McAdam Travel Bursary 2017
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Proposal Review

In my McAdam Travel Bursary 2017 Proposal, to learn more about potential Chemical Engineering career paths, I proposed a trip to explore the following areas of interest:

1. **Fermentation**
    a. Alcohols (spirits, beer and wine)

Fermentation is a huge interest of mine. I sought to learn more about it by visiting different distilleries and breweries.

2. **Waste water**
    a. Flooding
    b. Purifying water

I proposed to contact the Deer Island Wastewater Treatment Plant in Boston to receive a tour of the site.

Philadelphia

While in Philadelphia, I visited Penn State and a vodka distillery called Stateside Distillery.

Penn State

Before arriving in Philly, I reached out to Dr. Ali Demirci, the Professor-in-charge of the shared fermentation facility at Penn State. He was one of several professors whom I contacted and he was the only receptive to the idea of a site visit. He was extremely helpful and agreed to give a tour of the facility.

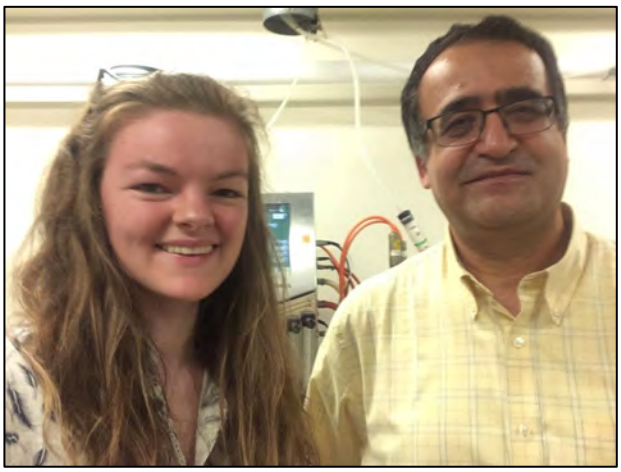

Figure 1: CG & Ali Demirci at Penn State

The fermentation facility at Penn State is known as a fermentation pilot plant is used to test out potential fermentations to see if they're feasible. The facility was open to academia as well as industry uses, which gave me a better overall idea of the applicability of fermentation.

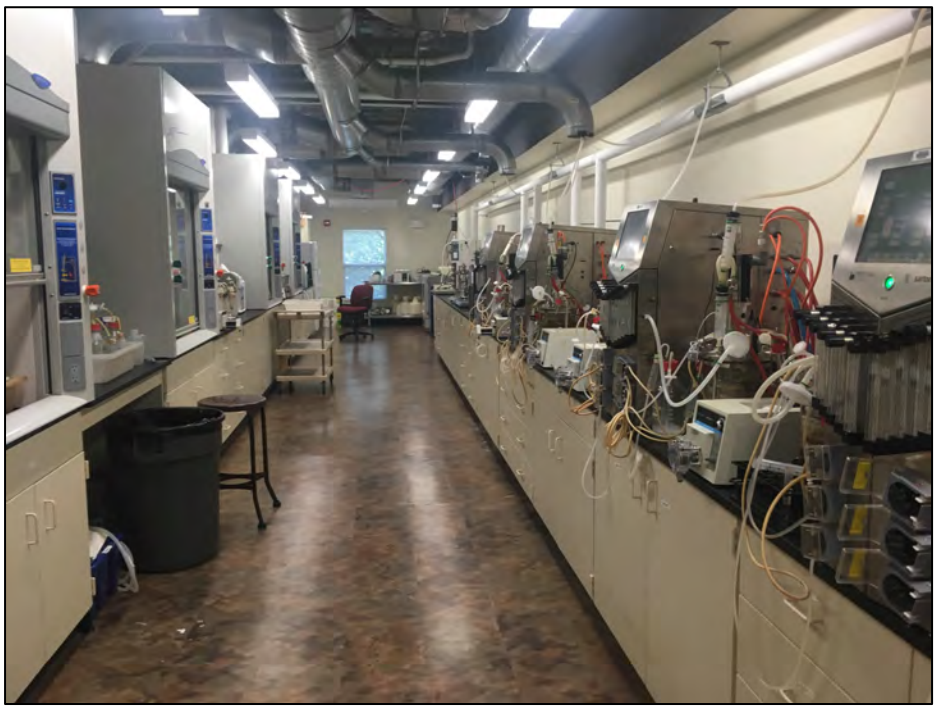

Figure 2: Fermentation lab 1

I travelled 5 hours from Philadelphia to Penn State via bus. Once there, Dr. Demirci showed me one lab based on small scale fermentation. At that time, vitamin K was being produced. Temperature and concentration, among other factors, were monitored by industry leading equipment.

Once the results were optimised, the batch was scaled up. Dr. Demirci walked me through the scaling up phase. They start small scale 0.5 - 1 L and work up using 5 L, 10 L, 20 L, etc. until 50 L is reached. 50 L is the largest tank at the current facility.

He also introduced me to several labs worth of equipment, where most pieces of equipment were worth upwards of $50,000 each. One piece of equipment, which had been designed by Dr. Demirci, was used to purify liquid foods using UV pulses (Figure 4), in lieu of chemicals. Another piece was used to purify dry foods using a similar approach (Figure 3).

Figure 3: UV purification machine for dry substances

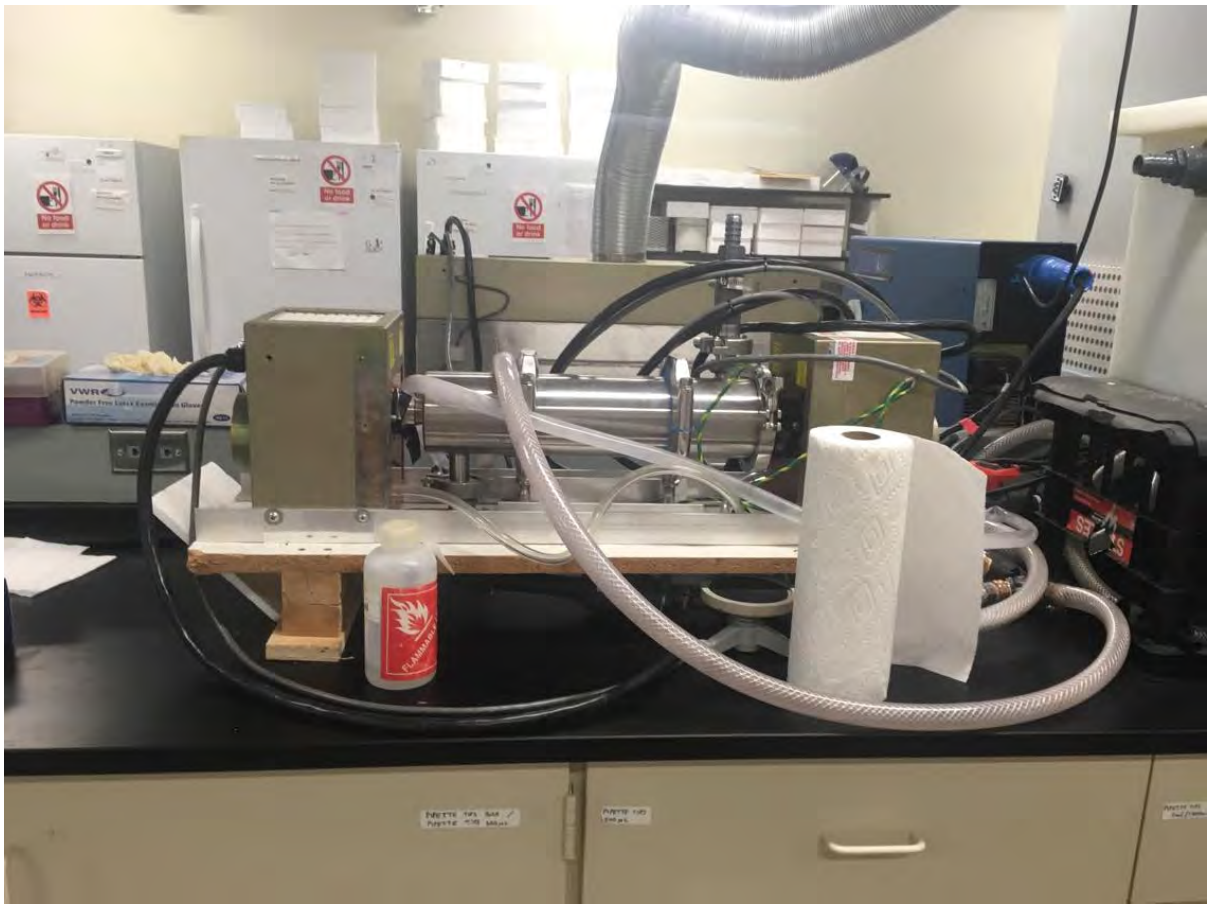

Figure 4: UV purification machine for liquid substances

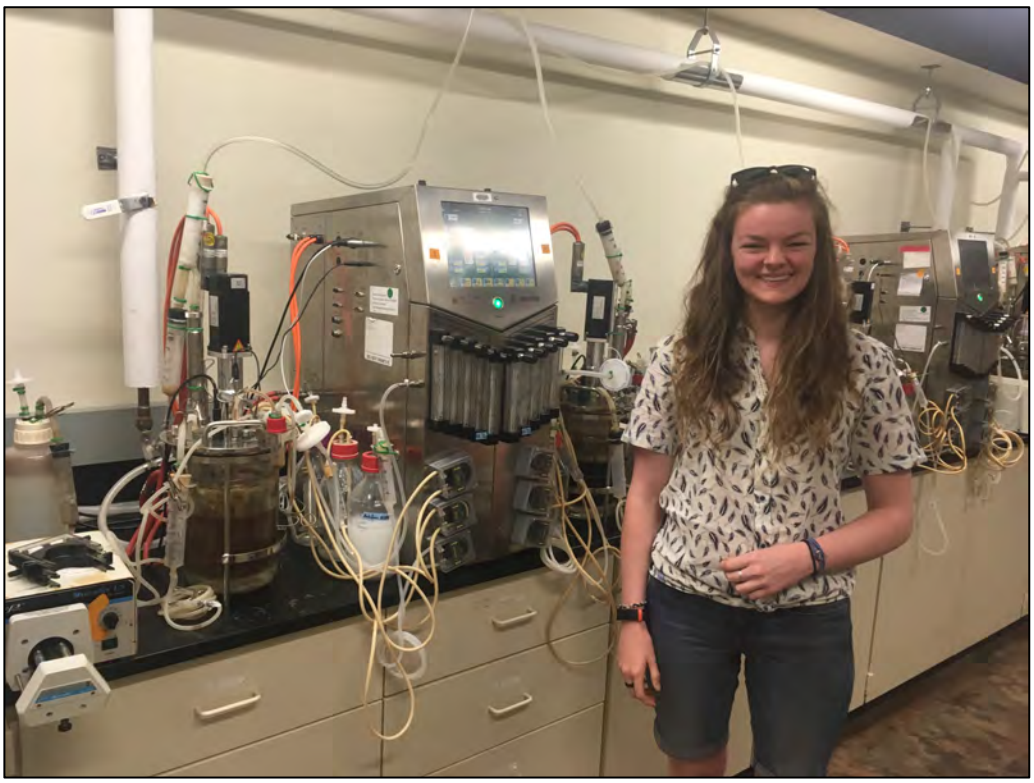

Figure 5: CG with two small-scale fermenters with a machine which monitors them.

Figure 6: Display screen for fermentation monitoring software

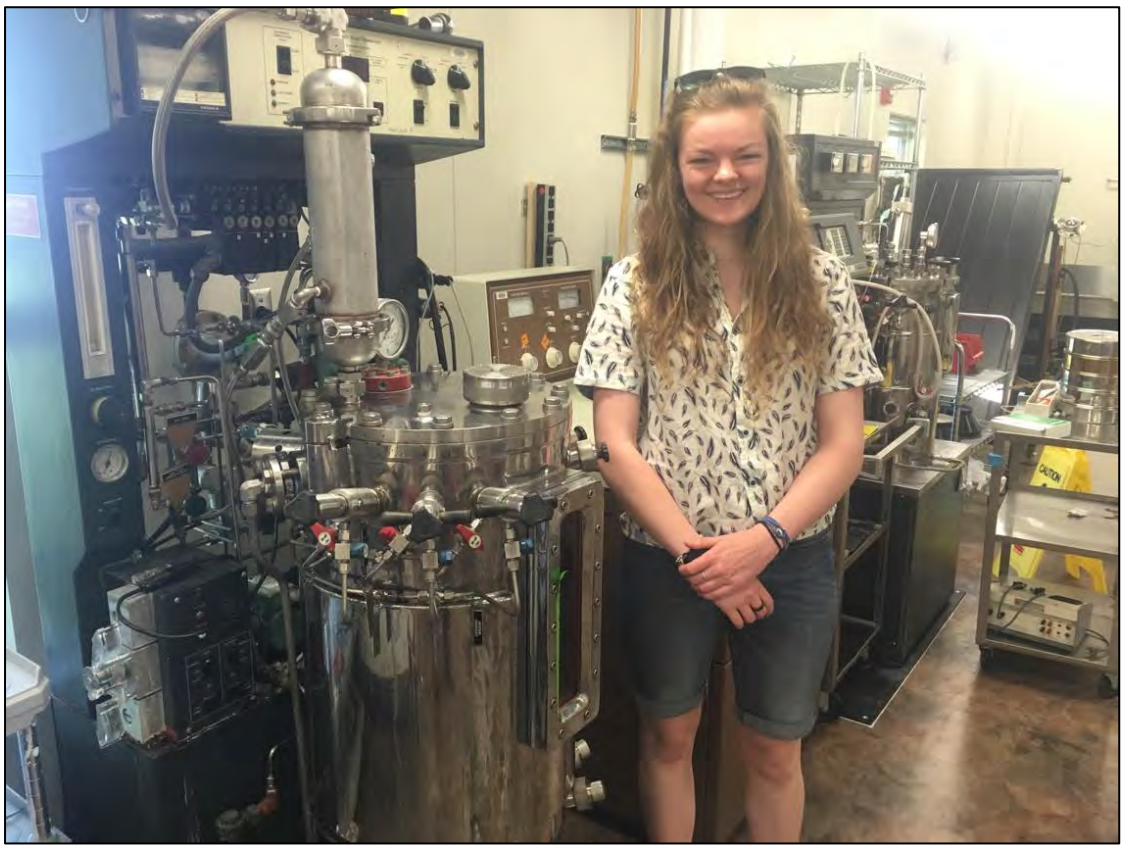

Figure 7: CG with a 50 L fermenter

When I returned to Ireland after the trip, I invested in some brewing equipment and have begun brewing craft cider (Figure 8), with the intent to scale-up and commercialise. Without visiting Penn State, I never would have had the confidence or fermentation knowledge to start brewing. I also learned the important of temperature, and how a few degrees can make an enormous different when fermenting certain products.

Figure 8: CG's "Cat's Cider" made with 4 L of Lidl-brand apple juice. 1-gallon demijohn with an airlock and thermometer

Stateside Distillery

Stateside have one of the fastest vodka turn arounds in the world, taking only 8 days to turn ethanol into bottled vodka. Stateside was established by two "jack of all trades" brothers, who started brewing hooch in their shed. Once they realised their alcohol wouldn't blind them, they reached out to pre-established contacts and purchased second-hand distillation equipment. It was fantastic seeing their "gung ho" approach to distilling and it instilled me with huge confidence to start brewing upon return to Ireland.

Stateside outsource several of the larger time-consuming steps in the brewing process; mashing and fermenting. They purchase 99% ethanol, which they then distil once. After distillation, they aerate the vodka with medical grade alcohol to speed up the "rest time". After this, the vodka only has to be bottled and sold. Thus, taking approximately 8 days to complete the process.

Their outsourcing approach to distilling is unusual in the drinks industry, but it is extremely successful. It cuts out the capital cost of large pieces of equipment and rapidly speeds up the overall process. I was very impressed by their setup and a little sceptical at how easy they offered their "trade secrets" during the tour. However, they didn't allow any pictures.

Boston

While in Boston, I visited the Deer Island Wastewater Treatment Plant and the Sam Adams brewery.

Deer Island Wastewater Treatment Plant

Visiting Deer Island was one of the most important things I did during the trip. It gave me wonderful insight into the waste water treatment process and I was given an impromptu interview and offered a potential ME internship at the site, if one became available. Ethan (Figure 10) is open to communication. I suggest contacting him in the future if a student is interested in a visit/internship. Otherwise, contact nadia.caines@mwra.com and mention CG.

Figure 9: Deer Island entrance sign

Figure 10: Contact details of the Deputy Director of Deer Island. Ethan is open to internship applications from students (contact him first)

Figure 11: The view from the top of the digester tower at Deer Island

Figure 12: An outside view of the digester shell

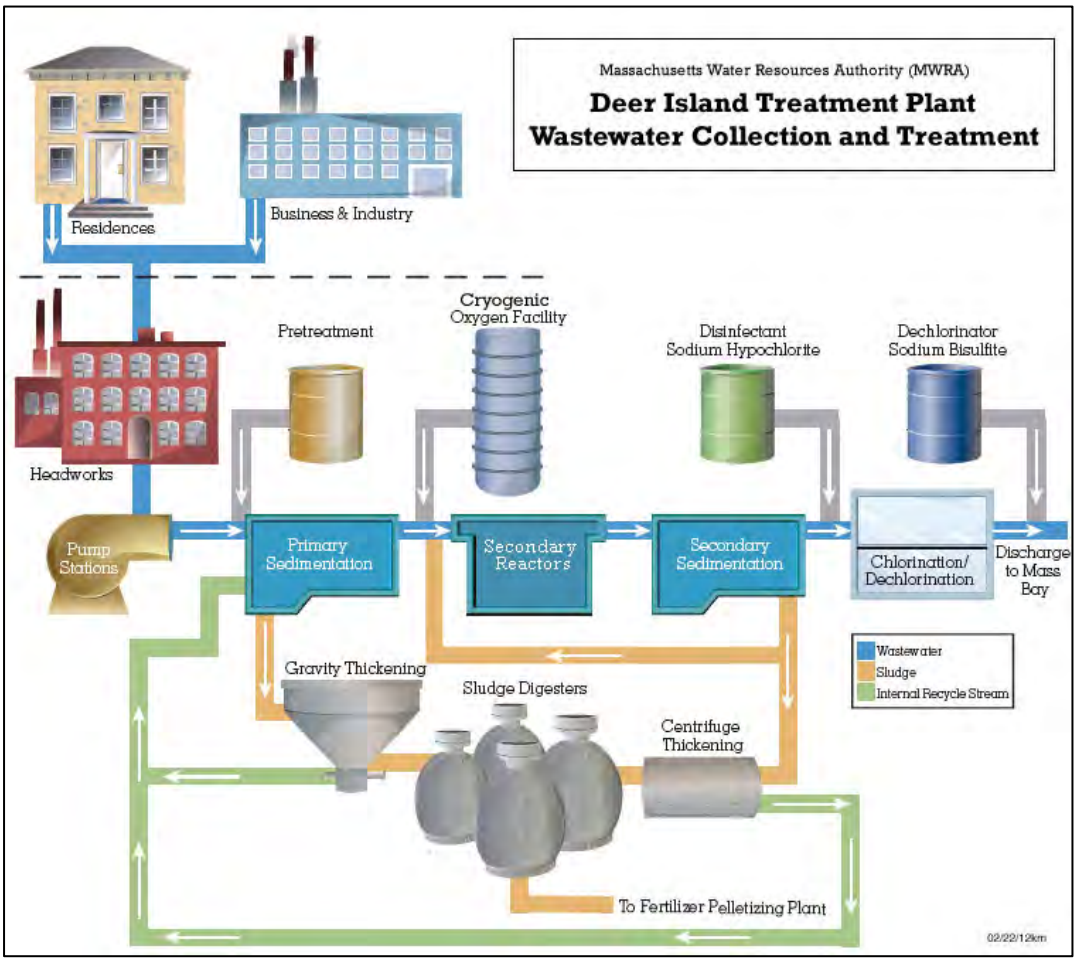

Figure 13: PFD of the wastewater treatment at Deer Island

Deer Island Waste Water Treatment Plant, or Massachusetts Water Resources Authority (MWRS) receives wastewater from over 2 million people and 5,500 businesses and industries in the Massachusetts area. Deer Island also treats almost 50% of the total flow caused by rainy-weather street runoff. Deer Island provides preliminary, primary and secondary sewage treatment.

Preliminary treatment involves allowing sewage to settle in a grit chamber and the solids, now known as grit (e.g. mud, sand), is separated and sent to landfill. Primary treatment removes up to 60% of the solids in the waste stream by allowing them to settle out as a mixture of sludge and wastewater. The sludge is separated and sent to sludge digesters. During secondary treatment, oxygen is added to the wastewater to speed up microbial growth. These microbes consume the majority of the waste in the wastewater and they settle to the bottom of the secondary settling tanks. After secondary treatment, 80-90% of human waste and other solids have been removed. A significant proportion of toxic chemicals are also removed by this process. Any remaining sludge is also sent to sludge digesters.

In the sludge digester, the sludge is mixed and heated to reduce its volume and kill bacteria. After this, the treated sludge is sent to a pelletising plant in Quincy, where the water is removed, it is heat-dried and converted to a pellet fertiliser. This fertiliser is sold for use in agriculture, forestry and land reclamation.

After secondary treatment, the wastewater is disinfected and chlorinated to lower the bacteria count and then dechlorinated, to ensure no wildlife damage occurs.

The treated wastewater, now effluent, travels through the 9.5 mile outfall tunnel out to sea. The last 1.5 miles of pipe containing 55 release points called diffusers. The effluent is not drinkable but it is swimmable.

Samuel Adams Brewery

The “Willy Wonka” of beers, Samuel Adams brewery has only been around since. Considering it’s known as a baby brewery amongst brewer, Sam Adams has won more awards than any other brewery of its size. The Sam Adams brewery in Boston sells no commercially available beer, the facility is solely used to test out potential brews. They experiment with different ingredients and new brewing processes. I attended a tour of the site and was given a rundown of operations.

Figure 14: Row of fermentation tanks at the Sam Adams brewery

Figure 15: Cleaning equipment used on fermentation tanks

There are 4 basic ingredients needed for beer: yeast, water, malt and hops. The process for making beer is as follows:

1. The malt, usually barley, is germinated and roasted to the desired colour.
2. **Grinding:** Then, the malt is put through a hopper and then grinded down through a mill to a fine grist.
3. **Mashing:** The fine malt is then added to water, which is known as the mashing process. Mashing is used to release sugars from the malt.
4. **Straining:** The solid-liquid mixture is then strained, where the solid, the spelt grain, is sent to cattle farms to act as cattle feed. The sugary liquid part, the wort, has no alcohol in it yet.
5. The wort is boiled in a brew kettle
6. **Hops:** The hops are then added to the wort. Hops add flavour to beer.
7. The wort and hops are then heated, to condense the liquid.
8. **Fermentation:** The mixture is then cooled and put into a fermenter, then yeast is added. Without cooling, the yeast would die and no fermentation would occur.
9. **Rest:** Once fermentation has stopped, the beer is allowed to mature and rest, for flavour.
10. **Bottling:** After aging, the beer is bottled or kegged and sold or consumed.

Washington, D.C.

When I visited Washington, D.C., I attended a distillery tour at Restorative Republic and also did a walk around of the University of Maryland's ChemE department.

Restorative Republic

I was keen to visit Restorative Republic because it was founded by women. It was opened in 2016 using the money gained from a crowd funding campaign; the first distillery in the world to be crowd funded. Restorative Republic sell three spirits, a vodka, a rye and a bourbon. Due to their age, only the vodka is made in-house. The other two spirits are bought from a supplier and flavoured in-house. They have their own whiskeys on the way, but it will be several years before they are ready to sell.

Figure 16: Oak barrels used for maturing whiskey at Restorative Republic

Figure 17: Processing equipment used at the Restorative Republic distillery

The process setup was very similar to the Stateside distillery. This was great to see this in person as it proved that, across the board, distilling equipment remains largely the same. Although I knew this in theory, seeing it in real life opened my eyes to how simple the procedure can be.

Visit to University of Maryland ChemE Department

Although I wasn't able to contact anyone in University of Maryland to provide a tour, I visited the campus and checked out the department. I would have loved to visit the Bio-process Scale-Up Facility but unfortunately it didn't work out. However, it was still interesting to take a walk around a different ChemE department and read the various ME and PhD projects stuck on the walls.

Figure 18: CG with the University of Maryland ChemE Building sign

Miami

Key West Distilling

I was lucky enough to get to see Key West before it was damaged by Hurricane Irma in 2017. I visited Key West Distillery and had great conversation with the owner, who has been in the brewing industry his whole life. He has been a head brewer at a distillery for 30+ years and decided to go out on his own. His distilling equipment was specifically made so he could create any type of spirit (whiskey/rum/vodka) he wanted. He also had specially made charcoal flamed barrels, which allows whiskey to mature with a great flavour. As well as giving me extensive detail on the distilling process, he gave me some great advice

"Stay away from the distilling business, all the money's in beer!"

Figure 19: Inside view of charcoal flamed barrels for storing either rum or whiskey

Figure 20: Specifically made equipment, which can make any type of spirit, depending on what the brewer wants to make

Accommodation

To cut down on costs, and to remedy the fact that I was travelling alone and wanted to meet other people, I couchsurfed for the entire trip. There's an online platform called couchsurfing.com where "couchsurfers" sign up and create a profile, which includes your name, gender, age and location, as well as interests and hobbies. Users then list themselves as a surfer or as a host. I reached out to hosts in the locations I was visiting (Philly, Boston, etc.). I usually messaged upwards of 10 hosts in each place before finding one who was available to host me.

I was extremely lucky with the hosts I stayed with. All of them were great and were interested in the purpose of the trip. They usually showed me around and brought me to their favourite nooks and crannies in the city. Overall, it was fantastic experience staying with locals and now I have good contacts in several parts of the U.S.A.

Budget

The bulk of the €1000 bursary went towards transportation between major cities. A small percentage went towards the tour prices for distilleries. I covered food, public transport inside cities and other expenses myself.

Itinerary

I started the trip from Montreal, following a year spent studying at McGill University as part of a JYA Study Abroad. I finished the trip in Miami.

The scheduling for this trip was immense. For example, I first travelled to Philadelphia because Dr. Demirci could only meet during certain dates and I had to plan accordingly. Starting in Philly was not the most practical location to reach considering my starting point was Montreal! However, the transportation down was an experience in itself (circa 9 hours via bus).

Before commencing, I had planned out where I was due to be each day and booked transportation between major cities well in advance. This provided me some security and allowed me to contact couchsurfing hosts before reaching each city.

The scheduling of this trip has taught me a massive amount about time management. I had several visits locked in, which left little room to reschedule. I was mindful of transportation times and I became quickly adept at learning my way around new cities. Upon returning to college, I found managing my time a breeze after organising this trip.

A big challenge was not having a working phone number or 3G, which meant I was dependent on finding fleeting Wi-Fi spots wherever I went. Although, this definitely made it more fun and forced me to talk to strangers for directions, which led to some great stories.

Fulfilling goals listed in the proposal

Below is a review of the items I sought to explore, listed under the heading "Proposal Review":

1. **Fermentation (success)**
    a. Alcohols (spirits, beer and wine)

I was very successful in learning about fermentation through a visit to Penn State and visits to several different distilleries and breweries. I have already begun home-brewing and intend to turn brewing into a profit-making side-hustle.

2. **Waste water (success)**
    a. Flooding

Unfortunately, I was unable to track down a contact who could help me learn about flooding procedures in the States. However, while visiting Deer Island, the staff there were able to answer some questions regarding the procedures taken with sewage when there is heavy flooding. This allowed me to learn more about flooding and to realise that I don't want to focus my career on it. Thus, I was still successful regarding exploring this career path.

    b. Purifying water

I was successful in learning more about wastewater and water purification. Following an extensive tour at Deer Island, I am more aware of the wastewater industry. Although I loved visiting the site, I do not see myself going down this career path. Mainly because the wastewater sector seems stagnant. The improvement of the effectiveness of wastewater techniques seems to be coming to a plateau and there are other, more innovative, more disruptive, industries that I am more excited by.

Conclusion

First, I would like to thank Mr. McAdam for this unbelievable experience. Without the generous bursary I would never have been able to go on this astounding trip. I have not only developed professionally, but also personally, and after this summer I came back to UCD with a renewed love for the engineering craft. Thank you again, Mr. McAdam. I would also like to thank everyone at UCD who reviewed my application.

Second, I learned so many things on this trip that I never would have encountered in UCD. I now have a deeper understanding about the water treatment process and better understand the associated theoretical aspects. I am more confident about the brewing process and have already begun brewing my own cider, based on the things I learned in the States.

Third, my confidence as an engineer has shot up. Before this trip I'd often feel nervous about reaching out to people in industry, as I didn't feel confident about my practical knowledge. My learning, up until now, has mainly been theoretical and being exposed to pure industry over the course of this trip has stripped away any nervousness I once felt. Regarding career paths, I see myself going into a sector that is innovative and is using new technologies. I certainly see myself continuing with fermentation exploration and will keep my eyes open for exciting opportunities in the water sector in the future, even if the area currently seems tame.

To conclude, this trip was absolutely unbelievable and has had huge impact on my personal and professional development. I now have contacts all over the States and have learned a huge, huge amount, as explained throughout the report. I was thrilled to be awarded the McAdam bursary and am incredibly grateful for the opportunity.

Catherine Galvin
January 2018