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

Design Review Presentation

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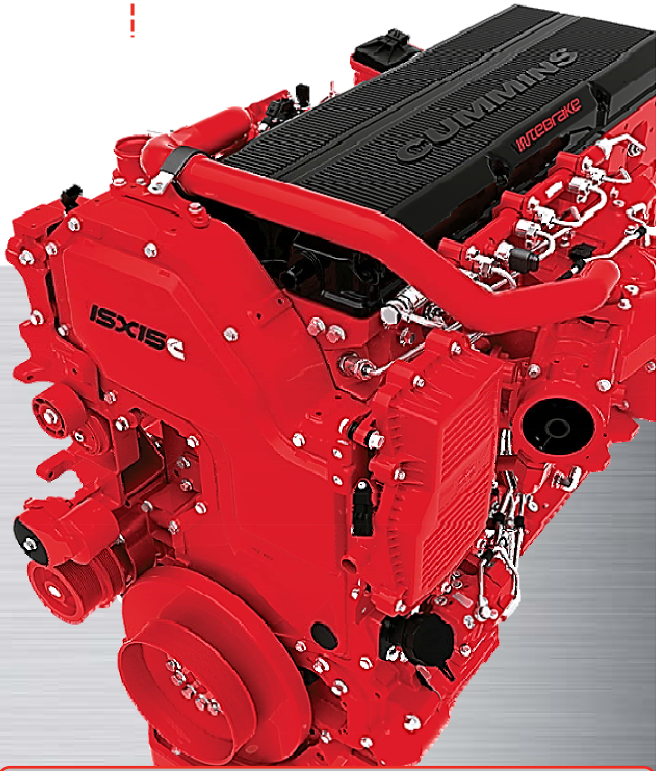


Cummins' Heavy Duty Truck engine, the ISX 15 @ 15 Liters, 600 HP

Presentation Overview

- **Project Review**
  - Background Information
  - Project Description
- **Design**
  - Components Selection
  - Test Rig Design
  - Seal Design
- **Testing**
- **Project Schedule**
- **Conclusion**

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

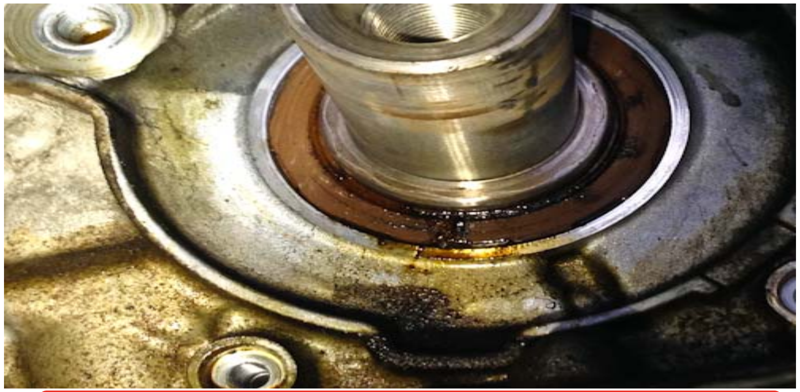


Figure 1: Depiction of rear crank seal leaking oil.[2]

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]

Presenter: Olaniyi Ogunbanwo

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 and Status

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	☑
5.) Construct oil capture device and Test Rig	On Going
6.) Perform 24 hour test to asses functionality of devices	Future Work

Component Selection

- 1500W Band Heater
  - 900° F at 120 Volts
  - Dimmer Switch to alter voltage supply to bring crankcase to 125° C
- 1/3 HP Belt Drive Dayton Motor
  - 1475 RPM at 120 volt
  - V-belt pulley system utilized to achieve desired shaft speeds for test
- Mounted Bearings
  - Pillow Block Bearings with 1” bore to support custom shaft

Fig 3. Components For Test Rig

Component Selection

- Custom shaft
  - Driven by belt over pulleys
  - Custom flanges: 2 with 165 mm and 1 with 140 mm OD
    - Seals press fit over flanges
  - Flanges press fit on shaft and welded in place
- Crankcase
  - Made from 8” schedule 40 steel pipe
  - Caps welded on either side for seals to be press fit inside

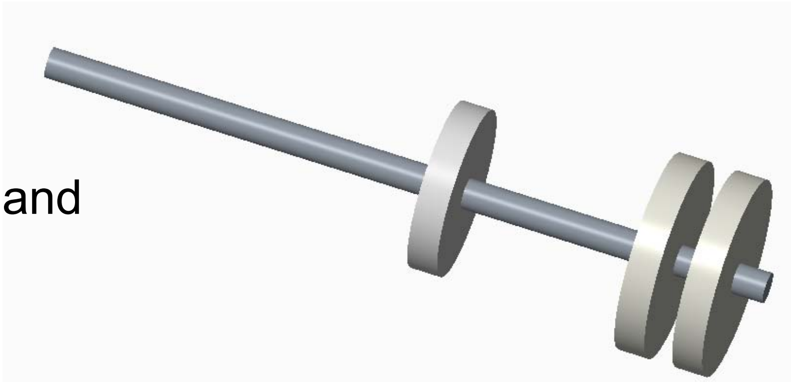


Fig 4. Custom Shaft

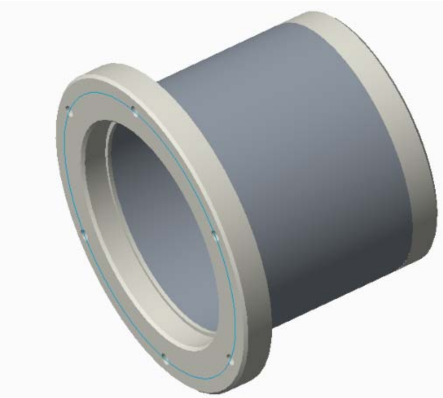


Fig 5. Custom Crank Case

Presenter: Jonathan Strickland

Test Rig Cad Depictions

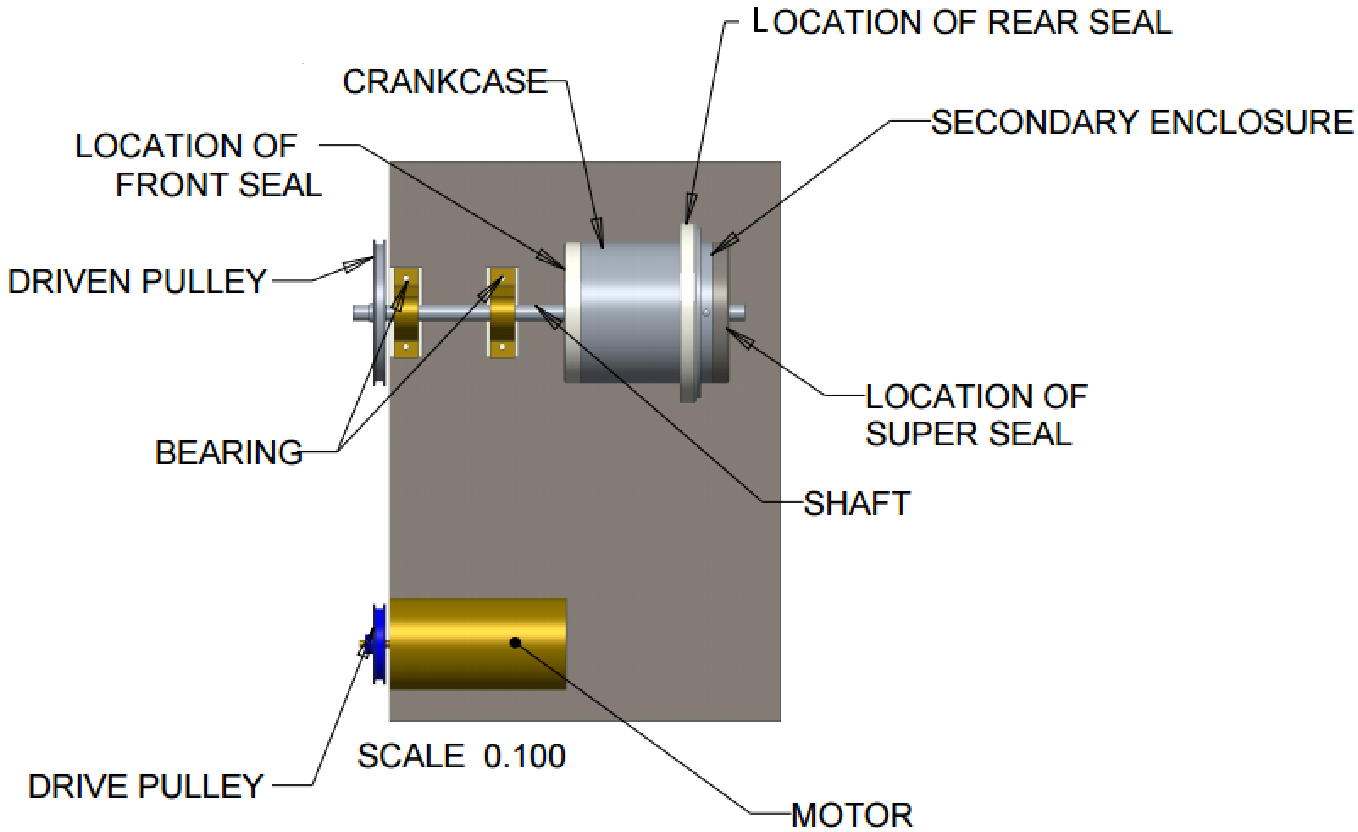


Figure_6: test rig assembly with labeled components

Test Rig Assembly

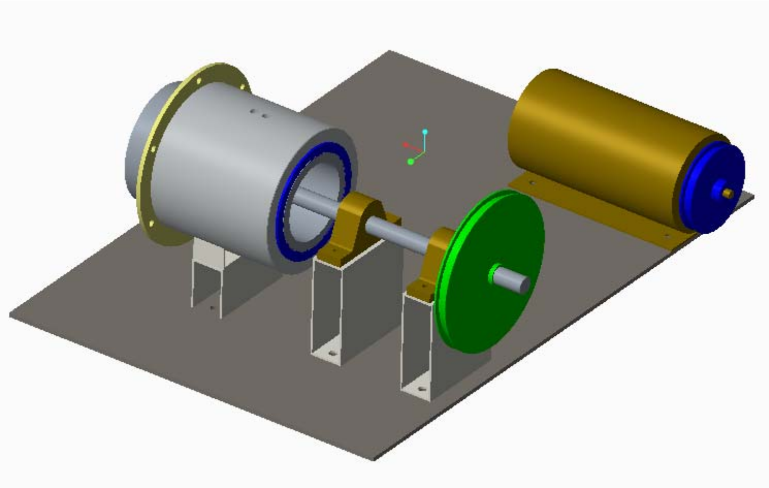


Figure 7: Cad Assembly of Test Rig Orientation 1

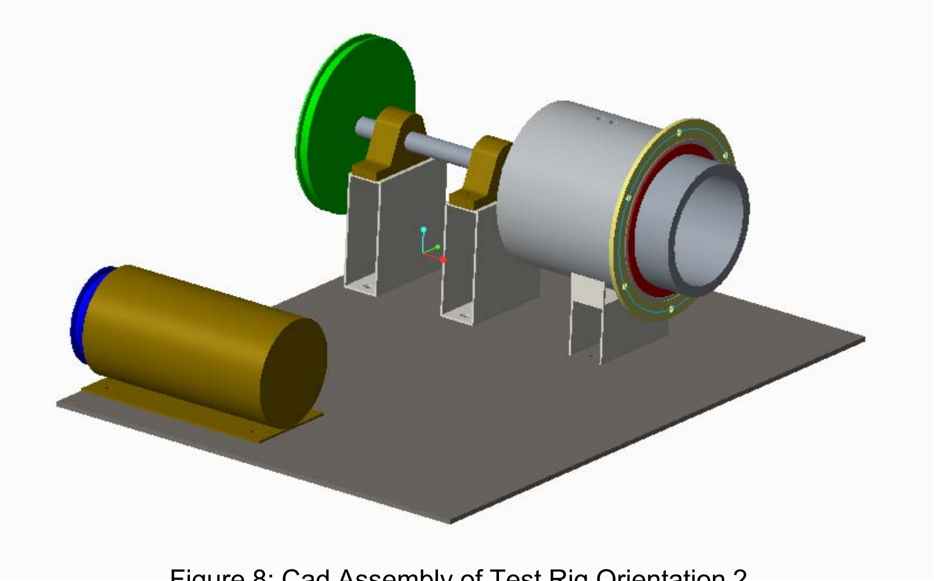


Figure 8: Cad Assembly of Test Rig Orientation 2

Exploded Diagram of Test Rig

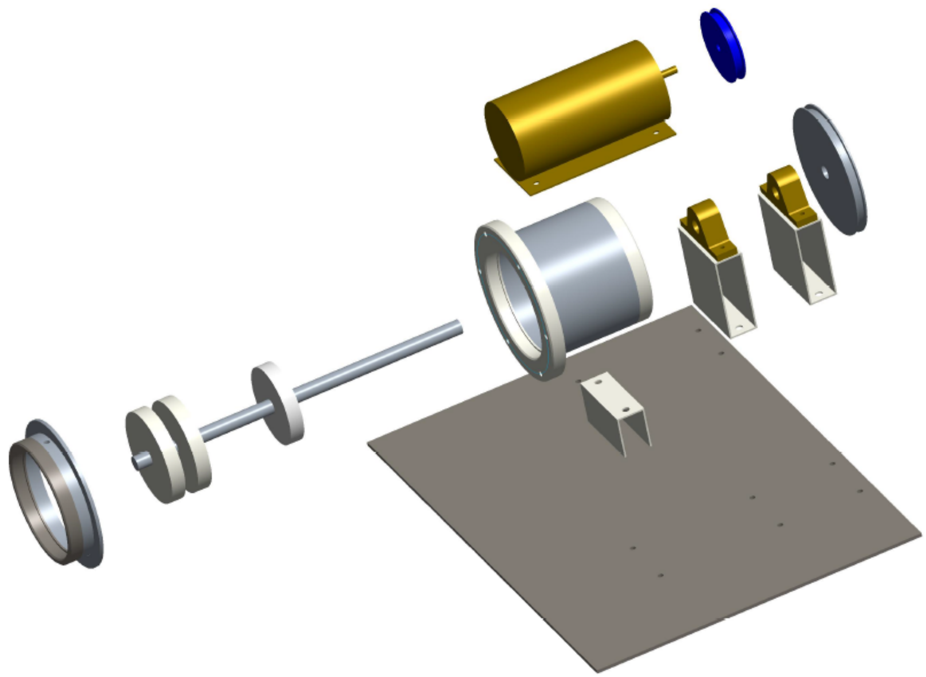


Figure 9. Exploded view showing
Individual components of assembly

Seal Design Selection

How to Maintain Pressurized Area Behind Main Seal?

- Implementation of a Labyrinth Seal

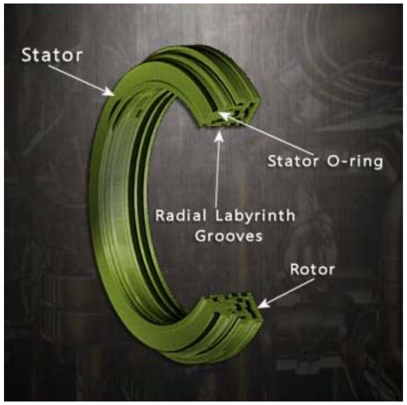
Why?

- 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

Fig 10. Various seal types

Seal Design

- Constraints
  - Target air consumption 2.25 L/s ≈ 1% of engine air intake
  - Static TIR = 0.5 mm
  - Dynamic TIR 0.35 mm
- Alterable Parameters
  - Number of teeth
  - Width of teeth
  - Tooth Geometry



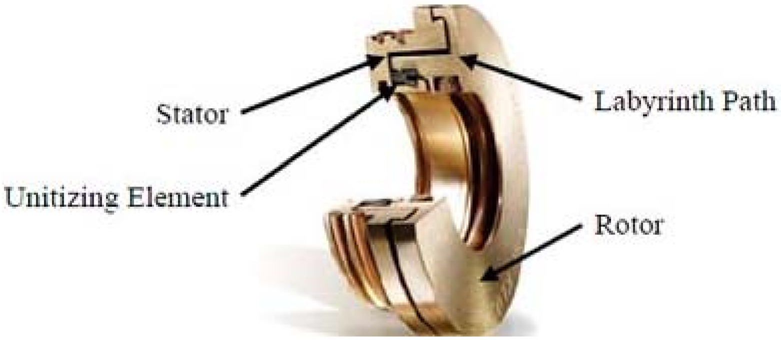


Figure 11: Hybrid labyrinth visualization.[5]

Seal Design

- Interlocking Teeth
  - Optimal solution is 10 teeth
  - Ideal for Cummins
  - Difficult to machine and assemble

- Single Row of Teeth
  - Optimal solution is 15 teeth
  - Ideal for Team 1
  - Easier to machine and assemble

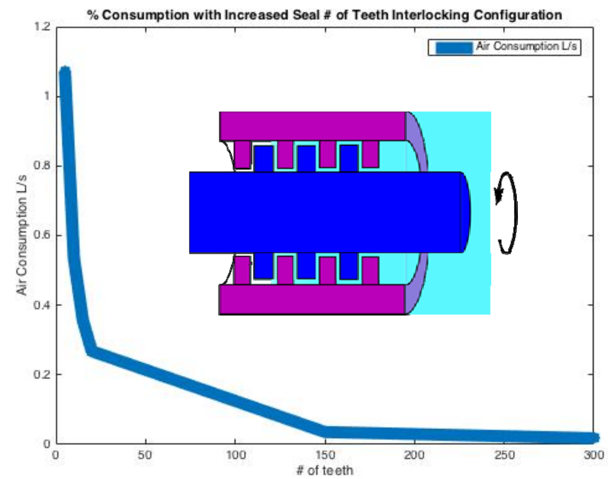


Fig. 12 Interlocking Teeth solution

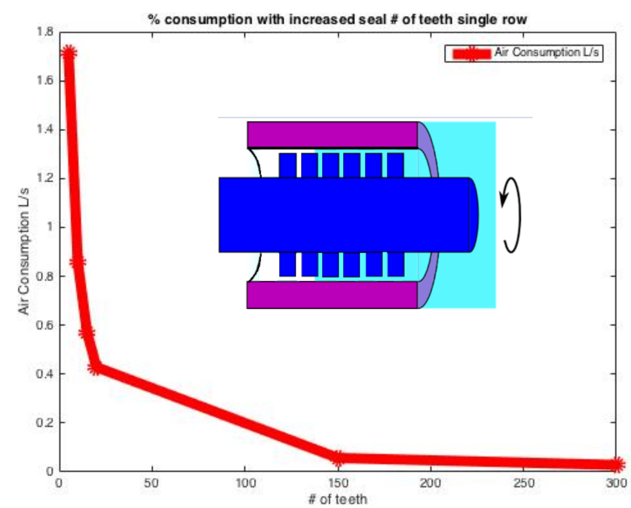


Fig. 13 Single row Teeth solution

Presenter: Sean Casey

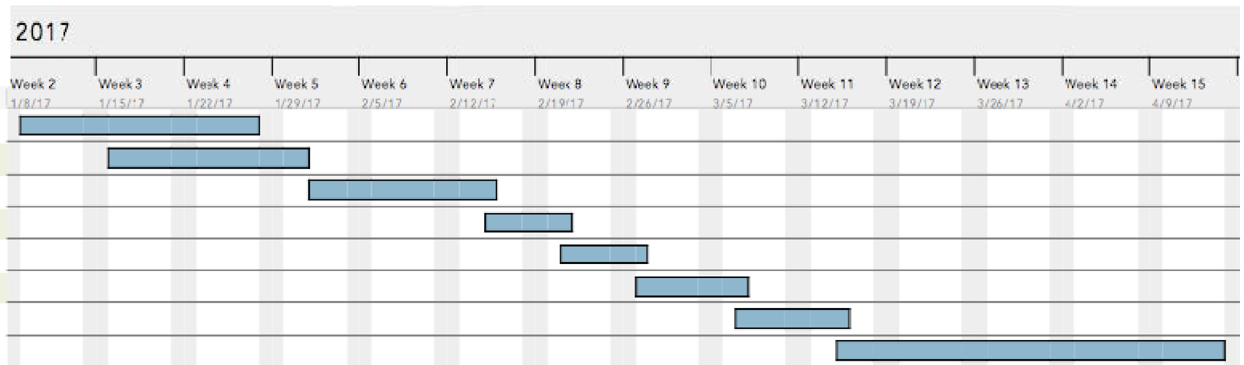
Moving Forward

- Assembly
  - Testing individual components & entire assembly
  - Mount remaining components
  - Assembling individual components as they are machined
- Testing
  - Appropriate environment for testing
  - Safety Shielding
- Analyze Results
  - Report results to sponsor

Figure 14: Plexiglass Cover

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



Presenter: Sean Casey

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?

- Assembly of test rig and device
- Testing

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Questions?