O-Ring Testing and Characterization
Midterm 1 Presentation

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OUTLINE

- Project Background
- Testing Method
- Challenges and Risks
- Summary

PROJECT BACKGROUND

- Cummins current sealing ring selection process requires extensive FEA
- Elastomeric sealing rings
  - Used to seal mating engine components
  - Resistant to high temperature, pressure differences, and corrosive chemicals
- Not always circular cross sections
  - Certain cross sections perform better in particular applications
  - Reduction in material used reduces cost

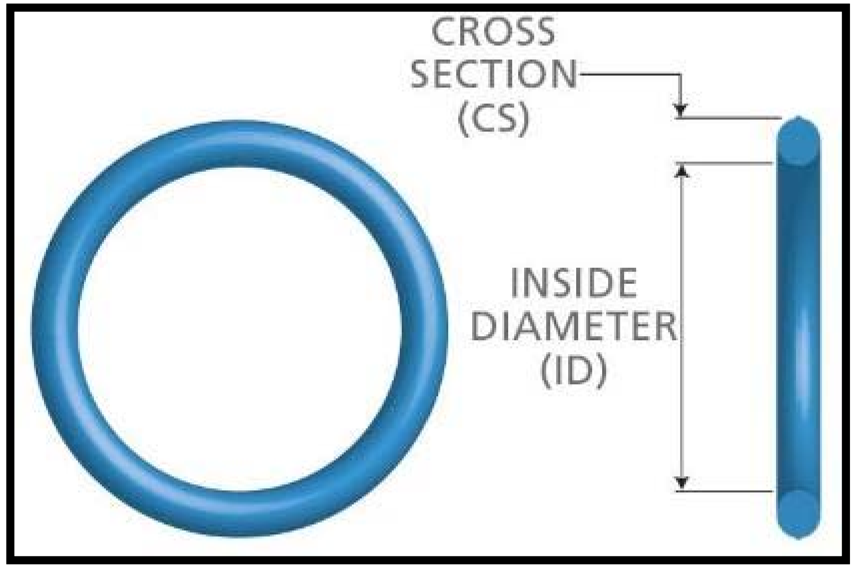

Figure 1: True O-Ring Profile[1]

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Midterm 1 Presentation

PROJECT GOALS

- Find a way to simplify the sealing ring selection process
  - Provide approximate starting point for selection
  - Reduce analysis iterations
  - Reduce time and effort needed for selection process

Figure 2: Seal Rings with Irregular Cross Section

Figure 3: Various Existing Seal Ring Cross Sections

OBJECTIVES

- Test Sealing Rings
  - Design test fixture
  - Test various cross sections
  - Measure sealing pressure corresponding to percent crush value
    - % crush is the differential between compressed and uncompressed height
- Analyze Test Data
  - Create a geometric shape factor that correlates with percent crush, and sealing pressure
  - Use new shape factor to form a 3-D contour plot
  - Create an interface that will allow users to access date from contour plot

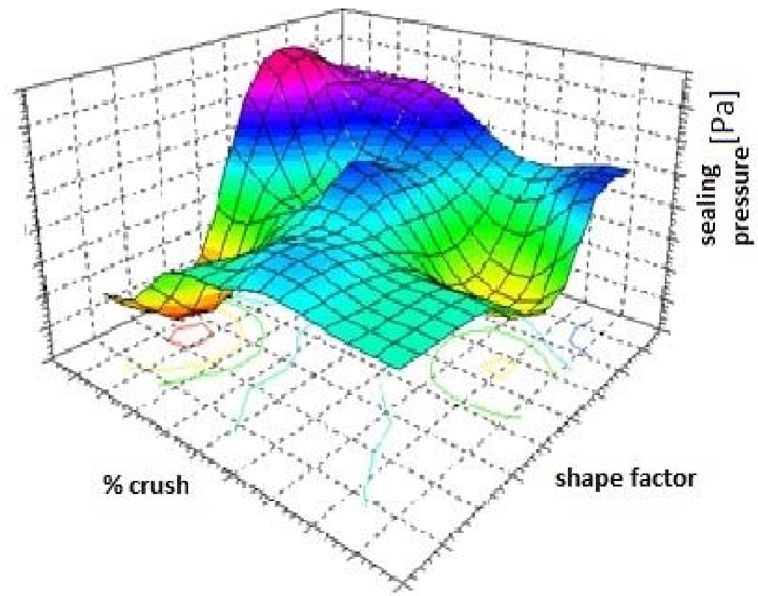


Figure 4: Generic Contour Plot

PROJECT SCOPE

- Devised method will be applicable to numerous cross-sections of FKM sealing gaskets
  - FKM material
    - Classifies 80% of fluoroelastomeric material
    - Is very resistant to heat and chemicals compared to other elastomers
    - Common material used by Cummins, Inc. in critical applications
  - Cross sections determined by Cummins, Inc.
    - 23 total cross-sections
    - Cross sections ranging from 1 mm to 10 mm
    - Limited to applying 1 kN load by MTS machine

Testing Method

- Testing Parameters
  - Multiple increments of percent crush (10%, 15%,....40%)
- Testing Variables
  - Load
  - Sealing Pressure
  - Shape Factor

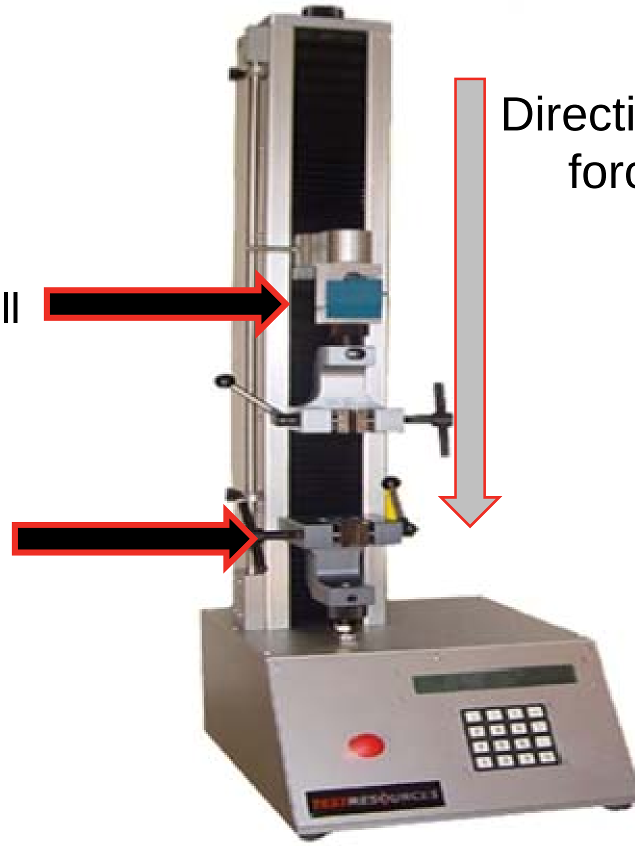
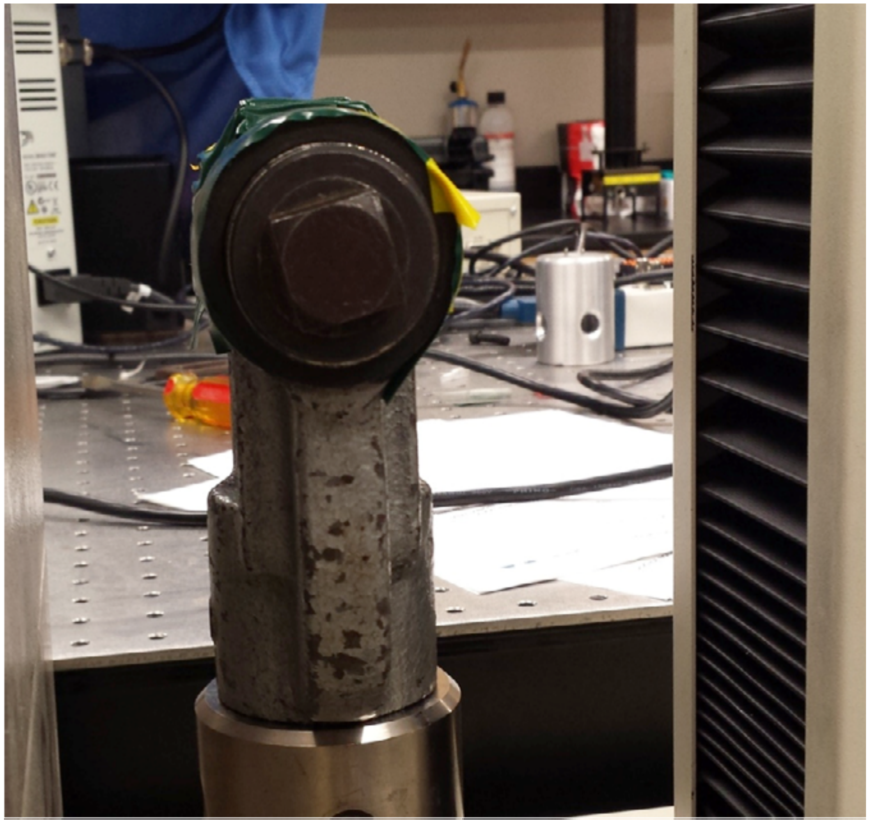


Figure 5: MTS Machine

Testing Method Continued



Side Picture of MTS Vice

Top-Down Picture of MTS Vice

Erin Flagler

Test Fixture Design

- Designed to work with MTS machine
- Individual groove plates
  - There will be individual plates for each cross section
  - Change with depth and width
- Sample must be parallel to load surface
  - Sample vice mechanism on MTS machine should self-level

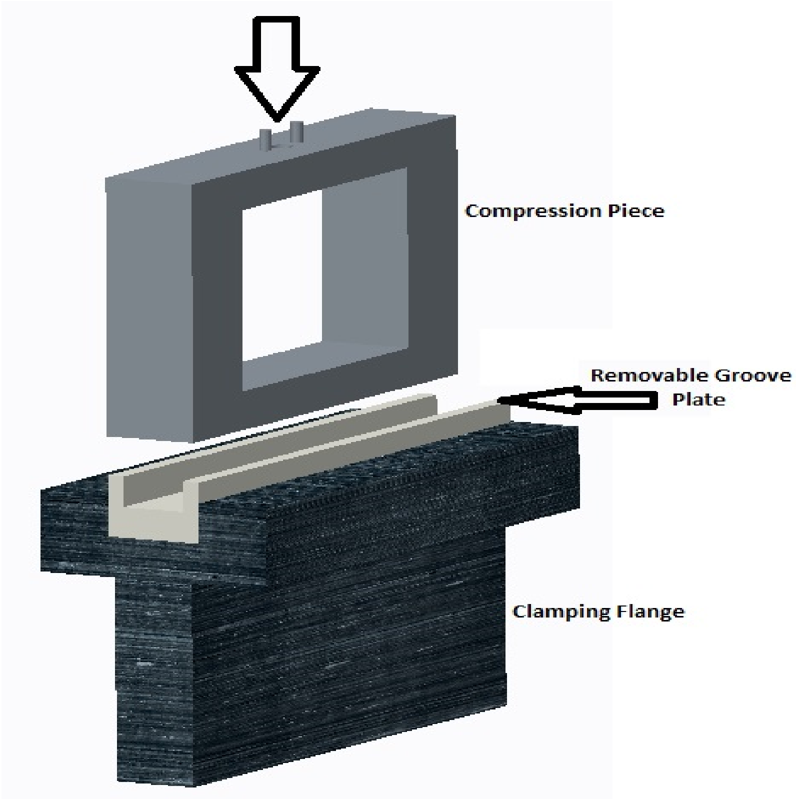


Figure 6: Test Fixture Prototype

CHALLENGES AND RISKS

- Technical Challenges
  - Test fixture concept must be rigid and level
  - Working under fairly tight tolerances
- Test Procedure Consistency
  - Ensure reliable and easily reproducible data
  - Account for errors and pressure sensitive paper
- Data Analysis
  - Mapping multiple, non-linear stress-strain curves to one another
  - Amount of data to be collected and analyzed is very large

PROJECT PLAN

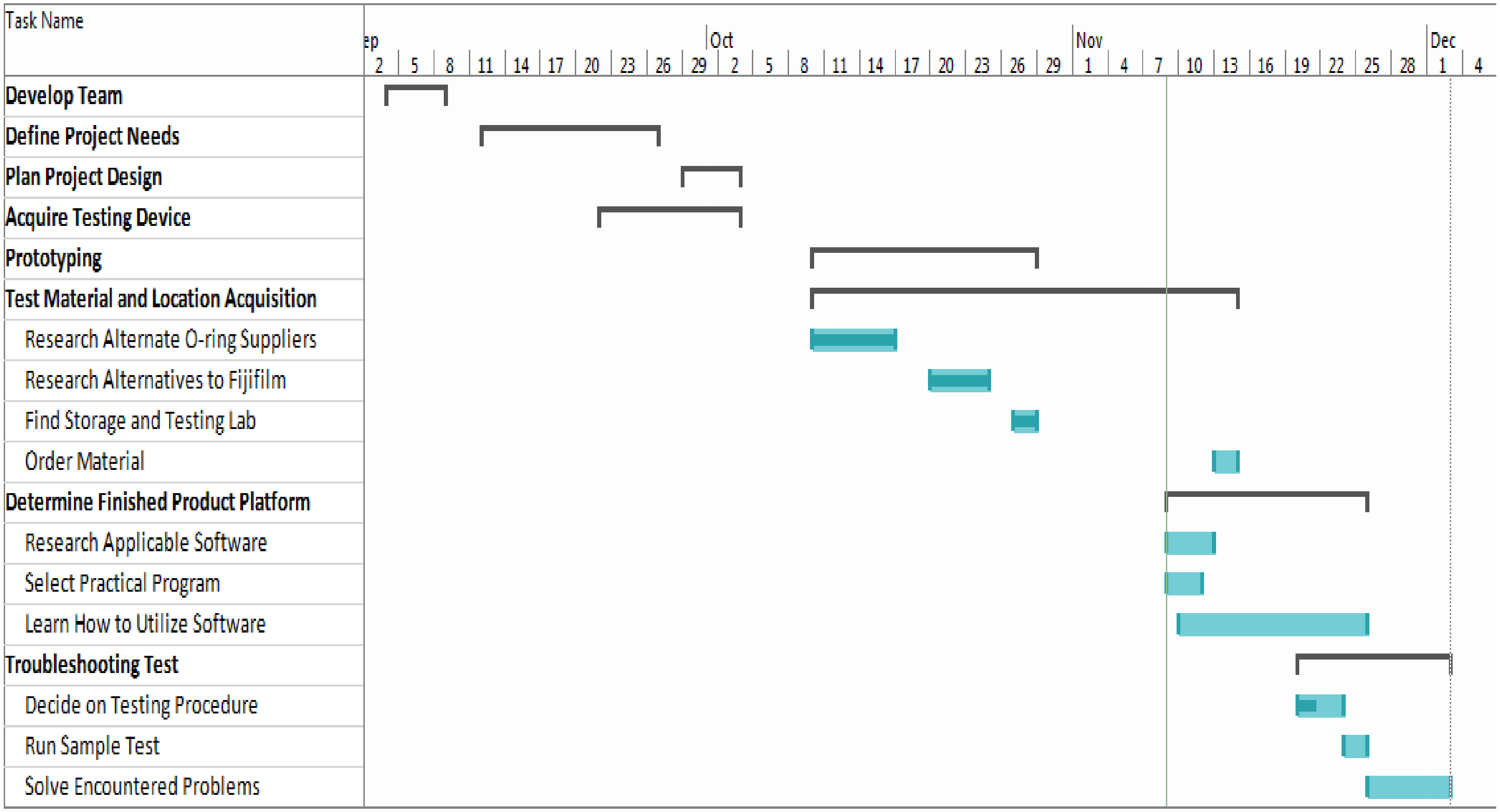


Figure 6: Gantt Chart

FUTURE WORK

- Order test fixture materials and FujiFilm pressure sensitive paper
- Machine test fixture concept
- Begin testing and data acquisition
- Research data analysis methods

SUMMARY

- In order to accomplish our goal:
  - Design test fixture to be used with MTS machine
  - Record data such as load needed to compress sample and percent crush
  - Analyze test data to find correlation across numerous cross sections and sizes
  - Develop Shape Factor
- Challenges
  - Test and data consistency
  - Technical challenges
  - Data analysis

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>.
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