Precision Measuring With Calipers

- **Precision:** Is the repeatability of a measuring process or how well identically performed measurements agree with each other.
- **Accuracy:** Is the agreement of the result of a measurement with the true value of the measured quality.
- **Standards:** Something that is setup and established by an authority as a rule for the measure of quality weight, extent, value, or quality. Modern civilization would be impossible without a good set of established standards to manufacture products by.

Calipers come in various configurations but there are three common styles. Vernier, Dial and Electronic.

These three types are similar in construction and general appearance but vary in function and ease of use. Each has their own strengths and weaknesses which must weighed before selecting the appropriate equipment.

Vernier Calipers

The Vernier caliper was originally designed and graduated similar to the micrometer in that it incorporated a scale equal in value to .025 (like the single revolution of the micrometer thimble). Later, the 50 grad style was introduced to expand the graduations and make it much easier to see without the use of an eyepiece.

Here lies the shortcoming of the tool. In order to interpret the dimension you must align an etched line on the tool's " vernier plate" with an equally spaced line running the length of the tool's handle. The alignment of the these lines is critical if you are to measure to the stated accuracy of the tool.

Despite this shortcoming they are rugged, forgiving instruments that if used and cared for properly by a skilled machinist, will last for many years.

Dial Calipers

Dial calipers came on the scene around 30 years ago and have,in my opinion overtaken the micrometer as the first measuring tool of choice for the machinist or toolmaker. They provide the ability to quickly read dimensions, both inside and out, like their predecessor and also feature the addition of the depth measurement rod. Also, the range from 0-6 or greater make these an attractive alternative to the micrometer which would require the purchase of multiple tools.

The dial caliper is also easier to read which translates to speed in the work place. As for the construction, the dial is fixed to the moveable jaw and rides along the tool's bar or slide, meshing with a toothed rack.

This rack typically is a ground bar so each tooth is equal to .025 or one quarter of the dial resolution, and four teeth equal .100. The bar is graduated in .100 increments instead of the more complex .025 or .050 of the vernier and the dial is graduated from .001 up to one hundred thousandths.

First you read the number on the bar and then the dial figure to get readings to the nearest .001 of an inch. Another relatively new feature to the caliper is the ability of the inside measurement jaws to pass by each other so smaller dimensions can be read and a single scale is needed which further makes the readings easier to determine.

The depth rod addition extends beyond the bar and travels as the jaws are moved in and out . Larger length tools have a detachable rod so when not in use the rod can be removed to prevent obstruction. This rod simply unscrews and is quickly removed or attached.

Like the vernier, the dial caliper has a few drawbacks, the first and unfortunately the most annoying being the toothed rack that is necessary to carry the dial pinion gear is subject to contamination. Some designs discourage this from occurring, such as with rack teeth that point down.

This tends to cause the foreign material to be shed more easily. However fine metal chips or similar materials could still become lodged in the gullets of the rack. And if the pinion gear is run over this chip this will cause the pinion to jump to the next gullet and cause the tool to get "out of time" resulting in the failure of the hand returning to zero.

The second consideration is the I.D. jaws. In order to make the pass by design function they are considerably thinner than the contacts on the vernier style which means they can wear quickly if used on abrasive materials.

Electronic Calipers

Enter the Electronic caliper, the latest tool on the block. It was introduced in the late 70's early 80's and has become very popular for a variety of reasons.
Constructed more like the dial than the original vernier, they offer even more functions because of their electronics.

They still perform the outside, inside and depth readings, but have the ability to convert from English to Metric, provide high and low limits alerts (some with colors) and the ability to set your zero position anywhere along the bar. The calipers have the ability to send readings to personal computers or data collectors for unlimited applications.

How do electronic tools work? The calipers employ a capacitance system. To the layman the system is like the electronic ignition in your car, (no actual physical contact). The system consists of a series of rectangular plates etched into a copper or glass strip that stretches the length of the bar, usually concealed by a taped scale or simple cover.

Mounted above this in the movable jaw is a similarly plated slider board. When these rectangular boxes align and misalign, signals are sent to an electronic chip within the caliper's case to generate the readings you see on the display.

Since the electronic calipers have no moving parts, foreign matter and other contaminates are less of an issue. However moisture is a problem, if water gets between the stator strip and the slider board the necessary air gap is eliminated and the signal can become garbled or nonexistent. There are some specially designed calipers with protective cases if you are required to work in harsh conditions like these.

Maintaining Calipers & Micrometers

Caring for calipers and micrometers is mostly an issue of common sense. These tools are delicate instruments, constructed to exacting tolerances and designed for long service. Keep them free of foreign particles whenever possible and when not in use, store them in their appropriate container. If you allow them to be left unprotected on a bench, they will probably be damaged.

A light coating of high-grade instrument oil will also go a long way to extend the life of the tool. A note of Caution, resist the urge to spray the tools with some of the protectarant type oils. Instead, these products are designed to place a coating on the material so as to resist rusting. Were this coating to attach to the threads or teeth of the micrometer/caliper you will notice a change in the calibration. If the tools are to be stored for a period of time, the placing of a silica gel pack into the toolbox draw will also help to retard rusting.

How often do you check the devices? With the advent of ISO certification this may be already predetermined by individual companies but a rule to follow on micrometers and calipers is to periodically throughout the day, close the measuring surfaces to assure that you are on zero.

With mechanical tools you are not so apt to be far away but the addition of the floating zero to the electronic tools makes this more important as the button could have inadvertently been pressed.

Recommendations for calibration, again, your company may have established a frequency for checking calibration but I would like to pass on a brief guidline on the subject. If a tool is under the control of an individual and is used in a normal measuring capacity (not abrasive), it normally needs to be checked by a technician once a year. If the tool is loaned from a central tool crib and is in use by many individuals. We recommend twice a year service.

Caliper or Micrometer?

Lastly, where is it appropriate to use the tools? When are micrometers used and not a caliper? This is easy if you remember the ten times rule. Which states that the tool to be used, MUST be accurate to at least ten times the tolerance involved with the construction.

If the part is tolerance to plus or minus .001 calipers are not used, (as they are only accurate to plus or minus one thousandths of an inch). A micrometer graduated to .0001 is then required. Otherwise it is an issue of construction, personal preference or convenience.