

# UNVEIL PACKAGE



## WATER FILTRATION Engineering Idol 2010

Presented By: Professional Engineers Ontario  
Etobicoke Chapter

Sponsored by:



Kingsway  
Chapter  
of PEO



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## Introduction

The purpose of this document is to describe to you the elements of Engineering Idol. Do not be frustrated when you see a lack of specifics around how you should build your device or put your presentation together. If the answers were always known – there would not be a need for Engineers. Engineers tend to excel at projects when they get to define both what the solution will be and how it will be arrived at.

It is our hope that this exercise will give you an opportunity to experience the profession of Engineering.

## Your Role

Congratulations! You are a member of a talented, ambitious and innovative Engineering Team. You and the members of your team all work for an international Engineering Firm hoping to win the contract from a group of rich, but shrewd investors hoping to build a world class water treatment plant in the middle of a third world country.

The investors are holding a Trade Show at the Ontario Science Centre on March 6, 2010 and have invited 12 Engineering Firms such as yours to present their proposals. It is at the Trade Show that they will pick their Engineering firm for this project.

Your team realizes that successful Engineers in this field are innovative, communicate well, remain professional even when under pressure, are highly skilled and prioritize well. You have already figured out that you need to convince the investors that your team has what it takes to design and implement the best project. Although you will have the opportunity to present and test one of your prototypes at the competition day, it is the team that will win the competition, rather than the prototype itself.

## The Project

The project is designed to give you the opportunity to learn more about “Water Treatment”. Your team needs to research and learn the technical aspects of Water Purification. You need to consider the trade-offs associated with the different variables and build a plant representing your view of the best technology available.

You need to consider more than the plant itself. Consider who will be investing in your proposal and how you will make your design interesting to them. The investors will be spending a lot of money on this project and understandably they have many concerns about the project, the timeline and the budget. Consider how your presentation can be used to put their fears at ease – and choose your team.

## Water Treatment

The ability to deliver clean water to people in third world countries or in areas devastated by natural disasters is a difficult technical challenge especially when electricity is not available. Disinfection techniques work only when the water is sufficiently clear and void of particulates.

Filtering water is a major component in the Water Treatment process. Choosing the components and configuration of these plants are an important factor in making water usable in remote regions of the world.

## Bare Bones Requirements

This quickly lists the “deliverables” required by your team just to make sure you do not forget anything!:

1. Monday, January 15, 2010, your *list of team members* should pick their T-Shirt sizes and make sure they are ordered by sending the order form to Richard Weldon, P.Eng. at [Richard@CDWengineering.com](mailto:Richard@CDWengineering.com). Please see Appendix 1 for the order form.
2. Monday February 8, 2010, your team will submit a *Preliminary Report* to Mr. *Paul Short P.Eng, 84 Prennan Ave., Etobicoke, ON M9B 4C3* or [pshort@ryerson.ca](mailto:pshort@ryerson.ca). Appendix 2 gives an outline of what this report should contain. The report includes a sketch of your proposed design that you will attempt to build on competition day. The Preliminary Report allows our Technical Expert to confirm that all the teams are on the right track ahead of the competition day. If problems are detected, it gives the teams time to work through the issue to ensure everyone has a successful day at the competition.
3. Friday February 12, 2010, Teams receive final approval regarding their concept design package.

4. Arrive on time on Competition Day (Saturday, March 6, 2010) at the Ontario Science Centre Great Hall with your notes, team and water treatment plant design. Please see Appendix 4 to be sure you know how to get to the competition. Be prepared to talk to the judges about your project. There is no reason to get nervous about the Competition Day – it is our hope that everyone is looking forward to it! We are looking forward to meeting all of you and hearing about your projects. It is likely that each team will discover they approached the problem very differently from the other teams. This is the wonderful thing about Engineering – there are no wrong solutions – they are all innovations!
5. Each team is allowed to spend up to \$120 on materials for their Prototype. Bring a complete list of materials, receipts along with the reimbursement form in Appendix 5 on competition day. You will be reimbursed during the day. One cheque will be issued; be sure you know to whom the cheque should be made out to. Your supervisor is required to sign off on the Materials and Cost Sheet to both ensure it is accurate and to verify the math is correct (we will not have much time to check this during the competition!).

## The Investors

The investors, at first glance, appear to have more money than sense. Do not let this fool you. While the investors are not experts in water treatment or environmental issues, they are smart people and self-educate themselves ahead of investing large sums of money.

They have been successful in implementing other large-scale engineering projects around the world and are familiar with problems that can arise. For instance, they once picked the most impressive technical design for one of their projects that ended up costing too much. Another time, something went wrong and the project took twice as long to build as was expected! One of their projects was built on time and within budget, but the plant cost a ton of money every year in maintenance.

One thing they have learned well is that good engineering is more than the initial design. Constructability, maintenance – and other factors you many want to point out – are all important considerations when investing large sums of money in new and innovating Engineering projects.

As far as water treatment is concerned, they understand that water purity and capacity (flow rate) is a big factor in designing the plant. They have heard about pressure drop, but are not clear how that relates to a water treatment plant. You will need to help them with the concept of filtration and pressure drop.

## The Judges

The investors have solicited the help of 5 technical experts in the field of Water Treatment to help evaluate the submissions of the teams. All five of these experts have built an impressive career in the field of Environmental Science. Being entrants into the field of Water Treatment technology, you and the members of your team are all very respectful of their accomplishments and realize the wealth of knowledge available through their acquaintance.

## The Judging Criteria

Each project will be evaluated by the panel of 5 judges according to the following criteria: scientific thought, originality, skill, team cohesiveness, written report and oral presentation. Greatest emphasis will be placed on scientific thought and an understanding rather than the attractiveness of the design itself. The judges will be assessing the planning and execution of the project as well as how well the student team worked together to achieve their goal. The testing of your Water Treatment Plant prototype will form part of the evaluation under “skill”.

We are allowing the judges the luxury of a jury-style deliberation. Their conversations and final deliberations will be left known only to themselves. Teams should not expect a detailed ‘mark’ for each element of the judging criteria.

We have asked the judges to appoint among themselves a commentator who will provide feedback for each team to be received at a later date. The feedback will be a summary of the judges’ comments of the teams’ strengths and weaknesses will be forwarded to the schools after the event. It is our hope that each of the teams will find the feedback useful.

## Building Your Prototype

The building of your prototype gives you the opportunity to demonstrate some of what your team has learned about Water Treatment technology. On competition day, you will be required to assemble your Prototype at the Trade Fair. You are expected to bring your materials prepared for assembly along with your list of materials and receipts with the form in Appendix 5.

Basic hand tools and power tools will be available at the competition day. Please refer to Appendix 10 for details.

The investors require a water treatment plant capable of processing 10,000 litres per day to satisfy the requirements of the villages they hope to service. Your team, however, is not required to build a plant this big! Your job is to provide a smaller scale prototype of your technology at the Trade Show taking the following into account:

### **Plant Specifications**

Your prototype should demonstrate the ability to clean water from approximately 20 NTU down to 1 NTU (Nephelometric Turbidity Units) or less. At these levels, the water can then be further sanitized and deemed safe for the population – your job is to provide the plant required to provide the particulate purification only.

The plant should be designed to remove particulates of the range from 1 - 180 microns. The distribution of particulate sizes is expected to vary, however, the design distribution is given in Appendix 11.

The plant must be operated by gravity only. No power is available for the operation of your plant.

Because the plant will be operating in remote locations, a preference is given to plants using recyclable, biodegradable and natural materials. *Media* is the term used to refer to describe the filtering component that may be used in the Water Treatment Plant.

*Commercially available or synthetic media specifically designed for water filtration purposes cannot be used. If you have questions whether your media is classified as commercially available or synthetic, please contact Paul Short, P.Eng. at pshort@ryerson.ca for immediate clarification.*

### **Physical Limitations**

The plant can be any shape or size – as long as it meets the process requirements given above.

Your prototype, however, must be suitable for the conditions of the trade show and, therefore, must follow the following constraints. Please refer to the dimensional drawings in Appendix 9 to ensure your unit complies with space limits of the testing station.

The prototype must be free standing (be able to stand on its own) and fit on a 600mm x 600 mm (2' x 2') test table and will be less than a total height of 1m (3').

The prototype must be suitable for the test apparatus by having a 3/4" outside diameter (OD) sample nozzle (spigot) attached to the bottom of the prototype for sample collection. See Appendix 6 for important details regarding the design of the spigot placement. (Spigot to be supplied by Engineering Idol).

The horizontal inside dimensions of your prototype cannot exceed an area of 42,000 mm<sup>2</sup> (64in<sup>2</sup>). For instance, a circular cross section of 230 mm (9in) or less is acceptable, as is a square cross section of 205 mm (8in). Any other shape meeting this area limitation is permitted.

The Prototype must be designed to hold 4 litres of testing liquid in the container, above the filtration media, so that none spills out when it is poured in quickly.

### ***Preparation of the Media***

Teams are encouraged to think about the preparation and pre-conditioning of their media materials ahead of the Prototype testing on Competition Day.

Each team will have 4 litres of clean water at the Competition Day to evaluate and correct any deficiencies of their unit, and for flushing before the testing, if needed.

Media requiring more intensive treatment than the rinsing with 4 litres of clean water is expected to arrive Pre-Conditioned at the competition.

### ***Testing Details of the Prototype***

Teams are reminded that the testing of the Prototype is only one component of the overall Engineering Idol competition. The Prototype test is part of the 'skill' component of the overall judging criteria.

It is recognized that each team is presenting a small version of their overall Water Treatment Plant design. It is conceivable that teams will present different capacities of the overall Plant and the purpose of the testing details is to take this into account. For example, one team may test a unit showing very high flow rates (and high cost) relative to a team showing a low flow rate (and low cost).

*Testing Procedure: 500 ml of water will be collected from the spigot of your device+.*

Timing will start once the first drop appears from the spigot (not when the test water is poured in). Sizes of Prototypes are expected to vary from team to team, but a reasonably sized unit would pass 500 ml in 10 minutes. This water will be thoroughly stirred and a small sample taken for testing in a precise optical device.

*+ After 15 minutes, a full 500 ml has not been collected, the testing will stop and the flowrate determined based on the actual test volume of water collected over 15 minutes.*

The following measurements will be conducted as part of the test:

*Efficacy:* 4 litres of turbid water mixed to 15 - 25 NTU will be poured into the Water Treatment Plant prototype. The resulting purity will be measured to see if the plant meets, exceeds or fails to meet the target purity of 1 NTU

*Flowrate:* the rate of flow through the Water Treatment Plant will be measured by the Testing Technician.

*Materials Selection:* natural, recyclable and biodegradable materials are preferred

*Design:* compact designs are preferred

*Media Cost:* the cost per unit of media will be considered

*Factored Cost of Media:* the cost of the media, together with the measured flow rate will be used to determine the Factored Cost of Media. See Appendix 7 for details regarding this evaluation in the Preliminary Testing Sheet.

*Ratioed Performance:* it is recognized that both flow rate and clarity are possibly opposing measures of unit performance. Units will be graded on performance by calculating the ratio:

**flow rate (litres/minute) / NTU rating**

Note that the NTU figure is in the denominator -- this gives clarity priority over flow capacity in the overall performance indicator.

*The astute team will notice the dilemma of this challenge: a high Ratioed Performance value would indicate a highly effective unit. The Factored Cost of Media measure then balances this technical success against the economic practicalities of the design itself.*

Coarse Grade Arizona Road Dust will be used to cause turbidity in the test sample. Despite its name, this is a scientifically formulated material used professionally throughout North America to test water filtration systems.

## ***Pre-Testing Your Prototype & Spigot Supply***

During the week of February 8<sup>th</sup> a package will arrive at your school via courier or other means. This package will contain the following:

- the spigot that you will use on Competition Day (do not forget to bring it with you).
- Enough Coarse Grade Arizona Road Dust (1-180 micron) for approximately 4 to 6 test runs of your unit,
- Recipe for mixing the Coarse Grade Arizona Road Dust with water, which will produce test water of approximately 20 NTU. On Competition Day, identical mixing portions will be used for testing.

## **The Competition Day**

The competition day will be from about 9 a.m. to 4:30 p.m. on Saturday March 6, 2010 at the Ontario Science Centre (location given in Appendix 4). Members of PEO (Professional Engineers Ontario), many visitors to the Ontario Science Centre and local politicians will be in attendance. You are welcome to invite friends and family; however, they should realize you will be busy building your Prototype until about noon. You will be given a lunch voucher to buy your lunch at the Ontario Science Centre Cafeteria.

Parking and entrance to the Science Centre will be complimentary for participants. Family and friends, however, will have to pay regular admission and parking.

The judges will arrive after the competition day gets going. They will be interacting with the teams during the building of the prototype.

The details of the agenda may change between now and March 6<sup>th</sup>, however, the day will look similar to that listed in Appendix 8.

Participant parking will be in Parking Lot A and will be free of charge. You are to enter via the main entrance of the OSC and follow the signs to the Great Hall. Adjacent to the Hall is the Imperial Oil Auditorium.

## **Presentations**

There is only one rule with respect to the team presentations – all team members need to participate.

Please feel free to design your own 4 – 5 minute presentation in a form that best suits the personality of your team and demonstrates the robustness of its technical evaluation and prototype design. A laptop and data projector will be available at the competition day.

If making a Power Point presentation, refer to Appendix 3 to make sure your file format will be compatible with the OSC system.

Be sure to bring a USB (memory stick) to transfer your final version of your presentation to the OSC computer at the competition. Make sure there is only 1 file on the USB when it is given to OSC to ensure the correct version of your presentation is loaded.

## Safety

Your school’s Supervising Teacher or Volunteer should be expected to help with keeping the building and testing of the Water Treatment Plants safe during competition day.

Your adherence to all safety precautions implemented by the testing engineer is both appreciated and expected.

## Questions

Our Technical Expert is available to answer questions (within reason) by posting them on the message board at the following website.

<http://engidol2010.websitetoolbox.com/>

The preference is for questions to be posted on the message board so that there is an opportunity for everyone to learn. However, if your team considers the question to be one that may offer your team a competitive advantage and you wish to keep secret, then you may email our Technical Expert directly at [pshort@ryerson.ca](mailto:pshort@ryerson.ca). The header of your Email should start with “EIdol – School Name –“. **If** the technical expert feels the question can be made public on the message board, it will be posted along with the answer.

## Appendix 1: Team T-Shirt Form Due January 15, 2010

School Name: \_\_\_\_\_

Supervising Teacher/Volunteer: \_\_\_\_\_ Size \_\_\_\_\_

Please indicate Size beside each name as S – M – L – XL – XXL

Names of Students (4 – 6 in total)

1. \_\_\_\_\_ Size \_\_\_\_\_

2. \_\_\_\_\_ Size \_\_\_\_\_

3. \_\_\_\_\_ Size \_\_\_\_\_

4. \_\_\_\_\_ Size \_\_\_\_\_

5. \_\_\_\_\_ Size \_\_\_\_\_

6. \_\_\_\_\_ Size \_\_\_\_\_

Please return (on or before the due date) to:

Richard Weldon, P.Eng.  
4 Maydolph Road  
Etobicoke, ON  
M9B 1V8

OR

Richard@CDWEngineering.com

## **Appendix 2: Preliminary Report Template Due February 8, 2010 (2 PAGES MAX plus sketch)**

SCHOOL: \_\_\_\_\_

PROJECT TITLE: \_\_\_\_\_

PROJECT TEAM MEMBERS: NAMES / GRADE LEVEL

SUPERVISING TEACHER OR VOLUNTEER: \_\_\_\_\_

METHOD OF APPROACH: How team members were selected, how subject was researched, how responsibility was assigned, etc.

RESEARCH REFERENCE SOURCES: Internet, books, standards, manuals, etc.

COMPARISON OF GRAVITY FED WATER FILTERING VS TWO OTHER WATER PURIFYING METHODS (5 bullets for each):

PROJECT CHALLENGES:

COMMENTS / SUGGESTIONS:

\*\* Attach a sketch showing your proposed Water Treatment Device along with a preliminary list of materials and their costs (Appendix 5 form) for the Prototype you plan to build on Competition Day.

SIGNATURE: \_\_\_\_\_  
SUPERVISING TEACHER OR VOLUNTEER

DATE SUBMITTED: \_\_\_\_\_

## Appendix 3: Presentation Format

If making a Power Point presentation, presentations are to be submitted on USB Memory Sticks using MS PowerPoint 97 - 03.

You are also required to bring a backed up copy of the presentation on a Compact Disk.

Any inserted photographs in the presentation should be a minimum of 1.2 Megapixels, as the display screen is quite large.

Submit only one final version file on the USB to avoid the possibility of the incorrect version being used for the presentation.

## Appendix 4: The Location for Competition Day The Ontario Science Centre

**By Car:** Take the Don Valley Parkway north until Don Mills Road north and then follow the signs!

From the north, take Highway 401 or 404 until you reach the Don Valley Parkway south. Continue south until Wynford Drive, then head west and follow the signs!

**By TTC:** Take the Yonge Street subway line north to the Eglinton station and transfer to the Eglinton East (route 34) bus. Get off at Don Mills Road.

Or, take the Bloor-Danforth subway line east to the Pape station and transfer to the Don Mills (route 25) bus. Get off at St. Dennis Drive, right in front of the Science Centre.



The Ontario Science Centre is at 770 Don Mills Road (at the corner of Eglinton Avenue East) in Toronto. Telephone: **416-696-1000 (toll free: 1-888-696-1110)**

Parking at the Ontario Science Centre is \$8.00 per vehicle and is cash only. If you arrive before 8:30 AM, parking is FREE! Take public transit and you'll not only save on the parking, you'll help save the environment, too!



## Appendix 6: Spigot (Sample Nozzle) Details



Spigot Details

1- Drill 19mm (.75 in) hole in the bottom of your container for the spigot

2- Rubber Sealing Washer is on the outside of tank

## Appendix 7: Test Sheet – Preliminary +

Team Name: \_\_\_\_\_

Exit Turbidity: \_\_\_\_\_

Flow Rate: \_\_\_\_\_

Media Cost: \_\_\_\_\_

Factored Cost of Media\*: \_\_\_\_\_

Ratioed Performance\*\* : \_\_\_\_\_

Comments regarding compactness, budget and materials used:

\*Factored Cost of Media Example:

Required Flowrate: 10,000 L per day  
Prototype Flowrate: 350 ml per  
minute or 500 L per day  
Team Media Cost for Prototype: \$10

Factored Cost of Media:

$$\frac{10,000 \text{ L/day} * \$10}{500 \text{ L/day}} = \$200$$

Ratioed Performance \*\*

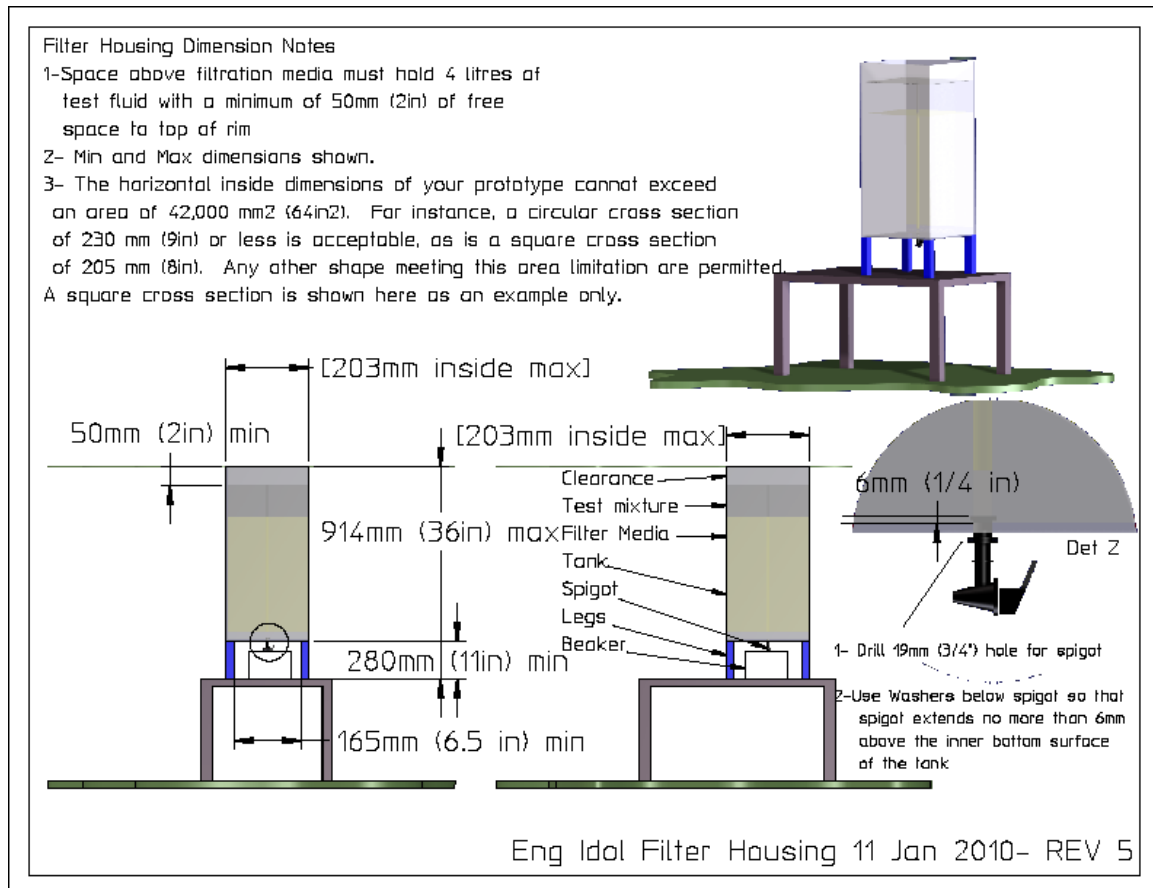
flow rate (litres/minute) / NTU rating

+ Test sheet may change on Competition Day

## Appendix 8: Timetable for Competition Day

- 8:30 a.m. Registration and T-Shirt Distribution
- 9:00 a.m. Event Kick off in Great Hall.
- 9:15 a.m. Students begin building Water Treatment Plant in Great Hall
- 10:00 a.m. Judges arrive and discuss projects with engineering teams. OACETT President welcomes participants and public
- 12:00 a.m. Lunch and Students prepare for their presentations
- 1:00 p.m. Testing and presentations start in Auditorium – two teams on stage at a time. Allow 6 minutes per presentation and 15 - 20 minutes for the test (concurrently).
- 3:00 p.m. Judges will begin deliberations.
- 3:05 Guests and participants exit the auditorium while judges deliberate. Teams proceed to their workstations and discuss their design with the public.
- 3:45 p.m. PEO President addresses audience; Etobicoke Chapter PEO awards scholarships to last year's participants in the Great Hall.
- 4:00 p.m. Judges announce winners in the Great Hall
- 4:10 p.m. Closing Ceremonies in Great Hall by a special guest speaker
- 4:20 p.m. Final Photos
- 4:30 p.m. End of Event

## Appendix 9: Prototype Dimensions



## Appendix 10: List of Tools Available on Competition Day

There will be a central tool table for your use. Available tools will include:

- wood saws (also usable for plastics) and metal hacksaws
- knives
- metal hand shears
- tape measures and set squares
- an electric drill with bits (metallic, plastic and wood) to drill the required hole into the bottom of your team's container. A supervisor will oversee the usage of all power tools.

You may bring simple hand tools such as scissors, screwdrivers, etc. You may request that additional tools be provided, by contacting Richard Weldon (below) before March 3, 2010.

*Safety is paramount. Please do not bring any power tools without first receiving permission from Richard Weldon (below). Such tools must only be used at the Tool Table, under supervision and in compliance with the competition day safety rules.*

*Richard Weldon at [Richard@CDWengineering.com](mailto:Richard@CDWengineering.com)*

## Appendix 11: Particle Distribution of Coarse Grade Arizona Road Dust

Typical particulate distribution for Coarse Grade Arizona Road Dust:

- < 5.5 microns = 13%
- < 11 microns = 24%
- < 22 microns = 37%
- < 44 microns = 56%
- < 88 microns = 84%
- < 176 microns = 100%