



TECHNICAL DESCRIPTION
Mobile Robotics



world **skills**
international

© 2010 WorldSkills International
TD23 v3.1 – WSC2011

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	4
4.	SKILL MANAGEMENT AND COMMUNICATION.....	7
5.	ASSESSMENT	8
6.	SKILL-SPECIFIC SAFETY REQUIREMENTS	10
7.	MATERIALS & EQUIPMENT	10
8.	MARKETING THE SKILL TO VISITORS AND MEDIA.....	12

Effective 31.03.10



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 design, manufacture, assemble, set up, programming, manage and maintain mechanical, electrical and control 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

1.4 Number of Competitors per team

[Mobile Robotics is a team skill with 2 Competitors per team.](#)

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

[Prototyping](#)

[Knowledge and understanding:](#)

- [Knowledge of designing, fabricating, assembly and commissioning of a Material Management System](#)

[Competitors shall be able to:](#)

- [Analyse a mobile robot work application to identify the specific robot performance capabilities required to meet the needs of the work application.](#)
- [Identify the specific information gathering hardware \(camera, various sensors\) required to support the robot performance.](#)
- [Design a Material Management System including the structural frame work, mechanical, electrical and information gathering systems capable of meeting the needs of the work application.](#)

- Integrate their Material Management System onto the mobile robot's base unit in a manner that does not compromise the robot base's mobility capabilities.
- Develop a Tele-operation control system (Programmable Radio) to control their Material Management System in a manner that is independent of the robot base's control system.
- Identify appropriate materials and processes for fabricating the structural and mechanical elements required for their Material Management System.
- Identify appropriate hardware (motors, sensors) to support the performance requirements of their Material Management System.
- Identify the Target Object Characteristics (surface texture, degree of fragility, overall shape, starting and ending locations, etc) that define the performance parameters their Material Management System must address.
- Design the electronics control systems for their material management system.
- Elaborate strategies to solved mobile robotics tasks including: navigation and orientation techniques using the provided actuators and sensors.
- Design considering of safety issues [ie: Competitor's robot does not damage opponent's robot. Competitor does not hurt him/herself with their robot. (avoid the mechanism easily to hurt oneself)]
- Fabricate the structural and mechanical elements required for their Material Management System.
- Fabricate electronics control circuits to control their material management system.
- Install, setup and make all necessary physical and software based adjustments, required for effective use all manufacturer provided equipment related to the mobile robot.
- Install, setup and make all necessary adjustments to the mechanical, electrical and sensor systems of their Material Management System.
- Install, setup and make all necessary adjustments required for effective Tele-operation of the competitor provided equipment related to operating their Material Management System.

Programming and control logic

Knowledge and understanding:

- Understanding of manufacturer provided control software

Competitors shall be able to:

- Use the manufacturer provided control software to assert effective autonomous control over the robot's movement.
- Use the manufacturer provided control software to assert effective autonomous control over manufacturer provided object management systems.
- Use industrial standard programming software (like C++) to assert effective autonomous control over the robot's movement.
- Use Tele-operation to assert effective control over competitor designed / fabricated object management systems.
- Implement programming methodologies to the control systems for the material management system.

Wireless communication

Knowledge and understanding:

- Understanding of wireless communication between mobile robot and (lap top) computer

Competitors shall be able to:

- Install the wireless hardware and establish a mobile robot to lap top computer wireless connection.
- Undertake basic problem solving in case of connection failures

Orientation and mapping

Knowledge and understanding:

- Understanding of advanced robot navigation by orientation and mapping

Competitors shall be able to:

- Assert robot movement control by implementation of all orientation and mapping capabilities present in the manufacturer provided mobility control software and hardware.
- Implement a navigation strategy to move around a known/unknown environment.

Sensor integration

Knowledge and understanding:

- Knowledge of sensor integration

Competitors shall be able to:

- Install and make physical settings adjustments to the complete range of manufacturer provided sensors such as inductive, capacitive, distance, tactile and other sensors.
- Use the manufacturer provided software to analyse sensor provided data and provide appropriate robot control based on the sensor data.
- Install a camera on the robot and make appropriate physical settings adjustments.
- Use the manufacturer provided software to analyse camera images and provide appropriate robot control based on the camera image analysis.
- Integrate sensors to their material management system to have control of the tasks assigned.

Target object handling

Knowledge and understanding:

- Knowledge of target object handling

Competitors shall be able to:

- Address the object handling needs identified in the Test Project documents.
- Integration of any kind of actuator.

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/electrical systems specialist and a control systems specialist or involve Competitors with Expertise in both areas.

3. THE TEST PROJECT

3.1 Format / structure of the Test Project

The format of the Test Project is 2 standalone multi-stage criteria with an increasing difficulty.

Project Categories:

- (a) Robots plus Sponsor provided add-on components
- (b) Robots plus Competitor Built Object Management System

Note: The Object Management System for handling objects will be described in terms of specifications in the information packages.

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 2 standalone multi-stage criteria.

The criteria 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 competition 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 5½ hour working time divided into 2 sessions each day.

Each session will comprise:

Robot programming / assembly / troubleshooting / maintenance work / robot performance in Competition Court.

Details defining the particular rules of the Competition Court and scoring pattern for each criterion will be presented in the Test Project document.

Each criterion will be unique, however they will all address two primary robot performance areas:

- 1 Overall Robot Mobility Tasks
- 2 Target Object Management Tasks

Each criterion will have a unique Competition Court Presentation, which can follow one of two core patterns.

- 1 Independent Mobile Robotics Competition Court Space where individual robots are in the Competition Court alone
- 2 Shared Mobile Robotics Competition Court 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 Court to define unique competition environments for each of the Mobile Robotics modules.

The Competition Court 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 criteria 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 Experts 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. Nine (9) months prior to the Competition the draft Test Project will be published on the Discussion Forum. The final text determined through a Forum Poll, and an expected publication date of the first week in January 2011.
- 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 London.
- The Expert meetings held during the preparation days at the Competition 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 be demonstrated by the **Skill Management Team**:

The Skill Management Team will be responsible for ensuring that:

- The Mobile The draft test project is published 9 months prior to the competition
- Robot criteria are accurate and complete.
- The Mobile Robot criteria are complete in all aspects. This part of the preparation must be completed six (6) months prior to the WorldSkills Competition (April 5, 2011).
- There are no criteria requirements that cannot be completed.
- The Mobile Robot criteria can be completed in the prescribed time of 5.5 hours.
- Proper function is achievable.
- The material/equipment list is accurate.
- Hardware and software used at the competition are available on the market 9 month prior to the competition.
- There will be no changes of hardware and software versions 6 months prior to the competition
- 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.

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 *Competitor Pre-Competition Information Package* will be circulated via the website 9 months before the Competition.

- The Mobile Robotic criteria will be disclosed to the Competitors at the Competition site.
- The Test Project descriptions will be provided at the start of the session.

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 and surface / 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.

The manufacturer will send the complete Mobile Robotic System to every team six months before the Competition. The teams are responsible for shipping the Mobile Robotic System to the Competition.

The manufacturer/sponsor makes a commitment to comply with the WSI approved timelines.

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 (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.

Criterion marks will be entered at the end of day 2 and 4.

It will take 2 days for all Competitors to complete a criterion.

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

Final Marks for criteria 2 will be calculated at the end of Day 4 when all Competitors have completed these criteria.

Section	Criterion	Marks		
		Subjective (if applicable)	Objective	Total
A	Criterion 1 (Day 1 and 2)	0	50	50
B	Criterion 2 (Day 3 and 4)	0	50	50
	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 Court.

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 recognising 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 finalised through Discussion Forum Poll and published to Competitors in January 2011. This package will have the following primary sections (1) Sponsor Provided hardware and software, (2) Object Management System plus a section on (3) Overall Robot Mobility.

Detailed Criterion Evaluation Criteria will be included in the final criterion descriptions provided to the Competitors in London.

Given 'On the Court Robot Performance' is the sole evaluation criteria competitors can expect marks will be awarded for example 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
- Successfully delivering the target object to a designated location

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.

The two competition periods 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.

Courts

- There will be two Distinct Competition Robot Courts.
- Competitors will divide their time equally between the two Competition Court environments.

Team competition

Mobile Robotics is a team competition consisting of two Competitors from each Country/Region. 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 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

- 1 or 2 laptop computers.
- 1 set of screwdrivers, plus other small hand tools and small portable power tools which is deemed necessary to maintain their robot and Object Management System.
- 1 measuring tape
- Competitors should bring an empty 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 laptops and USB Flash Drives will be kept in the Competition area at all times during the four Competition days.

7.3 Materials, equipment and tools supplied by Experts

The Host Country will supply:

- Stopwatches with 1-second accuracy
- Mobile robots for use in the criteria
- Competition Target Object Collection for use in the criteria
- Mobile Robot Parts Collection for use in the criteria
- Sets of notepads, pencils, pens etc.

7.4 Materials & equipment prohibited in the skill area

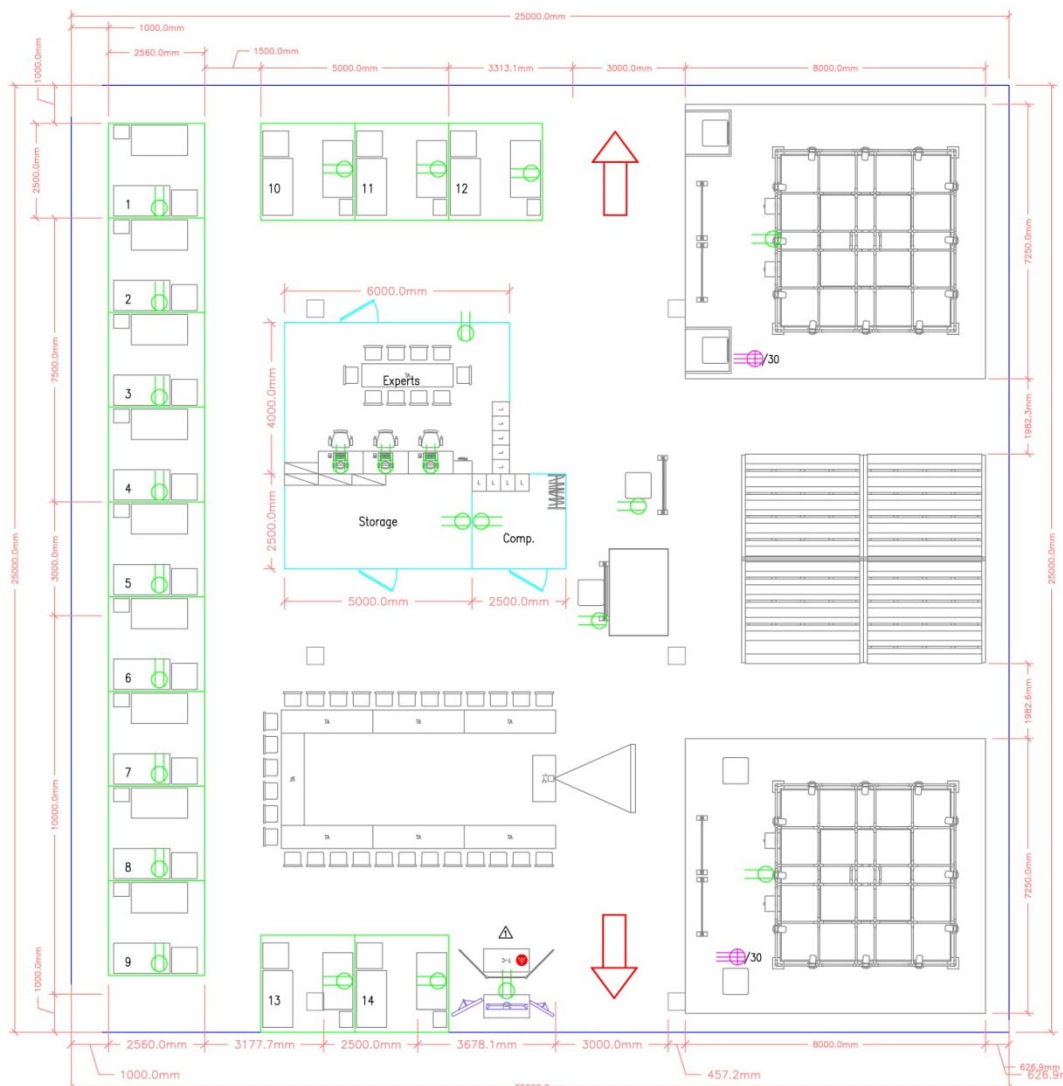
- No CDs/DVDs, floppy disks, flash memory or any other digital storage device containing prepared robot programs may be brought into the Competition area.
- Teams will be limited to the use of one computer in the court area.

7.5 Sample workshop layouts

Workshop layouts from Calgary are available at:

http://www.worldskills.org/index.php?option=com_halls&Itemid=540

Workshop layout from previous Competition:



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.
- Robot interaction with the public

8.2 **Sustainability**

Sustainability of Mobile Robotic Team Competition will be put forward by:

- Encourage Media Coverage
- Increase Industrial Applicability