR[2:Magazine Batt2]=R PR[3:Magazine Batt3]=R PR[4:Magazine Batt4]=R PR[5:Magazine Batt5]=R PR[6:Magazine Batt6]=R PR[7:Pack Battery1]=R PR[8:Pack Battery2]=R PR[9:Pack Battery3]=R PR[10:Pack Battery4]=R PR[11:Pack Battery5]=R

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resources
M1	Use of comment tool		The Competitors can navigate to the comment tool.	Yes/No	5	

Theme: Use of data driven programming

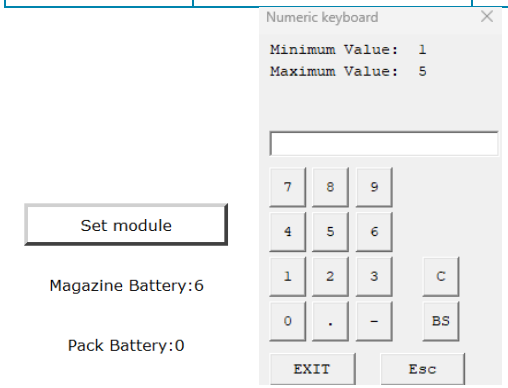
General comment:

Data driven programming describes the fact of separating the logic and the data. Classically, data-driven programming is used in robotics to allow the customer to automatically adapt the path of the robot to changing dimensions of a manipulated part by storing relevant information in registers.

Data driven programming should only be expected from the Competitors where explicitly requested in the Test Project description. The marking criteria risk therefore to be highly dependent on the exact application.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Data driven programming (where requested in Test Project description)		The path of the robot adapts to the dimensions of the parts by modifying registers or values on an HMI field. User defined data, if requested by the task, are registers that the user/operator can adjust to alter the operation of the robot. This can include but not limited to: Speed override, Part dimensions, Cycle count, etc.	Yes/No	5



Theme: Error handling concept

General comment:

Error handling describes the fact that a robot program is written in a way that it reacts in a reasonable manner on unwanted situations. This could simply be by stopping the robot if magazines run empty, by popping up an error message window when the robot is not in its home position or by communicating an error code to a PLC.

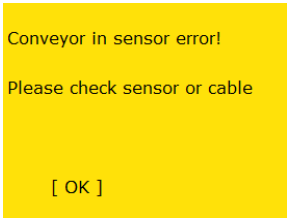
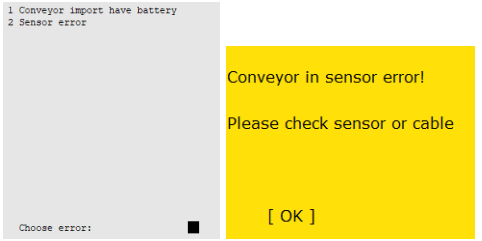
The Competitors should develop and realise an error handling concept even without explicit request in the Test Project description. They can limit however their efforts to manipulations errors in the cell (no TP errors) and to the available parts and sensors.

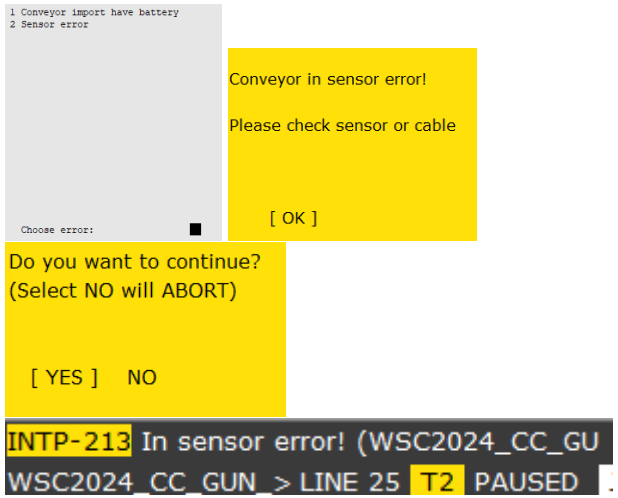
The error handling concept should also be described in the documentation (see chapter 18).

Furthermore, a robot program should always start from the same defined position to avoid collisions. This position is called Home. A check if the robot is in his Home position at program start must be performed. The "Home check", even though it is part of the error handling, is to be considered separately to due to its outstanding importance.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resources
J1	Error handling concept		The Competitors should present their error handling concept to the Experts by describing what type of manipulation errors they have considered and how their program reacts on what type of error. Description of zero (0) to three (3) expectations should be provided by the Independent Test Project Designer.		5	
		0	No concept No error handling completed.			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resources
		1	Poor concept Minimal scope to the error handling. System can be easily bypassed without fault being fixed/limited uses.			
		2	Good concept Well thought out error handling with consideration to users and other faults.			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resources
		3	Above expectations Robust error handling with fail safe to ensure fault is fixed before continuing, and if applicable, consideration and implementation of error handling in other areas.			
J2	Home check		A Home check before program start is realized. It isn't t allowed to use KAREL or other hacks.		5	
		0	No home check is done.			
		1	Home check is done, program stops, but no user message appears.			

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section	Resources
		2	Home check is done, and the user gets a message, but can only acknowledge the message, without being able to interact.			Robot not at home now! [OK]
		3	Home check is done, user gets a message and is asked how to proceed. (minimum Yes/No)			Robot at home now. Do you want to continue? (Select NO will ABORT) [YES] NO
M1	Error handling check		The Competitors can demonstrate in two situations, randomly chosen by the Experts, a working error handling according to their concept.	Yes/No	5	

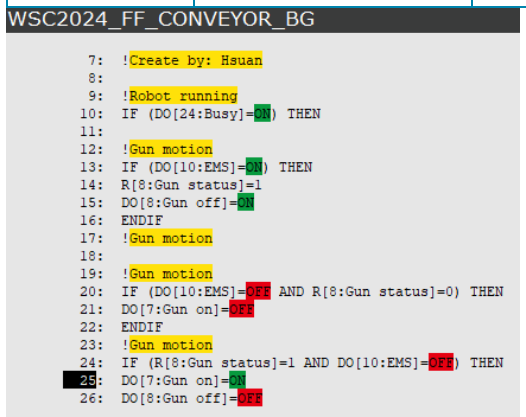
Theme: Parallel processing

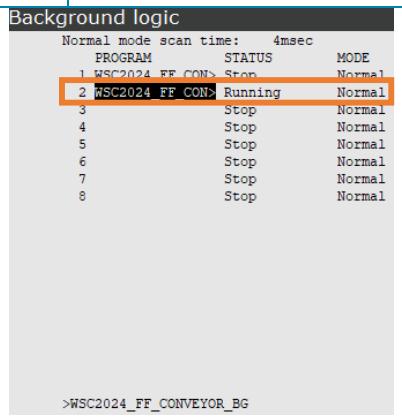
General comment:

If the robot controls machines that can run parallel to the robot, then a parallel processing technique should be used like the RUN command or a background logic control. The Competitors should be free to choose the technique except one of them has clearly an advantage for that application.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Check conveyor control technique		The conveyor is controlled as a parallel process to the robot, either with the RUN command or with background logic.	Yes/No	5





Theme: Use of position registers or calculations to solve a problem

General comment:

Some problems can be solved either by using a series of position registers or by calculating the position coordinates. Both approaches have their advantages, depending on the customer's expertise and the desired degree of flexibility.

In the WorldSkills Competition, one (1) of the two (2) strategies should only be rated higher if they have been explicitly requested.

No marking criteria are formulated here, as this theme is highly dependent on the application.

Sub-criterion: Vision

Theme: Vision system configuration

General comment:

The purpose of the check is to verify the correctness of the vision system configuration. During the check, the average calibration error, the correctness of the calibration tools and the correctness of other parameters related to the vision system will be verified.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Calibration verification		Vision Configuration and Calibration done by the team (Not always necessary – for instance when using QR Code only)	Yes/No	6
M2	Camera Relative to Cal. Grid Z-Distance		Evaluate vertical distance of camera result from calibration (Calibration Result -> Position of Camera Relative to Cal. Grid Z-Distance)	Yes/No	6
M3	Mean error value		Evaluate just Distortion Error/Pixel-mm ratio result from calibration (Calibration Result – E.g. Mean error value < 1 pixel)	Yes/No	6

Theme: Process tool configuration

General comment:

The purpose of the check is to verify the correctness of the configuration of the vision process.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
J1	Check iRVision Model Setup		The correctness of training the model is checked.		6
		0	Not done		
		1	Basic setup – model trained without masking unnecessary parts		
		2	Medium setup – a model with masking unnecessary part		
		3	Full setup – more than one locator used to better adjust angle and position/use of other tools/histograms, etc. (Snap Tool Set, Emphasis or do not Care Set, Refpos Height OK etc)		

Theme: Vision program configuration

General comment:

The purpose of checking is whether the Competitors have correctly chosen the method of triggering the vision process in the robot's program. Depending on the Test Project, the process should be carried out on the basis of one photo – one download of an item (in the case of elements that may move or whose position or orientation may change between subsequent downloads) or one photo – detection and download of all elements detected in the image.

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Correct implementation of the vision process		The Competitors correctly configured the vision process, choosing to detect multiple elements or detect a single element and take a single or multiple photos according to the project	Yes/No	6

Sub-criterion: HMI

Theme: HMI design

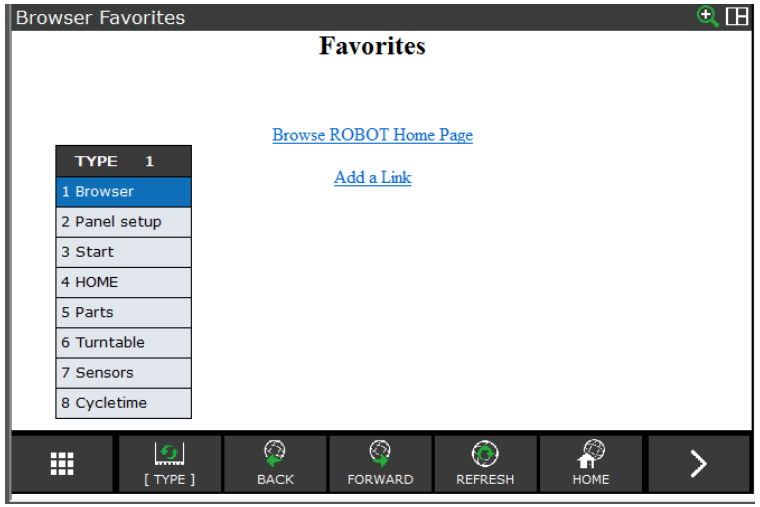
General comment:

Human-Machine Interface (HMI) is an important part of an operator's interaction with the robot. If an HMI is asked to be developed in a project, consideration must be taken for the operator and the use of the robot, providing relevant data in a clear manner. User defined data should also be given an opportunity to be controlled via HMI.

A general HMI controlling the robot cell program uses different pages and buttons. If it's necessary, they should setup UOP as well for it.

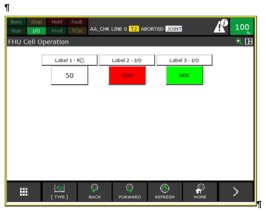
The important data and information about the program execution and robot status must be present on HMI pages.

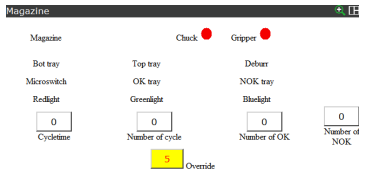
When referring to Webpages set up in Browser the criterion can be presented as illustrated:



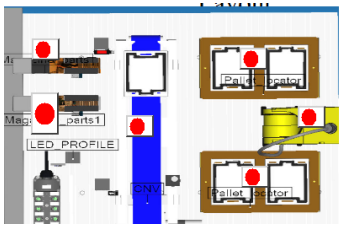
When referring to the Realistic design judgement the following types of criteria can be illustrated:

1. Modified - Simple HTML shapes like template

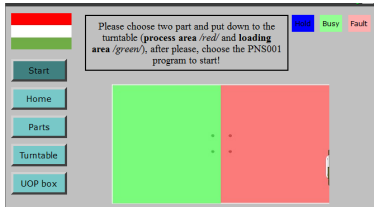


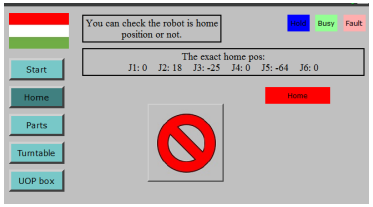


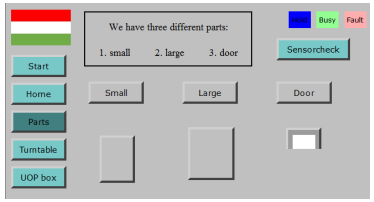
2. Image from RG or another image superimposed

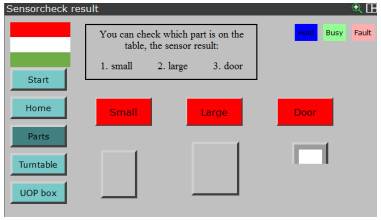


3. Web-page design for user-friendly access with images and buttons. All webpage title has been filled, size of the HMI is correct, so do not have to "scroll" to see every part of the webpage. NOT using NEXT between the main pages, just for sub-pages.









Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Webpage loaded - minimum template file		No web page – no points awarded.	Yes/No	6
M2	Webpages set up in Browser		Selectable from type menu. They have to fulfil the Browser type menu.	Yes/No	6
M3	Pages called with Built-in or other function		Must be displayed Automatically, eg DSP_WEBP KAREL is not allowed and also cannot be selected manually. The HMI must be loaded within a reasonable time of starting the program, taking consideration to the robots loading speed.	Yes/No	6
M4	Counter showing part number being processed		This aspect could require one (1) or more counter buttons, depending on the application. If applicable to the project, the HMI should provide a count of cycles/parts completed. This could be shown over multiple counter buttons, providing OK/NOK data, or the number of different types of parts that have been completed.	Yes/No	6
M5	Lamps used for each station to show robot position in the process		Red/green buttons on the cell layout to precisely show robot position.	0 – X (depending on number of stations)	6

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M6	Display open/closed status of Gripper, etc.		Webpage loaded with peripherals status; e.g. gripper, chuck, deburring, conveyor, etc.	0 – X (depending on number of peripherals)	6
M7	Display fault status of Robot		Recommended on the main page; but suffice if present.	Yes/No	6
M8	Menu/Function key to enable/disable iRVision		Acceptable to be labelled as basic task/extension task buttons.	Yes/No	6
J1	Realistic Design				3
		0	No User I/F or Unmodified template		
		1	Modified – Simple HTML shapes like template		
		2	Image from RG or another image superimposed		
		3	Web-page design for user-friendly access with images and buttons. All webpage title has been filled, size of the HMI is correct, so do not have to "scroll" to see every part of the webpage. NOT using NEXT between the main pages, just for sub-pages.		

Sub-criterion: Documentation

Theme: General cell setup

General comment: The purpose of this section is to present the general setup documentation that is introduced in each Test Project. Content of instructions are in the documentation Example as provided to WSI: *FEC_WS_Example_TP_Documentation.*

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	UFrames reference positions		Examples shown of the UFrames created for individual components of the cell which require the use of offsets or are on a different plane to WORLD (e.g. Trays, Pallets, Deburr etc.)	Yes/No	7
M2	Position teaching instructions for one cell component using a different UFrame		Screenshot of photo mandatory (e.g. output tray, magazine, etc.)	Yes/No	7
M3	Robot setup: UTOOL/TCP Setup		Screenshot with text description	Yes/No	7
M4	Payload setup		Screenshot with text description	Yes/No	7
M5	DCS Setup – Tool Model and Safe Zone		Screenshot with text description	Yes/No	7
M6	Input/Output Listing		Comment and Description	YES/NO	7

Theme: Numeric register documentation

General comment: Numeric Registers are used to store settings to control the cell operation and used by the program internally.

Register	Comment	Description	Default value
54	Chuck Pulse	Time to pulse Red LED on/off during machining simulation (sec)	.5
55	Chuck Cnt	Count	-
56	Chuck Lmt	Number of On/Off cycles for Chuck simulation	2

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
J1	Numeric Register Documentation				7
		0	Not Documented		
		1	One (1) of: Comment/Description/Default or example values		
		2	Two (2) of: Comment/Description/Default or example values		
		3	All of: Comment/Description/Default or example values		

Theme: Position registers documentation

General comment: Position Registers are used to store positions.

PR NUMBER	NAME	COMMENT	BASE VALUES
9	PISTON_PLACE	POSITION FOR PISTON PLACE TF2 UF3	X 36.62 Y 15.67 Z -8.23 W 0.08 P 90.54 R 0
10	SPRING_PICK	POSITION FOR SPRING PICK TF2 UF5	X 67.92 Y 50.23 Z 10.43 W 0.18 P 0.56 R 180
11	SPRING_PLACE	POSITION FOR SPRING PLACE TF2 UF3	X 90.41 Y 23.17 Z -80.46 W 0 P 0 R 90

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
J1	Position Registers Documentation				7
		0	Not Documented		
		1	One (1) of: Comment/Description/Default or example values		
		2	Two (2) of: Comment/Description/Default or example values		
		3	All of: Comment/Description/Default or example values		

Theme: Instructions provided on how to run the Test Project

General comment: Instructions on how to run the Test Project in the documentation Example as provided to WSI: *FEC_WS_Example_TP_Documentation*

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
J1	Instructions provided on how to run the Test Project Documentation				7
		0	None/Verbal/Incoherent instructions		
		1	Documented instructions are limited – vague or indirect explanation given		
		2	Well documented instructions – as good as example, suitable for an experienced end user i.e. line operator or technician		
		3	Very well documented instructions – better than example, with end user requiring no prior experience to operate		

Theme: List of programs – Name, Comment, Description

General comment:

Program	Comment	Description
AAA_WSEX	WS Example TP	Main WS Example Test Project Program – using Microswitch for assembly check
AAA_WSEX	WS Ex TP Vision	Main WS Example Test Project Program – using iRVision for picking and assembly check
AA_HOME	Move Home	This program moves the robot to the home position. Note that it uses Joint definition position – so independent of any UFrame or UTool settings
PWR_UP_WS	Power Up Message	Message for WS Example Project
WS_ASSY	Push Assy Tray	Insert Cylinder into Ring in Assembly Tray
WS_CHK	Check Start OK	Display HMI and check if OK to start

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
J1	List of programs – Name, Comment, Description				7
		0	Not Documented		
		1	Basic list		
		2	List of programs + ONE (1) of: Comments and description		
		3	List of programs + BOTH of Comments and description		

Theme: Content and layout of the Documentation

General comment: Content of instructions in the documentation Example as provided to WSI: *FEC_WS_Example_TP_Documentation*

Potential marking aspects:

Aspect type (M or J)	Aspect Description	J score (J only)	Extra Aspect Description	Requirement (M only)	WSOS Section
M1	Heading styles		Used to allow automatic table of content to work	Yes/No	7
M2	Table of content		An automatic table of content has been inserted and is updated	Yes/No	7
M3	Chapters numbering		Automatic and hierarchical numbering of the chapters is realized	Yes/No	7
M4	Page numbering		Automatic page numbering is realized	Yes/No	7
M5	Spacing and break pages		Minimal spacing used to align text and minimal use of empty lines to break pages	Yes/No	7
J1	Content of instructions in the Documentation				7
		0	None/Verbal/Incoherent		
		1	Documented instructions are limited – vague or indirect explanation given		
		2	Well documented instructions – as good as example, suitable for an experienced end user i.e. line operator or technician		
		3	Very well documented instructions – better than example, with end user requiring no prior experience to operate		

Sub-criterion: Troubleshooting

Theme: Troubleshooting guidance

General comment:

There should be a chapter dealing with troubleshooting in the manual or user guide developed by the Competitors.

Potential marking aspects:

M	Prevent troubles after releasing system		Section about troubleshooting in the user guide	Yes/No	6
M1	Guidance to Re-establish the system		Section about how to re-create/establish the system if necessary, in the user guide	Yes/No	6
M2	Suitable response on user interface		All error messages are easy to understand and troubleshooting methods are clearly described	Yes/No	6
M3	Troubleshooting checklist		To assist user to identify the problem they may face	Yes/No	6