O-Ring Testing and Characterization
Midterm 1 Presentation

Team 1:
Richard Edgerton
Emilio Kenny
Tawakalt Akintola
Kenneth McCloud
Erin Flagler

Sponsored by: Cummins, Inc.
Advised by: Dr. Oates and Dr. Alvi

OUTLINE

- Project Background
- Project Needs and Goals
- Objectives
- Project Scope
- Plan for Prototyping
- Potential Challenges and Risks
- Project Plan
- Future Work
- Summary
- Questions
- References



PROJECT BACKGROUND

- Elastomeric gaskets are used to create seals between mating engine parts that may contain a range fluids.
- Must be designed to withstand high temperatures, corrosive chemicals, high pressures, and overall harsh conditions
- Elastomeric gaskets are not always circular in cross section.
  - Certain cross sections perform better in particular applications
  - Reduction in gasket material used reduces cost
- But, designing for irregular cross sections is costly and time consuming
  - Multiple iterations using FEA

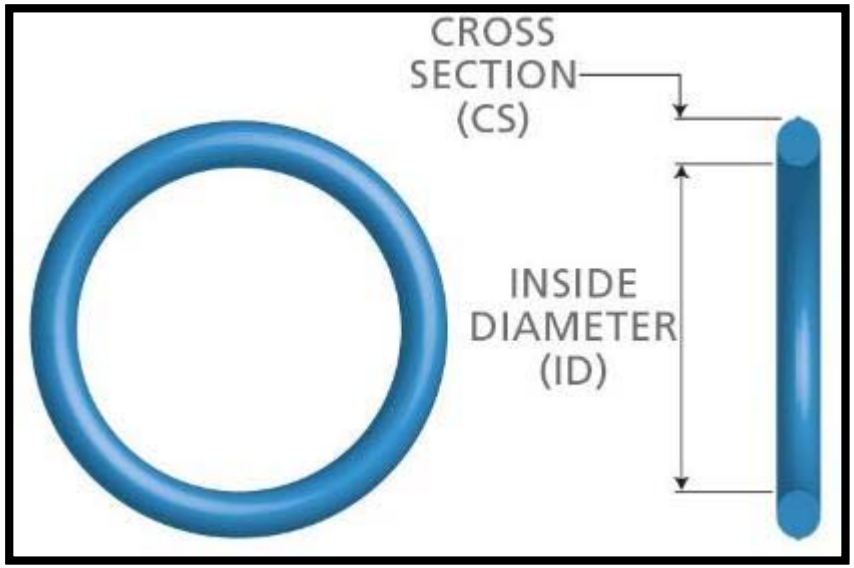

Figure 1: O-ring Profile[1]

Figure 2: Varying O-ring Cross Sections

PROJECT NEEDS AND GOALS

- **Needs Statement:**
  - The current design process for elastomeric gaskets requires numerous iterations of finite element analysis, which is lengthy and therefore costly.
- **Goals:**
  - Devise a method that will utilize design parameters
    - Relatively accurate starting point for design
    - Reduce the number of iterations needed
    - Reduce time and effort needed for design process

Figure 3: Irregular Gasket Cross-Section

OBJECTIVES

- Design a test fixture for the uniaxial compression material testing system (MTS)
  - Various cross sections and sizes
  - Measure load corresponding to percent crush value
  - Measure sealing pressure using Fujifilm Prescale
- Manipulate test data to find a correlation
  - Define shape factors from correlation for each cross section
- Create 3-D contour plot from test data
  - Given shape factor and percent crush, estimate sealing pressure

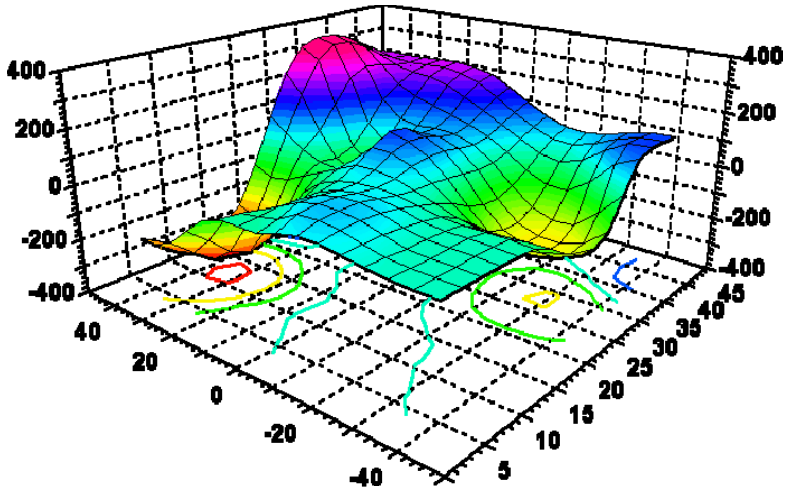

Figure 4: Example of Contour Plot

PROJECT SCOPE

- The new method will be applicable to numerous cross sections and sizes.
  - Material confined to FKM
    - 80% fluoroelastomers, resistant to heat and chemicals
    - Most commonly used by Cummins in critical applications
  - Cross sections to be determined by Cummins
  - Cross sections ranging from 1-10 mm
  - Limited to applying 1 kN load

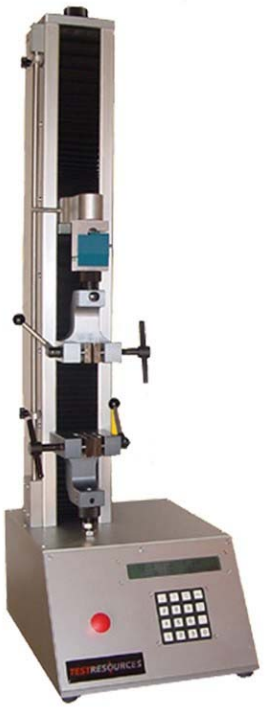

Figure 5: MTS Testing Machine[2]

PLAN FOR PROTOTYPING

- Awaiting cross section specifics
- Test fixture requirements
  - Designed to work with MTS machine
  - Grooves
    - Depth and width to be selected according to Cummins design standard
    - Design dictated by number of cross sections and sizes Cummins assigns
    - Adjustable or rigid grooves
    - Must be centered under load
  - Sample must be parallel to load surface
    - Locking mechanism
    - Self leveling using spherical joints
- 3-D contour plot requirements
- Axis
  - Percent crush defined by application
  - Shape factor defined by cross section
  - Sealing pressure estimate
- Sealing pressure estimate to be checked against measured value.

POTENTIAL CHALLENGES AND RISKS

- Material
  - Material shipping delays
  - Material shortage
- Budget
  - Testing material costs exceed the $2000 budget
- Testing Preparation
  - Test fixture parameters undefined
  - Testing fixture not fabricated in time
  - Testing fixture produces inaccurate data
- Final Product
  - Data Analysis leads to nonexistent correlation

PROJECT PLAN

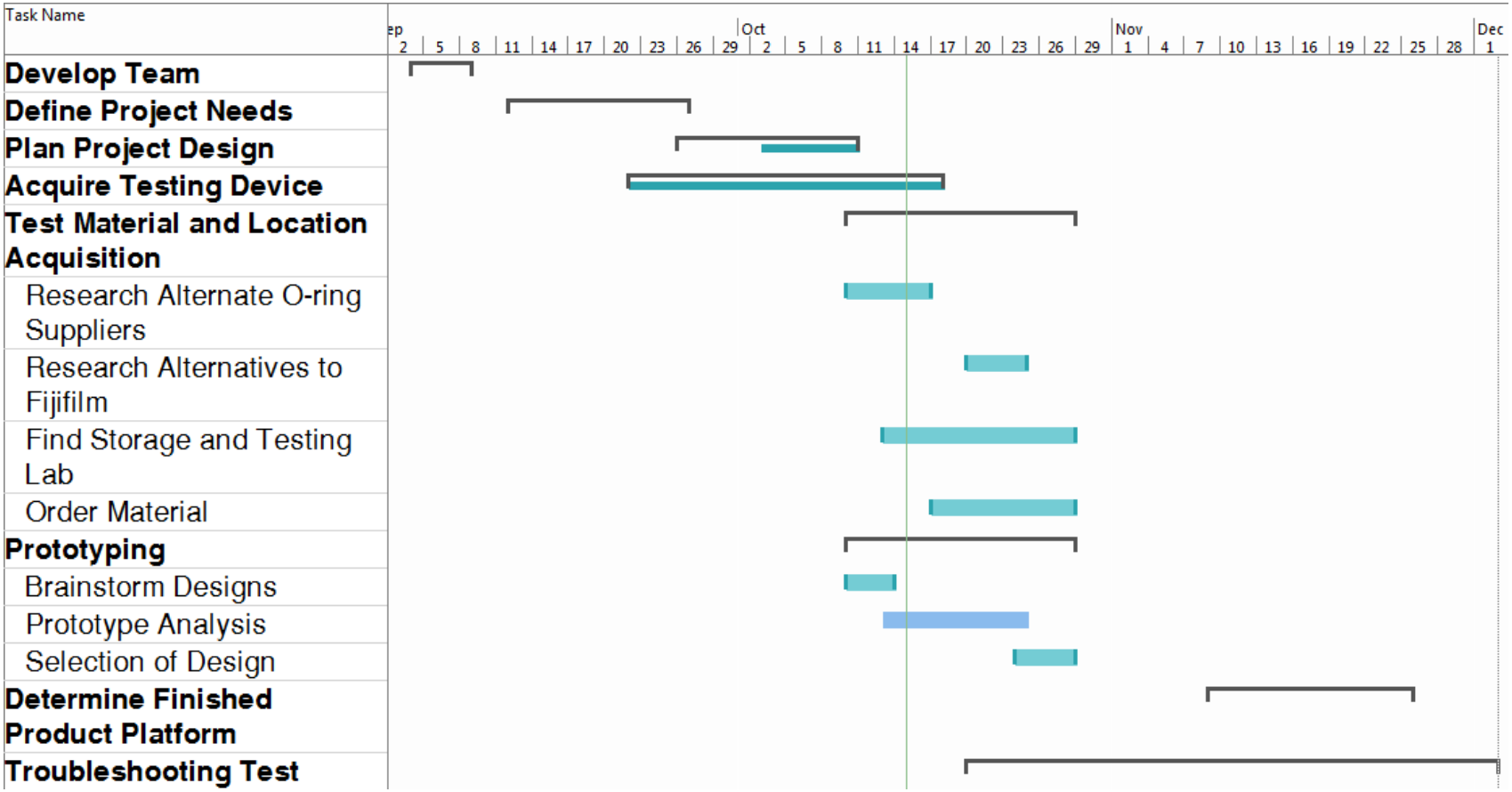

Figure 6: Condensed Gantt Chart

FUTURE WORK

- Research groove designs
- Design and prototype testing fixture
- Order materials
- Research data manipulation methods
- Run Practice experiment

SUMMARY

- Our project goal is to reduce time and effort needed to design elastomeric sealing components of irregular cross section by developing a method for estimating sealing pressure.
- In order to accomplish this:
  - Design test fixture to be used with MTS machine
  - Record data such as load needed to compress sample and sealing pressure.
  - Analyze test data to find correlation across numerous cross sections and sizes
- Challenges
  - Material accessibility
  - Over budget costs
  - Testing setbacks
- Next Steps
  - Designing a test fixture
  - Researching data manipulation methods

QUESTIONS? COMMENTS?

REFERENCES

1. *Typical O-Ring Model*. n.d. Webpage. 10 October 2014. <http://fs23.formsite.com/parcoinc/images/O-ring_Cross_Section_V2.jpg>.
2. *MTS Machine*. n.d. Webpage. 10 October 2014. <http://www.testresources.net/200-series-electromechanical-test-machines/210m1125-standalone-test-machines/>.
3. *3D Contour Plot*. n.d. Webpage. 10 October 2014. <http://www.agocg.ac.uk/reports/graphics/34/appii97/chapte_7.htm>.
4. *Fujifilm Paper*. n.d. Webpage. 10 October 2014. <http://sensorprod.ca/>.