

MANUFACTURING AND ENGINEERING TECHNOLOGY

Industry 4.0



Technical Description

WorldSkills International, by a resolution of the Competitions 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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1 Introduction

1.1 Name and description of the skill competition

1.1.1 The name of the skill competition is

Industry 4.0

1.1.2 Description of the associated work role(s) or occupation(s).

Information and communication technologies (ICT) are impacting on manufacturing and production processes to the extent that their effects are likened to a “fourth industrial revolution”; hence the term “Industry 4.0”. Others use terms such as “smart production”. The business case for introducing ICT is most immediately clear with large scale, complex manufacturing, where significant gains can result from early adoption. However, in diverse ways ICT will have a far-reaching impact, forcing rapid adaptation to the work people do, and the knowledge, skills and attributes that they need to do it with ICT enables

- variety and individualization in products and services;
- shortened response times for production processes;
- greater productivity through reduced time and costs;
- information to be collected, shared and used in different ways for new purposes.

For the Digital Production Systems Technician, implementing Industry 4.0 requires contextual awareness, including the business case as it affects their responsibilities. In the short term at least, the Technician may lack sufficient knowledge, skills and attributes to be able to grasp an assignment as a whole, since their initial and continuing training may have been in production technologies, or ICT. They may also not have gained the wider perspectives and understanding that are less crucial in more static environments. Therefore initially, and perhaps permanently in larger organizations, the required expertise and perspectives may need to come together in two or more personnel.

The role of the Digital Production Systems Technician is to understand the business case for enhancement, and to design and implement technical responses accordingly. Assembled and commissioned hardware in virtual and real context using various digital tools and technology provide the basis for programming, and the design and implementation of cyber security measures on real and virtual production processes. Responding to the business need, smart maintenance may be a universal enhancement. Optimization may be more business specific and take several paths, especially in relation to the role of hardware, connectivity, the location of data points, and the purposes and types of information and intelligence.

A flexible and open approach, combined with strong technical expertise, alertness to risk and security needs, and a recognition of the endless possibilities for optimization, are the hallmark of the outstanding and successful Digital Production Systems Technician.

1.1.3 Number of Competitors per team

This skill competition is a team skill with two Competitors per team.

Recommended:

- One participant is a Mechatronic/Mechanic/Electrotechnical/Automation Technician (ME)
- One participant is a Computer Science/an IT Technician (IT)

1.1.4 Age limit of Competitors

The Competitors must not be older than 25 years in the year of the Competition.

1.2 The relevance and significance of this document

This document contains information about the standards required to compete in this skill competition, and the assessment principles, methods and procedures that govern the competition.

Every Expert and Competitor must know and understand this Technical Description.

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

1.3 Associated documents

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

- WSI – Code of Ethics and Conduct
- WSI – Competition Rules
- WSI – WorldSkills Occupational Standards framework
- WSI – WorldSkills Assessment Strategy
- WSI online resources as indicated in this document
- WorldSkills Health, Safety, and Environment Policy and Regulations.

2 The WorldSkills Occupational Standards (WSOS)

2.1 General notes on the WSOS

The WSOS specifies the knowledge, understanding, and specific skills that underpin international best practice in technical and vocational performance. It should reflect a shared global understanding of what the associated work role(s) or occupation(s) represent for industry and business (www.worldskills.org/WSOS).

The skill competition is intended to reflect international best practice as described by the WSOS, and to the extent that it is able to. The Standard is therefore a guide to the required training and preparation for the skill competition.

In the skill competition the assessment of knowledge and understanding will take place through the assessment of performance. There will only be separate tests of knowledge and understanding where there is an overwhelming reason for these.

The Standard is divided into distinct sections with headings and reference numbers added.

Each section is assigned a percentage of the total marks to indicate its relative importance within the Standards. This is often referred to as the “weighting”. The sum of all the percentage marks is 100. The weightings determine the distribution of marks within the Marking Scheme.

Through the Test Project, the Marking Scheme will assess only those skills that are set out in the Standards Specification. They will reflect the Standards as comprehensively as possible within the constraints of the skill competition.

The Marking Scheme will follow the allocation of marks within the Standards to the extent practically possible. A variation of up to five percent is allowed, provided that this does not distort the weightings assigned by the Standards.

2.2 WorldSkills Occupational Standards

Section	Relative importance (%)
1 Work organization and management	5

The individual needs to know and understand:

- The principles and parameters of integrated automated production
- Their specific roles within integrated automated production
- Principles, applications, accountabilities and techniques for project management
- Principles and applications of safe working practice broadly and specifically
- The purpose, use, care and maintenance of equipment, facilities and materials
- Principles and methods for organizing, controlling and managing work and its outcomes
- Their personal strengths and limitations relative to the roles, projects and tasks assigned.

The individual shall be able to:

- Set up and maintain a safe, clean and efficient work area
- Maintain an appropriate state of preparation and readiness to receive, schedule and act on requests and assignments efficiently, effectively and safely
- Order, select, use and care for all equipment, facilities and materials in accordance with manufacturers' instructions and accepted good practice
- Conduct self and all operations with care and consideration for other personnel, cost efficiency and the environment
- Monitor progress, modifying or changing plans or approaches through a rational process, within their personal authority
- Complete assignments or tasks, and restore the work area to its state of readiness for future use
- Reflect on and review their personal performance, as part of continuing professional development.

Section	Relative importance (%)
2 Communication and interpersonal skills	5

The individual needs to know and understand:

- Their personal strengths and limitations
- In perception and awareness
- In communication with known and unknown others
- In working as a colleague, leader, learner or assistant
- Principles of communication and purposeful social learning
- Standards and protocols for formal and informal, direct and indirect communication with team members, managers and clients
- The technical language required for the role, including the content and structures of the English language
- Standards and protocols for communicating electronically and in the cyber space
- The scope and purposes of documentation in hard copy and electronic format
- The requirements for routine and exception reports, in all formats
- Principles and methods for analysing, synthesizing, using and communicating data.

The individual shall be able to:

- receive assignments, identify their salient points, and ask questions for clarification and confirmation
- read, interpret and extract technical data and instructions from given documentation in all available formats
- discuss and plan with relevant others the complex, joint and overlapping elements of assignments
- communicate verbally, in writing, and electronically, using methods that ensure clarity, efficiency and effectiveness
- make and retain reports on progress, issues and actions, in the required formats
- give and take feedback and support to and from others
- review the team's performance, one's own contribution, and individual and collective learning points.

Section	Relative importance (%)
3 Design, assembly, and commissioning	20

The individual needs to know and understand:

- Practical applications of engineering science and technology to the design and production of goods and services in virtual and real context
- Principles and directions for integrating local/artificial intelligence with wider communication capacities
- Principles and applications for the
 - Design
 - Assembly
 - Connectivity and
 - Commissioning
 of hardware and peripherals to meet cyber-physical requirements
- Principles and methods for integrating autonomous subsystems and components
- Principles and applications for data collection, storage, networking and use.

The individual shall be able to:

- Read and interpret instructions, using questioning techniques and research to check, verify and prepare
- Design systems for the automation and communication of production tasks, with the given parameters for cyber-physical systems
- Test and implement design solutions
- Assemble machines and equipment
- Select and apply sensors, communication technologies, and devices for motion control, position sensing, pressure testing and electronic communication
- Test the performance of electrical, electronic, mechanical and integrated systems and equipment, relative to their intended purpose
- Apply mechatronic or automated solutions to the transfer of materials, components or finished goods
- Integrate the equipment and sub-systems to ensure readiness for data capture, networking, exchange and use
- Commission the system
- Create and maintain project files.

Section	Relative importance (%)
4 Software design and implementation	20

The individual needs to know and understand:

- Mathematics and their applications
- Principles and applications of electronics
- Computer capabilities, subject matter, and symbolic logic
- Computer hardware and software, and their applications
- The required standards for code conventions, style guides, user interface designs, managing directories, and files
- Principles and applications of human-machine communication.

The individual shall be able to:

- Write, analyse, review, and rewrite programs
- Correct errors by making appropriate changes and rechecking that the desired results are produced
- Perform or direct revision, repair, or expansion of existing programs to increase operating efficiency or adapt to new requirements
- Write, update, and maintain computer programs or software packages to handle specific jobs such as tracking inventory, storing or retrieving data, or controlling other equipment
- Conduct trial runs of programs and software applications to ensure they produce the desired information and the instructions are correct
- Prepare detailed workflow charts and diagrams that describe input, output, and logical operation, and convert them into a series of instructions coded in a computer language
- Compile and write documentation of program development and subsequent revisions, using protocols to ensure that others can understand the programs
- Consult with others to define and resolve problems in running programs
- Perform systems analysis and programming tasks to maintain and control the use of computer systems software.
- Write or contribute to instructions or manuals to guide end users
- Investigate whether networks, workstations, the central processing unit of the system, or peripheral equipment are responding to a program's instructions.

Section	Relative importance (%)
5 Networking and cyber security	20

The individual needs to know and understand:

- The scale and nature of the organization's vulnerability to breaches in information security
- The trends, nature and intent of malicious breaches
- The nature and causes of incidental and accidental data breaches, both human and systemic
- Principles and methodologies for establishing and maintaining maximum information security and data integrity
- Principles and methodologies for addressing minor breaches
- Principles for the design and execution of disaster recovery plans.
- Development environment software
- Network protocols and topology
- Network monitoring software
- Transaction security and virus protection software
- Web platform development software.

The individual shall be able to:

- Design and implement network protocols and topologies
- Develop plans to safeguard computer files against accidental or unauthorized modification, destruction, or disclosure, and meet emergency data processing needs
- Maintain levels of preparedness and the availability of preventative and defensive tools commensurate with risks and trends in malicious attacks
- Monitor reports of computer viruses to determine when to update virus protection systems
- Encrypt data transmissions and erect firewalls to conceal confidential information during transmitted, and to keep out tainted digital transfers
- Perform risk assessments and conduct tests of data processing systems to ensure safe functioning of data processing and security measures
- Modify computer security files to incorporate new software, correct errors, or change individual access status
- Monitor the use of data files and regulate access to safeguard information
- Review violations of procedures and take steps to prevent their repeating
- Document computer security and emergency measures, policies, procedures and tests
- Test and simulate disaster recovery plans
- Train users and promote security awareness to ensure system security and improve server and network efficiency.

Section	Relative importance (%)
6 Testing, maintenance, and fault-finding	15

The individual needs to know and understand:

- Principles and applications of smart maintenance, based on data, to enable
- Condition monitoring
- Data analysis and correlation
- Predictive maintenance
- Mobile maintenance
- The use of augmented reality and other emerging technologies and tools
- The use of simulation models, reconfiguration and virtualization
- Operational parameters/process data
- The use of constraints and variables, restrictions, alternatives, conflicting objectives, and numerical parameters for conceptualizing and defining problems
- Principles and methodologies for designing alternatives and making decisions and recommendations
- The purposes and nature of maintenance records.

The individual shall be able to:

- Identify the parts of the production system to which to apply smart maintenance
- Establish the parameters for the parts' operation
- Use the access tools at the appropriate data points, or on a mobile basis
- Monitor the condition of each part, using augmented reality or other tools as helpful
- Discuss and check findings with relevant personnel
- Undertake preventive or predictive maintenance by reviewing alternative courses of action and scheduling or recommending the optimal measure(s)
- Use the available technology and measures to effect maintenance with least disruption to production.

7 Enhancement and optimization	10
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The individual needs to know and understand:

- The potential for smart production systems to be enhanced to
- Enable greater flexibility and individualization in production
- Shorten reaction and response time in production
- Reduce time and cost in production
- Collect, share and use information for continuous enhancement
- Principles and methods for identifying, analysing and pursuing opportunities for enhancement
- The implications of increased data storage and exchange
- Principles and methods for cost benefit analysis
- Principles and methods for work organization and workforce planning and development.

Section	Relative importance (%)
<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Reduce costs by removing waste and consumption caused by • Over-production • Stock and storage • Over- and unnecessary processing • Poor quality • Transport and movement • Waiting time • Analyse and recommend opportunities for optimization using • Simulations • Prototyping • Digital shadows/twins • Identify opportunities for • Greater lateral and vertical integration • The use of the Cloud • Identify the cost-benefit implications, financial and human, of optimization. 	
8 Analysis, evaluation, and reporting	5

The individual needs to know and understand:

- Principles and applications of critical thinking and complex problem-solving
- The uses and availability of self-monitoring equipment and tools
- The bases, techniques and tools for creating and using analytical models of performance, including
- Performance targets or specifications
- Numerical and quantifiable parameters
- Data requirements
- Constraints and variables
- Alternatives
- How to conceptualize, define and evaluate problems referred to them, and to derive recommendations for solutions
- The content, structure and presentation for reports serving different purposes
- Principles and applications to presentations for management, peers and clients
- Cost benefit analysis, and its uses for recommending alternative courses of action.

Section	Relative importance (%)
<p>The individual shall be able to:</p> <ul style="list-style-type: none"> • Take account of requirements for monitoring, review and evaluation in the design of the system and sub-systems • Optimize the use of self-monitoring equipment and tools to the extent feasible • Design and apply an appropriate model for monitoring and evaluating performance relative to specification • Anticipate requests for feedback and reports, and prepare accordingly on a data rational basis • Prepare reports in appropriate formats for routine and exception reporting • Make presentations customized to particular groups and individuals • Maintain awareness of new possibilities and options for improvement, making recommendations on the basis of return on investment. 	
Total	100

3 The Assessment Strategy and Specification

3.1 General guidance

Assessment is governed by the WorldSkills Assessment Strategy. The Strategy establishes the principles and techniques to which WorldSkills assessment and marking must conform.

Expert assessment practice lies at the heart of the WorldSkills Competition. For this reason, it is the subject of continuing professional development and scrutiny. The growth of expertise in assessment will inform the future use and direction of the main assessment instruments used by the WorldSkills Competition: the Marking Scheme, Test Project, and Competition Information System (CIS).

Assessment at the WorldSkills Competition falls into two broad types: measurement and judgement. For both types of assessment, the use of explicit benchmarks against which to assess each Aspect is essential to guarantee quality.

The Marking Scheme must follow the weightings within the Standards. The Test Project is the assessment vehicle for the skill competition, and therefore also follows the Standards. The CIS enables the timely and accurate recording of marks; its capacity for scrutiny, support, and feedback is continuously expanding.

The Marking Scheme, in outline, will lead the process of Test Project design. After this, the Marking Scheme and Test Project will be designed, developed, and verified through an iterative process, to ensure that both together optimize their relationship with the Standards and the Assessment Strategy. They will be agreed by the Experts and submitted to WSI for approval together, in order to demonstrate their quality and conformity with the Standards.

Prior to submission for approval to WSI, the Marking Scheme and Test Project will liaise with the WSI Skill Advisors for quality assurance and to benefit from the capabilities of the CIS.

4 The Marking Scheme

4.1 General guidance

This section describes the role and place of the Marking Scheme, how the Experts will assess Competitors' work as demonstrated through the Test Project, and the procedures and requirements for marking.

The Marking Scheme is the pivotal instrument of the WorldSkills Competition, in that it ties assessment to the standard that represents each skill competition, which itself represents a global occupation. It is designed to allocate marks for each assessed aspect of performance in accordance with the weightings in the Standards.

By reflecting the weightings in the Standards, the Marking Scheme establishes the parameters for the design of the Test Project. Depending on the nature of the skill competition and its assessment needs, it may initially be appropriate to develop the Marking Scheme in more detail as a guide for Test Project design. Alternatively, initial Test Project design can be based on the outline Marking Scheme. From this point onwards the Marking Scheme and Test Project should be developed together.

Section 2.1 above indicates the extent to which the Marking Scheme and Test Project may diverge from the weightings given in the Standards, if there is no practicable alternative.

For integrity and fairness, the Marking Scheme and Test Project are increasingly designed and developed by one or more independent people with relevant expertise. In these instances, the Marking Scheme and Test Project are unseen by Experts until immediately before the start of the skill competition, or competition module. Where the detailed and final Marking Scheme and Test Project are designed by Experts, they must be approved by the whole Expert group prior to submission for independent validation and quality assurance. Please see the Rules for further details.

Experts and Independent Assessors are required to submit their Marking Schemes and Test Projects for review, verification, and validation well in advance of completion. They are also expected to work with their Skill Advisor, reviewers, and verifiers, throughout the design and development process, for quality assurance and in order to take full advantage of the CIS's features.

In all cases a draft Marking Scheme must be entered into the CIS at least eight weeks prior to the Competition. Skill Advisors actively facilitate this process.

4.2 Assessment Criteria

The main headings of the Marking Scheme are the Assessment Criteria. These headings are derived before, or in conjunction with, the Test Project. In some skill competitions the Assessment Criteria may be similar to the section headings in the Standards; in others they may be different. There will normally be between five and nine Assessment Criteria. Whether or not the headings match, the Marking Scheme as a whole must reflect the weightings in the Standards.

Assessment Criteria are created by the person or people developing the Marking Scheme, who are free to define the Criteria that they consider most suited to the assessment and marking of the Test Project. Each Assessment Criterion is defined by a letter (A-I). *The Assessment Criteria, the allocation of marks, and the assessment methods, should not be set out within this Technical Description. This is because the Criteria, allocation of marks, and assessment methods all depend on the nature of the Marking Scheme and Test Project, which is decided after this Technical Description is published.*

The Mark Summary Form generated by the CIS will comprise a list of the Assessment Criteria and Sub Criteria.

The marks allocated to each Criterion will be calculated by the CIS. These will be the cumulative sum of marks given to each Aspect within that Assessment Criterion.

4.3 Sub Criteria

Each Assessment Criterion is divided into one or more Sub Criteria. Each Sub Criterion becomes the heading for a WorldSkills marking form. Each marking form (Sub Criterion) contains Aspects to be assessed and marked by measurement or judgement, or both measurement and judgement.

Each marking form (Sub Criterion) specifies both the day on which it will be marked, and the identity of the marking team.

4.4 Aspects

Each Aspect defines, in detail, a single item to be assessed and marked, together with the marks, and detailed descriptors or instructions as a guide to marking. Each Aspect is assessed either by measurement or by judgement.

The marking form lists, in detail, every Aspect to be marked together with the mark allocated to it. The sum of the marks allocated to each Aspect must fall within the range of marks specified for that section of the Standards. This will be displayed in the Mark Allocation Table of the CIS, in the following format, when the Marking Scheme is reviewed from C-8 weeks. (Section 4.1 refers.)

	CRITERIA								TOTAL MARKS PER SECTION	WSSS MARKS PER SECTION	VARIANCE
	A	B	C	D	E	F	G	H			
STANDARDS SPECIFICATION SECTION	1	5.00							5.00	5.00	0.00
	2		2.00				7.50		9.50	10.00	0.50
	3							11.00	11.00	10.00	1.00
	4			5.00					5.00	5.00	0.00
	5				10.00	10.00	10.00		30.00	30.00	0.00
	6		8.00	5.00			2.50	9.00	24.50	25.00	0.50
	7			10.00			5.00		15.00	15.00	0.00
TOTAL MARKS	5.00	10.00	20.00	10.00	10.00	10.00	15.00	20.00	100.00	100.00	2.00

4.5 Assessment and marking

There is to be one marking team for each Sub Criterion, whether it is assessed and marked by judgement, measurement, or both. The same marking team must assess and mark all Competitors. Where this is impracticable (for example where an action must be done by every Competitor simultaneously, and must be observed doing so), a second tier of assessment and marking will be put in place, with the approval of the Competitions Committee Management Team. The marking teams must be organized to ensure that there is no compatriot marking in any circumstances. (Section 4.6 refers.)

4.6 Assessment and marking using judgement

Judgement uses a scale of 0-3. To apply the scale with rigour and consistency, judgement must be conducted using:

- benchmarks (criteria) for detailed guidance for each Aspect (in words, images, artefacts or separate guidance notes)
- the 0-3 scale to indicate:
 - 0: performance below industry standard
 - 1: performance meets industry standard
 - 2: performance meets and, in specific respects, exceeds industry standard
 - 3: performance wholly exceeds industry standard and is judged as excellent

Three Experts will judge each Aspect, normally simultaneously, and record their scores. A fourth Expert coordinates and supervises the scoring, and checks their validity. They also act as a judge when required to prevent compatriot marking.

4.7 Assessment and marking using measurement

Normally three Experts will be used to assess each aspect, with a fourth Expert supervising. In some circumstances the team may organize itself as two pairs, for dual marking. Unless otherwise stated, only the maximum mark or zero will be awarded. Where they are used, the benchmarks for awarding partial marks will be clearly defined within the Aspect. To avoid errors in calculation or transmission, the CIS provides a large number of automated calculation options, the use of which is mandated.

4.8 The use of measurement and judgement

Decisions regarding the choice of criteria and assessment methods will be made during the design of the competition through the Marking Scheme and Test Project.

4.9 Skill assessment strategy

WorldSkills is committed to continuous improvement. This particularly applies to assessment. The SMT is expected to learn from past and alternative practice and build on the validity and quality of assessment and marking.

The following performance must be assessed:

- Mechanical assembly of all components (assembly must ensure correct functioning of the system)
- Ethernet communication between the communication components is established
- Output variables of the PLC application may be forced, some of them controlled via HMI
- Implementation of secured communication between MES 4 software and the HW application:
 - Creation of a VLAN
 - Data encryption
 - Redundant network
- Application Start-up procedure
- Smart/Preventive Maintenance
- Integration of an Energy monitoring system

- Work with MES software: Creation of
 - Resource
 - Customer
 - Product
 - Customer Order
 - Working Plan
- Analysis, evaluation, optimization reporting
- The maximum value of the time points will not exceed 20% of the total mark for the competition.

The Sponsor's support team will provide spare and replacement parts for Competitors only during competition time. Exceptions are announced by the Chief Expert.

4.10 Skill assessment procedures

Assessment and marking are an intense process that depends upon skilful leadership, management, and scrutiny.

Each Expert group will develop the sub criteria that they are responsible for, within the overall Marking Scheme. Each measurement of each section is clear and unambiguous, with appropriate parameters or tolerances specified.

The prepared and complete Marking Scheme must be checked and agreed by all Experts, who must sign off the final Marking Scheme prior to the start of the competition.

Procedure for testing PLCs and programming software prior to being used:

- Experts must check that no PLC's programme is copied on the Competitor's working PC
- Experts must be sure that PLCs contain so-called "Basic Project" prior to the Competition start and that the programming software is correctly installed. The Chief Expert will present the meaning of the "Basic Project" prior to the Competition start
- Competitors will get a USB stick from the Chief Expert with the "Basic Project" and all necessary "TIA Portal" add-ons to complete the PLC project.
- A seal must be put on the disk drive and the memory slot of the PLC if it has one. A USB slot is unsealed immediately after the Competitors receive the above-mentioned USB stick.

5 The Test Project

5.1 General notes

Sections 3 and 4 govern the development of the Test Project. These notes are supplementary.

Whether it is a single entity, or a series of stand-alone or connected modules, the Test Project will enable the assessment of the applied knowledge, skills, and behaviours set out in each section of the WSOS.

The purpose of the Test Project is to provide full, balanced, and authentic opportunities for assessment and marking across the Standards, in conjunction with the Marking Scheme. The relationship between the Test Project, Marking Scheme, and Standards will be a key indicator of quality, as will be its relationship with actual work performance.

The Test Project will not cover areas outside the Standards, or affect the balance of marks within the Standards other than in the circumstances indicated by Section 2. This Technical Description will note any issues that affect the Test Project's capacity to support the full range of assessment relative to the Standards. Section 2.1 refers.

The Test Project will enable knowledge and understanding to be assessed solely through their applications within practical work. The Test Project will not assess knowledge of WorldSkills rules and regulations.

Most Test Projects (and Marking Schemes) are now designed and developed independently of the Experts. They are designed and developed either by the Skill Competition Manager, or an Independent Test Project Developer, normally from C-12 months. They are subject to independent review, verification, and validation. (Section 4.1 refers.)

The information provided below will be subject to what is known at the time of completing this Technical Description, and the requirement for confidentiality.

Please refer to the current version of the Competition Rules for further details.

5.2 Format/structure of the Test Project

Day and time	Morning	Afternoon	WSOS section (figure 2)
Day 1	Design, assembly, connectivity, commissioning (ME) Design, programming (IT)		1, 2, 3, 4
Day 2	Security (IT+ME)	Smart maintenance (IT+ME)	1, 2, 5, 6
Day 3	Optimization (ME) Security (IT)		1, 2, 5, 7
Day 4	Analysis, evaluation and reporting (IT+ME)	All Competitors: systems networking	1, 2, 8

5.3 Test Project design requirements

The Test Project must fulfil the following requirements:

- To be based on a true story:
 - To retrofit/upgrade an existing “Industry 3.0” based production system to an “Industry 4.0” one, providing digital transformation I3.0 to I4.0
 - To produce a product based on a customer’s specific needs
- To be accompanied by a marking scale that is finalized at the Competition in accordance with the section 3
- To be validated according to the section 5.5
- To be modular
- Contain eight (8) Modules (in the further text: Tasks)
- To be supplied at the Competition 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
- To be supplied with documentation clarifying the operation of special or new equipment for the Experts to finalize the Test Project
- To be supplied with a library of photographs or drawings to clarify requirements of the tasks (if necessary)
- The tasks are closely associated to the hardware used
- If a Global Partner employee is the Independent Test Project Designer, WorldSkills may nominate an auditor to monitor, review and verify the development process. This can be a group of Experts who have a deeper understanding of the technology
- In order to keep the competition fair, the Independent Test Project Designer must keep the tasks secret. A trusted third party – an auditor – can monitor the preparation of the competition, receiving the completed tasks from the Skill Competition Manager three (3) months prior to the competition.
- All Experts send a signed confidentiality agreement to the Chief Expert of Skill I4.0

Information on the tasks are 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.

5.4 Test Project development

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

5.4.1 Who develops the Test Project or modules

The Test Project/modules are developed by an Independent Test Project Designer in collaboration with the Skill Competition Manager.

5.4.2 When is the Test Project developed

The Test Project is developed according to the following timeline:

Time	Activity
Six (6) months prior to the Competition	<p>The known stations are announced.</p> <p>The Skill Competition Manager and the Independent Test Project Designer check the concept of the eight (8) tasks;</p>
Three (3) months prior to the Competition	<p>The documentation for all components of known stations comprising the Test Project must be disclosed on the Infrastructure List</p>

5.5 Test Project initial review and verification

The purpose of a Test Project is to create a challenge for Competitors which authentically represents working life for an outstanding practitioner in an identified occupation. By doing this, the Test Project will apply the Marking Scheme and fully represent the WSOS. In this way it is unique in its context, purpose, activities, and expectations,

To support Test Project design and development, a rigorous quality assurance and design process is in place (Competition Rules sections 10.6-10.7 refer.) Once approved by WorldSkills, the Independent Test Project Designer is expected to identify one or more independent, expert, and trusted individuals initially to review the Designer's ideas and plans, and subsequently to verify the Test Project, prior to validation.

A Skill Advisor will ensure and coordinate this arrangement, to guarantee the timeliness and thoroughness of both initial review, and verification, based on the risk analysis that underpins Section 10.7 of the Competition Rules.

5.6 Test Project validation

The Skill Competition Manager coordinates the validation and will ensure that the Test Project/modules can be completed within the material, equipment, knowledge, and time constraints of Competitors.

5.7 Test Project selection

The Test Project/modules are selected by the Independent Test Project Designer in collaboration with the Skill Competition Manager.

5.8 Test Project circulation

If applicable, the Test Project is circulated via the website as follows:

The Test Project/modules are not circulated prior to the Competition. The Test Project/modules are presented to the Competitors at the Competition at the beginning of each module.

5.9 Test Project coordination (preparation for Competition)

Coordination of the Test Project/modules is undertaken by the Skill Competition Manager.

5.10 Test Project change

There is no 30% change required to be made to the Test Project/modules at the Competition. Exceptions are amendments to technical errors in the Test Project documents and to infrastructure limitations.

5.11 Material or manufacturer specifications

Specific material and/or manufacturer specifications required to allow the Competitor to complete the Test Project will be supplied by the Competition Organizer and are available from www.worldskills.org/infrastructure located in the Expert Centre. However, note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These such items may include those for fault finding modules or modules not circulated.

6 Skill management and communication

6.1 Discussion Forum

Prior to the Competition, all discussion, communication, collaboration, and decision making regarding the skill competition must take place on the skill specific Discussion Forum (<http://forums.worldskills.org>). 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 the moderator for this Forum. Refer to Competition Rules for the timeline of communication and competition development requirements.

6.2 Competitor information

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

This information includes:

- Competition Rules
- Technical Descriptions
- Mark Summary Form (where applicable)
- Test Projects (where applicable)
- Infrastructure List
- WorldSkills Health, Safety, and Environment Policy and Regulations
- Other Competition-related information

6.3 Test Projects [and Marking Schemes]

Circulated Test Projects will be available from www.worldskills.org/testprojects and the Competitor Centre (www.worldskills.org/competitorcentre).

6.4 Day-to-day management

The day-to-day management of the skill during the Competition is defined in the Skill Management Plan that is created by the Skill Management Team led by the Skill Competition Manager. The Skill Management Team comprises the Skill Competition Manager, Chief Expert, and Deputy Chief Expert. The Skill Management Plan is progressively developed in the six months prior to the Competition and finalized at the Competition by agreement of the Experts. The Skill Management Plan can be viewed in the Expert Centre (www.worldskills.org/expertcentre).

6.5 General best practice procedures

General best practice procedures clearly delineate the difference between what is a best practice procedure and skill-specific rules (section 9). General best practice procedures are those where Experts and Competitors CANNOT be held accountable as a breach to the Competition Rules or skill-specific rules which would have a penalty applied as part of the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System. In some cases, general best practice procedures for Competitors may be reflected in the Marking Scheme.

Topic/task	Best practice procedure
Drawings, recording information	<ul style="list-style-type: none"> Drawings of the hardware layout/configuration is provided by the Chief Expert
Equipment failure	<ul style="list-style-type: none"> Festo Support team provides spare and replacement parts by Competitors only during competition time. Exceptions are announced by the Chief Expert.
Health, Safety, and Environment	<ul style="list-style-type: none"> The Team of Experts will ensure the working place for all Competition Teams fulfil healthy and safety requirements prior to the Competition start.
Infrastructure	<ul style="list-style-type: none"> Working places are equipped with sufficient electrical and air supply Competitors are allowed to check/prepare air infrastructure during Familiarization Day;
Supervision of Competitors	<ul style="list-style-type: none"> It is done by the Team of Experts

7 Skill-specific safety requirements

Refer to WorldSkills Health, Safety, and Environment Policy and Regulations for Host country or region regulations.

Task	Safety glasses with side protection	Safety shoes with protective cap	Sturdy shoes	Tight fitting work clothes (long trousers)
General PPE for safe areas			√	√
During working/commissioning time in the workshop	√	√		√
During drilling, cutting and using electrical screwdrivers	√	√		√
When Experts and interpreters entering the Competitor's workstation	√	√		√

8 Materials and equipment

8.1 Infrastructure List

The Infrastructure List details all equipment, materials, and facilities provided by the Competition Organizer.

The Infrastructure List is available at www.worldskills.org/infrastructure.

The Infrastructure List specifies the items and quantities requested by the Skill Management Team for the next Competition. The Competition Organizer will progressively update the Infrastructure List specifying the actual quantity, type, brand, and model of the items. Note that in some cases details of specific materials and/or manufacturer specifications may remain secret and will not be released prior to the Competition. These such items may include those for fault finding modules or modules not circulated.

At each Competition, the Skill Management Team must review and update the Infrastructure List in preparation for the next Competition. The Skill Competition Manager must advise the Director of Skills Competitions 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.

8.2 Competitors toolbox



Competitors may bring one toolbox with the total external volume not exceeding 1.5 m³.

(Volume = Length x Height x Width, or $V = L \times H \times W$)

Volume measurement does not include a packing crate, other protective packing material, palette for transportation, wheels, etc.

8.3 Materials, equipment, and tools supplied by Competitors

Recommended tools to work with for the tasks

Description	Quantity	Photo
Combination Pliers VDE Certified Grip 180 mm	1	
Nose Side Cutting Pliers VDE Certified Grip 160 mm	1	

Description	Quantity	Photo
Retractable Blade Knife	1	
Cable outer isolation remover tool	1	
Diagonal Cutting Pliers VDE Certified Grip 180 mm	1	
Screwdriver, flat, 2.5; 4.0; 6.5; 1.2 - 1.6	1 set	
Allen screwdriver, 0.9, 1.3, 1.5 - 8	1 set	
Torx	1 set	
Multimeter	1	
Dustpan and brush	1	

- Competitors must provide own computers and tablets;
- The computer/laptop is of sufficient capacity to run all the programming software simultaneously at an optimal speed. This will require a specification from the software supplier at the time of the competition setup to be met or exceeded;
- The tablet is of sufficient capacity to run all Apps simultaneously at an optimal speed.
- Software requirements as well as all necessary Apps must be specified three (3) months prior to the Competition;
- The Competition Team is responsible for the provision of power supply connectors, adaptors, plugs, and interfaces suitable for the Host Country and for the PLC to any station;
- Competitors are not allowed to use prepared cables and tubes;
- Competitors are allowed to prepare air infrastructure during Familiarization Day;
- The electrical tool check is done during the Familiarization Day;
- When some special tools are needed, then this is announced in the WorldSkills Discussion Forum;

- Any commercially available tools may be used. This is subject to approval by the Workshop Manager from a safety perspective, but must not take away from commonly used "tools of the trade" as used by the Competitors in their everyday job. The use of knives is prohibited due to the risk of injury;
- Competitors are required to supply their own Personal Protective Equipment as specified in section 7 skill-specific safety requirements.

8.4 Materials, equipment, and tools supplied by Experts

- Stopwatch
- During Familiarization Day the Chief Expert has to:
 - Provide the software licenses (if needed) to the registered Experts
 - Ensure that the installed software run without any problem
 - Test all communications options required by the Competitors to work with the supplied hardware;
 - Verify if the creation of VLAN is known to the Competitors
 - Present a template to document certain results of the task executions
 - Provide a .bmp file of the CP-Lab Drilling Application
- When the Experts have to bring something with them, then this is announced on the WorldSkills Discussion Forum at least one (1) month prior to the Competition.
- Experts are required to supply their own Personal Protective Equipment as specified in section 7 skill-specific safety requirements.

8.5 Materials and equipment prohibited in the skill area

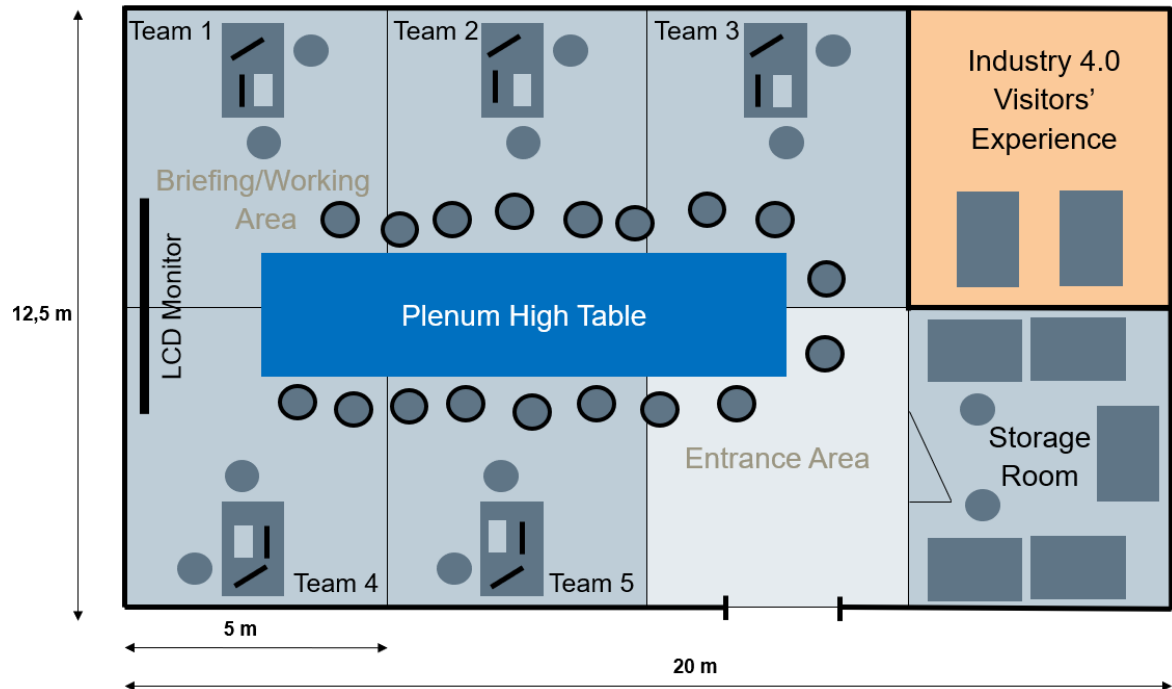
Competitors and Experts are prohibited to bring any materials or equipment not listed in section 8.3 and section 8.4.

- Preformed templates;
- Competitors may not supply components as spare parts;
- Any documentation other than operating manuals (no project instructions or procedures).








8.6 Proposed workshop and workstation layouts

Workshop layouts from previous competitions are available at www.worldskills.org/sitelayout.

Example workshop layout



Legend:

-  Polstered Chair, Qt. 12
-  Stool chair, Qt.18
-  Standard Working Table, Qt. 12
-  Plenum High Table, Qt. 1
-  LCD Monitor 24", Qt. 10
-  PC, like Skills #19, Qt. 5
-  LCD Monitor 86", Qt. 1

Elec. Power: 220 V DC, 20 A, 50 Hz

Air Supply: 6 bar, min. 1 l/min

Internet: WLAN High Speed

9 Skill-specific rules

Skill-specific rules cannot contradict or take priority over the Competition Rules. They do provide specific details and clarity in areas that may vary from skill competition to skill competition. This includes but is not limited to personal IT equipment, data storage devices, Internet access, procedures and workflow, and documentation management and distribution. Breaches of these rules will be solved according to the Issue and Dispute Resolution procedure including the Code of Ethics and Conduct Penalty System.

Topic/task	Best practice procedure
Use of technology – USB, memory sticks	<ul style="list-style-type: none"> Competitors are only allowed to use memory sticks provided by the Chief Expert. The name of each Competition Team is clearly indicated on the USB, delivered to the Team by the Chief Expert Memory sticks or any other portable memory devices cannot be taken outside the workshop. Memory sticks or other portable memory devices are to be submitted to the Chief Expert or to the Deputy Chief Expert at the end of each day for safe keeping.
Use of technology – personal laptops, tablets, and mobile phones	<ul style="list-style-type: none"> Skill Competition Manager, Chief Expert, Deputy Chief Expert, Experts, and Interpreters are allowed to use personal laptops, tablets and mobile phones in the Expert room only. Competitors are allowed to bring tablets and/or mobile phones into the workshop only during the Smart Maintenance part of the competition. If these items are brought at other times then they must be locked in the personal locker and can only be removed at lunchtime and at the end of each day.
Use of technology – personal photo and video taking devices	<ul style="list-style-type: none"> Skill Competition Manager, Chief Expert, Deputy Chief Expert, Competitors, Experts, and Interpreters are allowed to use personal photo and video taking devices in the workshop at the conclusion of the competition on C4 only.

10 Visitor and media engagement

Following is a list of possible ways to maximize visitor and media engagement:

- Display screens: Some web cameras could be dispatched on the Competition area and show details of the task to the public and on a website;
- Test Project descriptions;
- Competitors:
 - Enhanced understanding of activity;
 - Profiles
 - Status Daily Report.

11 Sustainability

This skill competition will focus on the sustainable practices below:

- 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 task.

12 References for industry consultation

WorldSkills is committed to ensuring that the WorldSkills Occupational Standards fully reflect the dynamism of internationally recognized best practice in industry and business. To do this WorldSkills approaches a number of organizations across the world that can offer feedback on the draft Description of the Associated Role and WorldSkills Occupational Standards on a two-yearly cycle.

In parallel to this, WSI consults three international occupational classifications and databases:

- ISCO-08: (<http://www.ilo.org/public/english/bureau/stat/isco/isco08/>)
- ESCO: (<https://ec.europa.eu/esco/portal/home>)
- O*NET OnLine (www.onetonline.org/)

These two roles relate most closely to *Mechatronic Technician*:

<http://data.europa.eu/esco/occupation/edf2e989-d7c5-496e-b365-81fc5cb9eb39>,

and a technician version of *Mechatronics Engineers*:

<http://data.europa.eu/esco/occupation/a7c1d23d-aeca-4bee-9a08-5993ed98b135>

And to *IT System Developer*:

<http://data.europa.eu/esco/occupation/a7c1d23d-aeca-4bee-9a08-5993ed98b135>,

and *Software Developers, Systems Developers*:

<https://www.onetonline.org/link/summary/15-1133.00>

There were no responses to the requests for feedback this cycle.