CNC4you

Practical knowledge for the shopfloor

1/2020

- Sinumerik One – "The digital native CNC"
- CNC know-how: your own CNC cycle
- From practical experience: Sinumerik in Voith and Tietjen

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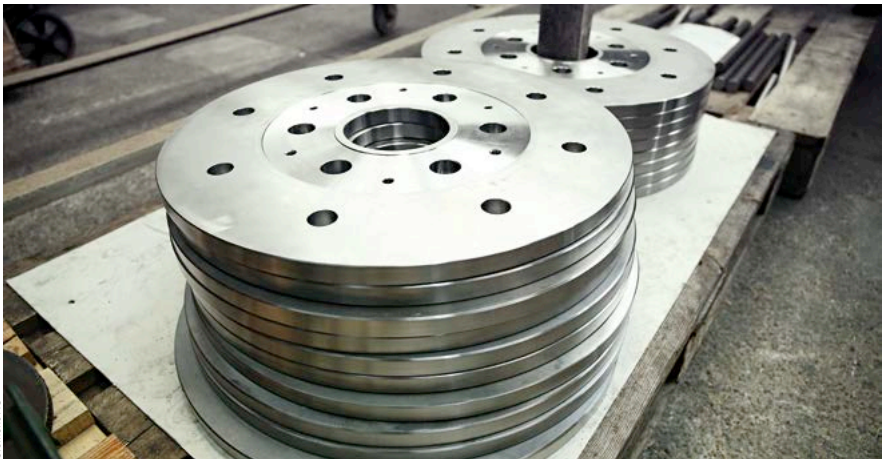

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Rotor parts for Tietjen mills: read about how Sinumerik increased the agility and flexibility of the company.

Title picture: Siemens AG

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The classic print version: CNC4you magazine

Just flick through it and get the latest news and information, in the office, when taking a break – paper certainly has its advantages. Our CNC4you magazine in print form is available in a somewhat more compact form than previously. Using QR codes in the magazine, you can now simply call up more information about content, graphics, videos etc. from the CNC4you portal using your smartphone.

The HQ: CNC4you portal

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Our suggestion: simply scan the QR code and check out our e-Magazine.

But first, enjoy reading this edition.

Your CNC4you team

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Sinumerik One – „The digital native CNC"

Not only does Sinumerik One represent a paradigm shift in machine tool production, but it also opens new opportunities to make your engineering and machining processes more efficient.

SINUMERIK ONE

Bring ideas to life

➜ Scan the QR code and watch the video

A new CNC from Siemens. After Sinumerik 840C and 840D, the next logical name should have actually been 840E. However, considering the significantly improved performance data of the new control system, just continuing the name syntax would not have seemed fitting. For Sinumerik One, the Sinumerik system software has been developed further and ported onto multi-core processor architectures. The first tests in 5-axis milling indicated that machining times had been slashed in the double-digit percentage range. The distribution of individual CNC tasks, such as Sinumerik Operate or the adaptation control, which is now a Simatic S7-1500, on different processor kernels increased the operating performance and shortened machine idle times.

The digital twin of engineering

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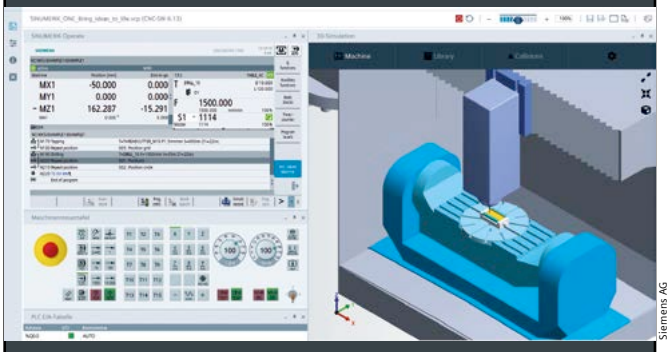

The digital twin of the application

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A paradigm shift

Sinumerik One represents more than just an improvement in performance. Sinumerik One focuses on just how massively machine tool businesses are changing. "The digital native CNC" name clearly points to this paradigm shift. The development of the new CNC really did kick off on a pure virtual basis, with a digital twin of the electronics module. Although the real CNC module only became available at a later date, machine OEMs were already able to engineer the CNC in the virtual world. Shifting the product development to digital twins is extending to include the production and operation of machine tools. The time it takes from the first conceptual idea until the first chips are made is significantly reduced.

End users benefit from virtualization

And the end users operating the machines? They also gain time and security. Thanks to Sinumerik One, end users can already discuss the solutions they require in the manufacturer's virtual showroom. This offers immense advantages and additional security, especially when it comes to customized machine solutions. End user personnel can also start training based on digital twins. Complex operating scenarios can be worked through on virtual machines in advance without the risk of damaging a real machine. Ultimately, machine manufacturers will be able to offer significantly improved hotline support and service based on digital twins.

The objective: Produce more efficiently and more flexibly

Machine tools are part of almost every value-add chain. Customization and shorter consumer product life cycles are demanding increasingly smaller batch sizes. This is why companies are shifting to CNC production planning as many activities as possible that would otherwise take up valuable machine cutting times. And this is precisely what Sinumerik One supports. Orders can be planned virtually using digital twins. This not only helps to prevent tool collisions with parts, clamping equipment or the machine itself, but now even makes it possible to execute a complete test CNC program run virtually. The CNC program's runtime is determined precisely and machine utilization can be accurately planned in advance. This represents a significant advantage, specifically for job shops, who must increasingly fight for orders on Internet platforms. After an order has been placed, the production order that had already been virtually generated is physically machined.

Together with the real CNC, Create MyVirtual Machine and Run MyVirtual Machine have created an extensive portfolio of solutions for the virtual machine environment. Run MyVirtual Machine /Operate can be used to verify virtual images of CNC programs offline. In Run MyVirtual Machine /3D, the virtual CNC is supplemented by a virtual image of the machining space. In addition to collision protection, the feasibility of actually machining the order in the specific machine can be verified down to the smallest detail. This is very useful, especially for restricted spaces in 5-axis machining centers.

Conclusion

Sinumerik One signals a paradigm shift. Digital Twins based on the Create MyVirtual Machine and Run MyVirtual Machine software portfolio help manufacturers and users achieve the productivity boost that they need when building and operating CNC machines.

Sinumerik One – "Bring ideas to life". ■

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Your own CNC cycle – the ultimate discipline in CNC programming

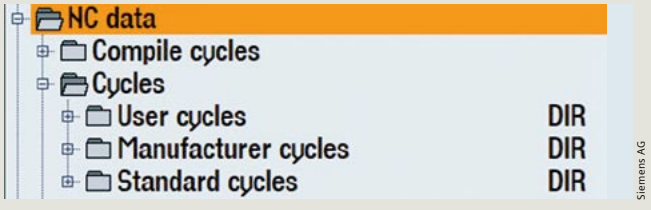
A machining task, where the range of Sinumerik cycles only helps to some extent or when it comes to efficiently combining recurring tasks. Just two examples, where generating your own macros – called CNC cycles in technical lingo – offers a solution.

Sinumerik technology cycles

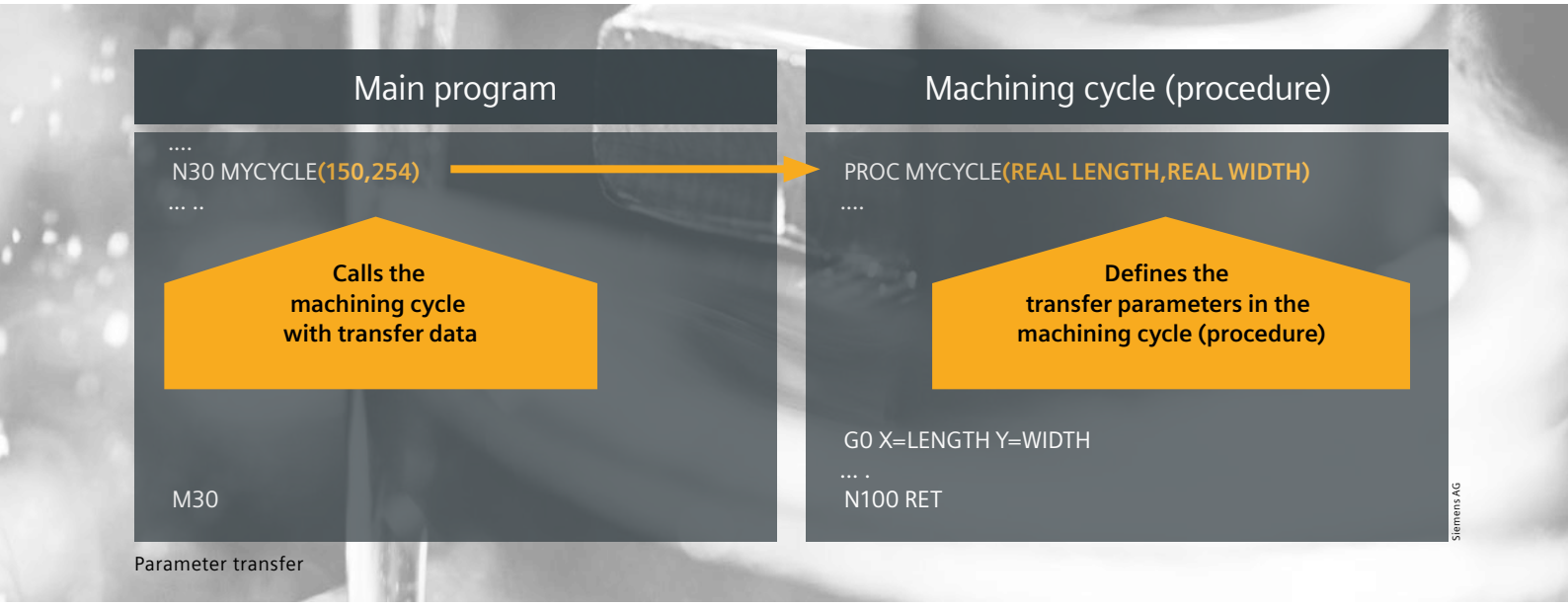
Sinumerik Operate already offers a very wide range of powerful technology functions for drilling, milling, turning as well as measuring. Having said that, the spectrum of technological options of these CNC cycles is always a tightrope walk. Although it is desirable to map every technological detail, this inevitably results in increasing complexity. As a result, the number of machining parameters of these CNC technology cycles must be restricted to keep programming transparent, and especially easy to handle for the widest possible range of users. To circumvent this dilemma, machine tool users have the option of generating their own machining cycles. This provides CNC programmers with a powerful medium for customizing and therefore rationalizing their own programming environment.

The file system

Here you must first understand the Sinumerik file system: CNC cycles must always be archived at a central location, so they can be found from every CNC program in any workpiece folder. The file system has three compartments at this central location. One for the standard Sinumerik cycles. The second is for the machine manufacturer, where the machine-specific CNC cycles are located. Tool changing in a milling machine, for example, is generally emulated in an



Sinumerik file system



Parameter transfer

individual tool change cycle. The third compartment belongs to the user. The CNC operator's own machining cycles can be archived there.

Parameter transfer interface

Parameter transfer is a central aspect when using CNC cycles. Of course, you can write machining parameters in R parameters in the calling CNC program and read these out in the machining cycle. However, this is cumbersome and, more importantly, prone to errors, especially if different people are working on a machine and there is no clear definition of which person is responsible for which R parameter. Using the transfer interface provided in the Sinumerik system software for cycles is without doubt the better alternative.

The CNC high-level language

Within the machining cycles, CNC programmers have the full functional scope of the Sinumerik CNC programming language at their fingertips. In addition to typical CNC commands such as G01, G02, F1000, S1000 etc., the emphasis quickly moves to using the Sinumerik high-level language. This is because the strength of your own machining cycles depends very heavily on how individually the machining adapts to the respective requirements, in other words, the transferred parameters.

The use of self-defined variables (DEF) is essentially indispensable. Machining sequences can be mapped systematically and in a structured fashion – by using program control structures such as IF-ELSE, REPEAT-UNTIL or FOR-ENDFOR Last but not least, mathematical operations such as SIN() or ROUND() allow tool paths to be very individually and efficiently derived from transfer parameters.

```
NC/CUS.DIR/MY_DRILLCYCLE.SPF
PROC MY_DRILLCYCLE(REAL DEPTH, REAL INFEED) SAVE DISPLOF¶
¶
DEF INT QUANTITY¶
DEF INT COUNTER¶
¶
;### calculation number of infeeds¶
QUANTITY=ROUNDUP(DEPTH/INFEED)¶
;### calculation of resulting infeed¶
INFEED=(DEPTH/QUANTITY)¶
¶
¶
;### program loop of infeeds¶
FOR COUNTER=1 TO QUANTITY¶
  G91 Z=-INFEED¶
ENDFOR¶
Z=DEPTH+1¶
G90¶
¶
RET¶
```

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Programming example for your own CNC cycle

Conclusion:

Without a doubt, your own CNC machining cycles are an important resource to further rationalize machine tool use. Programming machining cycles such as these is certainly not something that beginners should tackle. However, if you know how to handle procedures in the Sinumerik system software, and have fully explored the advantages of Sinumerik CNC high-level language programming, then you have at your disposal an unbeatable platform to leverage the last ounce of productivity of the CNC machine. ■

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From practical experience

» As a machine operator, I am extremely impressed with the flexibility of Sinumerik and just how simple it is to operate.«

Jürgen Höll, Voith

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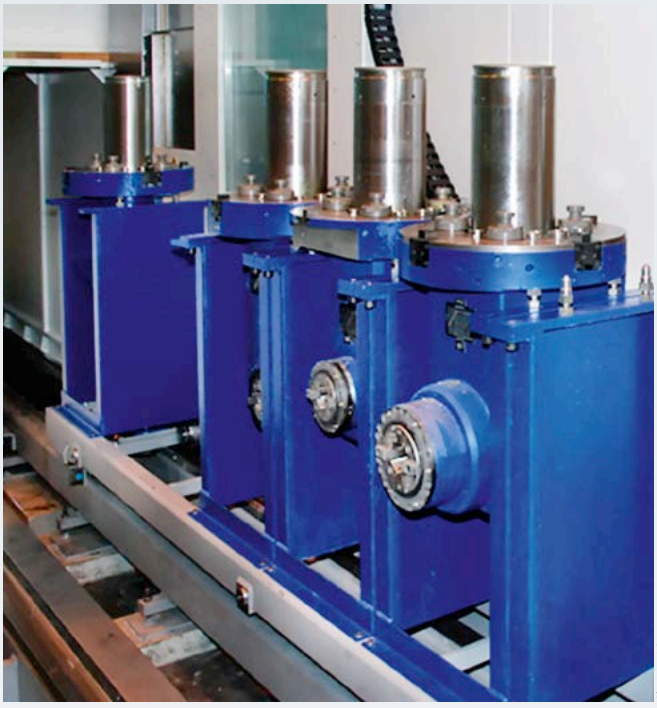
Heavyweight

We've struck oil! But how is it transported reliably to the consumer?

When you fill up your car with fuel, you probably never think about how the crude oil finds its way from the oil platform to the gas station. If you did, you'd see that it is quite an exciting topic as our report about Voith shows.

Voith is a technology company with a global reach. A broad portfolio of systems, products, services and digital applications meets the needs of the five dynamic markets of energy, oil and gas, paper, raw materials and transport and automotive in every region around the globe. Voith has locations in over 60 countries around the world, one of which is their facility located in Crailsheim, Germany, which was founded in 1956. Approximately 1,000 employees develop and manufacture solutions for mobility and industry. The main products include variable speed drives for pumping oil and gas.



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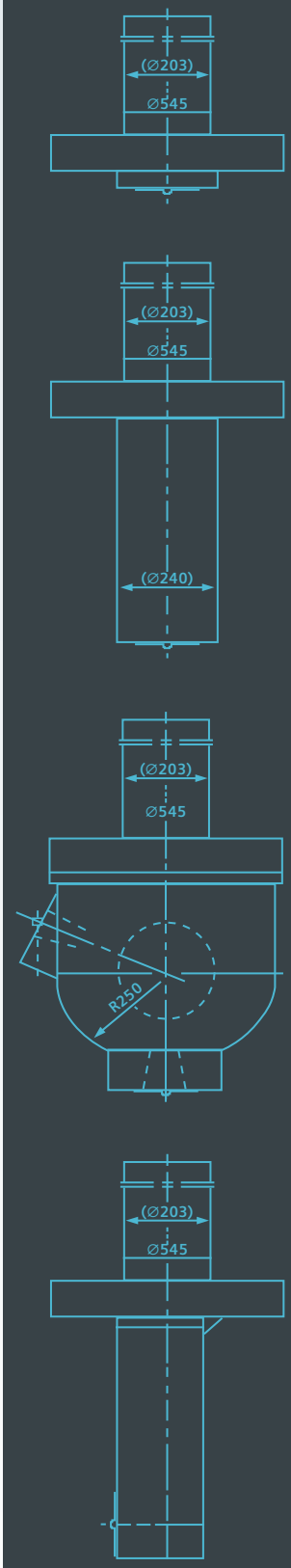
Automatic spindle unit changing station

Oil and gas often have to be pumped under adverse conditions: the heat of desert regions, or cold weather and high humidity on offshore oil rigs. Approximately 14.3 billion liters of oil are pumped every day. A real challenge for pump and drive technology. Voith Crailsheim plays an important role here with its VoreconNX product line, a multi-circuit controllable coupling with hydrodynamically controllable planetary gear for power ratings exceeding 50 MW and speeds exceeding 20,000 rpm. Reliable mechanics are combined here with hydrodynamic power transmission. The average operating time between non-scheduled downtimes (MTBF) is 48 years for this type of equipment.

The right kind of production technology is required to manufacture rugged products such as these. Production at Voith in Crailsheim is based on 27 top-of-the line CNC milling and turning machines. For decades now, Voith has relied on Sinumerik control technology for its machine fleet. Production Head Karl Augustin remembers the 880 and 840C systems very well. Today, most machines are equipped with Sinumerik 840D sl. This also applies to the machine from Waldrich Coburg, a MasterTec 3500 AT, which Voith purchased four years ago. Impressive: Workpieces weighing up to 20 tons can be loaded on to each of the two machining tables of the gantry milling machine.



VS 300/C
3300NM
63 kW
5000 rpm
Spindle head No.
50 DIN 2079
Automatic tool clamping
Internal/external coolant
Cooling circuit

VS 330/C/550
3300 NM
63 kW
5000 rpm
Spindle head No. 50
DIN 2079
Automatic tool clamping
Internal/external coolant
Cooling circuit

USP 300/C
3000 NM
63 kW
3000 rpm
Spindle head No. 50
DIN 2079
Automatic tool clamping
Internal/external coolant
Cooling circuit

HSD 70/C/650
700 NM
25 kW
2500 rpm
Spindle head No. 50
DIN 2079
Automatic tool clamping
Internal/external coolant
Cooling circuit

Possible variants of interchangeable heads (spindle units) for the automatic spindle changeover used by Voith Crailsheim.

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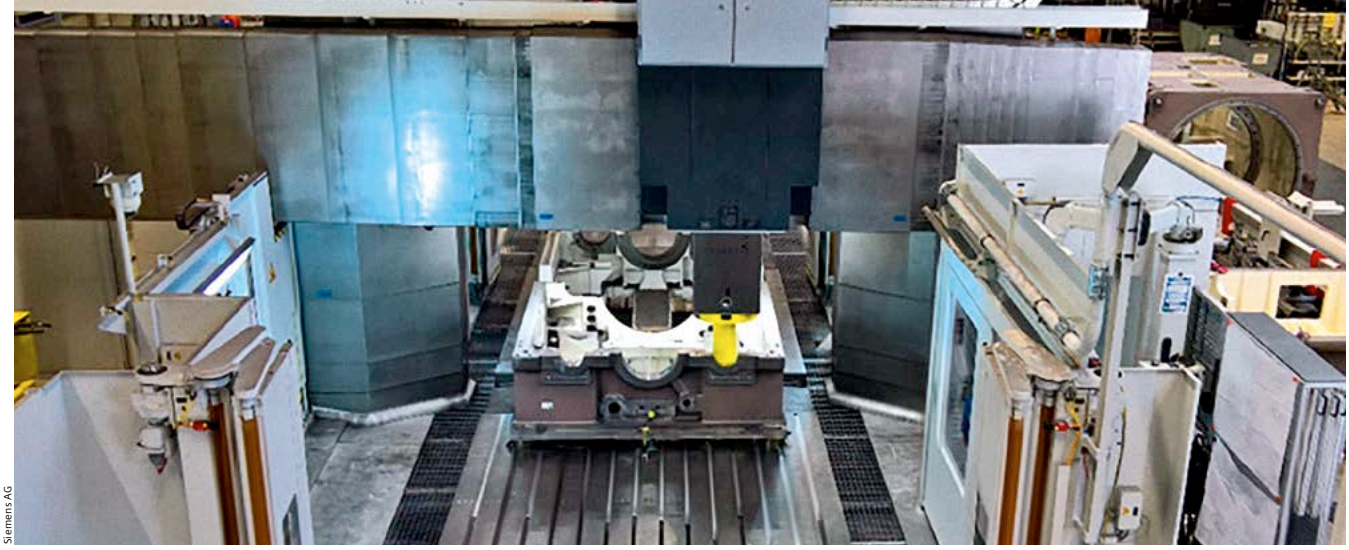

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Machining workpieces weighing up to 40 tons on the MasterTec 3500 AT gantry milling machine equipped with a Sinumerik 840D sl CNC

Changing heads

The VoreconNX enclosures are also machined here. The machine hall is climate-controlled to rule out any changes to the components or the machine as a result of temperature fluctuations. The Vorecon cast enclosures weighing up to 18 tons have to be machined on several sides, either as individual parts or as an assembly. To facilitate this, the portal gantry machine is equipped with four interchangeable heads. During operation, the machine kinematics can be modified by fitting a complete milling head so that surfaces and drill holes can be machined at the component in almost any situation.

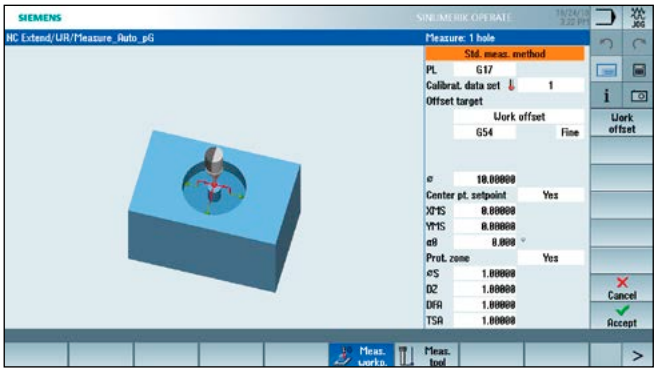
The requirements placed on the interchangeable heads are extreme. The spindle units have a mechanical spindle center offset of less than 0.02 mm. The maximum geometrical error between two tools must not exceed 0.005 mm. This demands maximum precision when processing the various machine parameters in the CNC. The Siemens VCR-Rotary software package reduces the spindle center offset to less than 0.01 mm. The interchangeable spindle units are mounted and removed fully automatically. This is implemented by switching over the motor data sets. Machine builder Waldrich Coburg generated these motor data sets during the commissioning phase.

Dietmar Danzer from the Voith NC programming department is very enthusiastic about the Cycle 800 swivel cycle. This makes it easier for him to program all the swivel operations on the component. Machine operator Jürgen Höll then implements these programs at the machine. As an experienced CNC technician, he is familiar with products from other CNC manufacturers, and is convinced that Voith has found the best possible solution with Sinumerik 840D sl. Operation, for instance when selecting the tools and programs, is easy to understand. The option of recompiling the cycles into the programs supplied by production planning is yet another feature that he finds very useful. This means that subsequent corrections can be directly entered at the control system without the risk of entering incorrect parameters.

Cast parts with fluctuating dimensions

The maximum batch size for this machine is three. Semi-finished products in the form of cast parts are used as the basis. However, machining individual pockets, fits and drilling patterns has to match customer specifications. For programming specialist Dietmar Danzer, Sinumerik 840D sl is the perfect solution for this level of variance.

The dimensions of the cast parts show production-related tolerances. Any variant can be essentially pre-designed, based on macros using the parameter programming and powerful high-level language commands in the NC program. Starting from the (initially unknown) unmachined dimensions of the castings, standard machining and measuring techniques (drilling, milling, boring with bridge dies, thread cutting/milling and measuring using probes) are implemented in the program. The post processor outputs a “standard” DIN/ISO program and the programs developed by Danzer take into account the continually varying upper/lower tolerances without having to change the main program.



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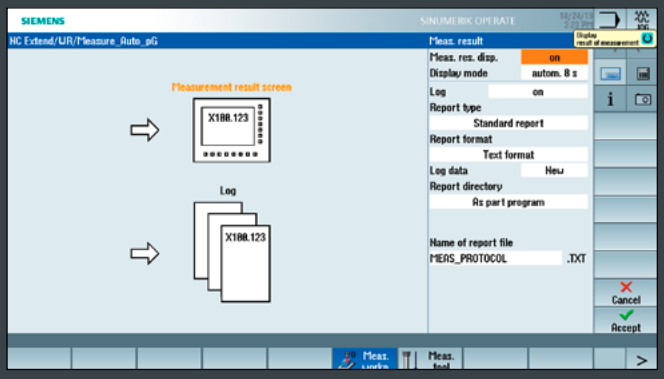
Practice-oriented Sinumerik measuring cycles in the Operate style ensure the quality of the machined parts by automatically performing measurements at the machine. The automatic measuring cycles are identical to the measuring cycles used in the setting up mode (JOG).



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Acquiring measurement results in Sinumerik

➜ Scan the QR code and read how Voith automatically logs the measurement results in Sinumerik

Virtual machines reduce production times and training needs

To further optimize the time between order intake and order dispatch, experiments are currently under way with a digital twin of the machine based on Siemens NX and the virtual NC kernel (VNCK). In the future, this means that production planning will be uncoupled even more from machine operation, thus saving valuable time. This can be achieved because the virtual machine and the control behave exactly like the real physical machine during the machining processes. While another part is being machined, the user can already run in the next part virtually, including a collision check. In this way, NC programs are already optimized in advance. A positive spin-off of having a virtual machine is familiarizing and training new personnel. The virtual machine can be used for testing and training without having to use the real CNC machine. ■

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Permanently on the test stand

The Siemens geared motors factory in Tübingen, Germany is a great example of how machine tool-based manufacturing has become significantly more productive by systematic use of digitalization products.

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From practical experience

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Modern mills are high-tech precision products

Sinumerik in the mill production of Tietjen Verfahrenstechnik GmbH

At velocities of up to 132 m/s, the rotating hammers in Tietjen mills crush raw materials for animal feed, plastic, organic waste, wood and many more products. Controlling the forces involved takes many years of mill expertise and precisely dimensioned components.

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»Right from the outset, it was clear that Sinumerik operation was smoother, more user-friendly and easier.«

Peter Wagner, Tietjen

The company's site in Hemdingen, Germany (near Hamburg) looks more like an agricultural enterprise than the head office of a manufacturer of industrial mills known throughout the world. The original idea for the first mill patent really came from the agricultural history of the Tietjen family. "The founder realized that when it comes to animal feed, the grain size is also important for how well animals absorb the nutrients, in addition to the recipe and ingredients. This led to the founding of the Tietjen machinery construction company in 1959. Today, we are process engineers who operate within the scope of project business to supply industrial mills with feeders, control systems and explosion protection for a vast range of applications around the globe", explained Thomas Runde, one of the three CEOs in the family-run business which employs 60 people.

Material-dependent design

Tietjen mills are impact crushers. Each mill is adapted precisely to the material to be crushed or milled: capacity, humidity, intended granularity, starting sizes, material hardness, surface attributes – and the list goes on.

This is why seven employees work on 3D design. All variants share a similar fundamental design: arranged in segments, many hammers are attached to a rotor, which rotates in the chamber at over 3,000 rpm. The material, introduced from the top into the mill chamber, hits the hammers, which crush it as a result of the force of the high-speed impact. The company's core expertise focuses on the arrangement of the hammers, and in particular the rotor design.

"We use different steel grades for the hammers. Stainless steel is frequently used, as the materials are acidic or else relatively hard. It's crucial that the rotor is manufactured with great precision due to its rotational speed", stated Peter Wagner, Tietjen's General Manager and Head of Production.

The components were produced semi-automatically for many years. The continuous growth and the restricted space on the factory site made us think about purchasing a CNC machining center, which would allow us to produce more flexibly, faster and with a higher degree of precision.

Another argument was the spare parts business. Tietjen is still producing replacement parts for mills that customers have had in operation since the beginning of the 1960s. These individual parts can be more efficiently produced with a higher repeat accuracy when using a CNC machine.


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The rotors of our hammer mills spin at speeds exceeding 3,000 rpm – and the components must be manufactured with the appropriate dimensional precision.

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From left to right: Michael Schaaf (Knuth), Ingo Bartsch (Siemens), Peter Wagner (Tietjen) and Christian Nickelsen (Tietjen)

»The 3-axis machining center was not available with Sinumerik. But we made it possible for the customer...«

Michael Schaaf, Knuth

Sometimes fate plays a role

Fate not only plays a role in crime thrillers, but also when it comes to making investment decisions. The Tietjen team quickly reached agreement with machine supplier Knuth about the selection of a 3-axis machining center with a tool changer.

"One of the last demonstrations involved a tool change and how it is mapped in the control system. As the whole thing appeared to be complicated and was taking somewhat longer, some of us wandered around the Knuth demonstration center. And as luck would have it, we bumped into Mr. Bartsch from Siemens, who was setting up a Sinumerik control system with ShopMill at another machine. Right from the outset, it was clear that the Sinumerik operations were smoother, more user-friendly and easier. This aroused our interest. We asked if we could see more, and then made a quick decision: we would be equipping our new machining center with a Sinumerik control system", recalled Peter Wagner, Head of Production.

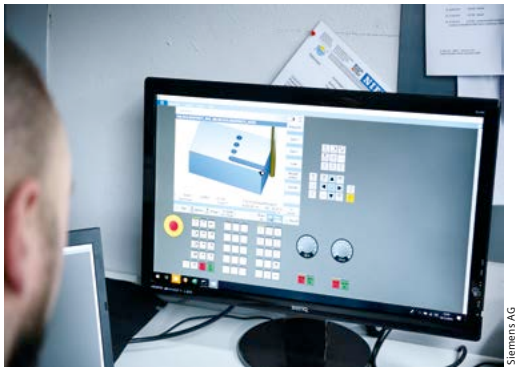
However, this turned out to be easier said than done. Michael Schaaf, Technical Manager of the STAHLWERK KNUTH brand: "The 3-axis machining center was not supplied with Sinumerik. However, we made it possible for the customer, and thanks to the support from Siemens, the machining center was installed with a Sinumerik 828D and ShopMill. For batch sizes of between 3 and 5 up to maximum of 50 parts, Tietjen really does benefit from the flexible programming options and the significantly easier operation of Sinumerik."

Installing the machining center in the narrow factory hall presented a challenge. With the plant still operational, machines had to be moved around, the floor of the hall opened up and a solid foundation poured. The machining center went into operation early 2018.

Offline programming with SinuTrain

This bold investment decision met with much praise internally. With the new machining center, key workflow steps which had previously been outsourced were re-integrated into the company, increasing our level of vertical integration. "This further improved our flexibility and supply capabilities. This gives us an important competitive edge in the project business, where milestones and completion dates are crucial," explained CEO Thomas Runde.

The Sinumerik control system also played a part in this: using SinuTrain, CNC programs are generated offline so that the machine can remain in productive operation for longer. "An extremely helpful option, which would not have been available with the original machine configuration.



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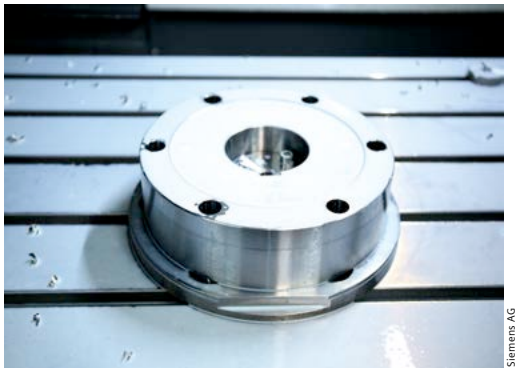
SinuTrain: Thanks to offline programming, the machine remains in productive operation for longer.



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With the milling center, outsourced workflow steps were re-introduced into the company.

The Knuth machining center equipped with Sinumerik and SinuTrain, as well as the excellent collaboration between Knuth and Siemens, provide us with the best possible solution – packed with features and offering a high degree of flexibility." ■

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Industrie 4.0 hands-on

Institute for Production Technology (IPT) of HAW Hamburg

Not dull theory, but digital production in practice. HAW Hamburg's CNC laboratory has created an end-to-end digital process and production environment using Sinumerik CNCs, the Siemens NX CAD/CAM system and digital twins of turning and milling machines. Integrated in the Industrie 4.0 project of "smart-production@haw.de" – including material logistics, handling robots and autonomous intelligent vehicles (AIVs) for transport.
This is the ideal, future-proof basis for state-of-the-art and advanced training.

Basic and advanced training

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Cutting-edge technology at its finest: HAW Hamburg provides machining training courses in a seamless process and production workflow.

Basic and advanced training

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From the aha moment up to a training partnership

rbz Steinburg

It all started with a training course at the DEX in Erlangen, Germany. Thanks to the commitment of two trainers, rbz Steinburg modernized its training workshop – and within a short period of time, developed itself to become an official Siemens training partner. It offers a wealth of advantages for not only trainers, but also companies in the area.

➜ Scan the QR code: watch the video

Questions and answers about digitalization

What does digitalization specifically mean for machinists and CNC specialists? We continue our series of questions and answers about the topic of digitalization.

What questions do you have when it comes to digitalization and your working environment? Simply write and tell us what you want to know.
Send your questions to:
contact.cnc4you.i@siemens.com
We will send you a reply based upon our own research and discussions with experts.

"CNC machines are increasingly being integrated into digital workflows, even robots are being used. At the same time, manufacturers are complaining about the increasing lack of skilled labor. How do you address this?"

In the CNC4you portal, you can read our answers and suggestions about which training courses enhance the skill sets of experienced CNC technicians even more.

↗ **sie.ag/3dErS72**

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Manual deburring tool workpiece

➜ Scan the QR code: Production description in the CNC4you portal

A manual deburring tool is frequently used during production – but where is it when you need it? Simply make this professional tool yourself – as a Sinumerik workpiece.

Our manual deburring tool workpiece has what it takes to become the product hit for all machinists. The rugged, professional tool uses commercially available interchangeable blades, and even has a compartment with a screw cap in its shaft for the blades.

To fabricate your own personal manual deburring tool, you only need one round nickel bar (CuZn39Pb3-zh) and one round steel bar (11SMnPb30+ C) as well as deburring blades and a grub screw, which are commercially available. You can download the documentation, drawings, tool data and NC programs (four different ShopTurn machining programs) from the CNC4you portal.

↗ **sie.ag/3cuybdi**
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Sinumerik online training courses – including a certificate

You decide when, where and how quickly you want to learn. These are just some of the advantages of our web-based training courses (WBT). You also have the option of doing an online test after each course. A certificate will be issued if the test was successfully completed. Our suggestion: simply try this state-of-the art learning technique.

Our range of online training courses includes:
1) SINUMERIK Operate – Fundamentals
2) Cutting
3) Cutting tools
4) Programming
5) Setup and manufacturing
6) Programming with SINUMERIK Operate

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Watch now: Three new video tutorials!

These video tutorials from the Sinumerik Live series are very popular with machine tool users. In these videos, our experts present application technology in a simple way that's easy to follow – and always with practical examples on the machine. The slides from these tutorials can also be downloaded from the CNC4you portal.

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Part 8: Effective multiple clamping with Sinumerik Operate

Multiple clamping systems save time and reduce the amount of space in the machining area. In the video, our experts explain the Sinumerik Operate function "Multiple clamping" – also live at a machine equipped with Sinumerik 828D. Here's a link to the video
↗ **sie.ag/3brVG5I**

Part 9: Thread types and their machining – the fundamentals

What thread types are there, and what do I have to consider when using the Sinumerik thread cycle? This video explains, clearly and logically, fundamentals of the complex topic of threads and how to use the Sinumerik thread cycle. Here's a link to the video
↗ **sie.ag/2LnaDuL**

Part 10: Machining threads with driven tools

Starting with the basic course (Part 9), you can learn more about using Sinumerik cycles for machining threads. Here's a link to the video
↗ **sie.ag/2WvypeJ**

Here's the link to all previous tutorials:

↗ **sie.ag/2Lu00GQ**
✉ **armin.baernklau@siemens.com**

NEU

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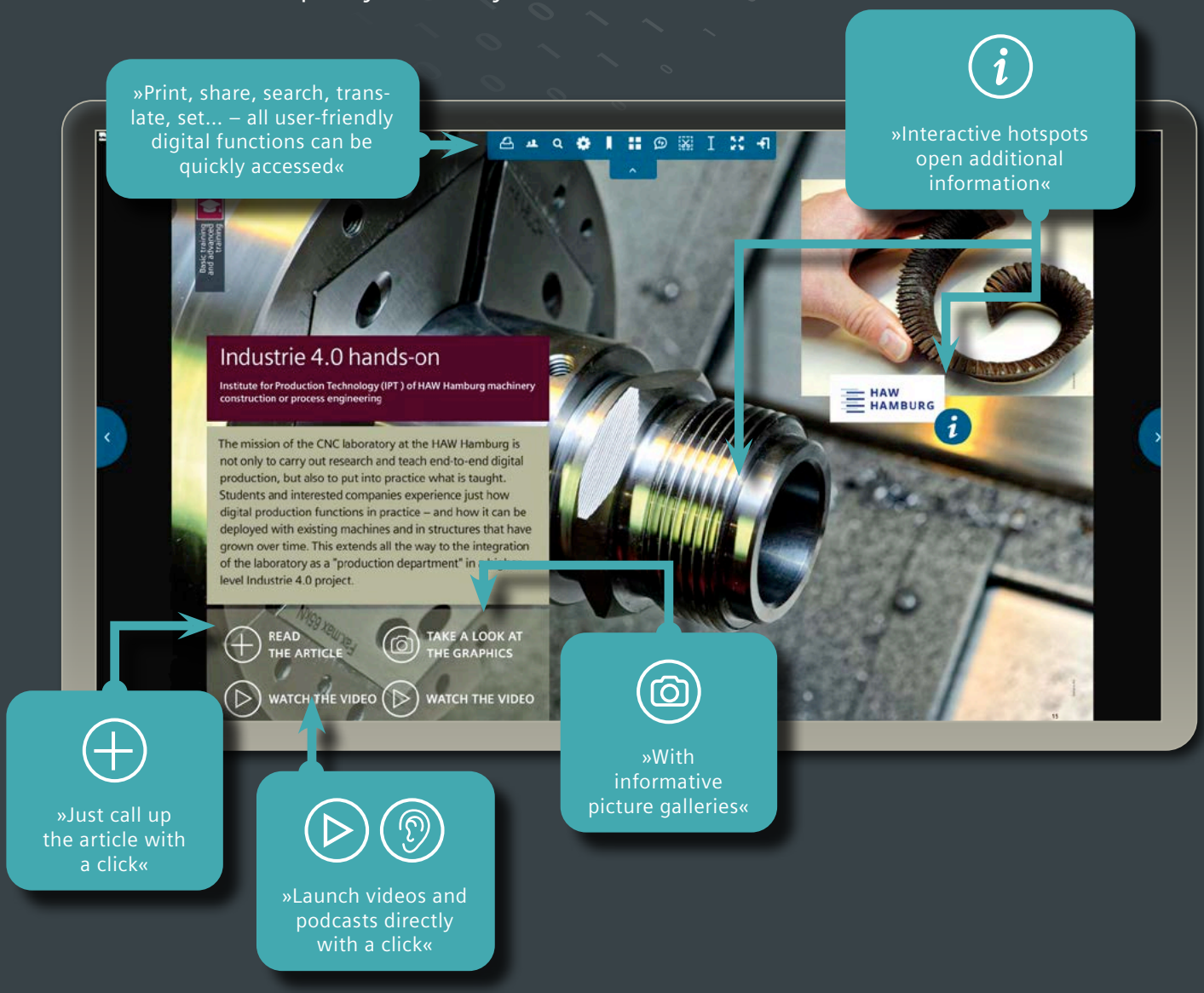

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Published by
© Siemens AG 2020
Digital Industries
Motion Control
P.O. Box 31 80
91050 Erlangen, Germany

For the U.S. published by
Siemens Industry Inc.
100 Technology Drive
Alpharetta, GA 30005
United States

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Article No.: DIMC-M10038-00-7600
Printed in Germany