

## TECHNICAL DESCRIPTION

# Mechatronics



WorldSkills International, by a resolution of the Technical Committee and in accordance with the Constitution, the Standing Orders and the Competition Rules, has adopted the following minimum requirements for this skill for the WorldSkills Competition.

The Technical Description consists of the following:

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Liam Corcoran  
Technical Committee Chair

## **1. INTRODUCTION**

### **1.1 Name and description of skill**

1.1.1 The name of the skill is [Mechatronics](#).

1.1.2 Description of skill

[Mechatronics technicians build engineering systems for the automation industry. Mechatronics is concerned with mechanics, electronics, pneumatics and computer technology. The computer technology element covers information technology applications, programmable machine control systems and technology which enables communication between machines, equipment and people.](#)

[This category combines skills in mechanics, pneumatics, electronically controlled systems, programming, robotics and system development. Mechatronics technicians design, build, maintain and repair automated equipment and programme equipment control systems.](#)

[Mechatronics top performers are able to meet a variety of needs within the industry. They carry out mechanical maintenance and equipment building. They also cover equipment information gathering, components \(sensors\) and regulating units. Mechatronics professionals install, set up, repair and adjust machine components and manage equipment control systems, including programming.](#)

[Everyday Mechatronics appliances include shop tills \(belt + cash register assemblies\) and automated bottle machines.](#)

[Industrial applications include industrial multi-product packing lines, labelling machines for tinned products, lifting and transport machinery \(automatic trucks, cranes, loading machinery\) and automatic assembly and measuring equipment in the electronics industry.](#)

### **1.2 Scope of application**

1.2.1 Every Expert and Competitor must know this Technical Description.

1.2.2 In the event of any conflict within the different languages of the Technical Descriptions, the English version takes precedence.

### **1.3 Associated documents**

1.3.1 As this Technical Description contains only skill-specific information it must be used in association with the following:

- WSI - Competition Rules
- WSI - Competition Manual
- WSI - Online resources as indicated in this document
- Host Country - Health and Safety regulations

### **1.4 Number of Competitors per team**

[Mechatronics is a team skill with 2 Competitors per team.](#)

## **2. COMPETENCY AND SCOPE OF WORK**

The Competition is a demonstration and assessment of the competencies associated with this skill. The Test Project consists of practical work only.

## 2.1 Competency specification

### Development of mechatronic systems

Knowledge and understanding:

- Designing, assembly and commissioning of a mechatronic system
- Understand the function, the application and the components of pneumatic systems
- Understand the function, the application and the components of hydraulic systems
- Understand the function, the application and the components of electric and electronic systems
- Understand the function, the application and the components of edrives
- Understand the function, the application and the components of industrial robotic systems

Competitors shall be able to:

- Carry out system design for a given industrial application
- Assemble a machine according to documentation
- Connect wires and tubes in a right industrial way
- Install, setup and make necessary adjustments to the mechanical, electrical & sensor systems
- Commission a machine by auxiliary equipment and together with a PLC using their standards and their documentation

### Industrial controllers

Knowledge and understanding:

- Understand the function, the structure and the operating principles of PLCs
- Understand the structure and function of industrial controllers (PLCs)

Competitors shall be able to:

- Connect their own PLC with the mechatronic system
- Make the necessary configuration of the industrial controller
- Configure all aspects of their PLC as required and the associated control circuitry for correct operation

### Software programming

Knowledge and understanding:

- Understanding of programming an industrial software program
- Understand how a software program relates to a machine action

Competitors shall be able to:

- Write programs to control a machine, and visualise the process and operation using software.
- PLC programming, including digital and analog signal processing

### Design Circuits

Knowledge and understanding:

- Knowledge required to design different circuits

Competitors shall be able to:

- Design pneumatic, hydraulic and electric circuits
- Design the circuits with modern software tools

### Analytical Techniques

Knowledge and understanding:

- Knowledge of analytical fault finding and repairing

Competitors shall be able to:

- Find different faults in an analytic way in a mechatronic system
- Repair components in short time.
- Demonstrate mastery of problem-solving techniques
- Optimise a mechatronic system consisting of different modules

## 2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.

### Mechanical Design

Competitors must be able to understand designing and assembling mechanical systems. This must include knowledge of pneumatic and/or hydraulic systems, their standards and their documentation.

### Circuit Design

Competitors must be able to understand designing and assembling electrical circuits in machine/controller systems.

### Industrial Controllers

Competitors must have an understanding of the configuration of the industrial controller and how a software program relates to a machine action. They must be able to configure all aspects of their PLC as required and the associated control circuitry for correct operation.

### Software Programming

Competitors must be able to write programs to control a machine, and visualise the process and operation using software.

### Analytical Techniques

Competitors must be able to demonstrate mastery of problem-solving techniques to ensure correct and safe machine operation.

2.2.2 Knowledge of rules and regulations is not examined.

## 2.3 Practical work

### Design

The Test Project will be designed from industrial components in a specification. Optimisation can be part of the project

### Assembly and connection

The purpose of the Test Project is to build a project using industrial components according to instructions in the documentation, or according to design criteria provided in the test.

- The assembly time of known stations will not be assessed. Assessing the quality of work will consist of industry standard supported in the "Professional Practice".
- If there is a robot in the Competition, the model will be disclosed once it is confirmed.
- The electrical connections must be in accordance with the instructions and documentation to ensure proper operation of the machine. All necessary electrical schematics will be provided.

### Switching

Machines will operate according to instructions, documentation and "Professional Practice". No faulty component will be used.

- Any robot cell used during the Competition should be adequately used to ensure safe operation without limiting the functionality of the robot in anyway.

### Troubleshooting

There may be one or more sections requiring multiple problem troubleshooting. These failures are drawn from a list of outages prepared in advance, preferably a selection drawn at random by computer immediately before testing. These sections of the Test Project will also include the introduction of the principles of Total Productive Maintenance (TPM called) so that the operation of the machine is self-diagnosed. It may also consist of repairing or replacement of defective parts.

### Information Technology

Some tasks will test the ability of Competitors to program systems. The documentation (the code) produced by Competitors and their presentation can be assessed.

### Optimisation

Improved processes to increase operational efficiency of a system can be evaluated.

## **3. THE TEST PROJECT**

### **3.1 Format / structure of the Test Project**

The format of the Test Project is a single TP with [separately assessed modules](#).

### **3.2 Test Project design requirements**

Overall the Test Project must:

- Be modular.
- Be accompanied by a marking scale that will be finalised at the competition in accordance with Section 5.
- Be validated according to Section 3.5.
- Be supplied at the Competition site for Expert teams to develop the project with fully functioning equipment. This is to allow the Experts to form a consistent evaluation of the tasks with the working models.
- Be supplied with documentation clarifying the operation of special or new equipment for the Experts to finalise the Test Project.
- Be supplied with a library of photographs or drawings to clarify requirements of the tasks.

### **3.3 Test Project development**

The Test Project MUST be submitted using the templates provided by WorldSkills International (<http://www.worldskills.org/competitionpreparation>). Use the Word template for text documents and DWG template for drawings.

#### **3.3.1 Who develops the Test Project / modules**

The Test Project / modules are developed by the equipment supplier, [Festo Didactic](#), in collaboration with the Chief Expert.

The Test Project must be compatible with products from Festo Didactic. Therefore the Test Project designer must prepare the modules in close collaboration with the R&D and Product Management of Festo Didactic.

#### **3.3.2 How and where is the Test Project / modules developed**

Test Projects tasks are developed in close cooperation with the R&D and Product Management of Festo Didactic as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

Extracts from the *Annexure in the MOU: specific aspects of involvement by Festo* is located in the Appendix on page 10 of this document.

#### **3.3.3 When is the Test Project developed**

The Test Project/modules are developed before the current Competition and finalised at the current Competition as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

6 montsh prior to Competition:

- The known stations, the robot type, will be divulged.

3 months prior to the Competition:

- The documentation for all components comprising the Test Project must be disclosed.

### **3.4 Test Project marking scheme**

Each Test Project must be accompanied by a marking scheme proposal based on the assessment criteria defined in Section 5.

3.4.1 The marking scheme proposal is developed by the person(s) developing the Test Project. The detailed and final marking scheme is developed and agreed by all Experts at the Competition.

3.4.2 Marking schemes should be entered into the CIS prior to the Competition.

### **3.5 Test Project validation**

It must be demonstrated that the Test Project/modules can be completed within the material, equipment, knowledge and time constraints. This will be demonstrated as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

The assembly and testing of the Test project must be done before the Competition.

### **3.6 Test Project selection**

The Test Project is selected as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

### **3.7 Test Project circulation**

The Test Project is circulated as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

### **3.8 Test Project coordination (preparation for Competition)**

Coordination of the Test Project will be undertaken by the Chief Expert and Festo.

### **3.9 Test Project change at the Competition**

The Test Project 30% change will be as described in the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

### **3.10 Material or manufacturer specifications**

PLC specifications and quantity are to be posted on the Discussion Forum at least 6 months before the Competition by the Chief Expert.

## **4. SKILL MANAGEMENT AND COMMUNICATION**

### **4.1 Discussion Forum**

Prior to the Competition, all discussion, communication, collaboration and decision making regarding the skill must take place on the skill-specific Discussion Forum (<http://www.worldskills.org/forums>). All skill-related decisions and communication are only valid if they take place on the forum. The Chief Expert (or an Expert nominated by the Chief Expert) will be moderator for this forum. Refer to Competition Rules for the timeline of communication and competition development requirements.

### **4.2 Competitor information**

All information for registered Competitors is available from the Competitor Centre (<http://www.worldskills.org/competitorcentre>).

This information includes:

- Competition Rules
- Technical Descriptions
- Test Projects
- Other Competition-related information



### 4.3 Test Projects

Circulated Test Projects will be available from [worldskills.org](http://www.worldskills.org) (<http://www.worldskills.org/testprojects>) and the Competitor Centre (<http://www.worldskills.org/competitorcentre>).

### 4.4 Day-to-day management

The day-to-day management is defined in the Skill Management Plan that is created by the Skill Management Team led by the Chief Expert. The Skill Management Team comprises the Jury President, Chief Expert and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalised at the Competition (agreed by Experts and submitted to the Chair/Vice Chair of the Technical Committee). The Chief Expert is to regularly share updates of the Skill Management Plan via the Forum.

## 5. ASSESSMENT

This section describes how the Experts will assess the Test Project / modules. It also specifies the assessment specifications and procedures and requirements for marking.

### 5.1 Assessment criteria

This section defines the assessment criteria and the number of marks (subjective and objective) awarded. The total number of marks for all assessment criteria must be 100.

Section	Criterion	Marks		
		Subjective (if applicable)	Objective	Total
A	Function		70	70
B	Professional practice		10	10
C	Time		20	20
<b>Total =</b>			<b>100</b>	<b>100</b>

Section	Sub-criterion	Marks		
		Subjective (if applicable)	Objective	Total
A1	Items for operation based on the API		30	30
A2	Items for operation based on the simulation box		20	20
A3	Mechanical assembly		10	10
A4	Electric connection		10	10
<b>Total =</b>			<b>70</b>	<b>70</b>

This mark distribution is given as an example only and doesn't match the evaluation sheets provided by Festo for each task.

CIS has to provide a software application with the appropriate mathematical formula that allowed the calculation of the time points.

Final assessment criteria will be supplied as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

The following criterions have to be added for the evaluation:

- Mechanical assembling (given mechanical dimension on drawing must be correct on the MPS station of the competitor after the assembling task)
- The wiring of I/O must follow the given I/O table



The maximum time points of the contest mustn't exceed 20% of the total marks of the competition.

## 5.2 Subjective marking

Not applicable

## 5.3 Skill assessment specification

Assessment specification is as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

## 5.4 Skill assessment procedures

Assessment procedures are as per the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo.

# 6. **SKILL-SPECIFIC SAFETY REQUIREMENTS**

Refer to Host Country Health & Safety documentation for Host Country regulations.

- In the case of using electrical screwdrivers with battery drive to be used with a drill bit, no safety glasses are necessary.
- A first-aid kit must be available throughout the Competition.
- The use of knives and cutters is prohibited due to the risk of injury.
- Experts will use the appropriate personal safety equipment when inspecting, checking or working with a competitor's project.
- Candidates must wear closed shoes.

# 7. **MATERIALS & EQUIPMENT**

## 7.1 Infrastructure List

The Infrastructure List lists all equipment, materials and facilities provided by the Host Country.

The Infrastructure List is online (<http://www.worldskills.org/infrastructure/>).

The Infrastructure List specifies the items & quantities requested by the Experts for the next Competition. The Host Country will progressively update the Infrastructure List specifying the actual quantity, type, brand/model of the items. Host Country supplied items are shown in a separate column.

At each Competition, the Experts must review and update the Infrastructure List in preparation for the next Competition. Experts must advise the Technical Director of any increases in space and/or equipment.

At each Competition, the Technical Observer must audit the Infrastructure List that was used at that Competition.

The Infrastructure List does not include items that Competitors and/or Experts are required to bring and items that Competitors are not allowed to bring – they are specified below.

## 7.2 Materials, equipment and tools supplied by Competitors in their toolbox

- Any commercially available tools may be used. This is subject to approval by the Safety Officer, but must not take away from commonly used "tools of the trade" as used by the competitors in their every day job.
- Competitors must supply their own tools.
- Competitors must bring all software required to program their PLC.
- It is the responsibility of the team's expert to check software compatibility with the PCs to be supplied by the host country.

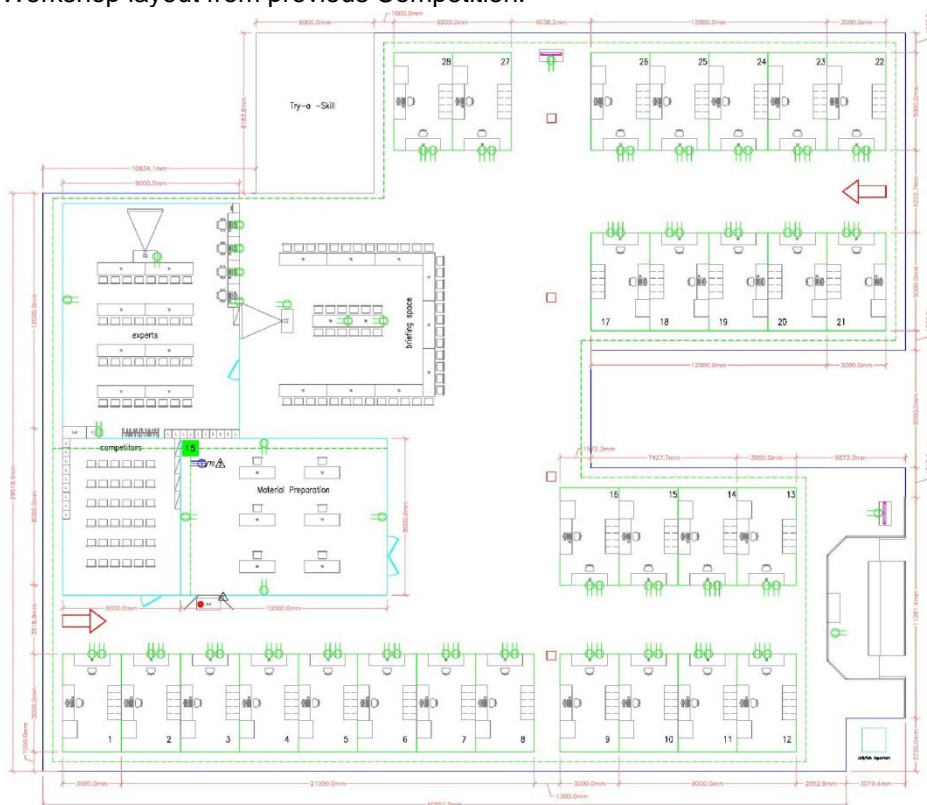
- The team is responsible for the provision of connectors, adaptors, plugs, and interfaces suitable for the host country and for the PLC to any station.

**7.3 Materials, equipment and tools supplied by Experts**  
Not applicable

**7.4 Materials & equipment prohibited in the skill area**  
Only those items listed in 7.2 are allowed.

**7.5 Sample workshop layout**  
Workshop layouts from Calgary are available at:  
[http://www.worldskills.org/index.php?option=com\\_halls&Itemid=540](http://www.worldskills.org/index.php?option=com_halls&Itemid=540)

Workshop layout from previous Competition:



**8. MARKETING THE SKILL TO VISITORS AND MEDIA**

**8.1 Maximising visitor and media engagement**

The following ideas may be considered to maximise visitor and media engagement:

- Display screens - some web cams could be dispatched on the Competition area and show details of the task to the public and on a website.
- Test Project descriptions
- Enhanced understanding of Competitor activity
- Competitor profiles - For each Competitor team provide a sticker with the national flag, the name of the Competitor and a brief description of their studies.

- Daily reporting of Competition status
- Do it yourself workshop - in the Mechatronic workshop provide an area where young people and public could implement Mechatronic systems. This activity could be managed by a couple of students of Mechatronics studies from the Host Member. Those students could explain the way to become a Mechatronic technician and answer public questions.
- Developing Mechatronics Test Projects competitions in different countries and presenting awards at the Competition.

## 8.2 Sustainability

- Recycling
- Use of 'green' materials
- Use of completed Test Projects after Competition
- Transmission of the Test Project digitally to the Competitor's computer immediately before starting the Competition. This allows the Competitors to print the pages they require on their own printer.

## 9. **APPENDIX**

### 9.1 **Memorandum of Understanding**

Following are extracts relevant to the Test project development which can be found in the Annexure in the Memorandum of Understanding: specific aspects of involvement by Festo, version 1.3, dated 30.05.07.

#### ***Transparent and secure project development for Mechatronics***

- 8 tasks are to be developed.
- The tasks must be compatible with Festo Didactic products. Therefore the test project author must prepare the tasks in close cooperation with the R&D and Product Management of Festo Didactic.
- Information on the tasks will be distributed strictly on a need-to-know basis: information will only be given to those involved in development who need to know, and they will only get the information they need to make their contribution. Each person involved in the development process must sign a confidentiality agreement prior to receiving any competition-sensitive information (agreement to be a Festo & WSI agreement).
- The author of the tasks must be familiar with Festo Didactic products and possible future products. The issue of presenting unknown stations was so important in the past, that special stations were created for the competition in order to ensure that no country would have an advantage. This makes the use of an external author difficult.
- In the event that a Festo employee is the task author, WorldSkills can nominate an auditor to monitor the development process. (This can be a group of Experts who have a deeper understanding of the technology).
- Approximately 6 months before the Competition the Chief Expert and the project author check the concept of the 8 tasks.
- All Experts send a signed confidentiality agreement to the Chief Expert of Skill 04, Mechatronics.
- 3 months before the competition 2 stations from 4 or 5 of the project will be announced on the Mechatronics discussion forum on worldskills.org.
- The tasks in Skill 04 are closely associated to the hardware used – so no significant changes can be made shortly before the competition. Tasks for troubleshooting and optimising can be defined at the competition and represent 30% of the total score.
- In order to keep the competition fair, the author must keep the tasks secret. A trusted third party – an auditor – can monitor the preparation of the competition, receiving the completed tasks from the Chief Expert 3 months before the competition. The auditor can be nominated by WorldSkills Technical Committee.