FINAL REPORT: SP0102 « Reducing Chemical Lab Waste »

1. Introduction

The SPF project SP0102 was designed to create meaningful change within the chemistry department. Originally, this was to be done by conducting different laboratory experiments to empirically determine greener practices for the chemistry department's research community. Professor Lumb donated his time as project supervisor and committed to housing relevant tasks in his laboratory.

As the project progressed, several transformations occurred and our team shed light on information regarding other universities' best practices. Through my personal experience, I was able to enter this project when it was at a relatively mature state and learned several things in a dynamic setting. This report will outline the accomplishments, some challenges and lessons learned as well as recommendations for similar projects in the future.

2. Accomplishments / Impact on McGill

Initially, this project was supposed to rely quite extensively on lab work to determine greener lab practices for undergraduate and graduate students. As well, previous work identified organic solvents to be responsible for the largest volume of liquid hazardous waste coming from the Otto Maass building. These initiatives led to the realization of the huge potential of solvent recycling, which led to our initial budget amendment requesting sufficient funding for a solvent distiller. Several phases complemented this process including negotiations with hazardous waste management, environmental health and safety as well as the chemistry lab director in order to approve of such a machine in our university. On the provider's side, an additional amount of time was necessary to wait for the preparation, shipping and installation of the equipment.

The original goal of this distiller was to optimize and expand the recycling program to distill a maximum of acetone from graduate labs. An initial experimentation process shed light on a slew of technical issues, making this portion of our project more much energy-intensive and complicated than initially predicted. Due to the generous collaboration of B/R Instruments, our group was able to conduct an indefinite trial phase on the distiller before we considered our purchase to be justified. The following sub-sections briefly summarize the technical problems that occurred and the steps taken to resolve them. Due to the complexity of the waste segregation habits, it was decided that an initial implementation step should focus on the undergraduate teaching labs before being expanded with graduate students.

Distillation data was included in the following table on the basis that it represents waste acetone from the undergraduate labs under similar program settings. They show relatively high incoming volumes and relatively high outgoing purities (99%+). The yield of 82% ± 6% can be explained by a high water content in the waste that remains in the boiler. This trend shows that it is possible to recover

approximately 80$ (or 25L) per run, which can contribute to significant savings for the teaching labs over the course of a semester.

Summary of undergraduate runs

Batch Distillation	Input (L)	Output (L)	Yield (%)	Recuperated cost ($)
October 29th	29	26	90%	81.77
November 3rd	28.5	22	77%	69.19
November 10th	36	26.5	74%	83.34
November 24th	32	27	84%	84.92
December 2nd	25	21	84%	66.05
Average	**30**	**25**	**82%**	**77**
Standard Deviation	**4**	**3**	**6%**	**9**

Technical difficulties contributed to some complications in developing a program that would be suitable across several waste streams. These included factors such as heterogeneity of waste, presence of sediments and presence of azeotropes. As well, an important concentration of water increased the mixture's boiling point which needed to be taken into account in the machine's program. Some parts were replaced and some operator practices were changed in order to facilitate waste collection, filtration and ultimate reuse.

Protocols and training materials were developed to ensure continuity and safety of operation. This task was handed off to the technical staff in charge of undergraduate labs and will be regularly used in future semesters to minimize waste from teaching labs. Safety retrofits ensured the compliance with all EHS guidelines.

Graduate waste was also collected and distilled but proved to be more complicated to manage than undergraduate waste. In the future, the graduate programs will be encouraged to complement their waste minimization habits with acetone recycling. Overall, the program was able to impact the McGill community by offering an alternative to the conventional single-use only system of rinsing glassware with acetone. Indeed, a total volume of 473 was collected and inserted into the distiller to recuperate a volume of 332L of purified acetone, representing a total savings of $1,307.29 for McGill University.

Undergraduate students from a plethora of departments will be exposed to the recycling program via demonstration videos and will therefore be encouraged to think about their research critically from a waste reduction perspective. They will be able to carry these concepts through their research career and further impact their findings for years to come. As well, through conversations and personal motivation, a student group was formed by the name of "McGill Green Chemistry Students' Association" dedicated

to ensuring visibility of green chemistry concepts to researchers. This group was a large part of my succession, and have handed off relevant reports that will live through their future workshops and informational events.

3. Project Management Experience

As a recent graduate of McGill, it was an incredibly exciting opportunity to impact the community in a concrete manner. Although this initiative had been in vigour for an entire year without my involvement, I was quickly given the responsibility of carrying on all tasks I believed would be impactful and making pertinent decisions to ensure the safe integration of the recycling program. During the transition between the outgoing project manager and me, several complications occurred and budget amendments became necessary to rectify future spending. As well, a contract detailing my resources and responsibilities added clarity to my job title, and would be recommended for any incoming participatory member of the SPF. Another suggestion would be more standardized information that could be made into some type of "training session" for project managers, given once per semester, including information on budgeting. More transparency on budgetary procedures will aid in better budgeting (ex. budgeting man-hours versus man-hours plus vacation, properly converting from American to Canadian dollars, etc.). This could also be an interesting opportunity to meet project managers of other SPF initiatives and exchange tips on a casual basis. Seven months later, I have come away with a new perspective and skills related to project management.

Firstly, it is important to mention how large the scope of this project was. This breadth needed more supervision and more time from various McGill faculty members, particularly when important decisions needed to be made. We also needed more flexibility in our project to account for the various challenges we faced. Personally, I learned how to prioritize my time through several tasks and to make difficult decisions, such as confirming the purchase of the acetone distiller.

As well, because of the safety concerns of this project, it was necessary to gain approval from different stakeholders. After several miscommunications, I realized the importance of explicit stakeholder involvement. Though several staff members were very willing to say they supported the project, this did not necessarily translate to the commitment I had implied. It became my task to decipher and determine the resources that would be given to me by various parties, and to make decisions accordingly. I therefore understood how to reach common grounds and communicate effectively important decisions needed to be made.

Through the technical difficulties of the project, I relied on my academic knowledge in addition to collaborative efforts from the lab technician team. Because the technical implications of the project directly impacted the logistics and policies put in place by the teaching labs, I learned to continuously ask myself "is this problem completely solved?" I also understood that the response needed to be technically feasible, convenient and safe for the operator and all participating students.

Finally, I learned how to get people invested. Several students and staff showed a great amount of generosity towards me and the projects, including the team of lab technicians and Professor Lumb's students. I involved these people in brainstorming sessions and showed my appreciation for their ideas and insight. This led to the creation of a volunteer group of young undergraduate students to test out new reactions to be implemented in lower-level courses. Similarly, discussions with specific lab groups were better because it was a relatively formal way of explaining the recycling program and, since the professor was present, there was an authoritative influence to agree with me.

4. Recommendations for future projects

There are several sustainable initiatives that merit attention in the future within the chemistry department. For example, heavy metal precipitation as well as substitution of some hazardous chemicals in experiments could greatly reduce the toxicity of most waste outputs. Furthermore, since xylene is produced in large quantities in the histology department, it would be interesting to investigate the potential to recycle this solvent in a similar manner to the acetone recycling.

In whatever project, understanding the policies set in place by Environmental Health and Safety as well as the faculty members in charge of specific lab rooms is paramount, since this will dictate the actions you are able to take. As well, making sure that stakeholders understand what they are committing to will help advance the project in a more straightforward manner.

The world of academics is slow and rigorous and projects changing research habits will follow similar patterns. Having a back-up plan will account for flexibilities in changing deadlines and deliverables. As well, making presentations in group meetings with the professor present proved to be a great way of reaching a level of commitment from graduate students.