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NUMROTO: 20 Years Trend-Setter in Tool Grinding

Dear readers,

Over two decades, in which machine manufacturing has considerably changed, NUMROTO has firmly established itself as a trend-setter in tool grinding. We are proud in being able to celebrate 20 years of NUMROTO at the GrindTec 2008 Trade Fair.

With the introduction of NUMROTO in 1988 we have been able to implement a strategy concentrating on the development of complex CNC complete solutions. As a partner of manufacturers of the automation for CNC-controlled production machines, NUM has amassed a great deal of user know-how, particularly in the tool grinding field.

For 20 years the continuous development of NUMROTO has ensured investment value in a number of respects. On the one hand, our customers can always count on having stabile and efficient software which meets their current needs. On the other hand, we regularly develop highly interesting innovations for NUMROTO, which offer better productivity and higher process reliability. From the beginning, very high functionality and logical, simple operation have been distinct features of the software.

NUMROTO has been led by the same three individuals for 20 years and is supported by a strong group of specialists and engineers with comprehensive expertise. The other members of the NUMROTO team have also been dedicated to the company for many years. Regardless of whether in development or customer service, the goal is to offer our customers a technically and economically appealing solution. Above all, our functions and solutions put us one step ahead of the market, which form an essential aspect of the software's success. NUMROTO is currently the market leader in the top market segment and is rightly considered a trend-setter.

Our customers – which includes you – play an important role in shaping the future of tool grinding. Many innovations in NUMROTO have emerged out of customers' problems or requests. In many instances our specialists work closely with the machine manufacturer as well as the end user, in order to jointly find an ideal solution. Such direct communication and flexibility ensure that NUMROTO will continue to define trends in the future.

We would like to thank you for your loyalty and cooperation and look forward to another 20 successful and innovative years with NUMROTO.

Your NUMROTO team

Hans Eggenberger
Jörg Federer
Patrick Schmid
(from right)

3D simulation becomes a standard for tool grinding

3D simulation is extremely attractive for manufacturing as well as re-sharpening. The high level of safety for the user and process, combined with a high-efficiency are just some of the reasons why this option for tool grinding is being used so widely.

3D simulation has also established itself in 5-axes tool grinding. Nowadays the majority of customers request almost every new NUMROTO programming system together with the excellent value for money 3D simulation. Existing installations are also upgraded with this additional function at the latest when the PC is replaced. The benefits are clear for tool manufacturers and re-sharpeners alike: regardless of the production process, the tool geometry results are evaluated on the programming PC in detail and the machine movements are checked so that they do not collide. Important developments to be introduced at GrindTec 2008 in Germany, will be 3D real time animation for tool grinding machines, automatic collision monitoring and chip volume/time evaluation.

From 2D simulation to virtual machines

Sectional views are often of great interest in tool grinding, such as for examining the tooth geometry. NUMROTO 2D simulation was already introduced 20 years ago as the world's first and has been continuously developed in the meantime. Calculating cross-sections to the exact micrometre is now so specialised, providing ideal supplementary information for the subsequent 3D simulation in a matter of seconds.

Due to the huge increase in PC processor performance, 3D simulators have now been used for 5-axes tool grinding machines for several years. The grinding wheels, the machine kinematic and the blank are seen as volumes. The tool volume is created by the grinding wheel moving along the machining path (according to ISO program) and the volume is continuously subtracted from the blank. A large number of volume subtractions is required before the complete tool volume is available, due to the complex

Background

The demand for high-tech tools is increasing rapidly. Many production processes can be greatly simplified and rationalised with optimised tool geometry. These tools are largely made of hard metal and are ground almost exclusively in CNC grinding machines with 5 interpolating axes. The sophisticated calculation methods of a modern programming system are used by today's high performance PCs which directly use the programmed tool geometry to control the 5-axes machine movements.


2) Simulated tool geometry

movements of the grinding wheel in the tool and the high degree of precision required.

The NUMROTO 3D simulation calculates the entire process chain of a tool grinding machine from the ISO program and its CNC processing to the machining process. This complete approach not only calculates the tool geometry but also many more additional functions which can be seen in the following.
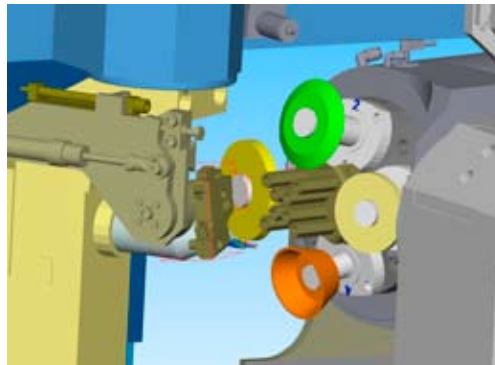
Tools are often ground in several machining operations with different grinding wheels. As the working space is usually very restricted in a tool grinding machine, there is still a risk of collision despite the programming system calculating the grinding wheel path so accurately. Therefore, the 3D simulator checks the calculated path so that there are no collisions at all. It detects collisions between
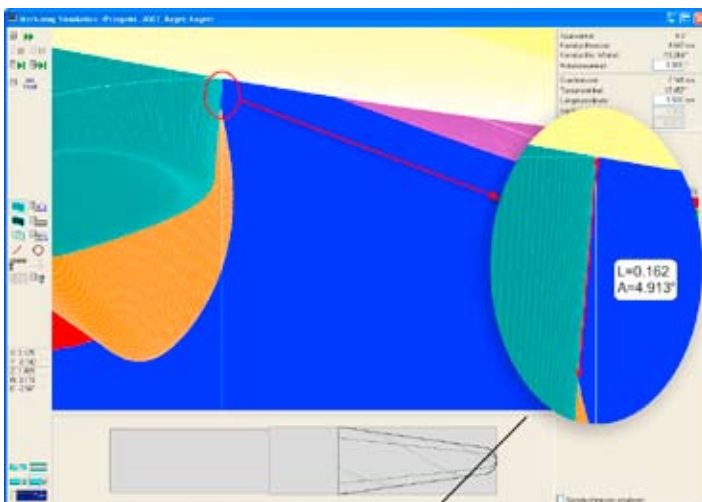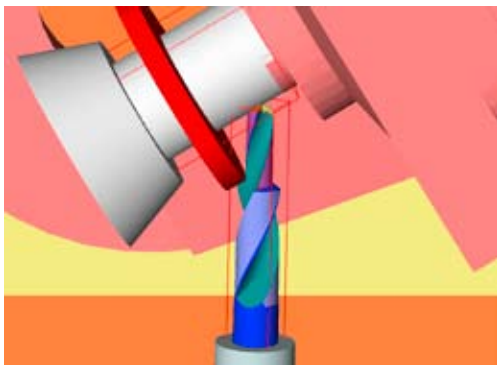

1) 2D simulation for analysing micrometre details
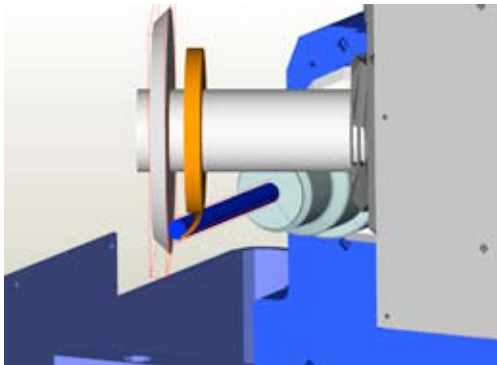
3a) Collision of a non-active wheel with the tool

3b) Collision between the tool and the grinding spindle

the grinding wheel, tool, machine elements, such as spindle housings, and probes.

Comprehensive automatic collision monitoring is required, particularly in loader mode during the night when no operating staff are present. Once the tool has been probed, the programming system works out the ISO

3c) Collision between the support and the grinding spindle

program and transfers this to the CNC control. At the same time, the tool is simulated and checked for collisions. If a collision is detected, the grinding procedure is not started and the next tool is processed.

In the new 3D real time animation mode, the 3D simulation synchronises with the "real" tool grinding machine and with the axis values of the CNC control respectively. A virtual tool grinding machine is created. The software is installed on the PCs for the machines, where the human-machine interface also operates with the axis display and the CNC functions. The user can follow the grinding process in great detail and at any viewing angle. This function proves especially useful when it is not possible to see the working space in the "real" machine, due to oil mist.

Evaluating the chip volume/time

The 3D simulator calculates the entire process chain but can also be used to calculate the chip volume/time (also called removal rate or material removal rate). This amount indicates how many mm³/s the current grinding wheel is removing at a certain time. A great deal of valuable information can be gained from the chip volume/time, as the following applications show.

Movements without material removal (for instance from and to the park position) are calculated by the programming system without collisions. However, the programmers occasion-
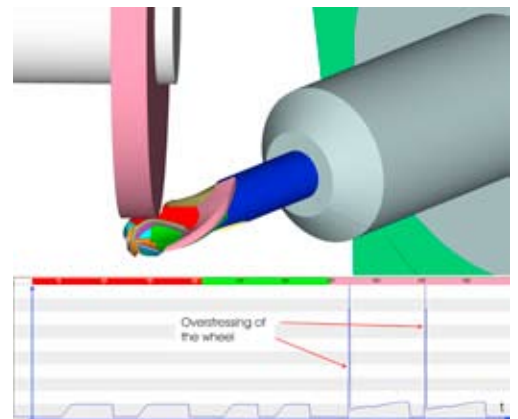
4) Overstressing of the wheel when it engages in the left-hand flute of an up/down cutter

ally reduce the distances to gain time. This could mean that grinding wheels with a high feed rate run into the material by a tenth of a millimetre which the operator does not notice on the machine. At best, he would notice that the grinding wheel is wearing relatively quickly. In the chip volume/time diagram, you can easily

5) Chip volume/time when grinding a flute on a tapered cutter

see the brief overstressing. This can be avoided by monitoring the maximum removal rate volume/time.

In figure 5, you can see the progress of the chip volume/time while a flute in a tapered cutter is being ground. The diagram above shows that a small amount of material is removed from the cone at the front, whereas the performance limit of the grinding wheel is reached at the back. If the NUMROTO variable feed rate is used, the chip volume/time from front to back can be kept constant approximately. This significantly reduces the manufacturing time.

Summary

The 3D simulation has become an integral part of a programming system for tool grinding. The variety of graphical options available support the development of programs for simple and highly-complex tools. Due to its comprehensive monitoring functions, it ensures that grinding operations are free of collisions and gentle on the wheels for resharpening or in automatic loader mode.

Release Notes

The most significant changes between version 2.8.4 and 2.9.1

NUMROTO general

In-process measurement
This new option allows the direct measurement of a dimension (e.g. external diameter) after the grinding procedure. The operation can then be repeated as needed in order to reach the desired dimension, thereby also allowing a high degree of precision to be maintained in loader mode.

Cylindrical grinding
"Cylindrical grinding – independent form" allows both edges of an 1A1 disc to be used when forms with rising or falling sides need to be cylindrically ground in a single pass.
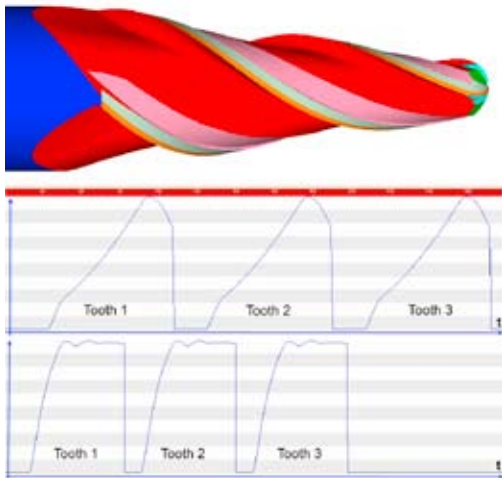
Machining sequence
The original name of a machining is now always shown even when a custom name has been given. The feed rates are now displayed in the 3D machining sequence and can be changed directly.

Trueing during a machining
During particular types of machinings the wheel can be re-trued between individual teeth or individual cycles, the grinding path corrected and grinding immediately continued.

Cyclical grinding
In the chart containing cycles per machining, individual cycles can now be separately switched on or off as needed.

NUMROTO 3D

CNC online simulation
During the grinding process, the current position of the grinding machine is dynamically displayed in a 3D computer simulation. This allows the grinding process to be monitored even when view of the grinding machine is obstructed (oil mist).

STL export
When exporting a model as an STL file an optimising function can be activated, which considerably reduces file size and improves the quality of the model.

Analysis options
This new function allows various values to be monitored during simulation. For example, removal rate (volume/time) can be monitored and axis movements and feed rates analysed.

Default values in NUMROTO
Various parameters can be programmed into the NUMROTO settings as default values.

Cutters

Radius correction
The radius form of ball nose and corner radius cutters can be corrected on a chart. This allows wheel and machine inaccuracies to be compensated and very precise radii to be ground.

Step drills

Relief and face grinding
Drills can now also perform relief grinding during the face grinding procedure. A peripheral wheel or a cup wheel can be used.

Milling cutters

Variable lead and left-hand helix
Milling cutters can now be ground with a variable lead and left-hand helix.

Rake surface along the form and variable helix
The operation rake surface along the form can now also be used with variable helix.

20 Years of Innovation and Collaboration

Close cooperation with our customers and continually innovative development distinguish NUMROTO. 20 years of NUMROTO also means 20 years of collaboration with Kennametal.

At first glance, the functional and well-maintained Kennametal factory building in the residential outskirts of Vohenstrauss, Germany does not do justice to its history. However, a walk through its three production halls then becomes quite impressive: 100 tool grinding machines stand side-by-side in perfectly lined rows equipped

Jürgen Schwägerl, carbide tool development and engineering; Dieter Mühlfriedel, head of manufacturing technology; Walter Grob, head of sales NUMROTO (from left)

with NUMROTOplus. This is the result of 20 years of continual and close collaboration between Kennametal and NUMROTO.
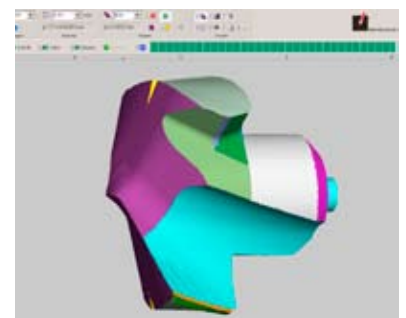
Originally NUMROTO was developed for the production of standard tools. In 1988 the software was first tested at Hertel GmbH in the Upper Palatinate, not far from the Czech border. With its introduction into the market one year later, it became evident that, along with the production of standard tools, there was a demand for a flex-

ible intelligent solution for customised tools.

As the requirements placed on tools continued to increase, so did their variety and their complexity. 5-axis tool grinding machines became the standard, which revealed new possibilities. The engineers and specialist

at NUMROTO, with their comprehensive expertise, met this development with innovatively practical solutions. The constant close collaboration with the specialists at Hertel as well as with other customers became essential to the sustained success of NUMROTO.

In 1994 the worldwide company Kennametal took over Hertel GmbH and continued to lead the successful operation: The production of standard and customised tools as well as the development of new tools and

types. The development and production teams met the new challenges and have thereby been able to count on NUMROTO and its specialists. "For example, the SE and HP drill tips were our ideas, but were developed and refined in collaboration with the NUMROTO team", Dieter Mühlfriedel states, head of manufacturing technology at Kennametal Vohenstrauss.

Dieter Mühlfriedel, who has been familiar with NUMROTOplus from the beginning, on the needs of the market: "Along with our successful carrier tools the demand is increasing for extra-long drills. Furthermore, as the tools become more complex, we have to adjust ourselves to smaller quantities." New tools are therefore developed in close collaboration with production in Vohenstrauss, which is adjoined to the development department. This close relationship, a comprehensive expertise and the many successful developments make the factory a competence centre in the company for carbide tools.

To produce the same tools in other Kennametal factories is no easy task. Jürgen Schwägerl, of carbide tool development and engineering, explains: "Industrialising a new tool is very de-

KenTIP cutting bit for drills

Approximately 60 apprentices are employed at three Kennametal factories. They all complete their basic training in Vohenstrauss before being assigned to the various factories where they are further trained. In this way, the company ensures that well-trained technical personnel are prepared to face the challenging tasks ahead. Approximately 350 people work in production and management in Vohenstrauss.

20 years as a trend-setter and co-operation with our customers – this successful concept will also shape the future.

10 machines in full production process, being operated by only 2 workers

manding, for not only are tool development and software involved, but the entire production environment. The training requirements are therefore great." NUMROTOplus provides the programmer and operator with support for design as well as for the hard day-to-day production with a variety of functions, such as 3D simu-lation with collision monitoring and 3D machine simulation. Apart from the 100 machines in Vohenstrauss, the software is used in many Kennametal factories across the world.

The company places great value on the training and expertise of its employees and trains many apprentices.

NUMROTO at the GrindTec 2008

We cordially invite you to visit us at our booth at this year's GrindTec Trade Fair. Some of the highlights we could show you:

- In-process measurement, which allows high-precision grinding, even of large series
- Volume/time removal rate monitoring for wheel protection and feedrate optimisation
- 3D real-time animation of the tool grinding machine

GrindTec 08

NUMROTO at the GrindTec:
Hall 7, Stand 742

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CNC HighEnd Applications