Dr. Fastener

Exploring the Basics of Inspection

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Why is Inspection and Measuring Important?

A The quality systems that manufacturers use to make sure they are making good parts is either what we call an "Appraisal" System or a "Preventative" System. Most manufacturers today have tried to adopt quality systems based on ISO 9000. These are preventative systems, meaning that they design their manufacturing processes with the intent of controlling them so that they do not make bad parts. Perhaps a simple way to sum it up is to think of it as a "good process equals good parts". Not everyone, however, has adopted this philosophy. Instead they have resigned themselves to accepting that they will make some bad parts but they can be vigilant enough through routine checks and inspection to find and remove them. This is appraisal. Regardless of whether a company uses a preventative or appraisal approach, both require good measuring and inspection practices. Of course in an appraisal system, it is all about using inspection and gaging to discover bad parts, whereas in a preventative system, the controls placed on the process often involve measuring to collect the data needed to make sure the process is in control. Therefore, measuring and inspection are a key part of any modern fastener manufacturing quality system.

What are the Basic Gages Used to Inspect Fasteners?

A There are many gages that can be employed to inspect fasteners, however, there are several that are used universally. These are the micrometer, caliper, comparator, recess gages, concentricity gages, and thread gages. Of course this is only a small selection of all the gages and measuring devices used by today's fastener manufacturers. The micrometer is probably the most used of all the measuring tools. It is particularly well suited to the cylindrical shape of most fasteners and is able to get very precise measurements. Calipers are a close second and well suited in making cylindrical measurements, head diameter, head height, and length measurements. They are a little less precise than micrometers. A comparator is a tool that shines a bright light at a part and is able to magnify the resulting image. Comparators are used to measure angles, radii, and lengths. Recess gages provide accurate measurements of the depth of a drive recess. Concentricity gages can be used to measure concentricity (how well two cylindrical features are aligned along the same centerline), runout (a measurement of a variety of common errors including concentricity, out-of-roundness, taper, and straightness to name a few), straightness and perpendicularity. Finally, different manufacturers have different strategies on the way that they verify the quality of their threads, but most certainly, they have gages which they use to do this. The most common variety of thread gages are threaded ring gages for externally threaded products and threaded plug gages for internally threaded products.

What are Some Other Gages or Measuring Devices Commonly Found in Fastener Labs?

A Fastener labs often have to do a lot of different types of testing and inspection. In addition to the standard measuring equipment covered in the previous question, it would not be uncommon for a fastener lab to have additional special gages like a Protrusion Gage, a Wobble Gage, or a Straightness Gage. Additionally a fastener lab may be making other inspections or tests such as tensile, hardness, or salt spray. A tensile test requires an axial load stand, hardness tests are conducted on hardness checkers, and a salt spray test is conducted in a salt spray chamber. Additionally, manufacturers that make really specialized parts might have some really specialized inspection equipment like a CMM (Coordinate Measuring Machine) or VMM (Video Measuring Machine.)

Is There a Difference Between Accuracy and Precision?

A Very often these two concepts are thought to be two ways of expressing the same idea. Nothing, however, could be further from the truth. Accuracy is how close the measurement is to the true value while precision is how close the next measurement is to the one previously taken. To illustrate this let's consider shooting arrows at a large ringed target.

Our goal is to get our arrows directly into the center bullseye. If our arrow hits the target in the dead center of the bullseye, this is an illustration of accuracy. Now imagine we take six shots and, although none hit the target they are all grouped very closely together two rings away from the bullseye. In this case we are not accurate because we missed the bullseye but we are precise because each of the six shots was extremely close to each other. Our goal is to have measuring devices that exhibit both accuracy and precision.

What is Better a Digital or Analog Gage?

The answer to this is pretty much a personal preference. Digital gages are easier to read and have the advantage of being able to quickly toggle between inch and metric. Digital gages, however, require careful operation and care. They must be zeroed between uses and are more likely to operate poorly if dropped or used in a rough manner. Personally, I prefer an old time analog micrometer and caliper, but realize that for those who are uninitiated in how to read the scales, these tools are very difficult to use.

When Would I Use a Comparator?

A comparator is a device that shines a bright light against a part and projects the shadow or image blocked by the light via a series of mirrors up onto a central viewing screen. The image that is projected is magnified from its actual size. Most comparators blow up the projected image by 10, 20, or 50 times. With this magnified image it becomes easy for the operator to measure features that are obvious in the projected shadow, such as a length or overall diameter. Comparators are also instrumental in measuring radii, chamfers, and angles that would otherwise be impossible to see or measure using traditional measuring tools. Most comparators are designed to hold removable templates that can have pre-printed objects, forms, or shapes on them. One template usually has radii that start very small and get increasingly larger. You can manipulate the part to align with the right radius on the template to get the proper size.

What is Gage Resolution?

Gage Resolution, also known as Gage Discrimination is how precisely a measuring tool can measure to. Take for example a metric tape measure. The large numbered divisions represent centimeters. In between these large divisions are ten smaller divisions (nine lines), with each representing one millimeter. The closet value we can read on this device is one millimeter. If we had to measure a part that had millimeter dimensions with two trailing decimal places, this measuring tape would not give us a good measurement. We would need to find a device that gives a measurement to two or more decimal places. This is the idea of resolution and is one of the driving factors that determine the proper gage for the job. In other words the gage must possess an adequate resolution to be able to inspect the desired characteristics.

What is Calibration and Why do We Do It?

Calibration is the process of setting the gage to a known reference standard to assure that the gage is measuring correctly. When measuring devices are not regularly calibrated it is hard to have confidence that they are going to be providing the right measurement. For example, how fair would it be to accept a speeding ticket from a radar gun that is ten years old and has never been checked against a reference to verify that it is reading properly? Using this same notion, we regularly calibrate our measuring tools to make sure that they are measuring properly.

Why is Calibration Important?

Gages, especially those used in the manufacturing environment may not be treated gently. Under the rigors of real world industrial use there is a good chance that the gages could start to exhibit some error. Calibration is important, therefore, to give us confidence that the gages are measuring accurately.

What is Uncertainty?

Uncertainty is the amount of error that a measurement might possess. When gages are calibrated, the calibrating organization monitors the process and reports on the uncertainty (or how much error is expected in the calibrating process.) Likewise, when a measurement is taken in a real-world shop environment, it too will possess an uncertainty. If the uncertainty is too large, the process will not be considered a good measuring method.

Explain What It Means for the Calibration to be Traceable?

One of the requirements of calibration is that the calibration standard is traceable back to a single master standard. This standard is usually held by a national government agency. In the case of the United States, calibration standards are traceable all the way back to a master standard maintained by the National Institute of Standards and Technology (NIST).

When Should I Have My Gage Checked Out?

There are several occasions when a gage should be checked: 1. On its calibration anniversary- each gage is given a time period where it is ok to use it before needing to recalibrate. When that time period runs out, it is imperative that the gage be recalibrated. This length of time depends on a number of factors, but usually is somewhere between six months and one year. 2. When a gage has been dropped or damaged in some way. 3. When the gage starts to behave erratically.

What are Some Measuring Best Practices?

1. Use a gage for the purpose it was designed for. For example, you would not use a micrometer to measure the overall length of a part because it was not designed for this purpose. In theory one might be able to measure the overall length this way, but likely not accurately because the gage was not designed for this purpose. 2. Fixturing- fixturing the part in the gage can be very important. If the parts slip or move during the process it will negate the measurement. 3. Measuring Position- the position where the measurement is taken can influence the accuracy or precision. Take for example a part that is tapered- if no instruction was given and the measurement was taken anywhere on the taper, each measurement would be different and there would be no accuracy or precision. 4. Simplicity- keep gages as simple as possible. The simpler the gage the more likely it is that the operator will not be confused and add a lot of appraiser variation to the total measurement variability.

Can you Give Any Examples Where Bad Gaging Has Caused a Problem?

Although this is not a modern day example, it is a very poignant illustration of the consequences of bad measuring practice. In the early 1600s, Gustavus Adolphius, the king of Sweden, aspired to have a mighty naval fleet. As such he commissioned the construction of a mighty war ship. On August 10, 1628 the Vasa, one of the most heavily armed and fearful war ships of the day, was christened and launched into Stockholm harbor. It made it out into the harbor and then proceeded to sink. In the late 1960s or early 1970s a group of explorers would find the wreck of the Vasa and embark on the monumental task of raising the remains and conserving her. Today the Vasa has been completely conserved and restored and sits in her own museum in Stockholm. As they reassembled her during conservation they discovered that the port side of the ship was heavier than the starboard side. She had been made with thicker planks on that side because the measuring tools used to calibrate the two sides were different. The builders had used measuring tools calibrated to the Swedish Foot (12 inches) on one side and the Amsterdam Foot (11 inches) on the other side. Surely this weight imbalance caused by incorrect calibration and measuring tools led to the demise of the Vasa.

What is a Recess Penetration Gage?

A special gage that drops a pin into the bottom of an internal drive recess to give an accurate and precise depth of the recess.

What is a Wobble Gage?

A special gage used to validate the quality of a cruciform recess. It measures how many degrees a pin placed in the recess will move from side to side. If the recess is tight it will possess little wobble, but if it is sloppy it will have a significant amount of wobble. A lot of wobble indicates a higher probability that the recess will cam out.

What is a Protrusion Gage?

A Protrusion Gage is a special gage that verifies the geometry of a flat head screw.

What is the Most Common Error in Thread Gaging?

When a manufacturer makes a part and first rolls the thread onto it, they will often use a set of ring gages to verify that the thread is correctly made. After thread rolling it is very likely that the parts get heat treated and plated or coated. The finished parts will need to be verified again. It is very common that those not knowing better will use the same set of gages to verify the threads. This is a mistake. When the part gets plated or coated it grows in size. In fact, the pitch diameter of the thread grows by four times the plating or coating thickness. This means that the threads are in a different condition than prior to plating and need different gages. The gaging rule therefore is this: For inch 2A threads before plating the proper gage combination is a 2A Not Go and 2A Go Gage. After plating, however, the proper combination is 3A Go Gage and 2A Not Go gage. (For metric the equivalent is: 6g Go and 6g Not Go before plating and 6h Go and 6g Not Go after plating.)

How Can You Use a System 22 Inspection Method to Make Better Threads?

System 22 inspection method calls for a variable measurement of the Pitch Diameter, a Not Go ring gage inspection, and verification of the major Diameter (probably with a caliper or micrometer). Usually, however, when manufacturers have to get a variable measurement of the Pitch Diameter they will purchase a gage set that gives them the variable measurement for the Pitch Diameter and the Functional Pitch Diameter (instead of using the attribute Not Go ring gage). On the gage that measures these values, the Pitch Diameter measures over only a single thread while the Functional Pitch Diameter is measured over multiple threads. Thus the Functional Pitch measurement picks up any errors that might be present between threads. If the thread were perfect there would be no error and the two values would be identical. Therefore, a very proactive manufacturer could use this gage set to bring the rolling set-up as close to one another as possible. By doing this they would be guaranteeing a better thread than a manufacturer that does not inspect and control the process this way.

Can you Sum up the Overall Importance of Good Inspection Practices?

Good inspection practices are very important. First of all, inspection and measuring are necessary activities in both appraisal and preventative quality systems. However, if the gages are not calibrated, in disrepair, or hard to use, the likelihood that the user's job is being made more difficult is very high. Additionally, poor inspection practice increases the possibility of quality spills, which can be costly in both dollars and a tarnished reputation.