# Homogeneous Charge Combustion Ignition Engine Research

Professor Robert Dibble

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Mechanical Engineering Combustion Analysis Laboratory *

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**Abstract**

From working in Professor Dibble's Combustion Laboratory this past semester, I gained practical powertrain experience and have met several amazing graduate and international students who also share my passion for engineering. My main contributions are: machining custom components to modify the engine's operation, assisting with running the engine for testing, and learning as much as possible about HCCI concepts from my fellow colleagues I work with.

We run a 2008 4-Cylinder Volkswagen Diesel engine that has been converted from diesel to compression ignition via a port injection system. This system consists of an air manifold, circled in red in Figure 1, which is where the pressurized air travels before becoming a homogeneous charged mixture with the injected primary reference fuel (PRF). Only one out of the four cylinders is utilized for HCCI due to the limited packaging space above the cylinder block with such air manifolds.

Currently, the port injection must be used in combination with the engine's original diesel direct injection system. Past tests have ran with 80-90% of port injected PRF and 10-20% direct injected PRF, depending on the goals of the research. The use of the custom injection system is what has driven the main projects of my research laboratory work.

Figure 2 displays the assembly of the fuel pump gear line that will be connected to the engine's timing belt (circled in green), enabling us to alter the injection process from complete port injection to partial port-direct injection.

*Permission to post Abstract: Of course please do so!!

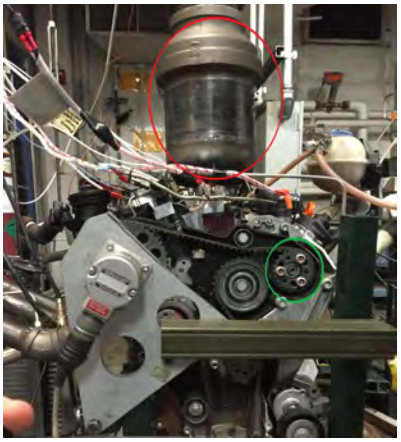

Figure 1: HCCI engine setup in located one of the research laboratories in Hesse Hall.

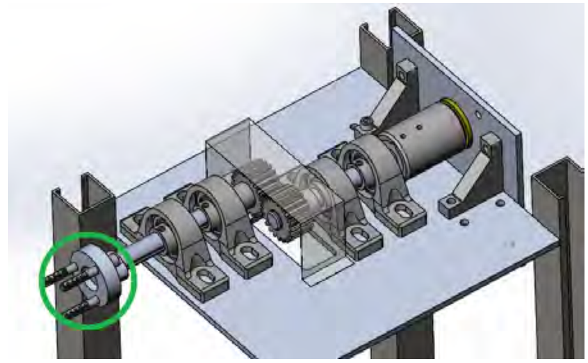

Figure 2: Fuel pump gear line CAD model that will be mounted in front of the engine.

This is achieved with the use of a decommissioned fuel pump, Figure 3, installed on the engine's timing belt when complete port injection is desired. For partial port-direct injection, the series of shafts and gears, shown in Figure 2, will connect to a working fuel pump that is mounted on the vertical plate at the receiving end of the gear line. Thus, allowing the working fuel pump to cycle a percentage of direct injected PRF that is synchronized with the engine's rotation and ignition timing.

Figure 3: The modified decommissioned Bosch fuel pump.

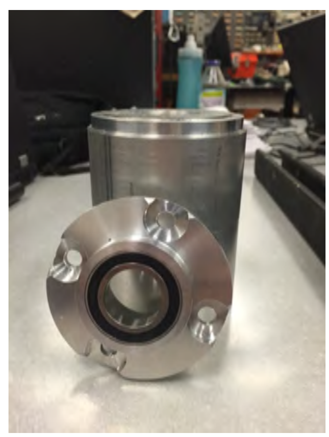

Figure 4: I reversed engineered the fuel pump housing cover with a pressed in bearing.

I also machined several smaller components to modify other aspects of the engine such as the fuel rail, exhaust manifold, and generator drive line. Such projects are shown in Figures 5, 6 and 7. By machining such components, I learned how the engine operates under its modified use for HCCI while furthering my knowledge of solid part design and manufacturing.

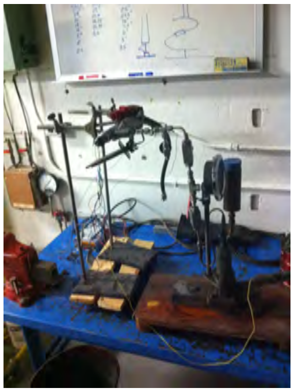

Figure 5: Pressure sensor calibration test setup. Only one of the four fuel inlets of the fuel rail allows flow through to the firing cylinder. See Figure 6 for custom inserts to achieve this flow reduction.

Figure 6: Two machined insert (bottom) and cap (top) used on the engine's fuel rail to open or plug its inlets.

Figure 7: Enlarged keyway on the output shaft of the generator drive line to eliminate the slop of the keystock while spinning.

In the process of all this work, I had the opportunity to meet some very bright international students who ran experiments with this engine during a study abroad. Two of such students I had the privilege of working with are shown in Figure 8.

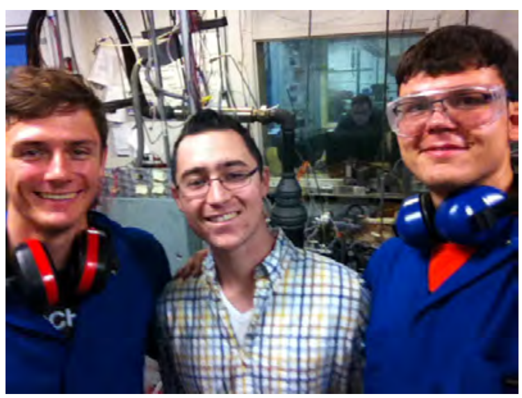

Figure 8: From Left - Frithjof Schwerdt, Johnathan Corvello, Malte Schäfer. German graduate students who performed their Master Thesis research at UC Berkeley.

In summary, the opportunity to join this lab's research has opened me up to a new way of engineering outside of the classroom. I gained specific knowledge of HCCI theory and practical knowledge of its execution in a real engine setup. I look forward to applying these skills to future research projects throughout my college experience.