

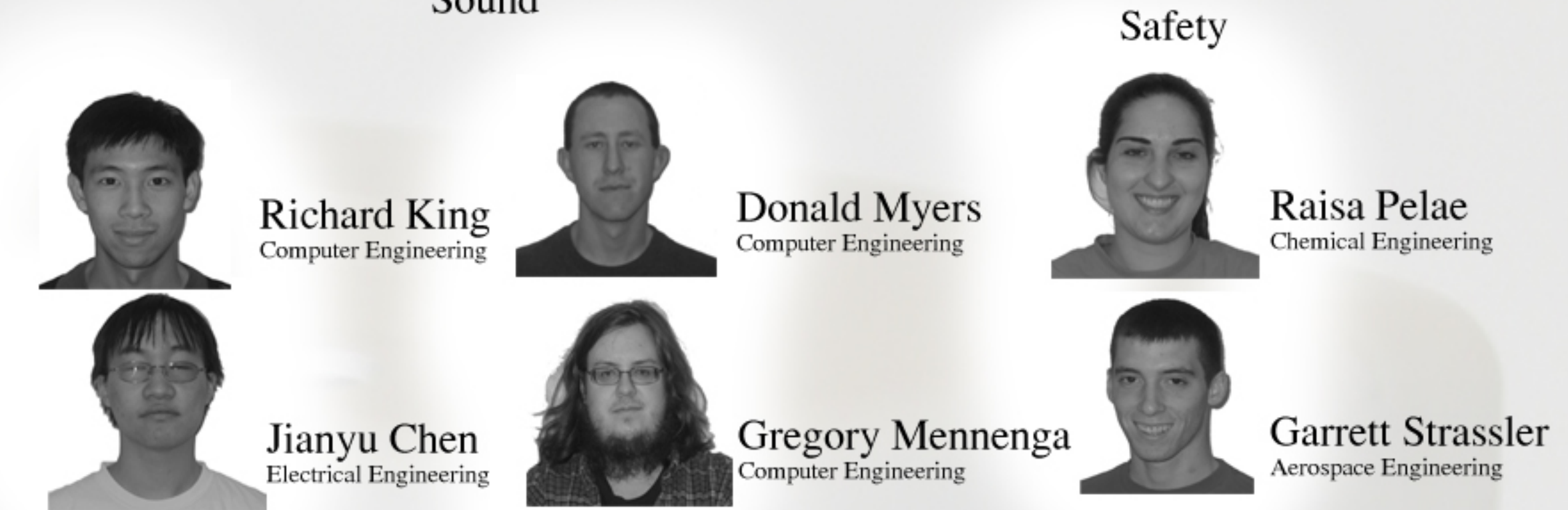
Team Members



I PRO 321

Product Design and Performance Evaluation

Team Members



Gears

Goal - Evaluate the gears and minimize the gear failure at initial shredding cycle.

Issue (Metal Gear):
The inside of the metal gear is stripping when load is applied. The manufacturer states that the gear has been hardened to eliminate the failure.

Findings:
-The Rockwell Hardness test on a B scale has been performed. The results are ranging in between 84.1 and 97.6. Rockwell B scale is used for the soft steels, aluminum alloys, copper alloys, malleable irons, etc.
-The images of metal's microstructure have been taken and are shown in Figures 1 through 4.
-Based on the images it has been confirmed that the gears are made out of powdered steel. On figures 3 and 4, the black dots represent the voids or empty spaces in the material.

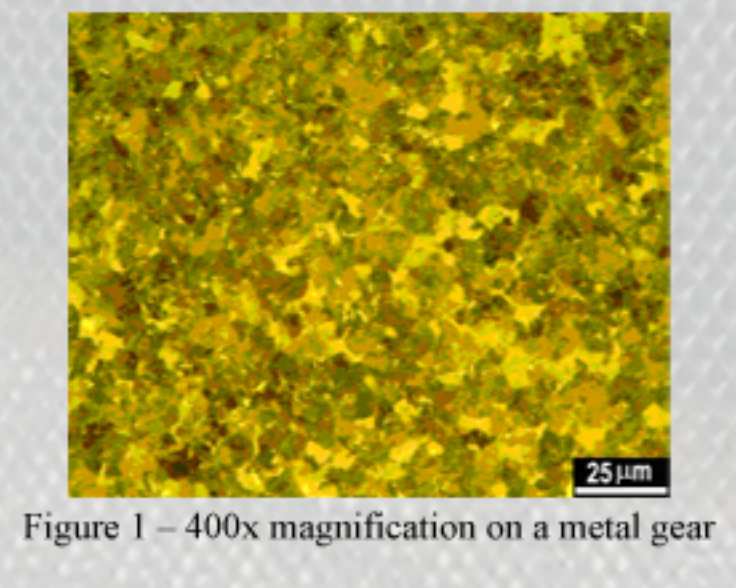
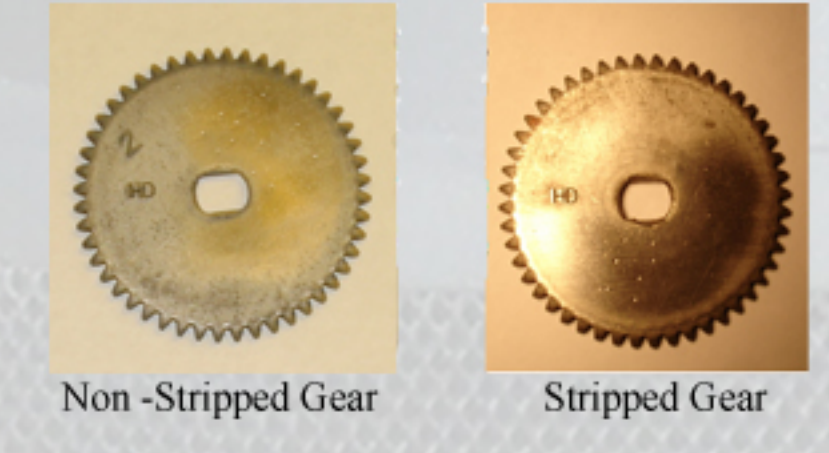


Figure 1 - 400x magnification on a metal gear

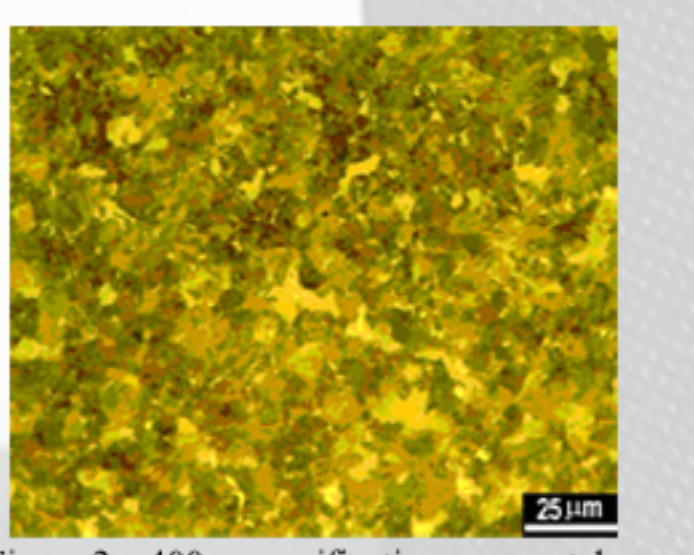


Figure 2 - 400x magnification on a metal gear

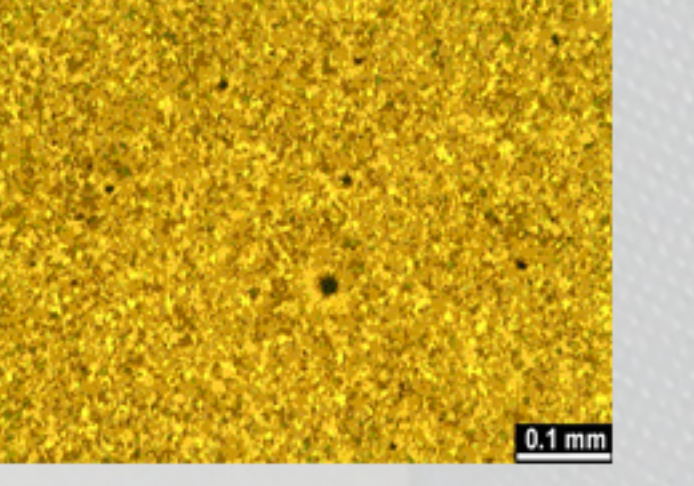


Figure 3 - 100x magnification on a metal gear

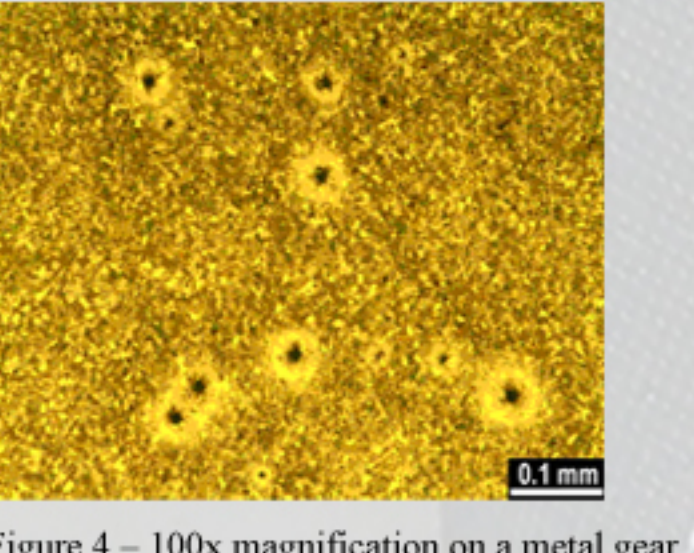


Figure 4 - 100x magnification on a metal gear

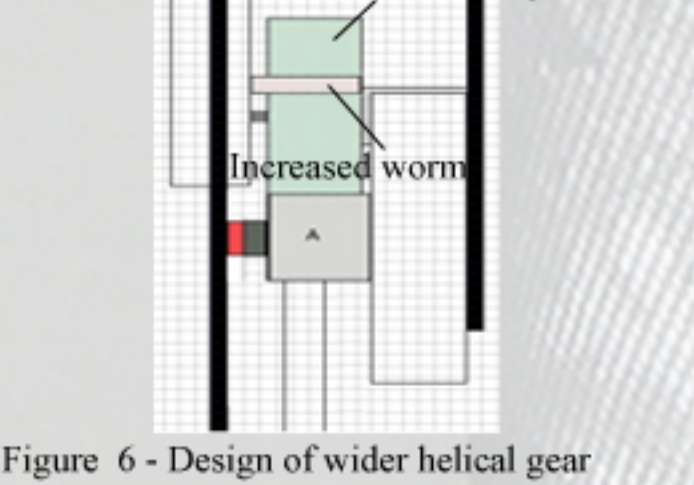


Figure 6 - Design of wider helical gear

-The gears have also been sent for the chemical testing to find the amount of carbon in the metal. Based on the findings, the carbon content is 1.6%.

Solution:
The metal gears used in the shredder are too soft and cannot withstand the load applied. In order for the gear to work, it has to have a hardness of at least 30 to 40 on a C scale of Rockwell hardness test. This can be achieved by performing heat treatment on the gears. Also, the center of the gear can be redesigned to achieve more contact and eliminate failure due to torque.

Issue (Plastic Gears):
Plastic gears fail at initial load or when paper shredder is jammed.

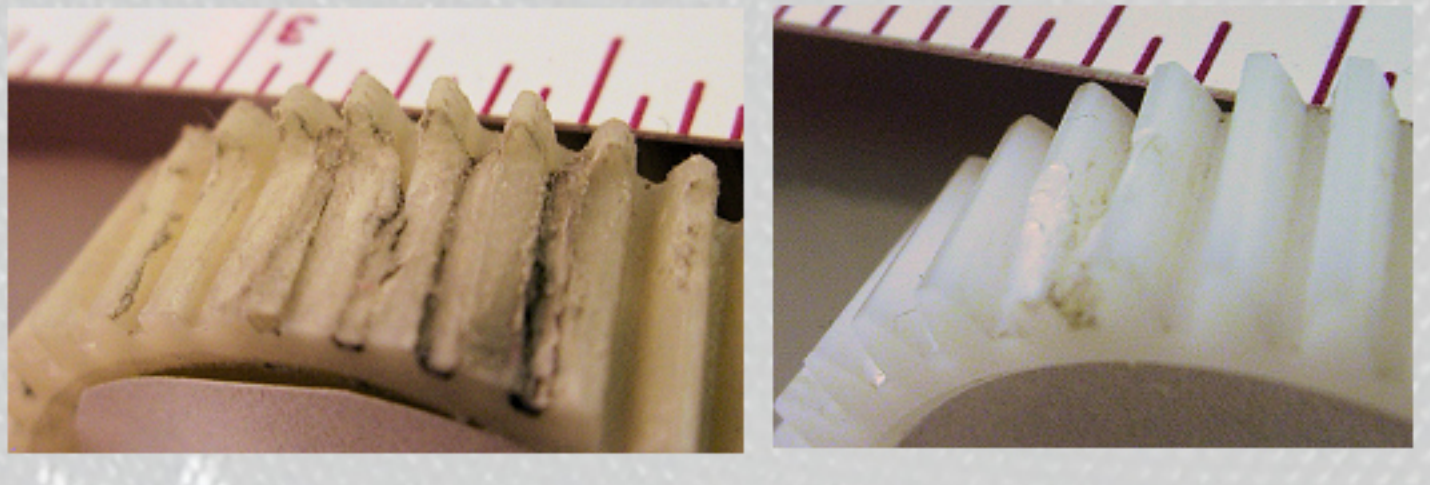


Figure 5 - Brittle (left) and High Strain (right) failures of the plastic gears

Findings:
-Based on the chemical analysis the gears are made of Nylon.
-4in-lb of torque is required to strip the teeth of the gear.

Solution:
-Lengthen Motor Worm and widen the helical gear
-Upgrade the material to glass filled nylon for more strength

Team Sponsor



Manhattan Group brings value to customers and factory partners by providing the best professional services or sourcing solutions for consumer, commercial or industrial hard goods.

Consumer Paper Shredders



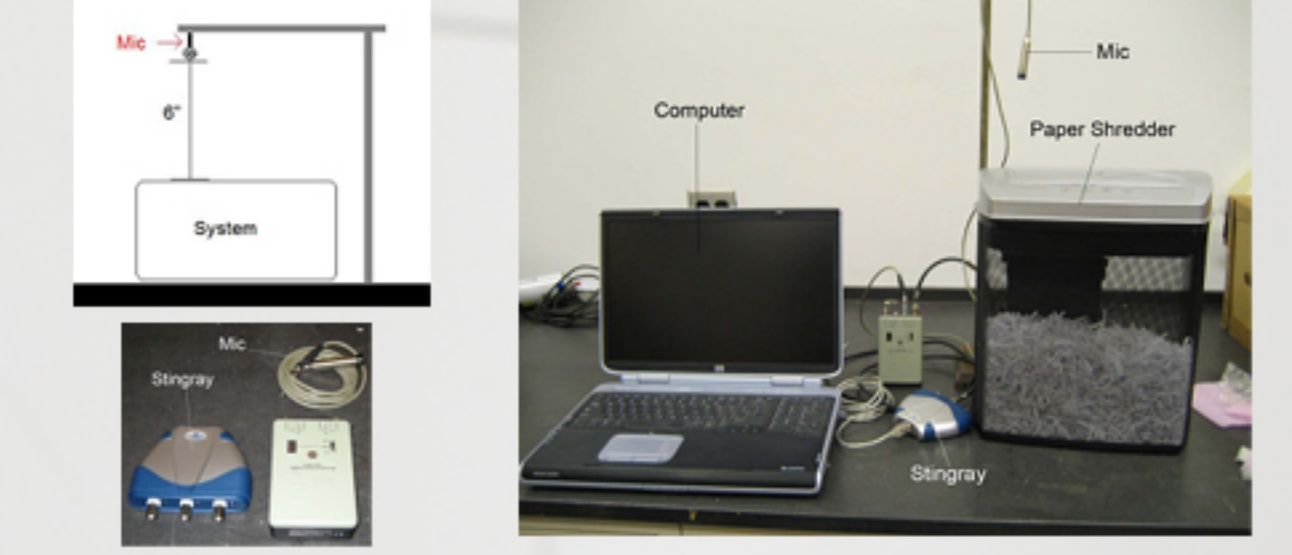
Goals

- Optimize Gear Train to Reduce Gear Failure
- Reduce Operating Noise Output by 10dB
- Evaluate and Advise on Improvements to Enhance Safety Features
- Design More Commercially Attractive Paper Shredder

Sound

Goal - To reduce the general noise output with a target of 10db reduction.
Issue:
- Many consumers report that they are dissatisfied with the level of noise produced by paper shredders.

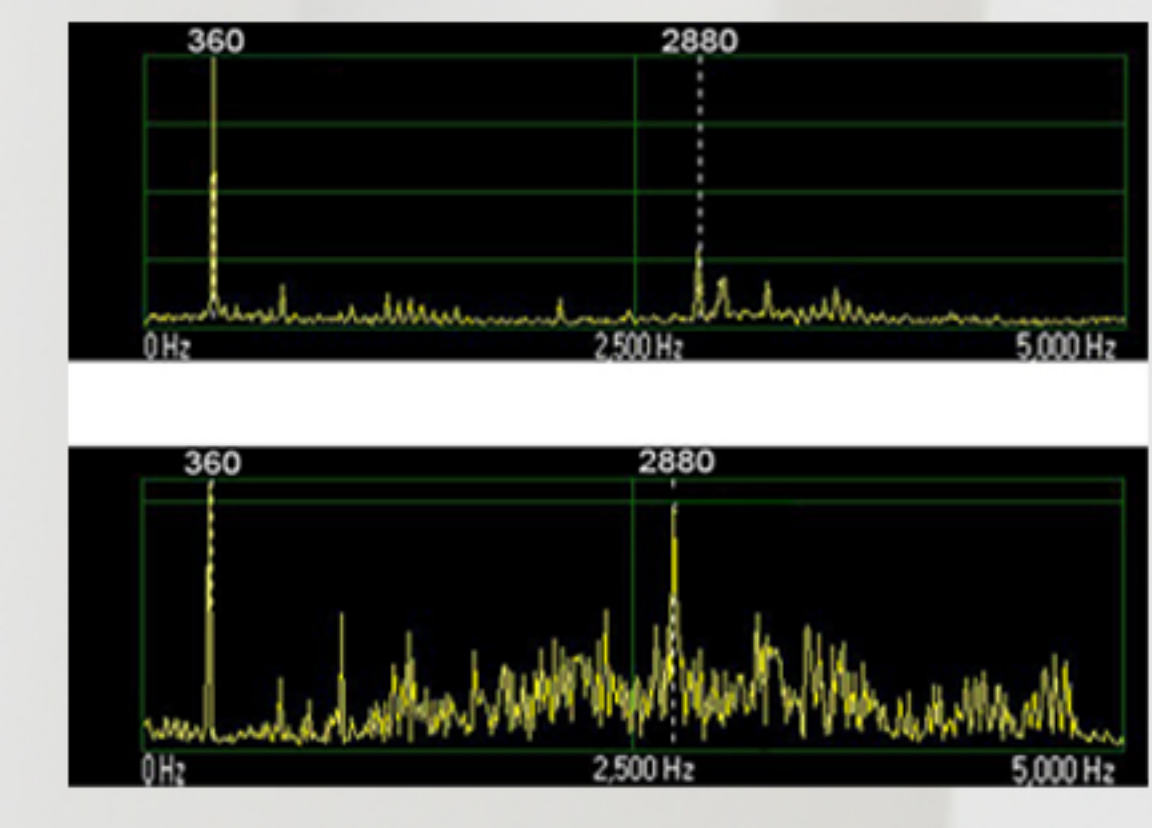
Apparatus and Setup



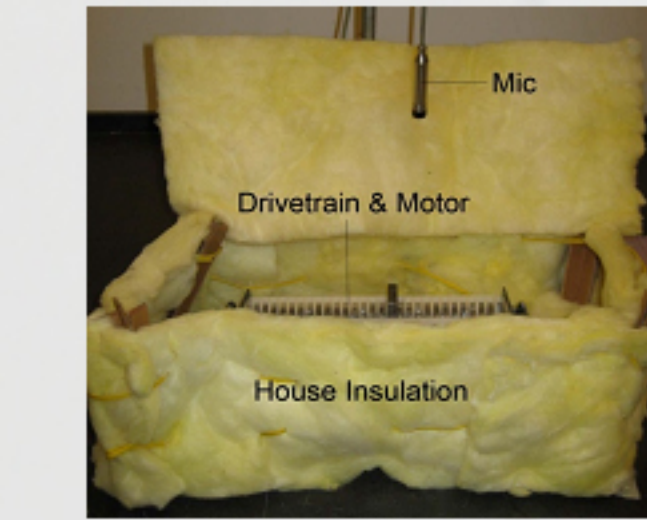
Investigated Solutions:
Active Noise Cancellation
Passive Noise Correction
Noise Dampening

Constraints
Costs must be less than cost to upgrade to DC motor (~\$3.00 per unit)

-Motor Noise:
360hz- 3rd harmonic of power output
2880hz- Vibration from carbon brushings
-Majority of Audible due to motor vibrations transmitted through Gear Train



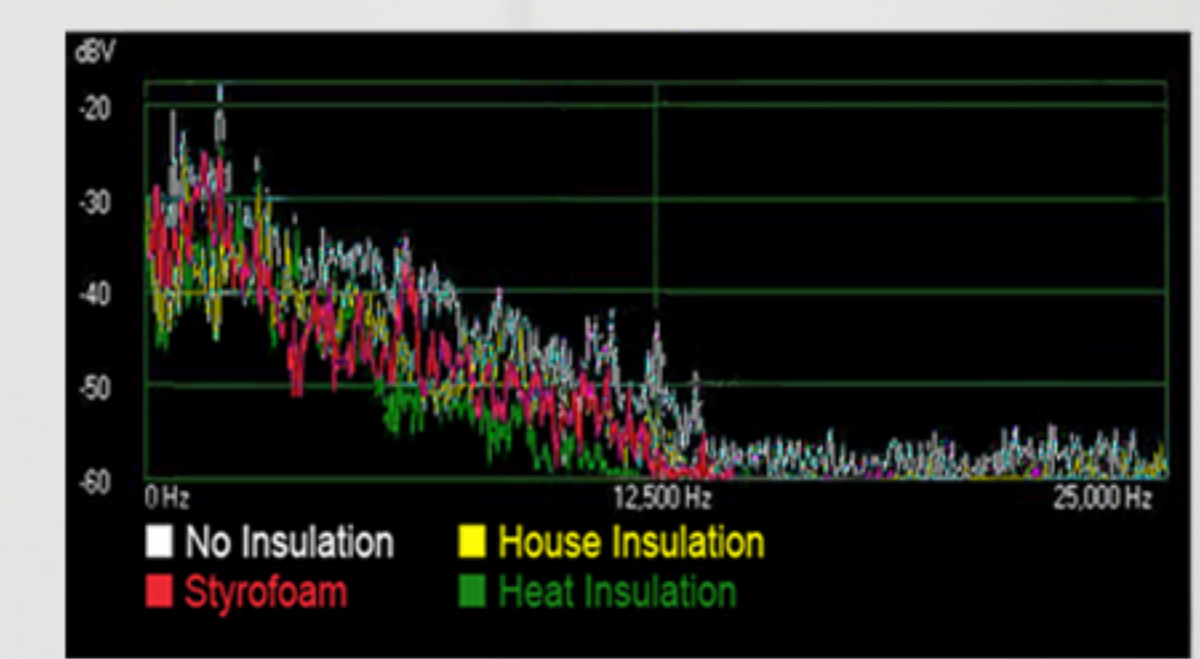
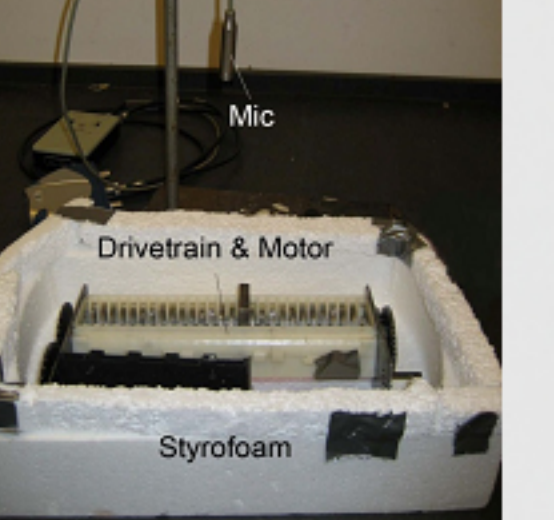
Household Insulation



Heat Insulation



Styrofoam



Recommendations

- Active Noise Cancellation
- High cost
- Passive Noise Correction
- Noise is from the motor vibration
- Addition of a flywheel
- Noise Dampening
- Noise transmitted through case and out from throat
- Recommend angled or shielded throat.

Design

Goal - Evaluate the gears and minimize the gear failure at initial shredding cycle.

Our new design focuses on new shredder features and styles.

- Steps to The New Design:
Team formation
Education and goal setting
Gathering information
Design optimization
3D Modeling



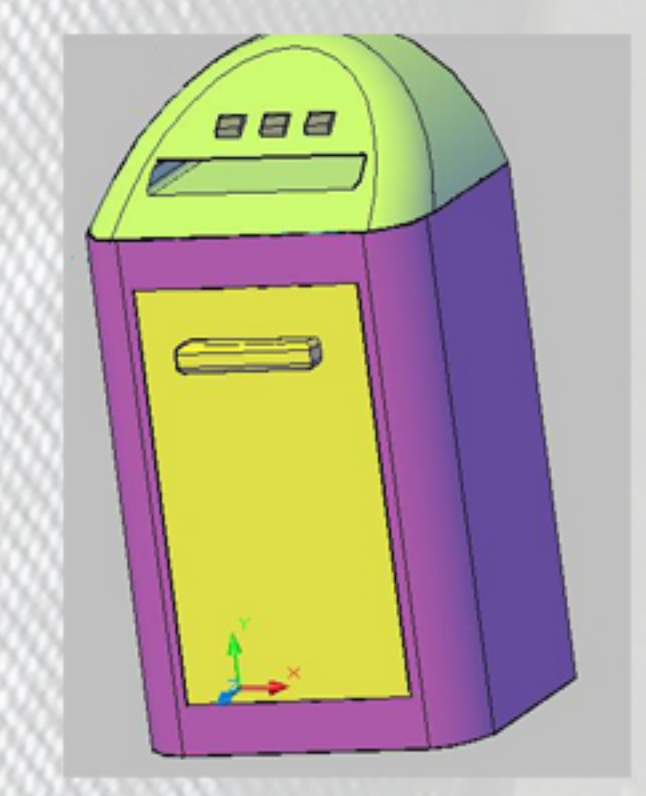
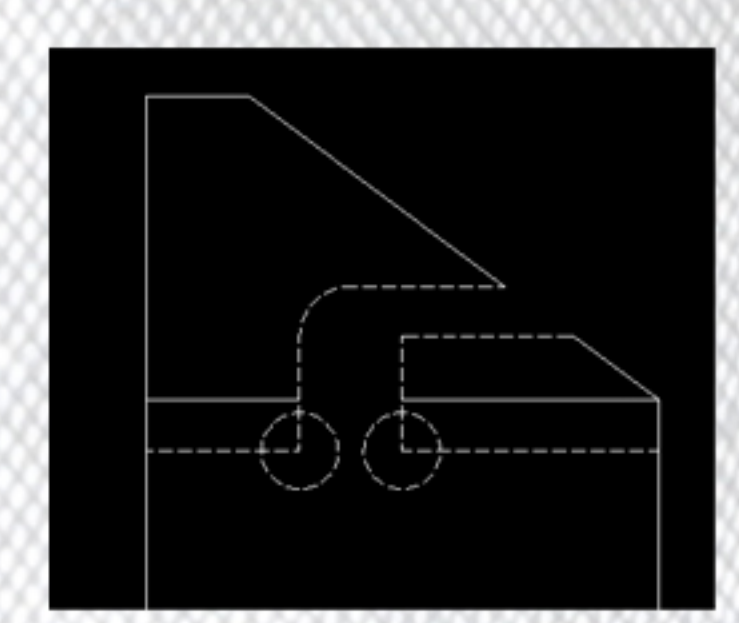
Lightweight Glossy Plastic
Clear Grey Universal Plastic Bin
26" by 10" Dimensions
8-11 Sheet Shredder
Attractive Design
Reasonably Priced



Other New Design Concepts - Blue, Red and Yellow LED Lights in Entry Way



3D Modeling Unique Entry Way



Bright Colors Glossy Black



Bright White

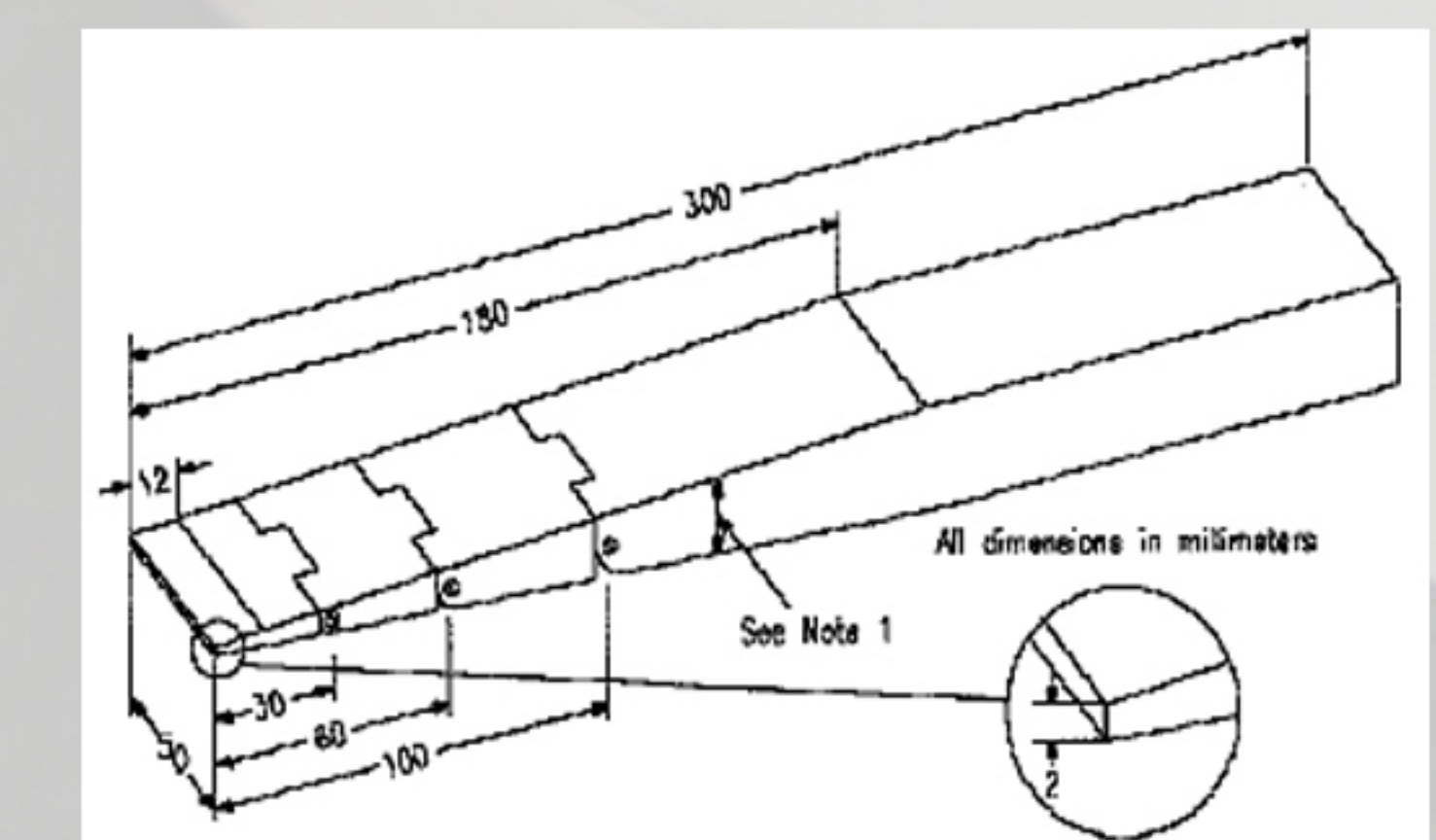


Seasonal Colors



Issue:
-According to the CPSC: finger amputations of young children are among the most serious injuries

Procedure:
-Manufactured a finger probe according to UL Standard
-Check for UL Standard compliance

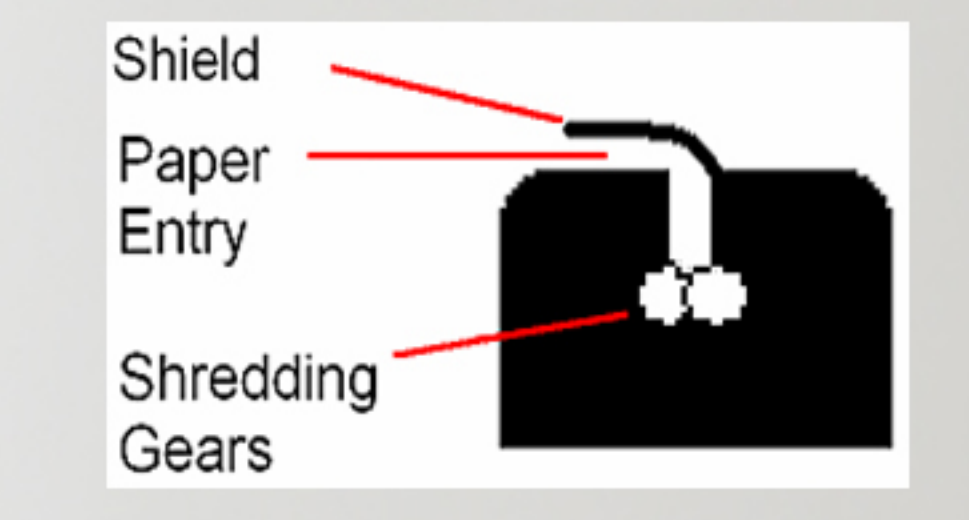
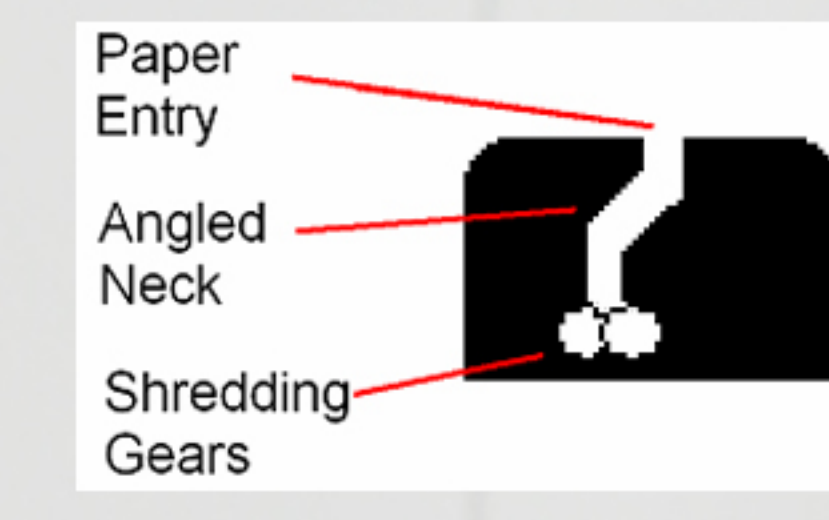


UL Finger safety probe

Safety

Goal - Evaluate the different models and advise improvements to enhance the safety features to exceed the 2007 UL Standards.

Solutions:
- New Design shown below



Suggested new safety sensor technology:
- Capacitive Touch-Sensor:

PARTS	COST (1)	COST (500)	COST (1000)
40106 Hex Inverting Schmitt Trigger	\$0.26	\$0.16	\$0.13
2n5457 JFET	\$0.12	\$0.061	\$0.052
10K Miniature Linear Potentiometer	\$0.28	\$0.22	\$0.21
1N4148 Diode	\$0.02	\$0.009	\$0.007
4 Capacitors (2x1nF, 2x0.1uF)	4 x \$0.10	4 x \$0.05	4 x \$0.03
6 Resistors (6.8k, 2x10K, 100K, 1M, 10M)	6 x \$0.04	6 x \$0.02	6 x \$0.016
TOTAL:	\$1.32	\$0.77	\$0.62

Source: Mouser Electronics <www.mouser.com>