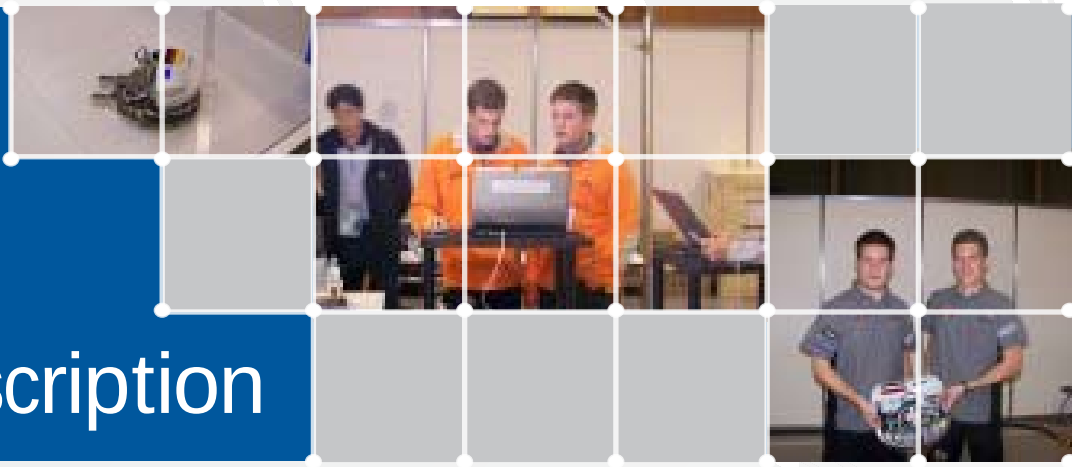

Technical Description

Mobile Robotics

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:

1. INTRODUCTION 2

2. COMPETENCY AND SCOPE OF WORK 2

3. THE TEST PROJECT 3

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6. SKILL-SPECIFIC SAFETY REQUIREMENTS 8

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8. MARKETING THE SKILL TO VISITORS AND MEDIA 11

Effective 04.12.08

Liam Corcoran
Technical Committee Chair

1. INTRODUCTION

1.1 Name and description of skill

1.1.1 The name of the skill is Mobile Robotics.

1.1.2 Description of skill
The theoretical and practical training of the Mobile Robotics technician is concerned with the mechanical and control systems of mobile robots.

Mobile Robotics technicians assemble, set up, manage and maintain mechanical systems within a mobile robot as well as install, operate and trouble shoot mobile robot control 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 - Competition Manual
- 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

The Competitor must be able to:

- Solve logic problems.
- Carry out mobile robot system design.
- Assemble a mobile robot according to manufacturer's documentation.
- Design a mobile robot control program.
- Connect a mobile robot to its control system.
- Commission a mobile robot to carry out its correct function to solve a series of practical operational problems as set by the Experts.
- Interpret hardcopy and/or electronic forms of manufacturer's technical documents.
- Design / Fabricate a Radio Controlled Arm-Gripper Add-on Component to meet specific Performance Requirements defined by the 2009 Mobile Robotics Expert Jury Panel in the Fall of 2008.
- Provide all Components / Parts / Documentation related to their Competitor Designed / Fabricated Radio Controlled Arm-Gripper.
- Mount their Competitor Designed / Fabricated Radio Controlled Arm-Gripper onto the Mobile Robot Base Unit.
- Integrate their Competitor Designed / Fabricated Radio Controlled Arm-Gripper's Information Gathering Elements into the Mobile Robot Base Unit's Control Software.

2.2 Theoretical knowledge

2.2.1 Theoretical knowledge is required but not tested explicitly.
The Competition Tasks will consist of practical work only.

- Theoretical knowledge is limited to that necessary to carry out the practical work related to installation and operation of mobile robot mechanical and control systems. This may include the reading and interpreting of manufacturer's drawings, sketches or schematic diagrams.
- Knowledge of rules and regulations related to the field of mobile robotics will not be examined.

2.2.2 Knowledge of rules and regulations is not examined.

2.3 Practical work

There will be two Competitors per team. Team composition may include a mechanical systems specialist and a control systems specialist or involve Competitors with Expertise in both areas.

The Competition may include team and individual tasks.

3. THE TEST PROJECT

3.1 Format / structure of the Test Project

The format of the Test Project is a series of 4 standalone modules involving two Independent Test Project Categories:
(a) Robots plus Sponsor provided add-on components
(b) Robots plus Competitor Built, Radio Controlled Arm / Gripper components.

3.2 Test Project design requirements

The total working time for the complete set of modules will be between 18 and 22 hours.

There will be new modules assigned each of the four WorldSkills Competition days. The modules will consist of practical work only.

Teams will work for two Competition days in each of the two Independent Test Project Categories:
(a) Robots plus Sponsor provided add-on components
(b) Robots plus Competitor Built, Radio Controlled Arm / Gripper components.

Modules for each of these Test Project Categories may be organized as either two separate AM / PM modules or as a single module running through both the AM and PM time period of a single Competition day.

The modules will be presented through descriptive document packages that:

- Define the manner of robot-to-robot direct interaction that will be permitted.
  Note: None of the modules allow destructive robot behaviour.
- Define the various operational environments in which the competition robots must function.
- Define the different functional mobility and target object management tasks that the competition robots must accomplish.
- Define the nature of the relationship between the Competitors and their competition robot when it is performing in the Mobile Robotics Competition Arena.
- Define the rules of play and scoring criteria for each module.

Any instructions to Competitors will be provided through the module documents.

The teams of Competitors will be required to assemble, maintain, repair and operate mobile robots.

The Competition robots will be required to complete various tasks (modules) set by the panel of Experts.

The modules will require Competition robots to perform tasks that reflect industrial / commercial mobile robots at work.

Competitors must generate all programs required by their mobile robots for the automated tasks.

Individual Mobile Robotic modules will require the production / preparation of robots for performance in the Competition Arena during each session.

There will be a 3 hour morning and a 2½ hour afternoon sessions each day.

Each session will comprise:
Robot design / Assembly / Troubleshooting / Maintenance work / Robot performance in Competition Arena

Each module will include details defining the particular rules of the Competition Arena game and scoring pattern that will be applied in that module.

Each module will be unique, however they will all address two primary robot performance areas:
1 Overall Robot Mobility Tasks
2 Target Object Management Tasks

Each module will have a unique Competition Arena Presentation, however they will follow one of two core patterns.
1 Independent Mobile Robotics Competition Arena Space where individual robots are in the Competition Arena alone and
2 Shared Mobile Robotics Competition Arena Space where two or more robots are active in the Competition Arena at the same time.

A variety of structures may be added to the Mobile Robotics Competition Arena to define unique competition environments for each of the Mobile Robotics modules.

The Competition Arena floor setup for each module will be unique.

3.3 Test Project development

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

3.3.1 Who develops the Test Project / modules

The Test Project/modules are developed by all Experts.

The Mobile Robotics modules will be developed by the Mobile Robotics Experts in consultation with the Chief Expert and the Robot Manufacturer Product Manager.

The design team is open to any country/region to provide suggestions

3.3.2 How and where is the Test Project / modules developed

The Test Project / modules are developed jointly on the Discussion Forum.

The Test Projects will be developed through the Discussion Forum and during the preparation days prior to the Competition based on the following format:

- A *Competitor Pre-Competition Information Package* will be developed through the MR Discussion Forum, with the final text determined through a Forum Poll, and an expected publication date of the first week in January 2009.
- The *Competitor Pre-Competition Information Package* will provide essential generic descriptions defining the broad range of robot / Competitor performance capabilities that Competitors will need to execute in Calgary.

- The Expert meetings held during the preparation days at the Cometition will set the final Competition tasks based directly on the task variables described in the *Competitor Pre-Competition Information Package*.

3.3.3 When is the Test Project developed
The *Competitor Pre-Competition Information Package* which defines the Test Project variable collection is developed by 6 months before the Competition.

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

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

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

3.5 Test Project validation
It must be demonstrated that the Test Project/modules can be completed within the material, equipment, knowledge and time constraints. This will this be demonstrated by the Skill Management Team:

The Skill Management Team will be responsible for ensuring that:
- The Mobile Robot modules are accurate and complete.
- There are no module requirements that cannot be completed.
- The Mobile Robot modules can be completed in the prescribed time of 6 hours.
- Proper function is achievable.
- The material/equipment list is accurate.
- Competitor instructions are kept to a minimum of text, and that they do not exceed the available space permitted on the approved instruction sheet for any one module.
- The Mobile Robot modules are complete in all aspects. This part of the preparation must be completed six (6) months prior to the WorldSkills Competition.

3.6 Test Project selection
The Test Project is selected by a combination of vote of Experts on the Discussion Forum and vote of Experts at the current Competition.

3.7 Test Project circulation
The Test Project is circulated via WorldSkills International website as follows:
The Mobile Robotic modules will be disclosed to the Competitors at the Competition site. Test Project descriptions will be provided at the start of the session. This may be only in the AM if the Test Project is running through both the AM and PM Competition sessions of a single Competition day or in both the AM and PM if the tasks are running as two separate AM / PM modules.

3.8 Test Project coordination (preparation for Competition)
Coordination of the Test Project will be undertaken by the Skill Management Team

3.9 Test Project change at the Competition
Not applicable. Final Test Project details (Robot Court Layout / Target Object Selection) will be set by the Mobile Robotics Experts during their pre-competition meetings.

3.10 Material or manufacturer specifications
Sponsorship, specifications, supply and support for the selected hardware and software will be co-ordinated by the host Member Workshop Supervisor and the Chief Expert. Details will be posted on the Discussion Forum as soon as they are finalised or at the very latest 6 months prior to the Competition.

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/testprojects) and the Competitor Centre (http://www.worldskills.org/competitorcentre).

4.4 Day-to-day management

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

5. ASSESSMENT

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

5.1 Assessment criteria

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

Each full day module will carry a value of 25 marks.

Module marks will be entered at the end of each day.

It will take 2 days for all Competitors to complete a module (Example:1/2 of the Competitors complete module 1 on Day 1 and the other 1/2 complete module 1 on Day 2).

Final Marks for modules 1 and 2 will be calculated at the end of Day 2 when all Competitors have completed these modules.

Final Marks for modules 3 and 4 will be calculated at the end of Day 4 when all Competitors have completed these modules.

Section	Criterion	Marks		
		Subjective (if applicable)	Objective	Total
A	Module 1 (Day 1 and 2)	0	25	25
B	Module 2 (Day 1 and 2)	0	25	25
C	Module 3 (Day 3 and 4)	0	25	25
D	Module 4 (Day 3 and 4)	0	25	25
	Total =	0	100	100

5.2 Subjective marking

Not applicable

5.3 Skill assessment specification

Evaluation will be based directly and exclusively on mobile robot performance in the Competition Arena.

The overall framework for the modules will be developed in the MR Discussion Forum and finalized during the pre-Competition meetings.

All modules will involve the following primary elements:

- Managing overall Robot mobility within the competition court environment utilizing all of the Mobile Robots mobility management capabilities.
- Robots will work in court environments that are structured to provide either exclusive use of a court space or shared use of the court involving direct robot to robot interaction.
- Interacting with Target Objects within the Competition court environment which may involve:
  - Searching for and locating designated Target Objects
  - Interacting with designated Target Objects including:
    - taking full possession of these objects
    - delivering these objects to designated locations

The Discussion Forum will focus on the creation of a *Competitor Pre-Competition Information Package*. This package will be finalized through Discussion Forum Poll and published to Competitors in January 2009. This package will have the following primary sections (1) Sponsor Provided Add-on Components, (2) Competitor Built Radio Controlled Arm / Gripper Component plus a section on (3) Overall Robot Mobility.

A) The Sponsor Provided Add-on Components section of the package will:
   a. Identify the particular Sponsor Provided Add-on Components that will be used in Calgary.
   b. Detail the specific performance characteristics of the Sponsor Provided Add-on Components that will be used in Calgary.
   c. Describe the collection of potential Target Objects and Court Environment Elements on which the final Sponsor Provided Add-on Components Modules will be based. This information will enable the competitors to create their own module practice situations while keeping the final Calgary module details unknown.

B) The Competitor Built Radio Controlled Arm / Gripper Component of the package will:
   a. Identify the performance requirements (length of reach, gripper opening closing capacity) for the Arm / Gripper the competitors must design and fabricate.

   b. Describe the collection of potential Target Objects and Court Environment Elements on which the final Competitor Built Radio Controlled Arm / Gripper Component Modules will be based. This information will enable the competitors to create their own module practice situations while keeping the final Calgary module details unknown.

C) The Overall Robot Mobility section of the package will detail all of the mobility management systems the competitors will be expected to utilize in Calgary.

Detailed Module Evaluation Criteria will be included in the final module descriptions provided to the competitors in Calgary. Given 'On the Court Robot Performance' is the sole evaluation criteria competitors can expect marks will be awarded for the following type of items:

- Successfully following the prescribed path;
- Successfully locating the designated target object;
- Successfully interacting with the target object when it has been found Example: knocking it off a pedestal or taking possession of the target object (picking it up);
- Successfully delivering the target object to a designated location Example: placing it on a platform / in a box or stacking a number of target objects in a prescribed pattern;
- Time taken will be a factor in particular when two robots both successfully complete the task. The one taking less time will be deemed more efficient and marked accordingly.

5.4 Skill assessment procedures

Final overall standing will be based on the total points scored by a team over the four WorldSkills Competition days combined.

Time to complete

'Time taken to complete the task' will be one of the most significant components used to evaluate mobile robot performance. In a properly designed module, the majority of the competing mobile robots will be able to complete the assigned tasks to some degree. However, it should be anticipated that more than one robot will complete the module entirely. Just as is the case in industry, degree of efficiency will become the important relative measure. If it is determined that multiple Competitors have indeed completed the assigned task set equally then time taken becomes the critical, distinguishing, objectively measurable and transparent critical variable. This will apply equally both where a definite time limit has been preset (for example four-minute game duration) or when teams are allowed to take as long as they need to complete the task.

All marking will be objective in accordance with the marking scale set out in each Mobile Robotics module.

- The eight competition periods (4 morning and 4 afternoon) will carry equal weight in the overall evaluation process. The degree to which a Mobile Robot is able to complete the various competition tasks taking into consideration preset performance efficiency standards as the core evaluation criteria.
- Marking is to be entered after each module has been completed.
- A sample marking scale and instructions for referees is to be included in each module.

Experts/Referees are to complete an Objective Marking Sheet for each module completed, for each team.

Two courts

- There will be Two Distinct Competition Robot Courts, one exclusively for Autonomous Robot / Add-on Component Performance and one for Combined Autonomous / Radio Controlled Arm-Gripper Performance.
- Competitors will divide their time equally between the Two Competition Court environments.

Team competition

Mobile Robotics is an individual team competition. The rules for all modules will require all Competitors to focus on maximizing their own score.
Teams may not act in a supportive partnership with an opponent.

6. SKILL-SPECIFIC SAFETY REQUIREMENTS

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

Competitors observed by the Experts to be exercising unsafe work place practices will be directed to stop working and required to demonstrate to the Experts that they have corrected the safety concern before they will be allowed to resume working.

All Competitors must use safety glasses when using any hand, power or machine tools or equipment likely to cause or create chips or fragments that may injure the eyes.

7. MATERIALS & EQUIPMENT

7.1 Infrastructure List

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

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

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

At each Competition, the Experts must review and update the Infrastructure List in preparation for the next Competition. Experts must advise the Secretary General 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

- 2 laptop computers. The *Competitor Pre-competition Information Package* will address the questions of (a) whether teams will be allowed to use two computers in their workspace, (b) the minimum specifications for the competitor computers and (c) whether competitors need to bring a spare computer for back-up purposes in the event of major computer hardware failure. Teams will be limited to the use of one computer in the court area.
- 1 set of screwdrivers, plus other small hand tools and small portable power tools which is deemed necessary to maintain their robot and RC Arm / Gripper.
- 1 two meter measuring tape
- Competitors should bring a USB Flash Drive for the purpose of storing back-up files and for transferring files between the Team's two lap top computers. Note: These USB Flash Drives will be kept in the Competition area at all times during the four Competition days.

** Quantities specified are the minimum – Competitors may bring more than one.*

7.3 Materials, equipment and tools supplied by Experts

- 1 stopwatch with 1-second accuracy
- Mobile robots for use in the modules
- Competition Target Object Collection for use in the modules
- Mobile Robot Parts Collection for use in the modules
- 1 set of notepad, pencil, pen etc.

7.4 Materials & equipment prohibited in the skill area

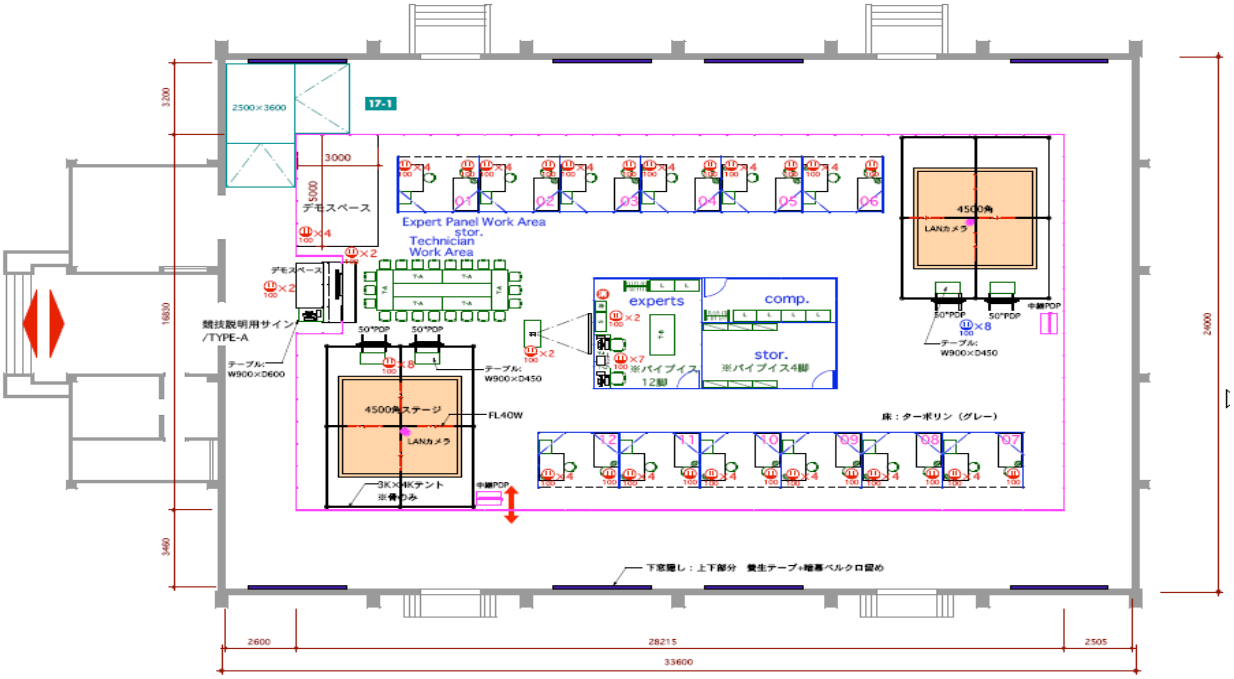
- No CDs/DVDs, floppy disks, flash memory or any other digital storage device containing prepared robot programs may be brought into the Competition area.

- Teams will be limited to the use of one computer in the court area.

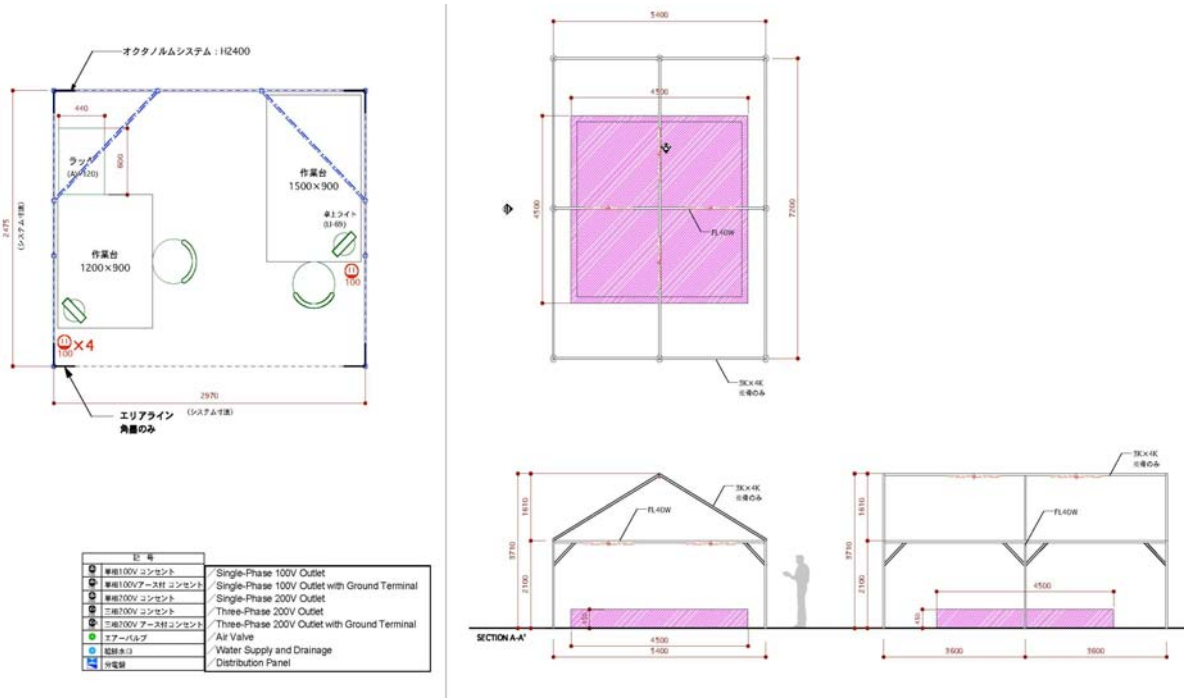
7.5 Sample workshop and workstation layouts

Workshop and workstation layouts from Shizuoka are available at:
http://www.worldskills.org/index.php?option=com_halls&Itemid=318

Workshop layout from previous Competition:

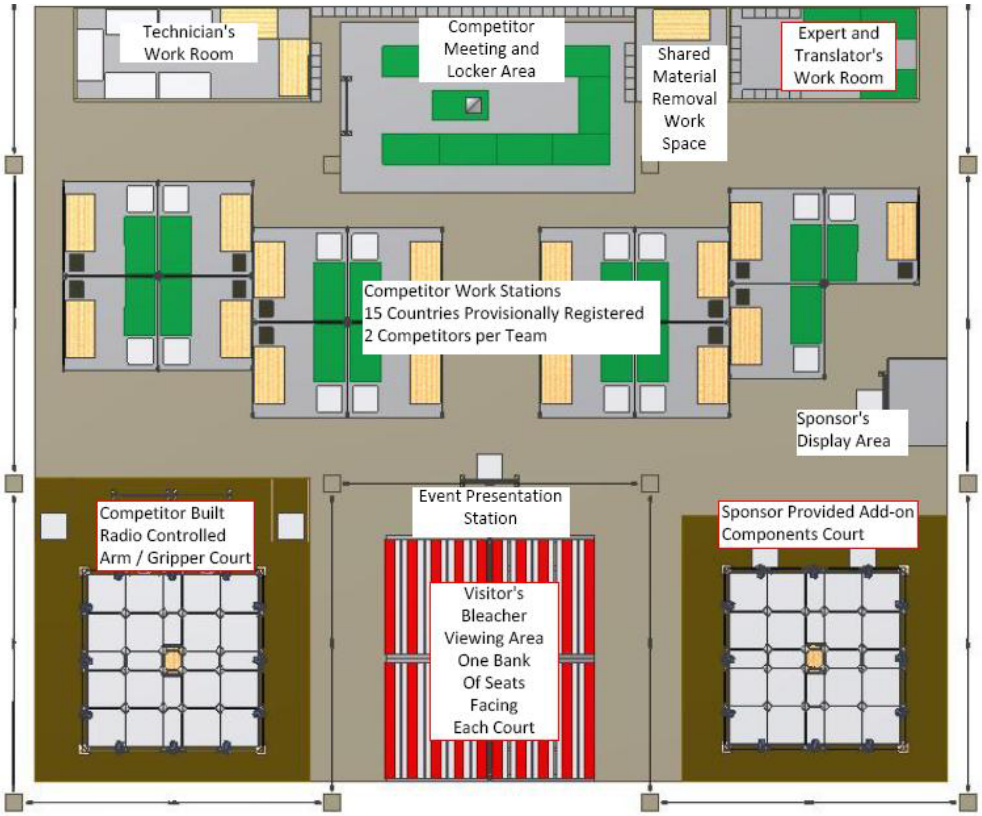


Workstation layout from previous Competition:



Proposed Workshop layout for the current Competition:

In this draft workshop layout the two Mobile Robot Competition Courts are situated directly in front of the main entry to the lower level of the Big Four Building. Note: this layout is subject to change.



8. MARKETING THE SKILL TO VISITORS AND MEDIA

8.1 Maximising visitor and media engagement

The following ideas will be considered to maximise visitor and media engagement.

- Court areas may have a presentation sound system and a commentator
- Passageway screens may show an event presentation running on loop throughout the Competition. Content could include:
  - An animation of a robot completing either the actual competition module or something similar.
  - The marking scheme 'Scoring Pattern' for each module along with descriptive text defining the module and what the robot is doing.
  - Images of Mobile Robots at work.

8.2 Sustainability

- Recycling
- Use of 'green' materials