

# **WATERLOO** **ENGINEERING**

## **Junior Design Competition Problem**

Spring 2014  
Waterloo Engineering Competition  
July 4-5, 2014

**SCHEDULE**

The schedule of the Spring 2014 Junior Team Design competition is as follows:

Friday, July 4	5:15 p.m. – 5:30 p.m.	Competitor Check-In	MC 2066
	5:30 p.m. – 6:00 p.m.	Welcome/Briefing	MC 2066
	6:00 p.m. – 10:00 p.m.	Design/Build	Various assigned classrooms
	10:00 p.m. – 10:30 p.m.	Submissions/Debriefing	MC 2066
Saturday, July 5	7:30 a.m. – 8:00 a.m.	Competitor Check-In	RCH 3 <sup>rd</sup> -floor lobby
	8:00 a.m. – 12:30 p.m.	Presentations/Demonstrations	RCH 301/302
	12:30 p.m. – 1:00 p.m.*	Announcement of Winners	RCH 301

\*Times are approximate and will be confirmed on the day of the competition.

Pizza will be available to teams around 8:30p.m.-9:00p.m., during the design and build stage. Please remind the competition coordinators and volunteers of your dietary restrictions and/or allergies.

**GENERAL RULES**

1. Competitors will be presented with a 15 minute question period following the welcome and briefing. Competitors may ask as many questions as they like during this period. However, after this, questions WILL NOT be answered.
2. The design and build stage is four (4) hours in duration.
3. All communication devices MUST be turned off throughout the duration of the competition.
4. Visitors are not allowed during the design and build stage. Violation of this rule will result in immediate disqualification.
5. All submitted materials must be labelled according to the following guidelines:
  - a. Prototypes must have the team number clearly labelled.
  - b. The team number and names of all team members must be written on the back of the poster.
6. All deliverables 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. Teams will receive a penalty for late submissions. If a team is three (3) or more minutes late, the team will be disqualified.
7. Competitors MAY NOT use the blackboard when delivering presentations.
8. If teams are unsure about rules or require further clarification, please ask one of the organisers. Volunteers may be able to assist, but in the event of discrepancies between volunteers and organisers, the organisers' opinion will be followed.
9. Time remaining in the competition will be announced to competitors at the 2 hour, 1 hour, 30 minute and 10 minute marks.
10. Keep work stations clean. Tidy up at the end. Failure to do so will result in marks deducted from your presentation score.

**THEME**

The theme of the Junior Team Design competition is "A Turn in Manufacturing".

**SCENARIO**

Working in a 24/7 manufacturing facility, it is critical that downtime is minimized. This is because every minute lost corresponds to a tremendous loss in product output and profits. As a manufacturing/reliability engineer, one is responsible for the continued efficiency, speed and availability of the equipment and processes. The ultimate goal is to develop a system, which corrects and prevents issues before they actually occur, as opposed to simply reacting.

Most manufacturing processes function in a linear fashion, where every step can act as a bottleneck. Identifying critical and reoccurring bad actors is one of the crucial components to mitigating downtime. Maintenance procedures, improvements and spare parts' lists can then be created for this purpose.

**OBJECTIVE, REQUIREMENTS & CONSTRAINTS**

You have noticed that the 90-degree-turn conveyor has been consistently failing, and has been the main source of downtime on the production line. Therefore, your challenge is to design a new method of transporting the products from one conveyor to another, requiring a 90-degree turn, so that the current piece of equipment can be replaced.

The two conveyors are separated by a 90-degree turn with a radius of curvature of 20 cm. The product will come down the first conveyor and fall into your mechanism. Your design, once set up, must have no human interaction throughout the entirety of the transport to the second conveyor. The second conveyor's height is adjustable, so that the product can be delivered at a height of 20 cm, 10 cm or 1cm. More points will be awarded for using the higher conveyor positions. The product's orientation from the first conveyor must remain constant, as it will need to be oriented in the same direction in order to be packaged. Your design may be temporarily affixed to the test set-up, so long as removal of the prototype does not leave residue or otherwise damage the test set-up.

You will have a 4 hour time limit from the beginning of the build session to create a working prototype and a poster board for presentation. Entries that are received late will be disqualified. Prototypes and posters are due in the Orifice (CPH 1327) at the end of the build session. Each team has a budget of \$4000. Cost-effectiveness is an important objective.

After the build session, the teams will be required to present their solution to a panel of judges. Your team will use the poster board as an aid while presenting. Following this, you will have a maximum of three attempts to complete the challenge.

### **DELIVERABLES**

At the end of the design and build stage, each team is required to submit the following items:

1. A working prototype of the machine
2. A poster presentation as a visual aid

### **PROCEDURAL RULES**

The following rules must be followed during the design and build stages of the competition. Any teams in violation of these rules may be disqualified at the discretion of the WEC staff.

1. Teams have four (4) hours to complete the design and construction of their prototypes.
2. Teams are not allowed to leave the competition premises unless they have submitted their prototypes and presentations to the competition staff.
3. Laptops, phones, and other personal communication devices are not permitted.
4. Teams may only use materials that they purchase from the shop.
5. Provided tools may only be used to construct the prototype and may not be used as part of the prototype. The tools must be returned at the end of the design and build phase of the competition.
6. 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.
7. Purchase Requisition Forms at the shop are to be completed by WEC staff only.

### **PROTOTYPE TESTING RULES**

In the first 20 minutes of the design and build stage, the scenario setup is open to all teams to look at and take measurements. Afterwards, the scenario setup 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. There will be two setups available.

**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.

**PRESENTATIONS**

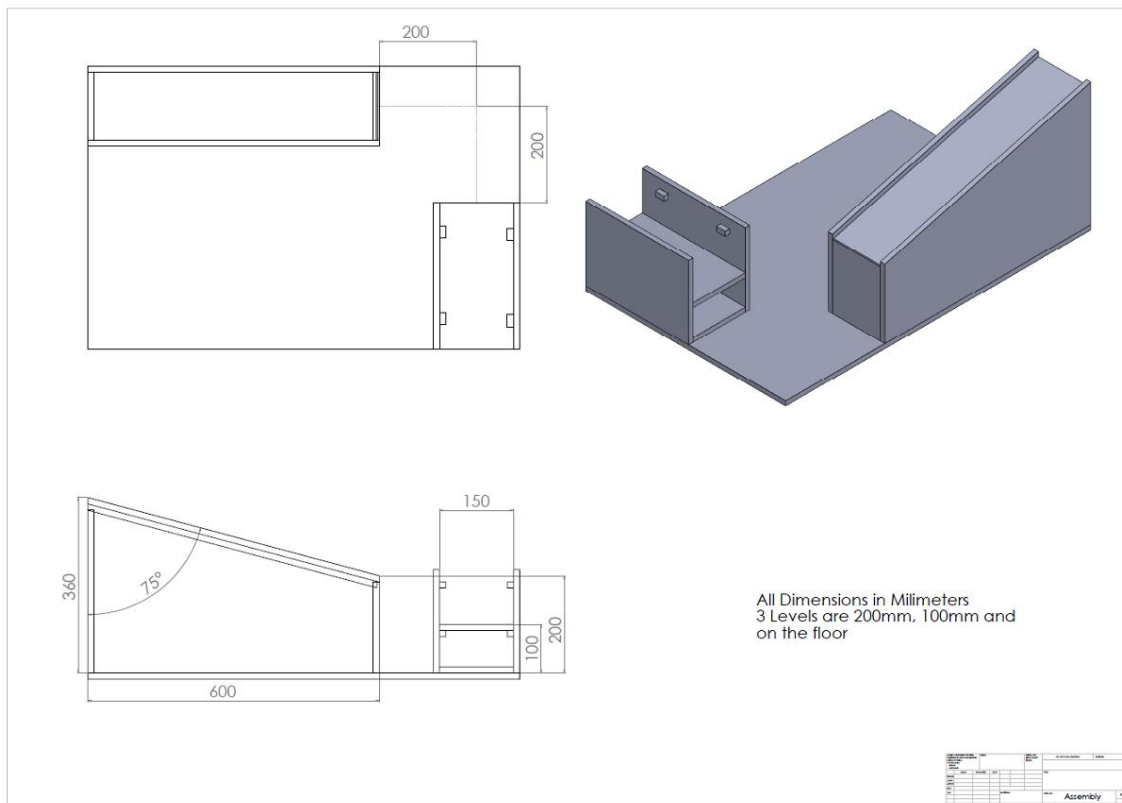
Teams will create and present a 6-8 minute presentation for a panel of judges. Order of the presentation and the rooms in which teams present will be determined randomly, and will be announced 30 minutes prior to the presentation start time. Teams will be permitted 5 minutes following the presentation in which judges and the general audience may ask questions. Testing of the prototype will be given a maximum amount of time of 5 minutes and will follow the question period. Parts of the presentation should be shared equally between the team members to score full points.

Because of numbers, teams will be divided into two rooms with two judge panels for initial judging. The top two teams in each room will perform a second presentation to all judges. From here, the judges will select the winning teams. The first place team will represent the University of Waterloo at the next Ontario Engineering Competition. In the event that the first place team is unable to attend, the second place team shall take their place.

**TESTING**

Due to the nature and scope of this scenario it is vital that a team's solution be successful during its first deployment. During the testing period, teams will have a total of 5 minutes to set up and complete their deployment. Teams will score full points if their device deploys successfully during the first attempt and will lose 2.5% for every successive attempt as shown in the marking scheme.

**TEST SETUP**



**SCENARIO MEASUREMENTS**

Note: drawing is not to scale. All dimensions in millimetres.

**SHOP RULES**

1. A maximum of one (1) person per team may be in the shop at any time.
2. Building materials will be available for preview at the shop. Competitors may examine the materials, but are not allowed to leave the display table with unpaid materials.
3. Teams are allowed to take pictures of building materials with a camera, but not a cell phone.
4. Teams must purchase the quantity of items that they request. If a requested quantity is not available, the team may request a new quantity.
5. Teams must keep track of their purchases for their own records. The shop will keep track of the official purchase records. In the event that a team has lost track of their purchases, the team WILL NOT be told how much they have spent.
6. All sales are final. Be sure to verify purchased items and quantities before leaving the shop.
7. Teams may not trade building materials. Violation of this rule will result in immediate disqualification for both teams.
8. Please be courteous and professional to shop personnel. The shop reserves the right to refuse service to an individual who behaves unprofessionally.
9. The shop will close 30 minutes before the design and build stage ends.



**MATERIALS LIST**

<b>Construction Material</b>	<b>Unit Price</b>	<b>Limited Items</b>
Foam Sheets	15 /cm <sup>2</sup>	Rare
Foam Board	40/cm <sup>2</sup>	
Cardboard	30/cm <sup>2</sup>	
Paper Plates	20	
Pot Pie Pans	40	
Skewers	20	
Popsicle Sticks	15	
Toothpicks	10	
Plastic Spoon	30	
Plastic Fork	30	
Plastic Knife	30	
Straws	40	
Thumb Tacks	10	
Nails (assorted sizes)	20	
Zip Ties	30	
Steel Wire	40/cm	
Twine	20/cm	
String	10/cm	
Pipe cleaners	30	
Playdoh	30/ball	
Sponges	40	

<b>Motion</b>		
Wheels (2 + axle)	200	Rare
Styrofoam Cups	100	
Styrofoam Balls (2 sizes)	75	
Dowels (2 sizes)	60	

<b>Power</b>		
Mouse Traps	400	
Rat Traps	800	Rare
Elastics (assorted sizes)	50	
Springs (assorted sizes)	200	
Paper Clips	30	
Binder Clips (2 sizes)	100	
Clothes Pins	30	
Balloons	40	
Magnets	300	Rare

<b>Adhesives</b>		
Duct Tape	25/cm	
Masking Tape	20/cm	
Double Sided Tape	30 /cm	
Hot Glue Sticks	50	

**MARKING SCHEME**

The following marking scheme is specific to the Spring 2014 Junior Team Design competition and will be used by judges during presentation and demonstration.

<b>Design Creativity / Originality</b>	<b>15%</b>
<b>Practicality</b>	<b>5%</b>
<b>Performance</b>	<b>40%</b>
Delivers product to second conveyor at 20 cm	40%
Delivers product to second conveyor at 10 cm	30%
Delivers product to second conveyor at 1 cm	20%
Prototype does not move	- 50%†
Product does not remain in correct orientation	- 20%*
Prototype damages test setup	- 20%*
Number of failed attempts (n)	- 2.5% x n
<b>Presentation</b>	<b>35%</b>
Poster	10%
Quality & Flow	7%
Design Process	5%
Meet Constraints & Criteria	5%
Highlights & Usability	5%
Prototype Critique	3%
Cost: under 50% of budget	+ 2%*
Cost: every 10% over budget	- 2%*
<b>Teamwork</b>	<b>5%</b>
Workload distribution	3%
Team synergy	2%
Does not follow dress code	- 2%*
<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.

\* 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 contraption not being able to move constitutes as a design fail. Be sure to keep this in mind when competing at OEC, as the same rule applies but is not stated in the marking scheme.

**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: \_\_\_\_\_

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