



UNC Charlotte – Lee College of Engineering Senior Design Program
Company Information

Company Name	<i>Cummins</i>	Date Submitted	<i>5/20/2022</i>
Project Title	<i>Combustion Cylinder Bore Imaging – Phase 2</i> (CUMMINS_BORE2)	Planned Starting Semester	Fall 2022

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	3	Electrical	1
Computer	1	Systems	

Company and Project Overview:

Cummins Inc., a global power leader, is a corporation of complementary business segments that design, manufacture, distribute and service a broad portfolio of power solutions. The company’s products range from diesel, natural gas, electric and hybrid powertrains and powertrain-related components including filtration, after treatment, turbochargers, fuel systems, controls systems, air handling systems, automated transmissions, electric power generation systems, batteries, electrified power systems, hydrogen generation and fuel cell products.

Headquartered in Columbus, Indiana (U.S.), since its founding in 1919, Cummins employs approximately 61,600 people committed to powering a more prosperous world through three global corporate responsibility priorities critical to healthy communities: education, environment and equality of opportunity. Cummins serves its customers online, through a network of company-owned and independent distributor locations, and through thousands of dealer locations worldwide and earned about \$2.3 billion on sales of \$23.6 billion in 2019.

The Cummins engine segment manufactures and markets a broad range of diesel and natural gas-powered engines under the Cummins brand name, as well as certain customer brand names, for the heavy and medium-duty truck, bus, recreational vehicle (RV), light-duty automotive, construction, mining, marine, rail, oil and gas, defense and agricultural markets. In a combustion engine, cylinder bore reliability is a key area of interest and is the focus of this project. See photo below of

a cylinder bore:



Project Requirements:

This project will build on the results of a previous Phase 1 project. The objective of this project is to devise a method of photographically scanning cylinder bores to visually assess damage and wear that is less expensive and easier to use than current commercial systems. The photograph below shows an “unrolled” image of a worn cylinder bore:

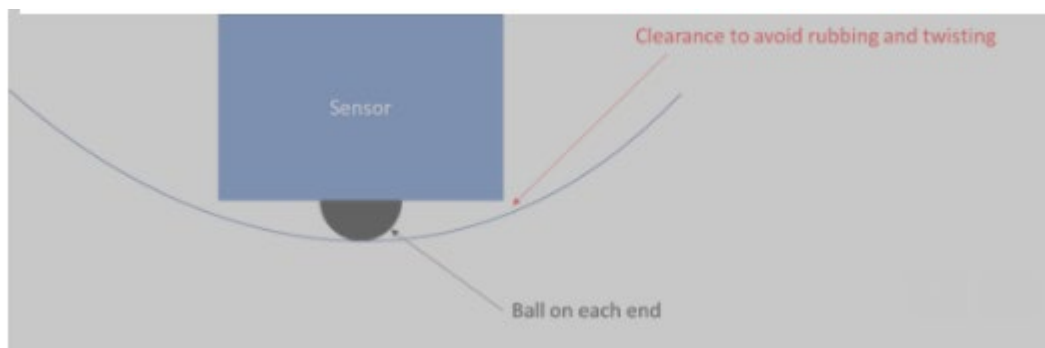


The project will investigate using a contact imaging scanner (CIS) for the visual assessment. CIS elements are used routinely in printer/scanners:



The team will assess CIS alternatives and select one for modification to do single line imaging with a minimum resolution of 600 dpi.

Here are some example sensors. <https://compo.canon/en/product/cis/list.html> The “Camera Link” interface is preferred as it allows for PC/software access of the pixel data at high speeds. Other approaches could be considered. Note: these sensors are designed to image a surface (e.g. paper) that is in contact with the sensor. For the cylinder bore, the sensor will be elevated from the surface via spheres (carbide, ruby, etc.) to maintain a constant working distance while avoiding contact at the edges.



Thus, the project will be primarily focused on the modification of a CIS sensor accommodate this “stand-off”. This line scanner will subsequently be integrated with motion control for rotation in the bore. That motion control is outside the scope of this project.

Cummins will supply test cylinders to use during proof of concept testing along with results from current inspection methods to be used for assessment purposes.

Expected Deliverables/Results:

- A CIS sensor that can image an axial line along a bore (100-200 mm diameter, 200-300 mm



- length) at 600 dpi (or better) with PC interfacing (e.g. existing Camera Link)
- While the motion control is outside the project scope for the proof of concept scanner, the Final report shall have a section that comments on potential design concepts for how this would be done.
 - Continue work from the previous group to complete functionality of the design.
 - Review initial design to see if there are needed enhancements.
 - Implement enhancements as needed.
 - Revise drive mechanism to be able to start and stop itself to collect data.
 - Align the speed of data collection and rotation speed for the best resolution possible.
 - Review data collection process to determine if there is a more efficient method.

Disposition of Deliverables at the End of the Project:

Students are graded based on their display and presentation of their team's work product. It is mandatory that they exhibit at the Expo, so if the work product was tested at the supporter's location, it must be returned to campus for the Expo. After the expo, the team and supporter should arrange the handover of the work product to the industry supporter. This handover must be concluded within 7 days of the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Interest in precision metrology