

This year's theme is "[Re]Fresh Our H₂O." High school student teams are invited to design technological solutions to address any problem facing humanity related to freshwater.

Program structure:

Each high school team is paired with PSU college student mentors. Mentors are trained by PSU staff and meet weekly with teams to help them conduct fieldwork, identify a problem that can be solved through design, and refine a solution by applying the engineering design process. Mentors will be matched with teams in December and meet weekly from January - early April 2016. All participating teams will convene at a final event in April where they will present their final projects before a panel of judges and audience of their peers.

Judging criteria:

At the final event, one team will be recognized as the top performer for the following categories:

- Scope and Depth
- Creativity
- Presentation
- Teamwork
- Technology Focus
- Human Impact.
- Audience Favorite - determined by a vote.

Important Dates

January 13, 2016 - Innovation Challenge kick-off at PSU, student waivers and MOUs are due

January 31, 2016 - Project proposals are due

February 28, 2016 - Fieldwork addendum is due

March 4, 2016 - Deadline for requesting prototype materials (plan on 2 - 5 days delivery)

April 1, 2016 - Team journals and posters are due

April 9, 2016 - Final event

LHS Team Members

- Colin Brock
- Alex Tees
- Laura Galle
- Andria Tattersfield
- Lang Ming
- Tristan Coffey
- Elaine Yang

LHS Coordinator

- Meg Kilmer, meg.kilmer@pps.net, 503.916.5200 ext 75419
- Office is in Counseling Center

PSU Mentors

- Melissa Preciado (civil engineering)
- Robert Sutton (mechanical engineering)

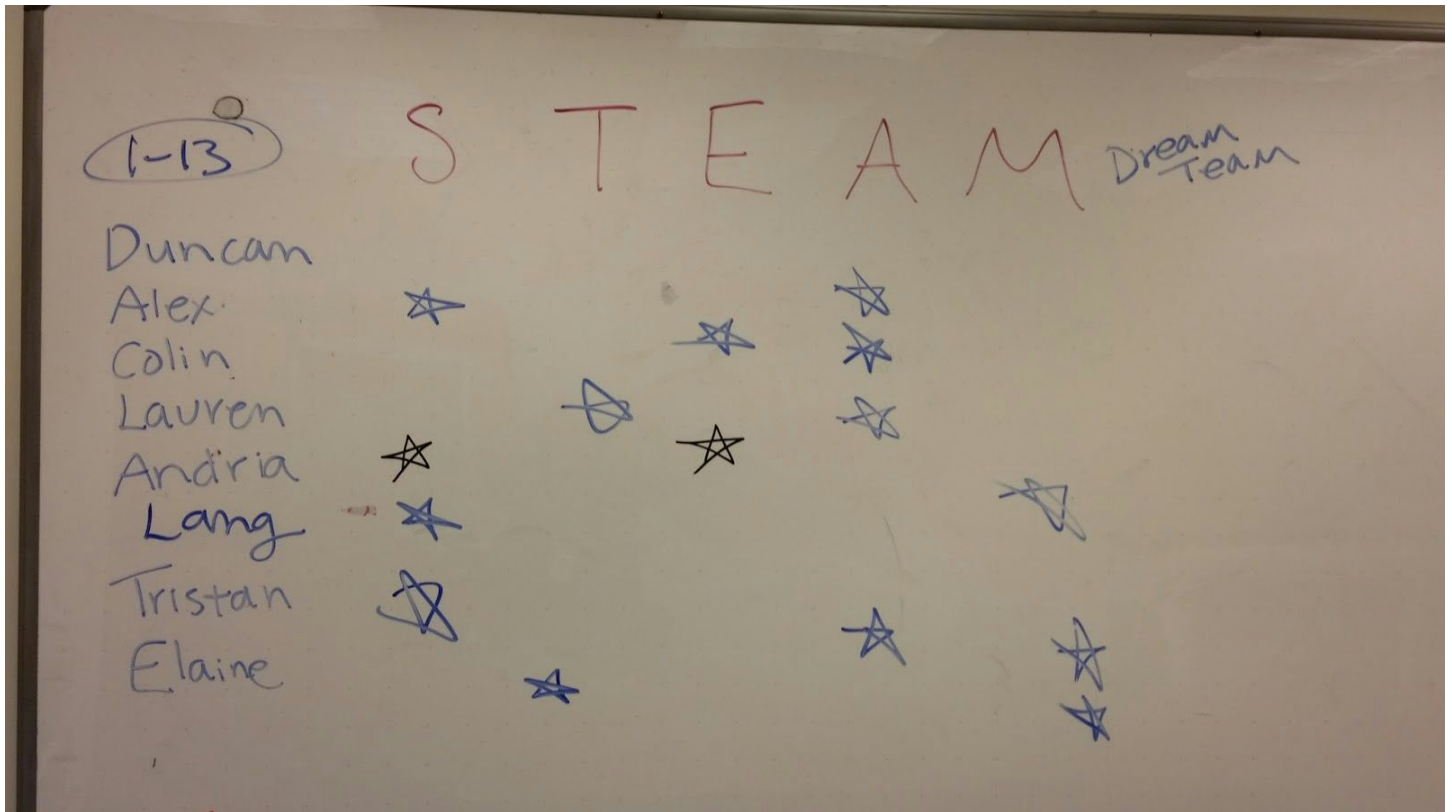
MEETING #1 December 16

Turned in participant waivers.

Agreed to meet on Wednesdays after school, acknowledging that sometimes people will have conflicts.

We could have weekend sessions in the prototyping lab at PSU too.

Meg asked everyone to identify their STEAM strengths:



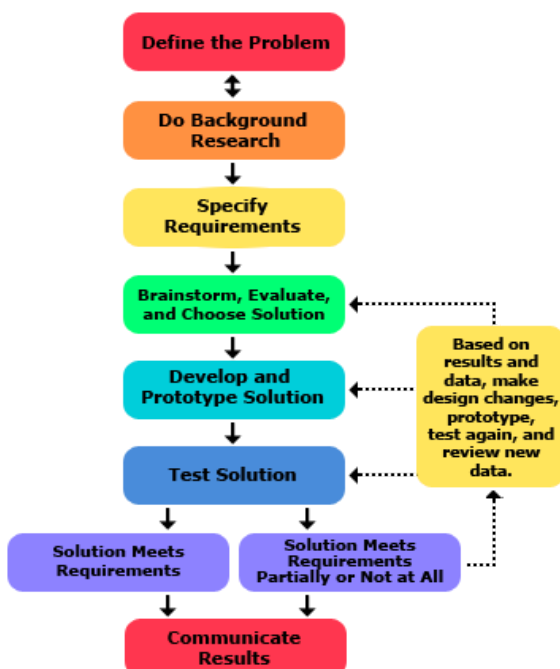
Diversity in talent will make us a strong team!

- **Proposed next meeting:** Wed January 6 (**FAIL!** After snow days on 1/4 -5, Meg totally forgot students were coming. Hey, it felt like a Monday!)
- **PSU Kickoff:** Wed January 13
 - Meet outside of Counseling Center and walk to PSU together or
 - since it is an Early Release Day, go home and then meet the group at University Pointe on the PSU Campus (on SW College, between 4th & 5th....right on the MAX line). See map on next page or visit <http://map.pdx.edu/#/map?zoom=17&lat=45.5112589&lng=-122.6838359&b=road&l=>



- Meeting with Melissa and Robb, January 12:
 - Engineering Design Process link: <http://web.cecs.pdx.edu/~far/me491/index.html>
 - When you click the link you will find the document link roughly half-way down the page.
 - Sample Meeting Agenda link: <http://web.cecs.pdx.edu/~far/me492/Index.htm>
 - When you click the link look for the Sample Meeting Agenda Trash Trolley link.
 - IDEO video on YouTube:
 - <https://www.youtube.com/watch?v=M66ZU2PClcm>

****Both of the links will download as a word document** We can fill it out on a printed out copy or just edit and save the Word Document if that's easiest--whatever you prefer.****



ENGINEERING DESIGN PROCESS

JANUARY 20 AGENDA

Everyone Report on their research

Vote on Options to Narrow

Learn Everyone's Name

Fun & Food

1/20/2016 ATTENDANCE

Acidic Andria

Tired Tristan

Chill Colin

Longitudinal Lang

EXTREME Elaine

Lovely Lauren

Marvelous Melissa

○

TOPICS DISCUSSED WED Jan 20th:

Notes on Freshwater (Lauren):

- I found this interesting TED talk by Peter Diamandis (mentions water at 8:50)

https://www.ted.com/talks/peter_diamandis_abundance_is_our_future?language=en#t-518538

- He discusses how 70% of our Earth is made up of water (mostly salt water or ice), and we as humanity is fighting over half a percent of the water.
 - not a quantity problem but a distribution problem
- Diamandis then brings up Dean Kamen's "Slingshot"
 - Video on this below:

<https://www.youtube.com/watch?v=VOQbVD7F1f4>

- I found this video inspiring for our project because Kamen was able to turn absolutely any liquid into water with his portable device.
 - Most people are intimidated by the idea of desalination of water because of its large expense and immense amount of energy.
 - the "Slingshot" has found a way to significantly decrease the cost and energy needed to create clean drinking water by creating a closed energy loop where the water is boiled until it is turned into vapor. This vapor is recollected into water, and the impurities do not vaporize with it.
 - Although this idea had been thought of, the distribution problem has not been solved. Clean water is seeming like more of a possibility but it still needs to be transported to countries in need.
 - My thoughts on a possible solution would be to have some sort of device like a drone transport the filtration system to eliminate the need for people to be there and help run the device.

- How this would help-
 - Right now, women and children spend 125 million hours each day collecting water.
 - If they no longer have to worry about this, they could use their time more effectively by working and selling goods to stimulate the economy.
 - There would be a great positive social impact.

Possible Problems to Attack

Seismically sound/earthquake proof pipe (Portland/Willamette example)

<http://www.enr.com/articles/10662-water-pipeline-designed-to-surf-seismic-waves>

Earthquake-proof pipe

Water purification system

Small / micro hydropower problems

in Bangladesh: <http://www.hindawi.com/journals/isrn/2012/635396/>

in Nepal: http://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=4697&context=etd_theses

in rural India (paper downloaded on my laptop, I can send it out)

general problems:

- <http://www.hydroreform.org/policy/smallhydro>
- <http://www.scidev.net/global/water/opinion/small-hydro-could-add-up-to-big-damage-1.html>
- <http://www.alternative-energy-news.info/micro-hydro-power-pros-and-cons/>
- <http://oilprice.com/Alternative-Energy/Hydroelectric/Small-Hydropowers-Negative-Impact-On-The-Environment.html>

videos:

Desalination solution w/ reverse osmosis (Elaine):

<http://www.cnn.com/2014/09/23/living/newater-singapore/>

It first filters out microbes, and then uses reverse osmosis to further purify the water.

<http://www.earthmagazine.org/article/drinking-toilet-water-science-and-psychology-wastewater-recycling>

g

(Scroll down to the explanation of Singapore's solution)

Desalination:

This video explains how desalination works. https://www.youtube.com/watch?v=aVdWqbpbv_Y

Well website <http://pubs.usgs.gov/sir/2008/5059/>

Today's Ideas

- Desalination
- Durable pipe
- Small turbine
- Well

JANUARY 27

---> Note from Tristan

Hey guy its me. Sorry about not being there for the meeting today. My mom is in the hospital and my family is coming in to town because of it. I will see you all next meeting and I assume that by that time you all will have decided on a topic for the challenge. I'm fine with whatever topic you chose but my two cents goes to the Durable pipe or the Small Turbine. I just like those ideas and think that they would work well with our group. Once again sorry I couldn't be there I will be around for the next meeting.

---Tristan Coffey

We'll miss you! Take care of yourself and mom

Colin forgot it was Wednesday (oops) and Elaine and Yang were at a math competition.

PRESENT: Alix, Andria & Lauren and Robb

SIGN UP TO GET REMINDER TEXTS FROM MEG ABOUT FUTURE MEETINGS.

PSU STEAM Team
@innov503

WAYS TO JOIN A CLASS

- In-class Instructions
- Phone or email invites
- Website link
- Printable PDFs

Ask students and parents to text @innov503 to 81010

TO: 81010

@innov503

Send

- 1 Send your text to 81010**
81010 is the Remind short code we created so people can join your class without seeing your personal information.
[81010 not working?](#)
- 2 Text the message @innov503**
This is the class code for PSU STEAM Team. Students and parents can always use innov503 to join this class.

Robb reminded us that we had to turn in a field work strategy by Sunday at midnight. Meg encouraged us to get it done today. We explained the topics discussed last week with Robb. Tried to focus on defining a problem - hard work. Conversation zoomed across the planet from drought stricken villages in Africa to water fountains in Portland schools.

pipe turbine?

- <http://www.gizmag.com/portland-lucidpipe-power-system/36130/>
- <http://www.waterworld.com/articles/wwi/print/volume-21/issue-2/regional-focus/hydro-technology-extracts-energy-from-sewage-water.html>
- there is a patent on one type: <https://www.google.com/patents/US20130099499>
- we could work on a smaller one?

WATER QUALITY SENSOR?

- Sensor to detect biological / mineral composition
 - Scanning electron microscope sensor?
 - Shows on sensor whether safe or not (green yellow red?)
 - maybe sensor can have different markings for different chemicals present or something
- Can (optionally?) connect to an app that tells you what you need to add to purify it
 - you can input what stuff you have in your kit so its suggestions take your supplies into account
-

We finally focused in on the big question of how you can know if you can drink the water you have? We expect that this will require us to learn how sensors work, how to build a model (3d print it) and how to code to make an app. This is what Meg sent to PSU.

PROBLEM: people need to know the quality of their water (backpacking, in emergencies, refugee camps, remote villages). Current water quality sensors are not as reliable, don't address all issues (chemical, mineral, biological composition, pH?), and are difficult to understand. They don't provide any solutions for how to improve the water.

- We will

HUMAN FACTORS

- a) Who will benefit: Backpackers, emergency responders, developing countries
- b) How will they benefit: people will now be able to know if they have access to clean drinking water and they will gain knowledge about what to do in emergency situations when needing water. This will be beneficial to anyone in need of access to clean drinking water.

HYPOTHESIS: Based on our current knowledge of water quality testing systems and our concern that systems are not user friendly or offer directions about what to do if water is not potable, we think we can improve through design an easy to use sensor and related mobile application offering advice.

FIELD WORK:

Steps

- a.) Review water testing kits and purification systems currently on the market to homeowners and backpackers to understand how they work and could be improved upon.
- b.) We will want to talk to people about sensing biological composition in water and sensors in general. We would like to get into the SWEET lab to further learn about sensors.
- c.) We need to do more research on how sensors work and how this could relate to detecting water quality. We are planning to create a model of our water quality sensor and have it 3D printed to have a 3D model.
- d.) We will rely on our mentors to introduce us to PSU professors and other experts.

NEXT MEETING FEBRUARY 3 in ROOM 135 (next to Counseling)

AGENDA:

Feedback from PSU via mentors

? Look at home water quality testing options: what's out there and how could it be better?

What are reliable resources on water quality?

<http://hydrationanywhere.com/how-to-test-water-quality-at-home/>

<http://www.epa.gov/dwstandardsregulations#listmcl>

Types of sensors:

- 1 Acoustic, sound, vibration
- 2 Automotive, transportation
- 3 Chemical
- 4 Electric current, electric potential, magnetic, radio
- 5 Flow, fluid velocity
- 6 Ionizing radiation, subatomic particles
- 7 Navigation instruments
- 8 Position, angle, displacement, distance, speed, acceleration
- 9 Optical, light, imaging, photon
- 10 Pressure
- 11 Force, density, level
- 12 Thermal, heat, temperature
- 13 Proximity, presence

<https://www.filtersfast.com/Sensafe-487986-Test-Filter-Kit.asp>

- This is a link to a water quality test kit. It lists the test strips included, showing that these are what needs to be avoided or looked out for when drinking water:
 - Sulfate Test Strips (2)
 - Chloride Test Strips (2)
 - Nitrate Test Strips (2)
 - Nitrite Test Strips (2)
 - Iron Test Strips (2)
 - Copper Test Strips (2)
 - Free Chlorine Test Strips (2)
 - Hydrogen Sulfide Test Strips (2)
 - pH Test Strips (2)
 - Total Alkalinity Test Strips (2)
 - Total Chlorine Test Strips (2)
 - Total Hardness Test Strips (2)
 - Pesticide Test (1)
 - Bacteria Test (1)
 - Lead Test (1)
 - Table to record and compare your results versus US EPA recommended levels
 - <http://www.epa.gov/wqc/national-recommended-water-quality-criteria>
 - This shows some of the guidelines for water quality from the US EPA.
 -

FEBRUARY 3, 2016

PRESENT: Alex, Tristan, Lauren, Lang, Elaine
Andria has Speech & Debate until 4 and Colin has Lovegram rehearsal.

We got Feedback on our proposal from PSU.

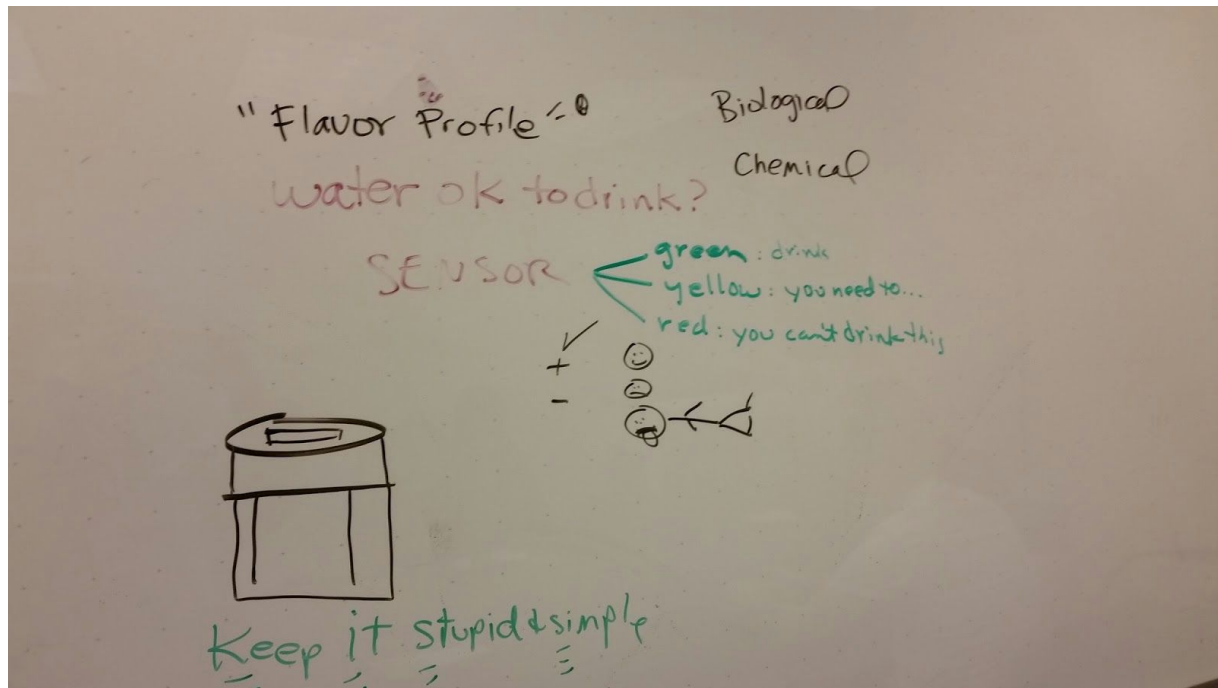
Team Lincoln:

It's wonderful to see how much work you've all packed into three meetings. We are very impressed with your idea to empower people in vulnerable situations to test water and treat it appropriately.

You're absolutely on the right track with your first step being a survey of water testing kits and purification systems currently on the market. If you'd like to test any in person, we can purchase them for you. Each team can spend up to \$250 on their project to conduct fieldwork or build a prototype. We are also happy to facilitate a meeting with SWEETLab. This will be very useful to your exploration of utilizing cell networks. A couple things to consider - not everyone will have a smartphone in the situations you describe (e.g. a refugee). We are really excited to see what your app may look like but take into careful consideration the limitations of some of the users you've identified, and how you see your solution implemented on a larger scale. Use fieldwork to help narrow the scope of your user base and/or expand feedback beyond a smartphone app.

Please let us know how you'd like to proceed!

Alex demonstrated a backpacker's water purifying system using a battery powered UV light. She had a solar battery charger too.



AGREED; Travel to PSU next Wednesday. Leave LHS from Meg's office at 3:30. Robb will set up a meet with his professor or a tour of the prototype lab or SWEET lab. Field Research time! We need to find out

- what makes water safe to drink (biological and chemical requirements)?
 - What can our bodies already kill?
 - What simple methods could be recommended to purify different contaminant levels?
- how do sensors work?
 - how to detect biological and chemical matter
- how will we make a prototype

SWEET LAB VISIT

February 10

Things to think about:

Materials used for filtration

1. What materials can be used that aren't as expensive
2. Currently out there: clays, ceramic, carbon foams? Membranes.
3. Insulation materials

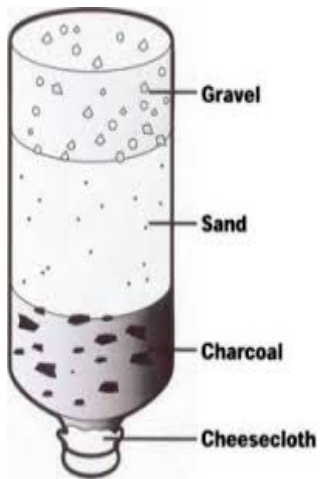
Making filtration systems work constantly

1. Sensors
2. DelAgua

Repurposing materials already available in new INNOVATIVE ways

Lauren -

- I researched materials used for filtration:
 - a very basic filtration system can include more natural items such as different sizes of gravel that remove the impurities in the water.



- even clean-looking water can have bacteria so it is important to filter any water that you are unsure if it is clean or not.
- this process can be done in nature, but in larger water purification plants, this is somewhat copied on a larger scale to remove bacteria, algae, and silt from the water.
 - this is an important step to water purification, but there are more steps before the water is considered drinkable.
 - There are 5 main steps (screening, coagulation, sedimentation, filtration, disinfection)
 - screening - Water from lakes, rivers or the ground passes through a screen as it enters the water treatment plant. When the water source is a lake or river, the screen serves an important function, keeping out large natural contaminants such as plants and wood, or fish. If groundwater is used, screening may not be necessary since the water has passed through layers of the earth in what is essentially a natural screening function.
 - coagulation - Treatment plant workers add alum and other chemicals to the water, which cause tiny sticky particles, or floc, to form. These floc attract dirt particles, making them eventually heavy enough to sink to the bottom of the water storage tank.
 - sedimentation - The water and floc flow into a sedimentation basin. As the water sits there, the heavy floc settle to the bottom, where they remain until removal.
 - filtration - Water passes through layers of gravel, sand and perhaps charcoal, which serve to filter out any remaining particles. The gravel layer is often about 1 foot deep and the sand layer about 2½ feet deep.
 - disinfection - Water goes into a closed tank or reservoir. Chlorine or other disinfecting chemicals kill any remaining microorganisms or bacteria in the water and help keep the water clean until distribution. If a water treatment facility uses groundwater as its only water source, disinfection may be the only step required to sufficiently treat the water. After it is disinfected, the purified water sits in the closed tank or reservoir until it flows through pipes to homes and businesses.

○ Types of water filters:

- Activated Carbon filters - are generally responsible for removing larger particles like sediment and silt from your water. They work by attracting and absorbing these particles so they're no longer present in the liquid that comes out of your faucet. An activated carbon filter will also make sure the end result has less in the way of odor and tastes much better. This is because they reduce the amount of chlorine and other contaminants.

- Reverse Osmosis - is incredibly popular mainly because it has the ability to remove all sorts of contaminants that can be a danger to your health, as well as making sure the end result is clear and odor free.
- Alkaline/Water Ionizers - use a process known as electrolysis. What this means is the water is passed over plates which are electrically charged, and it's separated into two streams. One is alkaline and the other is acidic. Not only do you get softer water as a result, water that's low in acidity is much better for your skin as well.
- UV filters - one of the newest technologies on the market. When ultraviolet radiation is used to treat water, it has the ability to destroy various bacteria that can be damaging to your health. If you want a more environmentally friendly way of purifying your water, this filter may well be the answer because it doesn't need any chemicals or additional heat to be effective.
- Infrared Filters - is used to help soften your water, so if you live in a hard water area, infrared technology will help. Much like alkaline filters, infrared uses heat and light to negatively charge the water, and give it a softer feel.

Hey Team!!

So I want to give just a quick recap of today's info (2/17):

I think the consensus is to break into mini 'expert' teams based on interest. We all agreed that removing particulate was the easy part but the hard part or more challenging part of the project is metal toxins and biological toxins (e.g. salmonella, e. coli, et cetera). That being said, think about what you'd be more interested in and if you would jot your name under one of the columns below:

Biological (salmonella, e. coli, et cetera)	Chemical (Metals, et cetera)
	<ul style="list-style-type: none"> - Lauren - Lang - Elaine

Research Notes:

Lauren -

- Some metals are essential for life, and are found naturally in our food and water. Other metals can be found in water than can lead to chronic or acute poisoning.
 - Metals can be in our water naturally in trace amounts from rain percolating down rocks. However, larger amounts can be caused by human activity (electronic and mining processes, agricultural activities, discarding of waste in landfills).
- Public water supplies are monitored regularly for metals like arsenic, barium, cadmium, chromium, lead, copper, mercury, selenium, nickel, thallium, antimony, and beryllium, based on a set of guidelines created by the EPA.
 - The biggest problem is lead, which can leach into the water from lead pipes (esp. in older homes).
 - damaging to the nerves and the brain (children are the most sensitive to lead poisoning).

- Nickel, Lead, Cadmium, and Zinc are typically the most prevalent metals at ground level.
 - These metals are present in water at ppb level under cationic form such as Zn^{2+} , Ni^{2+} , Cd^{2+} and Pb^{2+} .
- Reverse Osmosis can be effective at removing low level of heavy metals, although in aerobic conditions metal oxides can clog the membranes. Also, Reverse Osmosis is not a very cost efficient method, unless the water salt content requires further demineralisation.
 - The best way to remove heavy metal contamination in water is through the use of a selective ion exchange resin called **“Lewatit TP 207” or “Lewatit TP 208”**.
 - This resin is usually non regenerable (can be regenerated on site by acid and caustic soda if needed).

Note from Lauren:

I am sorry but I will not be able to make the 3/2 meeting this week because I have to babysit. I researched the chemical aspects of water, as well as the basis of a filtration system, which are both written above. You guys can read what I have researched if it is applicable to what you are discussing. Sorry again.

- Lauren

Notes from Elaine: (in case this will be handy later)

Metals	Allowed parts per billion	Source
Antimony	6	http://www.freedrinkingwater.com/water-contamination/antimony-removal-water.htm
Arsenic	10	http://www.epa.gov/dwreginfo/chemical-contaminant-rules
Barium	2000	http://www.water-research.net/index.php/barium
Beryllium	4	http://www.freedrinkingwater.com/water-contamination/beryllium-removal-water.htm
Cadmium	5	http://www.freedrinkingwater.com/water-contamination/

		cadmium-contaminants-removal-water.htm
Copper	1300	http://www.health.state.mn.us/divs/eh/water/factsheet/copper.html
Lead	15	http://www.cdc.gov/nceh/lead/tips/water.htm
Mercury	2	http://people.uwec.edu/pierce/hg/mercury_water/drinkingwater.htm
Nickel	10	http://www.atsdr.cdc.gov/toxprofiles/tp15-c1.pdf
Selenium	50	http://www.atsdr.cdc.gov/PHS/PHS.asp?id=151&tid=28
Thallium	2	http://www.freedrinkingwater.com/water-contamination/thallium-contaminants-removal-water.htm

Alex-

Here is some information about different water filter ideas:

<http://www.historyofwaterfilters.com/distillation-pc.html>

February 24

Field Work at PSU: History of Water in Portland/BullRun101 Dr. Catherine Howells



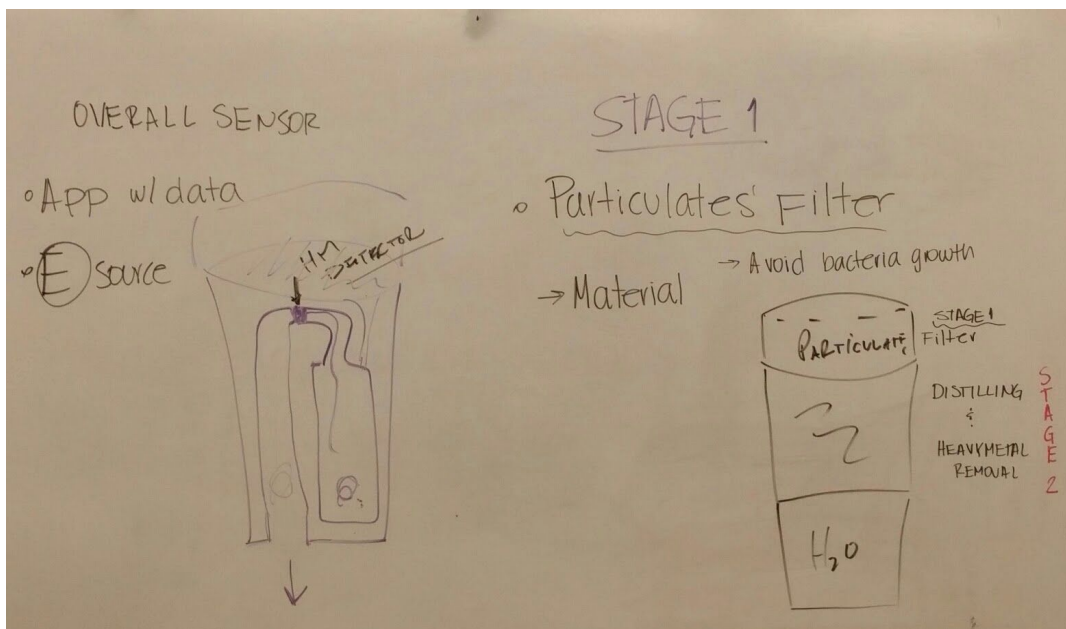
March 3

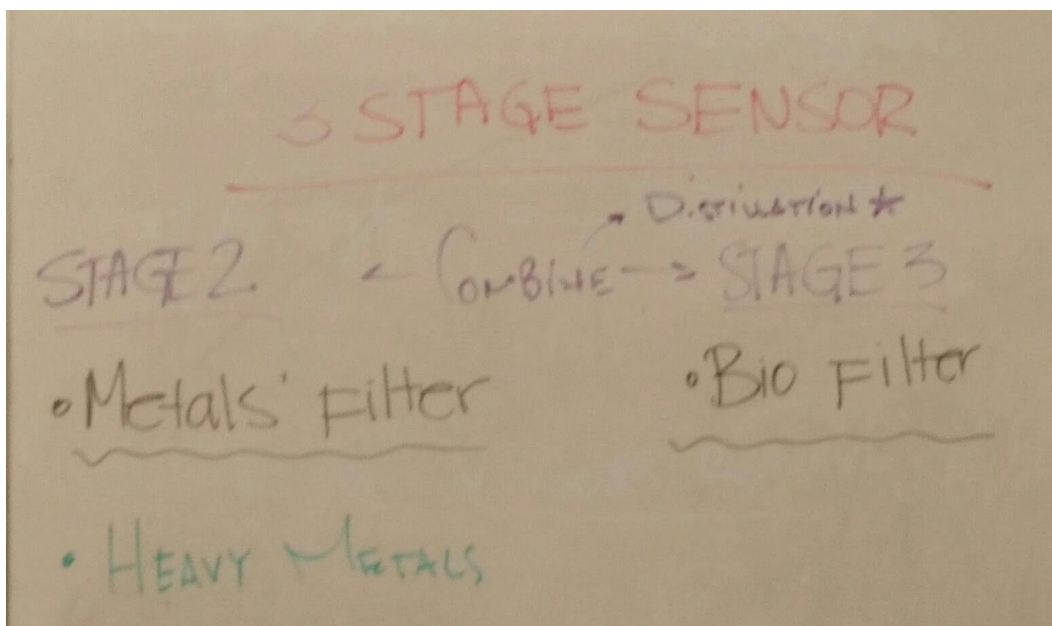
Divided into three groups. Agreed to meet more frequently.

DISTRIBUTION & POWERING: Alex & Tristan

HEAVY METAL DETECTION & POWERING: Elaine & Andria

PARTICULATE FILTER: Lang, Lauren





Particulate filter:

3-layer filter: first 2 layers are aluminum filters (or Al coated Fe filters, those commonly seen in kitchen), first one has larger pores and the second one has smaller pores. The 3rd layer is constructed of C-foam and each layer would be removeable. (distance between the layers & the thickness of the C-foam are to be determined)

Sample of the 1st layer:

<http://www.appliancepartspros.com/dacor-raised-vent-grease-82766-ap3393385.html>

Sample of the 2nd layer:

http://www.webstaurantstore.com/tablecraft-84-8-fine-tin-double-mesh-strainer/4078098.html?utm_source=Google&utm_medium=cpc&utm_campaign=GoogleShopping&gclid=Cj0KEQIAu9q2BRDq3MDbvOL1yaYBEiQAD6qoBiC1CO-xdVYZSUM1sGXSH2aoRLo-5I6bFmE_iMYzZWgaAvSc8P8HAQ

(I can't find the actual size of the pores for these filters, so I will probably go buy them in grocery stores at some point)

Sample of the C-foam:

http://www.ebay.com/itm/like/141522378616?ul_noapp=true&chn=ps&lpid=82

We all agreed to meet next week on Monday Wednesday and Friday and to attend at least two of the meetings.

Monday meeting @330pm

Wednesday @330

Friday @330

Everyone will come together with research and materials to purchase.

ANDRIA- HEAVY METALS

- Filtration
 - Ion exchange resin- layer of beads with sodium, potassium, or hydrogen that can exchange with & replace the metal ions

http://www.amazon.com/Deionization-Resin-Mixed-Bed-Bag/dp/B00I0DM69C/ref=sr_1_5?ie=UTF8&qid=1456972633&sr=8-5&keywords=ion+exchange+resin

 - Easy to replace, and certain kinds can be "recharged" by rinsing in salt water- cheap & accessible
 - Information about it (scroll down)

<http://www.freedrinkingwater.com/water-education/quality-water-filtration-method.htm>
 - Other interesting filters that are actually biological but I'll post anyway!
 - Tree branch <http://news.mit.edu/2014/need-a-water-filter-peel-a-tree-branch-0226>
 - Graphene

<http://phys.org/news/2012-08-graphene-based-materials-bacteria-mechanisms.html>
 - Titanium dioxide nanostructures- research apparently being done at PSU (found this on an ASE internship position description!) (It's #10, I actually applied for this one,

to me it seems to be something that can be really hard to apply here since a) time limit and b) it involves synthesizing molecules with a specific structure, which could involve a lot of technological challenges. But yeah it's definitely something fun to look at. - Lang)

- The principal idea of this research is to remove organic pollutants from water through the absorption of sunlight by titanium dioxide, and subsequent conversion of that energy from electrical to chemical energy, which is then capable of breaking down organic pollutants. In order to make the process more efficient, our goal is to synthesize three dimensional (3D) titanium dioxide nanostructures.

- Detection

- Fluorescence USING DNA? <http://andalyze.com/products/> <http://andalyze.com/technology/>
 - “One of the most important discoveries in the last decade is that DNA/RNA are not only materials for genetic information storage and transfer, but also catalysts for a variety of biological reactions, and thus called catalytic DNA/RNA, (deoxy)ribozymes, or DNA/RNAzymes. Because metal ions play essential roles in the structure and function of DNAzymes, the study and application of these new metalloenzymes has become a new frontier in bioinorganic chemistry. ANDalyze has created a product for detecting and quantifying heavy metals in water based on the recent discovery of these catalytic properties of DNA, coupled with established nanoparticle reporter technologies. This is how the technology works...
 - This technology is a universal platform that offers simple, fast, inexpensive and reliable detection of trace metals and other target chemicals. Measuring the metal ions is done through a reaction that occurs when a water sample containing a target metal ion contaminant (such as lead) is introduced to a sensor unit specific for that contaminant. This produces fluorescence (light) in direct correlation to the amount of metal ion present. The amount of light is measured by a fluorimeter. The fluorimeter reading relates directly to the amount of metal contaminant in the water solution. ANDalyze has designed and manufactured a modernized hand held fluorimeter which, in combination with the consumable DNA based sensors can quickly measure water contaminants at the sample site, greatly reducing the time and effort required by current technologies. This advantage creates a cost savings for organizations that are responsible for water testing of public drinking water supplies or industrial water operations.”
- There are some other chemicals that can be used with the fluorescence idea as well.
 - <http://link.springer.com/article/10.1007%2Fs002160000379#page-1>
- Potentiostat- we could maybe build one! there is open source code for it!
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0023783>
- Graphene based sensors
https://www.researchgate.net/publication/261751553_Graphene-based_sensors_for_detection_of_heavy_metals_in_water_A_review_Chemosensors_and_Chemoreception
- Sensor that uses nanotechnology:
https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/2174

- utilizes quantum phenomena: quantum tunneling, conductivity → tiny “nanoelectrodes”
- Atomic absorption spectroscopy: http://www.nipne.ro/rjp/2014_59_9-10/1057_1066.pdf
 - “**Atomic absorption spectroscopy (AAS)** is a spectroanalytical procedure for the quantitative determination of chemical elements using the **absorption** of optical radiation (light) by free **atoms** in the gaseous state.”
- Power
 - So I’m not sure if any of those methods require the water to be in a gaseous state (will look into it to make sure they still work with gas?) but either way one idea is to harness the potential energy of the moving steam.
 - Battery?

Lang: Filtration of some heavy metals

- http://people.uwec.edu/piercech/hg/mercury_water/removalmercury.htm This link talks about some common ways to get rid of Hg, the $\text{Ca}(\text{OH})_2 / \text{AlSO}_4$ precipitation seems to be doable.
- Chromium-VI can be somewhat removed by distillation, although not completely. Most commonly seen way of Cr-VI filtration is through reverse osmosis.
- Carbon filters, distillation and reverse osmosis are specially designed to remove Pb from water. <http://www.kleenwater.com/45-x-10-lead-removal-solid-activated-carbon-block-water-filter-p-825.html> There are tons of filters like this one on google shopping, BUT I haven’t found any that guarantees the lead level can be reduced to a safe level directly from “raw” water.

Lauren: more on particulate filter group

- Granular Activated Carbon (GAC)
 - Commonly used in water filtration processes.
 - Removes most organic chemicals and odors from water.
 - However, this type of filter does not attract iron and nitrate which can be harmful when in water.
 - Reverse Osmosis is often used to rid of the chemicals that remain after carbon filtration.
- <http://www.health.state.mn.us/divs/eh/hazardous/topics/gac.html>
- For a simple filter, the more visible particles are removed through different sized strainers and filters with various pore sizes.
 - When in need of immediate drinking water, it can be helpful to use different gravel sizes to have this effect (gravel → sand → coal)
 - The coal is used because it is high in carbon to have the effect of carbon filtration.
 - We could implement this basic idea into our filters to get rid of the major particles, except use strainers with different pore sizes in place of the gravel and a carbon foam layer in place of the charcoal.

- The picture to the left shows this basic idea, and we could have different layers of filtration to have this same basic concept (we would have to figure out how to remove of the chemicals that remain after this type of filtration).

! heavy metals and cyanobacterial toxins can survive boiling ! would need to detect for these after distillation.

THE FOLLOWING STUFF MAY BE A MYTH??? Still trying to do research, I'm coming up with some contradictory things. This website says its false <http://www.durastill.com/myths.html> ????

- Aside from desalinating water, the distillation process will reliably remove bacteria and viruses and dangerous heavy metals like lead, arsenic, and mercury. Distillation is ideal for recipients of non-municipally treated water, due to the particular challenges and heavy contamination of raw, untreated water. For this reason, distillation is often used as the preferred method of water treatment in developing nations that must work with heavily contaminated, untreated drinking water. Distillation is extremely effective at the removal of bacteria and often used in areas at high risk of waterborne diseases. Distillation also removes soluble minerals like calcium, magnesium, and phosphorous that may harden water and increase the occurrence of scaling.
- The distillation process contains several elements that make it undesirable for purifying drinking water. First of all, while the vaporization process will strip water of salt, metals, and bacteria, **the boiling point of most synthetic chemicals, including pesticides, herbicides, and chlorine solutions is lower than the boiling point of water.** Synthetic chemicals are the major contaminants remaining after municipal treatment. Distillation does not remove these harmful chemicals.
- Also, distillation is a very slow process and requires a heated energy source. Though experiments in the use of solar power have been attempted, this form of energy is only able to treat small quantities of water and difficult to maintain at a constant temperature (Holland et al, 1999). The inefficiency of solar power requires the use of more costly energy forms. Also, because **this process must be repeated several times to ensure significant water purity, it could take several hours to provide one gallon of cleansed water. Generally, distillation requires five gallons of tap water to generate one gallon of purified water.**
- Finally, distillation, like reverse osmosis, **strips water of natural trace elements.** When these elements are removed from water, the hydrogen composition becomes greater in proportion, **making the water very acidic.** Several studies have proven that drinking distilled water, stripped of minerals, can actually be harmful to the body system (Rona, 1995). Long-term consumption of such de-mineralized water can result in mineral deficiencies in the body. Though the removal of trace minerals creates water that is ideal for use in photo or print shops, it creates tasteless and even unhealthy drinking water.

^As it says, drinking distilled water is harmful cuz of the lack of minerals. We can add artificial minerals but it's still not a decent solution. Boiling the water might be easier to do & more healthy.

We still need to figure out the size/scale of our filter

- we determined that the biological and heavy metal components need to be filtered out, but the particulate filter may be able to be removed.
- possibility that we can start with a smaller prototype, and it could always be scaled up to provide water to more people.

Elaine -

ZeroWater filter removes heavy metals by replacing the ions w/ water molecules?

Hey Team! I am copying the feedback that we received from Denise and Julie regarding our last proposal. It is as follows:

Team Lincoln:

It's clear that you've done quite a bit of research to get where you are now. We are really excited to see what you present at the final event.

We have a few questions that you may already be addressing, but the answers were unclear to us based on the information you provided.

1. Scale / capacity / portability - it is unclear how big the device is, how much water it can process and how easy it is to carry. The answers to these questions will have an impact on who your user is. For example if it is really small and portable but can only process enough water for one person, this might be best suited for an individual (backpacker etc). If it's larger and can process water for many, perhaps it's more stationary and best suited for a refugee camp or emergency situation (e.g. a family's disaster preparedness kit). If you aren't already, think about how these issues correspond to who your user is. It is perfectly okay for you to narrow your user base.

2. What is the benefit of testing for specific contaminants vs. treating all of them blindly? Does your device run filtration and distillation for all water it processes? Or is it smart enough to only run the processes it needs to make the water potable?

Keep up the good work!

Andria: The items Dr. Howells talked about researching were:

-Halogen tablets

-Cryptosporidium *sp? (Milwaukee Wisconsin Protozoa not killed by Cl)

-Brita Filters

-Pittsburg and heavy metals

-MIT, EPA on heavy metals

-Arsenic cleaning in India and Bangladesh

and yeah the rest of my notes are on pipes :)

- Lauren: Notes on Spectroscopy
 - Spectroscopy: the branch of science concerned with the investigation and measurement of spectra produced when matter interacts with or emits electromagnetic radiation.
 - Focuses on the interaction between matter and electromagnetic radiation. Historically, spectroscopy originated through the study of visible light dispersed according to its wavelength, by a prism.
 - Currently, all drinking water is consumed before results of microbial tests are analysed. Raman spectroscopy could be the answer to this problem. It delivers results quickly, does not require a highly skilled operator and no additional chemicals need to be added.

- A Raman spectrum gathered from a particular microorganism is unique, combining the spectra of all the molecules making up that microorganism.
- Scientists tested this technique using water containing different strains of *Escherichia coli* and *Legionella*. They showed that their Raman method was powerful enough to discriminate between strains of these organisms under different environmental conditions.
 - There is a growing emphasis on using Raman techniques to obtain highly specific and reproducible molecular signatures of microbial cells for the purpose of cell classification and identification. The capability to identify waterborne bacteria with Raman spectroscopy in this research provides insightful indicators of bacterial species and strains.
- This method is seen as the first step for developing an online method to inspect for waterborne bacteria. The team points out that the technology could also be adapted for food and pharmaceutical testing, as well as biomedical monitoring.
- <http://www.rsc.org/chemistryworld/2013/04/raman-spectroscopy-drinking-water-escherichia-coli-legionella>
 - Raman Spectroscopy:
 - a spectroscopic technique based on inelastic scattering of monochromatic light, usually from a laser source. Inelastic scattering means that the frequency of photons in monochromatic light changes upon interaction with a sample. Photons of the laser light are absorbed by the sample and then reemitted. Frequency of the reemitted photons is shifted up or down in comparison with original monochromatic frequency, which is called the Raman effect. This shift provides information about vibrational, rotational and other low frequency transitions in molecules. Raman spectroscopy can be used to study solid, liquid and gaseous samples.
 - http://web.pdx.edu/~larosaa/Applied_Optics_464-564/Projects_Optics/Raman_Spectroscopy/Raman_Spectroscopy_Basics_PRINCETON-INSTRUMENTS.pdf

March 9

Only two members present. (Tristan and Colin (Andria left early))

Worked more on narrowing ideas and research topics.

Mainly focused on housekeeping and what is needed for next meeting. Mostly that we need to do our research and post our research on here. Also that ALL MEMBER MUST ATTEND NEXT MEETING.

March the 10th. 7:00 pm Tristan Coffey. Notes/Research on distillation process.

Notable problem with our idea and design. The distillation process produced water vapor which need to be cooled down in order to be stored and drank. we will have to create/design some form of condenser.

Info link

<https://www.chem.wisc.edu/deptfiles/OrgLab/distillation/CHEM%20344%20Distillation%20handout.pdf>

For optimal distillation container should be filled 50-60% with water.

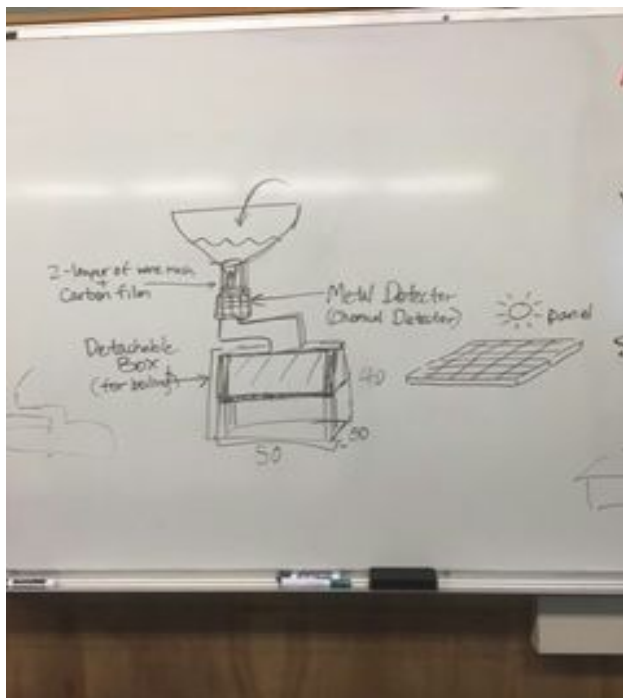
<https://www.waterwise.com/productcart/pc/faq.asp>

distillers use about 3.2 kilowatts per gallon. Based on the national average electrical cost of 8.48 cents per kilowatt hour, this equates to approximately 28 cents per gallon.

One gallon of 100% steam distilled water is produced in 4 to 4.5 hours, up to 6 gallons in 24 hours depending on heating device and energy input..

<http://orgchem.colorado.edu/Technique/Procedures/Distillation/Distillation.html>

March 11 Meeting:



-
- We drew out a plan of what we will make
- The parts need to be ordered by next Friday
- Posters **and** journal are due April 1st.
 - Anything that we research from now on needs to go on this document because we will be turning it in.
- Final event is April 9 (a Saturday)
 - Let someone know if you will not be able to be available during this day.
 - If parents or family is coming, bring a list of who will be there so they can prep for food. (Meg thinks there will be an online RSVP site)
- Presentation itself:
 - Focus on your specific area of research and prepare that.
 - Explain our method and process of engineering design.
 - We need to say how we developed our idea.
 - SWEET lab experience, talking with water expert (etc.)
- Next time we meet, bring what you have researched throughout this process and prepare it so we can be more confident about what we will be saying on April 9th.

- We may want to actually get some of what we want made in the picture below (at the LID lab).
 - We included:
 - An area for the water to be poured in
 - Possible idea: have a smaller reservoir
 - There will be a valve to control the water that continues to flow down at the bottom of this
 - a particulate filter with two layers of mesh and a carbon foam layer.
 - The carbon layer removes some metals, but it doesn't guarantee that it is completely safe. We will instruct the user to pour it back in again until it says it is drinkable.
 - A metal detector to detect what is in the water
 - A program will detect the amount of metals in the water:
 - Red: you need to...
 - Yellow: drink, but be precautionous
 - Green: okay to drink
 - For these lights, the instructions will be to run it through again if necessary
 - We would not necessarily have to code this, but just maybe press something for the colors to light up so that the judges can get a basic idea.
 - We still need to decide if it is necessary to have a filter right after the metal detector
 - Or we will have mesh in this part.
 - A metal box for the water to be collected in.
 - Below the metal box will be where the box can be heated with fire to boil it and kill the unwanted bacteria.
 - We will just boil the water, but will not turn it into steam.
 - We decided to use fire because it is fairly general and used all over the world.
 - This will be detachable so the plastics above the metal box will not melt.
 - We want this to be portable, so it will likely only be able to filter a gallon of water at one time.
- For the presentation roles:
 - Elaine: intro, metals

- For the intro, we will do a basic introduction of the components so that the audience and judges are aware of our design initially.
 - Lang: metal detector
 - Talk about how it works
 - Andria: metals
 - Tristan: distillation
 - Alex: First did bio., simplifying
 - Colin: powering
 - Lauren: spectroscopy, components of a filter
 - Talk about spectroscopy more as part of the process, but say why we didn't include it.
 - Alex and Lauren will talk a lot about the problems together. We should not be afraid to talk about our failures and perfection is not expected.
 - They focus more on the process and how we arrived to our solution. It is not as much about if it works or not.
 - During this process, we will explain all of our problems that we encountered and how we overcame our problems.
 - Common metals in water:
 - Fluorine
 - Chlorine
 - Lead
 - Copper
 - Poster design:
 - Short description of each component in the filter
 - A picture of the whole design
 - Maybe include smaller sections on the poster for the more important parts.
 - Ex: carbon filter, metal detector
 - Possibly include who it would help and how.
- For the section above the metal box, we may want to create somewhere for this to go so that it does not get dirty or damaged.
- Final Materials List (some of this can just represent what the actual product would be):
 - normal+fine mesh, C-foam (or filter) that can remove heavy metals/poisonous chemicals

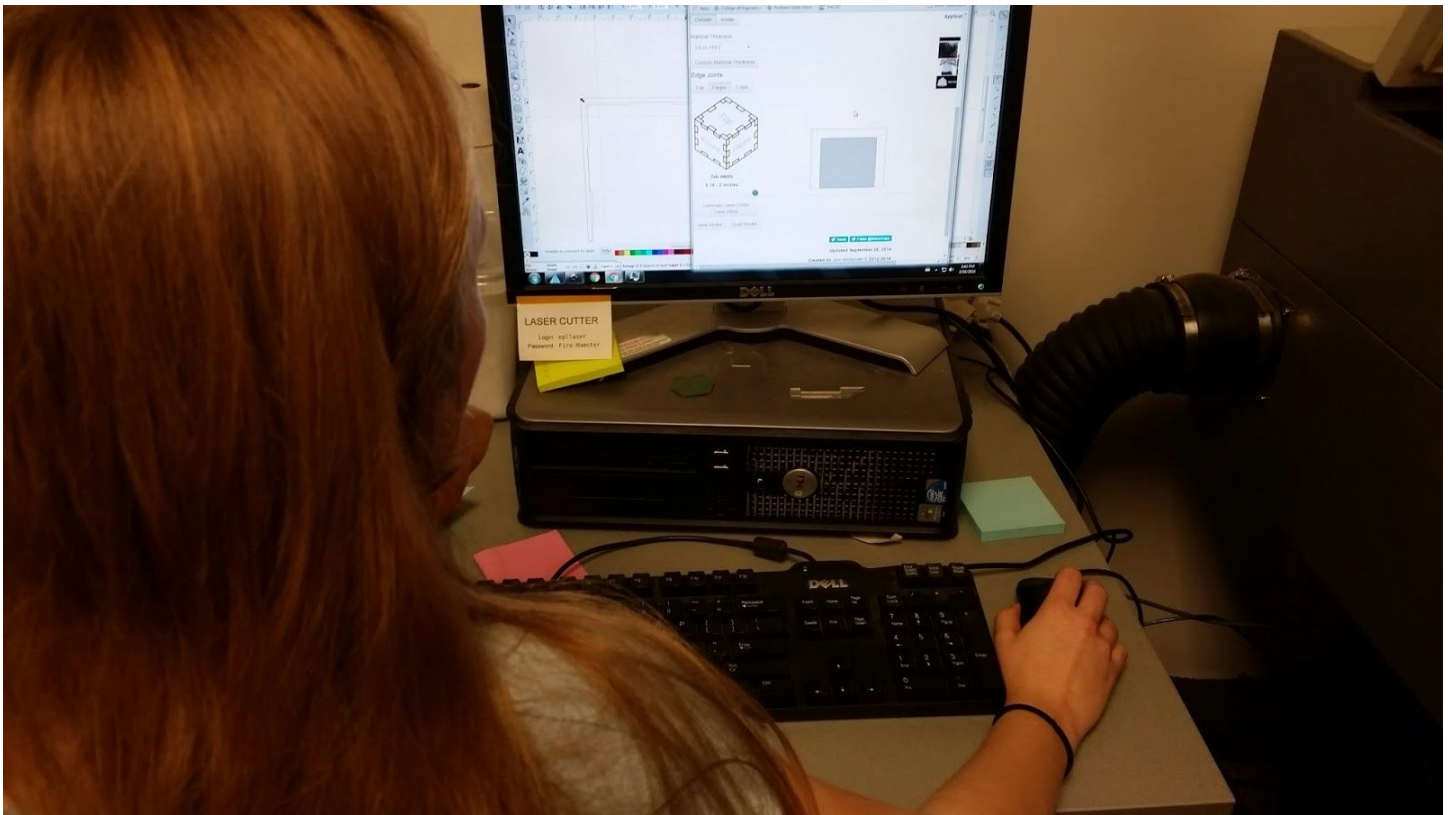
- Plastic funnel (?) (height = cm, diameter = cm)
- Tube (diameter = cm, length = cm matches the diameter of the smaller end of the funnel)
- LED lights (Red, yellow, green)
- Next week: Wednesday we could maybe go to PSU to start building at the LID lab (same time as usual)
 - Someone would possibly be here to show us the programming behind the detector

MARCH 16 2016 at the LID in the FAB at PSU

Team 1: Tristan, Lang, Andria & Colin worked on the sensors



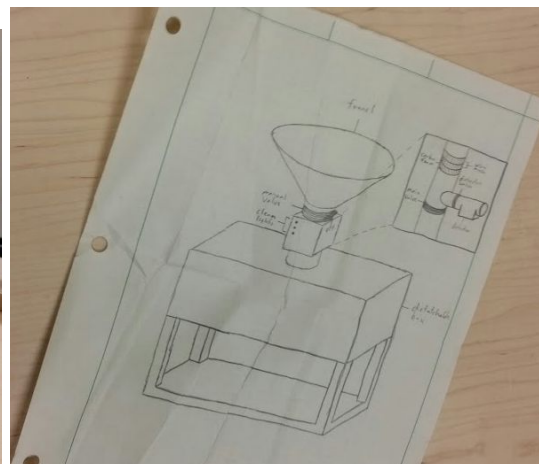
Team 2: Lauren, Elaine and Alex worked on the base. We changed the idea of the base as a box and made it a stand which would simply fit over the user's pot or bowl. The laser cutter could not cut the top of the table but the lab tech said he would work on the calibration problem and do it for us. Melissa will bring the top to the next meeting.



Shopping Needs

- Wire mesh for 2 layers
- Carbon foam (or a sponge to indicate foam)
- 2" pipe and fittings
- Milk jug or funnel

Alex is the lead shopper and will keep receipts to be reimbursed by PSU.

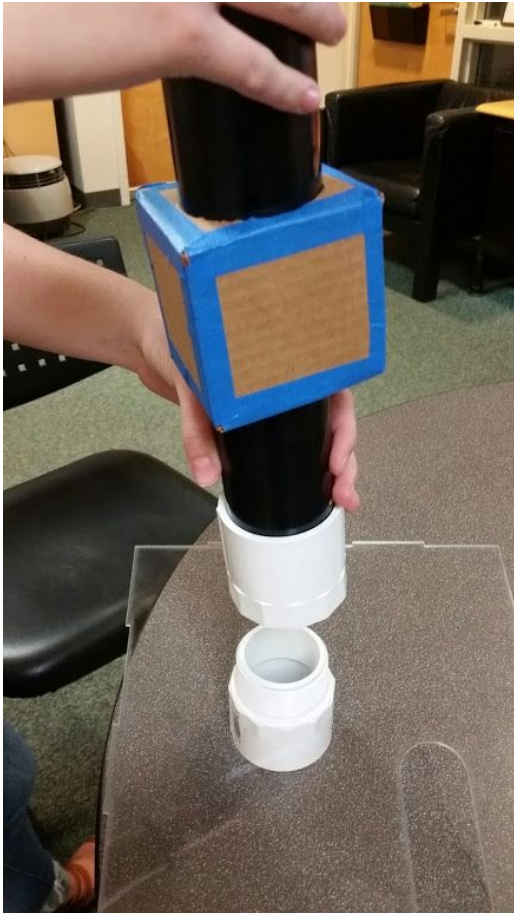


March 30, 2016

Mentors Melissa & Robb not available today.

Alex showed us the pipe, fitting and filters she bought at Home Depot. We don't have the top of the prototype which will have a 2.5" hole for the fittings and pipe, but Melissa will bring it to LHS tomorrow and give to Meg.

PROBLEM: Glues and adhesives were really expensive and Alex wasn't sure which would work so she didn't buy any. Rubber cement is not strong enough to hold the acrylic pieces together. Tristan suggested duct tape. Not pretty, but effective. No decision yet.



Tristan designed a cardboard box to hold the sensors. Lang and Colin rewired the switches so we only need one switch to control the green, yellow and red lights. Everyone contributed to the poster. Alex and Colin will work on the prototype (adding sensors, cutting the pipe) before the next meeting.

PROBLEM: Lauren has the ACT and Andria has a speech and debate tournament on 4/9 and can't attend the presentation. PSU Organizers have scheduled our presentation for after lunch so they might be able to join us . . . everyone else is to be at the event all day.

Next Wednesday we will work on the presentation and decide who tells which part of the story.

March 30: Progress on prototype. Still missing the top of the stand and the funnel.