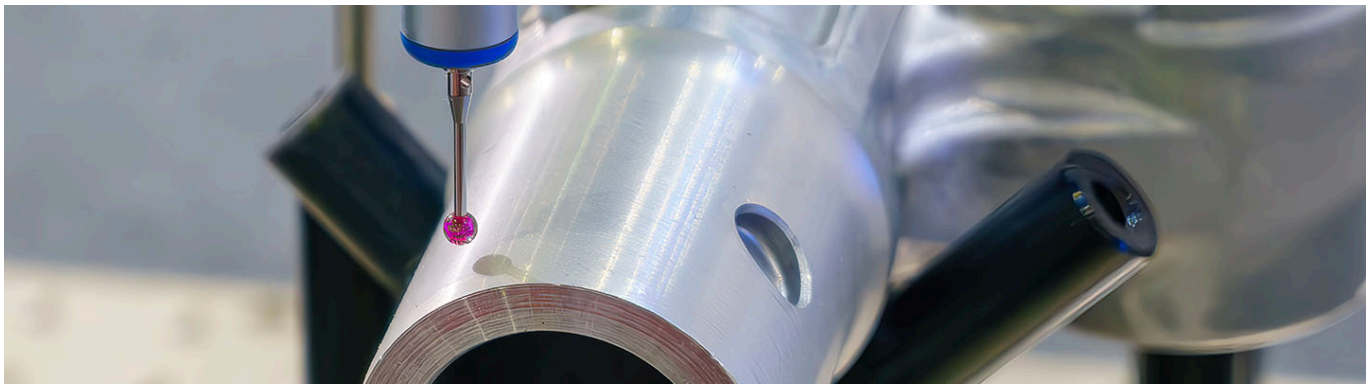

Metalworking

Quality Control: The Key to Precision Manufacturing

Kip Hanson | Feb 20, 2024

There's a whole lot more to successful quality control than inspecting parts for dimensional accuracy before delivery.

From ordering raw materials to final examinations, machine shops, sheet metal fabricators, tool and die makers, and other metalworking companies must ensure that every aspect of the manufacturing process is tightly controlled if they're to meet customer requirements consistently.

Doing so will reduce scrap rates, increase machine availability, and above all, help guarantee that those customers continue to order parts. The end result? Greater profitability and job security for everyone.

So what does "meet customer requirements" actually mean? Is it measured only by the shop's ability to ship products that meet the drawing's dimensional and surface finish requirements? For some customers, perhaps, but for manufacturers servicing the aerospace and medical industries, the road to becoming a qualified supplier is much longer than that.

We won't go into everything needed for ISO 13485 (medical), AS9100 (aerospace), or TS 16949 (automotive) certifications. All of them include a lengthy checklist that will take months or even years to complete.

Nor will we discuss ISO 9001 requirements, except to say that the ***American Society for Quality*** defines the standard as an organization's "ability to consistently provide products and services that meet customer and regulatory requirements."

What we will do is offer some quality management best practices, each of which will help shops meet the goal just described, whether they choose to pursue formal certification or not.

Inspection of Incoming Raw Materials

This one seems simple enough. You or the shop's procurement person ordered some ½-inch diameter 316L stainless steel bar stock last week and it just arrived at the receiving door. All that's left is to count the bars, take a few spot measurements and verify that the packing slip matches what was purchased, right?

Well, that's some of it. Depending on the part's end use, the "certs" that came with the material must

be stored for a predefined length of time—years, typically—but only after the inspector has verified that the hardness, tensile strength and chemical composition of the bar, billet, casting, forging or extrusion meet the relevant ASTM, SAE or ISO standards.

The raw material must also be tagged or labeled with the lot code, material identification, purchase order, job number and other pertinent information, then placed in a controlled area until manufacturing begins. Each step helps to provide a critical function: traceability.

Suppliers and Subcontractors

The incoming inspection process starts well before those steps, however. The material supplier in this case should have been vetted and approved well in advance, with regular quality audits conducted throughout the process.

The same can be said for component suppliers, plating houses, grinding shops and any other external provider. That's because, in the words of Harry Truman, "the buck stops here."

Truman was talking about presidential responsibility, but his well-known axiom applies equally well to manufacturers who subcontract to others. For instance, if workpiece anodizing doesn't meet Boeing's requirements, the aircraft giant won't bring its concerns to the subcontracted plating house involved, but to the shop that hired that business.

Building a Solid Record

That said, a solid track record of regular supplier audits, together with robust process and procedure documentation, can go far toward mitigating some of the likely unpleasantness that follows a quality lapse. The documentation should include the raw material and test certifications discussed earlier, as well as any corrective actions that were required.

As anyone who's endured a product recall will tell you, the traceability enabled by such documentation makes it much easier to determine why an aircraft crashed, a hip implant failed or the brakes on an automobile didn't work as designed.

Similarly, manufacturers should also document their continuous improvement initiatives, employee education, and process or programming changes, guaranteeing open communication and transparency between all involved.

Confirming Equipment Calibration

When you pick up a micrometer and use it to measure a journal diameter, a hole depth or the width of a milled boss, how do you know for sure the satisfactory results you get are correct?

Here too, it's all about traceability, but in this case, it's the traceability of the plug gage or block used to calibrate the micrometer, all of which are traceable to a global standard: the meter.

How long is a meter? Centuries ago, metrologists defined it as one 10-millionth of the distance from the Earth's equator to the North Pole, as measured along the meridian through Paris. Around the time Henry Ford was dreaming up the ***automotive assembly line***, the meter was equal to a special bar made of platinum-iridium alloy that was stored in Sèvres, France.

Since 1983, however, a meter has been defined as the distance light travels through a vacuum in 1/299,792,458 second.

This improbable number is the calibration standard to which every gage pin, gage block, micrometer, dial caliper, bore gage and dial indicator in your shop is traceable.

The trick is to perform these calibrations on a regular, well-defined basis, document the results and teach anyone who handles these metrology devices that they should be recalibrated when inadvertently dropped on the floor or otherwise mishandled.

Proper Equipment Maintenance

The same can be said for coordinate measuring machines, or CMMs. Here, a known artifact (again, one that's traceable) is placed on the CMM bed and inspected. Multiple measurements in multiple locations are usually taken, with any deviation recorded and then compensated for through the machine's operating software.

In many cases, a ballbar device or laser interferometer might be a better choice. These devices not only provide more accurate and comprehensive calibration but are also much faster than the traditional artifact-based alternatives.

Similarly, these systems should be used for routine calibration of CNC machine tools. Doing so ensures better part quality, less scrap and increased machine uptime.

It goes without saying that CNC machinery and metrology equipment of all kinds should be kept in good working order. Check hand tools every day for wear or damage. Keep gages and tooling clean and free of chips, grit and dirt.

Monitor and adjust cutting fluid concentrations as necessary, skim tramp oil from the reservoir, top off the machine's way and hydraulic oil and perform routine maintenance on spindle bearings, drive systems and other electromechanical components.

Each of these steps ensures that equipment will operate as scheduled, reducing process variability and unexpected disruptions.

Regulations and Industry Standards

Lastly, let's talk about standards. We already mentioned ISO 13485, AS9100, TS 16949 and ISO 9001. Each is a widely recognized and, depending on the industry, increasingly expected quality management certification.

But even without these, machine shops and other manufacturers have plenty of required reading from which to choose.

For example, the ASME Y14 (American Society of Mechanical Engineers) series of technical documents describes everything an engineer or machinist should know about drafting and dimensioning practices. ASME B46.1 defines surface texture and finish requirements.

ASTM F136 (American Society for Testing and Materials) and ASTM F138 offer technical information on Ti-6Al-4V ELI titanium and chromium-nickel alloy, respectively. And let's not forget U.S. Occupational Safety and Health Administration (OSHA) Standard 1910 to keep everyone on the shop floor safe and healthy.

There's plenty more, with regulators from the Food and Drug Administration to the Environmental Protection Agency weighing in on the do's and don'ts of the shop floor. Does your company need to follow these guidelines? In many cases, yes, while other standards apply only to specific market sectors,

materials or processes.

Regardless, it's up to each machine shop, sheet metal fabricator, plastic injection molding house or 3D printing service to brush up on applicable requirements and how to implement them.

With assistance from Luke Adair, senior national account manager at JPW Industries, and Dan Skulan, general manager of industrial metrology for Renishaw.

Which parts of quality control are most important in your business? Tell us in the comments below.

