Prevent machining defects with CNC machine tools using precise workpiece seating confirmation.

DENSO Corporation / Air Gap Sensor

Not noticing seating failures of workpieces produces defectively machined goods.

Our biggest headache was having to stop the line for a full inspection...

In Denso’s Driving Safety Production Division, ABS actuator parts must be manufactured with a high machining accuracy.

In the past, when cutting using a CNC machining center, a pneumatic "gap sensor" was employed to verify the seating of the workpiece and the chuck.

However, the repeatability of 20 - 30 μm obtained with the conventional pneumatic "gap sensor" was unstable and unable to detect trapped cutting chips or workpiece float, leading to defective products due to seating failure.

Since the machined workpieces are all subject to a full inspection, sending defective machined parts to the next process means that the line has to be stopped during the inspection process and productivity goes down.

Murata:
"Using a conventional pneumatic gap sensor, 20 μm was the limit of confirmable seating detection. We called it a ‘sensor to detect workpiece presence’, not a seating sensor.

Our goal was to find a detection method for defective workpiece seating using an entirely new technique to detect failures before cutting, keeping the next processes free of defective parts."

**Required accuracy of 5 μm!**

Everyone said "you can’t get that accuracy in mass production...", but they set out in collaboration with chuck manufacturers to develop new workpiece seating confirmation.

Firstly, high-accuracy chucking was achieved using a precision diaphragm chuck. The challenge was the Z-axis seating accuracy.

With 24-hour operation, continued machining without noticing that the seating of the workpiece is incorrect will reduce the yield and cause a drop in productivity.

1. Workpiece before machining

   A 5 μm seating accuracy was required in order to prevent machining defects.

2. Workpiece during precision machining

   Lathe→drilling processes are followed by machining actuator parts.

DENSO Corporation adoption example

DENSO Corporation
Driving Safety Manufacturing Division
Shoichi Murata
Problems

- The repeatability of a conventional pneumatic "gap sensor" is a low 20 μm, meaning that the accurate seating of the workpiece cannot be detected when held in the chuck.
- Defective machining results in stopping the line for a full inspection, decreasing productivity.

The opportunity to adopt a Metrol sensor came in the form of the M-TECH Mechanical Components & Materials Technology Expo held in 2013 at Tokyo Big Sight.

We received an inquiry after a chance visit to the Metrol booth, featuring a demo performance of our "Air Gap Sensor" precision seating sensor.

Murata:

"I saw the Air Gap Sensor seating demo at the exhibition and thought 'That's it!' Exactly the precision seating sensor I had been looking for.
I immediately asked for a trial sample, and started evaluation tests with the chuck manufacturers."

Conventionally, the pneumatic "gap sensor" adopted for machine tools had been used for detecting machined workpieces, but with a low repeatability of 20 μm, it was limited, at best, to simply confirming the presence or absence of the workpiece. Accurate seating confirmation of the jig and workpiece was impossible.

Technology which picks up on defects before cutting.
Incorporating a mechanism into the production process to prevent machining defects.

Murata:

"Serious, confirming precision seating with a 5 μm allowable tolerance? I was very dubious at first, but the chuck manufacturer’s evaluation results were, in fact, ±1 μm. The moment I heard this, I thought, 'That will do the trick!'"

"Since it is also necessary to consider the precision of the machine tools themselves, it was very hard to get stable accuracy, but with this, the machining line can get moving! I made the decision immediately."

After that, through rigorous evaluation tests over 4 months, the decision was made to formally adopt it on the machining line.

Detectors workpiece seating defects due to cutting chips before machining can take place, preventing machined defect products. The inspection process no longer stops the line, and there has been an overall improvement in yield.
Seating Confirmation with the "Air Gap Sensor"

The "Air Gap Sensor" allows **accurate seating confirmation** with the workpiece chucked.

Prevents machined defect products during the production process. **Productivity is improved significantly.**

**Results**

- The "Air Gap Sensor" allows **accurate seating confirmation** with the workpiece chucked.
- Prevents machined defect products during the production process. **Productivity is improved significantly.**

**Interior of the CNC machining center**

Precision diaphragm chuck + Precision seating sensor. *Air Gap Sensor* = The unbeatable pair eliminates defective products

**Exterior of the CNC machining center**

Installation is straightforward since the air piping of the conventional pneumatic "gap sensor" can be re-used as is, while the sensor is simply retrofitted.
Continuing the drive for ultra-precise machining and improved productivity.

The “Air Gap Sensor” adopted here has earned a high reputation within DENSO itself, and at the moment is being deployed company-wide as machining lines in one department after the next take it up.

Thank you very much for your cooperation, Mr. Murata.

The specifications and descriptions are subject to change without notice due to improvements in products.