

# **WATERLOO** **ENGINEERING**

**Senior Team Design  
Competition Problem**

Fall 2012  
Waterloo Engineering Competition  
November 2-3

**GENERAL RULES**

1. All questions regarding the competition problem must be asked during the welcome and briefing session. No questions will be answered during the design and build stage.
2. Teams are not allowed to leave the DWE building unless they have submitted their prototype and presentation to competition staff.
3. All communication devices must be turned off throughout the duration of the competition. This means you may not use a cell phone camera to take pictures for the purpose of your presentation or in the shop in this competition.
4. Wireless on laptops must be turned off. Violation of this rule will result in immediate disqualification.
5. Visitors are not allowed throughout the design and build stage. Violation of this rule will result in immediate disqualification.
6. Teams may only use materials they have purchased in the shop.
7. Final prototype and presentation materials must be submitted to the submission desk prior to the end of the design and build stage. It is the team's responsibility to bring its deliverables from the design area to the submission desk.
8. Competitors may not use the blackboard when delivering presentations.
9. Keep work spaces clean. Tidy up at the end - marks will be deducted otherwise.

**SCHEDULE**

Friday, November 2	5:30 p.m. – 6:00 p.m.	Competitor Check-In	RCH 3 <sup>rd</sup> floor
	6:00 p.m. – 7:00 p.m.	Welcome/Briefing	DWE 1501
	7:00 p.m. – 12:30 p.m.	Design/Build	Various
	12:30 p.m. – 1:00 a.m.	Submissions/Debriefing	DWE 1501
Saturday, November 3	7:30 a.m. – 8:00 a.m.	Competitor Check In	E5 Foyer
	8:00 a.m. – 12:00 p.m.	Presentations/Demonstrations	E5 5128
	12:05 p.m. - 12:30 p.m.	Deliberation	E5 5128
	12:30 p.m. - 1:00 p.m.	Announcement of winners	Announced at Check in

Volunteers will give instructions to teams on when and where to get their pizza, which will be available at some time between 8:30p.m. – 9:30p.m. Please remind the competition coordinators and volunteers of your dietary restrictions and/or allergies. Dress code for presentation and demonstration is business casual. There will be a question period after the problem is presented. No questions will be answered during the development and build stage to ensure fairness in the competition.

**THEME**

The theme of the Spring 2011 Senior Team Design is Mars Rescue.

**SCENARIO**

Tragedy has struck. Humanity's greatest hero, Dr. Astronaut, M.D., has become stranded on Mars during his last mission due to an unexpected Martian sandstorm. His transportation equipment has malfunctioned, and he does not have enough oxygen in his tank to walk the distance from his disabled Mars buggy to the nearby Mars base. He has only one hope for survival: the unmanned Waterloo Engineering® Mars Rescue Rover! This high tech semi-remote device is currently in orbit above Mars, ready for re-entry to safely retrieve Earth's greatest hero from utmost peril and return him to his natural habitat inside the artificial atmosphere of the Mars base.

You will design and construct a device which can survive re-entry to Mars, navigate to the stranded Dr. Astronaut, M.D., and move him from his disabled Mars buggy to the Mars base. Your device will be connected to a control panel so that you can direct the rover to move Dr. Astronaut, M.D. at your will. The fate of humanity itself, indeed, lies in your capable hands. Waterloo engineers, it is your finest hour.

**OBJECTIVE, REQUIREMENTS & CONSTRAINTS**

Design a device that is remotely controlled through a minimum of one (1) metre of cable using only the materials provided. It must be able to survive a one and a half (1.5) metre drop from a wooden scaffold onto the competition surface. The device must be able to hang from the release mechanism and may only touch the scaffold at these following points:

1. The release mechanism
2. The two additional hooks located on the scaffold

After completing re-entry, you will have two (2) minutes to connect your device to your control panel. You may touch the connectors and the control panel, but not the device itself. After the device is connected, you must remotely control it to retrieve Dr. Astronaut, M.D. and transfer him from one location to another. The vehicle must not exceed 30 cm in height, and 40cm in width and length.

Your device may not damage the competition problem setup. Additionally, during construction of your device, you may not damage your headquarters or the building in any way. Doing so will result in immediate disqualification from the competition.

The remote control and the attached cable must not have direct physical impact on the retrieving vehicle, i.e. steering by pulling the vehicle is not allowed. Only two people are allowed to operate the device at any point which includes a person holding up the cable to prevent physical interference. Teams are not permitted to touch the vehicle during demonstration. The Waterloo Space Exploration Club has granted you \$10,000 to design this device. Any additional funds required to construct your device will be taken out of your hard

earned work term savings. In the event that a team goes over budget, their budget will be compared to that of the lowest budget successful team and penalized based on percent error to a maximum of 10%. See the marking form for additional details.

### **PROTOTYPE TESTING RULES**

The scaffold and a portion of the terrain will be available for teams to perform prototype testing. Each testing period is 10 minutes, and is signed-up for on a first-come-first-serve basis.

#### **Reservations**

Each team may only have one reservation at any time, and must use up the testing period before reserving the next one. Teams may only reserve whichever time slot is available next (i.e. teams may not specify a time).

#### **Cancellations**

Teams are allowed to make cancellations to reservations. A cancelled time slot then becomes the next available testing period, and can be reserved by whichever team makes the reservation next. Time slots after the cancellation will not be bumped up.

#### **Consumable Items**

Some items are consumable, for example: batteries. Teams are responsible for purchasing enough of these consumable items from the shop during the design and build phase to successfully complete the presentation and demonstration.

**SHOP RULES**

1. A maximum of two (2) people per team may be in the shop at any time.
2. All sales are final. Be sure to verify purchased items and quantities before leaving the shop.
3. Teams may not trade building materials. Violation of this rule will result in immediate disqualification for both teams.
4. The competition shop will keep track of the official expense forms. However, teams are encouraged to keep track of their own Purchase Requisition Form to have an idea of how much they have spent. The shop will not tell teams how much they have already spent.
5. The shop will close 30 minutes before the development and build stage ends.

**DELIVERABLES**

At the end of the six- (6) hour development and build stage, each team is required to submit the following items:

1. A working prototype of the machine
2. A PowerPoint presentation
3. Purchase Requisition Form

**MARKING SCHEME**

The following marking scheme is specific to the Fall 2012 Senior Team Design competition and will be used by judges during presentation and demonstration.

<b>Design &amp; Performance</b>	<b>60%</b>
Workmanship / Aesthetics	5%
Able to survive re-entry‡	20%
Able to navigate to Dr. Astronaut, M.D.	10%
Able to successfully move Dr. Astronaut, M.D. to the Mars base	20%
Time taken to complete task (relative to other teams)	5%
Not able to move at all†	- 60%
Fails to meet constraints	- 20%
<b>Presentation</b>	<b>30%</b>
Explanation of Design Process	15%
Demonstration of Teamwork	7%
Knowledge	3%
Presentation Quality and Flow	3%
Effective use of Time	2%
Cost below \$5500	+ 10%*
Not Following Dress Code	- 5%*
<b>Originality</b>	<b>10%</b>
Creativity	5%
Uniqueness	5%
<b>TOTAL</b>	<b>100%</b>

In case of a tie in total marks, the teams will be ranked based on their points scored in Design & Performance.

Completed marking sheets will not be disclosed to competitors; however, if teams wish to know their strengths and weaknesses for improvement in future competitions, judges will be available after the competition for questions.

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\* The ± signs denote bonus or penalty points, respectively. Lowest possible score for each marking category is zero (0) points.

† The WEC marking scheme explicitly states that a vehicle not being able to move constitutes as a design failure. Be sure to keep this in mind when competing at the OEC, as the same rule applies but is not stated in the marking scheme.

‡ ‘Surviving re-entry’ is classified as the device landing upright or able to right itself, and able to function after being connected to the control panel.

Item Description	Size	Price	Item Description	Size	Price
<b>General</b>			Off-road Wheel 1		\$250
Metal Wire	Per cm	\$10	Off-road Wheel 2		\$275
Cotton String	Per cm	\$5	Ball Caster		\$400
Multipurpose Twine	Per cm	\$7	Axle		\$200
All-Purpose Rope (green)	Per cm	\$12	<b>Construction</b>		
All-Purpose Rope (white)	Per cm	\$10	Cardboard (light)	Per cm <sup>2</sup>	\$5
Bubble Wrap	Per cm <sup>2</sup>	\$5	Cardboard (heavy)	Per cm <sup>2</sup>	\$8
Aluminum Sheet	Per cm <sup>2</sup>	\$10	Foam Board	Per cm <sup>2</sup>	\$5
Plastic wrap	Per cm <sup>2</sup>	\$5	Styrofoam	Per cm <sup>2</sup>	\$8
Plastic Drop Sheet	Per cm <sup>2</sup>	\$7	Plywood ¼"	Per cm <sup>2</sup>	\$10
Foam Wrap	Per cm <sup>2</sup>	\$5	Plywood ½"	Per cm <sup>2</sup>	\$15
Plastic Bag		\$250	Hardboard ¼"	Per cm <sup>2</sup>	\$12
Ziploc Bag		\$200	Wood Dowel (ø 1/4")	Per cm	\$3
Paper Plate		\$200	Wood Dowel (ø 1/2")	Per cm	\$5
Spring (Various Sizes)		\$25	Wood Dowel (ø 3/4")	Per cm	\$7
Nail (Various Sizes)		\$5	Steel Strapping	Per cm	\$10
Screw (Various Sizes)		\$7	Angle Bracket		\$200
Nut & bolt (Various Sizes)		\$7	<b>Adhesives</b>		
Metal hook (earring)		\$500	Hot Glue Stick	1 Stick	\$150
Metal Hook (cup)		\$450	White Glue	Sml. Cup	\$100
Eye Hook		\$425	White Glue Stick	1 Stick	\$110
Balloon		\$100	Super Glue	1 sml. tube	\$250
Rubber Band	(32/64)	\$25	Double Sided Tape	Per cm	\$12
Rubber Band	Large	\$75	Packing Tape	Per cm	\$8
Wooden Skewer		\$90	Electrical Tape	Per cm	\$5
Plastic utensils (sp., for.)		\$75	Duct Tape	Per cm	\$10
Popsicle Stick		\$20	<b>Electrical</b>		
Clothes Peg		\$50	Electric Motor #1	1.5-3 V	\$ 400
Spool		\$100	Electric Motor #2	4.5-6 V	\$ 600
Pipe Cleaner		\$25	Double Gearbox		\$1500
Paper Clip		\$10	Single Gearbox	3-speed	\$1000
Party Drinking Straw		\$40	Battery Holder	1x 9V	\$100
Zip Tie	7½"	\$30	Battery Holder	4x AA	\$200
Styrofoam Cup		\$80	Toggle Switch		\$200
Play-Doh	Sml. cup	\$150	On/Off Rocker Switch		\$200
Modelling Clay	Sml. cup	\$250	Electrical Wire	Per cm	\$2
<b>Wheels</b>			Battery	AA	\$25
Slick Wheel		\$225	Battery	9V	\$50



**PURCHASE REQUISITION FORM**

Team Number: \_\_\_\_\_

Team Member #1: \_\_\_\_\_

Team Member #2: \_\_\_\_\_

Team Member #3: \_\_\_\_\_

Team Member #4: \_\_\_\_\_

<b>Item</b>	<b>Unit Price</b>	<b>Quantity</b>	<b>Total Price</b>	<b>Volunteer Initial</b>

**PURCHASE REQUISITION FORM (continued)**

Team Number: \_\_\_\_\_

Team Member #1: \_\_\_\_\_

Team Member #2: \_\_\_\_\_

Team Member #3: \_\_\_\_\_

Team Member #4: \_\_\_\_\_

<b>Item</b>	<b>Unit Price</b>	<b>Quantity</b>	<b>Total Price</b>	<b>Volunteer Initial</b>