Super Seal:
Development of a Robust 2nd Stage Oil Sealing Device for Heavy Duty Engines.

Design Review Presentation

February 21, 2017

Sponsor: Cummins Inc., Liaison Engineer - Terry Shaw

Faculty Advisor: Dr. William Oates

Course Instructor: Dr. Chiang Shih

Team 1 Members:

Christian Milione

Kyle Brooks

Jonathan Strickland

Olaniyi Ogunbanwo

Sean Casey

Cummins' Heavy Duty Truck engine, the ISX 15 @ 15 Liters, 600 HP

Presentation Overview

- **Project Review**
  - Background Information
  - Project Description
- **Ideal Design**
  - Test Rig Design
  - Capture Method Design
- **Testing Phase**
- **Future Work**
- **Challenges**
- **Project Schedule**
- **Conclusion**

Presenter: Kyle Brooks

Project Background

What's The Problem?

- Motor oil is repeatedly leaking past the rear crankshaft seal.
  - Failed seal[1]
  - Material fluctuations due to thermal transients

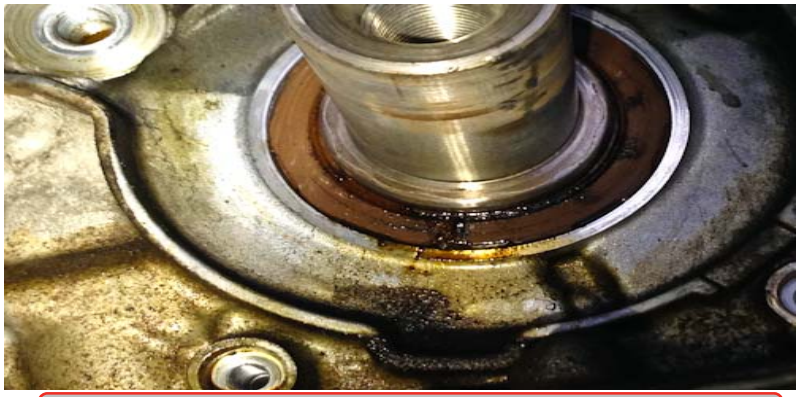


Figure 1: Depiction of rear crank seal leaking oil.[2]

Motivation

- Cost
- Evolution of Customer Perceptions

Figure 2: Cummins' newest engine,
the Hedgehog @ 95 Liters, 4500 HP
Cost for crank seal replacement: $21,000.[3]

Project Background

Goal Statement

- Design a device to capture leaking oil from a rotating test crankshaft and deposit it into a reservoir so that is can be reintroduced to the crankcase.

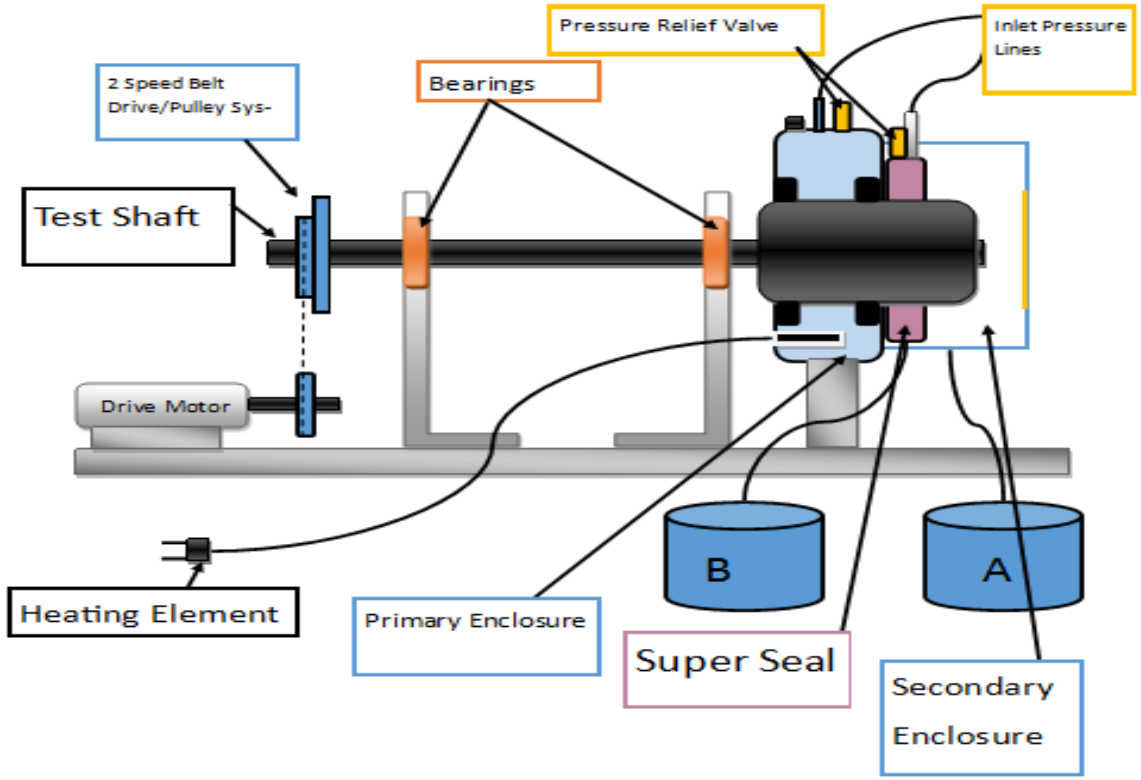
Special Consideration

- Test Rig
  - **Primarily demonstrate functionality/performance of design solution.**
  - **NOT to demonstrate life capabilities of design solution.**

Project Objectives

Key Project Objectives	
1.) Design oil capturing device	☑
2.) Design Test Rig to show functionality of design	☑
3.) Determine feasibility of each design with technical proof	☑
4.) Obtain needed components to build such devices	On Going
5.) Construct oil capture device and Test Rig	Future Work
6.) Perform 24 hour test to asses functionality of devices	Future Work

Ideal Macroscopic Design



Test Rig Assembly

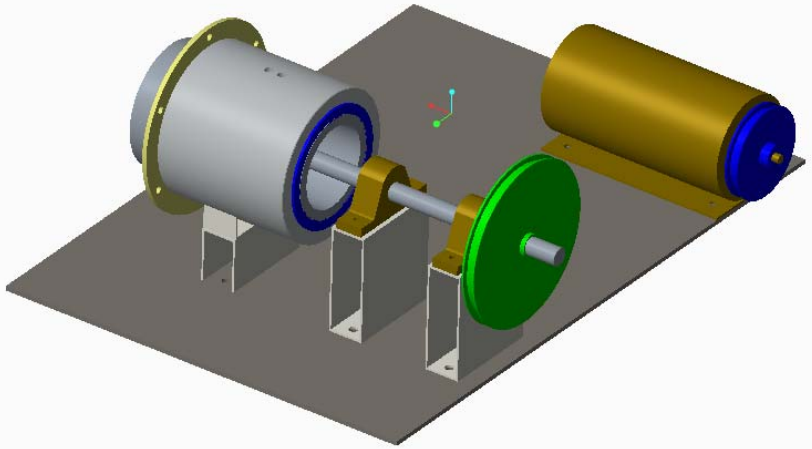


Figure X : Cad Assembly of Test Rig Orientation 1

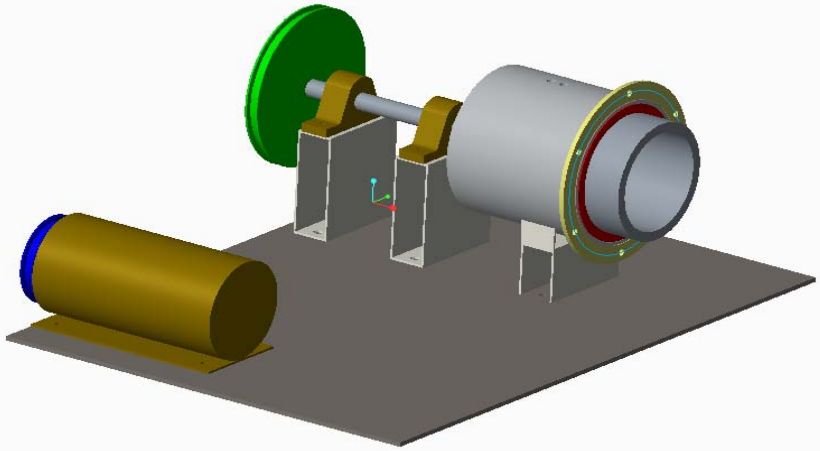
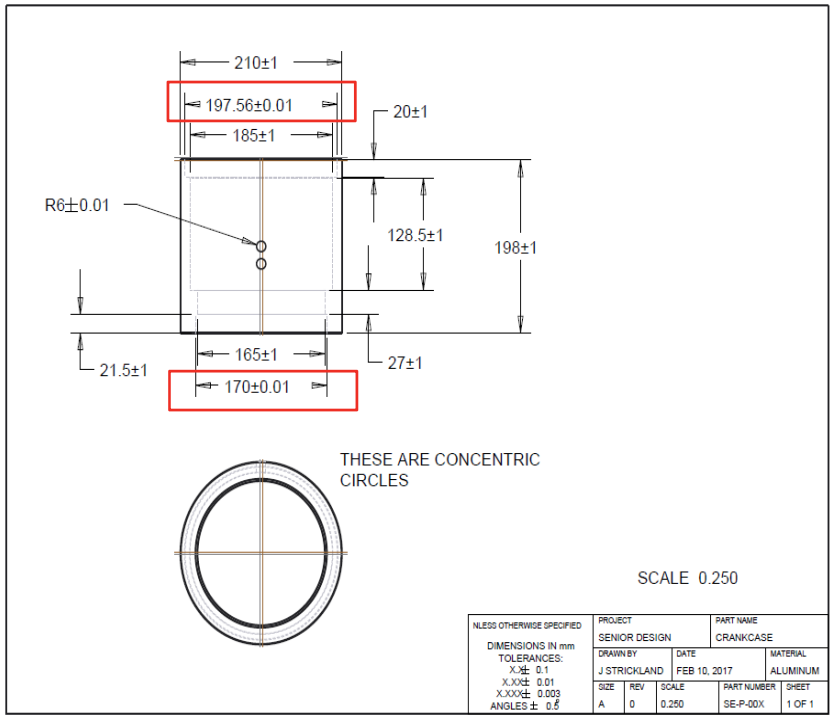
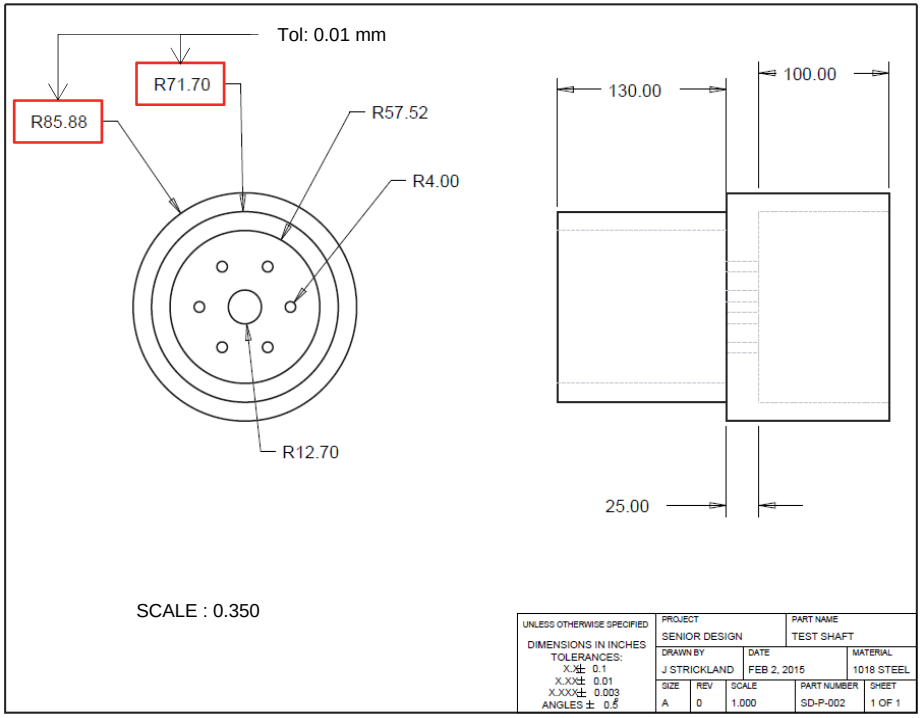


Figure x: Cad Assembly of Test Rig Orientation 2

Test Rig Cad Depictions

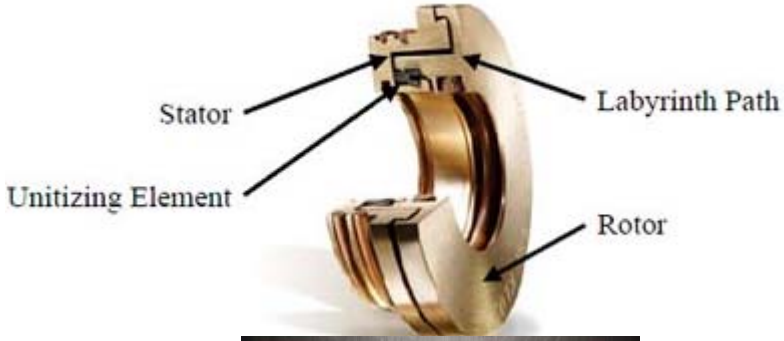




Seal Design Selection

How to Maintain Pressurized Area Behind Main Seal?

- Implementation of a Hybrid Labyrinth Seal



Why?

- Non-Contact Element:
  - Grooves designed for a tortuous path for fluid
  - Provides a seal when the shaft is rotating
- Contact Element:
  - Provides a seal when the shaft is not rotating
  - Contact elements lifts due to centrifugal force during operation

Figure x: Hybrid labyrinth visualization.[5]

Seal Capture Device

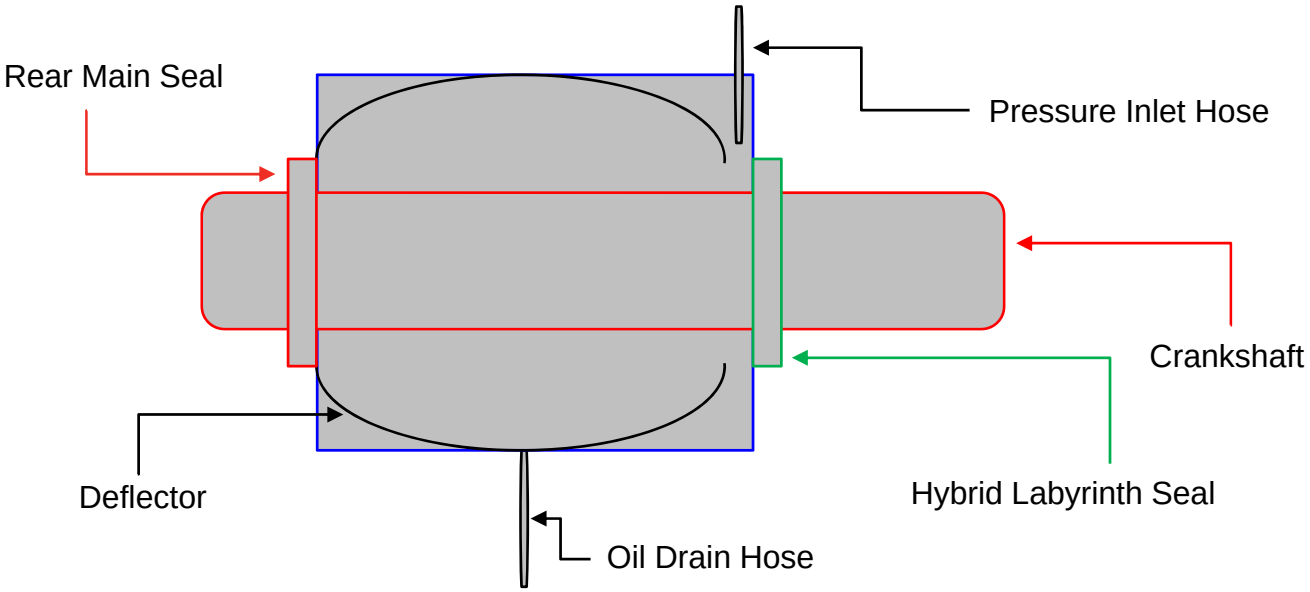


Figure X: Basic visual of intended design of device.

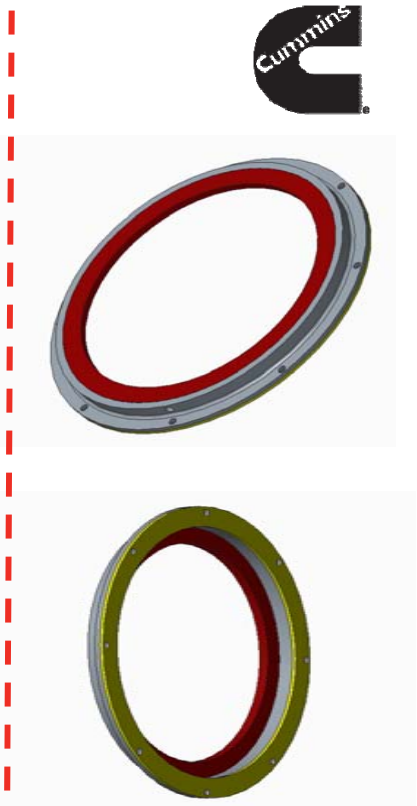


Figure X: CAD rendering of device housing.

Things To Consider:

- Dynamic TIR: .35 mm, Static TIR: .50 mm
  - Ensure seal tolerances to prevent a crash

Testing Phase Preparation

- *Safety shielding*
  - Provide protection from moving components
  - Also protection from potential hot oil splatter
- *Appropriate testing environment*
  - Potential for hot oil spill
  - Environmental and safety hazard

Figure X: Plexiglas Cover

Solution → *Plexiglas Shield Cover*

Challenges

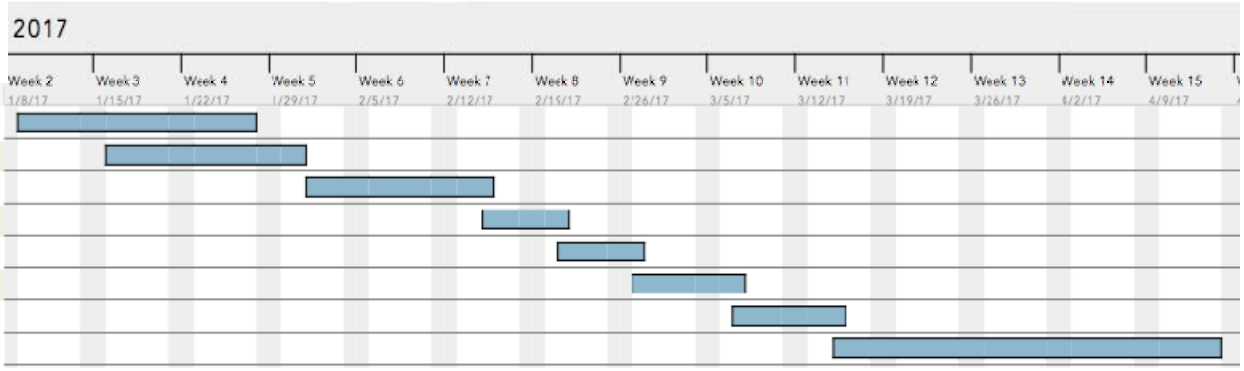
- *Seal Tolerances*
  - Such tight tolerances makes for difficult machining
  - Must be cautious in assembly and seal placement
- *Labyrinth Seal*
  - Mounting of labyrinth seal within capture device
- *Assembly of Test Rig*
  - *Careful assembly to ensure proper alignment*
  - *Placement of seals is critical*
  - *Safety*

Moving Forward

- Choose Oil Heating Element
  - Style, Power, Placement are important driving factors
  - Safety also key concern
- Construction of Test Rig and Capture Device
  - Remaining machined parts
  - Necessary hardware i.e. nuts, bolts, screws
- Testing
  - Appropriate environment for testing
  - Safety Shielding

Project Schedule (Gantt Chart)

Name	Begin date	End date
Finalize BOM	1/9/17	1/27/17
Order Parts	1/16/17	1/31/17
Fabricate Seal Solution	2/1/17	2/15/17
Assemble Test Rig	2/15/17	2/21/17
Fabricate Oil Catch	2/21/17	2/27/17
Test Sealing System	2/27/17	3/7/17
Analyze Results	3/7/17	3/15/17
Make Adjustments	3/15/17	4/15/17



Conclusion

Project Goal

- Design a device to capture leaking oil from a rotating test crankshaft and deposit it into a reservoir so that is can be reintroduced to the crankcase.
  - Paying close attention to the test rig

Ideal Design

- Design for test rig and capture device is finalized
  - Minor changes may still be implemented
  - Paying close attention to tolerances

What's Next?

- Heater Implementation
- Assembly of test rig and device
- Prepare for testing

References

- **1.** "Symptoms of a Bad or Failing Crankshaft Seal." *Your Mechanic*. N.p., n.d. Web. 28 Sept. 2016.
- **2.** Pawlik, Bernie. "2004 Lexus RX330: Front Crankshaft Seal And Timing Belt Replacement." *2004 Lexus RX330: Crankshaft Seal, Timing Belt Replacement*. N.p., 27 Sept. 2013. Web. 19 Oct. 2016
- **3.** Shaw, Terry. *Project 1*. N.p.: Cummins Inc., n.d. PPT.
- **4.** Shaw, Terry. Cummins Technical Drawings, ISX15.
- **5.** Jun 1, 2012 Michael E. Gamache President The Carlyle Johnson Machine Co. Bolton, Conn. | Motion Sy. "Engineering a Better Noncontact Seal."*Machine Design*. N.p., n.d. Web. 19 Oct. 2016.
- **6. .** "FRed Engine Seal." *Kaco.de*. Kaco, n.d. Web. 16 Nov. 2016
- **7. .** "Centrifugal Seals vs. Labyrinth." *Centrifugal Seals vs. Mechanical Shaft Seals* | *Centrifugal Seal* | *Centritec Seals*. Centritec Seals, n.d. Web. 16 Nov. 2016.
- **8. .** Angela A. Pitenis (1), Kathryn L. Harris (2), Christopher P. Junk (3), Gregory S. Blackman (3), W. Gregory Sawyer (1)(2), and Brandon A. Krick (4). "Ultralow Wear PTFE and Alumina Composites: It Is All About Tribochemis." *Springer*. Springer US, n.d. Web. 16 Nov. 2016.
- **9.** "Compressor Power and Efficiency Equations." *Enggcyclopedia*. Enggcyclopedia, n.d. Web. 16 Nov. 2016.
- **10.**. *OmniLip PTFE Rotary Shaft Seals Product Catalog, Saint-Gobain Performance Plastics* (n.d.): n. pag. *Seals.saint-gobain*. OmniLip. Web. 17 Nov. 2016

Questions?