



Machine Tools Get Vision

A new inspection tool provides video inspection for the masses. BY LARRY ADAMS

Part inspection on a machine tool is difficult because of environmental and climatic issues, but a new plug-and-inspect video measurement system can be used on a machine tool to magnify a part's geometry for visual inspection.

The MachineEye video measuring system from MachineEye, a division of MeV Technologies LLC (Westport, CT), was developed to be an affordable alternative to coordinate measuring machines (CMMs). While it does not offer the precision of a CMM, nor generate or capture the same amount of data, the MachineEye allows parts to be visually inspected on the machine tool without having to offload the part and before additional operations are performed on the part.

"If machining a complex part with a complex part setup, the part can be inspected before it's taken off the machine, so the operator can confidently move to the next machining step knowing that the first phase of the operation was done properly," says Milan Milosevic, chief technology officer and designer of the MachineEye inspection system.

The 4-pound and approximately 7-inch by 5-inch standard unit mounts directly on a machine tool such as a vertical milling machine, jig borer, jig grinder, sinker EDM—basically any machine tool with a vertical spindle and a table. A custom fixture can be used to mount the MachineEye to a lathe. It takes about 10 seconds to mount the video system onto the machine tool via a 5/8-inch shank, or a range of different shank diameters, according to Milosevic.

Using a 1/3-inch CMOS color camera and 40X magnification, the part surface is shown on a 4-inch TFT-LCD. The MachineEye has a working distance of 0.98 inch, a field-of-view of 0.10 inch and comes standard with a cross-hairs reticle or with custom-ordered angle and circle reticles. An illumination system has four ring-mounted white LEDs. The unit is powered by a 12-volt nickel metal hydride (NiMH) rechargeable battery pack.

The system uses the machine tool's precision movement along the XYZ axes. Not only does this result in precise movement, it means that the size of the part to be measured is limited only by the machine tool's travel

◀ The MachineEye video measuring system mounts directly onto a machine tool for in-process and finished parts inspection prior to off-loading the part. Source: MachineEye

capabilities. Whatever size part the machine tool can mill is the size of the part that can be inspected. Additionally, if the machine tool is computer numerical controlled, inspection routines can be programmed.

Because the MachineEye uses the tool's XYZ movement to find and view the part's surface, its accuracy is contingent on the machine tool's accuracy.

Before the MachineEye could be successfully launched, Milosevic needed to develop a quick, cheap and accurate way to qualify the machine and so they incorporated a precision gage plate. The gage plate measures 7 inches by 5 inches with a 1-inch grid. The plate can measure the XYZ positional accuracy by lining up the starting point on the grid with the MachineEye's crosshairs and zeroing out the position on the digital readout. By moving the machine from point-to-point on the grid, and lining up the crosshairs with the grid line points, the operator can tell if the machine is accurate.

"The gage plate can be placed on the work table to quickly check to make sure the machine is precise enough," says Milosevic. "Users should check the machine systematically. They should check all points on the grid, which is 35 points, to be confident about the machine's accuracy."

The prequalification of the machine can be done prior to a run of a part or periodically to evaluate the performance of a machine. This prequalification process not only ensures accuracy during the inspection process, but determining positional accuracy also can help improve part production and help eliminate out-of-alignment and other machining problems. Milosevic says that the first customer to buy the MachineEye bought it to check his machine tools to see if calibration was needed by an outside service.

INSPECTION FOR ALL

Milosevic admits that the system is not a replacement for a CMM, but a portable alternative for a company that does not need 'ultimate' precision. "We believe this is an affordable alternative to CMMs," he says. "As one customer describes it, the MachineEye offers 'video inspection for the masses.'"

MachineEye's genesis goes back to Milosevic's previous job as president of a sci-

QUALITY SPECS

- ▶ A video measuring system mounts on the spindle of machine tools such as vertical milling machines.
- ▶ Measure in-process parts without disturbing setup.
- ▶ Finished parts can be inspected on the machine on which they were made.
- ▶ An integrated 4-inch color LCD displays a 40X magnified image of the workpiece.

entific optical products company. While the company had a small, internal machine shop, 90% of all the parts were outsourced. Parts would come in and be put in the stock room. The vast majority were accurate, but occasionally the parts would be flawed; so quality control personnel using calipers would inspect each part before use. A CMM was cost prohibitive, and the shop had no room to fit the large footprint a CMM requires.

The metal parts were mostly in the shape of plates with features such as tapped holes, slots and grooves. Relatively simple parts, but inspecting them with calipers proved to be a tedious, labor-intensive process. "A good engineer might spend an hour to do one part," Milosevic says.

After the company was sold, Milosevic and his wife Violet, who now serves as chief executive officer of the new company, founded MeV Technologies LLC, a manufacturer of scientific optical instruments, and developed the MachineEye as a division of that company. "This was the first problem that we wanted to attack," says Violet. "Because we ran into a situation that needed such a system, we felt that there were a large number of businesses just like us who would have a similar type need."

One challenge of a video measuring system used on a machine tool is vibration. Because the image is magnified by 40X, even the smallest vibration has the potential to blur an image. Milosevic says this is not a problem because the MachineEye does not sit in the tool exchanger when the machine tool is running. It is installed into the tool holder when the machine tool has stopped and inspection is needed.

It is a robust system, made of precision-machined anodized aluminum alloy that can withstand some of the environmental issues found in a machine shop, he says.

While in-process and finished parts' inspections are valuable capabilities of the MachineEye, it is not the system's only use. It can be used in setup to find perpendicular

MachineEye Specifications

Mounting	Via 5/8-inch shank
Material	Precision machined, anodized aluminum alloy body
Dimensions	7.27 inches x 4.74 inches
Weight	~ 4 pounds
Shipping Weight	~ 12 pounds
LCD	High resolution color, 4 in. TFT-LCD 480H x 234V
Camera	1/3 inch color CMOS
Magnification	40X
Working Distance	0.98 inch
Field of View	0.10 inch
Depth of Field	~ 0.005 inch
Power Requirements	12V NiMH Rechargeable Battery Pack
Precision Gage Plate	7 inch x 5 inch plate with 1-inch grid
Illuminator	4 White LEDs, Ring Mounted

IN PROCESS OR FINISHED PART INSPECTION

- ▶ Install MachineEye via a tool holder that accepts a 5/8-inch shank.
- ▶ Flip the ON/OFF switch on the back of MachineEye.
- ▶ Raise/lower the machine's stage until the work piece is in focus (~1 inch away).
- ▶ Line up the starting point on the workpiece with the crosshairs on MachineEye's LCD.
- ▶ Zero the machine tool's display.
- ▶ Move the workpiece so its features line up with MachineEye's crosshairs.
- ▶ Check the position and compare with the print.

Note: A CNC-enabled machine can be programmed for automatic movement between the checkpoints.

—Source: MachineEye

lar edges of a workpiece and to locate a hole or other surface features. In addition, CMM operators can replace the touch-probe with a MachineEye to allow for noncontact magnified video measuring.

Currently, the magnified image is live; it cannot be recorded or captured. Future iterations of the MachineEye may include a wireless camera to capture the images and transmit the data to a computer, PDA or other electronic device for documentation purposes or file sharing across an IP.

In addition, Milosevic is contemplating other options such as incorporating digital zoom and shape recognition software,

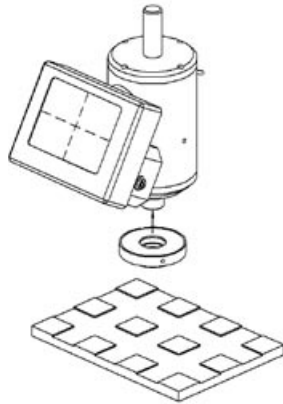
which would facilitate automated inspection. The most ambitious idea is to work with the machine tool manufacturers to build the MachineEye directly into production machinery.

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The MachineEye is mounted on a vertical milling machine. It takes approximately 10 seconds to install the unit. Source: MachineEye



This schematic shows the MachineEye components including a rendition of the gage plate. Source: MachineEye



A video image shows a machinist's ruler with 1/2 millimeter rulings. Source: MachineEye



The video unit can be stored in the box until ready for use. Source: MachineEye