

TECHNICAL DESCRIPTION

ELECTRONICS



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international

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

The Technical Description consists of the following:

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1. **INTRODUCTION**

1.1 **Name and description of skill**

1.1.1 The name of the skill is

Electronics

1.1.2 Description of skill

This skill involves manufacturing, testing and troubleshooting electronic equipment. Skilled technicians are able to build equipment and systems for electronics and other special applications. They use the required hand tools, solders and measuring devices and computers. Since the manufacturing processes of modern mass-produced electronics are highly automated, technicians build prototypes before production, and maintain and repair systems.

Computers and embedded systems (computers for which a fixed programming environment is embedded in the processor) play a central role in this skill area since electronic devices are mainly built with the aid of programmed systems.

1.2 **Scope of application**

1.2.1 Every Expert and Competitor must know this Technical Description.

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

1.3 **Associated documents**

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

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

2. **COMPETENCY AND SCOPE OF WORK**

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

2.1 **Competency specification**

General Competency

Competitors shall know and understand:

- Creativity
- Critical thinking
- Honesty and integrity
- Self motivation
- Problem-solving skills
- Working under pressure

Competitors shall be able to:

- Conduct their work in environmentally friendly conditions

Competency for all modules

Competitors shall know and understand:

- Analysis and design of electric circuit, electronic circuit, digital logic circuit and sensor circuit

Competitors shall be able to:

- Take measurements on electronic circuits (with DVM, scope, etc)
- Use materials and tools of the electronics industry in ordinary servicing, installation and repair tasks (hand tools, different soldering and de-soldering techniques)

Fundamental electronics principles

Competitors shall know and understand:

- Basics of AC and DC technology
- Two ports LRC network, resistive networks with up to three meshes
- RC oscillators

Components in electronics

Competitors shall know and understand:

- Properties, behaviour, characteristics and application (elementary circuits) of mechanically, electrically and physically adjustable components i.e. capacitors, resistors, Coils, transformers and Diodes: rectifying diodes, switch diodes, zener diodes, capacitive diodes, PIN diodes
Trigger components, diac, triac, thyristor and Uni. -junction transistors.

Multistage and special amplifier circuits

Competitors shall know and understand:

- Basic amplifier circuits (AC, DC and power amplifiers)
- Differential amplifiers/operational amplifiers
- Ideal operational amplifier: (infinite input resistance, zero output resistance and infinite open loop gain) Basic circuits with operational amplifier, analogue adder and sub-tractor, differentiator, comparator, impedance transducer.
- Real operational amplifier: Offset voltage and offset current, compensation, common mode gain and rejection, temperature drift, frequency response.

Generators and Pulse Shapers

Competitors shall know and understand:

- Generators for sine wave voltage: RC, quartz, LC oscillators; wien bridge generator, phase generator
- Pulse shaper: Schmitt trigger, differentiator, and integrator.

Digital Electronics

Competitors shall know and understand:

- Basic logic gates
- Level switching function, function table, pulse, diagram, circuit symbols (table in appendix)
- Properties of basic gates AND, OR, NOT, NAND, NOR, EXCLUSIVE OR EXCLUSIVE NOR
- Substituting basic NAND or NOR gates for basic gates.
- Creating switching functions from given circuits and vice versa.
- Making function table from circuit diagrams and switching functions
- Simplifying switching networks using Karnaugh diagram or mathematical techniques.
- Flip-flops, RS Flip-flop, D Flip-flop, JK Master slave Flip-flop (especially counter circuits, shift register and frequency divider).

Module 1 - Hardware design

Competitors shall be able to:

- Design small modifications to electronic basic electronics blocks
- Draw a developed circuit using E-CAD program
- Design a Printed Circuit Board using E-CAD program
- Assemble circuits and a Printed Circuit Board and develop into a prototype

Module 2 - Embedded Systems Programming module

Competitors shall know and understand:

- Circuit boards, processors, chips, electronic equipment, and computer hardware and software.
- Programming of embedded systems by using C-language and Integrated Development Environments (ex MPLAB).

Competitors shall be able to:

- Program embedded systems by using C-language and Integrated Development Environments (ex MPLAB).

Module 3 – Fault finding, repair and measuring module

Competitors shall be able to:

- Determine causes of operating errors and the required action
- Adjust and replace defective or improperly functioning circuitry and electronics components, using hand tools and soldering iron
- Skills to test electronics units, using standard test equipment, and analyze results to evaluate performance and determine need for adjustment.

Module 4 - Assembly module

Competitors shall be able to:

- Assembling and utilising mechanical parts such as DC Motor, Fan Motor, Solenode, bolt, nut, washer and etc
- Wire and form cables
- Assemble and use various types of parts and SMD part

2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.

2.2.2 Knowledge of rules and regulations is not examined.

2.3 Practical work

Assembly module

The Competitors will be asked to assemble a project from a kit of parts. The standard to be reached is determined by IPC-A-610 issue D (International acceptability of electronic assemblies).

Fault finding, repair and measuring module

The Competitor is expected to locate, test and replace faulty electronic components on a printed circuit board, surface mount board or mixed technology board. All surface mount components to have no more than 20 pins. The Competitor should be able to document fault finding method/procedure with results.

The Competitors are expected to work with conventional measuring and testing equipment to test, set, adjust and measure electronic components, modules and equipment that are based in DC, AC, digital and analogue electronics. They are further expected to record and analyse measured results. Boards must be pre-built before the Competition.

Hardware design module

Each Competitor will have to design a PCB. The Host Country and Chief Expert will negotiate with software sponsors. *If the sponsor can deliver a license to all participating countries by 12 months before the Competition all Competitors will use same software. In case the sponsor is not permitted to issue a license to some countries/regions because of an embargo, all countries/regions are free to select own CAD software.*

This project will be completed in modules over the 4 days of the Competition. Parts of the project may be in progress on days 1, 3 or 4. After phase 1 (circuit development) all competitors have the possibility to receive a version of circuit prepared by the expert who developed the project. If a competitor is not able to create a PCB of their own in phase 2 (PCB development) they can continue with a PCB prepared by the expert who developed the project to the final phase (unit assembly and testing). In this part they can have full marking point of assembly quality, but only 50% marking points of board functionality (Phases 1 and 2).

Embedded systems programming module

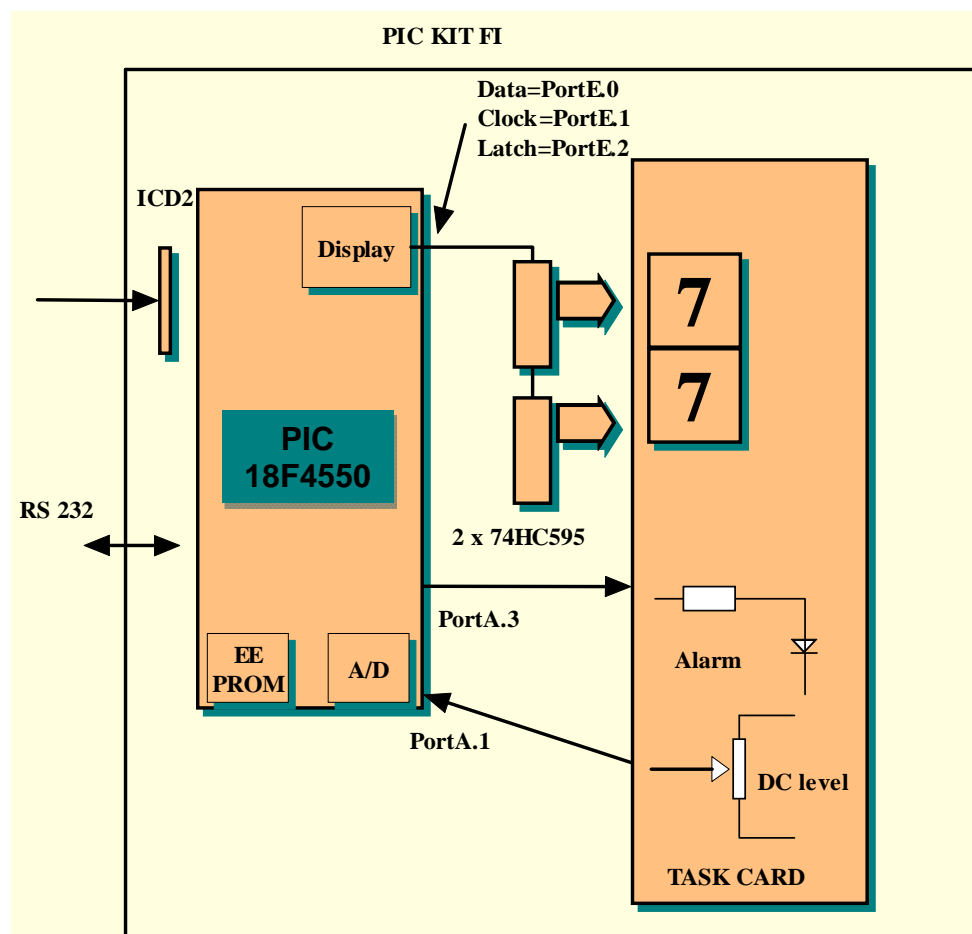
The Competition Organiser, together with the Chief Expert, produces a processor unit with task module interface 12 months before the Competition. The SW-design project is based on this unit and Competitors do the task paper and project module. See diagram.

Type of processor

PIC: 18F4550

Compiler: C18

A four hour programming module where the Chief Expert in conjunction with the Competition Organiser will confirm any final software arrangements six months before the Competition. This is a Software Design; the 18FXX2 processor family shall be used. **The 18F4550** device is to be used (details available at <http://www.microchip.com>).



3. THE TEST PROJECT

3.1 Format / structure of the Test Project

Series of standalone modules.

3.2 Test Project design requirements

Experts design modules for evaluation at the Competition according to the following requirements.

Assembly module

Experts may bring any modules they desire but the modules should include assembly of PC boards that include conventional and surface mount components. Wiring and mechanical assembly may also be required.

It is recommended that:

- 50% of the marks for assembly should be based on components
- 25 % be based on wiring
- 25 % based on mechanical assembly

Surface mount components should have no more than 20 pins. One or two modules may be selected.

The Experts have to supply replacement components for this module. All electronic parts brought to the Competition should be in anti static bags.

Measuring and testing module

The boards may be conventional (standard), surface mount technology or mixed technology boards. SMT components may have a maximum of 20 pins.

The Expert is expected to bring one working module demonstration board plus boards for all the Competitors as well as two spare boards, circuit diagrams, component overlays and data.

Fault finding and repair module

The Experts are expected to supply replacement components for this module. All boards must be pre-built before the Competition. Each board must have at least three faults. All Experts will bring one working project demonstration board, for the Competitors plus two spare boards; electronic circuit diagrams component overlays and data sheets. All electronic parts brought to the Competition should be in anti static bags. Integrated Circuits to be brought in anti static boxes inserted in anti static foam.

Hardware design module

The final solution to this must include circuit design or modifications to pre-built, or partially built board(s) and include test points as part of their design.

In this module the Competitor needs to create a solution defined in the assignment to meet the properties in a given environment in hardware using a breadboard to prove the design which they must bring with them.

The Experts responsible will supply a complete set of circuit specifications, schematic diagrams, and a list of suggested components. The Experts will also bring materials from which PC boards may be constructed.

Once the design has been proven, each Competitor will have to design a PCB. Circuit design is separate and PBC-design starts from original and right version, same for all)

6 months before the Competition

Add Design Rules document to the Technical Description as an appendix or give a link to the attachment on the Discussion Forum. This document will explain exactly what data is needed at the end of PCB Design Module.

2 months before the Competition

Explain exactly what data is needed at the end of the PCB Design module (data to include component packing).

This will then be manufactured at the Competition by the Competition Organiser for the afternoon of day three (C3).

This module shall include assembly skills that are hand assembled not using computer assembly programming. The Software Development Plan and Hardware Development Plan boards can contain analogue, digital and embedded components, or a mixture of such components.

Each Expert to bring one working module demonstration board for the Competitors plus two spare boards, circuit diagrams, component overlays as well as data sheets. All electronic parts brought to the Competition should be in anti static bags. Integrated Circuits to be brought in anti static boxes inserted in anti static foam.

Embedded systems programming module

A four hour programming module where the Chief Expert in conjunction with the Competition Organiser will confirm any final software arrangements six months before the Competition start date. This is a Software Design; the 18FXX2 processor family shall be used. The 18F4520 device is to be used (details available at <http://www.microchip.com>).

The program will be in C only. The C compiler must be brought by the Competitor and the one recommended is the one supplied by Microchip.

The C Programming marking system functionality will include the following:

- Use of Interrupts: Interrupt Subroutines (ISR) are allowed. Use of priority is allowed.
- In Line Assembly: This is NOT allowed, the only exception being as follows:
 - The use of commented sections of code that are not editable, that is the Competitor does not need to change any assembly code. The comments should be adequate to understand the function of the code without knowing the detail of the mnemonics.

Time allowed for each module

Module	Time allowed	Suggested Day
Hardware design	6 hours	C1 and C4
Embedded systems programming	4 hours	C2 or C3
Fault finding, repair and measuring	4 hours	C4
Assembly module	4 hours	C2 or C3

General notes on proposed modules

Each proposal must:

- Meet the Test Project design requirements
- Have a minimum number of words
- Be able to be translated quickly into the chosen language of the Competitor
- Have a small project brief
- Have a parts list
- Have a circuit diagram
- Have a data sheet pack

Project documentation must be brought to the Competition on CD/DVD or memory stick in Microsoft Word. When preparing the project no more than 200 words should be used in any one module. All words are to be double spaced underneath to allow for translation into the chosen language of the Competitors. Each Expert should also allow 25% space on each sheet for drawing modifications.

Where Experts have used drawing software, Experts should bring along the version of the drawing software used. Paper copies should also be presented and where possible in three official languages. Where possible, circuit diagrams, photographs, line drawings, etc. will be used for all modules and project wording should be as brief as possible.

Specifications for Test Project modules

All Test Project modules must be according to the following specifications (possible data lines and voltages, 5V, 12V).

- There is no DIN connector.
- Voltages are $\pm 12V$.

3.3 Test Project development

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

3.3.1 Who develops the Test Project / modules

The Test Project / modules are developed for the 2013 Competition by Experts and external company according to the table below:

Country	Assembly module	Hardware design module	Embedded systems programming module	Fault finding, repair and measuring module
External company				X
Brazil		X		
Canada	NO	NO	NO	
Finland		X		
Germany		X		
Japan			X	
Korea		X		
Portugal	X			
United Kingdom	X			
Morocco		X		
Iran		X		
Singapore			X	
Switzerland	X			
Chinese Taipei			X	
Tunisia			X	
Vietnam	X			
Spain			X	
Thailand	X			
Columbia	X			
India		X		
Total	6	7	5	1

Experts entering for the first time must contact the Chief Expert at least 3 months prior to the Competition to discuss which modules they must bring to the Competition

All modules must use a 12 volt plus or minus supply. This will be supplied by the Competition Organiser.

3.3.2 How and where is the Test Project / modules developed

The Test Project / modules are developed:

- Independently

3.3.3 When is the Test Project developed

The Test Project is developed:

According to the timeline below

Time	Activity
At the previous Competition	Experts decide on the modules for the next Competition then they select which modules they would like to develop. This process is controlled by the Chief Expert.
6 months before the Competition	New Experts contact the Chief Expert for allocation of module proposals.
2 months before the Competition	Experts send all library references and other support material to Chief Expert for circulation to all competing countries/regions.
At the Competition	Modules are selected by voting process described in section 2.9
At the Competition	A random ballot selection is used to determine the allocation of workbenches to Competitors.

3.4 Test Project marking scheme

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

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

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

3.5 Test Project validation

Experts will validate the Test Project modules together at the Competition. An agreement will be made that the following criteria is met.

- Test Project modules should meet the description of paragraph 2.3 *Practical work* and 3.2 *Test Project design requirements*.
- Time limit – time for each module is open depending on the total time of the Competition.
 - Hardware Design Module - 6 hours
 - Embedded Systems Programming - 4 hours
 - Measuring, Fault Finding and Repair Module (2 modules) - 4 hours
 - Assembly Module - 4 hours
 - Total time is 18 hours

3.6 Test Project selection

The Test Project is selected as follows:

By vote of Experts at the current Competition using the voting process described below.

Voting process

- First, vote for the project most appropriate for the skill description. Rank and give them a point.
- Second, vote for projects considering their level of difficulty and freshness of idea. Choose two projects you consider the best and the second in one vote.
- Then rank and give them a point.
- The two projects which have the highest and the second highest total points in votes 1 and 2 will be selected.

Rank Point	Vote 1	Vote 2	Vote 3
1 st			
2 nd			
3 rd			
4 th			
5 th			
Others			

3.7 Test Project circulation

The Test Project is circulated via WorldSkills International website as follows:

Not circulated

3.8 Test Project coordination (preparation for Competition)

Coordination of the Test Project will be undertaken by:

Chief Expert

3.9 Test Project change at the Competition

Not applicable

3.10 Material or manufacturer specifications

Material and manufacturer specifications for Test Projects set by each Expert should be updated on the Industrial Electronics forum by one month prior to the Competition. The information can be provided by uploading the full datasheet of main materials (IC, special parts, etc). The Expert who prepared the Embedded Systems Programming module should present a newly written library or special function.

4. SKILL MANAGEMENT AND COMMUNICATION

4.1 Discussion Forum

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

4.2 Competitor information

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

This information includes:

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

4.3 Test Projects

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

4.4 Day-to-day management

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

5. ASSESSMENT

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

5.1 Assessment criteria

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

Section	Criterion	Marks		
		Subjective (if applicable)	Objective	Total
A	Hardware design	0	25	25
B	Embedded systems programming	0	25	25
C	Measuring, fault finding and repair	0	25	25
D	Assembly	0	25	25
	Total =	0	100	100

5.2 Subjective marking

[Not applicable](#)

5.3 Skill assessment specification

[Specific marking criteria for each module differ. However, major marking features for each module are as follows:](#)

A. Hardware design module - 25 marks

Development of given basic circuit - 10 marks

Design of PCB-board layout - 8 marks

Functionality of proto unit - 7 marks

B. Embedded Systems Programming - 25 marks

Software functionality - 25 marks

C. Measuring, fault finding and repair module - 25 marks

Finding faulty spots and repair process (IPC-A-610-D) - 10 marks

Validity of measuring results – 10 marks

Documentation of measuring method – 5 marks

D. Assembly module - 25 marks

Operating condition OK - 13 marks

Assembled quality according ICP-A-610 D - 12 marks

5.4 Skill assessment procedures

Each Expert joins the Competition with a formerly allocated Test Project. The Test Project that will be used at the Competition is selected 3 days before the first Competition day.

The process of selecting Test Projects is as follows:

- The Expert who prepared a Test Project explains his/hers to all Experts.
- All Experts vote to decide the Test Projects.

Each Test Project is to be made based on section 3 *The Test Project* however the content of the prepared project can differ according to the project provider's intention.

Assessment procedure and detailed marking standard can be determined as below:

- Forming assessment group for each project
 - Survey every Expert's preference for marking which project
 - Chief Expert allocates 4 to 5 Experts for each project, considering the survey result
 - Each group selects its own group leader
- The project provider proposes the outline of marking standard to the project marking group
- All the Experts in each group confirm the final marking standard referring to the initial outline
- Each assessment group is responsible for the progress of the pertaining Test Project

Experts start marking after the end of each module. Each Expert marking group can organise the marking schedule after consultation with the Chief Expert.

Assessment is completed each day. All assessments are done when the previous module's assessment is completed.

Only the Expert marking group for a specific module assesses the module. All other Experts can leave the Competition site. Modules are assessment in the Expert room.

6. **SKILL-SPECIFIC SAFETY REQUIREMENTS**

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

Skill-specific safety requirements:

- All Competitors and Experts must have Electro Static Awareness (ESD)

7. MATERIALS & EQUIPMENT

7.1 Infrastructure List

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

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

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

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

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

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

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

- Laptop computers with English language, USB ports, Embedded System kit with a standard interface.
- Hand tools and soldering stations
- Competitors may also bring all their own equipment including step transformers

Note: Desktop computers are not required to be supplied by the Competition Organiser because Competitors will provide their own laptops for use during the Competition.

7.3 Materials, equipment and tools supplied by Experts

- Laptop computers, USB ports
- Hand tools and soldering stations
- Experts may also bring all their own equipment including step transformers

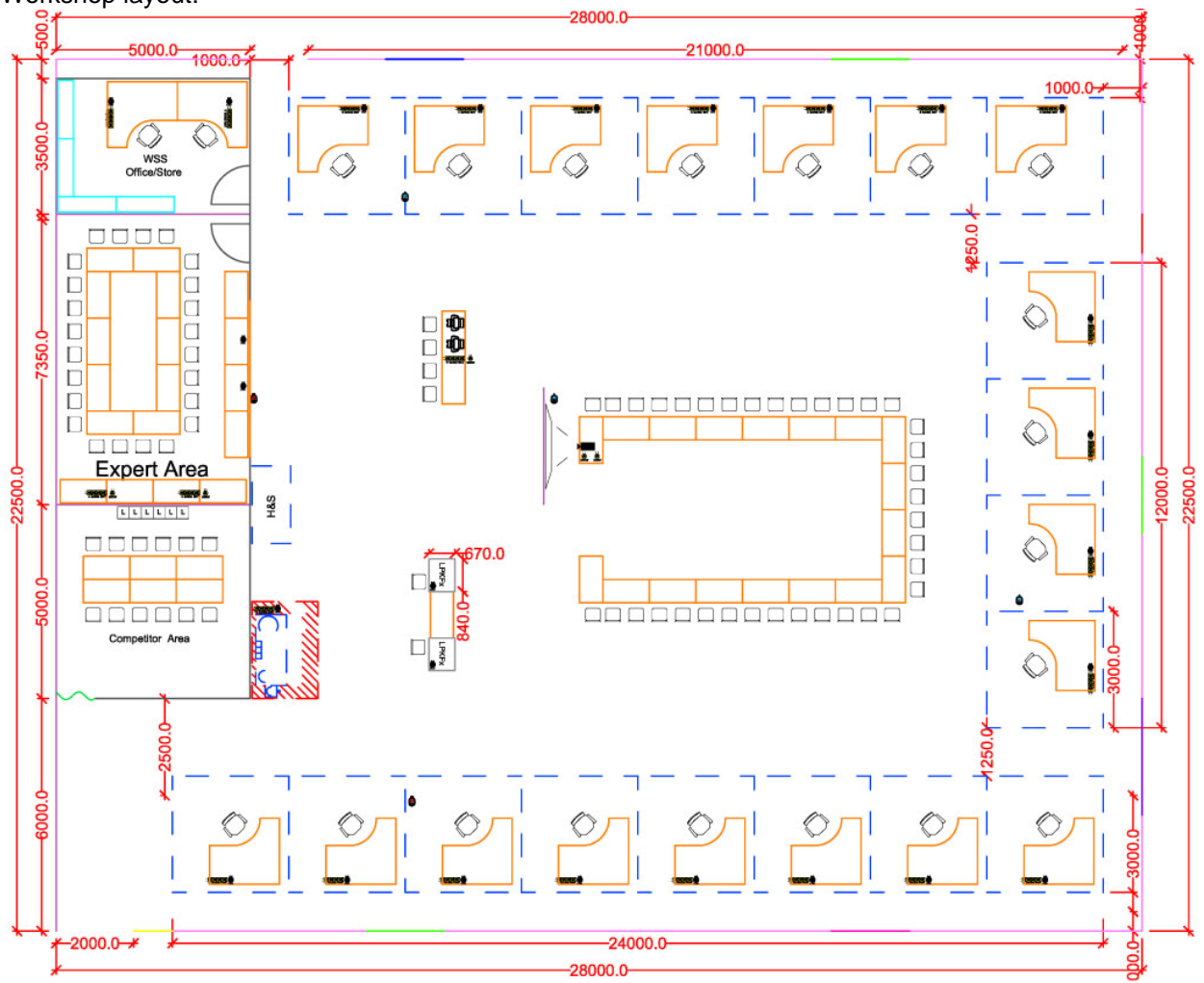
7.4 Materials & equipment prohibited in the skill area

Not applicable

7.5 Proposed workshop and workstation layouts

Workshop layouts from London are available at:
http://www.worldskills.org/index.php?option=com_halls&Itemid=540

Workshop layout:



8. MARKETING THE SKILL TO VISITORS AND MEDIA

8.1 Maximising visitor and media engagement

To maximise visitor and media engagement the following ideas will be considered:

- Try a trade
- Display screens
- Test Project descriptions
- Enhanced understanding of Competitor activity
- Competitor profiles
- Career opportunities
- Daily reporting of competition status

8.2 Sustainability

- Recycling
- Use of 'green' materials – Pb-free lead is used for soldering