



Everything You Need to Know Before You Ask About **CUSTOM GAGING**

These days many people assume only rich men have their suits custom tailored. But as any tailor knows, this is far from the truth. There are many reasons, other than economic, why men—rich or otherwise—have suits tailor-made to fit their specific frames.

The same is true for dimensional gaging. There are many applications—aside from those where custom gaging is the only possible solution—where custom tailoring a gage for an application can speed things up, improve accuracy, incorporate multiple measurements, generate sophisticated analysis or otherwise add value to the process.

How does one know if an application is a candidate? That will probably take

Custom gaging may be one way—or the only way—to meet a manufacturer’s needs. **BY GEORGE SCHUETZ**

some time and money to figure out. But to keep that process as efficient as possible, here are a few things to consider before calling a gage supplier.

First, understand that a custom gage is really a production tool. It does not shape or remove metal, but it can add significant value to the production process in terms of increased throughput, reduced reject rates and overall improvement in quality. Thus, the development and acquisition of a custom gage can be evaluated like a production tool, in terms of its return on investment.

MANUFACTURING SCENARIOS

And like a production tool, the need for custom gaging has its roots in some basic changes or production issues on the shop floor. Look at the following quiz and see if any of these are familiar:

1 Tolerances have been tightened so that you can produce a better performing, or more competitive, product. As a result, your machines are being pushed to near their ultimate capabilities. It becomes too risky to continue sampling inspection because too many

TECH TIPS

▶ A custom gage is really a production tool.

▶ Many factors can be important when defining the requirements for a custom gage including accuracy, the features to be inspected, inspection costs and budget.

▶ Evaluation of the gage maker should be as thorough as the evaluation of the hardware.

◀ **Measuring surface finish on crank bores had been relegated to the lab. Using general-purpose surface finish measuring machines, the measurements took hours to set up, and the long lag time between manufacturing and test results meant only sampling was capable. Worse, because of the length of the crank, the middle bores could not be measured at all. However, by custom designing a fixed plug surface finish system, every bearing surface can now be tested on each part right at the machine. Source: Mahr Federal Inc.**

parts with uncertain measurements are getting through.

Do you:

- A. Hire more inspectors?
- B. Buy better machines?
- C. Buy custom gaging?

2 There has been a report of product failure from the field.

Failure could mean injury, possibly loss of life and certainly high repair bills. You are already inspecting 100%, but the inspection is not 100% reliable; in reality it is only about 85% reliable. The 15% difference could mean lawsuits or a deteriorating reputation. Your share of the market could very well dwindle if the problem is not solved quickly.

Do you:

- A. Hire more inspectors to check the inspectors you already have?
- B. Institute a program to make the current inspectors more efficient?
- C. Buy custom gaging?

3 Rejection rate is low, but enough shop time goes into the part that the bad piece price tag at final inspection amounts to thousands or even tens of thousands of dollars. If you could catch defects earlier at various processes in the machining cycle, you could save unnecessary machining time, and also greatly reduce the amount of salvage time.

Do you:

- A. Hire additional inspectors to work upstream?
- B. Slow down the production so the operator can inspect?
- C. Buy custom gaging?

4 The new plant is well equipped and located in a low tax area. Unfortunately it is also well away from a skilled labor pool. There have been problems training available labor to

meet qualified inspector requirements. The time and money being spent is eating into profits.

Do you:

- A. Intensify the training?
- B. Import experienced inspectors from other regions?
- C. Buy custom gaging?



This fully automatic gage does 100% inspection of 21 characteristics on thousands of cylinder liners, in 12 seconds each. Results are recorded, classified and marked, and information about the process is fed back to the machine tool for offset compensation. No set of manual gages nor any number of inspectors were capable of the throughput this operation required. Source: Mahr Federal Inc.

5 Management has made a decision to reduce production costs by cutting the amount of scrap. However, analysis shows that the cost of more inspectors will be greater than the cost of the present scrap rate.

Do you:

- A. Hire fewer skilled inspectors than necessary?
- B. Intensify efforts with present inspectors to perform more efficiently?
- C. Buy custom gaging?

6 The new warranty on a product meets that of the competition head on. Consequently, bad and marginal parts are boosting replacement costs, dealer charge-backs and customer ill will.

Do you:

- A. Upgrade machinery and material?
- B. Invent new inspection procedures?
- C. Buy custom gaging?

Every one of these problems has been solved with a custom gage solution and in an economical manner.

JUSTIFYING COSTS

In an actual working environment, a custom gage can mean a lot of things to a lot of people. On the low end, a custom gage can be a \$5,000 custom-designed hand gage dedicated to do one specific task. No hand tool or off-the-shelf gage could do the measurement as fast and as accurately as the custom-designed gage, and the results in time saved and performance more than justify the cost.

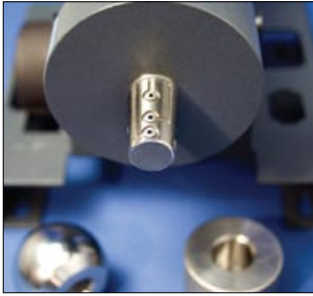
At the other extreme, a custom gage could be a full in-line inspection system that measures numerous dimensions and geometric conditions while providing feedback to machining centers to improve the performance of the process. It would not be out of the question to spend

\$500,000 on such a system—but in a lights out, 24 hours a day manufacturing process, this may be the best and most cost-effective way to meet demand.

COMPARING OPTIONS

If custom gaging may be the solution to a manufacturer's needs, what information needs to be provided to the gaging company that is going to make this custom gage?

One could begin by comparing hardware options, but this also could



Custom air gaging is the only solution for small parts having tight tolerances. Because of the small air jet size they can be designed into small air plugs to measure multiple diameters and tapers to millionths of an inch, and within a very small area. Source: Mahr Federal Inc.



Because of tightening tolerances it became impossible to do parallelism checks with off-the-shelf gaging to meet the 0.0001-inch requirement for this application. But by combining standard components with modified components and electronic signal conditioning, the parallelism can now be checked right at the point of manufacture by the machine operators. Source: Mahr Federal Inc.

be confusing. For example, look at a “simple” outside diameter measurement on a small part. This inspection task could conceivably be performed with at least seven different gaging alternatives:

1. Surface plate method, using V-blocks and test indicator
2. Micrometer
3. Purpose-built fixture gaging
4. Snap gage
5. Bench-type inside diameter/outside diameter (ID/OD) gage with adjustable jaws
6. Handheld air ring or air fork tooling
7. A fully automated system with parts handling

Actually there are many more solutions available—such as a coordinate measuring machine—if the “not-so-simple” is included. But these options alone span a price range from about \$150 to \$150,000. There also are differences in many variables including gage accuracy, operator influence, throughput and data output. It is confusing, to say the least.

GATHERING DATA

A better approach is to first define the functional requirements of the inspection task, and let that steer one toward hardware that is capable of performing the tasks. In order to do this, consider the following factors:

- **Nature of the features to be inspected.** Are they flat, round or otherwise? ID or OD? Is it easily accessible, or is it next to a shoulder, inside a bore or a narrow groove?
- **Accuracy.** There should be a reasonable relationship between job tolerance and gage accuracy, resolution and repeatability—very often on the order of a 10:1 ratio. A requirement for statistical GR&R (gage repeat-

ability and reproducibility) testing may require a 20:1 ratio. But there are other things to remember.

- **Inspection costs.** These increase sharply as gage accuracy improves. Before setting up a gaging operation for extremely close tolerance, verify that that particular level of accuracy is really necessary.
- **Time and throughput.** Fixed, purpose-built gaging may seem less economical than a more flexible, multipurpose instrument, but, if it saves a thousand hours of labor over the course of a production run, it may pay for itself many times over.
- **Ease of use and training.** Particularly for shop-floor gaging, manufacturers want to reduce the need for operator skill and the possibility of operator influence.
- **Cost of maintenance.** Can the gage be maintained, or is it a throw-away? How often is maintenance required, and who’s going to perform it? Gages that can be reset to a master to compensate for wear are generally more economical over the long run than those that lose accuracy through extended use, but they may require frequent mastering to ensure accuracy.
- **Part cleanliness.** Is the part dirty or clean at the stage of processing in which it is to be measured? That may affect labor requirements, maintenance and the level of achievable accuracy, or it might steer one toward air gaging, which tends to be self-cleaning.
- **Gaging environment.** Will the gage be subject to vibration, dust, changes in temperature, etc.?
- **Mobility.** Is the gage going to be brought to the part, or vice versa?
- **Parts handling.** What happens to the part after it is measured? Are bad

parts discarded or reworked? Is there a sorting requirement?

- **Workpiece material and finish.** Is the part compressible? Is it easily scratched? Many standard gages can be modified to avoid such influences.
- **Manufacturing process.** Every machine tool imposes certain geometric and surface finish irregularities on workpieces. Do they need to be measured, or at least taken into consideration when performing a measurement?
- **Budget.** What is the budget?

All of these factors can be important when defining the requirements for a custom gage. If one does not think of them, a good gage design company is going to ask. If they do not ask, it should be a red flag. It is critical to ask these questions up front, or one may be living with some assumptions for a long time. Define as many as possible to help narrow the field, but remember that help is readily available from most manufacturers of gaging equipment—just ask.

Finally, evaluation of the gage maker should be as thorough as the evaluation of the hardware. Field engineers experienced in providing on-the-spot assistance and full representation of the company’s needs are more than just a convenience. An ability to work with the buyer on the design of the gage is essential. Close liaison between the manufacturer’s design staff and the buyer’s team helps ensure successful completion of a gage that will meet all specifications. **Q**

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