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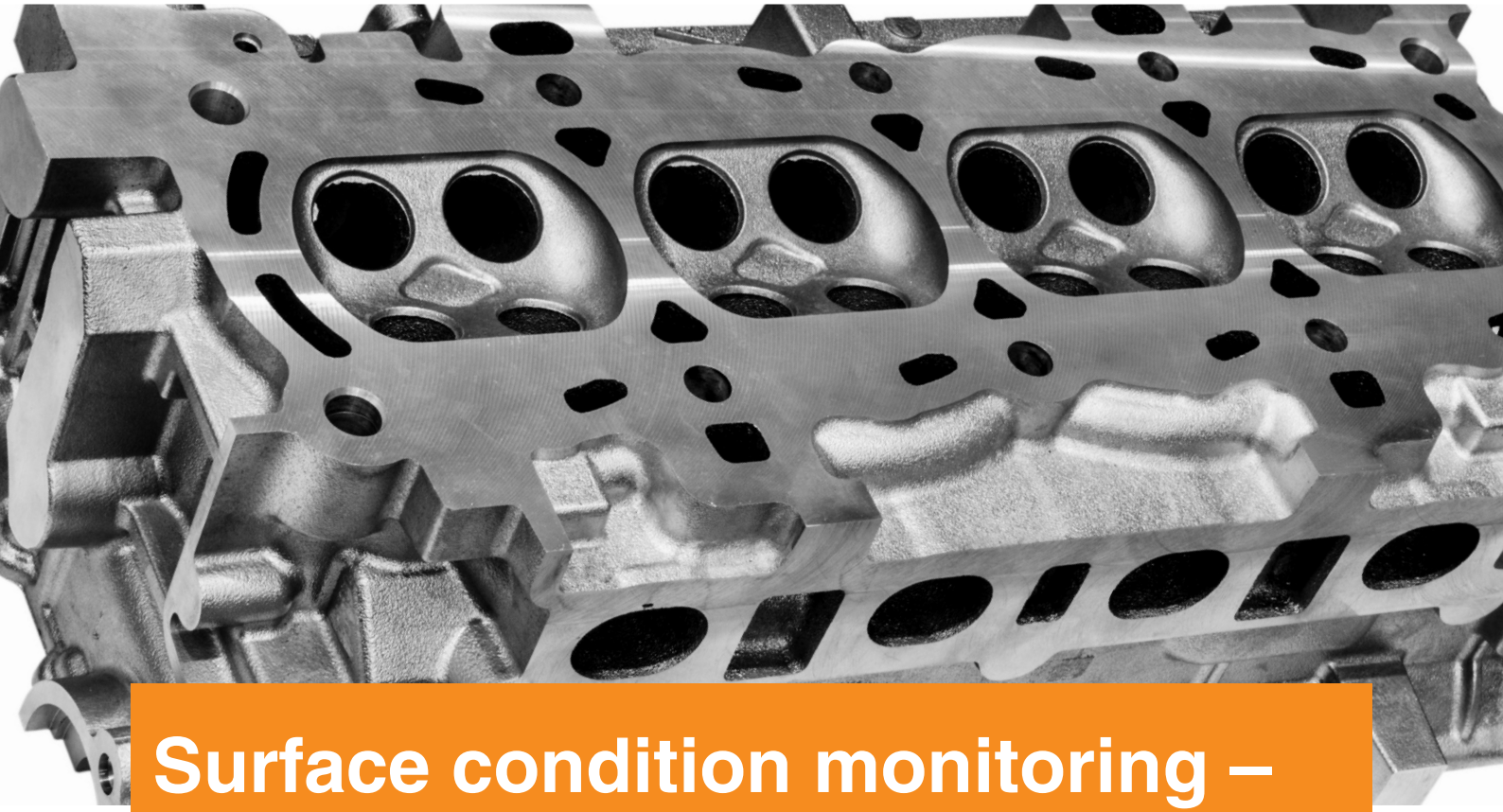


Surface condition monitoring – technology demonstration

Scanning capability for CNC machine tools

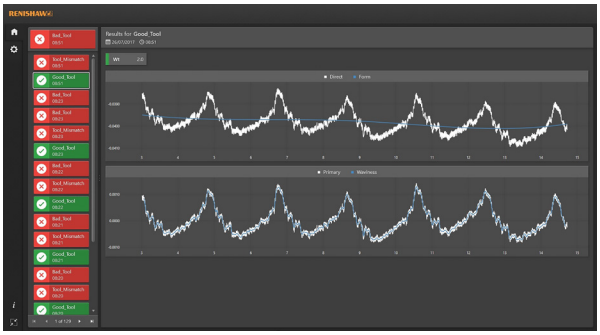
The OSP60 on-machine scanning probe with SPRINT™ technology provides a rapid and highly-accurate solution for a wide range of applications. Automated part setting, in-process verification, and adaptive machining can all benefit from the adoption of on-machine scanning. The OSP60 is also capable of monitoring the surface condition of nominally flat surfaces while the component remains in fixturing on the CNC machine tool.

This document outlines a surface condition monitoring technology demonstration which shows how surface condition monitoring with an OSP60 scanning probe compares with a traditional off-machine inspection system.

Technology overview

The output of OSP60 surface condition scans is total waviness (W_t). This value is passed into a machine variable and can be used to control subsequent processes or exported to file for further analysis.

A visual trace of the surface profile can be displayed in Surface Reporter, a free-of-charge PC-based app. Its real-time, colour-coded display of surface condition results allows users to quickly and easily determine whether a component surface is in or out of tolerance.



Surface waviness profiles in the Surface Reporter app

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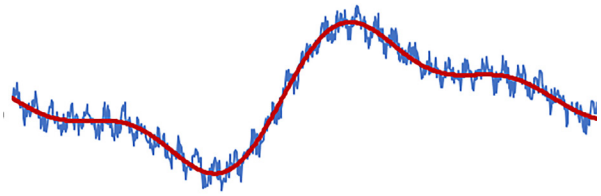
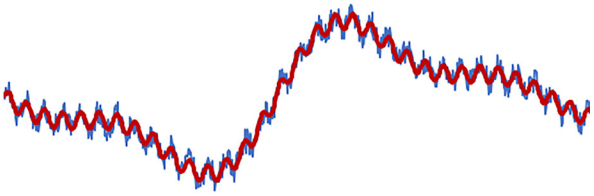
Surface condition monitoring for process control

Once a surface scan is completed, associated software filters the form profile from the raw surface scan data, and then filters the waviness profile from the remaining data. Users can customise how the waviness profile is filtered by adjusting the value of the λ_c cut-off wavelength. A setting of greater than 0.08 mm is recommended for process control applications.



Filtering waviness profile (red) from primary profile (blue) using a larger λ_c cut-off value



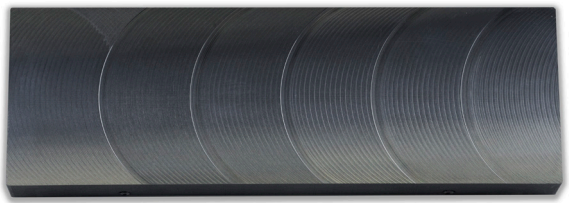
Filtering waviness profile (red) from primary profile (blue) using a smaller λ_c cut-off value

The OSP60 can be used to measure surface condition in any direction. Surface peaks, typically caused by chipped or damaged tooling, and scratches, potentially caused by material build-up on the tooling, can be measured accurately. Steps on a component surface, indicative of unexpected differences between cutter dimensions, tool push-off, part deflection under cutting forces, or thermal changes in the machine tool, can also be detected.

Surface condition measurement requires use of a 2 mm diameter stylus ball. This same configuration can also be used to perform additional probing tasks such as workpiece set-up, feature verification, and post-process inspection.

Technology demonstration

To demonstrate surface condition measurement capability of the OSP60, we have produced an aluminium test piece exhibiting different levels of wear. Six cuts were made on the test piece using tooling with varying levels of wear. As the wear levels of the tool performing each cut was different, a different surface condition was produced on each section of the test piece. Section one was cut with a new tool, section six which was cut with the tool exhibiting the highest level of wear.



Test piece with six cuts representing six different levels of surface condition

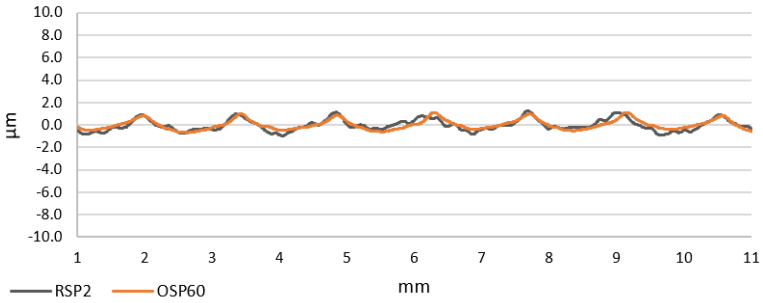
The following charts show the waviness profile of each section of the test piece as measured by:

- a machine tool with an OSP60 probe (with a 2 mm diameter stylus ball and a scanning feedrate of 500 mm/min);
- a CMM with a Renishaw REVO® RSP2 probe (with a 1 mm diameter stylus ball and a feedrate of 120 mm/min).

A λ_c value of 0.25 mm was used to filter the waviness profiles from the roughness profiles.

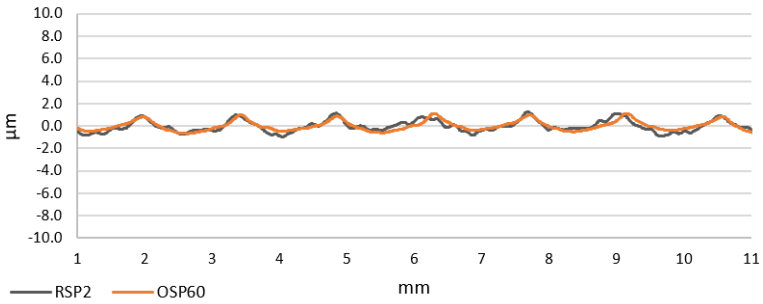
Tool images show a tool with a wear level representative of that used for the corresponding section of the test piece.

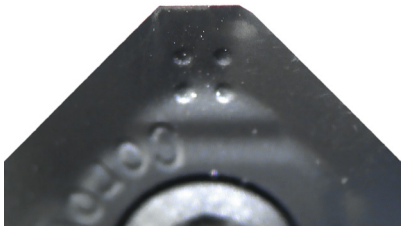
Section 1 waviness profile



Waviness values reported: RSP2 W_t = 2.560 µm; OSP60 W_t = 2.575 µm.

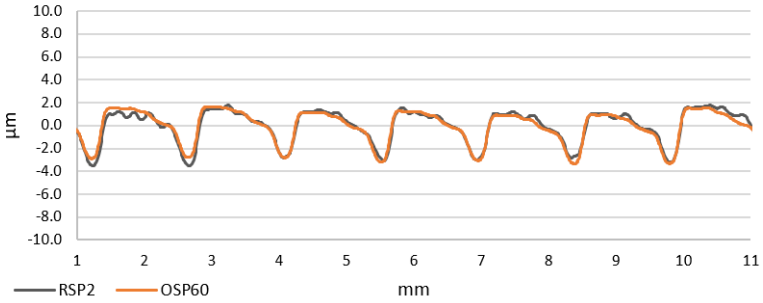
Section 2 waviness profile

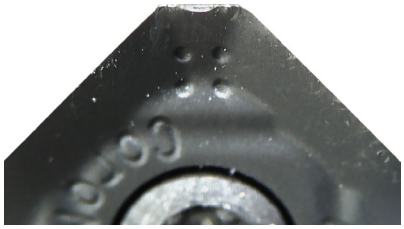




Waviness values reported: RSP2 W_t = 2.203 µm; OSP60 W_t = 2.086 µm.

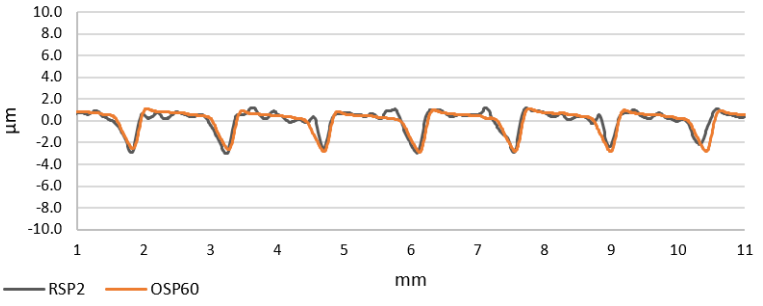
Section 3 waviness profile





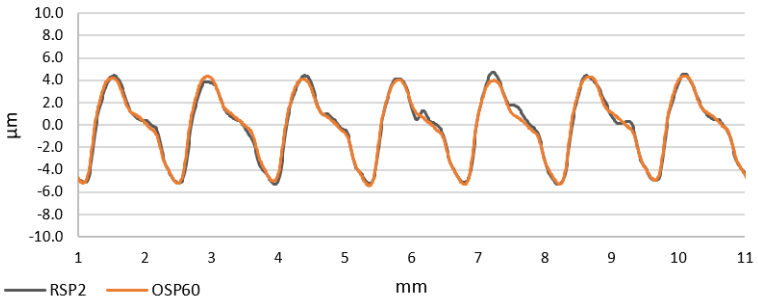
Waviness values reported: RSP2 W_t = 5.294 µm; OSP60 W_t = 4.985 µm.

Section 4 waviness profile



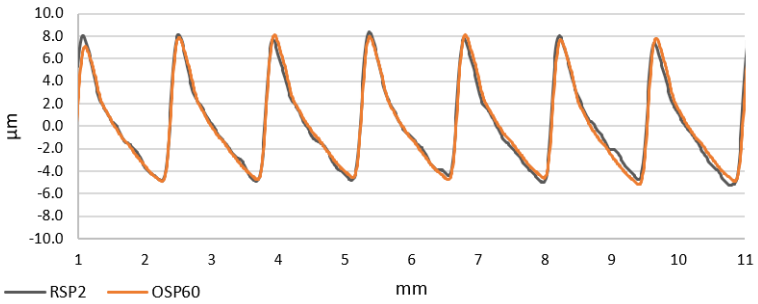
Waviness values reported: RSP2 W_t = 4.245 µm; OSP60 W_t = 4.109 µm.

Section 5 waviness profile



Waviness values reported: RSP2 W_t = 10.028 µm; OSP60 W_t = 10.067 µm.

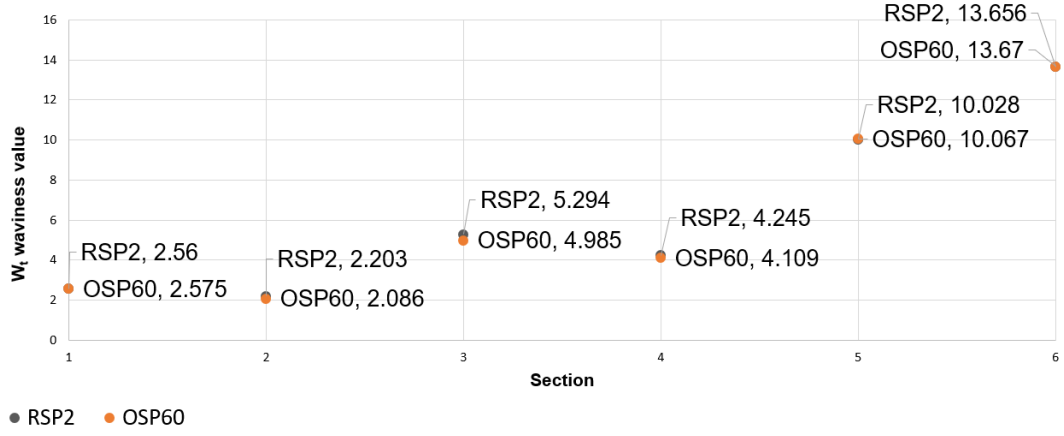
Section 6 waviness profile



Waviness values reported: RSP2 W_t = 13.656 µm; OSP60 W_t = 13.670 µm.

Conclusion

Results show a good correlation between the waviness profiles detected by the OSP60 on-machine scanning probe and the RSP2 CMM probe across each section of the test piece.



Correlation between Wt values from RSP2 CMM probe and OSP60 on-machine scanning probe

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