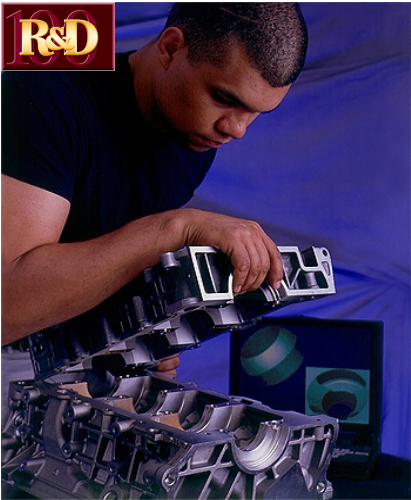


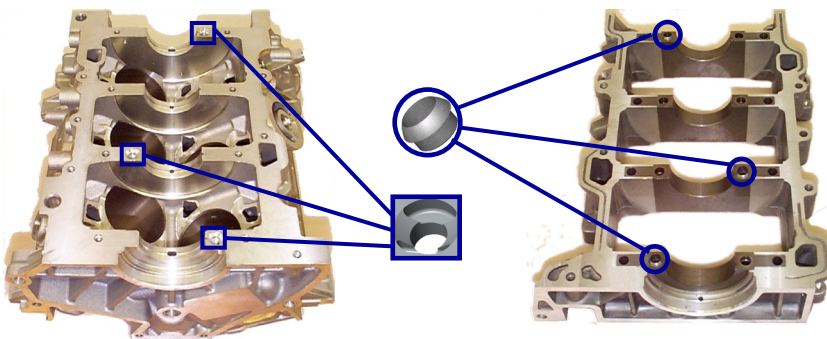
KINNI-MATE™ PRECISION COUPLINGS FOR LOW-COST PRECISION ALIGNMENT



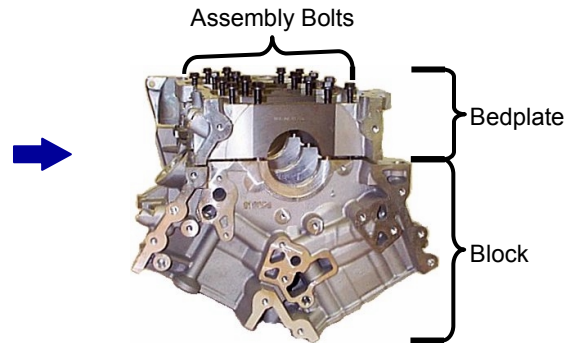
Background:

In manufacturing the Ford Duratec™ engine, the bedplate and block are aligned with 8 dowel pins, bolted together, and then the crank bore is simultaneously machined into the assembly, with half residing in each part. Later, it is necessary to disassemble the engine, install the crankshaft and journal bearings, and then reassemble the block and bedplate. Realignment of the two components must be accomplished with less than 5 microns error to prevent poor bearing performance. This design is costly to manufacture as it requires machining/gauging of 16 precision holes and 8 hollow dowel pins.

Ford, MIT, and Aesop Inc. have developed a low-cost coupling for precision alignment of medium-high volume product components (i.e. engines). This coupling is a type of kinematic coupling. Kinematic Couplings deliver repeatable alignment by mating three spherical members on one component into three grooves in the other component.



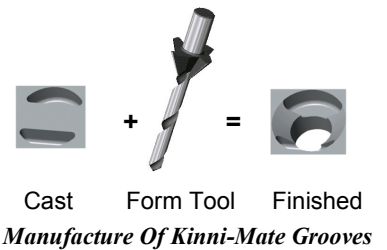
Block and Bedplate With Kinni-Mate Grooves and Inserts



Block and Bedplate Assembly

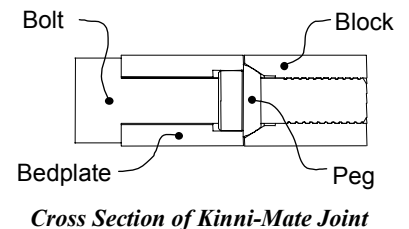
Application:

A low cost version of the coupling has been integrated into the Duratec engine. By positioning the grooves (Note: Side reliefs are cast-in before groove machining) over the location of bolt holes, one can machine the grooves and bolt holes simultaneously using the form tool seen at right. These grooves mate with spherical inserts (see above) which are pressed into reamed holes in the bedplate.



Operation:

During assembly, the spherical inserts mate in the grooves, leaving a 0.2 mm (0.007 inch) gap between the block and bedplate. Bolts are run through the joint and tightened, forcing the groove and spherical insert to comply and allow the block and bedplate to contact, thereby forming a stiff, sealed joint. The crank bore is then machined as before. Upon disassembly the grooves and inserts recover elastically, restoring a gap between the components. This is necessary to insure the kinematic nature of the coupling. After installation of the bearings and crank shaft, the components are reassembled.



Design Comparison:

ITEM	Kinni-Mate	Pinned Joints
# Precision Pieces	3	8
# Precision Features	3	16
Feature Placement Tolerance	+/- 0.08mm	+/- 0.04mm
Average Centerline Repeatability	0.75 μm	4.85 μm
Normalized \$/Engine	0.64	1

MIT Prof. M. Culpepper Prof. A. Slocum
Ford Motor Co. F. Z. Shaikh J. Schim G. Vrsek
Aesop Inc. R. Rines