Tool Check & Verification

This paper explores the idea behind tooling checks and verifications for manufacturing systems that perform high-speed machining with micro-tooling. The paper sets out to prove the effectiveness of the automated tool damage sensor/replacer over other systems.

The aspects defined

There are several different elements in discussing tooling checks and verifications, and they need to be explained for clarification's sake. First of all is the concept of tooling check and verification. This concept describes the ability of a high-speed machine to conduct spot checks of its micro-tools, verify that they are intact, and, if not, to correct the matter.

Micro-tools are defined as mills and drills a ¼" diameter or less. They are fragile and therefore come with their own particular needs. Such tools work best with high-speed spindles.

High-speed machining has no one fixed, standard parameter or definition, but for the purposes of this paper can be defined as machining with spindle speeds of 25,000 RPM or more.

The challenges

The more that industry uses "lights out" operations these days, the more urgent the need for things left running overnight remain running. If a tool breaks when no one is there, it can result in a chain reaction of breakage and loss of time.

As stated before, micro-tools are fragile. By their very nature, they have to be. Unfortunately, this makes the risk of breakage even greater. To make matters worse, tooling can take hours to accomplish, which means still more unattended production time. If a tool breaks during this time, the machine will continue operating with the broken tool, resulting in a waste of production time, as the job will have to be done over with a new tool.

In order to conduct "lights out" operations safely, the industry needs a system that will monitor tool length, checking for breakage, then, if the tools are broken, to replace them, all without disrupting the machining process. Just monitoring a tool is insufficient; if no one is there to replace a broken tool during an overnight shift, it's like a fire alarm going off but with no fire department available to respond to the call.

Ways to check tools

In large tool manufacturing, current running through the tool is used for detecting breakage. If there is a fluctuation (drop-off) in the current, then the operator knows that the tool is broken.

Unfortunately, this option is not available for micro-tools. The load involved is so small that the power usage doesn't register. In fact, the choices for such a system for micro-tools is limited.

One of the more widespread and popular systems for detecting micro-tool breakage is the contact sensor, which monitors the tool by a sensing needle's light physical contact on the tool's tip. However, this system does not replace the tool; it merely reports that the tool is broken. With the automated tool damage sensor/replacer, breakage is detected and a new tool is brought in automatically to replace it.

The best results one can expect from a system that only detects breakage is that the machine will shut off, which at least contains the damage and prevents things from getting worse. But production time is still lost, and the earlier that tool breakage occurs in an overnight shift, the more time is lost. Consider the waste of time if a tool breaks only an hour into an overnight "lights out" shift.

The difference between a contact sensor and a fully-equipped tool damage sensor/replacer is similar to the difference between a doctor that simply diagnoses a patient's condition then sends them away, and a doctor who diagnoses a patient and also cures him.

The system that works

A tool damage sensor/replacer system is made up of three separate components working in conjunction: the tool changer, the tool checker, and the software.

The tool changer is a rack, or tray, that has space for spare tools as well as empty sockets for placing broken tools. Machine operators can stock the rack with spare tools, thereby having a ready supply should tools break during "lights out" operation.

The tool checker is a mechanical sensor that measures tool length. This is the instrument that actually detects the broken tool in the first place.

The software is a macro program that can be set up to run a tool check after executing a number of lines of code. For instance, a tool check macro can initiate a check after every 500 lines of code. This is known as an "if/then" statement, in other words, "Measure this tool; if the length is shorter than the listed parameter, then change the tool."

This system provides the following:

a.   A time interval arranged for the system to measure the tool

b.   The tool length is measured

c.   If the tool is broken, a new tool is selected

d.   Machining resumes from the point of the previous check

The automatic tool-changer, used in conjunction with an automatic tool-length measurement tool, improves productivity, automatically detects tool damage, automatically measures tool length, and stores tools and tool data. There are also adapters for ¼" and 1/8" without collet changes.

These elements offer the convenience of automatic tool changes, tool length measurement and tools specs for each individual tool. Tool breakage can be detected immediately, preventing avoidable damage to a machine's parts.

The automatic tool-length measurement can be controlled manually or by software. Tool data (e.g.: diameter, length etc.) is stored within the tool database in the controller. This allows the tool data to be automatically activated and applied when the tool is in the spindle.

Wrapping it all up

By using an advanced control like the one detailed here, tool changes and tool measurements are done swiftly and accurately, ensuring maximum quality control. This permits unattended milling without compromising downtime which otherwise would happen on any other type of machining system.