

WATERLOO **ENGINEERING**

**Senior Team Design
Competition Problem**

Fall 2011
Waterloo Engineering Competition
November 4-5

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 RCH 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, Nov 4	4:45 p.m. – 5:00 p.m.	Competitor Check-In	RCH 211
	5:00 p.m. – 5:30 p.m.	Welcome/Briefing	RCH 211
	5:30 p.m. – 11:30 p.m.	Design/Build	Various Rooms
	11:30 p.m. – 11:45 a.m.	Submissions/Debriefing	RCH 211
Saturday, July 9	7:00 a.m. – 7:30 a.m.	Competitor Check In	RCH 2nd floor foyer
	7:30 a.m. – 12:05 p.m.	Presentations/Demonstrations	RCH 211
	12:05 p.m. - 12:30 p.m.	Deliberation	RCH 211
	12:30 p.m. - 1:00 p.m.	Announcement of winners	RCH 211

Volunteers will give instructions to teams on when and where to get their pizza, which will be available at some time between 7:30p.m. – 8:30p.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 Fall 2011 Senior Design is “Bridging the Gap”.

SCENARIO

You have been contracted by the Canadian government to help re-build infrastructure in a war-torn nation. They wish to build a bridge across a river. However, to support their maritime trade, ships must pass beneath the bridge. The bridge must open and close quickly but safely to allow maritime vehicles to pass with ease.

OBJECTIVE, REQUIREMENTS & CONSTRAINTS

Design a bridge to span a chasm of 75 cm, with a width of at least 8 cm. One side of the chasm is about 2 cm higher than the other. It must be smooth enough for a car to pass over, strong enough to support at least 2.2 kg of weight, and stable enough to support at least 10 N of lateral force from the center of your span.

The weight will be applied by placing a 5cm x 5 cm piece of plywood on your bridge at the centre of the chasm. The applied weight will be attached to this piece of plywood and will hang from a string beneath the bridge. You will be expected to design the span to hold this plywood and allow a space for the string. The lateral force will be applied with a string attached to a Newton-meter. The string will be tied around the centre of the bridge.

The bridge opening must have a space of 40 cm, and there must be unobstructed clearance 30 cm above the upper lip of the chasm. In other words, an object 40 cm wide and 30 cm taller than the rim of the chasm must be able to pass through. You must be able to both open and close the bridge with a minimum amount of intervention. It should open and close in as close as possible to five seconds (each), with a wait time of at least 10 seconds in between.

You have a \$4,000 budget to spend on materials.

PROTOTYPE TESTING RULES

The chasm 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 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 2011 Senior Team Design competition and will be used by judges during presentation and demonstration.

Design & Performance	60%
Meets length and width requirements	10%
Smooth enough for car to pass	5%
Can support 2.2 kg of weight	10%
Can withstand 10 N of lateral force	5%
Opens 40 cm width leaving 30 cm free space above chasm	10%
Minimal intervention from team to open/close	10%
Opens/closes in appropriate time	5%
Workmanship	5%
Over Budget	-5%*
Under Budget	+1%/\$250
Bridge does not open and close	-60%†*
Presentation	30%
Explanation of Design Process	15%
Demonstration of Teamwork	7%
Knowledge	3%
Presentation Quality and Flow	3%
Effective use of Time	2%
Not Following Dress Code	-5%*
Originality	10%
Daring/Outside the Box	4%
Creativity	3%
Uniqueness	3%
Work room not cleaned up	-5%*
TOTAL	100%

In case of a tie for 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.

Design & Performance Criteria Explanations

Meets the length and width requirements –The bridge will also be at least 8 cm wide and span the entire chasm length of 75 cm.

Smooth enough for car to pass – A car should be able to drive from one end of the bridge to the other on a road deck with ease.

Can support 2.2 kg of weight – Teams that are able to support 2.2 kg of weight will receive 5% in this category. Teams will be allowed to add more weight at their discretion to gain more points. The amount of additional weight that can be supported will be scaled among competitors according to the following formula.

$$\text{Extra Points} = 1 + \frac{kg_{Team} - \text{Min } kg}{\text{Max } kg - \text{Min } kg} \times 4$$

Where kg_{Team} is the additional mass held by a team's bridge.

$\text{Min } kg$ is the lowest additional mass held by a team.

$\text{Max } kg$ is the highest additional mass held by a team.

Can withstand 10 N of lateral force - Teams that are able to support 10 N of lateral force will receive 2.5% in this category. Teams will be allowed to add more lateral force at their discretion to gain more points. The amount of additional weight that can be supported will be scaled up to 20 N with the following formula.

$$\text{Extra Points} = \frac{\text{Lateral Force Held} - 10 \text{ N}}{10 \text{ N}} * 2.5$$

Opens 40 cm leaving 30 cm free space above chasm - While open, the bridge will leave a space of at least 40 cm in the chasm and above this space will be 30 cm of unobstructed clearance.

Minimal intervention from team to open/close – The bridge should open and close with a flip of a switch and should not open and close under the power of team members. Points will be deducted for additional switch flips required.

Opens/closes in appropriate time – The team closest to 5 seconds opening time will score 5% in this category. Any team within 2-8 seconds will score at least 2.5% in this category. Though exact values are at the judges' discretion, higher scores will be given to teams closer to the 5-second benchmark.

* The \pm 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 prototype 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.

Item Description	Size	Price (k)	Item Description	Size	Price (k)
General			Wood Dowel (ø 3/16")	/rod	\$60
Tin Foil	Per cm	\$10	Wood Dowel (ø 3/8")	/rod	\$120
Cotton String	Per cm	\$3	Wood Dowel (ø 5/8")	/cm	\$6
Sisal Twine	Per cm	\$4	Wood Dowel (ø 3/4")	/cm	\$8
All-Purpose Rope	Per cm	\$6	Wood Dowel (ø 1")	/cm	\$10
Metal Wire	Per cm	\$9	Adhesives		
Clothes Pin		\$25	Hot Glue Stick	1 Stick	\$150
Nail (1"-2")		\$5	Carpenter's Glue	1/4 Cup	\$70
Screw (Small)		\$10	White Glue Stick	1 Stick	\$70
Screw (Big)		\$12	Super Glue	sml. Tube	\$75
Miniature Nail		\$3	Double Sided Tape	Per cm	\$8
Miniature Screw		\$4	Packing (Scotch) Tape	Per cm	\$5
Tacks		\$2	Electrical Tape	Per cm	\$4
Paper Plate		\$55	Duct Tape	Per cm	\$12
Zip Tie	7½"	\$20	Electrical		
Styrofoam Balls		\$15	Gear Motor #1 *	6V/157RPM	\$500
Metal Hook		\$15	Gear Motor #2 *	3V/40RPM	\$700
Eye Hook		\$15	Gear Motor #3*	3V/24RPM	\$800
Mouse Trap		\$100	Gearbox	3V/38RPM	\$750
Rubber Band		\$15	Electric Motor #1	0.3 A	\$200
Spring (Assorted)		\$30	Random Motors		\$100
BBQ Skewer		\$30	Battery Holder	2x AA	\$100
Rubber band		\$40	Battery Holder	4x AA	\$200
Binder Clips		\$50	Battery Holder	6x AA	\$300
Hinges (Large)		\$275	Battery Holder	8x AA	\$400
Hinges (2") w/screws		\$150	Recycled Resistors	each	\$10
Hinges (1") w/screws		\$75	Brand New Resistors	each	\$25
Construction			Potentiometers	1k, 1M	\$150
Popsicle Stick		\$3	DPST Switch (Toggle)		\$150
Black Poster Board	Per cm ²	\$0.20	DPDT Switch		\$350
Bristle Board	Per cm ²	\$0.30	Off-Mom Switch		\$100
Plywood	4"X 7¾"	\$80	On-off-on switch		\$150
Cardboard	Per cm ²	\$0.25	Electrical Wire	Per cm	\$5
Sewing thread dowel*		\$30			

*Denotes a rare item

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