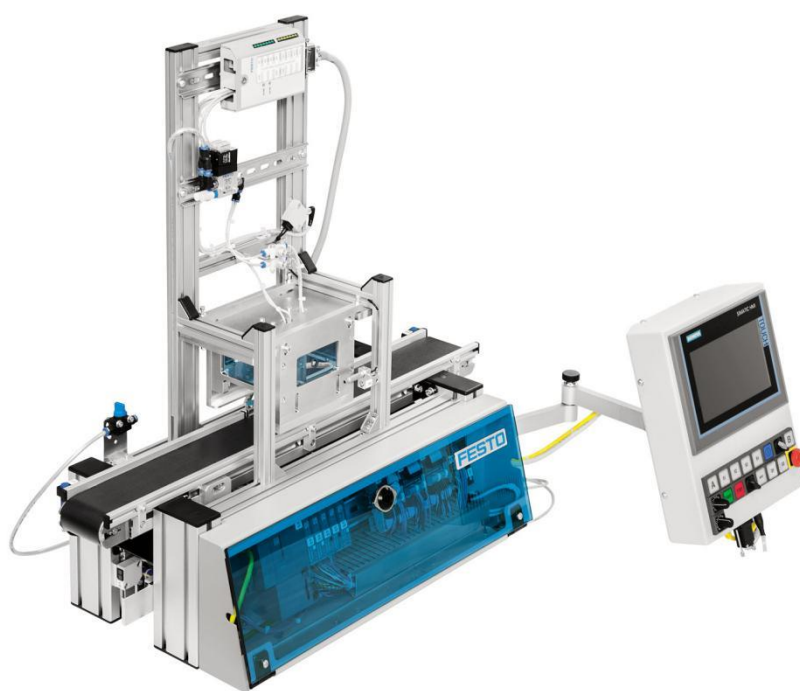




Technical Handbook

Industry 4.0 Nationals

2023 Cycle



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Introduction

The aim of this technical handbook is to help competitors who are preparing for Industry 4.0 competitions across all stages - from Entry Stage test to National Finals.

Career Pathway

To establish the use of Industry 4.0 technologies within a company, the training and qualifications of its skilled workers must be adapted to meet the new requirements of this interdisciplinary approach.

For example, service technicians not only need practical mechatronics experience but also knowledge of IT infrastructure, so that they can work at a high level to rectify machine standstills as quickly as possible.

The procession of I4.0 means that the tasks to be carried out are becoming more demanding, in both technological and organisational terms.

We are preparing for factories of a future with **"Digital Production Systems Technicians"** who are able to combine knowledge from different trades to create and maintain highly advanced production systems, that combined together form Smart Factories.

Technologies included in Industry 4.0 competition are relevant to various careers

- Mechatronics engineer
- Electronics engineer (for automation technology)
- IT specialist (automation technology)
- IT specialist (application development)
- Industrial manager

Competition overview

The competition tests practical skills of its competitors who are able to apply their knowledge of Industry 4.0's core elements, for example:

- Cyber-Physical systems (CPS)
- Radio-Frequency Identification (RFID)
- Augmented Reality (AR)
- Open-Protocol Communication Unified Architecture (OPC UA)
- Industrial Internet of Things (IIoT)
- Manufacturing Execution Systems (MES)
- Digitalisation

During competition, skills listed above are tested in the form of tasks. Each task combines a different set of technologies, which may usually be applied to a single module of a production system. Despite some of the core elements being more important than others, we are able to distinguish several topics, that participants must demonstrate their skills in:

- Hardware and software development.
- Working with i4.0 MES software
- Analysis, evaluation, and optimization reporting
- Linking of services and platforms, e.g.: Digital Dashboards
- Creation of Digital Twin
- Data Analysis on cloud system

Note

All major topics may apply to National Finals.

During the Entry Stage test and regional qualifiers, not all of them may be required.

1 - Registration

In order to take part in this competition, you must register your team using WorldSkills UK website. Upon successful registration, all competitors will receive a confirmation email. Each team signing up for Industry 4.0 competition must consist of two competitors.

While waiting for the next stage of the competition, you should start to prepare for challenges ahead. The **pre-competition activity** has been prepared to help you understand the tasks.

2 - Entry Stage Test

A period of time between registration and national qualifiers is called a "Entry Stage". Once registration closes, each team that has successfully registered for I4.0 competition will be sent an access link to an online task, prepared to test their skills. It is a mixture of multiple choice and open-ended questions.

Once everyone's scores have been calculated, competitor teams will be informed if they have progressed on to the next round, called the national qualifiers.

3 - National Qualifiers

Competitors who have successfully passed a Entry Stage will be invited to compete in national qualifiers. This event is a face-to-face competition, and all details would be emailed to you in advance.

National Qualifiers consist of similar tasks to those presented during National Finals; however, only a restricted number of technologies will be involved, mainly focusing on the basics.

National qualifiers are a one-day activity, typically involving three main topics (listed in competition overview). The top scoring teams meeting the minimum threshold from the national qualifiers will then go through to the next round, the National Finals.

4 - National Finals

The top teams in the UK will be invited to compete in the UK National Final which is the pinnacle of the UK national competition cycle.

Attend Pre-final training arranged by Festo & Didactic Services Ltd and virtual online training. These will take place well ahead of national competitions to make sure all teams have received the same amount of information and access to additional equipment.

5 - International Competitions

Beyond the national finals, there are a host of opportunities for competitors. Eligible competitors who show the highest skills, passion, and drive from the national finals will be given the opportunity to compete to train for the WorldSkills International competitions. The winners from national final competitions who are not eligible for international competitions may join the Skills Champions programme, which allows continued involvement, including the opportunity to work with WorldSkills. Alternatively, if training is of interest to you, you could consider supporting WorldSkills UK with organising and training, and even helping to run the National Finals.

Core competencies

Please note the following are core competencies for the full set of Industry 4.0 competitions, that competitors will be assessed on. Not all competencies are covered at all stages and/or levels.

Core competencies and standards for WorldSkills UK Skills Competitions activities			Regional Qualifiers	National Finals	International Competition
Design, assembly, and commissioning	Standards	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> Principles and applications for the : <ul style="list-style-type: none"> Design Assembly Connectivity Commissioning of hardware and peripherals Principles and methods for integrating autonomous subsystems and components. 	N	Y	Y
	Competency	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> Read and interpret instructions, 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 Integrate the equipment and sub-systems to ensure readiness for data capture, networking, exchange, and use. Commission the system Create and maintain project files. 	N	Y	Y
Software design and implementation	Standards	<p>The individual needs to know and understand:</p> <ul style="list-style-type: none"> 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, and files Principles and applications of human-machine communication. 	Y	Y	Y
	Competency	<p>The individual shall be able to:</p> <ul style="list-style-type: none"> Write, analyse, review, and rewrite programs 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 Investigate whether networks, workstations, the central processing unit of the system, or peripheral equipment are responding to a program's instructions. 	Y	Y	Y

Networking and cyber security	Standards	The individual needs to know and understand: <ul style="list-style-type: none"> • The scale and nature of the organization's vulnerability to breaches in information security • The trends, nature, and intent of malicious breaches • Principles and methodologies for establishing and maintaining maximum information security and data integrity • Network protocols and topology • Network monitoring software 	N	Y	Y
	Competency	The individual shall be able to: <ul style="list-style-type: none"> • Design and implement network protocols and topologies • Maintain levels of preparedness and the availability of preventative and defensive tools commensurate with risks and trends in malicious attacks • Encrypt data transmissions and set up firewalls to conceal confidential information when transmitted • Conduct tests of data processing systems to ensure safe functioning of data processing and security measures • Monitor the use of data files and regulate access to safeguard information • Document enabled security and emergency measures, policies, procedures and tests 	N	Y	Y
Analysis, evaluation, and reporting	Standards	The individual needs to know and understand: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Performance targets or specifications • Numerical and quantifiable parameters • Data requirements • Constraints and variables • How to conceptualize, define and evaluate problems referred to them, and to derive recommendations for solutions. 	Y	Y	Y
	Competency	The individual shall be able to: <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. 	Y	Y	Y

Task overview – Regional Qualifiers

The following is an example of the marking criteria for the Regional Qualifier.

Criteria	Task	Marks
A	PLC / HMI Programming	35
B	SCADA / OPCUA	30
C	Simulation	35
Total Marks		100

Criteria A : PLC/HMI Programming

This stage Involves programming a prebuilt hardware device (for example, a Festo CP Lab base module) according to a provided specification.

Example Technologies involved:

- Siemens TIA Portal PLC Programming
 - Device configuration of an existing system
 - Import/Export of PLC Tags
 - Sequential programming
 - Use of functions, function blocks, data blocks
- HMI Design
 - Single screen implementation
 - Configuration of PROFINET communication between PLC and HMI
 - Use of interactive components such as buttons, switches, graphs etc.
 - HMI tags

Competitors focus on setting up a project, detecting or setting up configuration of PLC and HMI according to devices supplied and programming them.

This competition involves writing or modifying a PLC program that enables a system to follow a specific sequence, specified in task description. The task description lists all requirements that will be marked by the judges. It is up to competitors to select a programming language and the way the system is being programmed; only system's final behaviour is marked.

Criteria B : SCADA / OPCUA

This competition requires further modification to an existing PLC program. This is to allow the PLC to run an OPC UA server with specific variables available. All the rules for server will be listed in task's description.

Example Technologies involved:

- PLC Programming
 - Device configuration of an existing system
 - Data blocks
 - Further modification on program's behaviour
 - OPC UA server activation
- Node-RED
 - Single dashboard implementation
 - Use of basic palette
 - Use of OPC UA palette
 - Use of Dashboard palette
 - Use of external software to act as a OPC UA client (i.e. *UA Expert*)

Next, competitors will be asked to create a dashboard using Node-RED package. The final outcome should display specific PLC data, received by establishing OPC UA communication (Server <-> Client). A List of required Node-RED palettes is included in **Equipment Required / Qualifiers** section (page 15). Use of external software for OPC UA server browsing will be also tested – for example “UA Expert” software.

Criteria C : Simulation

Example Technologies involved:

- Tecnomatix Plant Simulation
 - Modelling and simulation
 - Optimise the model based on requirement
 - Eliminate bottlenecks

The competition requires a simulation modelling using Siemens Tecnomatix Plant Simulation. Teams will receive a specific configuration of multiple CP Lab stations, with a task to create a model in Plant Simulation according to listed requirements. This will involve using SimTalk to control the material flow as a digital twin of the CP Lab.

Report:

Completed configuration should be documented, with screenshots, video recordings, and descriptions included in a documentation. Template will be supplied to competitors in **.docx** format, and submit withing their video recordings.

Task overview – National Finals

The following is an example of the marking criteria for the Regional Qualifier.

Criteria	Task	Marks
A	System upgrade	25
B	SCADA	20
C	Cloud Monitoring	20
D	Simulation	20
E	Augmented Reality	15
Total Marks		100

Criteria A : System Upgrade

Example Technologies involved:

- Siemens PLC Programming
- Siemens HMI Design
- Festo MES4
 - MES configuration
 - Creation/addition of:
 - Resources
 - Parts
 - Workplans

The National Finals begins with upgrading an existing Hardware System. Given all required files and documentation, teams will perform a modification/upgrade and later match it with correct configuration of MES4 software. It also includes development of a browser dashboard, used to support new configuration, and allow for remote access to a new system.

Criteria B : SCADA

Technologies involved:

- MES4
- Node-RED
 - Single dashboard implementation
 - Use of basic palette
 - Use of OPC UA palette
 - Use of Dashboard palette
 - Use of TCP/IP pallet
 - Use of external software to act as a OPC UA client (i.e. *UA Expert*)

In this section, competitors will mostly focus on configuring MES4 software according to a task, as well as adding further MES related functionalities to their node-RED dashboard, that will match requirements of this task.

Criteria C : Cloud Monitoring

Technologies involved:

- Node-RED
 - Use of basic palette
 - Use of OPC UA palette
 - Use of MindConnect palette
- MindSphere
 - Structure of the assets
 - Monitor the data
 - Creation of rules and events
 - Notification system

In this stage, competitors will be asked to make further modification in Node-RED in order to transfer data from CP system to a monitoring platform. Competitors will be asked to create rules and event on MindSphere and setup an alert service.

Note:

MindSphere tenant will be introduced to all teams who have been invited to National Finals prior to competition, during one of training camps.

Criteria D : Simulation

Technologies involved:

- Siemens Tecnomatix Plant Simulation
 - Modelling and simulation
 - Optimising the model based on requirement
 - Eliminating bottlenecks

The competition requires a simulation modelling using Siemens Tecnomatix Plant Simulation. Teams will receive a specific configuration of multiple CP Lab stations, with a task to create a model in Plant Simulation according to listed requirements. This will involve using SimTalk to control the material flow as a digital twin of the CP Lab.

Note:

Siemens Tecnomatix Plant Simulation will be introduced to all teams who have been invited to National Finals prior to competition, during one of training camps.

Criteria E : Augmented Reality

Example Technologies involved:

- Festo AR App

The final task of National Finals involves use of Festo Didactic AR App in conjunction with CP Lab module. With minor changes introduced to its functionality, teams will be asked to document their work, and present its functionalities.

Report:

The final report involves providing information on all work completed during National Finals and will provide user with a manual / report that is used as a proof of work that competitors have completed. The competitors will be asked to submit a video recording of their simulation.

Equipment Required

Regional Qualifiers

1. Competition hardware equipment is likely to be based on Festo Didactic Cyber-Physical Lab (CP Lab in short).
 - a. This equipment is provided by the organisers, and is subject to the discretion of the organisers
 - b. Supplementary equipment may be provided at the discretion of the
2. All competitor teams will need to bring their own laptops / computers with installed software packages and valid licences for:
 - a. TIA Portal V15.1 or higher (TIA Portal & WinCC Advanced licence)
 - b. Tecnomatix Plant Simulation V16.1 or higher
 - c. UA Expert (or other OPC UA client software)
 - d. Node-Red, with following palettes installed / tested
 - i. node-red-contrib-opcua
 - ii. node-red-dashboard
3. It is **compulsory** that teams have full administrator's rights on laptops they will be using.
 - a. Teams may be disqualified, if they cannot complete tasks, due to user-restrictions
4. While it is not necessary, competitors may bring their own supplementary tools, screens etc. to aid their work.

National Finals

1. Competition hardware equipment is likely to be based on Festo Didactic Cyber-Physical Lab (CP Lab in short).
 - a. This equipment is provided by the organisers, and is subject to the discretion of the organisers
 - b. Supplementary equipment may be provided at the discretion of the
2. All competitor teams will need to bring their own laptops / computers with installed software packages and valid licences for:
 - a. TIA Portal V15.1 or higher (TIA Portal & WinCC Advanced licence)
 - b. MES4 software
 - c. Tecnomatix Plant Simulation V16.1 or higher
 - d. Siemens Proneta
 - e. UA Expert (or other OPC UA client software)
 - f. Node-Red, with following palettes:
 - i. node-red-contrib-opcua
 - ii. node-red-dashboard
 - iii. node-red-contrib-mindconnect
3. It is **compulsory** that teams have full administrator's rights on laptops they will be using.
 - a. Teams may be disqualified, if they cannot complete tasks, due to user-restriction
2. Tablets/Wifi Network to use with Festo AR App will be provided by organisers.
3. While it is not necessary, competitors may bring their own tools, screens etc. to aid their work.

Judges Top Tips

1. **Pressure** – despite the stage of competition you will be taking part in, stress will be always involved. It is important to control your nerves and focus on the goal you are about to achieve. When managed, pressure can be good, increasing energy and performance potential.
2. **Time management** - The tasks are all against the clock. So, once you have had your task brief and know how long you have, then quickly plan your workload. Section the aspects of the task into time blocks.
3. **Practice before the competition** – use materials provided by organisers to prepare yourself the best way you can. Try timing yourself and competing with others. Ask for someone to watch and judge your work, while being super critical on your work quality, methods of work and approach.
4. **Think outside the box** – due to problem-solving nature of this competition, you will be asked to complete a task that may have more than just one solution. With the right knowledge of software and equipment, take into consideration all requirements of the task and find the most optimal and best way for you to solve it.
5. **Prepare** – before each stage, make sure you have all equipment and software required for the tasks ahead.
6. **Think of the marks** – each task involves multiple subsections, and some are worth more than others. When task is not going well and you are stuck with a problem, try covering as much as you can on other sections – it may give you those vital points and still secure you a good position.

Practice for Nationals

There are a number of competition test pieces available to download from the WorldSkillsUK website.

This is labelled the pre-competition activity. Please ensure you make full use of these in preparing to attend the qualifiers and national finals.

Conclusion

Remember, the competition will be difficult but achievable. There will be a lot of 'self-pressure'. You need to learn how to control this and focus on the task in hand. Once a task is complete, you cannot change the outcome good or bad, start the next task afresh and with positivity. Drink plenty of water throughout the competition, staying hydrated will help with your concentration, focus, and will reduce stress and headaches.

Contact

For any questions relating to the competition, please feel free to contact us.

To assist us in responding to you as quickly as possible... Please include in your email, Your name, Institution, and please CC a member of your faculty staff.

Subject : Industry 4.0 National Competitions Query

Email : support@didacticservices.co.uk



Competition Organising Partner



Lead Competition Supplier

Further sources of information and websites

WorldSkills UK

Email: enquiries@worldskillsuk.org Web: www.worldskillsuk.org Tel: 0800 612 0742