



# Cutting edge measurement of an insert

Whirling inserts are used to produce threads. The whirling process is complex, that's why there are many different angles (lead angle, angle of rake, clearance angle) on an insert (Figure 1a). In addition, there are inserts with up to 3 teeth on it. This makes it very difficult to measure an insert.

For previous quality assessments, one had to rely on simple optical devices for assessing the dimensional accuracy and on stylus devices for measuring roughness. The informative value of these measurements, however, is very limited. In addition, the parts often had to be destroyed so that the desired size could be measured. In order to constantly improve the quality of our tools, there is a need for a flexible device to measure and assess both critical dimensions and surface roughness of cutting tools.

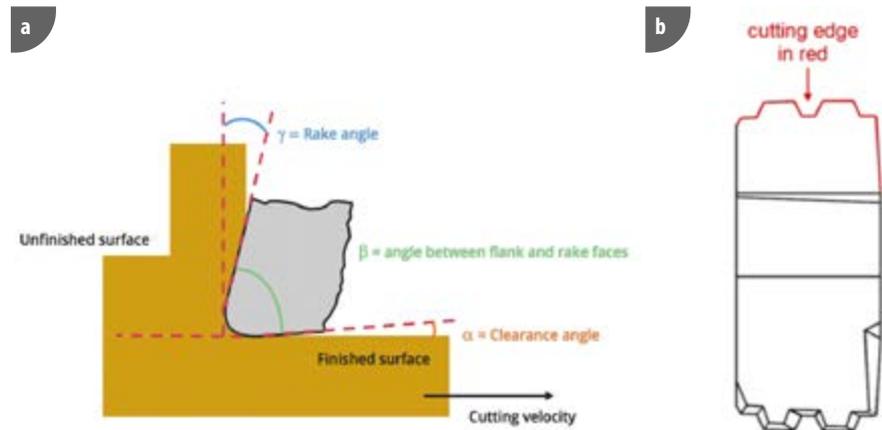
The purpose of this case study is to measure the cutting-edge radius of an insert with a 3D optical profiler and also extract the roughness parameters along the edge of the cutting tool. A schematic drawing of the insert to be measured is shown in Figure 1b.



[UTILIS AG](#) is one of the world's leading suppliers of precision tools for the metalworking industry. For more than 100 years, we have been developing, manufacturing and distributing high-quality and precise cutting tools, especially for micromechanics, watch and medical technology. Using state-of-the-art, advanced technologies and the breadth of know-how in manufacturing cutting tools, we position ourselves as specialists and one of the market leaders in the metal cutting industry.

Authors: Thomas Forrer – Head of Research & Development (right), Paco Neuhaus – Application Engineer (left)





**Figure 1.** a) Some of the parameters of interest in a cutting tool. b) Drawing of the measured insert. The red line shows the cutting edge profile that is under evaluation in this case study.

## ■ Measurements

The cutting-edge radius is very important for a good tool life expectancy. For this particular application note, we used the Fixe Axis 3D Optical Profilometer in Focus Variation HDR mode (Sensofar), in conjunction with a 100X Objective magnification, to acquire the cutting edge 3D topography of an insert (Figure 2). It is worth noting that for this particular sample, a Confocal technique would have provided accurate and robust results as well. The insert was held as shown in Figure 3 with an elevation angle of 63.5°.

**Figure 2.** On top we see the 3D topography of a rounded cutting edge measured with 100X Ai Focus Variation HDR. The transversal profile is shown at the bottom and the top-view on the right hand side.

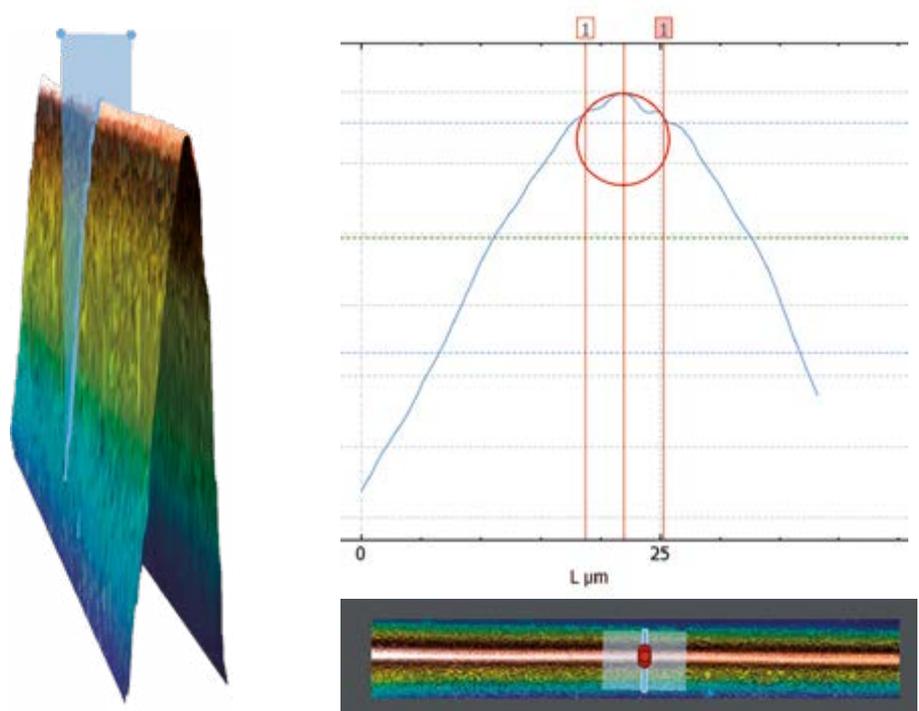




Figure 3. Positioning of the insert under the S neox Five Axis 3D optical profiler.

Once the topography was acquired, the data was sent out to the SensoPRO software 'Edge' plug-in for automated data analyses. This software module can automatically detect the cutting edge orientation and computes a certain number of profiles that are transversal to the edge. For this particular example, we chose up to 30 profiles, from which the cutting edge radius, among many other parameters listed in Figure 4, were computed.

Items	Units	Description
<b>r</b>	$\mu\text{m}$	Radius of the cutting edge
<b><math>\alpha</math></b>	deg	Clearance angle
<b><math>\beta</math></b>	deg	Angle between rake and flank face
<b><math>\gamma</math></b>	deg	Rake angle
<b>Sa</b>	$\mu\text{m}$	Cutting edge segment on flank face
<b>Sy</b>	$\mu\text{m}$	Cutting edge segment on rake face
<b>K</b>	$\mu\text{m}$	Relation between Sy and Sa
<b>Da</b>	$\mu\text{m}$	Flank face distance to the tangent
<b>Dy</b>	$\mu\text{m}$	Rake face distance to the tangent
<b>Kd</b>	$\mu\text{m}$	Relation between Dy and Da
<b>Wr</b>	$\mu\text{m}$	Edge width

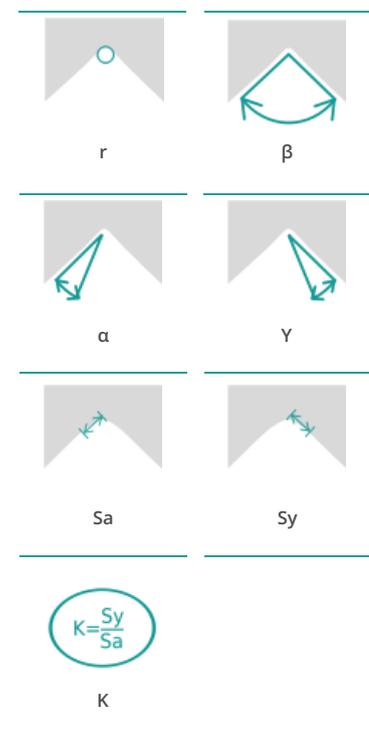
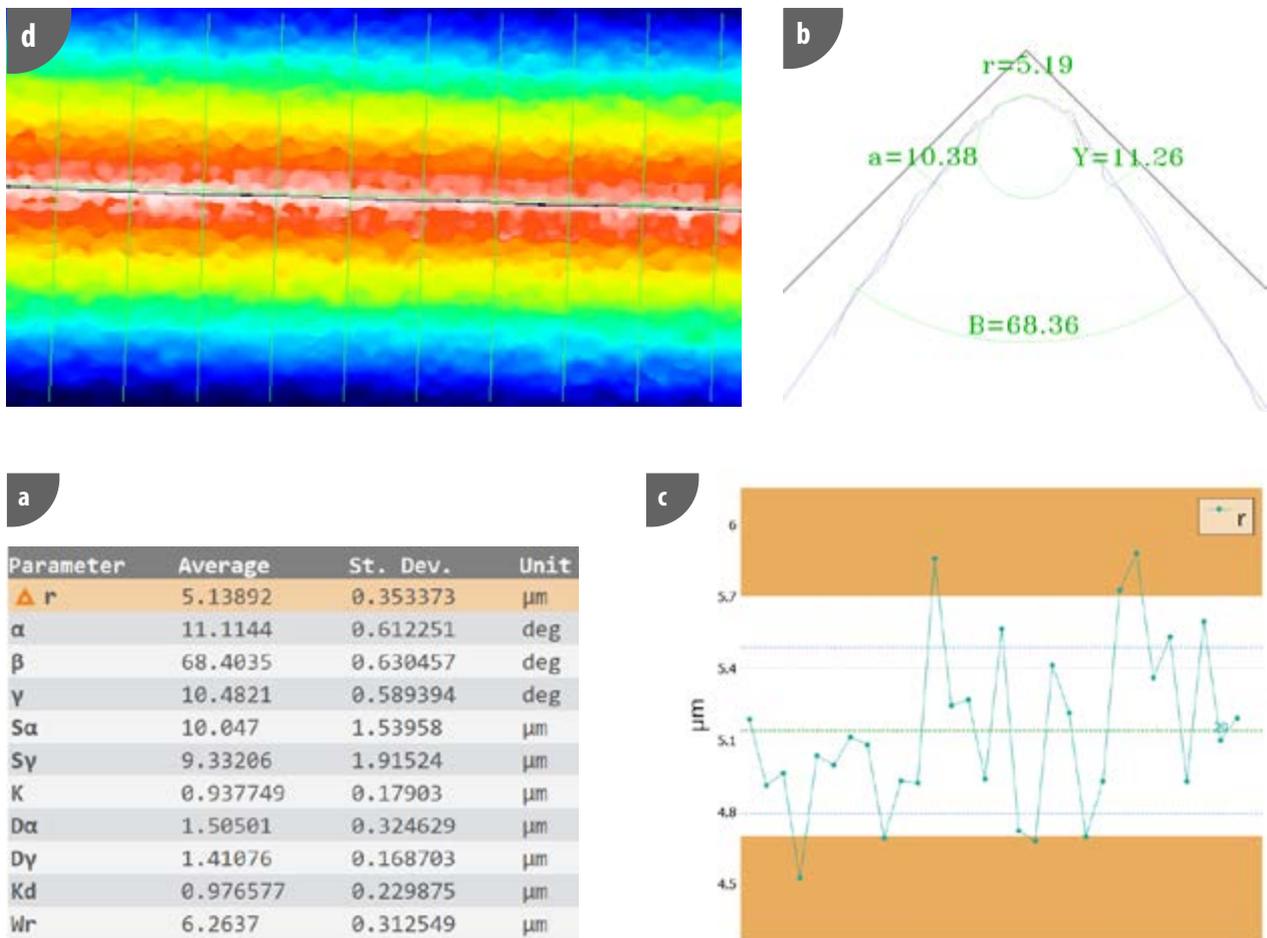


Figure 4. List of parameters computed for each profile transversal to the cutting edge. In addition to these parameters, the software also computes roughness (e.g., Ra, Rq or Rz among others) along the cutting edge.

The SensoPRO software allows for visualization of each parameter and provides some statistics on each parameter (i.e., mean value, standard deviation, minimum and maximum). As shown in Figure 5, the average radius of 30 profiles is 5.14  $\mu\text{m}$  with a standard deviation of  $\pm 0.35 \mu\text{m}$ . It is also worth mentioning that the software allows setting a tolerance range and exporting the results in a Pass or Fail Report, in our case, we set a minimum and a maximum cutting edge radius of 4.7 and 5.7  $\mu\text{m}$ , respectively, which can be seen at the bottom plot in Figure 5 (i.e., orange region).

Finally, one last parameter of interest is the roughness at the edge of the cutting tool. This information is provided automatically by the software in the form of many common and standard parameters such as Ra, Rz and Rq, among others. In this particular case, the cutting edge had an Ra of 0.05  $\mu\text{m}$ .



**Figure 5.** Outcomes of the SensoPRO 'Edge' plug-in . **a)** List of cutting-tool parameters. **b)** one out of the 15 transversal profiles with the corresponding cutting edge radius, clearance, and rake angles. **c)** The out-of-tolerance region (shown in orange) in a plot of cutting edge radius (y-axis) vs. each profile number from 1 to 30 (x-axis). **d)** Example of a cutting-edge topography with the transversal profiles.

## ■ Conclusions

The 3D optical profilometer S neox Five Axis makes it possible to quickly and flexibly obtain the key parameters necessary for the continuous improvement of our tools, such as the cutting edge radius, clearance and rake angles, or even the roughness at the edge.

In this particular case study we successfully measured an average cutting edge radius of 5.14  $\mu\text{m}$  and a roughness Ra value of 0.05  $\mu\text{m}$  at the edge of the cutting tool. This information was easily obtained using the Ai Focus Variation technology, with a 100X objective magnification and with the application-specific software, SensoPRO ('Edge' plug-in).

Having three measuring methods present within the same sensorhead (i.e., Confocal, Ai Focus Variation and Interferometry) allow for a very flexible measurement of different measuring tasks on various parts. From very smooth and shiny to heavily textured, rough surfaces: everything is possible with the S neox Five Axis. Steep angles and very small cutting-edge measurements of a few micrometers are no longer a problem for 3D optical profiling.



SENSOFAR is a leading-edge technology company that has the highest quality standards within the field of surface metrology

Sensofar Metrology provides high-accuracy optical profilers based on confocal, interferometry, focus variation and fringe projection techniques, from standard setups for R&D and quality inspection laboratories to complete non-contact metrology solutions for in-line production processes. The Sensofar Group has its headquarters in Barcelona, also known as a technology and innovation hub in Europe. The Group is represented in over 30 countries through a global network of partners and has its own offices in Asia, Germany and the United States.

HEADQUARTERS

**SENSOFAR METROLOGY** | BARCELONA (Spain) | T. +34 93 700 14 92 | [info@sensofar.com](mailto:info@sensofar.com)

SALES OFFICES

**SENSOFAR ASIA** | SHANGHAI (China) | T. +86 021 51602735 | [info.asia@sensofar.com](mailto:info.asia@sensofar.com)

**SENSOFAR GERMANY** | MUNICH (Germany) | T. +49 151 14304168 | [info.germany@sensofar.com](mailto:info.germany@sensofar.com)

**SENSOFAR USA** | NEWINGTON (USA) | T. +1 617 678 4185 | [info.usa@sensofar.com](mailto:info.usa@sensofar.com)

[sensofar.com](http://sensofar.com)