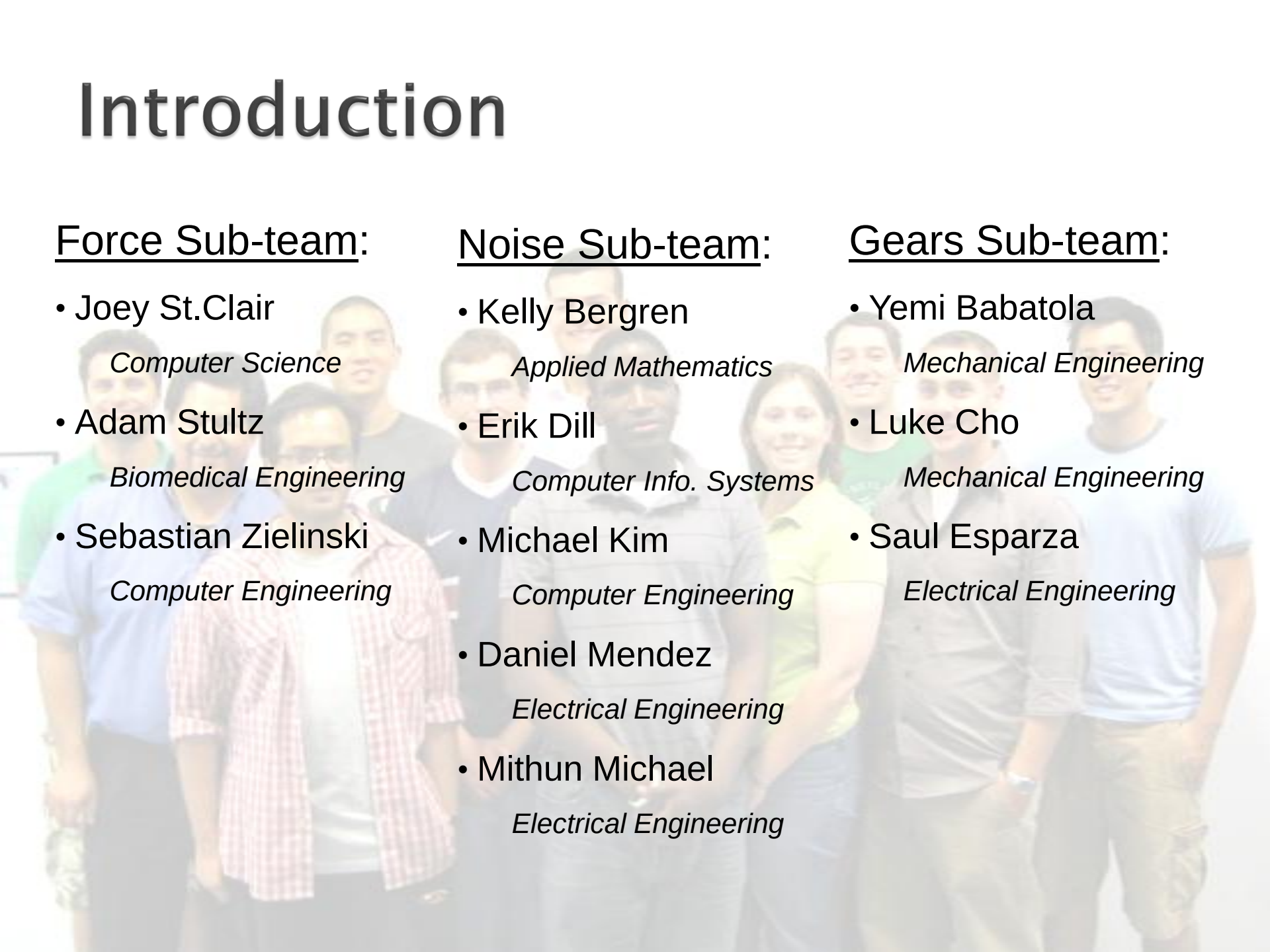
IPRO 321
Improving the Efficiency of a Paper Shredder

Summer 2007

Introduction



Force Sub-team:

- Joey St.Clair

  Computer Science

- Adam Stultz

  Biomedical Engineering

- Sebastian Zielinski

  Computer Engineering

Noise Sub-team:

- Kelly Bergren

  Applied Mathematics

- Erik Dill

  Computer Info. Systems

- Michael Kim

  Computer Engineering

- Daniel Mendez

  Electrical Engineering

- Mithun Michael

  Electrical Engineering

Gears Sub-team:

- Yemi Babatola

  Mechanical Engineering

- Luke Cho

  Mechanical Engineering

- Saul Esparza

  Electrical Engineering

Background

- The Paper Shredder Industry
- -multi million dollar industry
- -fast growing

- Why use a paper shredder?

- The industry today:
- -highly competitive, increasing consumer demand
- -extensive research to improve design

- The Manhattan group
- -Mr. Seth Lewis (sponsor)
- -improve Royal brand paper shredder

Objectives

- Mr. Seth Lewis approached our team with the following tasks
  - Determine force
  - Optimize the gear train
  - Reduce noise

Obstacles

- Shortened semester
- Research time vs. mandatory activities
- Tools
- Inability to contact previous semesters' team members
- Unavailability of professor expertise

Ethics

The IPRO 321 team shall conduct its business in a manner that best serves the community, the sponsor, and all affiliates with the project while acting within the bounds of the laws set forth by any governing board.

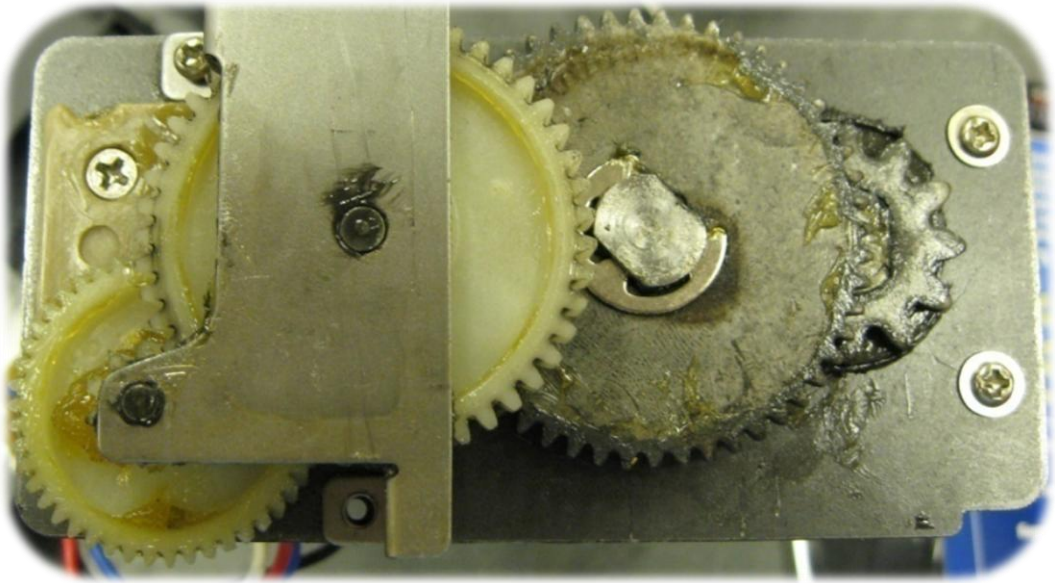
- Questioned sponsor about which ethic guidelines should be respected.
- It is an accepted industry standard to take a current product and reverse engineer it in order to make a new product or make the current product operate differently.
- Assured by sponsor that no ethic guidelines were violated.
- The IPRO team is under no contractual agreement. However, the IPRO team would strive to satisfy the sponsor's demands.
- Provide a professional environment in which all teammates would be treated with the utmost respect.

Noise

- Measurements done on Royal and leading competitor shredders
- Noise primarily comes from the gear train
- The frequency of the noise affects the perception of loudness
- Placement of sound dampening material has a larger effect on noise reduction

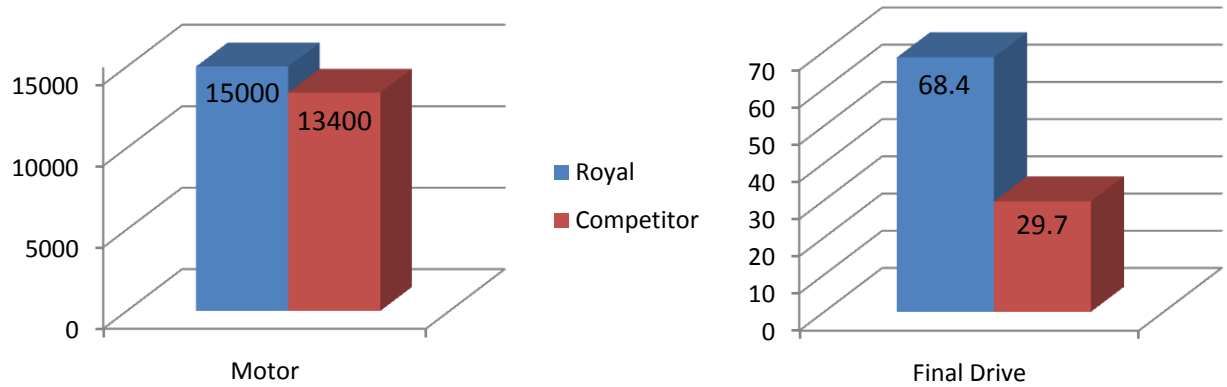
Gear Train

- Gear Ratio?
  - Ratio of input to output speeds
  - Calculated and confirmed using RPM Readings
- 225:1 vs. 400:1
- Shred Speed



Motor Speed

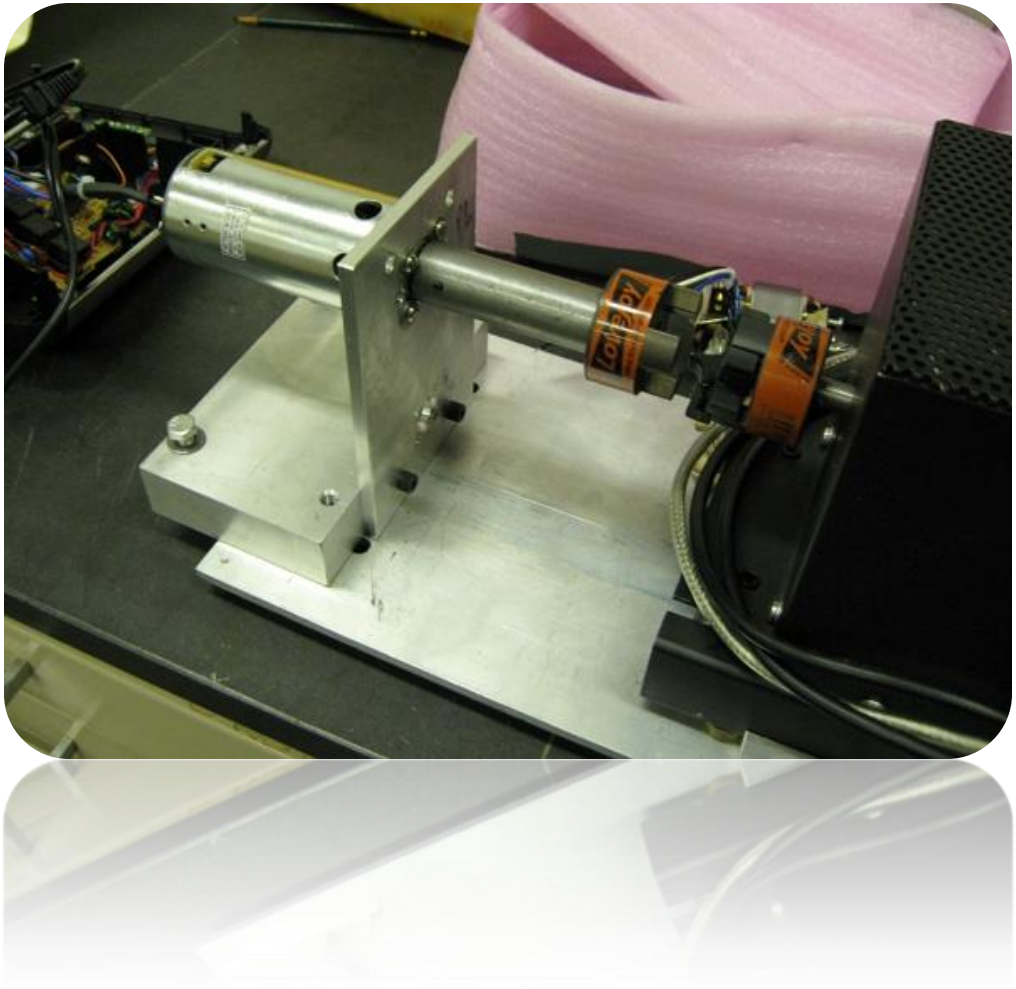
- Higher RPM: Source of High-Frequency Noise
- Royal brand vs. Leading Competitor



- Stroboscope Test – Measure RPM
- RPM $\propto$ Frequency

Torque

- Recommended optimum gear train requires more torque
- More powerful motor required



Conclusions

- Gear train not the motor makes the noise
- Higher gear ratio is ideal
- Higher frequency noise “sounds” louder
- More torque is needed

Recommendations

- Modify current gear train
- Reduce frequency of noise
- Use higher end motor
- Isolate vibrations of motor assembly

Acknowledgements

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  - Mr. Seth Lewis, President of Manhattan Group / sponsor
  - Professor William Maurer, faculty advisor
  - Dr. Sheldon Mostovoy, MMAE professor
  - Russell Janota, lab technician
  - David, Staples' store paper shredder expert