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AP101

Machine condition monitoring - multi-axis machines

Problem

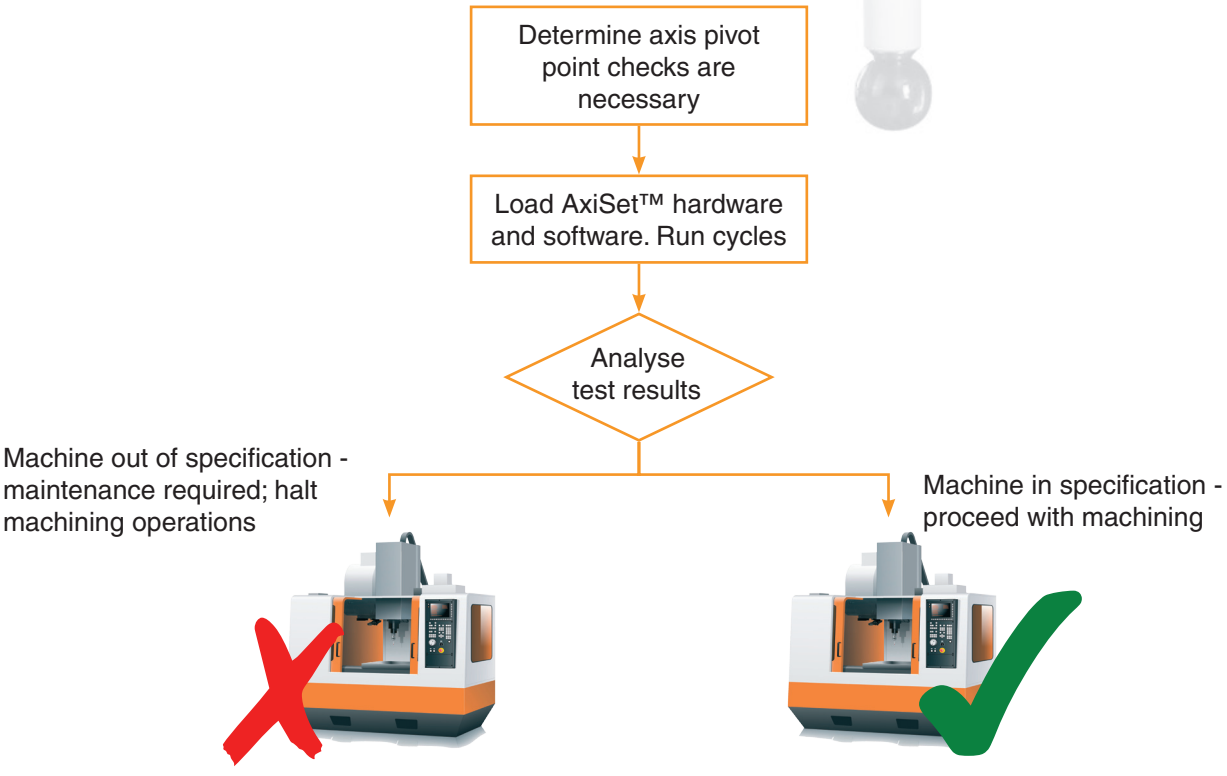
Multi-axis machines can provide great benefits by completing multiple metal cutting operations on a single machine and producing three dimensional free forms.

However, there has been no easy or reliable process for analysing the performance of rotary axes and identifying problems caused by incorrect machine set-up, collisions or wear for these complex machines. The ability to understand the location of the centres of rotation of the rotary axes relative to the machine's linear axes is key to precision machining. Without accurate data about these 'pivot points', a machine's controller will be unable to reliably control the relative positions of the tool and the component as the rotary axes are moving, leading to inconsistent machining results.

Solution

Use the inspection probe, which is often already fitted to complex machines, together with an AxiSet™ Check-Up system. In just a few minutes, users can identify and report on poor machine rotary axis alignments and, if necessary, alert the machine supplier to carry out further checks and possible error correction. The use of the AxiSet Check-Up system for machine condition monitoring could be considered to be part of a maintenance routine or indeed a pre-machining check.

Set-up is fast and simple. To perform the test a user quickly locates a supplied calibration sphere within the machine tool's working envelope using a magnetic mount. Using the supplied custom macro software, a touch probe is then programmed to automatically take measurements of the sphere position as it is indexed around the arc of each rotary axis under program control.



Machine condition monitoring - multi-axis

Analysis of a machine's capabilities is presented in various formats including a graphical representation of performance that highlights tracking and centring errors, a function that compares two sets of data for the same machine, a simple 'pass' or 'fail' test against the user's pre-defined tolerances, and a history screen that allows comparisons of the performance of rotary axes over time. All spreadsheet analysis can be incorporated in a simple report generated using Microsoft® Word®.

Benefits

- Causes of extended process setting times and non-conforming parts can be identified and reported.
- The system can be used as part of a regular maintenance check and provides traceable historical data about the performance of multi-axis machines.
- Automatic 'pass' or 'fail' decisions about machine capability can be made before critical component machining or after machine servicing.

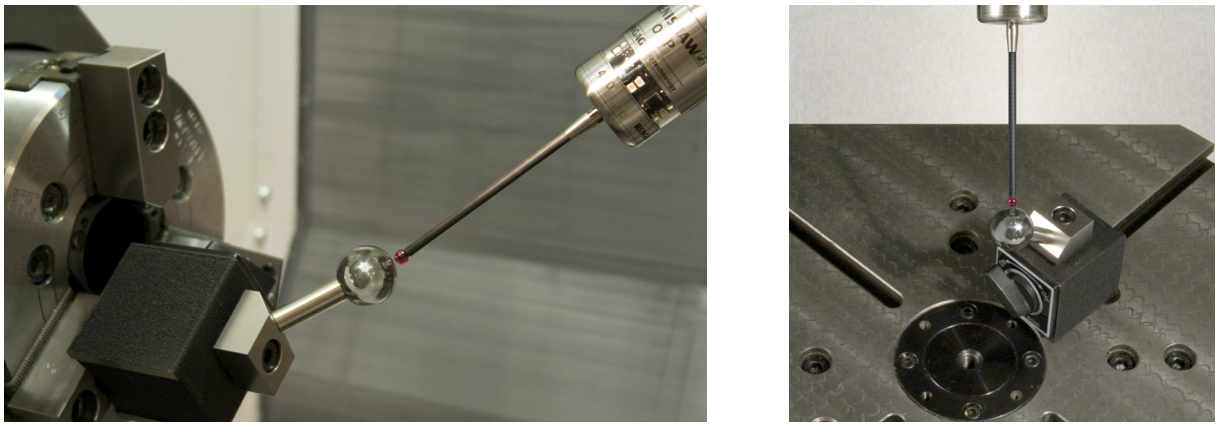


Figure 1: A machine tool probe measuring an AxiSet™ sphere in order to check rotary axis pivot points

Linear axes checks

To ensure optimum analysis of rotary axis performance using AxiSet™ Check-Up, it is important that the machine's standard three linear axes are also performing within specification. This should be regularly checked using a Renishaw QC20-W ballbar. Together these powerful performance testing products combine to ensure the highest quality parts can be consistently produced by five-axis machining centres and mill-turn machines. More information about the use of ballbar systems can be found in Pattern AP100, *Machine condition monitoring, linear axes*.

Example 1

A mill-turn machine is subject to an AxiSet™ Check-Up test every morning before the day shift production starts. The centring error of the A-axis is plotted each day in order to monitor the position of the actual pivot point for that axis compared to its nominal position.

The machine has a collision during the night and the centring error shows a massive increase above the pass/fail limit (indicated by the red line) when measured the following morning (as shown in Figure 2).

Engineers are called to correct the problem before high value work is started, avoiding costly scrap and downtime, as shown by a repeat test in Figure 3.

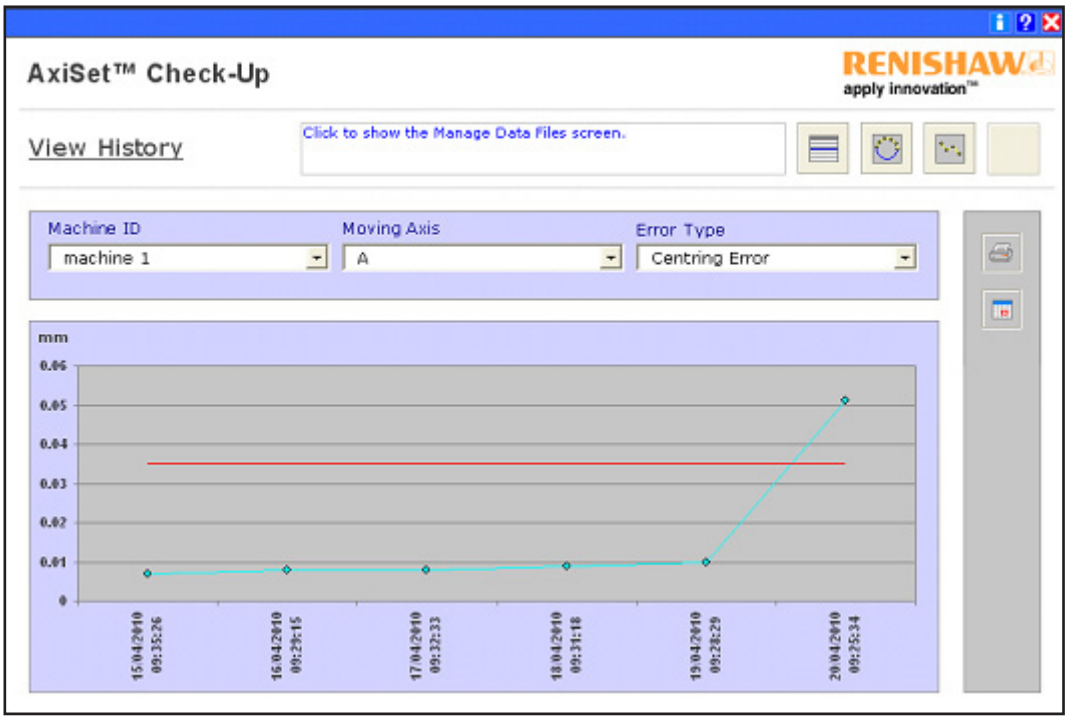


Figure 2: History plot showing sudden increase in A-axis centring error

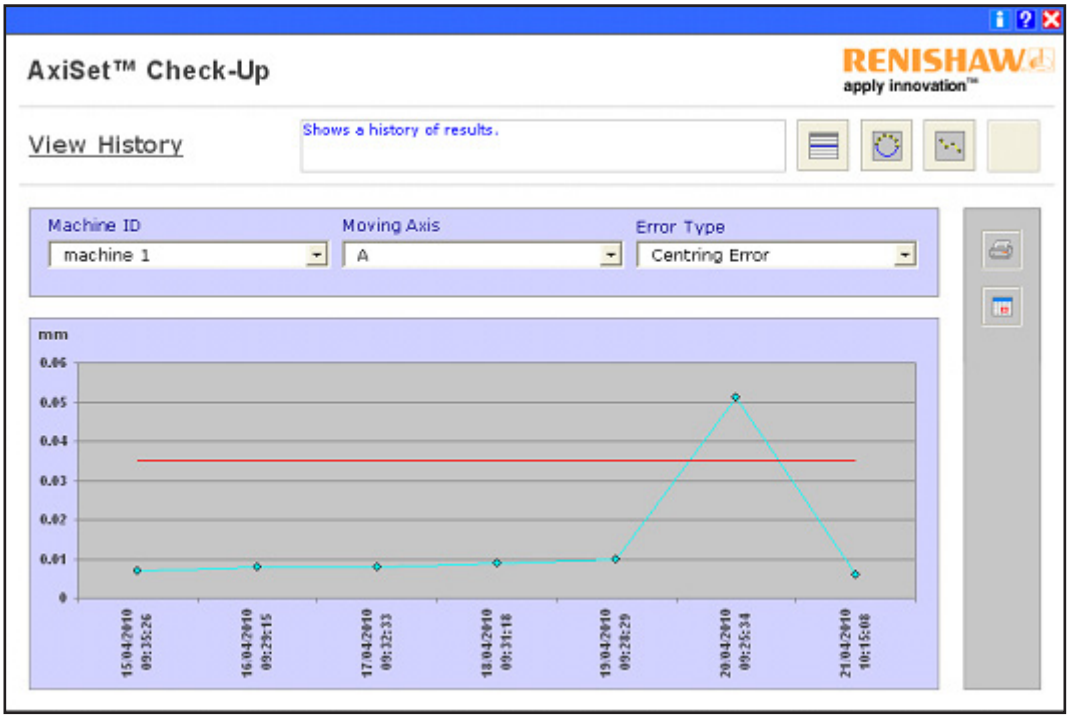


Figure 3: History plot showing A-axis centring error corrected

Example 2

A machine suffers a gradual drift of the centring error of its A-axis over the course of several weeks, as shown in Figure 4.

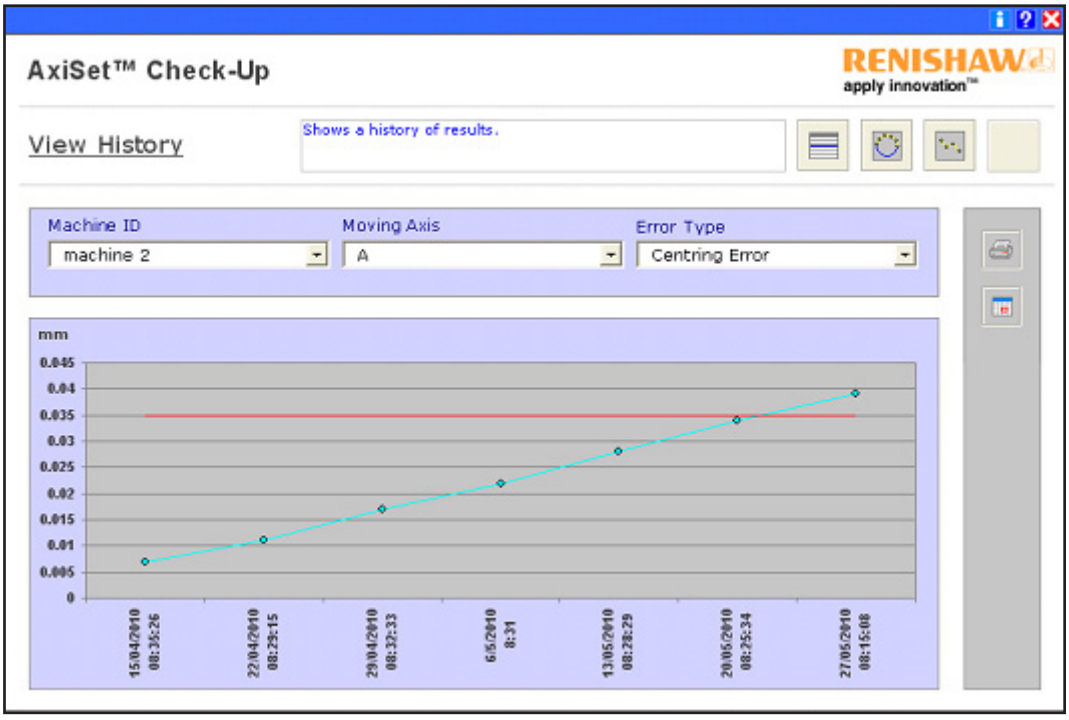


Figure 4: Gradual drift of centring error over several weeks

Example 3

Figures 5 and 6 show examples of the circular and angular plots output by the AxiSet™ Check-Up software.

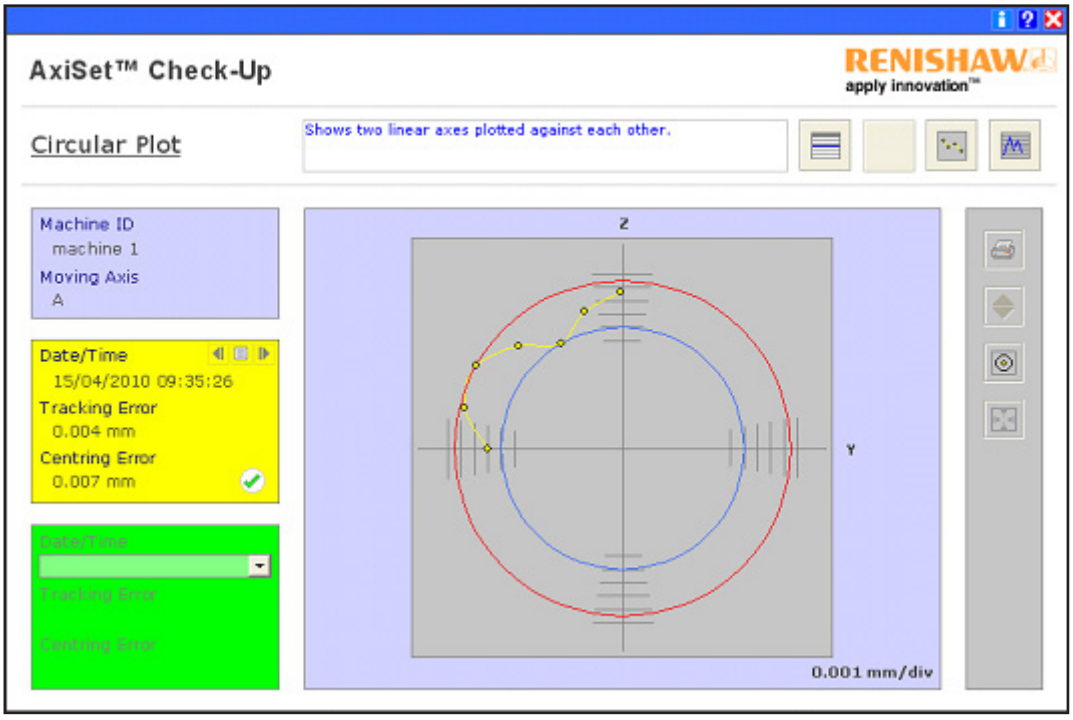


Figure 5: Graphical scale exaggerated to provide easy analysis of axis tracking error

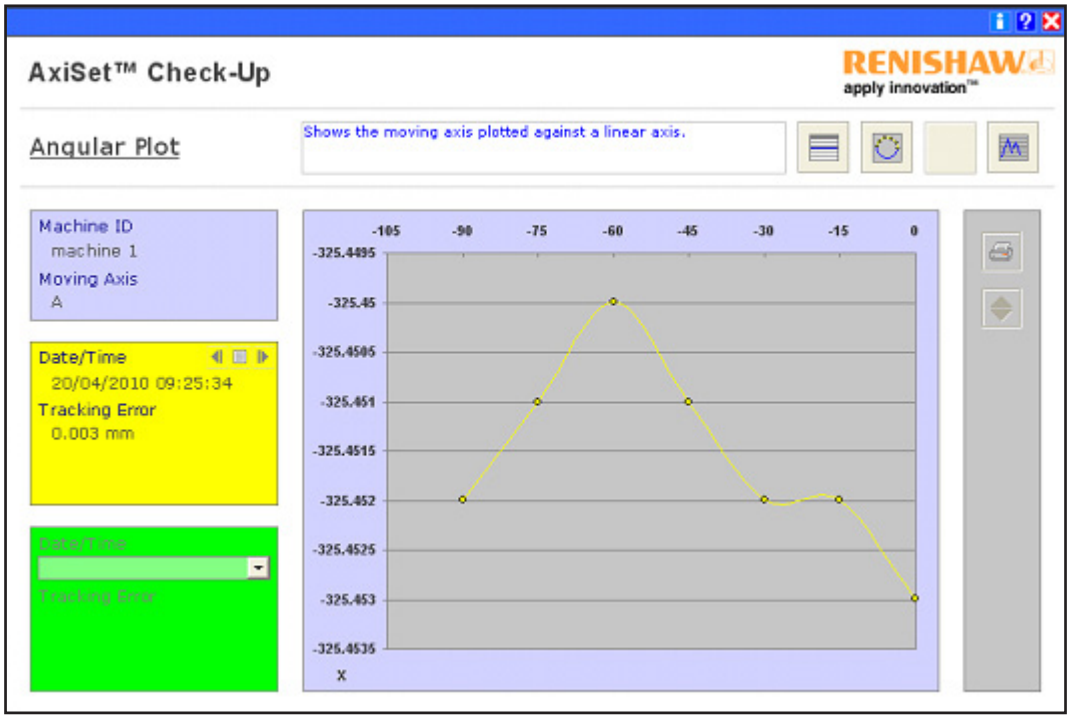


Figure 6: Angular plot showing motion of the A-axis pivot point relative to the X-axis for angular positions from -90 to 0 degrees

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