Group M2.2 - Intertek Chain Wear Optimization

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Sponsored by Intertek Automotive Research

Background

Intertek provides tests, inspections and certifications for various components in a wide array of vehicles. This project focuses on the optimization of the chain wear test for a Ford 2.0L EcoBoost engine. The first task was to identify areas of improvement that meet customer needs.

Customer needs

- Reduce build time
- Improve test accuracy
- Reduce rework
- Reduce overall cost
- Create compact storage solutions
- Eliminate process steps where feasible

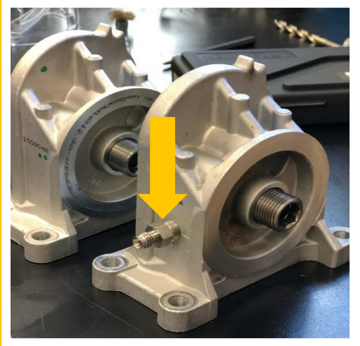
Identified Areas for Improvement

The project began with the team spending over 48 man-hours becoming familiar with the process and identifying the best areas for improvement.

Disassembly of the cylinder head requires the valve springs to be compressed one at a time to remove the valve train components.

Small valvetrain parts with no storage solution are commonly lost and time is wasted searching for or replacing them.

No quantifiable method for honing engines exists and rework is a common occurrence as a result of cylinders being out of spec.



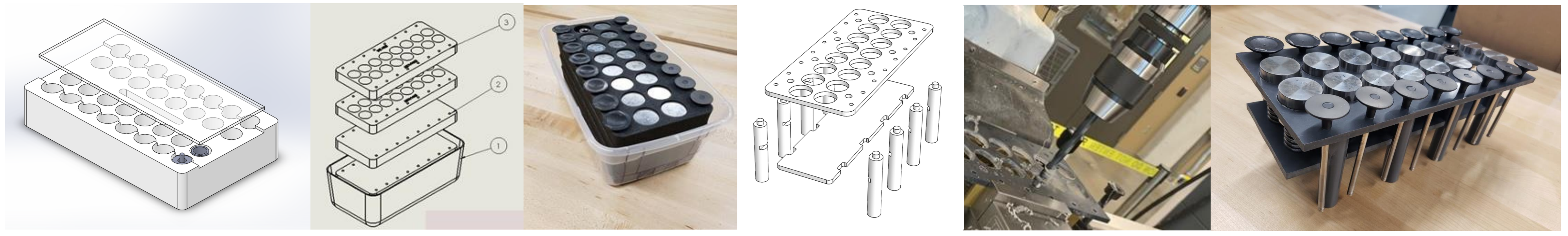
Thermocouple installation requires manually scribing a line and using a punch to mark position, drilling a pilot hole, and then finally drilling the hole to insert the thermocouple.

Timing tool being used requires the removal of two engine pumps, resulting in the loss of time and oil.

The goal for this project was to reduce the current process time by roughly 10% (48 minutes) using lean concepts to overhaul procedures and the engineering process to design improved tools and fixtures

Process

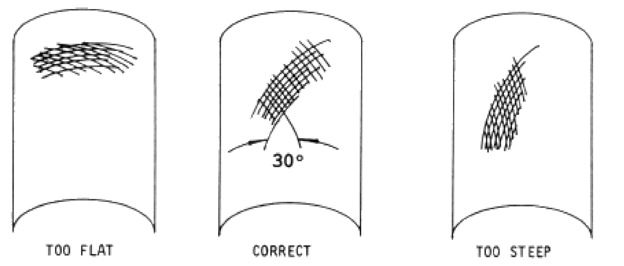
Valvetrain Parts Storage - Designed to reduce the loss of small valve train parts, this storage tray began with ABS construction. To reduce weight, the material was changed to polyurethane foam. The final working prototype features a PVC construction due to chemical resistance.



Valve Spring Compressor Attachment - Designed to reduce cylinder head assembly time by compressing multiple valve springs at once. The CAD model was first 3D printed to create a prototype. The final design was machined from steel after being modified to simplify manufacturing.

Honing Standardization - A spreadsheet was developed to calculate stroke rate using the given formula with input parameters highlighted in yellow and the output shown in blue. The mathematical model for honing was tested using a metronome to control stroke rate for better consistency. The test data can be used to apply this procedure to new applications.

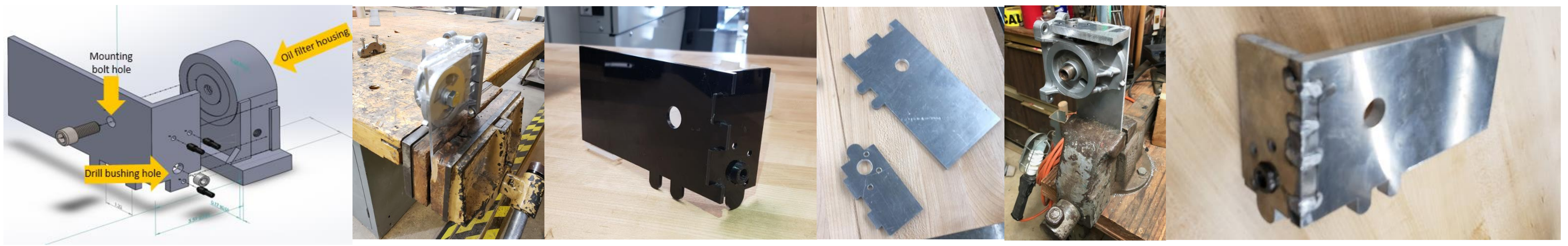
$$S = \frac{(Pi/2) * D * R * TAN\,(A/2)}{L}$$



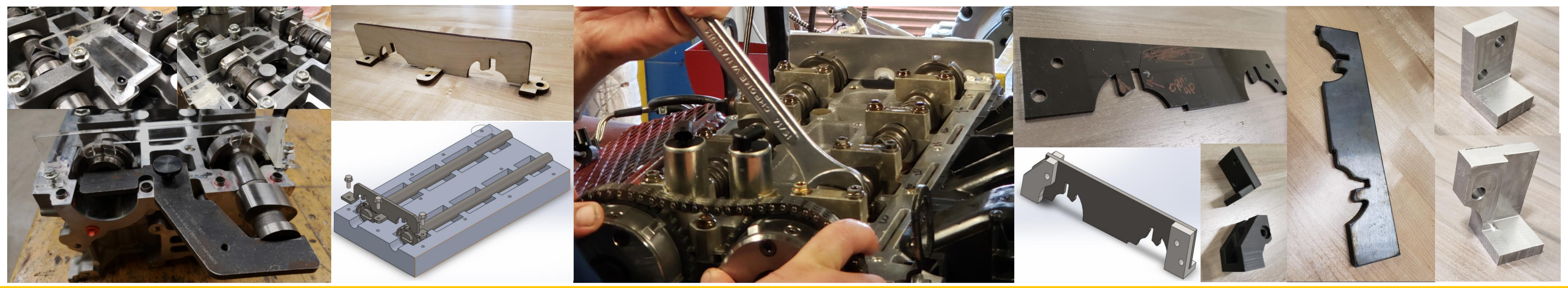
Trial 1		
STROKE RATE CALCULATION	Input	Units
Tan (A/2)	0.32	radians
Desired Crosshatch Angle (A)	35.00	degrees
Enter Cylinder Length (L)	150.00	mm
Enter Bore Diameter (D)	87.50	mm
Drill RPM (R)	500.00	RPM
Pi/2	1.57	
STROKES PER MINUTE (S)	144.45	

Trial 1 Data	Degrees
Cylinder 1	27.40
Cylinder 2	29.30
Cylinder 3	32.10
Cylinder 4	32.00
Average Angle	30.20
Standard Deviation	3.39

Oil Filter Housing Drill Jig - Reduces drilling time for sensor installation by over 300%. Various prototypes were created to ensure that proper tolerances were achieved. The design simply bolts onto the housing and features an aluminum construction with a carbide bushing and various locators to guide the drill.



Timing tool – Designed specifically for use on the EcoBoost 2.0L platform, this tool yields time savings of about 30 minutes by eliminating the extra engine disassembly required to install other timing tools currently on the market. Much time and effort was spent creating over a dozen different models of this tool to test fitment and tolerances. The final tool is milled from A2 tool steel with mild steel mounts.



Analysis

Challenges

- Designing solutions to be accepted by technicians
- Lack of CAD models led to reverse engineering components and copious prototyping
- Limited window for testing
- Limited access to machinery used to create final prototypes
- Limited data and access to actual processes
- Concerns from engineers and technicians led to the abandonment of the valve spring compressor attachment

Results

The **valvetrain parts storage** tray was implemented in the build process. Further testing is required to calculate time and cost savings.

Estimated time savings: 4 minutes

The **honing standardization** study found that the optimal stroke rate for this process specifically is 145 strokes per minute which yielded an average crosshatch of 30.2 degrees. All cylinders were in spec with a range of 27.4 to 32.0 degrees.

50% accuracy improvement
Estimated time savings: 16 minutes

The **oil filter housing jig** was tested and implemented into the procedure.

Measured time savings: 3 minutes
# of steps eliminated: 4

The **timing tool** is soon to be approved for use in the process. Proper fitment was confirmed on over a dozen tested engines without failure.

Measured time savings: 28 minutes
# of steps eliminated: 11
Reduction of oil loss: 250mL

Total steps eliminated: 15
Total savings per test: 51 minutes
Yearly labor cost savings: $8720

Future

- Continue to test and collect data for all implemented solutions to better quantify time savings, cost reduction, and other process improvements
- Find new applications for the honing standardization and parts storage solutions
- Potentially file a design patent for the timing tool
- Redesign and implement compressor attachment