In this column we have discussed how most dimensional gaging applications are really just variations on four basic themes, to measure height, depth, thickness, or diameter. Relational gaging applications are nearly as straightforward, conceptually. Measuring qualities like roundness, straightness, squareness, taper, parallelism, or distance between centers is usually a matter of measuring a few dimensional features, then doing some simple calculations.

Better yet, why not let the gage do the calculations. Even simple benchtop gaging amplifiers can measure two or more dimensions simultaneously and manipulate the readings through addition, subtraction, or averaging. (Air gaging can also be used in many of these applications, but for simplicity, we'll stick with electronic gage heads as the basis of discussion.) As shown in the schematics of Figure 1, a wide range of relational characteristics can be measured with just one or two gage heads: it's basically a question of setting them up in the right configuration and making sure that the fixture is capable of maintaining a precise relationship between the part and the gage heads.
With a little imagination, you can combine several related and/or independent measurements into a single fixture to speed up the gaging process. Figure 2 shows a fixture gage for measuring connecting rods. Transducers A1 and B1 measure the diameter of the crank bore: out-of-roundness can be checked by comparing that measurement with a second diameter at 90 degrees (C1 and D1). The same features are measured on the pin bore, using transducers A2 through D2. Finally, the distance between bore centers can be calculated, using the same gaging data.

Using these principles, machine shops can develop workable fixture gages in-house for a wide range of applications, or modify existing gages to add capabilities. Electronic gage heads (i.e., transducers) and air probes are available in many configurations and sizes, some of them small enough to permit simultaneous measurements of very closely spaced part features. Before you begin in earnest, you'll need to check the manufacturer's specs for gage head dimensions, accuracy, and range. Even if you don't want to build the gage in-house, you can use these ideas to design a "schematic" gage to aid you in your discussions with custom gage makers.