Spring 2009
Waterloo Engineering Competition
June 22 – 27

Senior Team Design Competition Problem

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 and RCH buildings unless they have submitted their prototypes and presentations to competition staff.
3. All communication devices must be turned off throughout the entire duration of the 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.

SCHEDULE

The schedule of the Junior Team Design competition is as follows:

Friday, June 26	5:45 p.m. – 6:00 p.m.	Sign-In	RCH 101
	6:00 p.m. – 6:30 p.m.	Welcome/Briefing	RCH 101
	6:30 p.m. – 12:30 a.m.	Design/Build	Various Assigned Classrooms
Saturday, June 27	7:45 a.m. – 8:00 a.m.	Sign-In	RCH 301

8:00 a.m. – 12:00 p.m.	Presentation/DemonstratiRCH 301 on

Drinks will be available throughout the development and build stage of the competition. Volunteers will bring pizzas around to teams between 8:30 and 9:00 p.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 2009 Senior Team Design is “”

SCENARIO

Unexploded mines continue to pose a significant threat to both property as well as human life in war-torn regions of the world. The challenge of safely removing unexploded mines and detonating them in a controlled manner is a complex engineering challenge. Hence, the problem for the competition will be to design a remotely controlled Mine Recovery Vehicle (MRV) capable of detecting unexploded mines and carrying them safely across uneven terrain and possibly large bodies of water. In the case of obstacles, the vehicle can either drive over the object if small, or navigate around the obstacle. Also, the site chosen for the safe detonation of the mines is across a deep, calm river.

OBJECTIVE, REQUIREMENTS & CONSTRAINTS

Design an MRV, completely remotely controlled through minimum two (2) metres of cable using only the materials provided. The MRV must be able to navigate the given terrain in the above scenario and cross the river without getting any of the recovered mines wet. The vehicle must not exceed 20 cm x 20 cm x 17 cm (L x W x H) in dimension, and should carry mechanism for removal of the mine.

The remote control and the attached cable must not have direct physical impact on the MRV i.e. steering by pulling the vehicle is not allowed. Only one person is allowed to operate the remote control at any time; another

person can hold up the cable to prevent physical interference. Teams are not permitted to touch the vehicle during demonstration. The cost of the design prototype may not exceed $10,000.

PROTOTYPE TESTING RULES

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 these consumable items for presentation and demonstration.

SHOP RULES

1. A maximum of two (2) people per team may be in the shop at any time.

2. When purchasing, a team member must bring the Purchase Requisition Form.

3. All sales are final. Be sure to verify purchased items and quantities before leaving the shop.

4. Teams may not trade building materials. Violation of this rule will result in immediate disqualification for both teams.

5. When there is a discrepancy between a team's Purchase Requisition Form and the shop records in either the type or quantity of purchased items, the team's Purchase Requisition Form will take precedence. (For example: if your Purchase Requisition Form indicates you have purchased three mousetraps and the shop records indicates otherwise, the shop records will be corrected to three mousetraps.)

6. When there is a discrepancy between a team's Purchase Requisition Form and the List of Materials in the unit price, the WEC reserves the right to make corrections on the team's Purchase Requisition Form.

7. The shop will close 30 minutes before the development and build stage ends.

BUILDING MATERIALS

Building materials will be available, while quantities last, for teams to build prototypes. Teams may use only the materials listed in the List of Materials.

List of Materials

Item	Unit Price
General	
Foam board (19.5 cm x 13.5 cm)	$1800
Foam board (19.5 cm x 10.5 cm)	$1600
Foam board (custom size)	$11/cm^2
Wooden board (20 cm x 15 cm)	$800
Wooden board (custom size)	$7/cm^2
Cardboard (27 cm x 16 cm)	$1275
Cardboard (27 cm x 10 cm)	$1125
Cardboard (19.5 cm x 16 cm)	$1200
Cardboard (19.5 cm x 10 cm)	$1050
Large dowel (30.5 cm x Ø 1.1 cm)	$300
Medium dowel (30.5 cm x Ø 0.9 cm)	$280
Small dowel (30.5 cm x Ø 0.4 cm)	$200
Popsicle stick	$60
Nail	$20
Paper clip	$10
Toothpick	$4
CD	$190
Styrofoam ball (Ø 6.5 cm)	$270
Plastic wheel (Ø 4.8 cm)	$320
Tube w/ foam padding (7.7 cm x Ø 6 cm)	$400
Pipe cleaner	$50
Plastic straw	$50
Steel wire 20 AWG (no insulation)	$4/cm
Rope (Ø 3 mm)	$10/cm
Utility cord (Ø 4 mm)	$12/cm
Cotton twine	$3/cm
Plastic spoon	$50

Plastic plate	$280
Plastic cup	$300
Pot pie pan	$350
Muffin cup	$20
Aluminum foil	$20/cm
Saran wrap	$15/cm
Sand paper	$50/cm
Paper towel	$30/segment
Large zip tie (20 cm x 0.5 cm)	$70
Medium zip tie (15 cm x 0.4 cm)	$60
Small zip tie (10 cm x 0.3 cm)	$40
Elastic band	$40
Adhesives	
Clear packing tape	$4/cm
Masking tape	$2/cm
Double-sided foam tape	$15/cm
Super glue	$100
Glue gun	Free
White glue	Free
Electrical	
Motor RF-500TB	$850
Motor RE-140RA	$850
Motor 169324	$950
Motor 9167AJ	$950
ON/OFF/ON toggle switch	$150
Battery holder 4-AA cells	$20
Battery holder 8-AA cells	$35
AA Battery	$17
Stranded wire 22 AWG	$1/10cm
Solder	Free

DC Motor Specifications

Choosing the right motor is extremely important for a successful engineering design. Four DC motors have been selected for this competition, and are listed below in order of rotation speed. Relevant specifications have been

Part Number	Voltage (V)		No Load	
	Operating Range	Nominal	Speed (r/min)	Current (A)
RF-500TB	1.5 – 12	6.0	2,700	0.020
RE-140RA	1.5 – 3.0	1.5	8,100	0.210
169324	6.0 – 12	12.0	10,000	1.400
9167AJ	6.0 – 24	24.0	14,000	0.600

Be sure to do a sanity check before leaving the shop with the motors to avoid faulty parts.

PURCHASE REQUISITION FORM

Team Number: _____

Team Member #1: _____

Team Member #2: _____

Team Member #3: _____

Team Member #4: _____

Item	Unit Price	Quantity	Total Price	Volunteer Initial

PURCHASE REQUISITION FORM (continued)

Team Number: _____

Team Member #1: _____

Team Member #2: _____

Team Member #3: _____

Team Member #4: _____

Item	Unit Price	Quantity	Total Price	Volunteer Initial

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 (both sheets)

MARKING SCHEME

The following marking scheme is specific to the Spring 2009 Senior Team Design competition and will be used by judges during presentation and demonstration.

Design & Performance		**60%**
Recover mine #1		5%
Recover mine #2		10%
Recover mine #3		10%
Recover mine #4		15%
Crossing the river		20%
Finish early	+	15% per minute*
Recover all mines within 60 seconds	+	5%
Not able to move at all†	-	60%
Get stuck in terrain	-	10% each time*
Getting the mines wet	-	40%
Hitting a boulder	-	2% each time
Presentation		**25%**
Design Process		6%
Meet Constraints & Criteria		6%
Quality & Flow		6%
Highlights & Usability		5%
Prototype Critique		2%
Cost below $2500	+	2%*
Cost over $8500	-	2%*
Originality		**10%**
Daring/Outside the Box		4%
Creativity		3%

Uniqueness		3%
Teamwork		**5%**
Knowledge		2%
Workload Distribution		2%
Compatibility		1%
Positivity	+	1%*
Follow Dress Code	+	1%*
TOTAL		**100%**

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.

* 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 fail. 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.