

Engineering Research Center for
Reconfigurable Manufacturing Systems



In-line Inspection of Engine Valve Seats

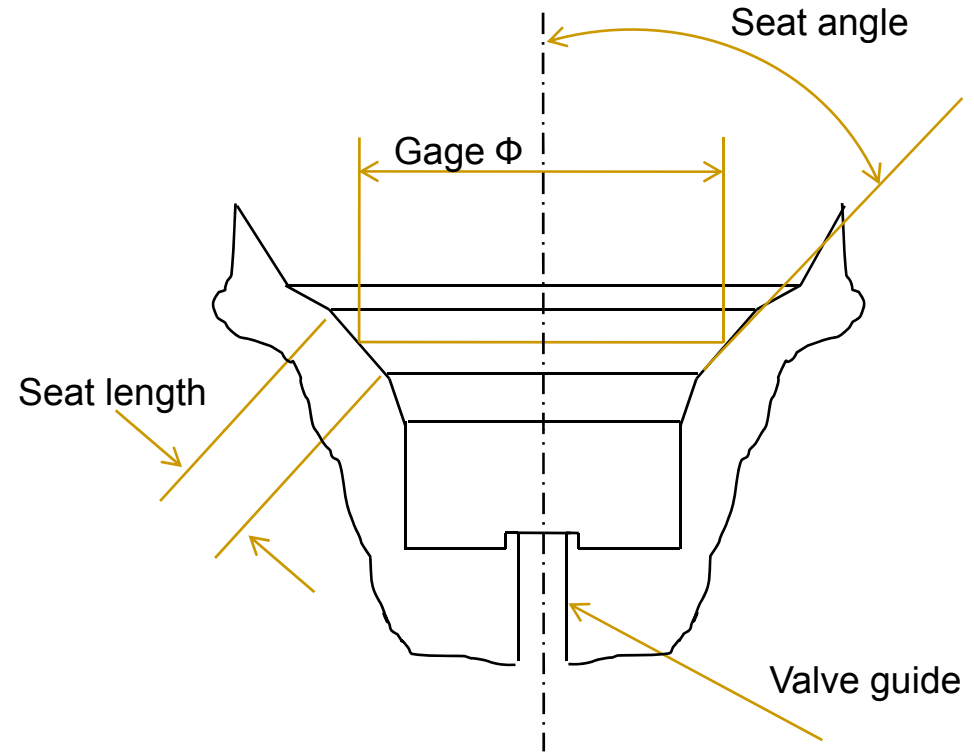
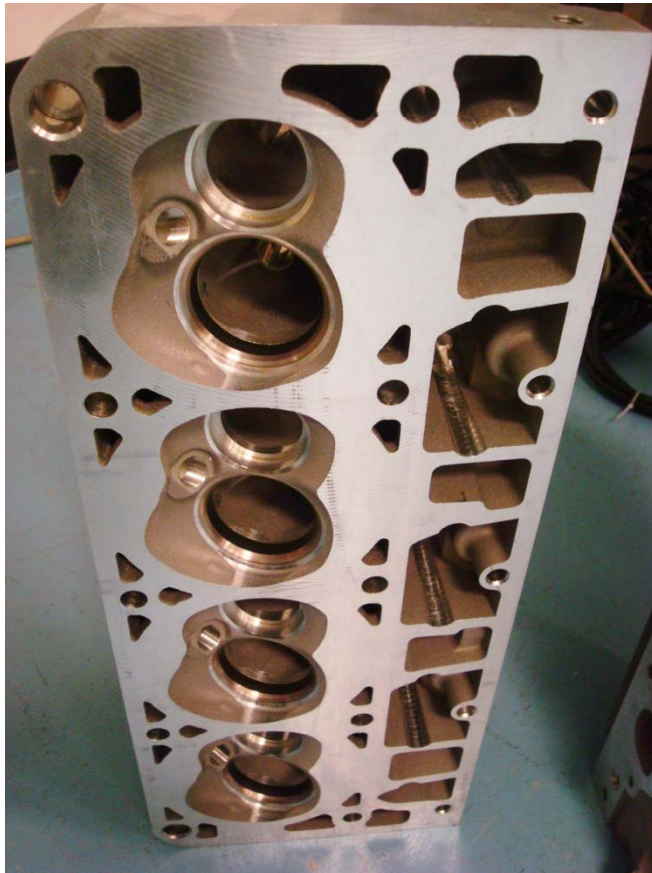
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March, 13th, 2009



The University of Michigan, College of Engineering

In-line inspection of engine valve seats



- Deck, seat ($\pm 0.1^\circ$), throat angles
- Seat length
- Seat roundness at gage
- Seat runout at gage wrt valve guide

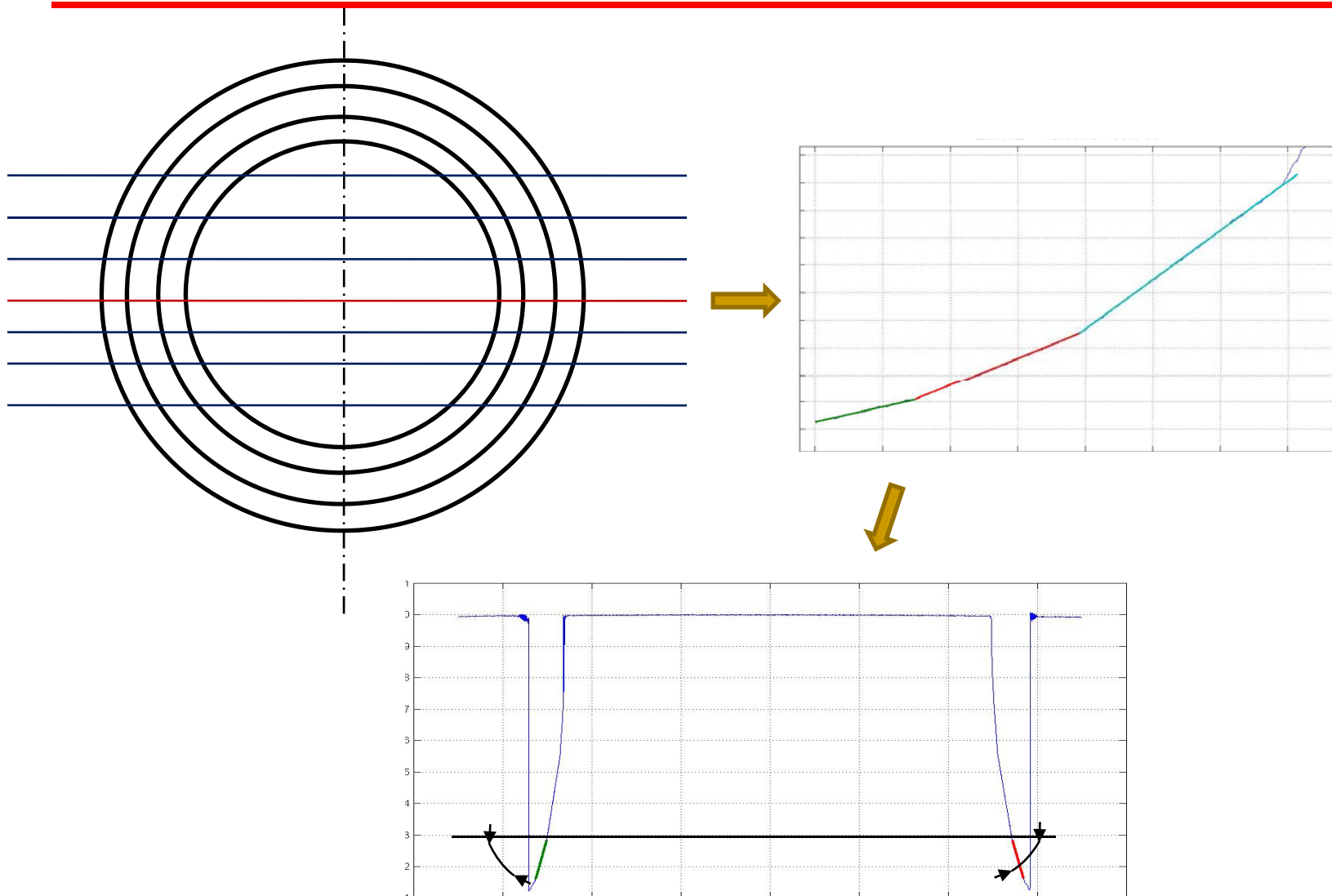


Project Goal

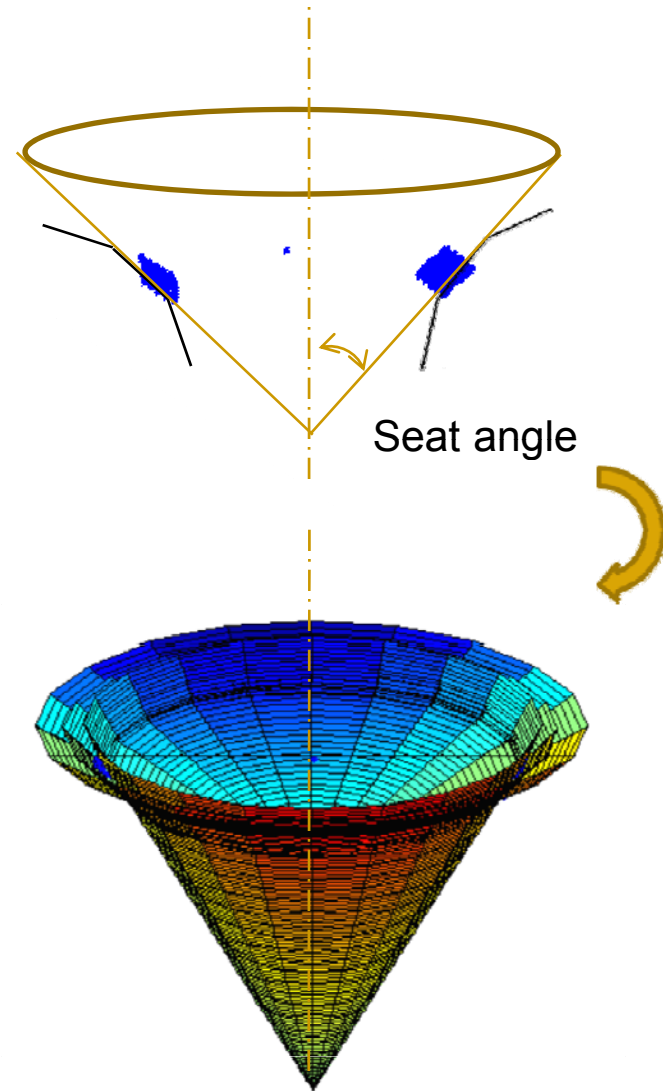
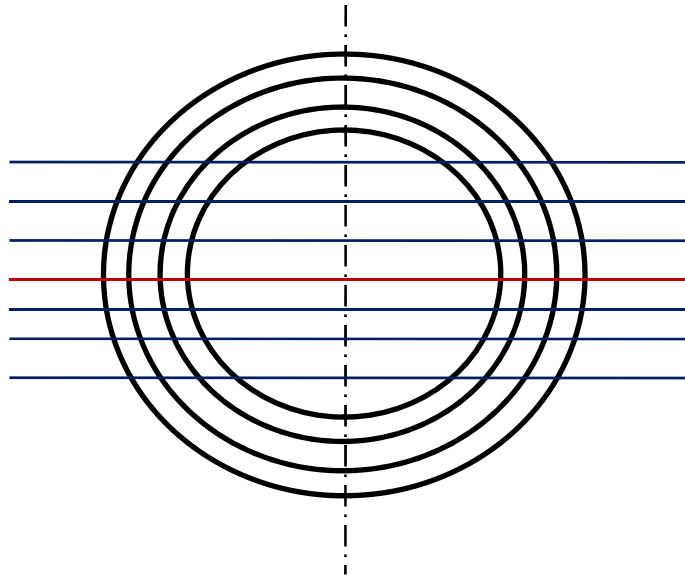
- In-line measurement of valve seat geometry (cycle time ~ 45 seconds)
- Rapid and accurate non-contact measurement
- Measurement of seat angles and seat length
- Preliminary repeatability test
- Evaluate in-line application feasibility
- **Comment:** All the study was done without having a defined specification of the problem



Approach 1: Single Cross Section



Approach 2: Least Squares Cone Fit w/ Five Cross Sections



	ERC Results			CMM Results		
	Run 1	Run 2	Run 3	Run1	Run2	Run3
60 segment angle	60.53	59.39	59.99			
Seat Angle	45.18	45.18	44.98	45.15	45.34	45.18
30 segment angle	30.28	30.33	30.27			
Seat Length	1.7137	1.6979	1.6991	1.729	1.772	1.738



Valve seats R&R test results

Results of the repeatability test

performed for 50 measurements across 5 cross-sections

	Seat Angle (degree)	Deck Angle (degree)	Throat Angle (degree)	Roundness (mm)	Seat Length (mm)	Gage Depth (mm)
Average	45.07468	60.40652	30.34172	0.02988506	1.747624	12.62412
Standard Deviation	0.017752769	0.043423985	0.017123847	0.002473562	0.012789657	0.002429748



Accomplishments and Next Steps

Accomplishments:

- Angle measurement to within $\pm 1^\circ$ degrees achieved using both approaches
- Seat length measurement to within 0.2 mm
- Two axis demonstrator designed and built by ME450 students.
- Complete statistical analysis of cone-fits for improving accuracy.
- Design repeatability set-up and testing

Next Steps:

- Evaluate the implementation feasibility i.e. increase measurement speed, optimize data collecting path
- Test serial robot and a evaluate the use of a PKM



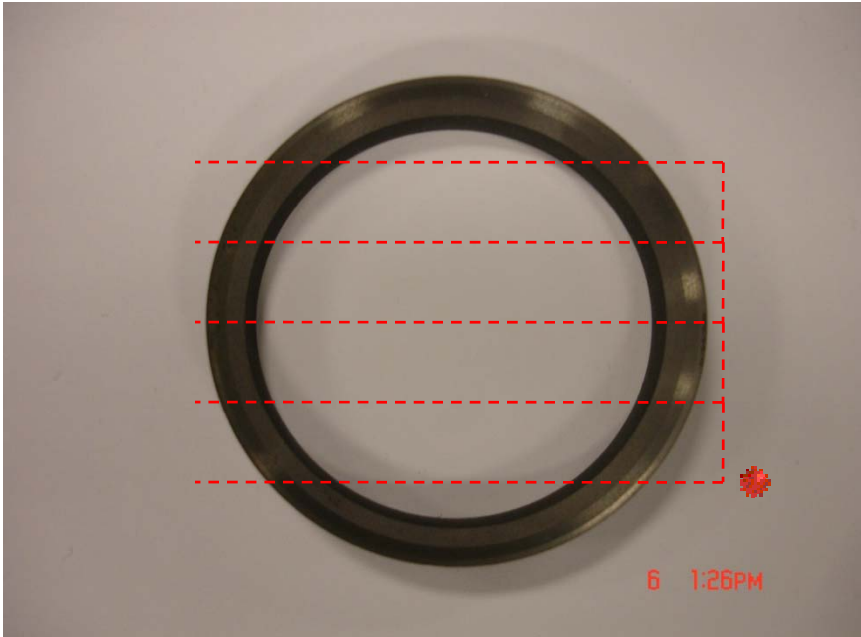
Operational Data of the Current Measuring System

- Optimet Conoprobe Laser Scan Frequency : **3000 KHz**
- The Motion Stage Forward Motion
Maximum Speed Possible : **5000 mm/min**
- Current System (presently not optimized for time)
Forward Speed used : **100mm/min**
Backward Speed used : **1000 mm/min**
Stop time between scans : **1 sec**

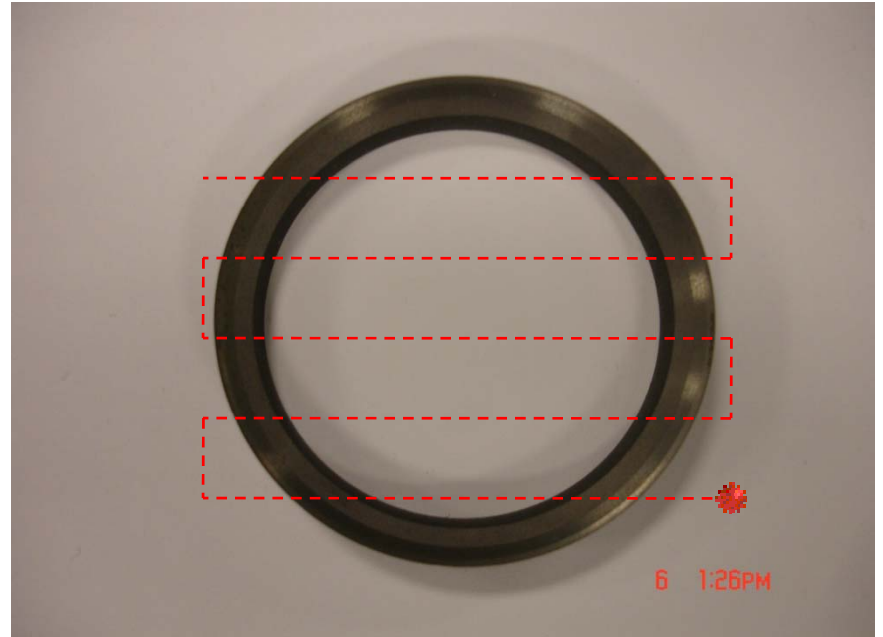


Methods for Time Optimization with above Specifications

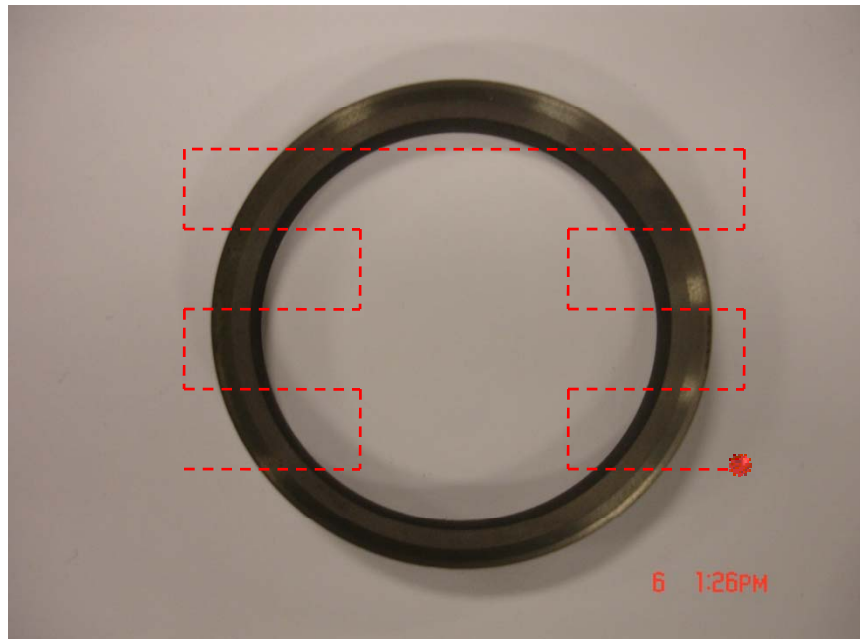




Current Method Time Taken = 193 sec



Time Taken= 176 sec



Time Taken = 88sec

Challenges

- To find the minimum time : we need to increase the speed of the scan.
- Increasing speed reduces the number of data points captured.
- The Speed Vs Data Capture is an OPEN ISSUE.
- Need to decide which parameter to compromise on, for the best time optimized performance.

