Determination of Minimum Flange Wall Thickness of General Motors Crankshaft

Overview
As part of its ongoing initiative to improve fuel economy and reduce part cost, General Motors has identified an opportunity to reduce rotating mass in its current line of steel and cast iron crankshafts. Such reduction could be realized by decreasing the wall thickness of the flanged end of the crankshaft. However, as the wall thickness decreases, localized deformation on the micron scale occurs due to large drilling and tapping forces during part fabrication. Such deformation disrupts the oil seal roundness needed to maintain a seal, which leads to engine failure.

Objectives
The main objective of this project was to experimentally determine the minimum wall thickness at which local deformation does not occur in either the drilling, tapping, or bolting processes. The results of the experiment will be used by GM in future crankshaft design.

Approach
- Use production cranks and tooling at production speeds and feeds
- Prepare the cranks by milling a flat surface on the crank
- Create a fixture plate to reduce part fixture time
- Center drill each crank to mate with the fixture plate
- On the flange, use 30HP CNC to drill between existing flange bolt holes while varying the wall thickness at each hole
- Tap holes using GM tooling and torque flywheel to flange using torque specifications
- After drilling, tapping, and torqueing, measure the oil seal deformation around each hole at the top and mid plane of the flange thickness with a finger-style dial indicator
- Record maximum localized deformation and plot deformation as a function of wall thickness
- Analyze results for both cast iron and steel cranks to find a zero-deformation threshold, taking into account both planes

Outcomes
- No wall thickness reduction is recommended for the V8 cast iron cranks
- 2mm wall thickness reduction is suggested for the forged steel cranks, resulting in 60g of mass reduction and $0.13 in material savings per crank
- Experimental results suggest reducing bolt torque specifications, as the deformation due to torqueing was substantially higher than that caused by drilling or tapping