Summary

To solve our proposed problem in the sustainability and practicality of Penn State’s food service, we would like to replace the plastic utensils used in dining halls with utensils made of aluminum. This would reduce waste production, and improve the quality of life because aluminum is much more recyclable than plastic.

Team Members: Yousef Alsaqabi, Kirk Cieniewicz, Mary Miller, Cole Terwilliger

Table of Contents:

A. Definition of Needs and Requirements- pg. 2
B. Detailed Description of Competing Alternative Conceptual Options- pg. 4
C. Concept Options Analysis/Selection and Combinations- pg. 12
D. Detailed Description of the Selected Final Concept Proposal- pg. 13
A. Definition of Needs and Requirements

To make aluminum, you must first mine bauxite ore. This required heavy machinery, resulting in some levels of pollution. Chemical processes separate alumina from the aluminum oxide in the bauxite ore. To market aluminum, companies advertise how lightweight and recyclable it is. China is the leading producer of aluminum worldwide, with the United States following closely behind.

We decided to look into the sustainability of everyday things at Penn State. Particularly, we looked at drinking fountains, bike racks, and utensils used in campus dining halls. We decided to research ways to include aluminum in the production of drinking fountains, as drinking fountains are everywhere on Penn State’s campus. Most drinking fountains are made out of stainless steel, which is not nearly as recyclable as aluminum. Twenty of Penn State University Park’s drinking fountains have implemented new bottle refilling stations, which quickly and easily refill reusable water fountains, discouraging the use of plastic water bottles, and decreasing Penn State’s ecological footprint. Making aluminum water fountains would also decrease Penn State’s footprint, as aluminum is both cheap and recyclable. Stainless steel is usually used to make drinking fountains because of its high level of resistance to corrosion, and its durability. Aluminum would also meet these requirements, and it has in the past. Some newer water fountains are made of aluminum, and they work just as well, if not better. Plumbing Supply.com says that a cast aluminum drinking fountain is more durable than a stainless steel one. Aluminum drinking fountains could improve Penn State’s sustainability through creating more recyclable drinking fountains and drinking fountains that would last longer. Aluminum drinking fountains could easily be recycled once they are no longer useable. The only pollution in the process would result from the transportation of goods in the manufacturing of the product.

We also decided to research bike racks. Usually, bike racks are made of stainless steel, steel, thermo plastic or recycled plastic. We could make the bike racks out of aluminum instead. To ensure
that the aluminum doesn’t corrode, we could add a magnesium or zinc cathodic protector to it. Through the passage of time, if the bike racks become damaged, they would be very easy to replace.

Finally, we looked into the campus dining halls. The buffets on campus use metal silverware, most likely stainless steel. But the made-to-order dining options use plastic utensils that are rarely recycled. This produces a lot of completely unnecessary waste. This waste creation could easily be prevented by replacing the plastic utensils with metal ones, perhaps ones made of aluminum. This would significantly increase the sustainability of Penn State’s dining halls.

http://www.globalindustrial.com/c/plumbing/drinking-fountains/wall

http://www.plumbingsupply.com/drinkingwall.html

www.aluminiumdesign.net/design-support/aluminiums-corrosion-resistance/

http://en.wikipedia.org/wiki/Bicycle_parking_rack
B. Detailed Description of Competing Alternative Conceptual Ideas

**Bike Racks- Cole Terwilliger**

**Problem:** The bike racks currently being used on campus are diminishing this campus’s beauty. Some are new and some are old, some are rusty and some look fine. By replacing the bike racks with aluminum bike racks, PSU could improve the look of the campus and help this place be more sustainable. 😊

- **Ship bike racks to PSU for use**
- **Apply lacquer coating to the aluminum to improve its look and ability to resist corrosion**
- **Bars are welded together to form a bike rack**
- **Recycling plant melts down aluminum for used in other products and ship the aluminum to manufacturers**
- **Recycle used aluminum**
- **Heated aluminum bars are run through dyes to form the bars of a bike rack.**
- **Ship bike racks to PSU for use**
1. **Human Factors** - It would be easier for students to destroy bike racks made of aluminum that it would be for students to destroy bike racks made of steel. However, bike racks made of aluminum would not be destroyed through daily use by students. Also, bike racks that are no longer usable would be easy to recycle.

2. **Innovation** - Bike racks are typically made of steel, not aluminum. This would be a pretty original idea, but one that would work pretty well.

3. **Quality of life** - The quality of bike racks would not noticeably decrease or increase, but bike racks made of aluminum would be significantly more recyclable than those made of steel.

4. **Implementation** - We could institute these bike racks when it is time to replace the current steel ones, in order to make this replacement more practical. But it would not be difficult to make this switch.

5. **Economic Viability** - Steel bike racks are cheaper than aluminum bike racks, so this idea is not economically viable.


Problem- Steel or plastic spatulas are harder to clean than aluminum spatulas. Aluminum spatulas resist corrosion, and they are also more sustainable when it comes to recycling them once they are no longer usable.
1. Human Factors- Based on measures of ultimate tensile strength, the steel spatulas would be stronger than the aluminum ones. Also, if the aluminum is anodized prior to use, it is food safe.

2. Innovation- The use of aluminum spatulas is not common, so this would be different, but the idea is not new.

3. Quality of Life- Aluminum spatulas are easier to clean than steel spatulas. They would also be recyclable.

4. Implementation- This would be very easy, as we would simply replace the current steel spatulas with new aluminum ones.

5. Economic Viability- Aluminum spatulas would be slightly more expensive than a plastic or cheap steel spatula.

Problem- The dispensable utensils currently being used on campus contradict the sustainable goal of the university. Aluminum is more sustainable and can be recycled easier if a utensil is damaged. Aluminum is easy to clean and also avoids corrosion. Instead of using plastic utensils around campus, aluminum utensils can replace them in order to be more sustainable. Using aluminum utensils instead of plastic ones will reduce the waste created in dining areas. Also, aluminum is more sturdy and durable than plastic making it more practical to use.
1. Human Factors- Plastic utensils have a tendency to break that would not be observed through use of aluminum utensils. If the aluminum is anodized prior to use with food, it is food safe. Also, we could wash aluminum utensils and recycle them when they are no longer usable.

2. Innovation- The idea of utensils made of different materials is present in our daily lives. Normally utensils are either made of plastic or steel, so making them out of aluminum would be slightly new.

3. Quality of Life- It would be a good thing to not have utensils break through daily use.

4. Implementation- This would be easy, as many of Penn State’s dining halls already wash plates and utensils. So it would not be difficult to also wash the silverware.

5. Economic Viability- Aluminum sheets costs around $1.14 a pound. Plastic utensils cost around 4 cents each, and if we choose to wash the aluminum the utensils, it would be around the same cost, and the initial investment would eventually pay itself off.

Problems- Water fountains made of stainless steel are far more expensive, less durable, and less recyclable than water fountains made of cast aluminum. By replacing the water fountains around University Park, the University could save money and reduce their carbon footprint, in compliance with their goal of being more eco-friendly.

http://www.hotrod.com/techarticles/1306_simple_aluminum_casting/
1. **Human Factors** - If students go around trying to destroy drinking fountains, ones made of aluminum may be easier to break than ones made of steel. Aluminum does not rust in water, so there wouldn’t be any health risks to using aluminum in the production of aluminum drinking fountains.

2. **Innovation** - Aluminum drinking fountains exist, but Penn State campuses do not use them.

3. **Quality of Life** - Besides being slightly more aesthetically pleasing, aluminum drinking fountains would not directly affect students. However, aluminum is more renewable than steel, so these would be significantly better for the environment.

4. **Implementation** - This could be done at the time that the current drinking fountains would need to be replaced, to make the process more practical. However, this process would be more expensive than simply fixing the current fountains.

5. **Economic Viability** - This idea is not very economically viable.


   [http://news.stanford.edu/pr/00/aluminum511.html](http://news.stanford.edu/pr/00/aluminum511.html)
C. **Concept Options Analysis/Selection and Combination**

<table>
<thead>
<tr>
<th>Criteria/Requirements</th>
<th>Weight Factors of Criteria= WF</th>
<th>Bike Racks</th>
<th>Aluminum Packaging</th>
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<th>Utensils</th>
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**Numerical Scoring Matrix**

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<th>Implementation</th>
<th>Quality of Life</th>
<th>Economic Viability</th>
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<th>WF for each row= total of row/Sum of totals</th>
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Determining Weight Factors

**Sum of Totals**

**Sum of WFs = 100%**
D. Detailed Description of the Selected Final Concept Proposal


Mine Bauxite Ore from the ground, mainly done in the Caribbean, Africa and Australia

Grind the bauxite (mixed with caustic soda) to create alumina

Through various processes of fabrication, the aluminum is mixed with other metals and then poured into casts

Through smelting, alumina becomes aluminum

The aluminum is poured into the appropriate cast (various utensils), and dried.

Recycle!
In order to better the sustainability and practicality of Penn State’s food services, we propose that we replace the current plastic utensils with utensils made of aluminum. To decrease waste production we would wash these utensils, in the same manner we wash the plates and utensils already used in the dining halls. This would increase levels of sustainability and decrease levels of waste. Another way aluminum utensils are more practical than plastic utensils is that they are stronger. Plastic utensils have a tendency to break; plastic has a tensile strength of only 30. Aluminum, however, has a tensile strength of around 120. Thus, aluminum utensils would not break as easily through extended use, making it much more practical to wash the aluminum utensils than to discard them as we do with the plastic ones.

It would be very simple to implement the use of aluminum utensils in our dining halls. To be practical and economical, we would obviously use up the plastic utensils we have already bought. Then we would simply start using the new aluminum utensils instead. Plates and metal utensils are
already washed in our dining halls, so it would not be difficult to wash these aluminum utensils as well.

We would make aluminum utensils that do not react to the acidic contents in certain foods. Certain types of aluminum are food safe, and they are often used in the making of pots and pans, as aluminum is a good conductor of heat. Aluminum is corrosion resistant, and can last for a very long time. As aluminum cookware is used over an extended period of time, it discolors, but this does not affect how it interacts with food, only aesthetics. In the case of this particular usage, the utensils could be used until they discolor or break, and then they could then be recycled.

http://www.thegreenbook.com/aluminium.htm