

# IPRO 321

## ENHANCING RELIABILITY AND PERFORMANCE OF A PAPER SHREDDER

### What They Did (Spring 2007)

- Evaluated and studied gears that fail, coming up with the solution modifying materials.
- Successfully implemented several noise dampening materials to the paper shredders; however, this did not prove effective in reducing noise levels.



- Addressed safety issues and suggested a few design considerations such as a capacitive touch-sensor.
- Proposed several different designs for the shredder, from an aesthetic view point.

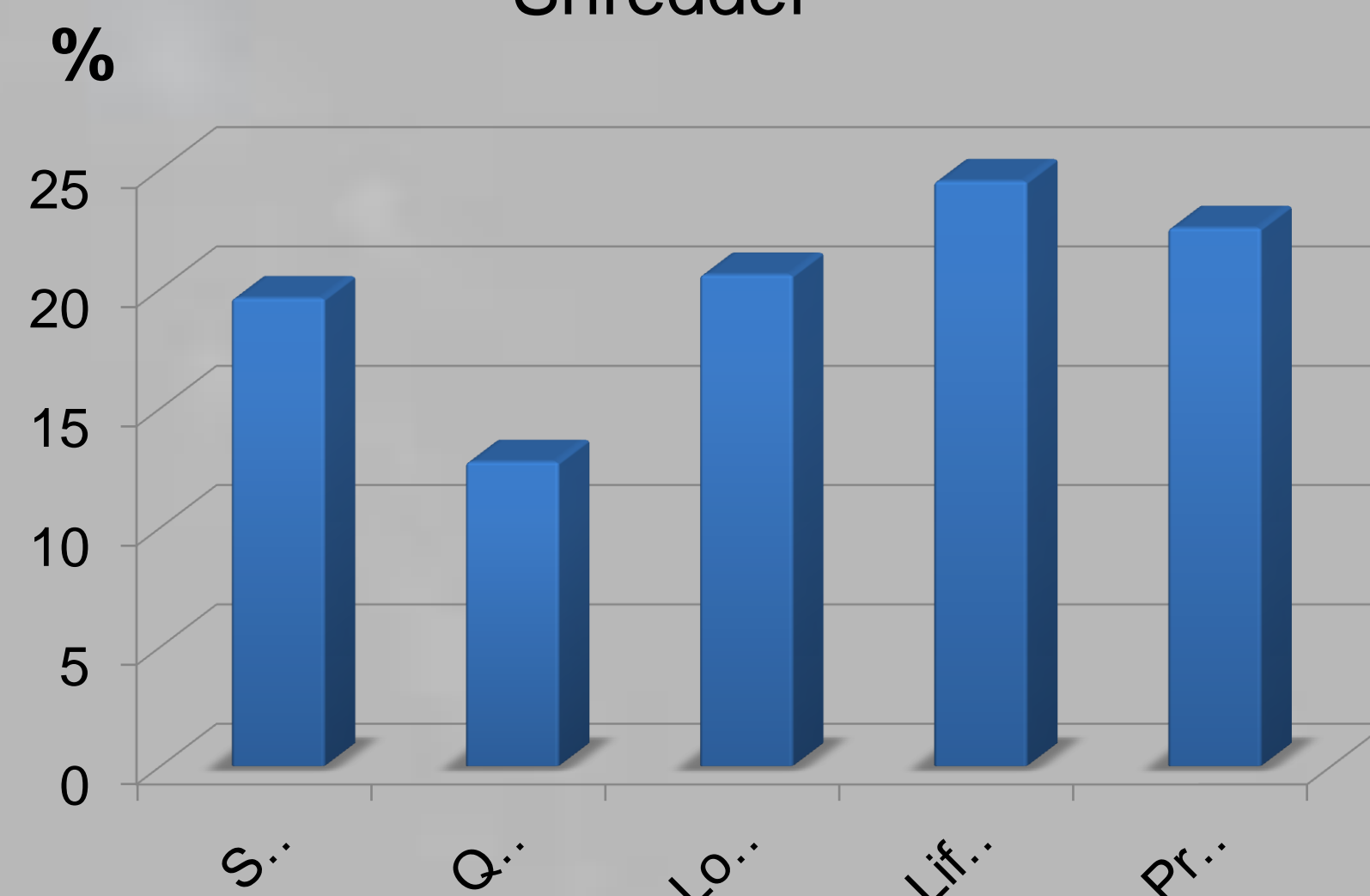
### Background

- Paper shredders have been used in the office environment for many years. Once sold and used exclusively in offices, paper shredders can now be found in consumers' homes.
- The paper shredder the team worked on is a cross cut, Royal brand, shredder.
- A higher end, quieter and more efficient market leading shredder was used as a means to make a product comparison.



### Survey/Stats

Consumer Factors in Selecting a Shredder



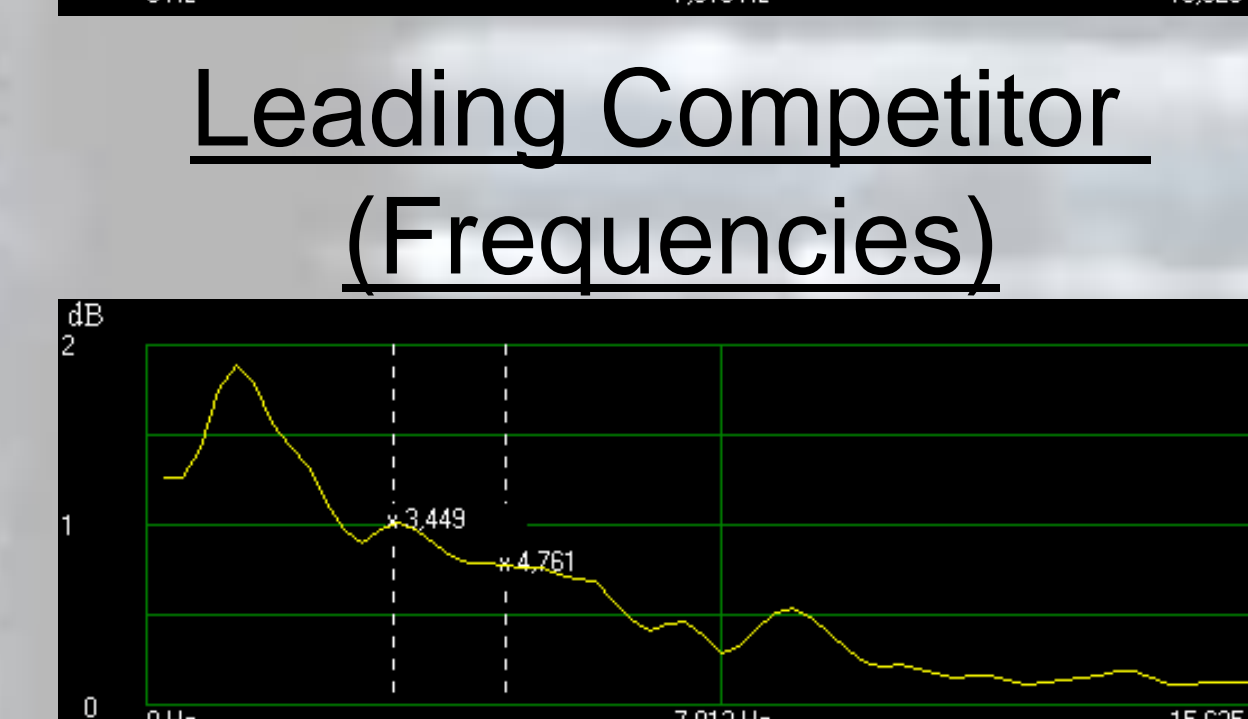
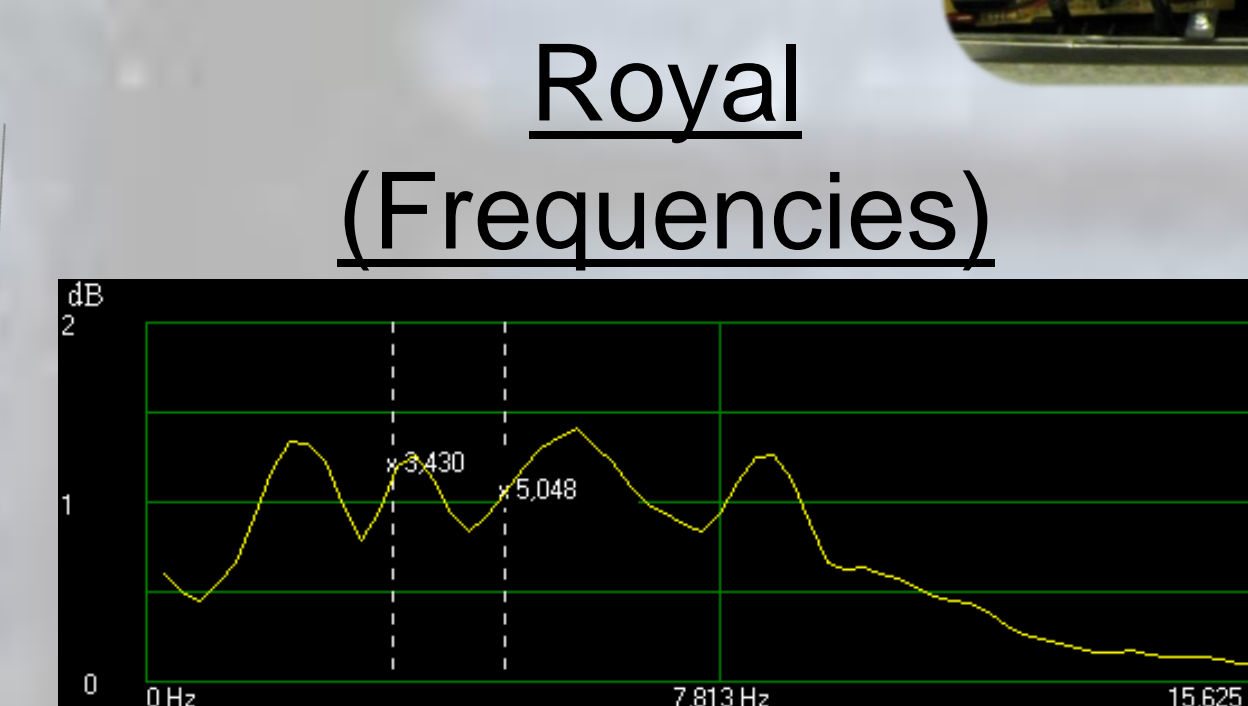
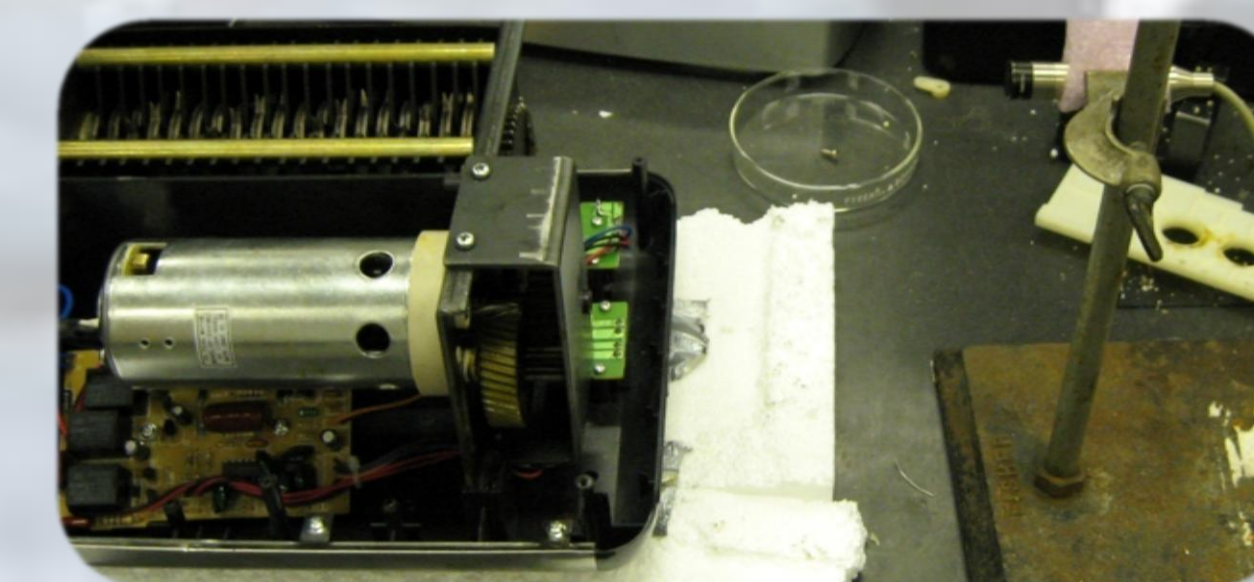
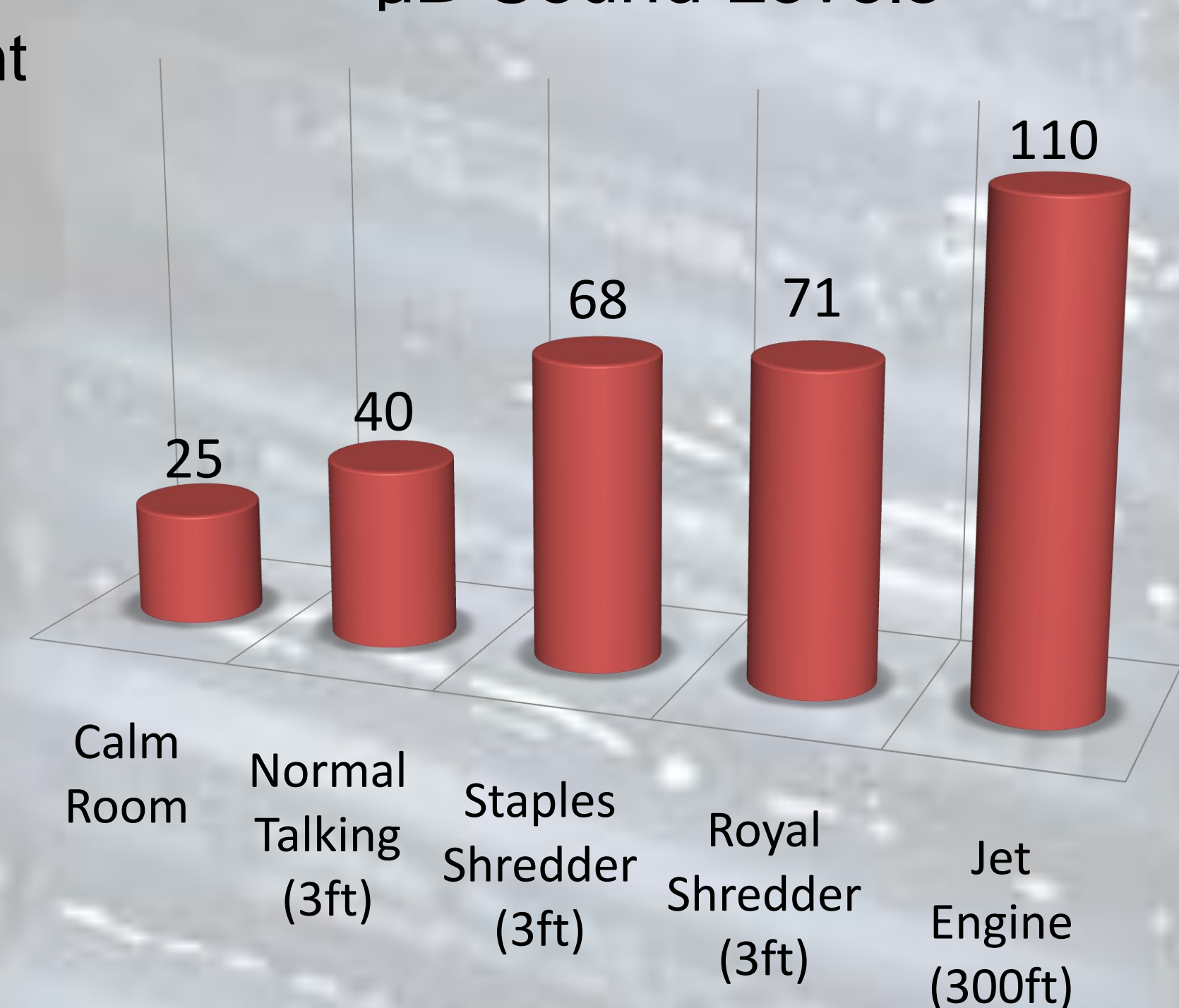
Additional consumer surveys revealed that **1 in 10** people perceived that a shredder operating at a lower frequency and the same noise level as similar shredder operating at a higher frequency was significantly quieter.



- Analyze the noise generated by the shredder and develop acoustical sound dampeners or "tune" the shredder to reduce the amount of noise created during the shredding process, reduce the noise output by 10 decibels or explore other possible means to lessen the unpleasantness of the shredding sound.

### Sound

Tests of the amplitude of the sound generated by the Royal shredder and a market leading shredder showed that the two shredders in question operated at the same sound amplitude.

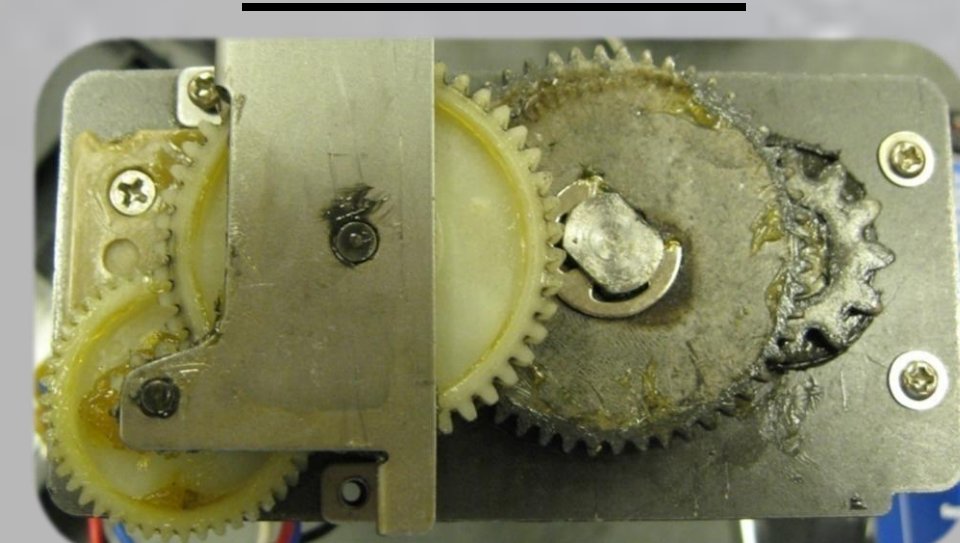


Further sound tests done on both shredders to determine frequencies; revealing that the Royal Shredder operates at both high and low frequency levels and the higher end shredder operates only at low frequency.

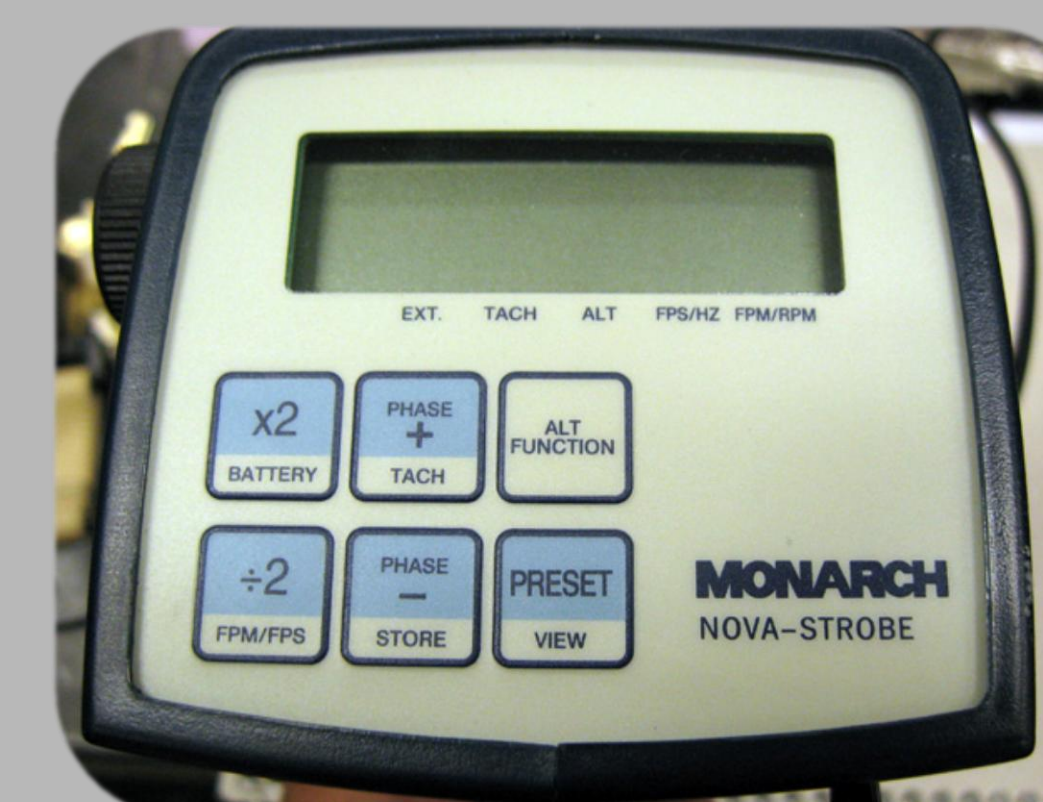
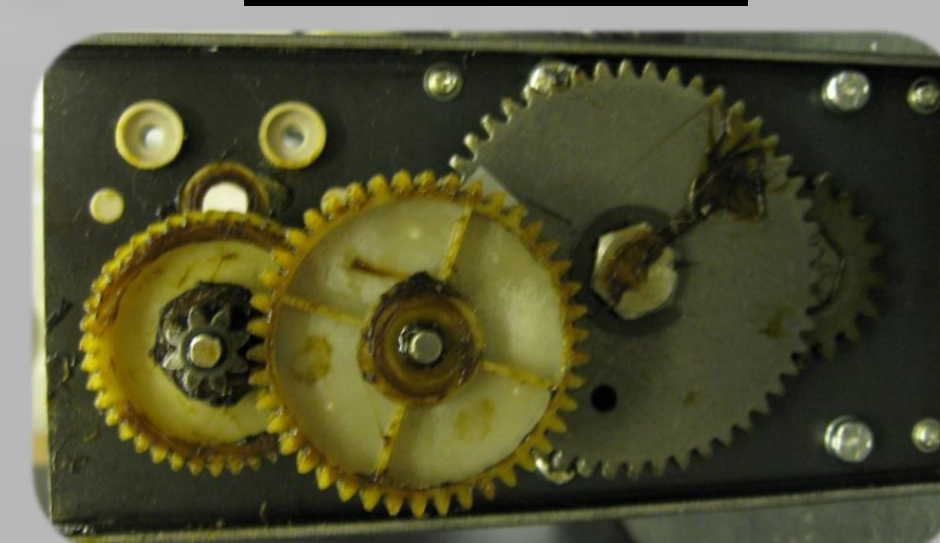
### Gears/RPM

- The RPM of the gear i.e. the speed at which it rotates is proportional to the frequency of the noise it generates.
- Once the motor starts to rotate, the strobe gives a reading of the RPM on its digital display.
- The RPM of the Final drive of the Royal shredder is 68.4 rpm and that of the market leading shredder is 29.7 rpm, confirming initial assumptions.

Royal Gear Train



Market leader Gear Train



- Both shredders employ the same gear train/ gear configuration
- Royal shredder has a gear ratio of 225:1
- Leading shredder has a gear ratio of 450:1
- Market leading shredder shreds slower but operates at lower frequency thus being one of the most bought shredders on the market

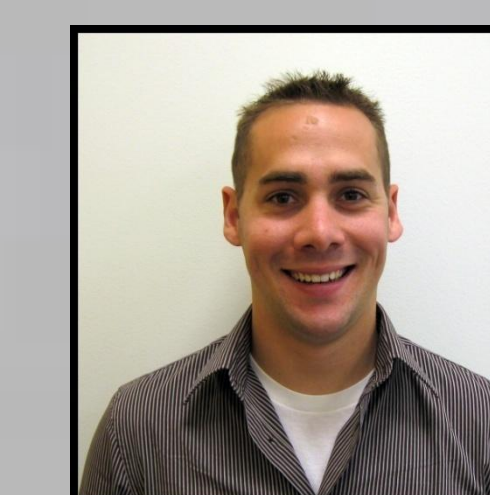
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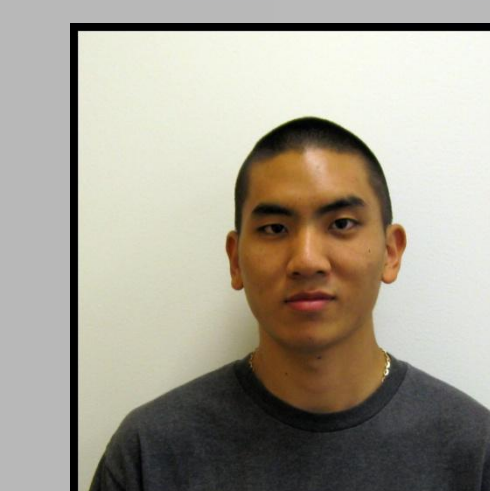
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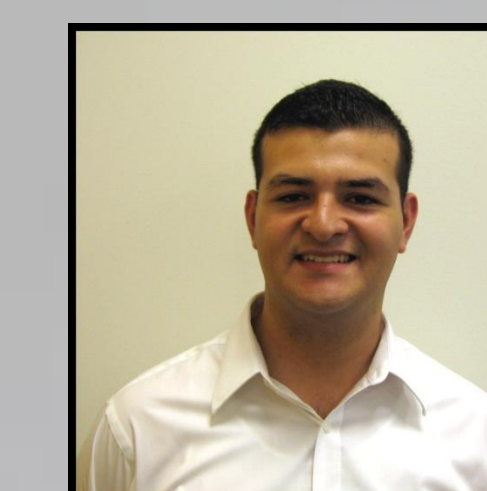
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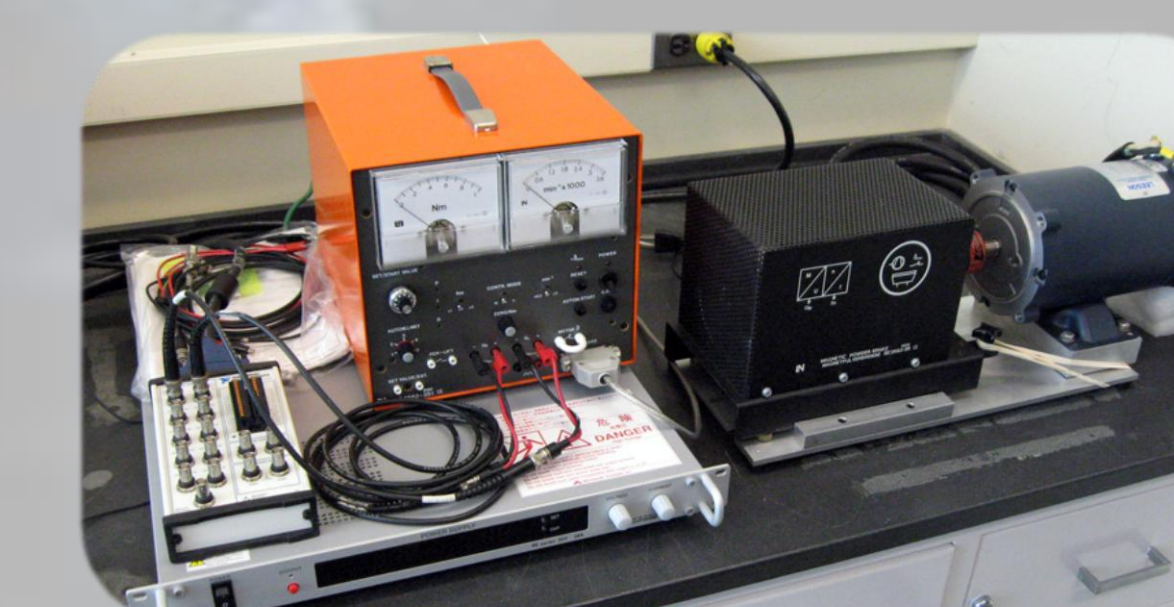


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### Torque



- Torque is a measure of the ability of a rotational motion to do work. Thus, the torque of the motor in a shredder could be an indicator of its ability to shred a given amount of paper.

- This apparatus gives the input torque value via an analog display as well as a voltage output.
- The Royal motor produces 0.160 Nm while the market leader produces 0.317 Nm, which is almost twice the torque the Royal motor generates.

### Recommendations

- Modify current gear train to a new gear train with a gear ratio of about 400:1 by enlarging select gears.
- Selecting bigger gear will extend the life of the gears and hence of the paper shredder. This change is very cost effective.
- This will reduce the frequency of the noise generated by the shredder as it is operating at a lower RPM, thus providing more pleasant operating conditions.
- Change motor to higher end motor which can provide double the amount of torque. This is displayed by extensive tests and experiments.