# Challenges Spring 2009

## Challenges Spring 2009

Team Leader: Nicole Ceci

# Automated Design Tool

## Design Spring 2009 Challenges

This team is responsible for maintaining and upgrading the automated design tool and for delivering AguaClara plant designs to implementation partners. This team will need to expand this semester.

### Subteam Leader: Sara Schwetschenau

### Number of team members needed: 5

Additional for spring 2009: 3

### Important team member skills:

CEE 3310 or equivalent Fluid Dynamics course
CEE 4540 co or prerequisite
Student must be comfortable with coding

### Challenges

- Create an organized method of handling multiple designs so that we don't have the confusion of not knowing what design assumptions correspond to the different facilities that are being designed. Perhaps zip all the files to make a package that can easily be downloaded for review. Include ALL of the associated design files so that as design algorithms evolve it will still be possible to see the designs of each facility. If possible make the design files available from the wiki page where the project sites are listed.
- Document the designs of the existing facilities (as built) in a table format.
- Integrate lessons learned during the construction of the Cuatro Comunidades plant into the design and AutoCAD code.
- Add construction details including ledge that supports the plate settlers, inlet manifold plates, sludge drain channel, sludge drain plates, sedimentation tank inlet drop tubes, inlet channel port covers, etc.
- Draw the sedimentation tank so that it is possible to see order of construction. Begin with the rectangular tank, and then fill in the additional items (bottom slopes containing sludge channel, drop tubes, sludge weir, sludge port plates, manifold sloped plates).
- Create several series of plant designs to illustrate how the designs vary as a function of flow rate and design assumptions. Post these designs on the wiki.
- Flocculation program: include the Energy Dissipation Approach (eliminate G as a design parameter) and draw the baffles correctly for different numbers of flocculator channels.
- Sedimentation inlet manifold program
    - Allow user to specify width of the plates used to create the manifold. Use the width of the plates to set the port spacing. Eliminate the dimensionless ratio of the port width to the port spacing.
    - Check the manifold design algorithm assumptions. Specifically the method of incorporating the pressure recovery term may be incorrect. It might be beneficial to create a full model of the flow out of each port and compare those results with the analytical model for the ratio of the flow between max and min flow ports.
    - Correct arbitrary assumptions - 1/3 velocity factor, Square ports, Distance between ports.
    - Check for reasonable values
- Update the Variable Naming Guide
- Check AutoCAD dimensions
    - H.SedRectangle > B.Port Check to be added to Sedimentation Slopes Program
- Add pictures to programs pages
- Group related objects in AutoCAD to make manipulation of the drawings easier (plate settlers, baffles, inlet manifold plates, etc.)
- Work with potential new partners to deliver detailed designs based on their specifications.

# Research

## Pilot Plant Spring 2009 Challenges

### Number of team members needed: 3 returning and 1-2 new members

### Important team member skills:

Returning Members
Familiarity with AguaClara Project
CEE 4540

It would be helpful to have a "handy" person on the team that feels comfortable using power tools.

## Challenges

### Floc Tank

- Use process controller to increment through a series of alum doses in order to find the optimal alum dose for a particular raw water turbidity. Perform this experiment routinely when the turbidity changes significantly.
- Learn to identify symptoms of over and under dosing of alum
- Compare uniform and non-uniform baffle configuration results from the flocculation tank with both low and high raw water turbidity

### FReTA

- Lower the tube flocculator elevation so that water from the flocculator tank will flow through the tube flocculator by gravity
- Set up FReTA
- Use FReTA to measure settling velocities of samples from the tube flocculator, pilot plant flocculator and also from samples taken from the CUWFP flocculator
- Compare sedimentation rates and residual turbidity readings from the Pilot Plant flocculator, the laboratory tube flocculator, the pilot plant tube flocculator, and the CUWFP flocculator
- Assess which flocculator will produce the lowest turbidity settled water

### Sed Tank (possibly put this project on hold due to the dependency on the consistent performance of the pilot plant flocculator)

- How long does it take to form a sludge blanket at different raw water turbidities?
- What is the optimal upflow velocity through the floc blanket? Compare with the results of laboratory studies by Matt Hurst. For these studies keep the tube settler capture velocity at 10 m/day.

# Plate Settler Spacing Spring 2009 Challenges

## Subteam Leader: Sarah Long/Colette Kopon

## Number of team members needed: max 3

## Important team member skills:

- Fluid Dynamics background

## Challenges

### System

- Make the system more robust
  1. Improve the tube settler connection
  2. Stabilize the tube flocculators

### Experiments

- Jet dissipation - Run experiments using a mesh with 1 cm diameter holes to determine if the mesh causes the floc blanket to form more rapidly
- Tube spacings

1. Vary flow rates with each tube size using process controller
2. Vary Floc blanket height
3. Vary alum dosage

- Develop some sort of video recording system to monitor floc blanket growth
- Work with Cameron to develop a floc blanket height detector
- Design a floc weir that can be used to maintain the floc blanket height to reduce the required wasting rate.

# Chemical Doser Spring 2009 Challenges

The Chemical Doser team will be responsible for the integration of the three technologies that form the dose controller (Flow Measurement, Flow Controller, and the float and lever system used to couple the two).

## Subteam Leader: unknown

## Number of team members needed: 3

## Important team member skills:

- Familiar with AguaClara project
- Comfortable with MathCAD
- Willing to put in extra time to learn how flow controller and linear flow orifice meter (LFOM) work
- Communication skills to work with the team in Honduras to implement the dose controller

### Challenges

- Create more comprehensive MathCAD program to design and model CD performance
- Find out (based on experiments) how small the chem doser vertical drop tubing can be before the open channel flow or free fall fails
- Create a robust algorithm for float sizing
- Develop methods for dosing with the CD when not next to the entrance tank (can use a small float tank that is connected hydraulically to the entrance tank or a pulley system)
- Work with the team in Honduras (and potentially UNAH students) to get the prototype in Tamara working
- Design a dose controller that will work for chemical flow rates in excess of 400 mL/min. This design is needed for the Gracias plant. This dose controller will use orifice flow in the entrance tank flow meter and in the flow controller.
- Last semester a point of failure experiment was conducted on the LFOM. The results were contrary to the expected hypothesis. Instead of the LFOM working to a certain flow rate and then failing the flow rates were linear with depth but with a different slope than the predicted values. Information is available on the experiment page. We now suspect that if the pipe is sized too small to accommodate the flow rate which the orifice pattern is designed to deliver then the LFOM will fail for all flow rates. This hypothesis could be easily tested by using the momentum approach to determine the maximum flow rate out of the bottom of the LFOM for all water depths. This hypothesis should be tested by doing the analysis in MathCAD. This should be a trivial extension of the design challenge in 4540.
- Write an article for Journal of Water Supply: Research and Technology-AQUA documenting the design and performance of the dose controller. See the article on the Flow Controller as an example. The paper should document the design algorithm for the LFOM. Ideally the paper would include design guidelines for dose controllers in the flow range up to 400 mL/min and in the next larger flow range where orifice flow will be appropriate.

## Floating Floc Spring 2009 Challenges

This team should add an experimental component to first replicate the floating floc problem and then test methods to eliminate them. The laboratory research will be a new strong focus for the spring semester.

### Subteam Leader: Tiffany McClaskey

### Number of team members needed: 3 total

### Important team member skills:

- Laboratory experience
- Programming in MathCAD
- CEE 3310 or equivalent

### Experimental Challenges

The first step is to replicate the problem that is occurring at Tamara and Marcala and then devise a method to solve the problem. Given that we are confident that the problem is due to excessive dissolved oxygen, it would be possible to immediately begin research on methods to strip excess oxygen from the water and use dissolved oxygen probes (available in the Environmental Teaching Lab) to measure the effectiveness of the oxygen stripping methods. This simple method of measuring the air stripping methods should be started before beginning on the more complicated method of actually creating floating flocs.

- Design a laboratory setup to create floating flocs
    - High pressure aeration to create water supersaturated with oxygen
    - Hydraulic flocculation
    - Sedimentation could be conventional horizontal flow to easily illustrate the problem of floating flocs
- Test various methods to strip excess air from the water to eliminate floating flocs
    - Sub atmospheric pressure aeration using either a high velocity zone or more likely, a zone that is above the hydraulic grade line.
    - Atmospheric aeration
    - Bubble flotation zone to release the bubbles prior to adding coagulant to prevent entrainment of the bubbles in the flocs.

### Modeling Challenges

- Review program and make sure everything is correct. Especially look into the head loss calculations
- Determine the optimal hole size, number of holes, length of pipe and diameter of pipe
- Give the numbers to the guys in Honduras and have them try it
- If it works calculate fittings for any other plants having this issue, if it doesn't choose a different set up and try again

## CFD 3D Floc Tank Simulation Spring 2009 Challenges

### Subteam Leader: Unknown

### Number of team members needed: 2

### Important team member skills:

- Comfortable with coding;
- Basic knowledge of fluid mechanics;

### Challenges

- Appropriate mesh in 3D
    - Mesh interval size and boundary layers
    - Validate: Check grid convergence, etc.
- Define the model in FLUENT
    - Turbulence model and other parameters
- Validation of the model
    - Numerical stability: convergence, accuracy
    - Compare with experimental data: find similar flows and related experimental data (free/confined jets, back step,etc. )
    - Compare with 2D model: verify the assumptions and validity
- Automation of mesh generation and FLUENT setup
- Data/Parameter analysis and recommendations
    - Recognize important variables and parameters
    - Write user defined functions to extract analysis data
    - Investigate the performance of different geometry

# Outreach

## Outreach Spring 2009 Challenges

### Subteam Leader: Unknown

### Number of team member needed: As many as possible

If more than 5 people join, subteams should be created

### Important team member skills:

- At least one returning Outreach team member
- Experience with AguaClara is helpful, but this is a good team for new members
- Communication
- Graphic design
- Grant writing

## wiki updating

- Update the top level wiki pages to reflect the current state of the project.
- Coordinate translation to Spanish with Leopoldo Rodriguez (mailto: leoaryroar@hotmail.com)

### Challenges

#### Fundraising

Overview: In the Spring 2008 the Outreach team worked to make contacts to develop relationships for future funding and potential partners. The Fall 2008 Team took the opposite approach and devoted much effort toward applying for grants and creating the materials that would make it easier. The next Outreach Team needs to go back and reach out to the contacts made last spring through presentations, newsletters, and any other applicable means you feel would be effective. In the future we hope that communities will be able to outright buy an AguaClara plant based on their affordability. Until that day comes we rely on grants and donations to see us through. It has also been proposed that microfinance partnerships could benefit us, although it seems that it would be a direction that needs to be well research and thoroughly planned before implementation could occur. (See Business Team below.

Fundraising challenges:

1. Plan events to present to Alumni (Reunion, Cornell Clubs?)
2. Apply for some grants: search for foundations that share our goals and then contact them to discuss the possibility of gaining their support
3. Write an update to thank donors who supported the Cuatro Comunidades plant when the plant comes online (expected mid February)
4. Raise funds for Agalteca plant in coordination with the team in Honduras

#### Publicity

Overview: Publicity ties in with both our fundraising and recruitment efforts. Our current awareness initiatives include the conferences we attend, the fliers, brochures, and posters we create, and the presentations we give. Awareness challenges include those that we already do, but a few new ones have been suggested.

Publicity Challenges:

1. Update brochure about the project and keep a constant supply in rack next to the engineering admissions office.

2. Work with Anne Ju (Cornell Chronicle writer) to create new stories on the AguaClara project
3. Write a blurb and submit it for inclusion in the Water Advocates listserve
4. Follow up with and maintain contact with organizations and contacts from both D.C. trips in Spring 2008
5. Continue with AguaClara newsletter using the Google Group on an every 3 month schedule
    a. Update AguaClara Alumni to include grads from last semester
    b. In the future ask students if they wish to be on the list serve for the newsletter.
6. Finish the Demo Plant Instructions Manual, laminate for the suitcase, and make available on the wiki
7. ESW Conference scheduled for Fall 2009, keep an eye out for any new deadlines or correspondence
8. Lesson plan for local schools present about Honduras/water/AguaClara at local schools
9. Organize trips/events for team members to publicize the project

## Recruitment

Overview: Recruitment initiatives continue to be based on Presentations to freshmen's Intro 1050 Classes. Other initiatives have included attempting to get CEE 2550 cross listed, so more non-engineering majors might enroll, but hasn't proceeded very far. Assess what is required to get students from other disciplines into the project. The goal is to recruit students interested in graphic design, communication, education, and business.

Recruitment Challenges:

1. Organize ENGRG 1050 presentations, host meetings open to class to go over using the demo plant and the presentation aka training for 1050 presentations

## Business Team?

If there is interest in creating a separate business team, it could be 2-3 members. Tasks (suggested by last spring team) could include:

1. Need to decide grants/microfinance
2. Microfinance proposal with help from someone with business experience (there is interest in a revolving low interest loan to make it possible for communities to self finance the water treatment plants)
3. Better projections of global demand
4. Better generic public health statistics about the importance of water
5. Follow up on contacts made by Larry Harrington...lots of contacts so figure out a way to reach more of them
6. Contact Engineering firms/Government Agencies about the potential for partnerships.
7. Follow-up with SEA and figure out a strategy that can work for both groups to keep them involved