**Mission Statement**

- Design a scalable system to remove the calyx from a strawberry with an eventual throughput of 120 strawberries per second.
- This machine will be designed for implementation at a strawberry processing facility, and will remove the calyx with high cutting precision of 1/16", while maintaining worker safety and food quality standards.
- The design will consist of a single lane, scalable system. It will include the positioning of the strawberry via the "V"-conveyor and the final cut. Suggestions and evaluation for scaling to the full size model will be done as well.

**Background And Project Overview**

Team Leaf-Be-Gone is a state-of-the-art, interdisciplinary team of engineers tasked to solve one of agriculture’s longest standing processing problems: strawberry calyx (stem) removal.

A 50 year old problem, the job is to create a machine that can integrate into existing production lines for frozen strawberry production. Prior to flash freezing, strawberries need the calyx removed, as it is undesirable in final products as it causes discoloration. Currently, the process is done by hand as they are picked in the field, a labor intensive process that is low on sanitation and extremely high rate, and at a high volume industrial machine must be reliable and easily maintained.

Since strawberries have a short shelf life, the strawberry processing industry will have to focus on selling frozen bulks, rather than frozen bags, in order to meet the demand. The frozen product is used in smoothies, frozen yogurt. For frozen strawberries to be viable, they must have the leafy stem portion, or the calyx, removed prior to freezing (individual flash freezing, or bulk freezing in buckets).

Currently, and for the past 50 some odd years, the industry has used field labor to remove the calyx in the field, during harvesting. In the same 50 years, many attempts have been made to try to automate the process for higher efficiency and food safety.

Calyx removal immediately before freezing has 3 principal advantages: Centralized Efficiency, Food Safety and Sanitation Improvement, and Maximum Product Retention.

The desired cut as stated to us by our client is a flat, even top without any calyx remaining, but to also not cut into the calyx of the strawberry. Cavitation can cause deformation and "explosion" during flash freezing.

For our project, we want to remove the calyx portion of the strawberry, while minimizing fruit loss at 120 strawberries per second, and extremely high rate, and at a high precision of within 1/16" of an inch.

**Functional Design**

The machine is broken up into 3 parts by function:
- Sorting and Sizing Alignment and Positioning
- Cutting and Separating

We went through many different designs for each function, and selected our final designs based on a few important factors:
- Simplicity: a high speed, high volume industrial machine must be reliable and easily maintained
- Accuracy: cutting and positioning must be precise in order for a good final cut
- Speed: The design must be able to achieve high flow and volume, without bottlenecks

**Future Research and Development**

- Testing for force and durability requirements
- Life Cycle Analysis and Economic Analysis
- Stress testing
- Optimization
- Optimization of size, shape, and flow rate
- Optical pressure, curvature, material composition for grippers
- Optical Sensor System Integration
- Provisional Patent Filing
- Assembly and Production Analysis

**Test Data**

To maximize flow, we needed to find the bottleneck. It became obvious that he bottleneck to the device was the funnel feeding the conveyor belt. The test data here represents flow tests done with fresh strawberries from the supermarket, with and without the air vibrator on. There is a trend towards 30 degrees, with vibrations improving the flow.

We also measured a sample batch of strawberries for critical sizing, and found that although strawberry fruit dimensions varied wildly, the most important ones for cutting, as shown to the right, were within the tolerance of a few millimeters. To compare, 1/16" of an inch is about 1.5 mm.