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Digitalization

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Sophisticated technology and an easy-to-use control system are the foundation for manufacturing the most exclusive motorcycles

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News

Cover photo: Siemens AG/W. Schmauß

Mastering digital challenges

Increasing digitalization of machining processes means that the role of the CNC expert will be changing in the future. Although the objective of creating a workpiece within the specified time and required quality parameters will not change, more process knowledge will be needed.

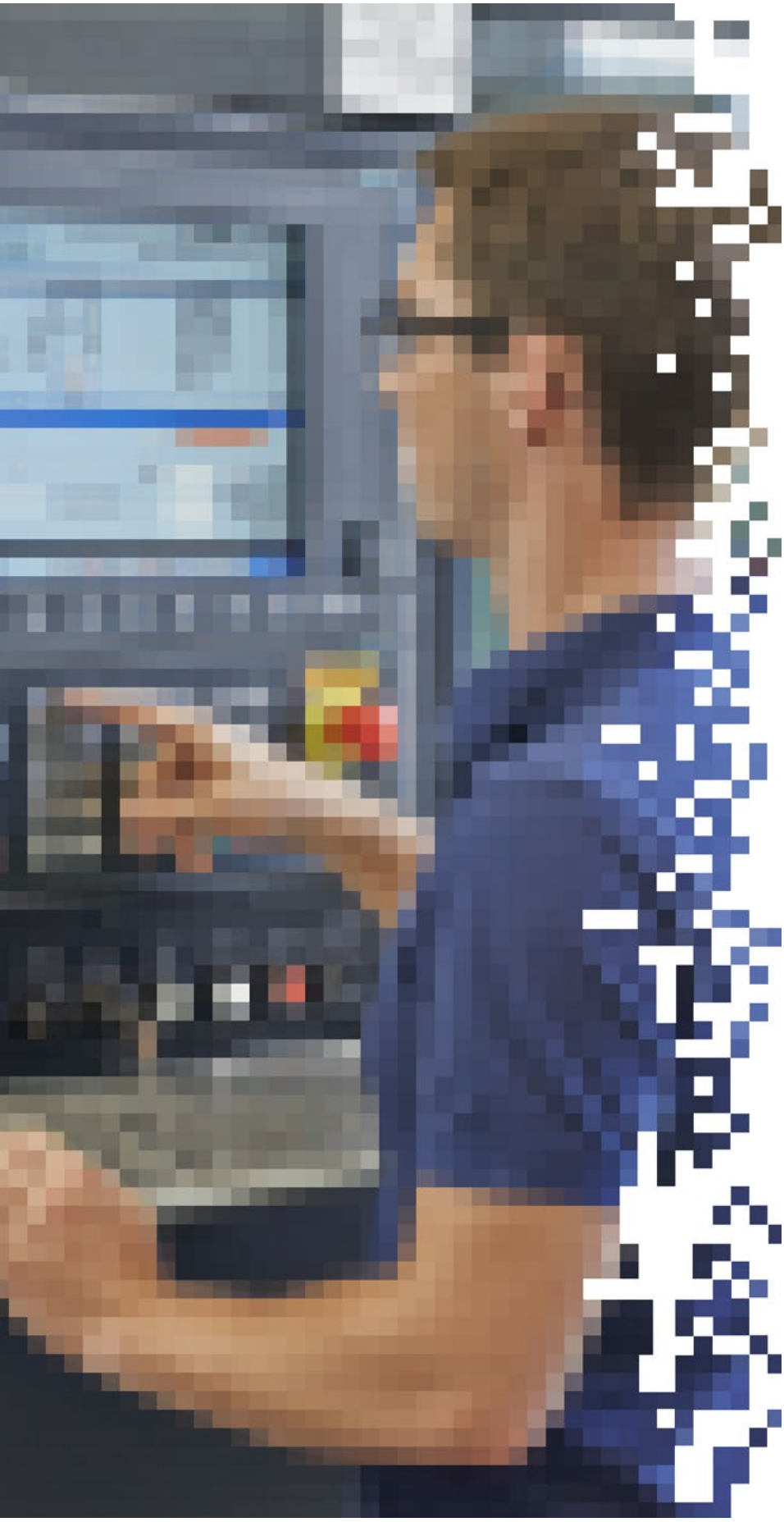
An initial step toward the digital production process is to begin using a CAD/CAM CNC process chain. This can increasingly shift programming, simulation, and setup tasks away from the machine. This means that CNC specialists will be faced with the challenge of understanding the data generated, or even being able to work with it themselves.

We will increasingly see the “CNC workstation” being integrated into shopfloor IT systems. This means transparency of OEE statistics for individual machines for the company within the overall context of the manufacturing efficiency or tool data. CNC professionals of the future must be able to interpret the indicators provided and to draw conclusions about what they mean for their tasks.

In light of increasing digitalization, the specialists operating the machinery will be using MES and ERP systems more and more in order to ensure a more effective workflow on individual machines, as well as to make better use of resources throughout the production process. ■

Making the dream of a digital twin come true

Siemens AG/S. Köppel



Conversations between CAD/CAM experts and CNC professionals may sound confusing to outsiders. Recently, many companies have been talking about wanting "digital twins," for example. But what is a digital twin, exactly? And what do you do with it?

The increasing customization of products and ever-shorter product lifecycles are posing new challenges for CNC contractors: competition and cost pressures are growing and, as a result, the production process has to become more and more efficient. On top of that, machines are at their most productive when their tools are at work. In other words, nonproductive time needs to be decreased and as many tasks as possible have to be shifted away from the machines and into production planning. This is exactly what companies hope to achieve by digitalizing the machining process. The first important step toward digitalization is using a

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By combining the NX CAD/CAM system and the Sinumerik CNC system, Siemens offers a digital twin for the entire machining process.

CAD/CAM CNC process chain. This allows programming, simulation, and setup procedures to be performed offline as part of production planning.

A perfectly matched pair to facilitate the machining process

The more integrated and complete the CAD/CAM CNC process chain is, and the more realistic its digital map, the greater the gain in productivity for the company. A digital map of the production process is also referred to as a "digital twin" – because the real and the digitalized process should be as similar as possible. By combining the NX CAD/CAM system and the Sinumerik CNC system, Siemens already offers a digital twin for the entire machining process.

Integrated CAD/CAM CNC process chain

Computer-aided design (CAD) is a computer-supported design and development process. The product is created on-screen down to the last accurate detail. While CAD used to be similar to technical drawing, modern systems such as NX-CAD have developed into complex expert systems. For example, a finite element analysis or flow and heat-transfer analysis can be conducted in the very early phases of development. However, CAD also has a role to play in CNC production planning: Here, the focus is not on making constructive changes to the CAD data provided, but rather on analyzing and – where applicable – adding to the CAD data for CNC production. In CNC production planning, the technician becomes the designer, when it comes to modeling clamping aids, special tools, or more complex blank geometries using CAD. With this in mind, the integration of the CAD and CAM module, as in NX, is a key productivity factor.

Computer-aided manufacturing (CAM) involves using software that is independent of the CNC machine tool to create the NC code. Unlike workshop-oriented programming (WOP), NC programs are created during production planning. A CAM system's main task is to transform CAD data into tool paths. As such, the integration of the CAM system and the CNC control is a major advantage. For example, when machining free-form surfaces it is extremely important for the CAM system to accurately parameterize the CNC's speed. NX and Sinumerik are perfectly matched in this respect: NX provides the Cycle832 high-speed-setting cycle with the required data, which allows the Sinumerik in the machine to perform at its best.

Increasingly complex machine concepts mean that measures for avoiding collisions are required, ideally during CNC production planning. CAM systems offer simulation modules that ensure process efficiency and reliability in CNC production. The depiction of tool paths can be expanded by integrating tool geometries and blank dimensions for removal simulation. In the case of simulation with virtual machine tools, the tool paths are also displayed on

Example of a CAD/CAM CNC process chain using NX and Sinumerik VNCK (Chiron ProcessLine)

Siemens AG

a 3D model of the machine. This enables identification of both collisions between the tool and the workpiece and collisions between the tool and the machine or clamping aids. The virtual machine in NX-CAM significantly increases process reliability. While traditional CAM systems simply supply the simulation with neutral – CNC-independent – tool paths, NX-CAM uses the CNC parts program translated by the postprocessor as an input value. This means that NX includes the impact of the CNC in the simulation result. The outcome is a more precise process image than offered by traditional CAM systems – and therefore greater process reliability.

Perfect simulation with Sinumerik VNCK

A technical prerequisite for the virtually complete simulation of the CNC program is for the CNC kernel to be recreated in the CAD/CAM computer. This includes typical functions such as a CNC interpreter and CNC interpolator and the calculation of kinematic transformations: for example, a five-axis milling machine. With the Common Simulation Engine, NX-CAM has a universal CNC emulator that can very accurately recreate the CNCs of different manufacturers.

The interplay with Sinumerik, however, is especially precise since NX-CAM offers the Sinumerik virtual NC kernel (VNCK) specifically for this CNC. As this VNCK is identical to the Sinumerik in the target machine, the process image of the simulation comes very close to that of real-life machining. Because of this, the Sinumerik VNCK is frequently used as a tool in CNC production planning, particularly in the case of complex machinery and expensive workpieces. Another benefit of this integration: The simulated program runtime of the Sinumerik VNCK is virtually identical to the program runtime in the machine. This allows users to calculate unit costs extremely reliably during the quotation phase, based on simulation. Thanks to the Sinumerik VNCK's fully fledged Sinumerik Operate interface, the run-in of the CNC program on the machine can even be verified on the PC. Experience shows that this facilitates the shortening of setup time for new parts by up to 20 percent.

The VNCK application benefits both large-scale producers and manufacturers of long-term components such as complex molds, because production costs can be identified transparently up front and non-productive machine times can be avoided. However, machine builders will only reap the maximum benefits if they consistently integrate the VNCK application into their production process.

A digital twin with prospects

In addition to greater process reliability and process efficiency, the combination of NX and Sinumerik offers even more advantages: The process chain comes from a single source and is perfectly harmonized, thereby minimizing the effort for interface adjustment and software updates. A firmly established complete solution from a single provider such as NX plus Sinumerik, also provides more reliability in staff and resource planning. In contrast, a CAD/CAM CNC process chain made up of software modules from different manufacturers generates additional costs in the form of interface adaptations and pending software updates due to incompatibility, for example. Moreover, combining the software modules of different manufacturers always requires the work of specialists. Today, when skilled workers are scarce or in the event of staff changes, this can quickly result in bottlenecks in production.

With Sinumerik and NX, Siemens is currently the only provider on the market offering both CNC technology and a CAD/CAM system from a single source. The extremely broad market position of both subsystems ensures a high level of investment security in the CAD/CAM CNC process chain – meaning good future prospects and development opportunities for the digital twin. ■

Advantages of the digital twin

- Process reliability and process efficiency
- The process chain comes from a single source and is perfectly harmonized, minimizing the effort for interface adjustment and software updates
- Greater reliability in staff and resource planning

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CNC knowledge

No reservations

Siemens has developed touch panels for the Sinumerik 840D sl and 828D that meet the special requirements of the industrial workplace and can be intuitively operated using specific gestures.

Smartphones, tablets, ATMs, info terminals – we now use touchscreens throughout our daily lives without thinking much about it. However, the potential of touch panels is enormous in the industrial environment: They not only make operating plants much faster and easier; they also increase the number of control options. The elimination of buttons and controllers on PLCs also makes it possible to install considerably larger screens. All of the many mechanical elements of a control system are always visible at the same time – whereas with touch panels, the user only sees the control elements that are necessary or useful for the relevant situation, or for the currently selected process or dialog box.

However, in harsh industrial environments touch panels are confronted with additional requirements. Panels for industrial use have to be especially robust, scratch-resistant, and anti-reflective. It is also important that they can be operated while wearing gloves. Dust, shavings, dirt, and lubricants must not impair either operability or service life. Finally, the gestures needed for operation must, wherever possible, offer all of the functions that are already established in the consumer sector, such as swiping and scrolling using fingers.

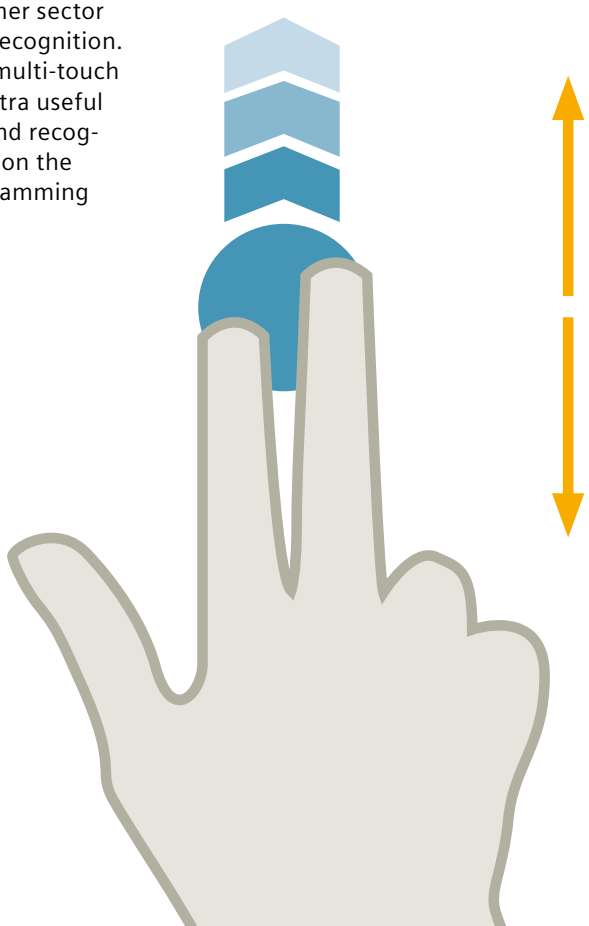
Robust and easy to operate

Siemens has taken on these challenges and developed efficient touch panels for Sinumerik 840D sl and 828D CNCs. Thanks to the use of new technologies, these touch panels are suitable for the tough, dirty industrial environment and can be operated while wearing gloves. One further advantage is that the new touch panels are very robust.

The Sinumerik touch panels boast all of the features of state-of-the-art touch panels in the consumer sector when it comes to gesture recognition. Siemens touch panels are multi-touch compatible and have an extra useful feature in their “heel of hand recognition”: operators can lean on the control system while programming without the gesture being misinterpreted and hindering operation.

Especially convenient

The touch panels offer more advantages besides simplified operation. A mouse and keyboard are no longer required. The intelligent scroll function (swipe up or down with one finger) provides access to the CNC parameters and subprograms quickly and easily. The multi-touch capability



The intelligent scroll function facilitates rapid access to CNC parameters

Intuitive to operate: the Sinumerik touch display

Thanks to the use of new technologies, these touch panels are suitable for the tough, dirty industrial environment.

also speeds up operation even more: Scroll with two fingers to move page by page, or use three fingers to jump straight to the start or end of the program.

The greatest benefit becomes clear when using simulation in Sinumerik Operate: During simulation, it is possible to zoom in and out, rotate, and move the workpiece using gestures. These functions provide users with an overview, allowing them to immediately detect errors in programming. Another example is working with the integrated DXF reader in Sinumerik Operate. The touch panel makes the scanned drawings simpler to process because contours can be selected and edited easily using the finger.

The use of touch panels in the industry opens up a wealth of new opportunities. For example, it is now possible to implement innovative operating concepts. Thus, touch panels ensure additional convenience on the shop-floor. ■

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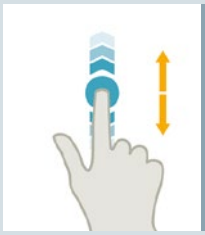
Intuitive gesture-based operation: smartOperate

Sinumerik PLCs with touch panels are intuitive to operate. Tapping, swiping, and sliding motions have the effects that we are already familiar with (and expect!) from using smartphones and tablets. The panels' quick and easy gesture-based operation with multi-touch capability is therefore known as "smartOperate."

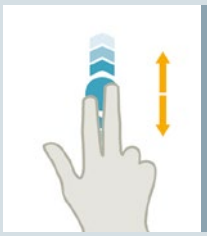
Tap

- Select window
- Select object (e.g., NC set)
- Activate input field



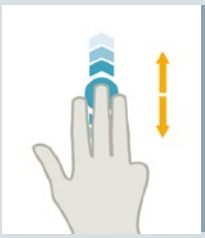
Vertical swipe with 1 finger

- Scroll in lists (e.g., programs, tools, zero points)
- Scroll in files (e.g., NC programs)



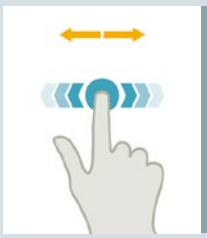
Vertical swipe with 2 fingers

- Scroll page by page in lists (e.g., R parameters, machine data)
- Scroll page by page in files (e.g., NC programs)



Vertical swipe with 3 fingers

- Scroll to start or end of lists
- Scroll to start or end of files (e.g., large mold-making NC programs)



Horizontal swipe with 1 finger

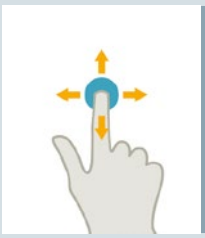
- Scroll in lists with many columns (e.g., tool list)

Enlarge

- Enlarge graphical content (e.g., simulation, to better view details)

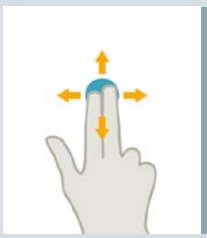
Reduce

- Reduce graphical content (e.g., simulation, to see a full view of the workpiece)



Slide with 1 finger

- Move graphical content (e.g., simulated image, to see the approach movement better)
- Move list content

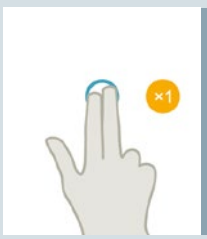


Slide with 2 fingers

- Rotate graphical content (e.g., simulation, to see the back of the workpiece)

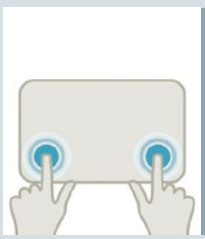
Tap and hold

- Open object for editing (e.g., NC set)



Tap with 2 fingers

- Bring up context menu (e.g., copy, paste)



Tap with 2 index fingers

- Tap right and left corner at the same time to open main menu

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Good ideas pay off

600-mm-long hydraulic strips for the pharmaceutical industry can be manufactured twice as fast as before on the five-axis machine

To remain competitive, contract manufacturers need to become more flexible and more productive. The example of Giessmann Maschinenbautechnik shows that it can be done – with good ideas and targeted investments.

At first glance, Giessmann Maschinenbautechnik oHG appears to be a traditional family firm. Günter Giessmann founded the company as a one-man metal and tinsmith workshop in Remscheid, Germany, 45 years ago. His sons Andreas and Stefan, both trained metalworkers, joined the company in 1989 and took over management of the business – which now has 22 employees – in 2004. Not long after the two sons became involved, the company began to focus on investing in modern machine technology and automation.

The first milling machine went into operation in 1990, paving the way for what is now a range of 15 CNC machine tools of different sizes and designs.

Variety as the recipe for success

The variety of features offered by the machines is no coincidence. Precision and reliability are, of course, important factors for all customers, but Giessmann consciously caters to the needs of customers from a wide range of sectors. For example, the firm manufactures bone grinders for the ›

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Delighted with the excellent working relationship: Jürgen Ries and Alois Penzkofer (Siemens), Claus Widmer (Spinner), and the two Giessmann managing directors, Andreas and Stefan Giessmann (from left)

medical industry, 20-ton spare parts for enormous excavators, and complex modules for granulate machines that are used to make cocoa powder for the food industry, tablets for the pharmaceutical industry, or granulates for plastics processing companies.

This diversity requires a great deal of expertise as well as a large, modern machine park. But why all this effort? The Remscheid-based company utilizes this versatility in its technology and customer base to compensate for fluctuations in the economic situation of individual sectors. If a sector or an individual customer is not doing too well, additional orders from other customers in sectors that are doing better usually compensate for the resulting drop in orders. Stefan Giessmann sums it up: "It involves more effort without doubt, but this strategy has brought us much stability in capacity utilization and growth over the years."

The second secret to success: flexible machines

The company's two owners also keep flexibility in mind when making new acquisitions. A good example in the area of machining is the new five-axis Spinner U5-2520 machining center, which has a high-end Sinumerik CNC 840D sl. Stefan Giessmann describes the special features of the machine: "The level of flexibility that this machine offers is outstanding. On the one hand, we can machine very long components of up to 2,560 mm. On the other hand, we can split up the machining space in less than 10 minutes, and then work on smaller components

»Because the Sinumerik interface is identical for all turning and milling machines, our turning experts quickly find their way around the Spinner machine.«

Andreas Giessmann

pendulum-style." This makes the machine versatile and highly productive: When in pendulum mode, the machine operator can be setting up on one side while a workpiece is machined on the other. This procedure is also used to produce a 600-mm-long hydraulic strip for the pharmaceutical industry. In the past, this workpiece had to be reclamped and carefully and precisely calibrated each time. Now the part is manufactured in pendulum mode on the Spinner U5 at more than double the speed – at the same or better quality.

In addition to the divisible machining area, the key to the high level of productivity and quality offered by the

Spinner U5 is the machine's five axes, which Giessmann has so far primarily used in a 3+2 configuration. This allows many workpieces to be created with one clamping process for the first time. The company also plans to tap new business areas with simultaneous five-axis machining. Initial enquiries about parts with free-form surfaces have already been received. In addition to its flexibility and precision, the Spinner U5-2520 impresses with its technical performance. A linear motor is integrated into the long x-axis, achieving axis accelerations of 5 m/s² and rapid traverse rates of 48 m/min. This reduces downtime and increases productivity. Thanks to a digital position measuring system, the machining center achieves positioning accuracies of Tp max. = 10 µm in the room and repeat accuracies of up to 3 µm in the individual axes.

The control system combines speed and surface quality

According to Giessmann, the Sinumerik 840D sl paired with the Sinumerik MDynamics technology package is the ideal control system for the Spinner five-axis center. Especially when it comes to simultaneous five-axis machining, the Advanced Surface motion control is invaluable with its optimized look-ahead function and powerful data compressor. This means that the programmer can set or adjust the program sequence at any time, ensuring that the machine works at the optimal speed while generating the necessary surface quality. Sinumerik measuring cycles are used to ensure that the machine maintains its accuracy over an extended period. These facilitate the calibration of the machine kinematics in all parts of the room using a calibration sphere. Jürgen Ries, who handles user support at Siemens, explains: "This keeps the machine's accuracy at a constant level throughout the entire lifecycle, and ultimately shows in the accuracy of the milled parts."

Andreas Giessmann believes that the Sinumerik Operate user interface is particularly beneficial. Based on the well-known Windows style, it is simple and intuitive. His employees have quickly become familiar with the ShopMill graphical step sequence programming. In this mode, the CNC asks for each individual command and models it visually. Sinumerik also has plenty of flexibility to offer: "Because the Sinumerik interface is identical for all turning and milling machines, our turning experts quickly find their way around the U5," explains the managing director. Another advantage is the folder structure in the Sinumerik 840D sl that enables the archiving of completed orders in a clearly organized manner. In addition, Giessmann has another trick to make its employees' lives easier. Machine operators do not just file the CNC programs and tool selections: To complete the file, they use smartphones or tablets that are provided free of charge by Giessmann to photograph all relevant settings. This means that any employee can produce the same or similar parts at a later date without too much effort, because all of the necessary information will be in the image, saving valuable time. ■

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Discovering new business with high-end smokers

Andreas and Stefan Giessmann believe that anyone seeking a true BBQ experience will need a smoker. But the brothers were not satisfied with the equipment available on the market. Over the space of several evenings they designed their own model, programmed the necessary components, and finally produced it in stainless steel on the Sinumerik-controlled Spinner U5. At 150 kilograms, the final assembled smoker is by no means light, but "it works great," the brothers confirm. The entrepreneurs have even discovered a new business field with their high-end, self-designed smokers: They are now building them in small series ready to sell.

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Giessmann is setting out in a new field of business with the production and sale of a self-designed high-end smoker

Siemens AG/P. Klingauf

On the shopfloor

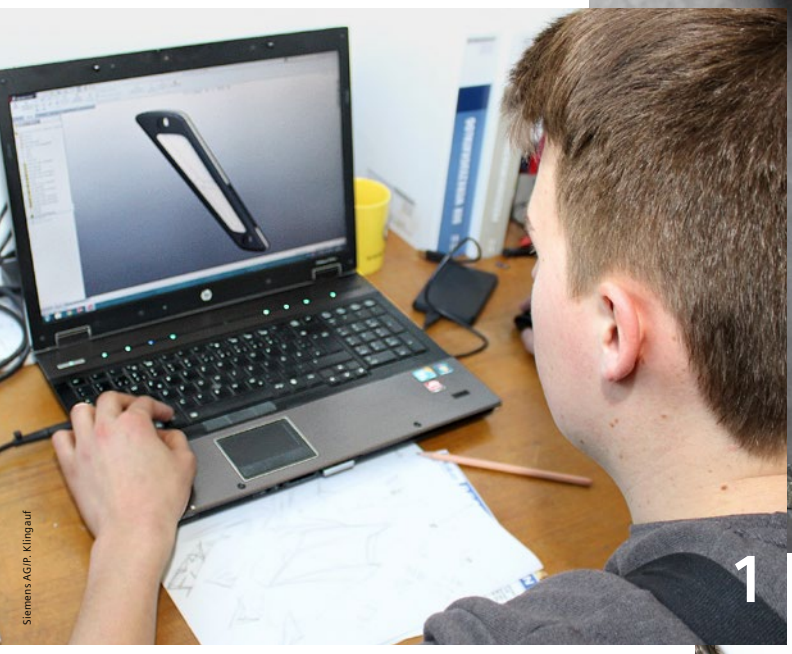
Easily creating one-offs

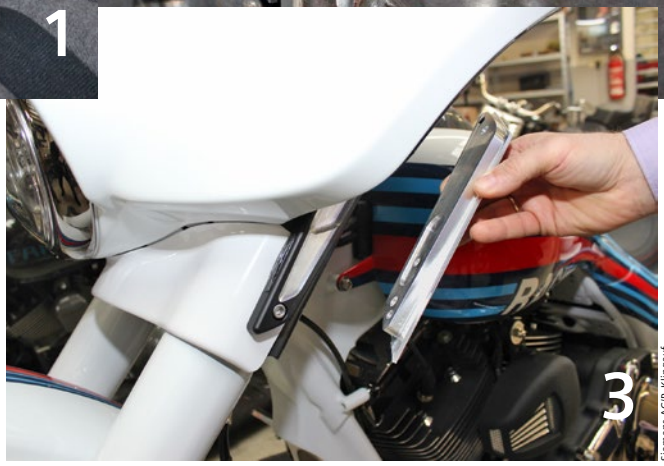
Kodlin Motorcycle customizes motorcycles based on bikes from the legendary American brand Harley-Davidson. Sophisticated technology and an easy-to-use control system are essential – which is why the company opted for the Sinumerik 828D.

There is no denying it: the Kodlin family has motorcycles in its blood. Master blacksmith Fred Kodlin gave his son Len his first motocross bike for his fifth birthday. There was never really any question about what Len would do when he grew up. Today the father-and-son team runs the Fred Kodlin Motorcycle workshop, founded by Fred Kodlin back in 1984, in the small town of Borken in the German state of Hessen.

The company is highly specialized: together, father, son, and 10 employees customize Harley-Davidson motorcycles. Up to 50 motorcycles leave the shopfloor each year, to the great excitement of their new owners. Many customers simply want to have their series-produced bikes adjusted to suit them better, or to look more individual. Other customers come to the company looking for bigger modifications, such as the installation of a big front wheel, which has a very striking effect and is popular among Harley-Davidson fans.

The most passionate bikers, however, want their bikes to be completely personalized. “These unique bikes cannot be beaten in terms of exclusivity. When it comes to design and technology, we make the virtually impossible possible,” explains junior manager Len Kodlin. In some of these models, the only thing that’s left is the engine, with its unmistakable Harley-Davidson sound: the rest of the bike is made up of components that have been developed and





1 Len Kodlin creates the CNC programs for many self-designed components at an external CAD/CAM workstation: here's a decorative part made of aluminum

2 The part is then machined using the PreMill VL 1000 CNC machining center from MMD Werkzeugmaschinen, with Sinumerik 828D. A 10-kW milling spindle enables the quick and precise machining of components

3 The milled decorative aluminum elements give Kodlin bikes that individual touch

produced entirely by Kodlin. Customers' budgets are the only thing limiting their imagination: Enthusiasts pay up to €120,000 for the unique cycles. And then, of course, there are also the technical approval restrictions (TÜV, and so on).

Avoiding imitations

When it comes to realizing a customer's dream of owning a personalized motorcycle, the customizers at Kodlin Motorcycle not only adapt parts, they also manufacture many individual parts themselves. Various styles of footboards, footpegs, turn-signal trim, air filters, engine covers, hand grips, and mirror brackets are manufactured individually or in very small series. Outsourcing production could be cheaper in many cases, but for Kodlin this is not an option. Len Kodlin explains the reasoning behind the decision: "Unique pieces are the basis of our whole company. The risk of copies appearing is simply too great. Our customers pay for something unique, and that's what we give them. This is why we do everything ourselves, from sheet-metal work and welding to milling, turning, painting, and assembly."

Kodlin has an extremely large range of manufacturing capabilities to prevent imitations and rival products, thus safeguarding its competitive edge. The company invests heavily in production expertise and machinery. Kodlin even has a world manufacturer identifier. This official authorization signals that Kodlin is officially a manufacturer that can build and approve motorcycles.

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An integrated process from the design to the machine

Anyone who wants to survive the competition as a small, independent customizer needs top-quality machinery. That's why the core of Kodlin's production process is a PreMill VL 1000 CNC machining center from MMD Werkzeugmaschinen with a Sinumerik 828D control system. Len Kodlin, a trained precision mechanic himself, explains what matters to him and his father: "MMD was extremely cooperative and, with the PreMill VL 1000, gave us a machine that meets our needs perfectly. The price/performance ratio was good, and with the Sinumerik 828D – including the Sinumerik Operate user interface – our core requirement, namely ease of operation, was met to our utmost satisfaction."

The demands on machine tool and control system are high and diverse. Many simple parts are programmed directly on the machine. For this type of machining, it is important for the shopfloor programming to be as simple as it is reliable and efficient. Jan Rosenkranz, a mechanic on the Kodlin team, gets straight to the point: "ShopMill's menu-based navigation makes everything really quick and easy." He also praises the convenient setup functions.

The production of custom parts, which often involve extremely complex contouring, is entirely different. The junior manager creates the programs for these separately at an external CAD/CAM workstation and then transfers them to the machine using a USB stick. This means that the machine can remain in operation while the junior manager can design parts for his spectacular creations far away from production noise, in peace and quiet. Once the blank is in place, the entire machining process itself goes very quickly. With the help of various Sinumerik cycles, workpiece and tool are set up quickly and machining on the PreMill VL 1000 can begin.

Len Kodlin specifically mentions the clearly organized folder structure in Sinumerik Operate, which is designed in a similar way to that found on a traditional PC. Meaningful names – such as "Handlebar1-Customer3" – with up to 28 characters can be assigned to the programs. This improves the ability to maintain an overview, and products that have already been made can be clearly identified and accessed again at a later date.

The entire production spectrum covered

In terms of production technology, the PreMill VL 1000 offers everything needed for bike parts. The machine gets extra points for its framework construction, which makes it very stable and easily accessible. The majority of the components are less than 500 mm long. However, there are exceptions, such as long fork tubes. With travel paths of X = 1020 mm, Y = 510 mm, and Z = 560 mm, and a 1200 x 500 mm clamping table, the machine comprehensively covers the spectrum. The 10-kW milling spindle provides the power needed to quickly and precisely machine the parts, which are usually made of aluminum or steel. The changer can be equipped with up to 30 tools, and the linear guides on all three axes ensure utmost precision. According to Jens Bubenheim, a sales consultant at MMD, the PreMill VL 1000 achieves a repeat accuracy of ± 3 µm and a positioning accuracy of ± 5 µm, which means that the desired quality is always guaranteed.

Siemens AG/P. Klingauf

»Our core requirement, namely ease of operation using the Sinumerik 828D and the Sinumerik Operate user interface, was met to our utmost satisfaction.«

Len Kodlin (on the right), co-owner of Kodlin Motorcycle

A special feature on the Sinumerik 828D scores additional points for high quality: the Sinumerik MDynamics technology package with integrated Advanced Surface motion control. The program sequence can be set or adjusted at any time, ensuring that the machine generates an optimal ratio of speed, accuracy, and surface quality. Take the turn signal trim, for example: In this case, production accuracy is of less significance. Corresponding settings in MDynamics and the activated Advanced Surface therefore ensure that the machine works with a focus on both surface quality and speed of production. ■

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VDW Nachwuchsstiftung

Training on modern equipment:
one of the aims of VDW Nachwuchsstiftung

Pioneering modern training methods

The way that we work, develop products, and operate machine tools is going to change dramatically over the coming years. The focus will be on integrated, digitalized production processes. But what does this mean for education and training in machine tool manufacturing?

Machine tools are powerful and complex machines that place a number of demands on the operator. Only those who have received sufficient education and training are able to program and operate the machines in such a way that they achieve the highest possible accuracy and productivity. However, extensive training is not enough. New machines, improved PLCs, and changes to production processes mean that operators are continually faced with the challenge of expanding their knowledge and skills – more or less throughout their entire career.

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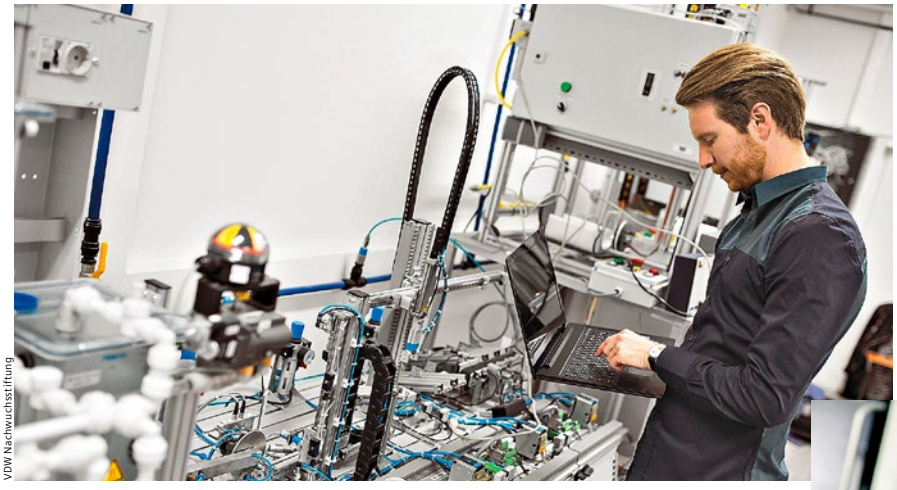

VDW Nachwuchsstiftung

Modern online learning platforms support training within companies …

VDW Nachwuchsstiftung

… and also training on the machines

Digitalization of production processes is like a new, gigantic wave of innovation washing over companies. Many experts believe that digitalization will change production processes as much as the changeover from manual workbenches to CNC machines. Education and training in schools and within companies must be prepared for this and that is not yet the case.

Training must always be future-oriented

People who are learning to use machine tools today should be trained in such a way that they can operate modern machines, work with the latest auxiliary equipment, and are familiar with the production processes that are going to be used in the industry over the coming years. But the situation in companies' training workshops and in vocational schools is quite different. The machines are typically older types, and communication – for example about workpiece data, orders, and information about the process – is primarily done on paper. Even the training itself takes the traditional form: a lot of mechanical tools, calipers, paper textbooks, and other outdated tools and methods are still being used.

We seldom see training workshops using tablets or Internet-based learning and support platforms, exchanging data electronically, or teaching the complete product lifecycles – from CAD design and the developer workstation – to the issue and modification of CAM data and the correct digital integration into the control system. New, digitalized processes are also changing employees' job descriptions: IT skills as well as confident handling of mobile devices, data, and software applications, are now considerably more in demand than in the past.

And all of the things that apply to the training of young people also apply to continuing and advanced training. Even those who have been working successfully on a machine tool for years will have many new things to learn – simply because they will soon have to work in a different way. The first few companies and vocational schools have recognized the challenges and are starting to make changes.

Companies are driving changes in training

The German system serves as a role model for many countries and companies around the world when it comes to training in technology and production-related professions. Depending on the profession, trainees receive training over two to three years, alternating in a carefully coordinated system between company training workshops and vocational schools. It is now even possible to study while working, in order to further strengthen the links between theory and practice. Nevertheless, even in Germany, making the required shifts in education and training toward digitalization is proving to be difficult. Now companies in machine and machine tool manufacturing are taking the initiative themselves, and have launched their own foundation for up-and-coming talent. We spoke to the foundation's director, Peter Bole.

Making changes in education


Olaf Hermann

»The entire German mechanical engineering sector is undergoing a radical change; the speed of innovation is increasing. Networking and digitalization are going to dramatically alter work in manufacturing firms.«

Peter Bole,
Director of VDW-Nachwuchsstiftung

Mr. Bole, you are considered a pioneer in training for the German machine tool industry, and were one of the key players in the founding of VDW Nachwuchsstiftung in 2009. What were your reasons behind this? What is it that drives you?
Training has always been close to my heart, and I spent a large part of my career as head of training at Gildemeister. While I was in that role, I saw major shortcomings throughout the industry. Back at the start of the 2000s, some places – both vocational schools and many companies – were still training using ancient machines and completely outdated content. The trainers were still teaching what they had learned themselves. There was an enormous backlog in investment in the machine park. There was no consistent training on computers and CNC machines. The result was that trainees were being prepared for machines, activities, and processes that companies would soon stop using in the future. The training was not meeting needs – to the detriment of both companies and the trainees. It was time to launch some improvements.

And your solution was VDW Nachwuchsstiftung. What is it, and what does it do?
It quickly became clear to me that if training in companies was going to be permanently and sustainably modernized, we would need an institutional framework, an organization to push the improvements at as many companies and schools as possible. We cannot wait on politicians and ministries. And so the idea of a foundation to foster new talent arose. German machine tool manufacturers organized themselves into the German Machine Tool Builders' Association (VDW) some years ago. The foundation is funded by the VDW and actively supported by large member firms like Siemens. The focus is on modernizing training, providing continuing education and consulting for trainees at schools and companies, and making up-to-date materials and content available to them for their work.

Mr. Bole, VDW Nachwuchsstiftung is now going to be expanded. What are the reasons for this, and what will the expansion look like in concrete terms?
We realized that digitalization is throwing even bigger challenges at us. We need more impetus and speed if we want to align training with new procedures and machines in companies. As a result, VDW Nachwuchsstiftung will become VDMA Nachwuchsstiftung this year. It means that we will be able to speak and work on behalf of the 3,200 companies that are members of the VDMA (the Mechanical Engineering Industry Association), one of the biggest and most important industry associations in Germany. This will expand our opportunities and influence training even more.

What challenges do you hope to master with the new structure?
We have achieved a lot in just a few years, and of course I am very proud of that. But achieving exactly what we need in the field of training is very much a moving target. The entire German mechanical engineering sector is undergoing a radical change; the speed of innovation is increasing. Networking and digitalization are going to dramatically alter work in manufacturing firms. A growing number of companies are now recognizing this change, and they are driving modernization and digitalization. However, this mentality has not yet reached their training.

Little help can be expected from politics, because schools have many other problems to solve, and money is tight – hypothetically or in reality. The machine and machine tool manufacturing sector has to pull itself up by its own bootstraps and step up its efforts – otherwise the already small number of graduates in the STEM subjects (science, technology, engineering, and mathematics) will simply go to software and IT firms. Our industry must also specifically target school graduates with digital skills because the networking and digitalization of machines, plants, and production processes offer challenging and interesting activities. Trainers need to talk more to planners about teaching content: What will production look like in 5 to 10 years? What skills will be needed? Training must be adapted to suit future requirements as quickly as possible – and I am glad that we are now in a better position to tackle this major task.

To what extent can this model serve as an example to other countries and regions?
Well, training in mechanical engineering is organized extremely differently in different parts of the world. I would not really want to speak for other regions. But one thing is for sure: Companies all over the world will have to push for solutions in order to ensure that digitalization and new production processes find their way swiftly into teaching content. Without well-trained, future-ready specialists on the machines, the benefits and potential efficiency of new production processes will not be able to be leveraged – wherever in the world this may be. ■

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End-to-end digital manufacturing

Within the scope of a training partnership with Siemens, the Environmental Campus Birkenfeld is educating future engineers in manufacturing with machine tools – both in theory and in practice.

NC programmers with workshop shopfloor experience know the problem well: Many components are designed in a CAD system without considering the specifications or limitations of production machinery. This results in quality defects, higher costs, and time-consuming reworking. Prospective engineers at Trier University of Applied Sciences in Germany are taught the limits of what is feasible and learn to make allowance for these limits in the design process. They have to actually manufacture their designs in collaboration with experienced shopfloor managers and technicians. To facilitate this, the university provides them with top-quality production facilities, from a 3D printer to a complete machining center.

Certificate for successfully completing CNC training

The students can learn NC programming thanks to a training partnership that Dean Dr. Ing. Peter Gutheil arranged with Siemens. His students have Sinutrain licenses that allow them to illustrate the Sinumerik CNC 840D sl user interface on their PCs.

Instructor Stefan Hirsch explains just how well this works: "The visual structure of Sinutrain on the PC is virtually identical to how it looks on the control terminal. The only difference is that commands are triggered using a mouse and keyboard rather than the soft-touch push buttons of the control panel." The students receive a certificate for their successful completion of CNC training from Hirsch and shopfloor manager Christian Seibert. To prepare themselves to teach, both completed the "train the trainer" sessions at Siemens' Technical User Center in Erlangen, Germany.

Learning shopfloor programming on a PC

Students are introduced to programming with programGuide – a classic G-code language. Hirsch

The students are able to display the Sinumerik CNC 840D sl user interface on a PC …

Siemens AG/P. Klingauf

explains: "My students have to learn how an NC works and how it passes on commands to the machine tool. Once they've learned that, I can show them how to make their work easier with the ShopTurn and ShopMill graphical step sequence programming. The young men and women are delighted every time we get to the right NC program twice or three times as fast."

The programs are checked in a Sinutrain simulation, and the students have to iron out any errors. If the program runs smoothly in the virtual environment, it can be input into the real machine center – step by step.

A consistent, end-to-end digital manufacturing process

The students also learn how to develop complex assemblies on CAD/CAM systems. In order to offer them sufficient capacity during examination periods, the Environmental Campus provides a total of 507 "floating" licenses for the high-end Siemens NX CAD/CAM system. This pays off for internships as well, as Gutheil explains: "For one thing, the spread of NX is enormous. Numerous partner companies where our students do practical semesters or write their bachelor's thesis work with it, and are delighted that we teach CAD/CAM on the same system."

Virtual depiction of the machining center

One of Siemens NX's major strengths is its unique production simulation. Machining is depicted realistically on the screen thanks to the integrated virtual NC kernel (VNCK). This rapid simulation teaches the engineers to calculate the manufacturing time in order to make calculating costs and drafting quotes easier for employers at a later date. One prerequisite is that the machining center used on the shopfloor is stored as a virtual machine in the CAM system. This means that the simulation and actual manufacturing sequence are virtually identical, and the machine space and user terminal for the respective machine are realistically depicted. Created programs can be transferred to the actual machine, which can be equipped with tools and blanks – input becomes superfluous.

Many manufacturers provide virtual machine images for Siemens NX. If one is not available, it can be generated in Siemens NX. Student Frederick Thull from the Environmental Campus Birkenfeld did just that as part of an outstanding bachelor's thesis on the Spinner TC 600 (with Sinumerik 840D sl) turning center on the shopfloor. This virtual map of the modern turning machine is now available to all students for three-dimensional 1:1 simulation of their component programs. ■

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Education and training

Digitalization requires training

Digitalization is changing work environments and job descriptions. But with the Siemens CNC training package, trainees and students can prepare for the future requirements of their profession in a targeted way.

The training package is tailored to suit the needs of vocational schools and universities. It includes the Sinutrain controller-identical software and can be used as an offline programming station, and an NX Academic Bundle (CAD and CAM module). A virtual machine completes the package.

Find out more about the training package in the new video:

↗ **bit.ly/2n5U2P0**

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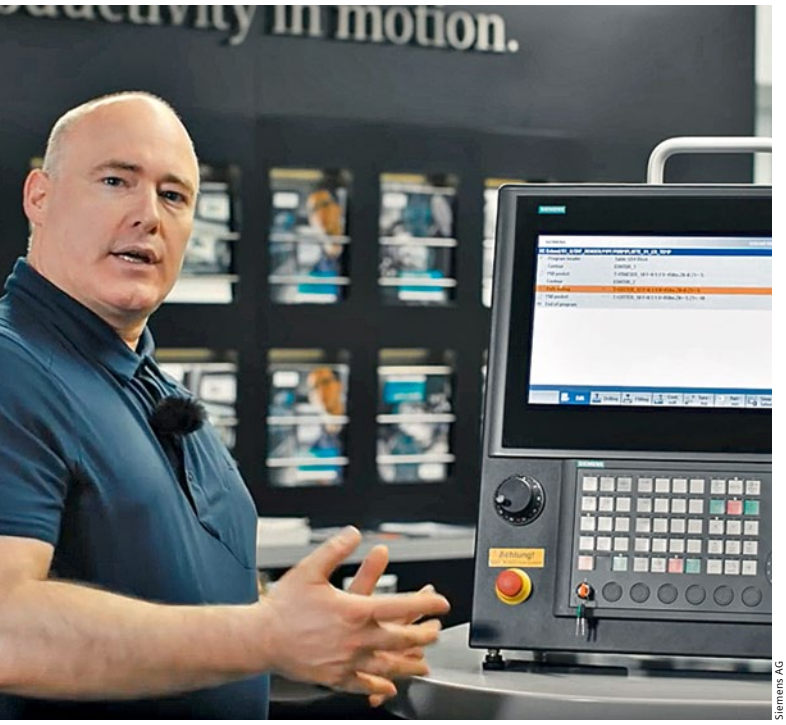
Applications engineering made easy



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In the new video series "Sinumerik live," we explain applications engineering to you in a way that is clear and easy to understand. A mixture of theory and practical examples introduces you to a productive and correct use of Sinumerik control functions. We start with the topic

"DXF application: The faster route from the drawing to the workpiece – opportunities and limits."

What is DXF? What are DXF readers used for, and how do they work?

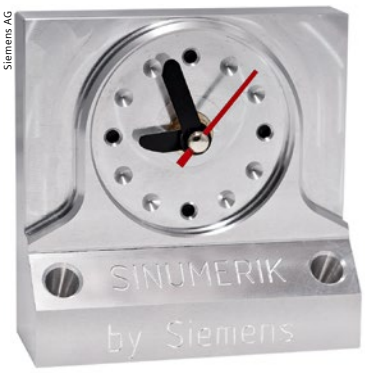
Find out how to get a working view of a three-dimensional solid object, input generated data directly into Sinumerik, and select individual contours for milling. Click here for the video:

↗ **bit.ly/2mB1rb0**

You can, of course, also find the video among our videos and tutorials at siemens.com/cnc4you:

↗ **sie.ag/2lXFX44**

New workpieces



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Our collection of CNC workpieces to reproduce is growing. New additions include chess pieces and a table clock with an integrated pencil holder.

Want to get started right away? You'll find all the templates, including manufacturing instructions, at siemens.com/cnc4you → CNC workpieces.

↗ **sie.ag/2plX2ad**


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News

Posters: cycles and NC commands

See the most important Sinumerik cycles and NC commands at a glance with our new poster series. The commands are briefly explained using simple drawings. There are extra posters on cycles, measuring, five-axis machining, and the basics available as pdfs. An overview of functions as wallpaper is also available for download. You will find the files on the CNC4you portal among the CNC downloads under "Sinumerik documentation":

↗ **sie.ag/2mFieKo**

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Dates

Moulding Expo	**May 30 – June 6, 2017**	Stuttgart, Germany
EMO	**September 18 – 23, 2017**	Hannover, Germany

You can find an overview of additional trade fair dates and training courses in the Events section of the CNC4you portal.

↗ **sie.ag/1TEVXG6**

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