

Technical Handbook

Mechatronics



About WorldSkills UK

WorldSkills UK is a set of dynamic skills competitions for young people and adults, designed and delivered by industry experts annually in over 70 skills.

Many WorldSkills UK competitions lead into WorldSkills International competitions which are biennial global events.



For further details, please visit:
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Mechatronics

Introduction

The aim of this manual is to help competitors prepare for the Mechatronics competition at regional and national level. We hope this will help competitors to perform to the best of their ability during the competitions. The guide contains general advice, technical tips and a more in-depth overview of the competition structure and its content.

Using the tips and advice throughout the guide will help you focus on the competition areas with a higher level of accuracy, read, look at and review tasks thoroughly before beginning and teach you to step back occasionally to see if you are achieving your goal.

Remember it's not a race, you are competing against a standard, a very high standard, but one that is achievable.

Competition Overview

This is a practical competition that will test your logic, design and fault finding skills in a challenging environment.

To complete the tasks competitors are expected to apply their theoretical knowledge of fundamental principles, automation, pneumatic, electrical/electronic and PLC technologies.

The skills that are tested in the practical competition include:

- designing, building and testing pneumatic, electro-pneumatic circuits and PLC programmes for sequential and non-sequential tasks
- mechanically assembling a given set of components to a specification
- electro-pneumatic circuit simulation
- adding new functionality and operations to a given application
- general impression and function.



Stage 1 Registration and preparation

To compete in the competition, you must register using the WorldSkills UK website. You will then receive a confirmation of whether you have successfully registered. Normally, Mechatronics competitions is a team of two however due to the current pandemic, this has been temporarily converted into an individual competition. Whilst you wait to get to the next stage of the competition, you should do your best to prepare for the competition by taking a look at the **pre-competition activity task** made freely available to you on [our website](#).

Stage 2 Passive stage

Shortly after registering, the competition journey will begin with what is called a passive stage. This will be an online task that the competitor will complete and then return to WorldSkills UK for marking. This is a really important part of the competition journey as it gives the competitor an early taste of what knowledge is needed to be successful on the journey. Once everyone's scores have been totalled, competitors will be informed if they have passed on to the next round, called the national qualifiers.

Stage 3 National Qualifiers

For competitors who have managed to pass through the passive stage, the next step is the national qualifiers. This year, the qualifiers will be a virtual round with details of the tasks sent to you once you have been confirmed to have progressed to the qualifiers. The top eight scores from the national qualifiers will then go through to the next round, the national finals.

Stage 4 WorldSkills UK National Finals

The top eight (8) competitors in the UK will be invited to compete in the UK National Final which is the pinnacle of the UK national competition cycle.

The finals are usually a large scale event, and a chance to show off your skills, meet a bunch of industry professionals and other competitors taking part, as well as bring your family along to see you compete. The UK National Final is currently planned to take place involving physical activities subject to circumstances allowing.

Stage 5 WorldSkills UK International Competitions

Please note the 2021 competition will not be a selection year for the international competitions.

Beyond the national finals, there are a host of opportunities for competitors. Age-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 EuroSkills and WorldSkills international competitions.

Those who are not eligible for international competitions may join the Champions programme, which allows continued involvement, including the opportunity to work with WorldSkills UK and visit schools, colleges, and events to inspire the next generations.

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 Mechatronics competitions, that competitors will be assessed on. Not all competencies are covered at all stages and levels.

Core competencies and standards for WorldSkills UK Skills Competitions activities		Qualifiers/ Passive stages	National Final	WSI Team UK
Competency	<p>Development of mechatronic systems</p> <p>Knowledge and understanding:</p> <ul style="list-style-type: none"> designing, assembly and commissioning of a mechatronic system understand the function, the application and the components of: <ul style="list-style-type: none"> pneumatic systems hydraulic systems electric and electronic systems drives industrial robotic systems PLC systems 	Y	Y	Y
Standards	<p>Competitors shall be able to:</p> <ul style="list-style-type: none"> carry out system design for a given industrial application assemble a machine according to documentation connect wires and tubes in the correct 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. 			
Competency	<p>Industrial controllers</p> <p>Knowledge and understanding:</p> <ul style="list-style-type: none"> understand the function, the structure and the operating principles of PLCs understand the structure and function of industrial controllers (PLCs) understanding of the configuration of the industrial controller and how a software program relates to a machine action. 	Y	Y	Y
Standards	<p>Competitors shall be able to:</p> <ul style="list-style-type: none"> 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. 			
Competency	<p>Software programming</p> <p>Knowledge and understanding:</p> <ul style="list-style-type: none"> understanding of programming an industrial software program understand how a software program relates to a machine action. 	Y	Y	Y

Standards	Competitors shall be able to: <ul style="list-style-type: none"> write programs to control a machine, and visualise the process and operation using software PLC programme, including digital and analogue signal processing and industrial field uses. 			
Competency	Design Circuits Knowledge and understanding: <ul style="list-style-type: none"> knowledge required to design different circuits understanding of designing and assembling electrical circuits in machine/controller systems. 	Y	Y	Y
Standards	Competitors shall be able to: <ul style="list-style-type: none"> design pneumatic, hydraulic and electric circuits design the circuits with modern software tools. 			
Core competencies and standards for WorldSkills UK Skills Competitions activities		Heats/ Passive stages	National Final	WSI Team UK
Competency	Analytical Techniques Knowledge and understanding: <ul style="list-style-type: none"> knowledge of analytical fault finding and repairing. 	Y	Y	Y
Standards	Competitors shall be able to: <ul style="list-style-type: none"> find different faults in an analytic way in a mechatronic system repair components in short time. demonstrate mastery of problem-solving techniques to ensure correct and safe machine operation. optimise a mechatronic system consisting of different modules. 			
Competency	Mechanical Design Knowledge and understanding: <ul style="list-style-type: none"> knowledge of designing and assembling mechanical systems including pneumatic and/or hydraulic systems, their standards and their documentation. 	Y	Y	Y
Standards	Competitors shall be able to: <ul style="list-style-type: none"> design and assemble mechanical systems. 			

General Instructions

1. Passive stage will involve 1 hour test, aimed at testing general knowledge of pneumatic and electro-pneumatic components and associated circuits and PLC programming. The test will be administered during 20-21 May 2021. Competitors will be informed for their specific allocated time soon after the closing of the registration period.
2. Maximum working time is 3 x 1-hour tasks at National Qualifiers and typically 5 tasks of differing lengths over 9 hours (2 days) at the National Final.
3. At the start of the competition an allotted time will be allocated for work planning. This time is not part of the working time.
4. The National Final will typically consist of 5 modules/tasks.
5. All supplied equipment and materials must be accurately checked by the competitor upon commencing the competition.

6. All materials and equipment must be marked out/used in the most economical method.
7. Competitors will lose marks for any misplaced, lost or spoiled materials and/or equipment, where this is the result of competitor error.
8. Minimum marks will not be awarded for dimensional accuracy or technical perfection where instructions have been disobeyed.
9. Competitors will lose marks for each minor breach of the Health & Safety rules. Where a competitor puts themselves or any other person at risk as a result of a Health & Safety breach, the task will be stopped. Where a task is stopped due to a Health & Safety risk, the judge will decide if the task can be continued safely.

Competition equipment needed at National Qualifiers

Due to the online nature of this year's competition, the three tasks that form the National Qualifier round will be done using simulation software.

1. Following successful completion of the Passive Stage, all competitors will be given access to Electro-pneumatic simulation software, Fluidsim version 5.
2. No prior knowledge of Fluidsim is needed, and initial familiarisation will be offered soon after the outcome of the passive stage is known.
3. Any training offered will be done online.
4. Competitors will need access to a computer running using Windows and must have administrator rights to install software.
5. First two tasks will be carried out exclusively using Fluidsim.
6. The third and last task will involve PLC programming. In this task, physical PLC will not be needed but a PLC simulator will be used to test your programme in conjunction with Fluidsim.
7. Competitors will need to ensure they have a PLC programming software which has a built-in PLC simulator which will be needed to be compatible with EzOPC, an OPC 2.x compliant server that enables connections with your PLC programming software and Fluidsim.
8. Your PLC code will be used to control a pre-configured system which will be provided in Fluidsim. This will be used in place of a physical setup.
9. EzOPC software can be downloaded from Festo web site at <https://www.festo-didactic.com/int-en/services/software/software-licences-trial-version/ezopc.htm>
10. Fluidsim and EzOPC are compatible with Codesys (V2.3 & V3.5 and higher) and Siemens STEP 7 Simulator PLCSIM/PLCSIM Advanced via TIA Portal.
11. While there maybe other PLC simulator software which are compatible with OPC 2.x client, it is the competitors responsibility to ensure they have a functional setup, and the organisers cannot provide technical support for systems other than those based on Codesys and TIA Portal.

Competition equipment needed at National Finals

Once progressed to the National Finals, competitors will need to bring along their preferred PLC with the relevant programming software. PLC will need to have 16 Digital Inputs and 16 Digital Outputs. Bringing your set of standard tools are also advisable although basic tools will be provided.

Practice

There are a number of past competition test pieces available to [download from the WorldSkills UK 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.



A wise man can learn more from
a foolish question than a fool can
learn from a wise answer.

Bruce Lee

Judges Top Tips

The following eight aspects are neither exhaustive nor prescriptive and not a 'magic' formula to success. However, these are tips based on being involved with competitions for many years and we hope these will help you in future competition participation.

- 1. Pressure.** You will be nervous, but you will need to keep nerves under control and not let the pressure overtake you. But managed pressure can be good, increasing energy and performance potential.

How to handle nerves;

- a. Listen to the Judge's brief and ask questions – what sort of questions depends on you, i.e. repeating an aspect of their brief; gives you a chance to understand more.
 - b. Importantly, understand at what point your allotted time actually starts, i.e. normally after the Judge's brief.
 - c. Read your competitors' brief; everything you need to know for the task is in that brief. Allow yourself 2 to 3 minutes to read it. Read it at least twice as your first reading will be too fast.
 - d. Take a deep breath and start the task. You are against the clock and so you will need to work with focus.
 - e. Task going wrong? Take a moment, think. If necessary, quickly re-read that part of the instructions and then refocus. You may need to move on from that particular aspect of the task.
- 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. **Remember**, it is a competition and so practically everything you do within the task is marked and worth points; so focus on gathering points. Leave some time to put tools away at the end (that is worth points), clean up the working area (again, worth points). If you are stuck on a particular aspect then accept you may or may not get points for that particular part and in order to move onto the next part of the task, ask the Judge for assistance. Remember, there are other points to be earned.
4. **Think outside of the task.** Where are the Risk Assessments? If using any POL, where is the COSHH? If in doubt, then ask the Judge where these items are. Remember, you have a limited time to display your technical skill to the Judge and so you must be smart with your actions and work levels.
5. **Practice before the competition** at working under pressure and with someone watching you; perhaps your works' supervisor or college lecturer. Get them to be super critical on your work quality, methods of work and approach.
6. **Understand the advantage of selecting the right tool for the job.**
7. **Sleep.** Get plenty of sleep the night before. If offered, take advantage of accommodation for the night before the competition. Resist the temptation to consume alcohol the night before and have a good breakfast on the day of the competition; these actions will assist in preparing your mind and body.
8. **Arithmetic.** Practice mental arithmetic. It will sharpen your mind. Perhaps try Sudoku; aim to achieve at least medium level (start at mild or easy). Do mental arithmetic whenever the opportunity arises, e.g. just filled your car or motorbike, how many litres did you put in the tank. Mentally (without the aid of calculator convert Litres to Imperial Gallons - divide Litres by 4.5 to give Imperial Gallons or multiply Litres by 0.22). Understand the relationship between imperial and metric. Remember some datums.
e.g. 25.4mm to 1 inch and so, 12.7mm is $\frac{1}{2}$ inch and 6.35mm is $\frac{1}{4}$ inch. 1 Imperial Gallon is 4.5 Litres (to 1 decimal place - it is actually 1 Imperial Gallon = 4.5461 Litres).

Technical Guidance

Technical guidance for each specific task and / or tooling will be given at the competition.

Task Breakdown

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

Criteria	Task	Mark
A	TASK 1: Pneumatic sequence	30
B	TASK 2: Electro-pneumatic (Hard-wired system)	30
C	TASK 3: PLC programming	40
Total Marks		100%

Health & Safety

During the competition as in any work or educational facility you have a duty to protect yourself and those around you.

As an Organising Partner, our delivery partners have a responsibility to protect you and keep you informed about health & safety procedures and practices including;

- making the competition area safe and without risks to health
- ensure plant and machinery are safe and that safe systems of work are set and followed
- ensure hazardous articles and substances are moved, stored and used safely
- provide adequate welfare facilities
- give instruction, information, supervision and where applicable training necessary to maintain health and safety.

As a competitor you have a legal duty to:

- take reasonable care for your own health & safety and that of others who may be affected by what you do or do not do
- cooperate with the Organising Partner and/or their appointed delivery team on health and safety matters
- correctly use work/competition items provided, including personal protective equipment, in accordance with instructions and/or training given
- not interfere with or misuse anything provided for your health, safety or welfare

In particular:

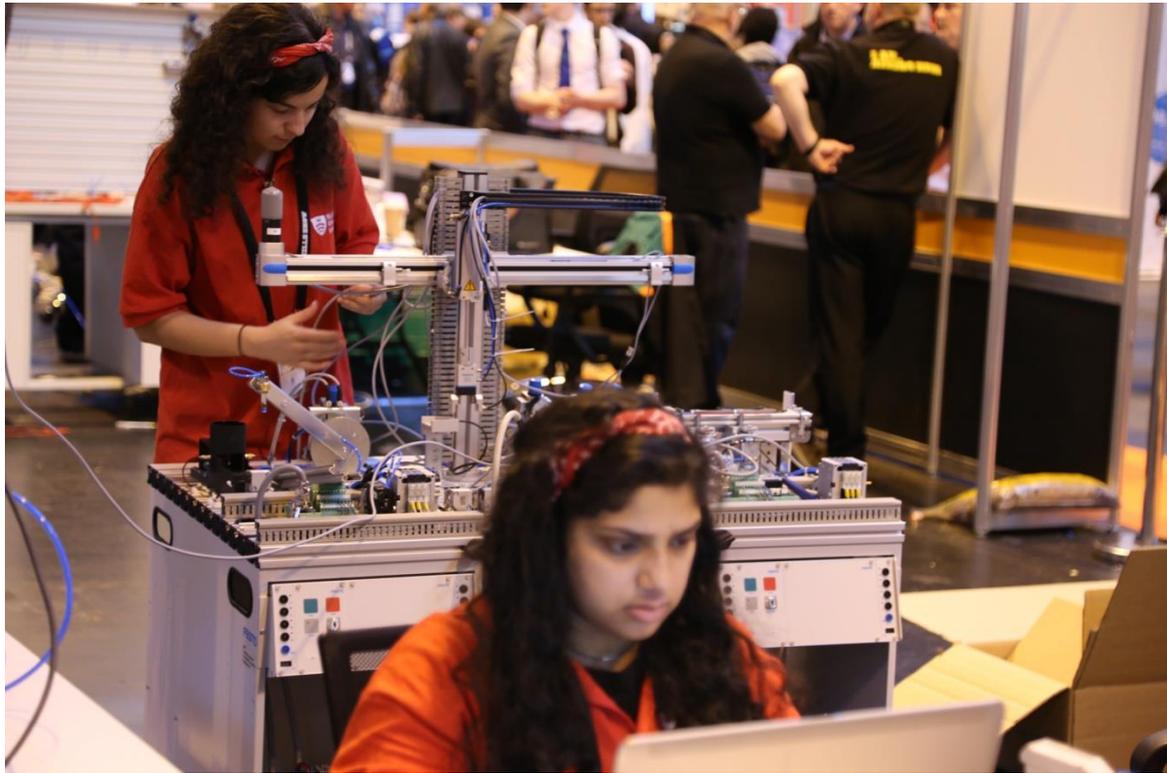
- all health and safety regulations, including protection standards, specified by the competition hosts and delivery team, must be followed exactly. Any defect in machines or equipment must be reported immediately.
- safety goggles must be used in all material-removing operations.
- shoes and clothing must comply with health and safety regulations.

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.





We wish you the best of luck in your competition journey,
and would like to leave you with the following quote:



Life is a series of experiences, each one of which makes us bigger, even though sometimes it is hard to realise this. For the world was built to develop character, and we must learn that the setbacks and grieves which we endure help us in our marching onward.

Henry Ford

Further sources of information and websites

WorldSkills UK

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