General Motors 2: Wall Thickness Quality Loss Function - Part 2 Grinding

Overview

As part of an ongoing study to improve fuel efficiency and lower manufacturing costs, General Motors has identified an opportunity to reduce the mass of its current line of steel and cast iron crankshafts by reducing the diameter of the flywheel flange. General Motors has tasked our team with experimentally developing an equation relating surface roundness to pre and post grinding of the oil sealing surface of the flywheel flange. The challenge that faced our team was finding a way to replicate the grinding process General Motors crankshafts undergo at their facilities while collecting enough data points for statistical analysis on the budget allocated to our project.

Objectives

The objective of this project was to determine how far down the outer flange of a V8 (nodular cast iron) and SGE (4340 forged steel) crankshaft could be ground down using the quality loss function while keeping the circularity of flange within a 10 micron tolerance so that the oil sealing surface of the crankshaft would not be compromised.

Approach

- Conduct background research on crankshafts to understand how they work
- Gathered customer needs through teleconferencing with sponsor
- Weighed customer needs using an analytical hierarchy process (AHP) matrix
- Discussed with sponsor which needs were most important and ranked needs from there
- Developed potential test plans for grinding the outer flange using the ranked needs of the sponsor and other analytical methods
- Rationalized between the various test plans to decide which one best met the needs of both the team and the sponsor
- Determine the range of wall thickness values at which to measure for circularity error using the relative properties of nodular cast iron and 4340 forged steel
- Conduct statistical analysis on the data to determine a mathematical function of wall thickness to surface roundness
- Make final statements based any trends shown in data
- Propose future improvements if project was going to continue next semester

Outcomes

- Based on the team's findings with the nodular cast iron V8 crankshaft, our sponsor can reduce the wall thickness from 4.004mm to 3.230mm which represents a mass reduction of 35 grams and equates to $700 in estimated savings over the lifetime costs
- Future tests should focus more on the SGE crankshaft since the results of this test were inconclusive about how much the wall thickness could be reduced