Practical SPC for Internal Threading

This article was prepared exclusively for Fastener Technology International Magazine

by: Joe Greenslade
5279 Zenith Parkway
Rockford, IL 61111

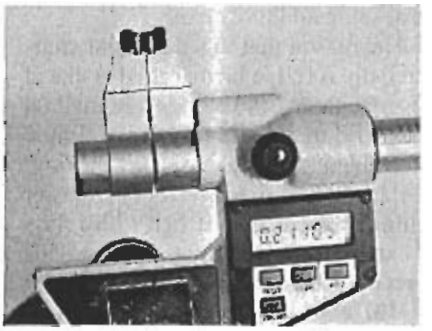
The quality of fastener threads is a matter of growing concern for many major fastener users. A significant step toward improving the overall quality of threads is the implementation of Statistical Process Control (SPC) during the manufacturing cycle. Process variation is the cause of most quality problems. SPC is a method for measuring and analyzing process variation. Supplier's proper use of and constructive response to statistical data will definitely result in improved fastener quality and probably measurable production cost savings.

A previous article in this publication addressed the practical approach to the use of SPC in rolling of external threads. This installment will offer some logical suggestions regarding the use of SPC in the production of internally threaded fasteners. First, a major misconception needs to be cleared up. Thread characteristics which can be rather easily measured on external threads are frequently not so easily measured in internal threads. In fact there are some internal thread measuring requirements being proposed by the federal government which cannot yet be accurately and consistently measured because of inadequate verification technology available in measuring internally threaded master setting rings. Suppliers and users alike need to be aware of these misconceptions and be prepared to resolve disagreements with some logical approaches.

Two common problems frequently arise in the initial implementation of an SPC program on a given product. Often too many characteristics and/or the wrong characteristics are selected to chart. To generate an efficient SPC program one must be careful to select the minimum number of characteristics for the chart. This will indicate to the user the process performance without redundaney.

Here are five suggestions to consider in making characteristics selection:

1. Choose characteristics that have direct bearing on the product's final function.
2. Select elements that affect the quality of subsequent processes.
3. Choose one characteristic that is indicative of the machine's operation and one typical of the tooling.
4. Control a minimum number of characteristics that will demonstrate process performance.
5. Control four characteristics or fewer in a fastener process. Never control two or more characteristics that will vary together in the process.



Inside diameter measuring

With these suggestions, let's look at what we perceive to be the logical internal thread characteristics to control to minimize process variation.

Inside Diameter

Fastener inside diameters (ID) can be pierced, extruded, or drilled depending upon the process being used. The ID is always processed in some way prior to the tapping process. It is important to control this characteristic because it has a major impact on both the final function of the part and on the consistency of the tapping operation. The fastener blank's ID should always be controlled for size. It is also advisable to control its perpendicularity to the fastener's face.

Whether the fastener is form tapped or cut tapped the blank's ID results in the creation of the thread's minor diameter. The size of the thread's minor diameter is critical in the fastener's final function by providing the depth of engagement required to prevent the thread from stripping out when the fastener is put into tension in its application. If the minor diameter is allowed to become too large the depth of engagement can become too small to support the required load and cause field failures. If this condition is not caught or controlled in processing it will frequently result in failing the required proof load tests.

If the blank's ID is produced too small or too much variation is accepted the tapping operation is adversely affected. As the ID becomes smaller the percent of thread engagement in tapping goes up, which dramatically affects the tapping torque required. Too much ID variation can affect the performance of the tapping equipment and the taps.

Controlling Taps

You cannot tap a consistent thread in an internally threaded fastener using taps that vary beyond the limits you want to obtain in the finished product. Unfortunately there are few if any tap producers who have recognized the need to utilize SPC in the processing of their products. Therefore, those trying to implement SPC in the production of internally threaded fasteners are discovering that they must inspect all incoming taps prior to use. They must sort the taps according to size to make sure that taps of similar size are used in the production of a given

lot. Many taps are being found to be out of specification when they are received.

The standard method of inspecting taps is to measure their pitch diameter with the "over the wires" method. This will indicate the size of the pitch diameter, but does not provide any indication of the correctness of the "functional diameter size." The functional diameter size is the diameter which includes the pitch diameter plus any variations attributable to lead, thread angle, taper, and roundness. This is the size which has normally been inspected in the internal thread with a GO plug gage to make sure it will mate with an external thread.

Manufacturers of internally threaded fasteners should inspect the taps they receive with a variable thread measuring system such as Tri-Roll gages for both their pitch diameter and functional diameter size. The reasoning is simple. You cannot create an internal thread without variation if the taps you are using already vary outside of the limits you wish to achieve.

Controlling Functional Diameter

The functional diameter should definitely be measured with a variable gage.

Gaging internal threads

This thread characteristic has a direct bearing on the use of the final product and therefore should always be an SPC control characteristic. If the functional diameter is not within the pitch diameter size specification the internal thread will probably not assemble with the corresponding external thread. If parts do not mate they obviously are no good.

Most, if not all variations in the tapping process including those in the machine and the tooling will be obvious on the X bar and R chart of the functional diameter. You will see variations due to tap wear and tapping pressure. Obviously, as the tap wears you will expect to see the functional size change. You want to change the tool before you start to produce out of tolerance product.

Many who have already started to implement SPC in the tapping operation have discovered that tappers with lead screws produce more consistent internal threads than do tappers which apply end load to the taps with pneumatic, spring, or dead weight pressure. Any method of controlling the tap's advance except something like a lead screw or a CNC tends to cause taps to cut away portions of the internal thread's flanks as the tap is pushed forward. This condition will be seen in a variation in the functional size.

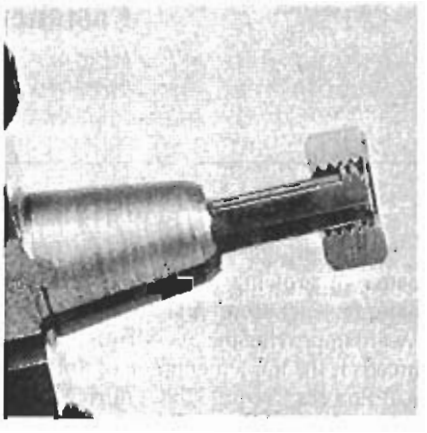
Simple Pitch Diameter Size

This is the measurment of the internal thread's pitch diameter at a single position in the thread. This measurement by itself does not assure fit, because this measurement may be correct but so much lead error may be present that it will not mate with an external thread. If a supplier is supplying the military or Ford Motor Co this characteristic must also be controlled. In the author's opinion it is of marginal value as a control characteristic, but may be of some value as an inspection characteristic at setup and tool change.

The reason that this particnlar characteristic is felt to be marginal is that at this time there is no recognized method of certifying the accuracy of the simple pitch diameter of the master setting ring. The functional diameter of the master setting rings can be certified with a class W externally threaded setting plug. This is recognized in the ANSI B1.2, ANSI B1.3M and the military's FED-STD-H28/20A specifications.

None of these however, recognize a method of verifying the simple pitch diameter. A working task group of the ANSI B1 committee made up of representatives of several of the leading gage producers in the U.S. has not been able to correlate its independent measurement results of the simple pitch diameter of an internal master setting ring within closer than 0.0006".

This is a major problem since this is considerably larger than the required "W" tolerance for master setting rings.



Simple pitch diameter measuring

If leading gage companies with the best metrology equipment in the country cannot agree on this size, fastener suppliers are going to have problems with customers on disagreements on the size of this characteristic. Until this issue is resolved simple pitch diameter is felt to be a poor characteristic to use as an SPC control characteristic and as a criteria for product acceptance.

Electronic Data Collection

The traditional approach to SPC implementation has been with the use of "pencil and paper" charts. Anyone with any shop experience knows that equipment operators detest paperwork of any kind and in particular paperwork requiring computations. Many good "user friendly" electronic computerized SPC data collection systems are available With these the operator simply inspects the parts similarly to tbe way he always has, except he presses a button as the measurements are being made. The system does all the rest. The data is recorded. The calculations are made and the charts are created. The operator then reviews the charts and takes appropriate action.

Fastener manufacturers will find that a data collection system will give them more accurate and more timely data with less operator fear and reluctance. Electronic variable thread measuring, coupled with an electronic data collection system is the most efficient and expedient way to implement an SPC program in fastener manufacturing.

For more information contact the author.