Green Fund Project
Final Report

This report may be published on the SIU sustainability website.

Project Title: 3D Print Recycling & Filament creation System
Project ID #: 16SP135.
Award Date: 4/23/2016
Completion Award: $4,458.90
Total Funds Used: $4,558.90

1. Please provide a write up of your project/project experience.

   After acquiring the needed equipment, we ran into an issue where the large-scale granulator could not be utilized within our department because the machine needed a 220V outlet. We found that the 220V outlet that existed within our lab was accidentally wired as 110V when they initially wired the building. After a large delay due to a re-wire cost analysis, it was determined that the cost would be $6,000 to rewire the 110V outlet as a 220V. The Industrial Design department didn't have that kind of money. Since part of the goals of the initial proposal were to bridge the silos of the many departments on campus, we decided to evaluate the cost of wiring a 220V in the Engineering department, and splitting the cost with them. The cost was $400.00, leaving $200.00 for the Design Department to pay. This is the route we chose to take. This would give two departments on campus dual access to this equipment, create a sustainable connection and foster collaboration between Engineering and Design, and increase the odds of sustainable actions via recycling from both departments. The decision had been made, but taking action to set it up would take additional time which we didn't have.

   To create results and save time, I decided to scale down. Instead of a large-scale granulator, I would use a small-scale blender and decrease the amount of plastic I was to test in order to acquire data. This shifted my entire project from a campus-wide active development initiative (postponed it anyway) to a small scale proof-of-concept and data acquisition project, that would enable large-scale launch at a later date. The steps I took are as follows:

   1. I collected 3D printing plastic waste from various departments. Two locations on campus were used as sources for data collection: The Dunn Richmond Center, and the Library. Other departments exists that have known sources of PLA waste: Engineering,
   2. Weight of plastic was measured by color from each source. Due to the large amount of plastic waste retrieved from Morris Library, I decided to leave it unshredded until the granulator was operational. I used the PLA plastic from the Dunn Richmond Center to acquire the data needed in order to expand the operation to a large scale at a later date.
   3. The data I acquired was plastic weight, extrusion temperature, virgin and recycled plastic extrusion ratios, colorant ratios, documenting the proper procedure to create needed filament diameter, documentation of 4403D PLA & 3D850 PLA mixture failures, filament market analysis and cost comparisons, costs and savings with and without the filament extruder system, and other documentation.

4. After successfully creating new filament spools out of the recycled plastic, and creating various successful prints, the data and procedures were logged into a directions and procedures manual for future GA's and UGA's to utilize.
5. Now that proof of concept has been initiated on a small scale, the data and documentation I acquired during this research project can be implemented indefinitely on a larger scale once the granulator is operational. Any and all 3D printing filament waste on campus can be saved, separated into PLA and ABS waste, and retrieved from future SAM Lab UGA's and GA's as part of their job duties. I will be distributing recycle bins for these departments for this purpose. Once collected, a future UGA will bring them to the granulator where they will be shredded, brought back to the SAM Lab, and recycled into filament. In order to stimulate active recycling among these departments, a percentage of the created filament will be distributed back to them (no more than 15%, as the ratio of the created filament is 70% virgin PLA and 30% recycled PLA.) This means that half of the weight of their own recycled plastic will go back to them, and we will keep half for the services we provide. This ensures that mutual benefits exist and that the act of recycling is an economic benefit for all departments that participate. We hope that these savings can also stimulate decrease costs for printing services, subsequently increasing student demand for 3D-printing services and increasing the output of student innovation on campus.

2. Please provide a summary of your results (environmental, social, and/or economic) including quantifiable data as appropriate (ex. # of individuals reached, lbs. diverted from landfill, energy saved, etc.).
   - In all, 10.506 kilograms were gathered from campus during this project and saved from going to the landfill. I collected samples from 2 out of 5 inquired departments that utilize 3D-printing. This amount is the market equivalent of about 10 full spools of filament.
   - 9529 grams of PLA waste were gathered from Morris Library *(White: 2823g | Black 803g |Orange [Red, Orange, and Yellow]: 973g |Green [Blue, Green, and Yellow]: 1547g | Grey: 2141g | Clear: 844g | Purple: 398g)*
   - 977 grams of PLA waste gathered from Dunn Richmond Center (*White: 385g | Black: 444g | Mixed: 148g)*
   - A 30:70 weight ratio of recycled PLA to virgin PLA granules is required during recycling to maintain proper molecular bonds, which preserves its 3D printing capability.
     - If adding colorant to a recycled/virgin mix of the same color, colorant additive percentage is 2.8% of mixed plastic weight.
     - If adding colorant to 100% virgin granules, colorant additive percentage is 4% of weight.
   - 6670.3g of virgin PLA granules required to recycle Morris Library sample at a 30:70 ratio.
     - Current stock: 2634g
     - Granules needed after inventory of stock: 4036.3g
     - Price of virgin 5000g virgin PLA granules from Filabot.com: $62.10
     - 13565g of filament can be created from combining 5000g of virgin PLA granules with The Morris Library Sample *(9529g)* at a 30:70 ratio.

- **13565g of filament is the Makerbot Filament equivalent of $723.36 worth of filament. For one $62.10 purchase of 5000g virgin PLA granules, $723.36 worth of filament can be produced.**

- 4043D PLA Extrusion temperature is at 160 C, print temp at 190 C – 215 C

3. Summarize how your project promoted the Green Fee/Sustainability on campus including, but not limited to, flyers created, screenshots of website, signage, etc. Please include website links, if applicable.

   The UGA research poster was labeled with the "Funded by the Student Green Fee" logo. I also gave thanks to the sustainability department within the poster. In addition, any promotional media we make for web or print will also contain this logo.

4. Is there anything you would do differently if you were to do a similar project in the future? If so, please describe.
   I would make sure to log weights and percentages better from the start.

5. Please attach a minimum of 5 digital images –these will be images used to promote interest in sustainability projects on campus. These can be photos of the progress of the project or the completed project.

6. Optional: Do you have any suggestions for the SIU Sustainability Council to improve the Green Fund Award Process?

   No. It was fairly straightforward.