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Probing

This paper covers machine probes used during the process of high-speed machining with micro-tooling. Specifically, the paper highlights and champions a type of advanced machine probe found in certain manufacturing circles. The paper also touches upon the benefits of the capabilities of these advanced probes and explains how to apply the advanced probing technology to everyday high-speed machining challenges.

Probing defined

A probe is defined as an instrument which can measure a material's surface by contact. These measurements are used to ensure uniform depth in the machining process.

The challenges that require probing

What are the challenges and obstacles in manufacturing, that make probes such a necessity? Sometimes, blanks need to be measured, edges found, surfaces probed, and programs intended for perfect, flat workpieces adapted to the "real world."

What's available out there?

There are two types of probes commonly found in machining. The first is an accessory added to a pre-existing machine, otherwise known as a spindle-mount probe. The second is a probe built into the machine from the ground up, called an integrated probe.

Spindle-Mount Probes

Machine tools not already built with a probe included can be fitted with some limited probing capabilities. One of the problems with probes of this type is that they take up room that the designers of the host machine hadn't planned for in the first place. Spindle-mount probes are called that for a reason: they're mounted on the spindle, and that means it prevents a tool from being mounted there instead. Thus, using a spindle-mount probe inherently requires a tool change, adding more time to production.

There are two varieties of spindle-mount probes: wireless and wired. Wireless probes require batteries, and batteries eventually run down. While normally this doesn't pose a major problem, a problem can arise if the batteries need replacing in the middle of an important job. Furthermore, industrial environments sometimes play havoc with radio transmissions, generating considerable interference. Since wireless probes send telemetry via radio transmissions, data can be lost due to signal interference. Wired probes don't have the same problems, but wires can get tangled, and loose connections are always a threat.

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Integrated Probes

Integrated probes are built into the machines right from the start. These probes can fold down so that they don't get in the way of the tooling, eliminating the need for a tool change. Machine-integrated probes are reliable and always available, eliminating drawbacks such as dealing with cables, coping with radio interference, and securing power sources.

A conventional machine built with an integrated probe becomes a machine that senses and reacts to the environment. Machines with these capabilities are a valuable tool in today's market, where parts are getting increasingly smaller and come in more versions…

The idea that accessories such as a spindle-mount probe can be added on to an existing machine and be expected to function as well as an integrated probe is about as realistic as adding a race car engine to a suburban family's minivan and expecting it to compete in the Indy 500.

One particular integrated probe worth noting is the Z-Correction Probe. This unique probe compensates for uneven surfaces, whether those irregularities occur accidentally or by design. Unlike conventional sensing equipment, the Z-Correction Probe never gets in the way because it is permanently mounted right next to the spindle. The Z-Correction Probe is pneumatically retractable, so it is extended only when needed. Based on its integrated design, it requires no tool changes, there's no cable to get in the way, and the device cannot be damaged by accidentally turning on the spindle.

Single points or custom matrices can be probed to measure the surface. A 'flat' machining program can be applied to the measured surface, ensuring uniformly precise depths throughout the work-piece. In addition, the probe can be made more flexible courtesy of an item known as the 3D-Probe extension.

In order to simplify work-piece set-up, the 3D-Probe extension is capable of locating parts in the X,Y, and Z co-ordinates. This includes finding centers of holes and bosses, as well as pre-measuring blanks before the machining starts. The 3D-Probe extension enables the Z-Correction Probe to function in three dimensions. Intuitive programming allows machining programs to adjust themselves to the particular work-piece on the machining bed. Work-pieces can be checked after machining for quality control. Certain parts can be reverse engineered. Material variations in X, Y, and Z can be compensated dynamically.

To machine round stock or engrave on round work-pieces, the 4^{th} axis provides the necessary flexibility. The 4^{th} axis integrates virtually seamlessly with the CNC machining control.

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The 4th axis can be used to substitute either the X or the Y axis, and can be dynamically switched under program control.

The 4th and 5th axis together provide the flexibility needed for the most complex workpieces. The 5th axis is used to independently rotate the 4th axis, each axis independently and dynamically controlled by the appropriate machining program. As a result, machining at an angle on a round part is easily accomplished.

Meeting the challenge of probing

When an integrated probe is built into a high-speed machine, the result is a smart machine. Smart machines can probe fields and curvatures in order to program parts as if they were flat. They can adapt the program to the surface of the workpiece, and find the contours.

Integrated probes can measure a part's true center and outside diameter. They can even begin at a point on the outside diameter and find a point located at a certain distance from the center.

Bringing it all together

Smart machines take probing to the next level. It's not enough anymore to just have a machine recognize an irregular surface. It's now necessary for a machine to have the ability to not only recognize the surface but to also compensate for it, instead of making a programmer spend hours doing it.

Smart machines can:

- Adapt to uneven panels and ensure constant depth.
- Save programming time and improve quality on round and uneven parts.
- Adapt to the irregularities of cast blanks.
- Adjust to the tolerances of extruded materials.
- Ensure constant machining quality for parts that vary from lot to lot.

Building a machine with a probe already installed is the best way to proceed. Taking a probe's requirements (space, power supply, range of motion) into account ahead of time eliminates many headaches and ensures that the probe is practically invisible and causes minimal impact to the manufacturing procedures.