

**SPECIAL EDITION**  
for the Grinding Symposium 2019

The customer magazine of the  
UNITED GRINDING Group

# Motion

**STATIONS**  
**LECTURES**  
**FUTURE LAB**

New solutions in practical application  
Experts from research and practice report  
Technologies of tomorrow and beyond



## THE WORLD OF GRINDING

Experts in precision machining  
meet at the Grinding Symposium of the  
UNITED GRINDING Group



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Stephan Nell,  
CEO, UNITED GRINDING Group

“THE TECHNOLOGIES OF THE FUTURE WILL ALSO ULTIMATELY BE MEASURED BY HOW MUCH THEY BENEFIT OUR CUSTOMERS.”

DEAR READERS!

It's that time again! Every five years we organize the **Grinding Symposium** in Thun and this year we are holding it for the fourth time. In a total of 13 technology presentations our visitors will have the opportunity to experience all the new hardware and software solutions from our company brands. You can find details in this edition from page 15.

Internationally renowned experts will speak in the second main section of the Symposium, the lectures. They will tackle relevant trend topics on the production industry and explain new **developments and insights** in the grinding machine and manufacturing industry. In this special issue of MOTION we have put together a summary of all the lectures for you, as a reference guide to the Grinding Symposium.

The **Future LAB** will celebrate its premiere at this Symposium. Here we will present innovative technologies developed by our Group and offer you **a look into the future**. But for UNITED GRINDING it is also essential that these solutions offer added value for you, the customer.

With the Grinding Symposium and its events we want to thank you for your loyalty and the confidence which you have placed in us in recent years.

**Stephan Nell**  
CEO, UNITED GRINDING Group

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# A QUESTION OF ADDED VALUE

The latest technologies in precision machining, trends in the manufacturing industry of tomorrow: As if it was under a magnifying glass, the Grinding Symposium shows the spirit of the corporate group: The focus is always on the benefit for the customer

Text: Heinz-Jürgen Köhler

“FOR US IT IS VERY IMPORTANT, that everything we do has added value for the customer.” This is the view of Stephan Nell, CEO of the UNITED GRINDING Group. This focus applies for everything the Group does. Machines, software and automation solutions, Customer Care in all markets as well as digital tools for production control and support – everything is intended to make the Group’s customers more successful. The same thing applies for the Grinding Symposium.

## PRESENTATIONS AND LECTURES

From the world’s largest portfolio of internal cylindrical grinding machines to special machining for robot joints: The latest machine solutions from the company brands can be discovered on the technology stations at the Grinding Symposium. With live demonstrations and expert lectures, the UNITED GRINDING experts will explain the special applications for which the machines are optimized.

The lectures will cover a wide range of topics. Sometimes it’s about human-machine cooperation, sometimes it’s drawing

a big picture of the manufacturing industry, or it may be describing the tangible optimization potential provided by improved use of coolants. These lectures are given by researchers from internationally renowned institutions like ETH Zurich and RWTH Aachen and by experts from everyday grinding practice.

## INTERNATIONAL EXCHANGE

The technology presentations and lectures can be found in the program brochure for the Grinding Symposium. What isn’t in the brochure, but is at least as important, is the exchange between the more than 1500 visitors from all over the world, who with their expertise make the Symposium the world technology conference for precision machining.

Customers from all over the world talk to one another and to experts of the UNITED GRINDING Group: An international exchange, which enables the Group to get to know its customers even better.

For the first time the Grinding Symposium will also offer a glimpse into the production of tomorrow and beyond with FutureLAB (more about this on the next page).

## THE UNITED GRINDING GROUP IN FIGURES:

**69,000**

*Around 69,000 spare & wear parts stocked by the Group*

**500**

*500 km/h acceleration is reached by a high-speed grinding spindle – in just 2.3 seconds*

**40**

*In more than 40 countries the UNITED GRINDING Group has a presence and offers consultation and service*

**700,000,000**

*Around 700 million euros in turnover achieved by the company brands of the UNITED GRINDING Group in 2018*





Photos: Thomas Eugster (2), Aaron M. Conway, Stanislav Krupar

#### **UNITED GRINDING worldwide:**

1. MIKROSA machines are completed at the assembly plant in Leipzig (Germany)
2. The high-bay warehouse in Steffisburg (Switzerland) is one of the starting points for a global production
3. Dr. Michael Gebhardt coordinates customer-specific machine adjustments in Miamisburg (USA)
4. In Kuřim (Czechia) project managers Julia Schäfer and Milan Urban optimize the internal and external logistics processes

# EXPERIENCE INNOVATIONS

Over 250 engineers, technicians and software developers work at the UNITED GRINDING Group on new machine, process and manufacturing solutions for the customers' success. The Group places special emphasis on the long-term development of its leading-edge products and processes. "We seek to ensure a healthy mix of radical new technologies, pioneering new machine concepts and classic product optimizations", explains CTO Christoph Plüss. In the FutureLAB at the Grinding Symposium customers are invited to experience preliminary and new technological developments and discuss them with the Group's experts.

## DIGITAL SOLUTIONS

All machines exhibited at the Symposium are connected live and online in the digital control room of UNITED GRINDING Digital Solutions™. Current machine states can be checked on the PRODUCTION MONITOR, and upcoming maintenance tasks on the SERVICE MONITOR. At the press of a button a direct and secure data tunnel can be established to the Customer Care team via a SERVICE REQUEST. For service issues direct digital assistance can be provided with the REMOTE SERVICE and the new CONFERENCE CENTER.

The connection of third-party machines to the UNITED GRINDING Digital Solutions™ products can also be experienced in FutureLAB for the first time. In the area of "Condition Monitoring" and "Predictive

## In the FutureLAB, which will also be part of the Grinding Symposium for the first time, visitors are invited to experience and discuss the latest technologies

Maintenance" initial approaches to a digital fingerprint of the main axes will be presented, enabling a quick condition comparison of the machine.

## NEW TECHNOLOGIES

Technological developments of high-performance materials constantly present new challenges for grinding and machining processes. New, complementary technologies such as EDM (Electrical Discharge Machining) or contactless measuring technology have long been among the Group's core competencies.

Cutting-edge laser technology is used for machining super-hard materials. Current research is focused on the new femtosecond laser for "cold" micromaterial machining. With special laser processing optics, the Group is already able to generate focal diameters of less than a micrometer. In future

it will be possible to produce micro components in all possible materials.

## INNOVATIVE CONTROL CONCEPTS

Controlling machines through gestures, speech or looks – this is the vision of the UNITED GRINDING Group. "Our groundbreaking aim is to simplify and standardize the operation of our high-end machines across the Group in future", explains Plüss.

The HMI (Human Machine Interface) will be adapted to the capabilities, needs and key tasks of the operators. Thus a shift worker will only have access to the functionalities that he needs for component production; an experienced service technician will have access to relevant process and diagnostic functionalities.

## ADDITIVE MANUFACTURING

Industrial 3D printing is a future topic which also occupies the UNITED GRINDING Group. Together with IRPD AG the Group provides 3D printing services in plastic and metal for both internal and external customers. "SLM technology (Selective Laser Melting) could become relevant in the future as an important forming process for the production of complex metal components", says Plüss. In combination with its expertise in precision machining and the digital networking of production processes and machines, the Group is developing the value chain from metal powder through to ready to use component – calling it "Powder to Part® / P2P®".

900

*Over 900 years of experience are represented by the Group's brands. JUNG and WALTER will celebrate their 100-year anniversary in 2019*

550

*Around 550 employees in Customer Care support the Group's customers around the world and ensure maximum machine availability with a wide range of services and support*

10

*One in ten employees of the UNITED GRINDING Group works in the field of research & development*





Photos: Thomas Eugster, David Schweizer, Meinrad Schade

#### **Future technologies:**

1. With the tools provided by UNITED GRINDING Digital Solutions™ the Group is working on networked production
2. Subsidiary IRPD in St. Gallen, Switzerland carries out pioneering work in Selective Laser Melting
3. The Group already uses virtual reality applications for visualization at trade fairs, and plans to use them in machine maintenance and repair in the future
4. Ewag AG is world technology leader in the laser micromachining of spiral diamond tools

# FOUR WAYS TO INCREASE EFFICIENCY

Whether a special production technique like that for corrugated board or a revolutionary dressing process: The Group's experts are constantly developing ways to maximize efficiency. Four examples:

## 1. WIREDRESS®

Sintered metal bonded grinding wheels are ideal. They can grind steel, carbide, ceramics and special alloys very efficiently. They are precise, wear-resistant, geometrically extremely stable and dissipate heat well.

But: They are a niche product, because they are very difficult to dress with conventional mechanical technologies. This became the focus of several years of development work by STUDER engineers. Together with researchers from ETH Zurich they developed the WireDress® dressing process, which enables easy dressing of sintered metal grinding wheels.

With the principle of wire-electro-erosion the grinding wheel is dressed contactlessly in the grinding machine. This results in a maximum proportion of grain space and optimum cutting ability. "Using sintered metal grinding wheels and WireDress®, one of our customers works in the µm range 70 percent more effectively and grinds five times faster than with ceramic bonded wheels", says Development Project Manager Michael Klotz. The dressing process is currently available for several STUDER machines, and will soon also be offered as an option for machines from other brands.

## 2. MANUFACTURE OF CORRUGATING ROLLS

Every delivery of products ordered online has them: corrugated cardboard boxes. The manufacture of corrugated board is howev-

## Process integration, minimization of downtimes, optimization of materials: The UNITED GRINDING Group explores four different possibilities for increasing efficiency in production

er not so simple. Paper webs run through meshed corrugated rolls, are shaped and then glued. Traditionally, corrugating rolls are pre-machined first of all, transferred to the hardening shop and then reground using reciprocating grinding. And bear in mind: the rolls are up to 4.5 meters long and 4 tons in weight.

Thanks to the robust design of the MÄGERLE MGC, corrugating rolls can be ground directly in the hardened state without the need for pre-machining. The grinding wheels are continually sharpened with an overhead dresser. "This means that the production time for corrugating rolls can be reduced by a factor of 3 to 4", explains Viktor Ruh, Product Manager at MÄGERLE.

## 3. TWO MACHINING STATIONS

Working efficiently means working more quickly, could be the simple calculation. But at some point machining times simply cannot be reduced any further. "We therefore looked at auxiliary times", explains Head of Process Engineering at SCHAUDT and MIKROSA, Wadim Karassik. The result: Two workheads in one machine. The SCHAUDT CamGrind S and L with integrated robot offer this option. "I thus have two machines in one and a 50 percent higher productivity", says Karassik.

This highly efficient production method is suitable in robotics, for instance, for machining eccentric shafts for robot joints or in the automotive sector for machining modern cam units, which are used in engines with cylinder shut-off.

## 4. INTEGRATED MEASURING SYSTEM

How can I increase the efficiency of the machine with the existing machine features. This was the starting point for the development of IMS (Internal Measuring System) by WALTER. Based on the 3D probe fitted in all WALTER machines, a software program was developed for the integrated measuring system.

The 3D probe measures the tools after the grinding process using adjustable parameters. These are diameter, core diameter and rake angle. On the basis of the preset tolerance range, the measuring system checks the quality of the tools and stops production if the specified tolerance range is deviated from.

IMS allows automated, unmanned production with integrated quality control. "An increase in efficiency of ten percent can be achieved", emphasizes Head of Product Management Martin Hämmerle.

12,500

*Around 12,500 challenges were taken on and solved by the service technicians in Customer Care in 2018*

2500

*Around 2500 employees work for the UNITED GRINDING Group worldwide*

1600

*Over 1600 individually configured machines were sold by the brands in 2018 – that's 1600 solutions for customers' specific machining requirements*

30

*People from over 30 countries work for the UNITED GRINDING Group around the world*





**More efficient production:**

1. Project Manager Michael Klotz and his team developed WireDress® to market readiness
2. MÄGERLE Product Manager Viktor Ruh shows the clamping of the four ton corrugating rolls
3. Two machines in one is the solution offered by Wadim Karassik and Process Technology at SCHAUDT and MIKROSA
4. "Three parameters are enough to control the process", says WALTER Product Manager Martin Hämmerle



*Stephan Nell has been CEO of the  
UNITED GRINDING Group since 2012*

# “INVESTMENT IN A RELATIONSHIP”

How digitalization increases productivity, what the UNITED GRINDING Group promises from the Grinding Symposium and what he himself is most looking forward to during the event – CEO Stephan Nell explains in the interview

Text: Michael Hopp

Photographs: Natalie Bothur

## **What does the UNITED GRINDING Group expect from the Grinding Symposium?**

**Stephan Nell:** Our mission is basically to make our customers more successful. The Grinding Symposium is a key element for this. We want to present our customers with the latest news from our industry and inform them about existing and new technologies which will help them work more efficiently right now. We also want to provide them with relevant information about issues of tomorrow. These don't have to just be directly about grinding. In our lectures we include topics that illuminate general trends and challenges of the future, which also affect our customers outside the world of grinding. Last but not least, we want to enter into an exchange with our customers and find out their views on relevant topics, so that we can continue to offer the right solutions in future

and help our customers become even more successful. If we succeed in doing this, we have achieved our goal.

## **But the Symposium isn't a sales event?**

Definitely not. Most visitors are existing customers, and the Symposium is also a way of saying thank you to them. We endeavor to offer added value and give our customers something back for the trust they have placed in us over the years.

## **This Symposium will include the FutureLAB for the first time. What can visitors expect there?**

We separate this deliberately: The technologies on the technology stations can be ordered and used right now. In the FutureLAB our aim is to provide an insight into topics that will not necessarily be brought to market tomorrow. This is comparable to



an automotive manufacturer who presents a prototype at a trade fair. We show what developments we have coming up in the next few years and hope to get feedback from our customers.

**Studies indicate that the expected increase in productivity due to digitalization has not yet happened in machine manufacturing. How do you perceive this development?**

We can only speak for ourselves here. Naturally productivity is always an important issue for us too. Let me give you an example. We operate a smart factory and the aim here is to increase the Overall Equipment Effectiveness (OEE). Our solution was a visualization tool for our employees, in order to explain the issues at stake. This resulted in a customer solution which will also help our customers increase their productivity by visualizing relevant parameters. I'm talking about the products of our UNITED GRINDING Digital Solutions™.

**In this case this means, more productivity thanks to digitalization.**

For us it is very important that everything we do in the area of digitalization always has added value for the customer. I see many technological solutions at trade fairs and wonder, 'Why are they doing that?' And often I have the feeling that the answer is: 'Because they can, not because customers need it'. We always ask ourselves: 'Are we only doing this because we can, or does it bring real added value?' Do you really want to know the exact temperature of the front left wheel hub of your connected car? Hardly. But you do want to know if it breaks. So the task is to consider how I can achieve an increase in safety or a rise in productivity with the collected data. And if I know I have to do something at a certain point, then I'm on the way to Predictive Maintenance. And



**“FOR US IT IS VERY IMPORTANT THAT EVERYTHING WE DO IN THE AREA OF DIGITALIZATION ALWAYS HAS ADDED VALUE FOR THE CUSTOMERS.”**

if we evaluate and use digitalization and the acquired data intelligently in this way, then digitalization can absolutely contribute to increasing productivity.

**To what extent do new business models emerge as a result of digitalization?**

In principle I can say: We are, and will remain, machine manufacturers. We won't become a software business, others can do that better. I also don't know if you can separate digital and analog quite so easily. We develop intelligent components for machines, that's a combination of digitalization and machine tools. The great thing about machine tools is that without them there would be nothing here in this room – no

tables, no chairs and not even a camera. If, however, as already mentioned, we are able to collect relevant data and evaluate it intelligently and beneficially for the customer, then I could very well imagine new business models emerging from this.

**Does the focus on digitalization sometimes obscure other optimization potential?**

At UNITED GRINDING we separate this. We have employees who focus on digitalization, and entire departments that are occupied with mechanical development. There are always aspects in the grinding process that contribute to increasing our customers' efficiency. The WireDress® dressing technology,

**“WE HELP OUR CUSTOMERS FIND THE BEST SOLUTION FOR THE SPECIFIC REQUIREMENT IN THE RESPECTIVE COUNTRY.”**

## IN CONVERSATION

### STEPHAN NELL

joined STUDER as Head of Sales in 2003. He was a member of the Management Board from 2005 to 2011. Since 2012 he has been CEO of the UNITED GRINDING Group.



for instance, has nothing to do with digitalization and achieves significant efficiency gains. We work intensively on such aspects.

**Automation is viewed differently in a global comparison – in Germany it is associated with the fear of losing jobs, while in China it is seen as a driver of development. How does a global company position itself for this?**

I don't think it's so difficult. Automation in terms of technical solution is the same everywhere. The motivation for buying it is different. In our industry it's always about precision, and automation solutions can make an important contribution here. Of course, the motivation can also be to remedy shortages of skilled labor. This is an issue in the USA, where there is a shortage of thousands of skilled workers in the manufacturing industry, or in Europe, where we have aged societies. The question is, whether automation will ultimately destroy jobs. But there have already been many changes in industrial evolution – and society has always adapted. Therefore I'm not so pessimistic.

**“WE WANT TO GIVE SOMETHING BACK IN RETURN FOR THE TRUST THAT OUR CUSTOMERS HAVE PLACED IN US OVER THE YEARS.”**



**“I THINK THE GOOD THING IS THAT WE CAN NOW THINK AND ACT EVEN MORE ENTREPRENEURIALY.”**

**The UNITED GRINDING Group configures its technology specifically for the individual markets. What does this mean for automation?**

For us it's always about offering customers what they need. And that's not the same the world over. Our mission is: To be international, to be customer-focused, to understand the customer. This doesn't just mean language, but production philosophy. We have customers who manufacture the same parts in different regions of the world – and they do it differently everywhere. We help our customers find the best solution for the specific requirement in the respective country.

**But automation also has the dimension of labor costs. Robots don't get sick, don't take holidays and don't receive a pension. What does automation mean in this respect?**

As we've said, there have already been many changes in industrial evolution. None of these have ever meant that people were no longer needed as workers. These changes have always given rise to new challenges and opportunities.

**At the beginning of 2019 the Group published its business figures for the first time. How would you assess the**

**financial year 2018 and which developments do you expect for 2019?**

2018 was an absolutely record year. We achieved a turnover of around 800 million Swiss francs, that's 700 millions Euros, and had a double-digit return on sales. Also helped by the flourishing world economy, of course. The outlook for 2019 is more difficult, there are many problems all over the world, you only need to read the newspaper: What will happen with Brexit? Which trade barriers will there be in future? And many other questions. These are issues that are difficult to predict and they will lead to uncertainties and thus to a slowdown in demand. We are prepared for this development.

**Since the middle of 2018 the UNITED GRINDING Group has no longer been part of the Körber Group. What impact does this have on customers?**

The change of ownership has no direct influence on the individual company brands or the customers. You can also see that the change was uneventful. There was no change in strategy, the management is the same, the companies are the same. I think the good thing is that we can now think and act even more entrepreneurially.

**Back to the Grinding Symposium. You will be there the whole time. What are you most looking forward to?**

I'm looking forward to the customers most of all. That's what I always enjoy, at trade fairs too: Talking to the customers and hearing what interests them. And also hearing about what we could do better. ◦



# EXPERIENCE NEW TECHNOLOGIES, STATION BY STATION

The latest machines and solutions from the  
UNITED GRINDING Group. At station 11  
visitors can see a world innovation with the  
MÄGERLE MFP 30

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CUSTOMER CARE

# MORE THAN JUST CUSTOMER SERVICE

With Customer Care the UNITED GRINDING Group offers its customers support throughout the entire lifetime of the machine

### THE ADVANTAGES AT A GLANCE

- Increased machine availability
- Increased productivity
- Production monitoring
- Minimization of process times
- Reduction of non-productive times

*Customer Care international: Service technician Charles Yang from Shanghai and his over 550 colleagues support customers in all markets*

CUSTOMER CARE – this is more than the supply of spare parts and the deployment of over 550 qualified employees worldwide. The individual brands of the Group also offer numerous additional services, which ensure machine availability as continuously as possible and increase system availability. In addition to machine overhauls, these services also include retrofittable modules and software tools.

### DIGITAL PROCESS MONITORING

Within the scope of UNITED GRINDING Digital Solutions™ the Group develops Industry 4.0 technologies for the digital acquisition,

visualization and analysis of all machine and process data: The Production Monitor visualizes the machine's productivity and provides basic data for optimizing it, while the Service Monitor ensures that the necessary maintenance measures are performed professionally and on time. Remote Service enables the UNITED GRINDING specialists to access the machine in an emergency, after the user has invited them via a Service Request.

Monitoring of the machine axes and grinding spindles within the interpolation cycle of the control will in future allow indirect monitoring of the machine condition. This enables the swift detection of signifi-





*Handover of the machine to the customer is an important milestone in the customer journey*

cant machine damage and gradual process changes through comparison with historic reference values.

The objective, transparent monitoring of the machine condition also records key performance indicators – including error messages, switching operations and operational performances of axes. Last but not least, the recording of coolant pressure, flow rate and temperature allows final control of the process. The result is reduced grinding times and tool costs as well as fewer component rejects, together with higher component quality and higher productivity.

#### OPTIONAL SOFTWARE MODULES

STUDER enables an extensive functional expansion of its machines with retrofittable modules for its grinding software programs, StuderWIN and StuderTechnology. In addition to StuderDress for efficient (re)profiling of grinding wheels and StuderContour for peel, convex and contour grinding, the optional extension packages include StuderThread thread grinding software and StuderForm noncircular grinding software for simple applications, as well as the highly efficient StuderFormHSM noncircular grinding software for machining curves

and polygons. StuderWIN programming software enables efficient offline programming. StuderTechnology also supports the operator during setup and programming of the machine. The customer achieves good quality at first attempt and a quick, stable process – independently of the operator.

#### PERFORMANCE PACKAGES

With the “FANUC Performance Package” WALTER enables users of the HELITRONIC POWER with an older Fanuc control to easily increase the performance of the control. Machining in HELITRONIC TOOL STUDIO can be accelerated up to fourfold, and non-productive times can be significantly reduced.

#### MACHINE AVAILABILITY

To ensure machine availability, Schaudt Mikrosa GmbH offers an upgrade of mechanical hard disks to the latest compatible hard disk type SSD Sata. Not only are data loss and unplanned machine downtimes prevented by the update, but the PCU and IPC performance is also significantly increased.

#### RETROFIT FOR SPINDLE DRIVES

To increase flexibility and productivity, EWAG has developed a RETROFIT KIT for users of its WS 11 and WS 11-SP grinding machines. The upgrade kit enables modernization of the control and simplified operation of the machines. The KIT includes a control unit for adapting direction of rotation and speed of the workpiece or grinding spindle to the respective grinding task and a freestanding control cabinet, which includes cutting-edge electronics and temperature monitoring.

With the combination of comprehensive, qualified customer service, machine overhauls and retrofittable options, UNITED GRINDING maximizes the machine availability and system productivity of its customers. ◦



Photos: Thomas Eugster, David Schweizer

*With UNITED GRINDING Remote Service the company also offers its customers the opportunity for exchange with service experts*



01

# FOR HIGH-PRECISION TOOLS

The new HELITRONIC POWER 400 and the HELICHECK 3D from WALTER are the ideal combination for the high-end production of tools for the aviation industry



*The WALTER HELITRONIC POWER 400 with wheel changer and "Robot Loader" option*

*The WALTER HELICHECK 3D measures tools with a length of up to 420 millimeters*



**THE ADVANTAGES AT A GLANCE**

- Maximum precision and surface accuracy
- Saving of resources with "First time right"
- Maximum process stability through continuous checking and compensation

**THE PRODUCTION OF MODERN ENGINES** for the aviation industry requires highly precise tools, such as fir tree cutters, for example. For the production of these tools not only are state-of-the-art technologies required but also high-precision measuring methods, to control and qualify the process at

all times. WALTER achieves the necessary precision using a process-optimized production strategy in the HELITRONIC POWER 400 tool grinding machine and process control by the HELICHECK 3D fully automated measuring machine. The HELITRONIC POWER 400 has a wheel changer as well as extended traverse paths, which enable the machining of workpieces with lengths up to 380 millimeters in one clamping. The new machine also has a completely reworked base, which further improves the damping behavior and consequently the precision and surface accuracy.

**OWN SOFTWARE**

With the HELICHECK 3D CNC measuring machine the fir tree cutter is first digitized and a virtual image is created, which can then be saved, further processed, analyzed and measured. With the 3D Tool Analyzer,

a software program specially developed by WALTER for this purpose, horizontal, vertical and freely selectable sectional planes can then be taken through the 3D model at any position. These are analyzed and evaluated fully automatically. The digitized image is also compared or "matched" with the ideal model of the tool. WALTER has also developed its own software for this, called 3D Matcher. This instantly provides the operator with a statement about the quality of the product and deviations from the target value. The operator can then regulate the process on this basis if required.

At the Grinding Symposium WALTER will demonstrate the combination of high-end grinding process and quality control in a self-contained system.

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*Depending on the robot loader version, loading on up to seven pallet levels is possible with the HELTRONIC POWER 400 and HELTRONIC POWER DIAMOND 400*



02

# PRODUCTION OF MODERN PCD TOOLS

In order to produce PCD tools efficiently, several process steps are necessary. With the HELTRONIC POWER DIAMOND 400 WALTER offers a hybrid process combining grinding and eroding for this purpose

## THE ADVANTAGES AT A GLANCE

- Eroding and grinding on one machine
- State-of-the-art technologies
- Easy programming of complex geometries with HELTRONIC TOOL STUDIO Eroding
- Highest degree of flexibility and automation
- Multi-use robot cell undertakes important functions during non-productive time
- High-quality laser marking



THE USE OF COMPLEX, MODERN full-head PCD tools is steadily increasing. The demand for combined grinding and eroding is in turn also increasing. This development is already apparent today in the new types of PCD tools which are required for machining fiber reinforced plastics (FRP) in the aerospace industry, for example.

Combination machining, where the carbide is ground first of all and then the PCD cutting edge is eroded, is the only method for producing such PCD tools efficiently.

WALTER offers such combination machining with the "two-in-one concept" of the HELTRONIC POWER DIAMOND 400. Advantage: Users of the grinding and eroding machine can perform all necessary machining steps on the tool using the same machine. Time-consuming reclamping of the tool is eliminated.

This method of machining modern PCD tools, in which the carbide blank is already provided with the soldered PCD head, is especially cost-effective.

## NEW OPERATING CONCEPT

After machining, the quality of the PCD tool is checked and confirmed on the HELICHECK PLUS measuring machine – this is done fully automatically by a robot. The measuring machine's new robot cell first of all cleans the finished tools fully automatically, before loading them into the HELICHECK PLUS for measurement of all key parameters.

The new "Metrology Center" operating concept of the measuring machine ensures easy operation. After measurement the tools can be individually labeled with the integrated laser marking system. This provides a particularly high quality annealing marking, in which color change and not engraving forms the distinctive feature.

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03

# VERSATILE FOR INDEXABLE INSERTS

The COMPACT LINE and PROFILE LINE from EWAG are two innovative grinding machines for high-precision machining of cutting inserts as well as highly complex interchangeable grinding inserts

## THE ADVANTAGES AT A GLANCE

- Grinding of highly complex geometries
- Gain in precision and productivity
- Maximum reliability, availability and ease of use
- Minimized non-productive times

THE HIGH-PRECISION, FLEXIBLE 6-axis COMPACT LINE machining center is specially designed for grinding a variety of cutting inserts made from carbide, Cermet, ceramic, PCB and PCD. The machine combines high-performance technology in the smallest space. The optional sixth axis enables efficient peripheral grinding. The optimized kinematics of the

machine and the newly developed peripheral C-axis allows the application of protective chamfers on the main cutting edges of the indexable inserts. Short traverse paths and the integration of a Fanuc robot minimize non-productive times.

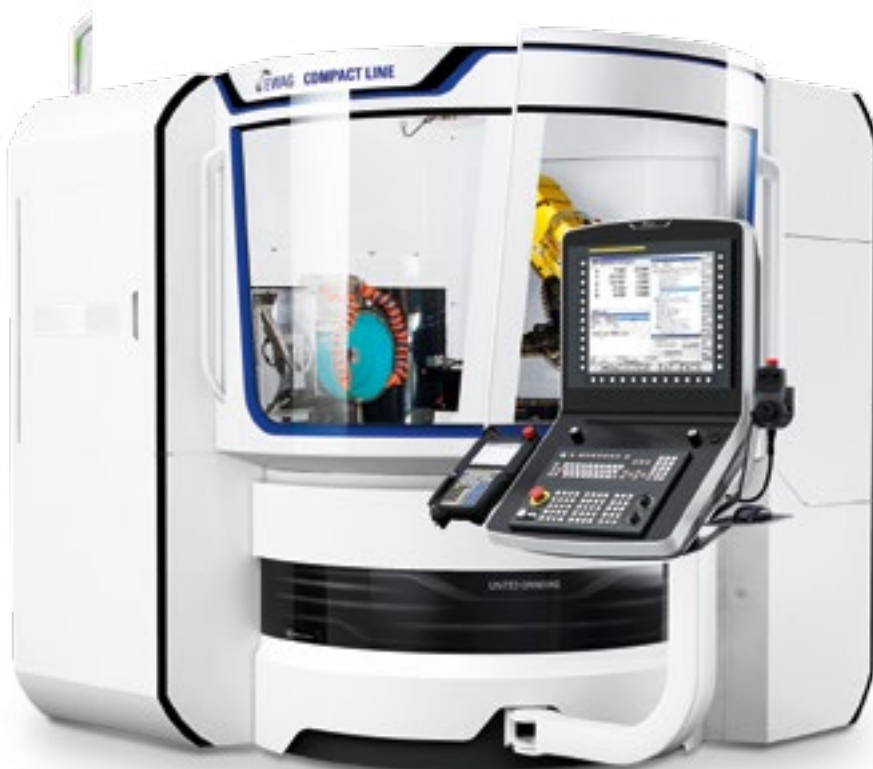
The agile 6-axis robot offers an extremely high level of flexibility for the autonomous loading of complex cutting inserts. Perfect concentricity of the grinding wheel and a high process repeatability precision are guaranteed by the "three-in-one" dressing unit for dressing, regeneration and crush dressing of the grinding wheels. The Fanuc control unit and user-oriented ProGrind grinding software also complement each other perfectly. All grinding programs can be programmed quickly and easily with the user-friendly touch screen panel.

## INTEGRATED WHEEL CHANGER

The new PROFILE LINE is designed for efficient and flexible machining of exchangeable carbide cutting inserts. Manufactured in cooperation with sister company WALTER and finished with the tooling and software expertise of EWAG, this union has produced a highly efficient grinding center for grinding highly complex geometries including the interface, setting a new benchmark. An integrated 6-position wheel changer with integrated coolant supply ensures optimal tool selection and thus guarantees the best possible metal removal rate for the sintered blanks.

The integrated 6-axis Fanuc robot allows autonomous multiple-shift operation and the acceptance of customer-specific pallets. Cleaning, reclamping and centering stations are optionally available and are adapted to the customer-specific product portfolio.

Both machines can be equipped with the innovative CCD-HD vision system for autonomous part detection on request.



*The EWAG COMPACT LINE with integrated 6-axis robot*

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#### THE ADVANTAGES AT A GLANCE

- 5 CNC and 3 optical axes for maximum flexibility
- Efficient machining using picosecond technology
- Modern programming from DXF in 2D and 3D



*The EWAG LASER LINE ULTRA uses ultra-short pulse laser technology for gentle machining of all cutting materials*

# 04

## LASER IN TOOL MACHINING

With the LASER LINE ULTRA from EWAG, the smallest spiral and ultra-hard tools can now also be produced

THE LASER LINE ULTRA is the high-end laser machine tool for the manufacture of rotary tools and indexable inserts. In the all-in-one machining concept the complete tool is now manufactured from the blank – including chip breaker and all other optional geometries. All possible materials can be machined. However, the LASER LINE ULTRA is especially suitable for the production of tools made from ultra-hard materials such as CBN, PCD, CVD-D and MCD/ND.

Tools with diameters up to 200 and lengths up to 250 millimeters, with a maximum weight of five kilograms, can be machined. More recently it has also become possible to machine the smallest drilling and milling tools from full-head PCD and carbide with diameters between 0.5 and 3 millimeters.

The control software used is LaserSoft from the EWAG ProGrind software family. A new feature of this software is the programming of center insert geometries directly from DXF in the profile editor – in 2D. Extensive modeling options – for the chip breaker, for example – are also optionally available in 3D.

The Laser Pro3D software program also includes a plugin for the ANSYS Space Claim software for modeling, visualization, simulation and CAM path calculation of the geometry to be lasered.

The software is so easy to use that no laser knowledge is required. The machine operator simply enters the geometries via an input mask and the machine does everything else. For the automation of the LASER LINE ULTRA EWAG offers standard solutions for

HSK63 as well as a triple gripper for both hydraulic chucks and indexable inserts.

#### CONFIGURE IT YOURSELF

At the Grinding Symposium EWAG together with Dutch company Van Frankenhuyzen B.V. will present a study on fully autonomous production, in which the LASER LINE ULTRA can demonstrate all its strengths. The highlight: Visitors can configure the tool themselves at Station 4, have it autonomously produced by the machine and take it home as a souvenir.

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05

# FROM ONE PART TO ANOTHER

Visitors to the Grinding Symposium can experience change-over processes live on the MIKROSA KRONOS S 250

## THE ADVANTAGES AT A GLANCE

- Highest precision
- Highly productive
- Technologically flexible
- Quick change-over
- Easily automated
- Intuitive operation

THE KRONOS S 250 CENTERLESS GRINDING MACHINE combines best grinding qualities with high grinding speeds. But this compact and versatile machine also has a great deal to be proud of in terms of change-over times. Grinding and regulating wheels, dressing tools, work rests and workpiece-dependent automa-

tion components are replaced so quickly that change-over from one batch to another requires only little time. This is ensured partly by a newly developed quick change gripper system for mechanical and vacuum grippers as well as quickly exchangeable and easily adjusted shuttle V-blocks. In addition, many of the necessary settings are made electronically. Short set-up times, high process reliability and repeatable results are thus guaranteed.

## FOR A WIDE RANGE OF PARTS

Thanks to these characteristics, the KRONOS S 250 is suitable for grinding large series as well as smaller batch sizes – ideal for companies with a very wide range of parts. The unique machine concept with two cross-slide systems on the grinding and regulating wheel side is perfect for through and plunge

grinding, but also allows several work operations to be combined on one machine. In addition, the KRONOS S 250 can be equipped with a loading gantry and shuttle or charge and discharge storage belts for cost-effective machining of a large range of parts and different quantities.

At the Grinding Symposium MIKROSA will demonstrate the high flexibility and easy change-over of the KRONOS S 250 using a practical example: Visitors can experience a change-over process live. This comprises the rapid changing of grippers, work rest and shuttle V-blocks, enabling change-over from the individual machining of a large control spool to the quadruple production of small pump pistons.

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*The KRONOS S 250 is not only suitable for mass production, but also for companies with small lot sizes and a wide range of parts*

*The growing robot market is boosting demand for the SCHAUDT ShaftGrind S*



06

# PRODUCTIVE GRINDING OF ECCENTRIC SHAFTS

At the Grinding Symposium SCHAUDT will present its compact and versatile ShaftGrind S cross-slide machine with integrated robot

## THE ADVANTAGES AT A GLANCE

- High machining flexibility
- Low auxiliary process time
- Compact cross-slide machine (installation dimensions: 3000 x 3351 mm)
- Direct-drive workhead for high dynamics and excellent runout characteristics
- Can be automated for highly productive grinding

AUTOMATED WITH A ROBOT, this small cylindrical grinding machine is equipped for highly productive grinding of shaft-type workpieces with a length of up to 650 millimeters. The robot is controlled with the Sinumerik 840D sl machine control, via a specially developed interface. The robot automatically loads and unloads the machine in different center lines during the machining process, ensuring very short non-productive times. The transfer interface is located in the machine, on the side of the shuttle.

But the robot is not just in the machine. With the ShaftGrind S, SCHAUDT also presents grinding of eccentric shafts for robot joints. The shafts, with drilled-through, internal splines, are placed on the clamping mandrel of the ShaftGrind S by the robot. The mandrel's external teeth mesh with the internal teeth of the workpiece and securely clamp the workpiece in the pitch circle diameter of the spline. A tailstock, as is normally used for grinding between centers, is

no longer required. Highly precise grinding results are guaranteed.

## ROBOT MARKET IS GROWING

This accuracy is also ensured by the direct-drive workhead, an optional barrel tailstock mounted on plain bearings and in-process gauging, as well as the thermally stable Granitan® machine bed with its optimal damping characteristics. The machine's productivity can also be further increased with a second grinding position.

"With increasing automation, the market for robots is continually growing. As each robot contains a large number of joints and eccentric shafts, we are seeing a growing demand for grinding machines like our ShaftGrind S", explains Wadim Karassik, Head of Process Engineering at Schaudt Mikrosa GmbH.

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07

# HIGHLY FLEXIBLE PRODUCTION MACHINES

With the compact S11 and the proven S22, STUDER has two high-performance machines for the cylindrical grinding of large and small series

*The S11 is STUDER's smallest production cylindrical grinding machine*



*The S22 is suitable for the mass production of medium-sized workpieces*



**THE ADVANTAGES AT A GLANCE**

- S11 – extremely compact design, high productivity, superior ergonomics, simple automation
- S22 – diverse grinding options
- STUDER-WireDress® – revolutionary dressing technology for CBN/diamond grinding wheels

THANKS TO A LARGE NUMBER OF CONFIGURATION POSSIBILITIES the S22 has a broad range of machining options for the high-capacity production of medium-sized workpieces. Configured appropriately, it is the perfect production machine for cylindrical, form and thread grinding as well as for high speed grinding with peripheral speeds up to 140 m/s and for heavy-duty applications with 160 millimeters wide grinding wheels. The revolutionary STUDER WireDress® dressing technology ensures a further boost in performance on the S22. With this unique patented process for dressing metal-bonded diamond grinding wheels, the wheels can actually be profiled rather than simply conditioned, as was previously the case.

The compact S11 is specially designed for high-production machining of small workpieces with a workpiece weight of maximum three kilograms. On a footprint of less than 1.8 square meters, it has a distance between centers of 200 and a center height of 125 millimeters. Optimal access to the efficient and reliable machine is guaranteed. A grinding wheel with a diameter of 500 millimeters enables exceptional power density. Equipped with appropriate technology options, the S11 can be used for high speed grinding as well as, for example, grinding nozzle bodies on a mandrel.



*Wheelhead on the S22 for high speed grinding*



*The center pressure on the rigid tailstock of the S11 can be set easily and sensitively*

Both machines can be easily automated using an integrated loading/unloading device or loading cells.

At the Grinding Symposium STUDER will demonstrate a peel grinding operation with a following steady rest on the S11, in which a blank will be ground down. The S22 (with WireDress®) will show off its abilities with a threaded spindle, which will be ground from solid exceptionally quickly in one pass.

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08

# INTERNAL CYLINDRICAL GRINDING TO PERFECTION

With its entry-level, universal, production and radius grinding machines, STUDER offers the world's largest portfolio of internal cylindrical grinding machines

## THE ADVANTAGES AT A GLANCE

### STUDER S141

- Positionable swiveling table (-91° – +61°)
- Turret with direct drive and four internal spindles
- Up to 2 external spindles (Ø 250 mm)
- Measuring probe for lengths and diameters
- Software for machining die plates and radius profiles

### STUDER S151

- Two machine lengths (700, 1300 mm)
- Positionable swiveling table (-10° – +15°)
- Turret with direct drive and four internal spindles
- Up to 2 external spindles (Ø 300 mm)
- Up to 2 swivelling dressers with diamond or dressing turbines
- Steady rests for clamping long parts

THE PRODUCT RANGE INCLUDES the S110 and S121 entry-level machines for internal cylindrical grinding of small to medium-sized workpieces, as well as the S122 production machine with numerous applications in the hydraulics and automotive sector. Four machines are available for universal internal cylindrical grinding: S121, S131, S141 (table lengths: 300, 700 and 1300 millimeters) and the S151 (table lengths: 700 and 1300 millimeters). They are ideally suited for internal, face and external grinding of chuck components for the sectors of machine tool, drive element, aerospace and toolmaking industries.

## FOR HARD MATERIALS

Appropriately equipped as radius machines, the S121, S131 and S141 are ideal for grinding complex workpieces made from very hard materials such as carbide, ceramic, titanium and sapphire, but are also suitable for general grinding tasks. Typical products are can dies, hydraulic components and workpieces with several tapers for the watch or medical industries.

At the Grinding Symposium STUDER will present the S151 universal internal cylindrical grinding machine, with a workpiece table length of 700 millimeters, and the S141 radius grinding machine.

The S151 is a typical machine for machining spindles. Faces, external diameters and tapers on the front of the shaft and the inner bore, as well as tapers and polygons, are ground in a single clamping. A measuring probe and the Quick-Set software ensure rapid set-up on the machine and automatic detection of the lengthwise position of the spindles.

On the S141 radius grinding machine STUDER will demonstrate machining of a carbide drawing die. The direct-drive B-axis under the work spindle ensures the highest precision when grinding tapers and radii. It has angular adjustment with X- and Z-axis interpolation, direct measuring system and hydraulic brake as well as a fixed dresser.

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The S141 radius grinding machine for the highest precision in drawing die machining



The S151 is used for machining large spindle and rotor shafts

09

# FROM SIMPLE TO COMPLEX

From the favorit to the S41, STUDER offers reliable and high-quality grinding technology for every application

**THE ADVANTAGES AT A GLANCE**

- Distances between centers of 400, 650, 1000 and 1600 mm possible
- Machine base with integrated coolant tank and temperature control
- Wheelhead swivels automatically on all machines
- High-performance drive spindle

FROM ENTRY-LEVEL TO HIGH-END MACHINE, STUDER'S cylindrical grinding machine portfolio is consistently designed for value, reliability and excellent grinding quality. This applies just as much to the favorit entry-level model as to the high-end S41.

**STUDER FAVORIT**

As with all STUDER cylindrical grinding machines, the proven Granitan® machine bed also ensures the legendary STUDER precision in the favorit. The wheelhead, which can be

automatically positioned every 3°, can take one belt-driven external and internal grinding spindle respectively. This makes the favorit the right machine for easy grinding of the external diameter of a drive or pinion shaft, for example.

**STUDER S41**

The S41 comes with the revolutionary StuderGuide® guideway system as well as high-precision axis drives with linear motors, extremely fast direct drive of the B-axis and a huge selection of wheelhead variants. In addition, TouchControl, WireDress® and special customer-specific configurations are also optionally available for the S41. STUDER offers automation solutions from a single source.

However different the machines may be in respect of their capabilities, they also have much in common. Both machines are equipped with a touch screen and Studer-WIN grinding software, as well as Studer-Pictogramming and StuderTechnology. This means that as soon as a machine operator is familiar with one STUDER machine, he can easily operate any other STUDER machine. And last but not least, one and the same Customer Care team supports all STUDER cylindrical grinding machines.

STUDER will present both machines in action at the Grinding Symposium to demonstrate the broad scope of the STUDER portfolio, which offers the right grinding machine for every application. The favorit entry-level machine will be shown grinding a diameter and a taper, as well as form grinding. The S41 will demonstrate its capabilities with multi-stage machining in a single clamping – from grinding several diameters and tapers through to thread machining and HSG grinding.

*The STUDER favorit offers an exceptional price-performance ratio*



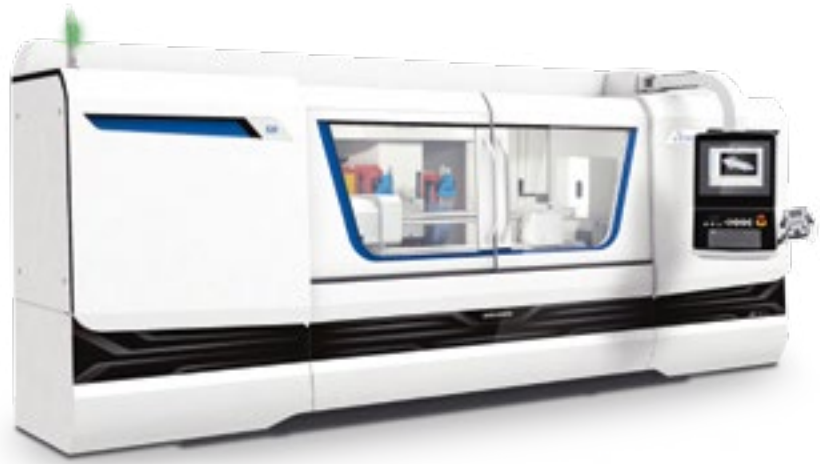
*High-end machine and highly complex grinding system: STUDER S41*

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*The STUDER S33 is designed for grinding short to long workpieces in individual part and series production*



*The STUDER S31 is suitable for toolmaking and aerospace applications*

10

## TWO MACHINES, EACH WITH FOUR DISTANCES BETWEEN CENTERS

STUDER will present the two new universal external cylindrical grinding machines S33 and S31 in Europe for the first time

### THE ADVANTAGES AT A GLANCE

- Distances between centers: 400/650/1000/1600mm
- StuderGuide® guideway systems (S31)
- Thermal stability thanks to innovative base temperature control (CD 650mm to 1600 mm)
- Double T-slot for dressing units
- Numerous wheelhead variants
- StuderWIN programming software with StuderTechnology
- Automatable

**BOTH MACHINES** are based on the STUDER T-slide concept. They have an extended X-axis stroke, now 370 millimeters, enabling additional wheelhead variants. The series have been extended by an additional two center distances. Altogether four distances between centers of 400, 650, 1000 and 1600 millimeters are now available.

The newly designed machine base geometry has been supplemented by an innovative base temperature control, further improving the dynamic and thermal stability of the machines. Thanks to the fixing of the dressing device on the double T-slot of the longitudinal slide, the complexity of setup and resetting in particular, is significantly reduced. The standard control is a Fanuc Oi-TF with the efficient and user-friendly StuderWIN programming software.

StuderTechnology also supports the operator during setup and programming of the machine. The customer receives immediately good quality and a fast, stable process - independent of the operator. The machines can be easily automated for series production thanks to the standardized loader interface.

### S33: AFFORDABLE AND PRODUCTIVE

The STUDER S33 has a new wheelhead which can be equipped with two motor spindles for

external grinding and an internal grinding attachment, in different configurations. Three grinding wheels ensure that the workpiece can be machined even more individually and quickly - complete machining in a class of its own! The machine has a B-axis with an automatic 1° Hirth coupling. The maximum workpiece weight is 150 kilograms.

### S31: PRECISE AND VERSATILE

The machine boasts StuderGuide® guideways and a B-axis with optional direct drive with a resolution of 0.00005°. The wheelhead can take up to three grinding wheels – a combination of external/internal, up to a maximum of two external or internal grinding spindles.

For high-precision form grinding with the Fanuc 31i-B control system, the STUDER S31 features a workhead with direct measuring system and the StuderFormHSM software program.

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11

# COMPACT SOLUTION FOR AIRCRAFT TURBINES

MÄGERLE will introduce the MFP 30 as a world premier at the Symposium. Grinding and milling operations will be presented on an aircraft engine blade

## THE ADVANTAGES AT A GLANCE

- Small space requirement and optimal production flow thanks to it's compact design
- High flexibility and efficient machining
- Precision and long working life thanks to the hydrostatic guideway system

FOR GRINDING COMPLEX GEOMETRIES, particularly those of vanes and blades or heat shields of aircraft turbines, the new, compact 5-axis grinding center MFP 30 from MÄGERLE is ideal. Its compact and space-saving design allows optimal use of the available production area and enables an effective production flow.

In addition, its compact design benefits ergonomic work area loading – either manually or automatically. The integrated tool changer can be equipped with different grinding wheels and tools for milling and drilling operations, as well as a measuring probe for quality or workpiece position checks. This guarantees a high degree of flexibility in workpiece machining.

## HIGH REMOVAL RATES

The MFP 30's powerful spindle drive allows the combination of different grinding processes – such as creep feed grinding with corundum and CBN. In addition, the high-performance spindle with speeds up to 12,000 rpm offers optimal machining conditions for carrying out demanding grinding and milling operations in a single clamping.

Full power and high torque are available even at low spindle speeds. Robust tool holders guarantee wide machining contours with high material removal rates. Either emulsion or oil are available as coolant.

Thanks to the integrated grinding wheel cleaning, the grinding wheel remains clean and sharp for longer during the grinding process. This significantly increases removal rates and at the same time reduces grinding wheel wear. The large table dressing unit enables the mounting of a wide variety of diamond roll profiles and helps significantly minimize changeover times. The modern drive technology enables reliable dressing across the entire speed range.

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*Top performance in a compact space is offered by the world innovation MÄGERLE MFP 30*

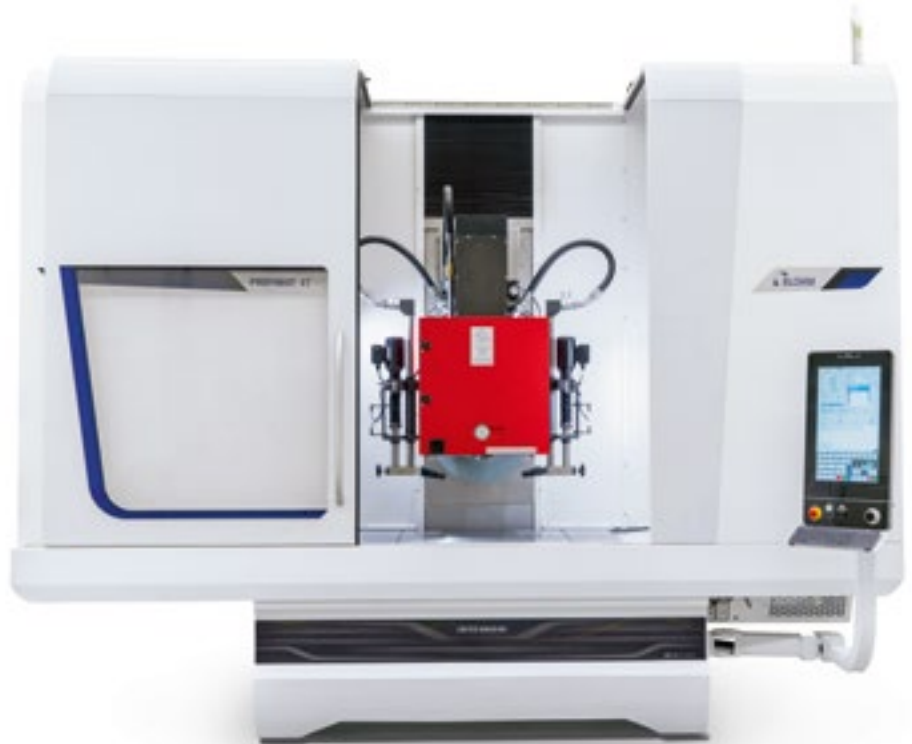
## 12

# SELECTION OF THE IDEAL PROCESS

The new PROFIMAT XT combines four grinding technologies. BLOHM reworked many machine components and improved the stiffness and dynamics of the new machine

## THE ADVANTAGES AT A GLANCE

- Gentle processing of temperature-sensitive materials thanks to small infeeds and high feed rates
- No peripheral zone damage
- Positive residual compressive stresses
- Lower tool costs due to reduced grinding wheel wear
- Shorter productive and non-productive times



**THE BIGGEST INNOVATION** and the prerequisite for speed stroke grinding is the linear drive in the X-axis which, with up to 200 percent more dynamic axis acceleration and up to 160 percent higher axis speed, ensures a significant increase in the dynamics. The better running behavior of the linear direct drive in comparison to classic drive trains comprising motor and recirculating ball screw drive also lead to improved surface finish values on the workpiece.

## SELECTION OF THE OPTIMAL STRATEGY

BLOHM has also integrated well-proven components into the machine, such as an overhead dressing attachment for CD grinding and a table dresser. The automatic coolant nozzle trace system and a large sheet metal enclosure for coolant quantities up to 500 l/min were an essential addition for creep feed grinding. The customer can choose the optimal machining strategy for his purposes:

- CD grinding achieves high productivity through continuous grinding wheel dressing.
- Reciprocating grinding enables high accuracies for flatness and surface quality.
- Creep feed grinding enhances productivity by increasing the individual infeed.
- In speed stroke grinding high dynamics and high feed rates lead to high productivity combined with gentle workpiece processing.

Which process is the right one depends on many different factors: In addition to workpiece material and size, it is also necessary to take account of the lot size and the required work result – for example the quality of the machined workpiece in respect of roughness and flatness.

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*The BLOHM PROFIMAT XT features a multi-touch screen for simple operation*





*The J600 enables measurement and dressing within the grinding process*

13

# HIGH-PRECISION GRINDING OF STANDARD COMPONENTS

In the second generation of the JUNG J600 a comprehensive technology package ensures constant production conditions and improves precision, especially with long machining times

**THE ADVANTAGES AT A GLANCE**

- “Cloning” of master part onto series parts
- No unclamping of parts thanks to in-process gauging
- Maximum process reliability and quality
- Improved productivity

HIGH-PRECISION GRINDING of standard components for die and mold applications requires form and position tolerances of +/- 2 µm. The grinding machine must fulfil special requirements in respect of positioning accuracy, form accuracy and geometric accuracy.

The second-generation J600 not only provides the requisite basic mechanical accuracy. Through active temperature control

of crucial machine elements, it also guarantees the necessary temperature stability. In addition it is completely enclosed, in order to eliminate environmental influences, increase operational safety and minimize coolant emissions. As the encapsulation prevents visual and acoustic contact with workpiece and grinding wheel, JUNG has integrated an acoustic sensor including software. The sensor detects contact between workpiece and grinding wheel, and the software visualizes it on the machine control. A further advantage: The software also enables monitoring and optimization of the dressing process.

**MASTER AND CLONE**

At the Grinding Symposium JUNG will demonstrate the strengths of the J600 using “clone” grinding of the lateral surfaces of fine centerings, which are clamped as a set. As during the dual-sided face grinding process only the wheel edges cut and are

therefore subject to higher wear, in-process gauging and dressing are especially important.

The integrated measuring probe of the J600 records the position and width of the fine centerings during the process and compares the values with those of a “master”. This “cloning” of the master onto the prepared series workpieces significantly reduces environmental influences and position inaccuracies of the clamped workpiece. In addition, unclamping of the parts is not required. The dressing process uses relief dressing with PK-130 in conjunction with acoustic dressing.

Process reliability, component quality and productivity increase as a result. Automated grinding of high-precision standard components under production conditions therefore presents no problem for the J600.

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# ALL LECTURES AT A GLANCE

Experts from science and practice  
talk about trends and efficient  
manufacturing methods

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Wednesday, 8th May 2019, 2:00 pm

# DR. DAVID BOSSHART

Dr. David Bosshart is CEO of the Gottlieb Duttweiler Institute for Economic and Social Studies. Holding a PhD in philosophy, his areas of expertise are the future of consumption, social change, digitalization and especially the relationship between humans and machines



Illustration: Uli Knörzer

## Human and machine – how can we best complement each other?

### Short Summary

Thinking in ecosystems should replace thinking in industries. Digitalization and AI, Cloud and IoT create continuous patterns of change, which affect everyone

Human beings are still one step ahead in the competition with machines. This relates to cognitive and fine motor skills. There is even talk about the comeback of craft

Whether new or established companies take the lead in this process of change remains to be seen. However, the human element is crucial: Good or bad management makes the difference

We are all reliant on how human, artificial and emotional intelligence quotients interact

WE ARE AT THE BEGINNING of a learning process, in which the context is constantly changing. Automation processes are a constant pattern in production, because they make us more efficient and quicker. Digitalization opens up new possibilities thanks to Artificial Intelligence (AI), Cloud, IoT and Blockchain. If we look at the history of robots, from the beginnings, Kuka, Baxter and Pepper to the current hype about voice computers like Alexa, we can see that machines are becoming more and more like humans.

It's true: In many areas machines have already overtaken us in unimaginable ways. Last summer I attended a concert in Colorado, which was performed by AI robots. So instead of just creating standardization and better quality industrial products, we can now progress to art: An artwork created by artificial intelligence was sold at Sotheby's last year for 432,500 dollars. Who is the author here? Who should receive the selling price? Who is the legal subject behind the artwork? For every answer we get, there are ten new questions.

### MORAL CHALLENGE

In the last thirty years, with the shift in the industrial world, the pressure on production and even more on productivity has constantly increased. We have tried to make people into machines – high-performance machines. This works up to a certain extent, and can be a very inspiring vision. But we

are reaching the limits: People are involved in relationships, have headaches and get ill, they become physically weaker and forget appointments as they age. Machines don't have these problems. It is no coincidence that we are starting to make machines into people. If people become machines and machines become people or at least similar to people, distinguishing between them will become a legal, political and moral challenge. But we shouldn't be afraid of this development. Fear is never a good thing. We should have a lot of respect, because we have no experience in dealing with such increasingly intelligent beings. In many skills, humans still have a head start. Machines are not good with context. Machines give immediate

**“MACHINES GIVE IMMEDIATE ANSWERS, BUT THEY DON'T ASK QUESTIONS THAT COULD HELP ME PROGRESS.”**

*David Bosshart*



answers, but they don't ask questions that could help me progress. It is not just a question of cognitive skills; fine motor skills also play an important role, for example. Why do robots have such difficulty developing dexterity? The human hand has always played an important role in innovation and production. The hand is intelligence, and we have not recognized this enough. We talk about the virtuosity of the pianist, by which we mean his or her incredible dexterity. And we are even talking about the "comeback of craft". Robots are a long way from doing this. I see much more of a complementary relationship between humans and machines.

There is a lot of talk about the special threat to jobs in certain industries. I believe that we need to move away from the narrow industry perspective – and learn to think and act in terms of ecosystems. Digitalization and AI, Cloud and IoT create continuous patterns of change, which affect all industries. I also wouldn't talk about a threat. Change generally comes not from inside, but from outside. In the automotive industry a single mad visionary was enough to make an arrogant industry change. The longer you hold back change, the worse it is for the employees concerned.

### REINVENTING JOBS

The dramatization of the huge job losses is a media issue, in reality we haven't seen this yet. Especially not in countries with high-

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ly trained employees, like Switzerland. The USA only dominates in the top technology segment, where the focus is on software. Its problem is that it invests far too little in training and further education.

I suspect that many top jobs will become even more coveted and diverse, and that many mid-level and simple jobs will be reinvented, not because they are endangered, but because in all these jobs there are activities that can be performed more quickly and efficiently with automation. This applies just as much for the lawyer as for the health-care professional or truck driver.

The human-machine interaction will be the result of successful software and hardware innovation. Software will become increasingly important, and probably in ten years' time we won't be talking about ma-

chine manufacturing any more. The potential of Blockchain and IoT in particular will set the framework within which the change takes place. Drivers will be physical and virtual infrastructure issues centered around energy and mobility as well as information and communication technology. Whether these changes are led by companies that are still unknown today, or well-known companies, remains to be seen. Once again, however, the human element is crucial: Good or bad management makes the difference.

### THREEFOLD INTELLIGENCE

In 2019 for the first time my Institute will award the Gottlieb Duttweiler Prize not to a person, but to IBM's artificial intelligence platform, Watson. With this we want to send the message that a good manager or a good specialist is no longer the sole deciding factor, nor even a well integrated team. We are all reliant on how "IQ + KIQ + EQ" interact in the human-machine team, in other words how human intelligence quotient plus artificial intelligence quotient plus emotional intelligence quotient develop constructively together to solve problems, which we can no longer solve alone, or working as specialists in silos.

Wednesday, 8th May 2019, 2:45 pm

# REINER SCHMOHL

Reiner Schmohl is a Certified Engineer in Industrial Electronics and Product Manager at Bosch Connected Devices and Solutions GmbH



## MEMS-based sensor technology for machine and process monitoring – application possibilities and limits

### Short Summary

MEMS sensors, as used in the automotive sector and consumer electronics, offer new possibilities in production monitoring

They enable cost-optimized and Predictive Maintenance

MEMS sensors measure machine vibrations and noises and thus react not only to the machine operating states, but also to additional parameters, for instance the quality of raw materials

Processing of the collected data results in new business models and service offerings for machine manufacturers

BOSCH CONNECTED DEVICES and Solutions GmbH develops and distributes networked sensor technology and supports its customers in the digitalization of their production processes and services. Under the direction of Bosch and with the active participation of the UNITED GRINDING Group, seven partners have been developing the sensor system of the future for machine monitoring in the framework of a research project known as AMELI 4.0. The system is based on the newly developed so-called Intelligent Vibration Analysis Sensor (IVAS).

### HIGH DEMANDS ON SENSORS

Sensors play a key role in Industry 4.0. They are the artificial “sensory organs” of machines and workpieces and record their condition and characteristics. For intelligent control and networking of production, the sensors must collect and process large amounts of data in real time. At the same time they should be as energy efficient as possible and capable of easy integration into complex production systems. Current industrial sensors have their limitations as regards Industry 4.0. They are generally not intelligent or flexible enough, consume too much energy and are too expensive for many applications.

For the AMELI 4.0 research project the researchers use a key technology from the networked world: MEMS sensors (MEMS stands for Micro-Electromechanical System). MEMS sensors are already an indispensable element in the automotive industry and consumer electronics. They are the central

component of the ESP anti-skid system, for example, and they ensure that smartphone screen displays adapt when rotated.

In comparison to current industrial sensors, MEMS sensors are tiny, intelligent, energy-saving and low-priced. However, in the past they were often not robust or powerful enough for demanding industrial environments. For this reason the potential of condition monitoring in production systems remains partially unused. The AMELI 4.0 research team has now further developed MEMS sensors, so that they are also suitable for industrial applications.

### MARKET EXPECTATIONS

The starting point was the increased expectation of machine manufacturers and their customers for better monitoring of machines and processes. Grinding machine users will in future make two key demands on the maintenance of their installations:

- Cost optimization: Only carry out maintenance when actually necessary
- Performance optimization: Carry out maintenance before production downtime occurs (Predictive Maintenance)

The actual machine monitoring process must take place in parallel with the production process and should not interfere with it. The times required for scheduled maintenance of production machines mean a high, but still calculable cost factor for companies. Times for unplanned downtimes represent a significant and far more difficult to measure

risk. Both, the costs of machine maintenance and the risk of a machine downtime, can be significantly reduced with the help of IVAS.

**ADDITIONAL BENEFIT**

Through the online monitoring of production processes – in parallel with production, we can also reach conclusions about other factors which are critical for the success of companies. Abnormal measured values for vibration or temperature often have their origin not in the production system itself, but in the raw materials used. Users of sensor technology for machine monitoring therefore have the opportunity to control many more processes than just production. The detection of issues such as reduced quality of raw materials from suppliers is just one of many examples.

In order to monitor the machine, the IVAS measures 3 different physical variables: Vibrations in three axes up to a signal frequency of 3KHz, in one axis also up to a signal frequency of 20 KHz, and the exact temperature. If an installation is not working as planned, it will vibrate and sound different to its normal operating state. The system compares the measured signals with saved profiles. The system is also self-learning and only reacts to changes that indicate a defect or wear. The sensor system can thus detect at an early stage when a machine needs to be repaired or maintained. With more complex systems, the gateway (or router) to which the sensors send their data, or the production computer network can undertake this intelligent evaluation.

Additional business models and service offerings result for machine manufacturers from using such systems. Their customers collect the data themselves and of course also own the data that comes from production.

**“FOR INTELLIGENT CONTROL AND NETWORKING OF PRODUCTION THE SENSORS MUST COLLECT AND PROCESS LARGE AMOUNTS OF DATA IN REAL TIME.”**

*Reiner Schmohl*

*MEMS stands for Micro-Electromechanical System. These sensors can process mechanical and electrical information*

**PREDICTIVE MAINTENANCE**

In order to effectively use Predictive Maintenance, the collected data must be compared with known profiles, such as vibration profiles, from other production systems. And this results in a business model for the manufacturers: Digital 24/7 maintenance of their customers’ production system. The manufacturers can thus develop from machine suppliers into strong production partners. Clearly such a business model is not limited to production machines manufactured in-house.



*The machine control is a self-learning system and only reacts to changes in parameters that indicate a defect or wear*



Wednesday, 8th May 2019, 3:30 pm

# CHRISTOPH PLÜSS

Christoph Plüss is Chief Technology Officer of the UNITED GRINDING Group. He has worked for the Group since 2009 and was previously Head of R&D and CTO of EWAG



## UNITED GRINDING Digital Solutions™ – The customer benefit

### Short Summary

Digitalization in the machine tool sector is more a generational issue than a technological issue

Key distinguishing features of modern machine tools will increasingly be found in the area of intuitive operation and handling in future

The supreme discipline of digitalization is to automatically perform optimizations on the basis of acquired data and to identify connections and patterns using smart data analysis

The success of our customers is the driving force of the UNITED GRINDING Group – and will remain so in the digital age

DIGITAL TRANSFORMATION IS OMNIPRESENT and is shaping society, environment and the economy in a rapid and unprecedented way. The increasing networking of people, Internet and things is increasingly becoming the focus of industrial production, where it allows us to revolutionize business models and offer our customers new services and solutions. But how does one develop and design successful digital services? Successful “digitalizers” clearly focus on the customer benefit and User Experience (UX) – the goal being to quite simply make the customer’s life simpler! This is ultimately the recipe for success.

### A GENERATIONAL ISSUE

Realistically, the increasing digitalization in the machine tool sector has little to do with the fourth industrial revolution. Developments in the private social environment as regards interaction with modern devices and systems (smartphone generation) are a clear expectation today. Therefore the topic of digitalization is more a generational issue than a technological issue. The next generation take for granted much of what is still being debated today.

### CUSTOMER JOURNEY

As a technology and market leader, the UNITED GRINDING Group wants to decisively contribute to shaping digital development in the modern manufacturing industry, so that it can remain a reliable partner for its customers and maintain its leading position in the future.

We have brought the “touchpoints” together in a “Customer Journey” with our customers throughout the useful life of the machine – from evaluation and procurement through to decommissioning. This “customer experience chain” explains which customer interactions can be simplified by digitalization to make the customer’s life easier.

### DIGITAL ECOSYSTEM

In order to provide customers in a digital ecosystem with a positive “User Experience” (UX), we consider three digital touchpoints to be essential:

1. “Machine panel”: Key distinguishing features of modern machine tools will increasingly be found in the area of intuitive operation and handling in future. We want to establish a milestone in operation and simplify and digitally support work on the machine for all.
2. “Web portal”: A new UNITED GRINDING web portal will act as a hub for specific business and customer information, market and product news.
3. “Customer portal”: In future every registered UNITED GRINDING Digital Solutions™ customer will be able to obtain products and services on the customer portal quickly and easily.

### KEY AREAS OF DIGITALIZATION

With UNITED GRINDING Digital Solutions™ our intention is to offer our customers a well

designed and expandable portfolio architecture, for increased productivity, reliability and quality. We have identified four essential key areas of digitalization in day-to-day digital production:

- **Digital Connectivity:** The networking of people, machines and systems is the basic prerequisite for digitalization. To this end, we are working on integrated software and hardware concepts. Standardized data exchange is essential. Together with leading control and machine tool manufacturers the “umati” interface (universal machine tool interface) has been developed and launched, under the direction of VDW.
- **Digital Usability:** Ideally even complex machines will be easy to operate, without requiring specialists. The operator must be digitally supported in his activities and we are therefore working intensively on new interaction concepts. A consistent UNITED GRINDING operating philosophy will make life much easier for operators as well as our application and service technicians.
- **Digital Monitoring:** The first step in any optimization, following the collection of data, is to create transparency, identify patterns and derive optimization potential. We have two initial products

here, the UNITED GRINDING Digital Solutions™ SERVICE MONITOR and the PRODUCTION MONITOR. The latter enables us to create a digital image of production and to record capacity utilization and efficiency in production. With the SERVICE MONITOR we support the service personnel in the planning and performance of maintenance activities.

- **Digital Productivity:** The supreme discipline of digitalization is to automatically perform optimizations on the basis of the acquired data and to identify connections and patterns using smart data analysis. This will enable us in future in to

accurately predict the service life of key components (Predictive Maintenance) or to dynamically adapt machine parameters for a required production quality.

**OUTLOOK**

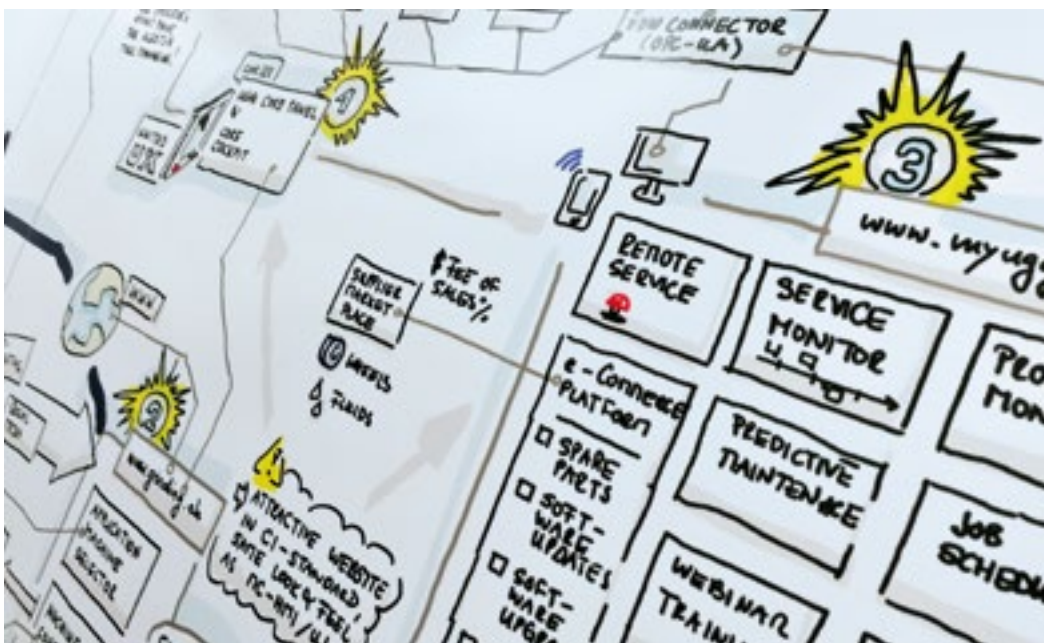
The portfolio architecture of UNITED GRINDING Digital Solutions™, as presented here, lays a successful foundation for the digital machine tool industry of tomorrow. Our focus is on the customer benefit and scalable solution concepts. In all four quadrants of UNITED GRINDING Digital Solutions™ we will launch further production innovations in the coming years, which we are already working on intensively.

Real and digital world will merge closer together, and “Augmented Reality” will be increasingly adopted in industrial applications. In the area of data analysis and optimization artificial intelligence will increasingly support us in making the right decisions. We will increasingly use intelligent sensor technology to regulate the current production process even more precisely and safely and to plan activities and measures ahead.

The goal is clear: no unplanned machine downtimes and a consistently high manufacturing quality with maximum productivity. The success of our customers is our driving force - and will remain so in the digital age.

**“THE GOAL IS CLEAR:  
NO UNPLANNED MACHINE  
DOWNTIMES AND A  
CONSISTENTLY HIGH  
MANUFACTURING  
QUALITY WITH MAXIMUM  
PRODUCTIVITY.”**

*Christoph Plüss*



*The three essential touchpoints of the User Experience: Machine panel, web portal and customer portal*

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Wednesday, 8th May 2019, 4:15 pm

# DR. SEBASTIAN RISI

Dr. Sebastian Risi is Associate Professor at the IT University of Copenhagen, Denmark



## Artificial Intelligence – Towards machines that can continually adapt

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### Short Summary

Based on insights from artificial intelligence, robotics, and biology, new generations of machines can be created whose bodies and artificial brains are not limited to performing one specific task, but can instead evolve to handle a variety of tasks in changing real-world settings

Lifelong learning agents, for example for autonomous driving, will continually improve its performance and update its knowledge unsupervised, rapidly adapt to unforeseen context, and learn and consolidate new tasks without forgetting old ones

Artificial intelligence has the potential to significantly disrupt many different industries by replacing the traditional design and deploy approach with an iterative evolutionary approach of design, deploy and adapt

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ARTIFICIAL INTELLIGENCE (AI) METHODS and autonomous machines are becoming part of our daily lives, in face recognition, speech recognition in mobile phones, automatic translation or autonomous driving. Machines can now outperform humans in many domains such as Chess, Go, or even poker. However, these systems still pale in comparison to even simple biological intelligence, which can learn, evolve and adapt to unforeseen experiences. Current machine learning systems can only deal with situations they have been trained for in advance; they are unable to adapt during execution to unexpected situations, that were not anticipated by the designer which greatly limits their autonomy. Additionally, while living organisms adapt and evolve in order to survive, current machines are static, orders of magnitudes less autonomous, specialized to only perform a very limited and fixed set of functions, and still laboriously planned and designed by teams of engineers.

### TO HANDLE A VARIETY OF TASKS

This brittleness contrasts starkly with the capabilities of animals that can adapt to a specific habit through adaptation by natural selection on an evolutionary time-scale and through behavioural flexibility on a daily-life time-scale. Because they live in dynamic and changing environments, biological systems had to develop robust, yet flexible, solutions that allow them to survive.

Based on insights from artificial intelligence, robotics, and biology, my research group aims to create the foundations for a new generation of machines whose bodies

and artificial brains are not limited to performing one specific task, but can instead evolve to handle a variety of tasks in changing real-world settings, go on unmanned explorations of unknown environments, or can facilitate the development of new medical technology such as shape adapting prosthesis for children. Some of the research projects we have been working on are detailed below.

### RIBOSOMAL ROBOTS

We have developed a novel 1D printing system that uses an approach inspired by the ribosome to fabricate a variety of specialized robotic morphologies from a single string of source material. This proof-of-concept system involves both a novel manufacturing platform that configures the source material using folding and an optimization tool based on artificial evolution that allows designs to be produced from the specification of high-level goals. The system can produce distinct robots from the same source material, each of which is capable of accomplishing a specialized task.

Additionally, the printer is able to use recycled material to produce new designs, enabling an autonomous manufacturing ecosystem capable of repurposing previous iterations to accomplish new tasks. We are currently extending this manufacturing platform to create a novel generation of robots, called EvoMorphs, shape-shifting robots that will be able to climb over the rubble of a collapsed building, morph to fit through narrow passages, and reform after being damaged.



A hallmark ability of humans is to continually learn from experience. However, creating artificial agents that can continuously adapt to novel situations and learn new skills within their lifetime without catastrophic forgetting of previous learned skills remains an unsolved challenge in machine learning. In contrast to current AI approaches, biological systems are able to adapt quickly to changes in their particular surroundings.

Together with a diverse group of researchers we are aiming to create lifelong learning agents for autonomous driving. The system will power a self-driving agent that continually improves its performance and updates its knowledge unsupervised, rapidly adapts to unforeseen contexts, and learns and consolidates new tasks without forgetting old ones. For example, the novel algorithm should allow a machine to recover from sensor failure during execution where current machine learning algorithms fail.

**DEMOCRATIZING AI**

Our society increasingly depends upon more advanced and pervasive forms of AI. Ensuring that these systems are useful for the community is a critical challenge. To address this challenge an ideal machine would not need to be programmed to perform a certain task but could instead be taught to do so in interaction with us, similarly to how we teach



Illustrations: © 2018 HRL Laboratories

*The machine-learning architecture will emulate interactions of the hippocampus to consolidate lifelong learning*

**“ARTIFICIAL INTELLIGENCE HAS THE POTENTIAL TO SIGNIFICANTLY DISRUPT MANY DIFFERENT INDUSTRIES.”**

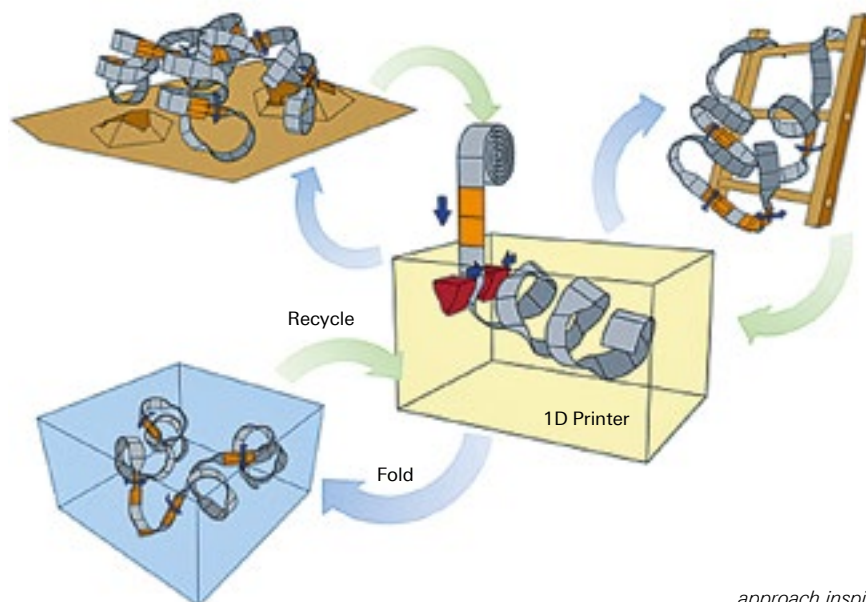
*Sebastian Risi*

children. An important part of our research takes a step towards the democratization of AI techniques by allowing casual users without any knowledge about AI or robotics to design robot behaviours through a process of interactive artificial evolution.

Similarly to how we breed dogs, users can interactively select robot behaviors they prefer from a set of candidates, and the next generation of behaviors is produced by slightly changing (mutating) and combining (crossover) the genetic material of the robot’s artificial neural networks. Because humans have intuitions about how animals should behave, they are able to selectively breed simple robot behaviors in a simulator without having to understand robotics or design principles of neural networks.

**LEARNING AND EVOLVING MACHINES**

Artificial intelligence has the potential to significantly disrupt many different industries by replacing the traditional design and deploy approach with an iterative evolutionary approach of design, deploy and adapt. This could limit the need for human designers or even human-operated facilities. The long-term vision of our lab is to create artificial organisms that can continuously adapt and evolve to fit their particular environments, thereby overcoming the limitations of systems designed directly by humans.



*A 1D printing system uses an approach inspired by the ribosome to fabricate a variety of specialized robotic morphologies from a single string of source material*

Thursday, 9th May 2019, 9:30 am

# PROF. DR. THOMAS BERGS

Prof. Dr.-Ing. Thomas Bergs holds the Chair of Manufacturing Technology at the Laboratory for Machine Tools WZL of RWTH Aachen University



## Assistance system-based process monitoring in grinding technology

### Short Summary

Current developments such as customizing or new drive concepts in the automotive sector require agile process control using assistance systems in production

The prerequisite for this is sound, physically-based process knowledge. Digital twins are necessary to obtain this knowledge

Digital twins are data-based images of real components, tools and machines, which exist throughout the lifetime of the real object

They generate large data volumes, which can be analyzed for previously unknown trends and patterns using artificial intelligence methods, and help facilitate quality control

THE PROGRESSIVE DEVELOPMENT of alternative drive concepts in the automotive sector is causing a major shift in machining technology. Lightweight concepts and the processing of materials with previously unknown machining characteristics pose additional challenges for the machining process. In addition, new manufacturing methods and a change in the drive components required result in a significant reduction in primary machining times in the automotive production chain.

However, machining processes are relevant for the manufacture of components with high demands in respect of form and position tolerances. Customer requirements also result in a shift away from mass production to the production of components in small batches. Cost-effective production of these components makes efficient and agile process control more necessary than ever before.

Within the "Internet of Production" Cluster of Excellence at RWTH Aachen University, the Laboratory for Machine Tools WZL of RWTH Aachen has set itself the goal of raising the inter-technology interaction of machining processes to a new level, by providing and using context-dependent data from production in real time and with a sufficient degree of detail.

### INTERNET OF PRODUCTION

Agile production is one of the pillars of the networked, adaptive production of the Internet of Production, the Aachen interpretation of the Industrial Internet of Things. The

key element of the Internet of Production is the systematic digitalization and networking of development, production and product throughout the entire value chain. Assistance systems in production technology form the link between human experience and the capabilities of IT systems for improving data handling, analysis, modeling and planning. The assistance system initially supports decision, control and regulation processes, with an increasing level of maturity. It subsequently controls the production line as an autonomous system.

The basic requirement for the development of such an assistance system is sound, physically based knowledge about the process. The implementation of an assistance

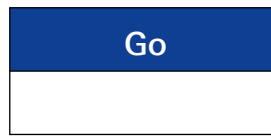
**"TODAY, MORE THAN EVER, COST-EFFECTIVE PRODUCTION REQUIRES EFFICIENT AND AGILE PROCESS CONTROL."**

*Thomas Bergs*

system in grinding technology is particularly difficult, because a large number of influencing variables are difficult to measure due to the limited accessibility of the contact zone between abrasive grain and workpiece, as well as the geometrically undefined cutting

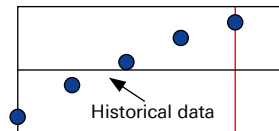
*With increasing maturity the assistance system is capable of progressing from pure condition measurement to autonomous process control based on historic and projected data*

Stage 1: Signaling



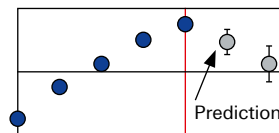
Status

Stage 2: Observation



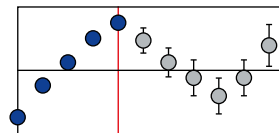
Warning

Stage 3: Prognosis



Indication

Stage 4: Support



Specification

edge. It is therefore necessary to make valuable process variables measurable online using virtual sensors and models.

The method of data analysis and projection is enabled by a digital twin. This represents a sufficiently precise, data-based image of real components, tools and machines and exists throughout the lifetime of the real object. The use of high-performance sensor technology and multi-sensor platforms in the smallest of spaces enables precise creation of the digital twin.

The sensor data and metadata flow into a data lake as an integrated whole. These are then made available for big data analytics using artificial intelligence, to discover unknown relationships, trends and patterns. Data-driven modeling using artificial intelligence methods identifies unknown relationships between process control, disturbance and output variables. To create the digital twin the data of workpiece, tool and other production equipment, as well as the direct and indirect process signals, must flow into a common database. This provides the basis for understanding and preventing scattering and trends.

**DEMONSTRATION IN PRODUCTION**

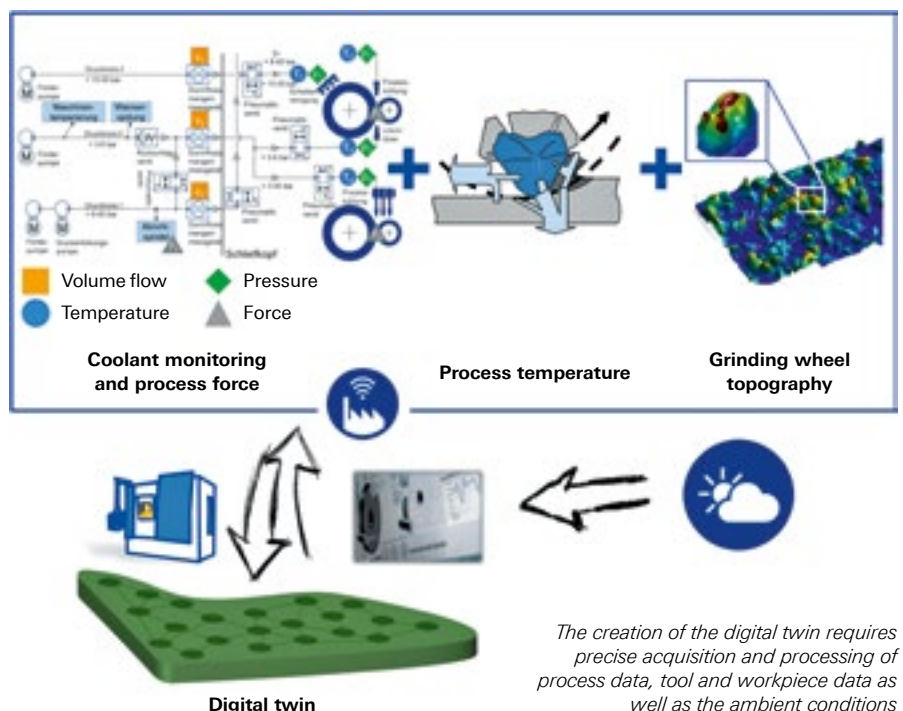
The benefit of the digital twin in modern production technology is mapped out at the Laboratory for Machine Tools WZL of RWTH Aachen on demonstration systems in a production line, using the example of a solid carbide shank cutter. The sintered carbide blank represents a hard-to-machine material with both ductile and brittle machining characteristics. Due to the difficult machinability and the high demands on form tolerance and surface finish, the blank is ground in several roughing and finishing processes, in which flute spaces, main and secondary cutting edges as well as flanks are produced.

If knowledge about the workpiece in terms of material, geometry and peripheral zone is also available for previous machining steps, these twins can be linked together in a virtual process. The technologically and

economically efficient design of the cutting tool used in the milling process thus becomes possible with a lot size of one.

**STATISTICAL PROCESS CONTROL**

Based on these findings in the research context the customer can then draw conclusions about the component peripheral zone characteristics as well as surface parameters and form tolerances through the acquisition of indirect process signals by modern machine controls. A costly and time-consuming one hundred percent inspection of all quality characteristics, as required for safety-critical components, can thus be reduced to a statistical process control (SPC), or even completely omitted. Finally, the process knowledge generated by data-driven models enables the design of technology meta-models, so that disturbance and influencing variables of the processes can be taken into account right from the planning stage in future.





Thursday, 9th May 2019, 10:15 am

# ROMAN RUDOLF THOMAS SCHENK

Roman Rudolf is Head of Sales and Support, and Thomas Schenk is Head of Production of FISCHER AG. The company based in Herzogenbuchsee, Switzerland, produces rotation systems such as precision spindles, electro-compressors and milling heads



## WireDress® in practice (practical examples and experiences)

### Short Summary

Difficult-to-machine hard materials and rising quality standards place enormous demands on a reliable production process

Using a bond with a high dimensional stability, almost any profile can be precision-contoured in the  $\mu\text{m}$  range

Other important factors that contribute to reproducibility in the absolute range of less than  $1\ \mu\text{m}$  are a fully air-conditioned hall, automatic loading and unloading, adapted tooling, cutting-edge measuring technology, an efficient cooling concept and, of course, highly trained and motivated personnel

THE AERODYNAMIC AIR BEARING from FISCHER requires very precise machining of the shafts in the  $\mu\text{m}$  range. The bearing geometry is precisely defined and the quality of the monoblock precision components is systematically documented. Materials such as carbide present new challenges for production. To increase the removal volume, special abrasives such as metallurgically bonded diamond wheels are used – and these require technological improvements of production systems. WireDress® is an example of a small but important element of technological development to increase productivity by increasing part throughput and improving process stability.

The challenge was: As well as our goal of increasing productivity, we were also reaching our limits when grinding difficult-to-machine hard materials with increasingly stringent quality requirements. We had to admit that we couldn't solve this issue with a conventional grinding machine. So we began searching for a possible solution.

Over the years our technology partner STUDER has supported us in completing numerous successful projects. At our request STUDER suggested the WireDress® technology in combination with High Speed Grinding (HSG), which provided a perfect solution to the problem. Here, the dressing is done at full wheel speed. In contrast to conventional mechanical or external EDM dressing, WireDress® dressing occurs

through modified wire erosion in the grinding machine, where the grinding oil serves as a dielectric.

The dressing process is contactless and wear-free, with no mechanical contact. The grit itself is not dressed, but the metallic bond around the grit is removed. Depending on how deep the grit is embedded in the bond, it either falls out or remains with original

**“WIREDRESS®  
CONTRIBUTES TOWARDS  
INCREASING  
PRODUCTIVITY BY  
INCREASING PART  
THROUGHPUT AND  
IMPROVING  
PROCESS STABILITY.”**

*Thomas Schenk*



sharpness in the bond. The grinding wheel receives a high grain clearance for maximum cutting capability, lower grinding forces and low burning risk. You can now harness the capabilities of metal bond with WireDress®. Using a bond with a high dimensional stability, almost any profile can be precision-contoured in the  $\mu\text{m}$  range. Long dressing intervals can also be achieved.

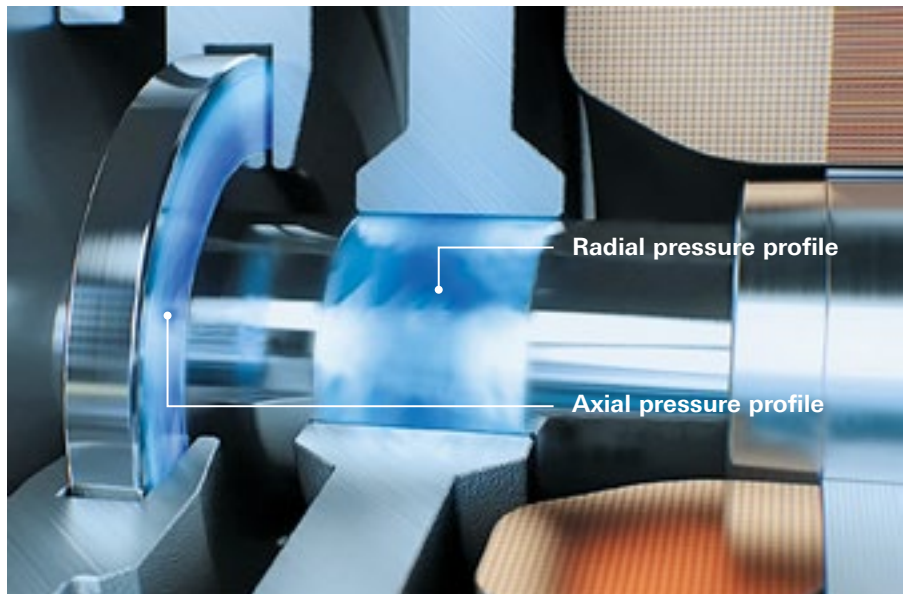
### REPRODUCIBLE PRODUCTION

If you have the right technology, the process is peanuts. In the past, you had to feel your way, today everything is process-stable. This has the advantage that the costs can be clearly calculated. We also know that the right technology is not just about the machine.

Other factors that contribute to reproducibility in the absolute range of less than  $1 \mu\text{m}$  are:

- a fully air-conditioned hall
- automatic loading and unloading
- adapted tooling
- cutting-edge measuring technology
- an efficient cooling concept
- highly trained and motivated personnel

For FISCHER AG, the investment in the STUDER S41 with WireDress® technology has paid off. In order to develop the full potential of the technology machine we will continue to invest in grinding technology development.



*An aerodynamic bearing specially optimized by FISCHER*



*The electric turbocompressor developed by FISCHER allows small mass flows to be efficiently compressed*

Thursday, 9th May 2019, 11:00 am

# DR. STEFAN BOHR

Dr. Stefan Bohr is Director of Application Engineering & OEM Management at Saint-Gobain Abrasives, a global manufacturer of abrasives



## High-performance grinding... rapid development of various technologies

### Short Summary

The efficiency of grinding processes mainly depends on parameters such as cutting speed and grain size of the grinding wheel

With a suitable grinding wheel specification, a higher cutting speed leads to an improved grinding performance – but also to increased heat generation

The grinding direction (synchronous or counter-rotation) is also an important factor for the chip formation process

A suitable design of the grinding process results from analysis of the chip formation process taking account of the grain characteristics

THE EFFICIENCY OF GRINDING PROCESSES is constantly being improved in terms of material removal, grinding times, surface qualities and complexity of the process flows. This is necessary for machining new materials and also reduces grinding costs. But how is this achieved? With new grinding machines, on the one hand, which enable quicker operations and optimized processes. And on the other hand through the development of innovative grinding tools, which make optimal process parameters possible in the first place. The individual combination of the right abrasive grain and a suitable bond leads to a specification which ensures the highest performance for the respective application.

### CUTTING SPEED

Does a higher cutting or grinding wheel peripheral speed lead to an increased grinding performance and thus a higher removal rate?

The simple answer is: "Yes... but!" For an explanation let us look at the equivalent cutting depth. This is defined as the quotient of removal rate and cutting speed (see Figure 2). Experience and theoretical considerations show that in normal grinding processes the equivalent cutting depth is always within a similar range, between 0.1 and 0.7  $\mu\text{m}$ .

So if we increase the cutting speed, we can increase the removal rate accordingly, to keep the cutting depth the same. Therefore: Higher cutting speeds actually allow a better grinding performance in this respect!

But: The higher removal rate generates more heat. To dissipate this heat the cooling system must be adapted in respect of flow rate, pressure and output speed; otherwise thermal damage to the workpiece would result. There is also a second "But": It must be ensured that the abrasive grains and the entire tool can withstand this additional loading.

### EFFECT OF THE ABRASIVE GRAIN

Figure 1 shows the relationship between spindle power and removal rate for the abrasive grains white aluminum oxide and Altos TGX; this relationship can be represented as a linear function in time-independent processes. Two essential characteristics of abrasive grains can be determined from this:

1. The specific grinding energy, i.e. the energy required to cut 1  $\text{mm}^3$  material (line gradient). A small slope, i.e. a flat straight line, means that a high removal rate can be achieved with low spindle power. The diagram shows that Altos TGX has a significantly lower specific grinding energy and is therefore better suited for a high removal rate than white aluminum oxide.
2. The "threshold power", i.e. the power required to stimulate the chip formation (y-axis section). From this threshold the abrasive grain is able to penetrate the material and generate a first chip. Below this threshold only processes such

as friction, temperature increase and possibly deformation of the workpiece result. The figure shows that white aluminum oxide has an advantage here, i.e. it is already "easy-cutting" at a lower power.

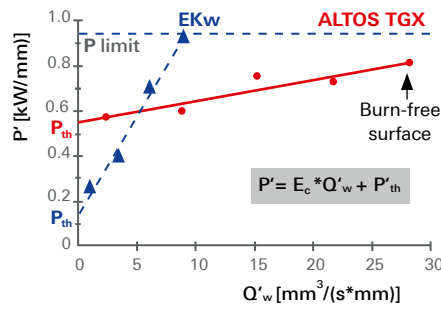


Figure 1:  
The specific grinding energy, i.e. the relationship between spindle power  $P'$  and removal rate  $Q'$  for the abrasive grains white aluminum oxide (EKw) and Altos TGX

High removal rates thus require grains with a lower specific grinding energy, which enable a high material removal to be achieved with a low spindle load. It is therefore often advisable to use Altos TGX, so that the higher cutting speeds make sense.

If, however, high-performance grinding is understood to mean precise working on sensitive components (thin-walled, hollow, unstable...), abrasive grains with a low threshold power are the right choice. These grains penetrate the material easily and produce a "soft" chip formation. White aluminum oxide would therefore preferably be used here.

Another key parameter is the choice between synchronous or counter-rotation (Figure 2). During counter-rotation grinding the grain penetrates the workpiece at a flat angle; the initial chip formation process is therefore of crucial importance. A tool with a low threshold power should be used here; otherwise thermal damage or chatter marks would result due to the high friction component.

During synchronous rotation grinding, on the other hand, the grain penetrates the workpiece spontaneously. Here the chip

**"THE INDIVIDUAL COMBINATION OF THE RIGHT ABRASIVE GRAIN AND A SUITABLE BOND ENSURES THE HIGHEST PERFORMANCE FOR THE RESPECTIVE APPLICATION."**

Stefan Bohr

formation is forced, but the grain must be capable of withstanding this load. Abrasive grains with higher strength and lower specific grinding energy therefore have significant advantages here.

**PERFORMANCE AND SURFACE**

High-performance grinding with higher metal removal rates on the one hand and better surfaces on the other – both are possible, if all boundary conditions in terms of workpiece and requirements are known. The appropriate combination of grinding tool, grain, process and machine concept must be individually tailored, based on an understanding of the microscopic processes.

Analysis of the chip formation process taking account of grain characteristics such as threshold power and specific grinding energy leads directly to a suitable process design. High cutting speeds are a correct strategy in many cases, if the machine equipment in respect of cooling and stability is correctly adapted to the changed situation.

*Parameters of the grinding process*

Threshold power  $P_{th}$

Cutting speed  $v_c$

Cutting depth  $h_{ec}$

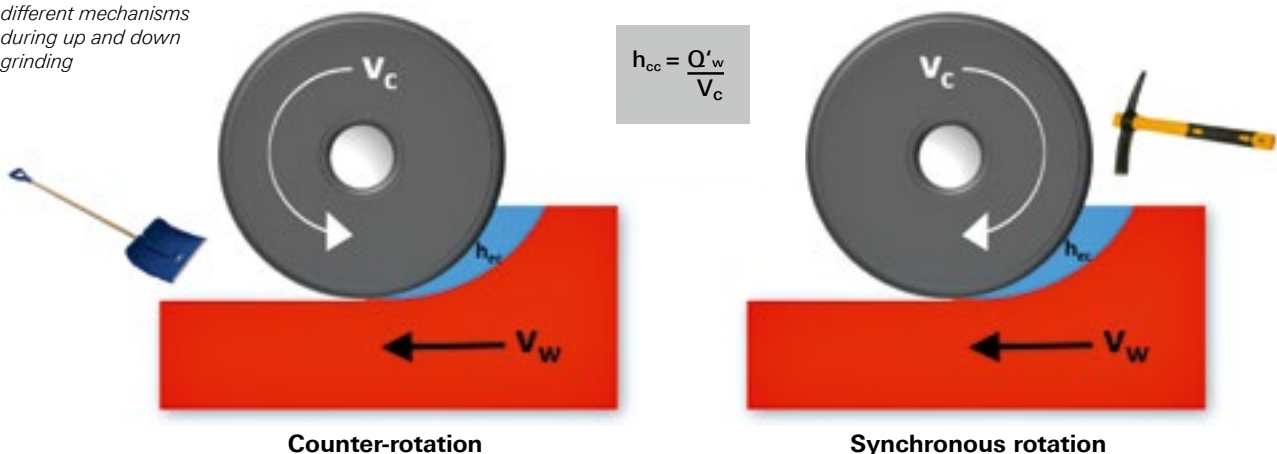
Specific grinding energy  $E_c$

Spindle power  $P'$

Workpiece speed  $v_w$

Removal rate  $Q'_w$

Figure 2:  
Representation of the different mechanisms during up and down grinding





Thursday, 9th May 2019, 11:45 am

# DIPL.-ING. ECKHARD HOHWIELER

Dipl.-Ing. Eckhard Hohwieler is Head of Department at the Fraunhofer Institute for Production Systems and Design Technology (IPK) in Berlin



## Potential and applications for machine learning in the manufacturing industry

### Short Summary

Through condition monitoring of critical components and adapted maintenance measures, unforeseen machine failures can be avoided and system availability can be increased

Artificial intelligence provides the algorithms and methods necessary to process data efficiently and interpret it profitably

Digital twins make all data from the product development process available and enable it to be experienced by means of virtual reality technologies

In order to ensure efficient production, production systems must monitor the state of wear of functionally relevant components and adapt their behavior according to the situation

THE AVAILABILITY OF production machines and systems is an essential requirement for ensuring efficient and stable production. For production and service planning, it is crucial to know the condition of production systems and how this is likely to develop in future. Through condition monitoring of critical components and adapted maintenance measures, unforeseen machine failures can be avoided and system availability can be increased.

Predictive maintenance helps to identify the optimal time for maintenance, avoid production failures and optimize processes. Condition monitoring detects and monitors the state of wear, while predictive maintenance entails predicting probable developments of the future machine condition and planning maintenance measures on this basis. Effective predictive maintenance reduces the number of maintenance activities and increases the machine availability. It also enables system use to be planned more efficiently, since unplanned repairs are virtually eliminated.

### LIFECYCLE MONITORING

During the operation of production systems by customers a large volume of information is generated in the course of the life cycle, which provides information about load and wear development. Life cycle monitoring enables the machine manufacturer to collect

this information and prepare it for the user. Users can evaluate and use this information themselves, both fleet-specifically and on a general level, in order to optimize their products and services.

In cooperation with grinding machine manufacturer Schaudt Mikrosa GmbH, Fraunhofer IPK developed a concept which enables the dynamic behavior of components to be detected on the basis of self-tests. For the self-test the respective feed axis or main spindle moves at a constant infeed speed or rotational speed. During this traversing movement the drive data are acquired and further processed using a software application on the operating computer. Statistical moments were chosen as characteristic values for the evaluation, as they are easy to calculate and interpret and have a high informative value.

### DATA ANALYTICS AND AI

With data analytics insights can be gained from raw data about cause and effect relationships in industrial production. Data analytics is used to clean, transform, organize and model the data, in order to draw conclusions and identify significant patterns. Data analytics is therefore not a new technology, but is gaining in importance with the rapidly increasing availability of data enabled by low-cost MEMS sensors and IoT communication. A huge challenge is posed by

Connection of the machine tool to data analysis in the cloud



\*) Source of the Machine Tool:  
 Schaudt Mikrosa GmbH  
 CMMS: Computerized Maintenance Management Systems

the generation of meaningful characteristic values, which form the basis for the use of machine learning processes and AI.

Artificial intelligence provides the algorithms and methods necessary to efficiently process and interpret data from industrial processes for the benefit of companies and their customers. AI is thus a key component and an important driver for the intelligent monitoring, control and regulation of these processes.

**PREDICTIVE MAINTENANCE**

The key focus is on clustering, the classification and regression of features which are obtained from data from industrial processes. Tasks with multi-dimensional non-linear dependencies can be supported by teaching and refining initial models. Predictive maintenance is improved through pattern recognition and on the basis of classifiers taught with case data. Cognitive machines with intelligent assistance systems will in future undertake the end-to-end optimization of processes, and agent systems will undertake the autonomous control of processes in production and logistics.

The digital twin, as a virtual image of a production system, makes all data from the product development process available and enables it to be experienced by means of virtual reality technologies. In a showcase at Fraunhofer IPK, a machine equipped with a

MEMS sensor-based condition monitoring system was connected to its digital twin via M2M communication and an IoT platform and thus expanded into a cyber-physical system. The condition monitoring triggers service visits when required, the service technician is supported on site by the cloud platform and the activities performed are documented automatically in the digital twin.

**“COGNITIVE MACHINES WITH INTELLIGENT ASSISTANCE SYSTEMS WILL IN FUTURE UNDERTAKE THE OPTIMIZATION OF PROCESSES IN PRODUCTION.”**

*Eckhard Hohwieler*

**END-TO-END OPTIMIZATION**

In order to ensure efficient production, production systems must in future have the capability to monitor the state of wear of functionally relevant components and adapt their behavior according to the situation. Cyber-physical systems and the digital networking of systems and processes in Industry 4.0 offer access to a wide range of data, and their intelligent evaluation not only creates new transparency but can also be used to optimize processes and systems.

The efficiency of machine learning can complement human capabilities in specific areas. AI will change previous value added processes and open up new value added potential in production and production technology. Cognitive machines with intelligent assistance systems will in future undertake the end-to-end optimization of processes and the control of processes in production.

Thursday, 9th May 2019, 2:00 pm

# PROF. DR. KONRAD WEGENER

Prof. Dr. Konrad Wegener is Head of the Institute for Machine Tools and Production (IWF) at ETH Zurich



## Vision and developments in grinding machine technology

### Short Summary

Without grinding technology, future technologies such as optics and electronics as well as classic machine manufacturing are inconceivable

Major lines of development in production technology today are Industry 4.0, artificial intelligence and biological transformation. This generally involves a further intensification of automation

An important application of artificial intelligence will in future also be the service sector in the sense of predictive or assessment-based maintenance, and accuracy improvement via self-learning compensation algorithms

The future will see a more intensive collaboration between machine manufacturer and machine user, with the need to protect reciprocal security and confidentiality interests

GRINDING AND ULTRA-FINE MACHINING are more important than ever today. Without grinding technology, future technologies such as optics and electronics as well as classic machine manufacturing are inconceivable. Competing with grinding technology are innovative laser-manufactured carbide tools made from solid PCD, CBN and nanocrystalline or monocrystalline diamonds for specific applications, and in some cases even new lasers from the development of ultrashort pulse technology.

### ENVIRONMENTALLY INTERESTING

However, the combination of cost-effectiveness, efficiency or throughput and machining quality does not provide a manufacturing process that can outdo grinding when it comes to surface, surface-near zone and material portfolio.

The fact that cutting with a geometricaly defined cutting edge depletes the earth's tungsten reserves, while grinding tools use corundum, SiC, artificial diamonds and CBN, whose source products are available in abundance in the world, makes grinding highly interesting for the future from an environmental point of view. "Grinding is necessary" will continue to apply in future and will call for grinding machines that are efficient in every regard. In the figure the most important lines of development for grinding machines are analyzed and summarized as a future perspective based on the development of grinding process technology, market requirements and the technology environment.

Major lines of development in production technology today are Industry 4.0, artificial intelligence and biological transformation. This generally involves a further intensification of automation. This development is not short-term hype, but is here to stay. Grinding technology is still largely experience-based. The reason for this is the multitude of parameters that need to be and are not actually managed, which is generally termed "complexity". Tools now exist for making such complex processes manageable, in the form of self-learning systems. Computing power, low-cost sensors, Internet and sophisticated modeling techniques make it possible to implement these ideas.

### ARTIFICIAL INTELLIGENCE

For the paradigm of the learning, intelligent machine, process technology and path preparation must both be accessible by the control on the machine, so that their two-way interaction can be utilized. As the training of a complex process technology requires a large number of training cases, model-based learning methods are clearly an advantage. These include computing models with adaptable parameters for known interrelationships and trainable qualitative guidelines.

The processability of uncertain information will be increasingly implemented in future, and biological intelligence is a model for this. This means the availability of information can be distributed over time. Models are necessary for the creation of master data, the protection and validation of information

as well as the transfer of knowledge from other machines. They shorten the learning process considerably.

**UNCERTAIN INFORMATION**

An important application of artificial intelligence in future will also be the service sector in the sense of predictive or assessment-based maintenance, and accuracy improvement via self-learning compensation algorithms. In the case of predictive maintenance the remaining life of the grinding machine is determined from currently measured condition data of the machine and its elements, for instance the grinding wheel, and wear or failure models. Determining the condition of the machine and its elements is often not directly possible, so that an indirect determination of the wear condition with a variety of sensors and broadband sensors (microphones, cameras) is increasingly pursued.

Cheaper and more efficient sensor technology as well as redundant sensor networks, which carry out self-checks based on plausibility, enable this development. In particular, remaining service life prediction via durability modeling will not succeed without the collection of field data, including failures and damage, i.e. from real working machines. This requires a large number of individual incidents, which is the only way to give the machine builder the data feedback from the field.

**TRANSFER LEARNING NECESSARY**

Due to the relatively small series in the machine tool industry, the transfer of information from one type to another with the aid of transfer models and transfer learning is also necessary. The future will see a more intensive collaboration between machine manufacturer and machine user, with the need to protect reciprocal security and confidentiality interests.

The various system components will be integrated more intensively into the grinding machine. This particularly applies to balancing and dressing systems as well as coolant supply. Reproducibility, also one of the basic prerequisites for expert systems, demands nozzles that can be positioned in relation to the grinding process, with an adjustable outlet velocity and volume flow. Meta-models are generated via flow simulations, and can

**“IN THE COMBINATION OF COST-EFFECTIVENESS, EFFICIENCY AND MACHINING QUALITY, GRINDING TECHNOLOGY IS SUPERIOR TO ALL OTHER MANUFACTURING PROCESSES.”**

*Konrad Wegener*

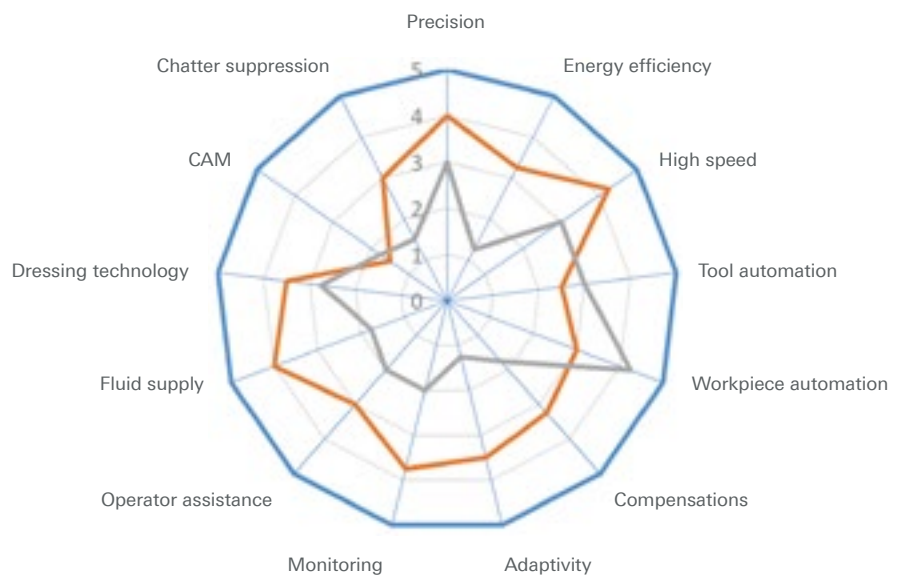
then be used by the machine control or tool presetting to provide the coolant precisely and in the correct dosage.

**PRECISION ON THE WORKPIECE**

Grinding technology as a finishing process is steadily advancing towards higher precisions on the workpiece. Error budgeting is likely to become established in the future as a systematic procedure for design for accuracy. Generally, precision requirements go beyond what can be achieved with design, so that algorithms have to be used for the compensation of kinematic errors, thermal movements, dynamic errors and even gravitation errors and wear, which in turn places demands on the reproducibility of the machine in particular.

Tougher requirements will be made on the machine in future due to the relaxation desired by the customer in terms of air-conditioning requirements. Here too there is a possible field of application for artificial intelligence, in adapting these compensation models to the varying conditions.

*Development trends and their implementation*





Thursday, 9th May 2019, 2:45 pm

# DR. MARKUS WEISS

Dr.-Ing. Markus Weiß is Head of Grinding Technology at TYROLIT Schleifmittelwerke Swarovski KG



## Process-adapted grinding tools and innovative wheel bodies

### Short Summary

Only through the optimal interaction of machine tool, coolant, conditioning process, process settings and grinding tool can high removal rates, high productivity and high-quality workpieces be achieved

The geometrical and mechanical characteristics of the abrasive grain materials decisively define the chip formation mechanisms, the grinding force generated and the wear behavior

Shape, material as well as mechanical and dynamic characteristics of the grinding wheel body influence the vibration and damping behavior of the grinding wheel

AS A MANUFACTURER OF HIGH-QUALITY grinding tools, TYROLIT Schleifmittelwerke Swarovski KG has been continually optimizing and developing tool technologies for 100 years, in order to meet the demands of industrial applications on efficiency and productivity. The grinding tool plays a central role in the complex grinding production process, in which all system components involved such as machine tool, coolant, conditioning process, process settings and grinding tool must be adapted to the machining task. Only through the optimal interaction of all these components can high removal rates, high productivity and high-quality workpieces be achieved.

### GRINDING WHEEL CHARACTERISTICS

Grinding wheels are high-performance tools, whose characteristic profiles are adapted to the respective grinding process depending on their design and specification. Figure 1 shows a modern grinding tool with a multi-layer, ceramic-bonded abrasive coating on a steel wheel body. The abrasive coating comprises the components grain, bond and pores.

The grain material performs the cutting function. Its geometrical and mechanical characteristics decisively define the chip formation mechanisms, the grinding force generated and the wear behavior. The grinding and wear behavior are also determined

by the type of bond system used. The bond system also defines the resilience in the contact zone and therefore forms part of a grinding wheel's damping capability. Pores produce the chip space needed to ensure the removal of chips and enable the supply of coolant to the contact zone.

### CBN AND DIAMOND TOOLS

In high-performance grinding processes with CBN and diamond tools, in addition to the abrasive coating specification the grinding wheel body decisively defines the grinding process behavior. Therefore, the wheel body is not just a carrier material which is required to connect the grinding machine to the abrasive coating, but it is also an important component of the grinding system. The vibration and damping behavior in particular is influenced by shape, material and dynamic characteristics. The wheel body also largely determines the weight, the maximum peripheral speed of the grinding wheel and the grinding tool costs. Classic representatives of wheel body materials used are steel, various aluminium alloys, ceramics and resin. Glass (GFRP) or carbon fiber reinforced plastics (CFRP) are also used for various applications.

Which wheel bodies are best suited for a grinding operation is generally determined in complex tests based on the "trial and error" principle. However, modern sim-

ulation methods make it possible to reduce some of this effort and implement a knowledge-based design of wheel bodies.

**SIMULATION-SUPPORTED DESIGN**

For knowledge-based and simulation-supported design of grinding tools, it is first necessary to define the boundary conditions. Which geometrical boundary conditions must be observed for clamping? Which dimensional and shape accuracies are required of the component? Is there a maximum weight which the grinding tool must not exceed?

Optimization variables include the weight or dynamic behavior of the tool, for example.

■ **Weight optimization**

An electroplated grinding tool for plunge-cut grinding of gear shafts, for instance, at 30 kilograms is 47 percent lighter than a solid body version made from the same material. This means reduced loading of the drive spindle, less effort when changing the grinding wheel and shorter tool change times.

■ **Optimization of the vibration behavior**

The vibration behavior of the machine tool can be influenced by changing

**“GRINDING WHEELS ARE HIGH-PERFORMANCE TOOLS, WHOSE CHARACTERISTIC PROFILES ARE ADAPTED TO THE RESPECTIVE GRINDING PROCESS DEPENDING ON THEIR DESIGN AND SPECIFICATION.”**

*Markus Weiß*

the wheel body design. Often a vibrational response or self-excited chatter occurs in specific speed ranges during the process. In this case too simulation can help design grinding wheels with different dynamic behavior, in order to guarantee process stability and component quality.

**DESIGN STUDY**

Design studies are performed in order to achieve different goals when optimizing grinding wheel bodies. Combining parameters results in a vast number of design variants, which can be evaluated in respect of maximum expansion at speed, characteristic frequency and wheel body mass. Additional design scenarios result from modifying the number of sprockets, and the parameter constellations can quickly go into thousands here.

For use in a grinding process it is then possible to select the variants that present a suitable or sufficiently different vibration behavior, so that negative process influences can be excluded. Simulation methods supplement empirical knowledge, continuous further development and experimental studies. The TYROLIT company is thus able to offer optimal grinding tools for a wide range of grinding applications.



*Figure 1: Design of high-performance grinding tools and wheel body variants*

Thursday, 9th May 2019, 3:30 pm

# PROF. DR. CARSTEN HEINZEL

Prof. Dr.-Ing. habil. Carsten Heinzl is Deputy Head of the Main Production Technology Department at Leibniz Institute for Materials Engineering (IWT) and Honorary Professor at Bremen University



## Coolant supply conditions as the key to process capability, energy efficiency and peripheral zone influencing during grinding

### Short Summary

Significantly improved machining conditions can be achieved through effective coolant supply to the grinding gap

The thermomechanical loading of the workpiece can be reduced and the process performance increased, without negatively affecting the peripheral zone of the workpiece

Thanks to flow-optimized coolant nozzles and smaller coolant quantities energy consumption decreases, and coolant systems can have smaller dimensions

The cost-effectiveness of the grinding process can be significantly increased as a result. Practical examples show a potential of 20 to 30 percent

THE SYSTEMATIC DEVELOPMENT of grinding in respect of fulfilling increasing quality requirements and increased process reliability while also increasing productivity, contributes to maintaining the competitiveness of industrial users of this technology. The use of coolants should be seen as an essential element of grinding process design.

During grinding the large contact area between tool and workpiece impedes the effective supply of coolant to the grinding gap. Thermal overload of the peripheral zone of the material, increased tool wear and poor machining results are possible consequences of an inadequate coolant supply. A wide range of influencing variables must be considered in the design of an effective coolant supply:

- Selected nozzle position
- Nozzle design
- Jet characteristics and velocity
- Coolant volume flow

An analysis of the relevant factors shows that in this area there is considerable potential to increase process reliability, process performance and cost effectiveness during grinding. The aspect of energy efficiency is also increasingly becoming a focal point of research and development.

As well as coolant type, composition and coolant cleaning, the effective supply of coolant to the contact zone is extremely important. Essential aspects of coolant supply are the coolant jet velocity, effective

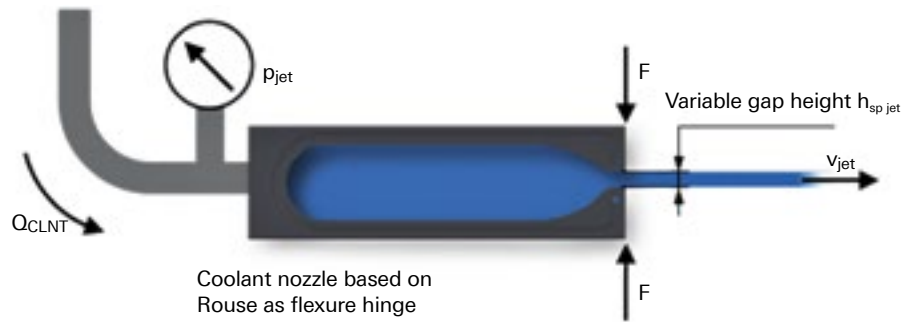
design of the supply nozzle, its jet characteristics and its exact positioning in relation to the grinding wheel and workpiece to be machined.

Generally changes in the coolant supply can only be identified through complex analytics. A special test setup enables changed coolant supply parameters to be traced back directly to the temperature reached in the contact zone between grinding wheel and workpiece. If we systematically work through the possible setting parameters for orientation of the coolant nozzle, the measured temperatures clearly show how important correct positioning of the coolant supply nozzle is (Figure 1).

**“THE OPTIMIZED SUPPLY OF COOLANTS HAS CONSIDERABLE POTENTIAL FOR INCREASING COST-EFFECTIVENESS DURING GRINDING.”**

*Carsten Heinzl*

The parameters of jet velocity and volume flow are inextricably linked together. If the volume flow is varied, the coolant pressure in the supply line and the jet velocity also



change. To set the jet velocity for a given volume flow it is therefore necessary to adapt the outlet cross-section of the coolant nozzle accordingly (Figure 2).

The design of the coolant nozzle also has an influence on the process performance and cost effectiveness. Depending on the nozzle used, the coolant jet expansion and drop size distribution, as well as the efficiency, or the energy required for coolant acceleration, vary considerably. The coolant nozzle design also influences the jet velocity, volume flow and jet expansion as well as the jet homogeneity, drop distribution and jet force.

With the help of performance measurements on the components of machine tool and coolant system during roughing when surface grinding, it is possible to show how different process conditions affect the energy consumption of the grinding operation.

**TOOL CLEANING**

It can be deduced that although an increase in the coolant volume flow enables an increase in the material removal rate, it also causes increased power consumption by the coolant feed pump. By contrast, the use of a separate coolant nozzle for tool cleaning enables an increase in the achievable material removal rate with a reduction in spindle power.

Once again, the nozzle position and flow characteristics of the cleaning nozzles used determine the cleaning effect that can be achieved, with the impact energy of the coolant jet representing a key variable. This finding also reflects the results of grinding tests, in which a maximum cleaning effect was achieved with relatively moderate coolant supply conditions:

- Coolant pressure = 20 bar
- Coolant volume flow = 14 - 17 l/min
- Coolant pump capacity = 2 - 3 kW

In addition, with the use of tool cleaning a reduction in the process forces and tool wear of up to 30 percent was determined. This results in an increase in the process perfor-

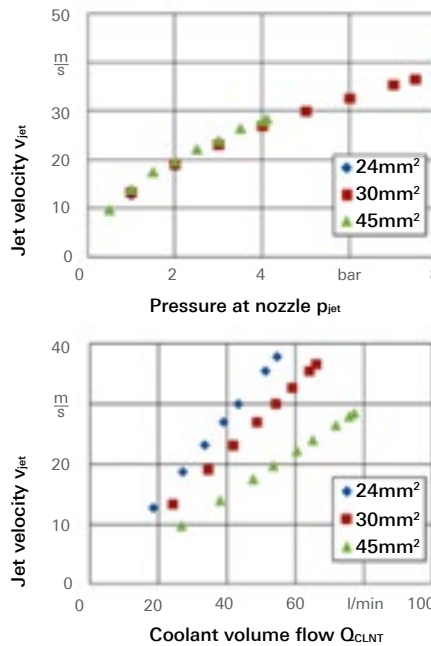


Figure 2: Relationship between coolant pressure and volume flow for different nozzle outlet cross-sections

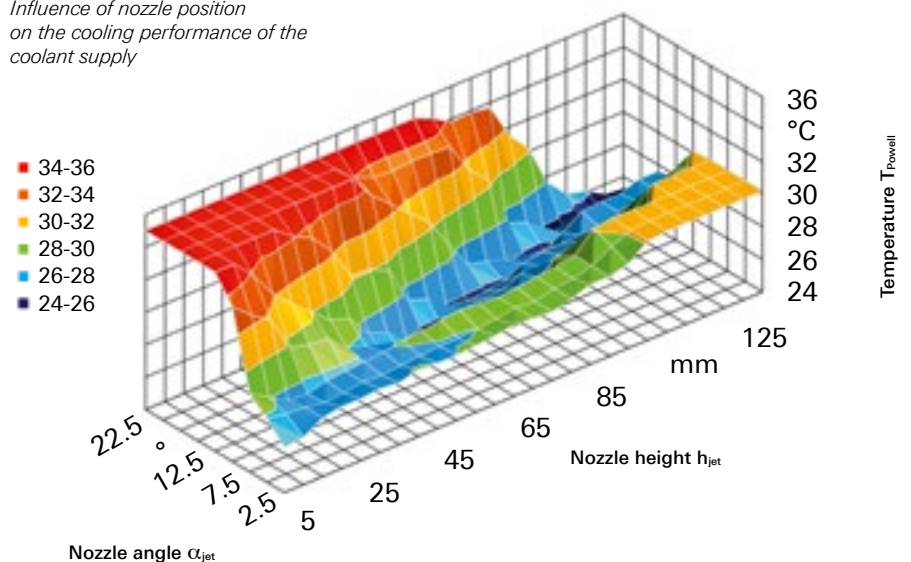
mance of around 20 percent without affecting the workpiece peripheral zone.

From the studies presented and discussed here, we can conclude that flow-optimized nozzle concepts enable efficient lubrication, cooling and tool cleaning – also with a reduced coolant volume flow. More productive cutting conditions can thus be achieved with smaller process forces. The resulting reduction in thermomechanical loading of tool and workpiece opens up potential for a further increase in process performance and reliability.

**EFFICIENCY AND COST-EFFECTIVENESS**

A reduction in the coolant volume flow also causes reduced energy consumption of the coolant pumps, and the coolant systems can have smaller dimensions. A significant increase in the energy efficiency and cost-effectiveness of the complete process can thus be achieved. The approaches described indicate considerable potential for increasing process performance and cost-effectiveness during grinding and can often be implemented directly in practice at relatively low cost.

Figure 1: Influence of nozzle position on the cooling performance of the coolant supply





Thursday, 9th May 2019, 4:15 pm

# MARC BLASER

Marc Blaser is CEO of Blaser Swisslube AG, an international coolant manufacturer, which has been in family ownership for three generations



## Effectively and demonstrably improve the profitability of your company with the liquid tool

### Short Summary

Influence of coolant on manufacturing costs is often ignored in reality

The savings in the form of higher productivity and increased machining quality correspond to a multiple of the capital used for coolants and grinding oils

To verify this, all relevant key points of machines, process, workpiece and materials are recorded in a situation analysis

The savings are higher if a high-performance, stable and well maintained machine is used

**THE FACT IS:** Coolant and grinding oil are often underestimated. Labeled an auxiliary material, the indisputable influence of coolant on manufacturing costs is often ignored in reality. Thousands of productivity studies show, however: It is well worth paying special attention to coolant and turning it into a liquid tool. The savings in the form of increased cost-effectiveness, higher productivity and increased machining quality correspond to a multiple of the capital used for coolants and grinding oils. Applications have resulted in potential savings of four to five times the coolant costs

### SITUATION ANALYSIS

With the right application expertise, a combination of process and product knowledge and supporting services, we use the coolant as a lever for achieving substantial improvements together with the customer. To this end, all relevant key points of machines, process, workpiece, materials, grinding wheels, coolant system, coolant and the essential soft factors are recorded in a situation analysis. It is important to understand what a machine costs per hour, so that every minute of downtime or every reject can be evaluated correctly. Prices and hourly rates can simply be stored in our Liquid Tool Analyzer, multiplied by the minutes, the rejects, the seconds of cycle time and other parameters, resulting in a calculation of the actual costs.

We invite you to change perspective and tap previously unknown potential in terms of productivity and cost effectiveness. When machine, grinding strategy, grinding wheels and coolant are matched to one another, extraordinary results are achieved. We will gladly help you bring your company into the next generation with the liquid tool. How will you select your next coolant, as an auxiliary material or a liquid tool?

**“IT IS WELL WORTH PAYING SPECIAL ATTENTION TO COOLANT AND TURNING IT INTO A LIQUID TOOL.”**

*Marc Blaser*

### PRECONDITION: A HIGH-PERFORMANCE MACHINE

A central finding from studies is that the savings are higher if a high-performance, stable and well maintained machine is available. Only then can elements such as grinding wheels and coolant help you get the most from the machine. Grinding proj-

**“APPLICATIONS HAVE RESULTED IN POTENTIAL SAVINGS OF FOUR TO FIVE TIMES THE COOLANT COSTS.”**

*Marc Blaser*

ects in particular impressively demonstrate the advantages that can be achieved with a high-quality machine and how price differentials can be quickly offset. The gains in productivity are higher and the processes run much more stably.

We decided to perform grinding trials in our Tech Center on a BLOHM machine, which we installed a year ago. With this machine we are able to discover all limitations and experience our coolants under both realistic and extreme conditions. The machine must be able to meet the challenges of constantly discovering and realizing new productivity potential.

**OVER 45 YEARS OF EXPERIENCE**

For over 45 years we have provided training in conscious handling of coolants. The use of coolant as a liquid tool requires that the consistency of the medium is stable over time. We need to consider two different types of coolant here:

- Grinding oils  
(are used unmixed)
- Water-soluble coolants  
(emulsion or solution)

In the case of grinding oils, special attention must be paid to contamination. Micro debris with a large surface can lead to the accumulation of particles, which can endanger the health of the operator or cause problems

with coating or re-working. The operating conditions can be checked with a targeted formulation and prompt laboratory analysis. Any malfunctions of the filter systems can thus be detected and eliminated.

Enormous potential can be tapped especially in relation to water-soluble coolants. However, any grinder who has worked with water-soluble coolants knows how arduous it is dealing with a contaminated machine or emulsion. The machine must be stopped, cleaned, flushed and freshly filled. If this is to be done correctly, several hours or a whole day are quickly lost. To make sure the investment in cleaning pays off in the form of long-term stability, it is worth doing this correctly and taking the necessary time.

**LIQUID TOOL**

Several thousand studies worldwide demonstrate the intrinsic value of the liquid tool. Our customers have recognized that the small cost factor of coolant has a huge influence on the cost-efficiency of their production.

Friday, 10th May 2019, 9:30 am

# PROF. DR. WILFRIED SAXLER

Prof. Dr.-Ing. Wilfried Saxler is Head of the Institute for Machine Tools and Manufacturing Technologies at the University of Applied Sciences in Cologne



## Avoidance of grinding burn and clogging through targeted coolant supply

### Short Summary

A targeted coolant supply is necessary for efficient process control during grinding

Coolants fulfil different functions, for instance cooling and lubrication of the grinding slot and the contact zone

The right amount of coolant is crucial: too much will virtually cause aquaplaning in the contact area, and too little will cause thermal damage to the peripheral zone

**DURING EFFICIENT PROCESS CONTROL** when grinding steels there is a risk of thermal peripheral zone damage. With soft steels the small chip spaces of the grinding wheels can become clogged or weld-ons can result. A targeted supply of coolant alone is generally not sufficient to prevent these effects.

The coolant can be used in different ways during grinding. These can be differentiated as follows:

1. Separation of the air cushion rotating around the grinding wheel
2. Flushing of possible clogged regions on the grinding wheel
3. Impregnation of the grinding wheel
4. Cooling and lubrication of the grinding slot and contact zone

The right combination of these four possible applications leads to an improvement in grinding performance. The process reliability can also be increased. This issue is the focus of the research project "GrIntCool – Grinding with intelligent coolant supply" (Figure 1) at iWFT, the Institute for Machine Tools and Manufacturing Technologies at the University of Applied Sciences in Cologne. This is aimed at developing a multifunctional coolant nozzle with a special control strategy, in order to avoid grinding burn and grinding wheel clogging.

A special feature of grinding is the removal of material by multiple cutting edges at high cutting speeds. As a result, high form and dimensional accuracy can be achieved

as well as high material removal rates, especially due to the development of synthetic, high-hardness cutting materials. Compared to cutting with a geometrically defined cutting edge, significantly higher specific energies must be used during grinding. As a result, due to mechanical and thermal stress during machining, undesired changes in the microstructure properties in the surface zone occur.

### LUBRICATION AND COOLING

Adequate lubrication and cooling are essential, especially with high material removal rates, to prevent damage to ground components. Cooling of the contact point becomes more difficult due to the large contact area between grinding wheel and workpiece, as well as the high cutting speed. In addition, the speeds lead to the formation of an air cushion around the grinding wheel, which deflects the jet of coolant.

Another problem during grinding is clogging of the grinding wheel. There is a risk of clogging particularly when machining ductile steel materials or nickel-based alloys. Due to the clogging and/or an excessively high machining volume, the transport of the cooling medium to the contact zone is impeded and the grip of the wheel is reduced. The process forces and temperatures increase, surface roughness and the risk of grinding burn increase and dimensional accuracy is lost.

#### 1. ROTATING AIR CUSHION

The air cushion surrounds the grinding wheel on both the front and circumferential surface

and acts as a barrier to the penetration of coolant. The rotating air only has around half as much peripheral speed as flow velocity after only a few tenths of a millimeter distance from the grinding wheel surface (Figure 2).

### 2. FLUSHING OF CLOGGED AREAS

Clogging of a grinding wheel basically means obstruction of the chip spaces with grinding chips. There are various phenomena that lead to clogging:

- **Chip nest:** Chips can deposit or get caught between the grains in the near-surface pores
- **Obstruction:** If a chip space is successively filled with chip material, chip compression results
- **Weld-on:** Workpiece material gets stuck on the grain tips through abrasive effect

Due to the high operating speeds of the grinding wheel these points constantly rub across the workpiece, so that the temperature in the grinding area increases on the one hand, and on the other the surface roughness deteriorates. This can be remedied with flushing the wheel by blasting the coolant under high pressure vertically onto the surface of the grinding wheel.

### 3. IMPREGNATION OF THE GRINDING WHEEL

Impregnation of the grinding wheel means filling the pore spaces in deeper grinding wheel regions with coolant. This only works with grinding wheels which have open pores connected with each other (pore network). Grinding wheels with closed metal or resin bonds, which only form bubble-type cavities, cannot be impregnated.

### 4. COOLING AND LUBRICATION OF THE GRINDING SLOT AND THE CONTACT ZONE

If too much coolant is pressed into the contact zone, hydrodynamic effects result which will virtually cause aquaplaning in the contact area. This can lead to dynamic effects which cause vibrations in the grinding wheel and the entire machine, resulting in undesirable surface marks and a deterioration in the surface quality.

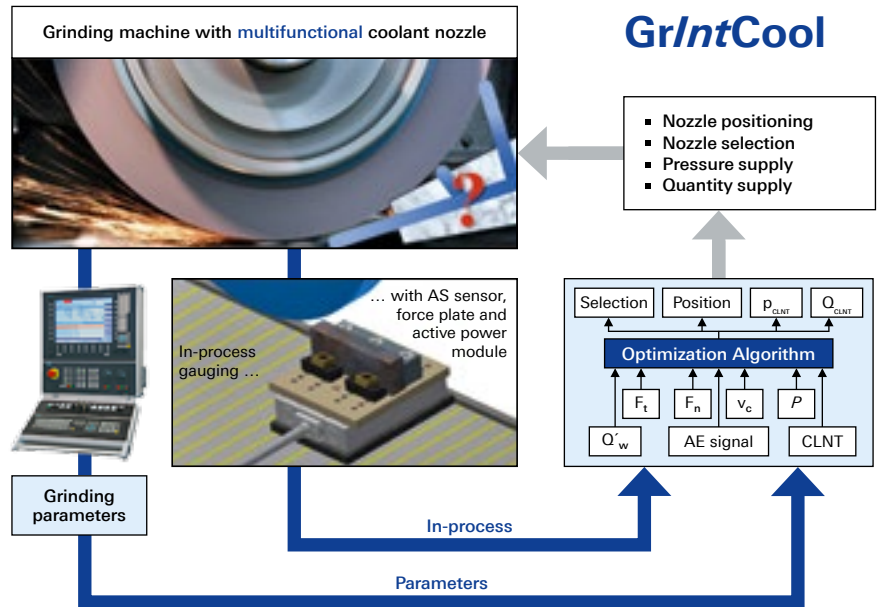


Figure 1: Overview of the project "GrintCool – Grinding with intelligent coolant supply"

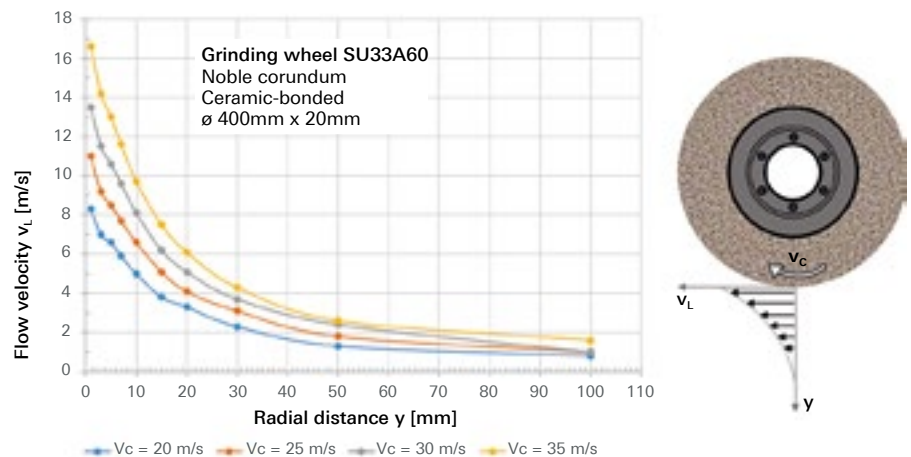


Figure 2: Measurement of the air flow velocity with grinding wheel rotating in radial direction

**“THE RIGHT COMBINATION OF POSSIBLE APPLICATIONS FOR COOLANTS LEADS TO AN INCREASE IN PERFORMANCE AND PROCESS RELIABILITY.”**

*Wilfried Saxler*

Tool grinding machines must therefore have higher rigidities than surface grinding machines. This is generally a special challenge, due to the 5-axis capability of tool grinding machines. A further issue is that during flute grinding of carbide or HSS – i.e. the classic cutting materials – very dense, non-porous bonds are used.

There is therefore a risk of “aquaplaning” if the coolant quantity is dosed incorrectly. Too little coolant can result in overheating of the grinding zone and leads to undesirable thermal damage of the peripheral zone. Therefore, only the appropriate amount of coolant for the chip space size should be supplied.



Friday, 10th May 2019, 10:15 am

# WOLFGANG VÖTSCH

Wolfgang Vötsch is Senior Milling Product Manager at Walter AG



## Trends in tool development and their implementation

### Short Summary

The requirements of climate protection have an impact on the development of machining tools. Design changes and new machining strategies are required

For the machining of lightweight components made from aluminium lithium alloys special milling cutters with very high cutting speeds are required

Material groups such as ISO M, which are difficult to machine, can be machined efficiently and reliably with Dynamic Cutting

Machine data analysis in real time helps reduce the machining time per workpiece and increases process reliability and machine service life

THE REDUCTION OF GREENHOUSE GAS CO<sub>2</sub> has become an important objective worldwide, in order to fulfil the climate protection targets of the Kyoto Protocol. Alternative drives; new, lighter materials, energy and resource saving concepts are more in demand than ever. This has a big impact on the development of machining tools. New fields of application emerge, and existing ones must be adapted. The greatest potential lies in tools and their application: in design changes and new coatings, in new machining strategies – and in digital solutions, which respond in real time.

### MILLING CUTTERS FOR THE AIRCRAFT INDUSTRY

New aluminium lithium alloys are on the rise. And conventional tools are quickly overwhelmed by these materials. This leads to an increasing demand for high-performance tools.

Aircraft industry example: Aircraft components made from aluminium alloys have metal removal of up to 90 percent! Numerous chamfers or cavities must be milled out of the metal, depending on the desired component geometry. The goal is always the same: to ensure stability and save weight. In order to manufacture these components economically and with high quality, they

must be machined using the “High Speed Cutting” method (HSC), with cutting speeds up to 3000 m/min.

The tool developers at WALTER had this requirement profile in mind when they developed the new M2131 ramping milling cutter. They equipped the 90° milling cutter with a new type of indexable insert, which is coated using a special physical process. Advantages: Friction, and therefore the tendency to form built-up edges, is significantly reduced. At the same time the cutting edge stability and resistance to flank wear are increased.

### DYNAMIC CUTTING

Increased process reliability, faster machining – at ever lower costs! Suppliers in many industries are under this pressure. And, of course, there must be no decrease in the product quality! Often the demands on surface quality and dimensional stability increase to the same extent as requirements on process reliability and cost effectiveness. This is exacerbated by a growing requirement for materials that are lightweight or heat-resistant, such as materials in material groups ISO M and ISO S, which are often difficult to machine due to these very characteristics. Dynamic milling offers a solution here.

The main differences between conventional High Performance Cutting (HPC) and

## “WE ARE SEEING AN INCREASING DEMAND FOR HIGH-PERFORMANCE TOOLS FOR MACHINING ALUMINIUM, ESPECIALLY IN AEROSPACE TECHNOLOGY.”

Wolfgang Vötsch

High Dynamic Cutting (HDC) lie in the movement of the cutter – and in the forces generated. In HPC, the milling tool moves with relatively shallow cutting depths. In HDC, the CAD/CAM control unit adapts the paths followed by the tool to the workpiece shape. This prevents unnecessary unproductive movements, or at least reduces them. The cutting depth is significantly greater in HDC than in HPC. This also saves travel distances (at different depths), because the complete tool length can be used from the beginning.

Higher cutting parameters, fewer unproductive movements and increased process stability result in a substantially higher removal rate with HDC cutting compared to HPC. Overall, High Dynamic Cutting is characterized by higher process stability and longer service life.

### OPTIMIZATION WITH SOFTWARE TOOLS

Automation and digitalization have been commonplace in many industries for a long time. But they still hold a great deal of potential. Hardware and software solutions for the acquisition and analysis of “live data” have achieved significant advances in performance in recent times. How this creates new possibilities for process optimization is demonstrated by “Comara iCut”, a software tool from WALTER.

The iCut adaptive feed control analyzes machine data in real time and adapts the machining process. This enables a significant reduction in the machining time per workpiece. In addition to the positive effect on the machining time, this also increases the process reliability. For example, more constant forces act on the spindle, increasing its working life.

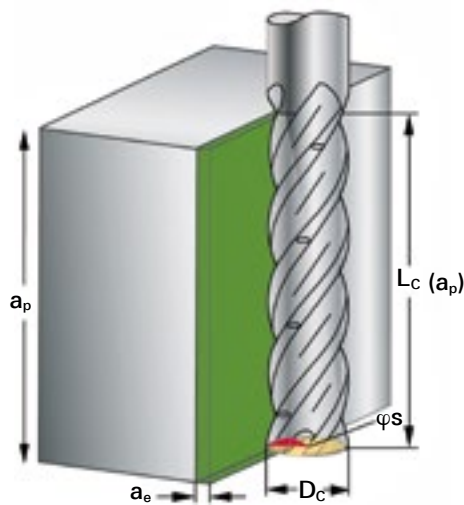
How we can meet new challenges during the tool development phase is demonstrated by the new generation of WALTER milling cutters, Xtra-tec® XT. The most striking design feature is the installation position of the indexable inserts: at a greater incline and with a larger contact surface. This reduces the surface pressure in the seat while increasing stability. The larger screw hole cross-section additionally stabilizes the indexable insert.

### GREATER PROCESS RELIABILITY

Many factors increase process reliability. The new installation position of the inserts also allows for the addition of an extra tooth, thereby increasing productivity. The precise 90° shape of the shoulder milling cutters also helps to reduce additional finishing operations. Another new feature is the smaller indexable inserts which can be fitted to the milling cutters. They are continuing the current trend towards reduced machining allowances. This applies even more to the M5009 face milling cutter: it combines shallow depths of cut with the advantages offered by double-sided Walter Tiger-tec® indexable inserts. These inserts have eight usable cutting edges instead of the usual four – so cost effectiveness is also increased.

As part of Walter Green, the production and supply chain of Xtra-tec® XT milling cutters is CO<sub>2</sub>-compensated. This means they meet a requirement which will probably be more important than any trends in future: sustainability.

*Dynamic cutting has a high machining rate  $Q_{max}$ , a small cutting width  $a_e$ , a large axial cutting depth  $a_p$ , and a constant average chip thickness  $h_m$*



*The ramping milling cutter is specially designed for the requirements of HSC machining of aluminium materials as well as new aluminium lithium alloys*

Friday, 10th May 2019, 11:00 am

# DR. CLAUD DOLD JAN VAN FRANKENHUYZEN



Dr. Claus Dold is Head of Process Innovation at Ewag AG and responsible for the development of new machining processes and applications

Jan van Frankenhuyzen owns the van Frankenhuyzen B.V. company in Lexmond, Netherlands, which manufactures high-quality tools in small series

## Think Laser! on tools and 3D geometries

### Short Summary

The production of spiral tools in solid material on a laser machine tool enables autonomous production of individual tool geometries

A customer application was developed for the van Frankenhuyzen B.V. company in a joint study

The machine has a storage area with blanks of different diameters in the automation cell. The customer can configure and order any tool via the webshop

This enables automated production in small series, including a lot size of one

THE MANUFACTURE OF TOOLS using laser technology for high-precision production with optimal surface qualities has become established as an integral part of tool manufacture at EWAG over the past few years. Today, standard applications are in the area of soldered inserts, rotary tools and indexable and profile inserts. In order to expand the present portfolio, a key focus of current development is in the area of small spiral tools. Autonomous production processes and the networking of machines are also an increasing focus.

Together with a longstanding customer, van Frankenhuyzen B.V., a new type of process chain configuration has been developed. The entire chain – from ordering of the tool by the end customer through to delivery of the finished component – was taken into account in this process. The digital front and back end was created by JDI smart web applications B.V. in Spankeren, Netherlands. This consists of a web application, which enables online connection of the customer as well as logic programming of all processes, including data flows from the online portal, the cloud service through to the machine tool. EWAG implemented all interfaces on the machine software for processing incoming data.

Huge progress has been achieved in the production of spiral tools – for example drill and milling cutter geometries in solid

material. Today, drilling and milling geometries can already be produced as standard in PCD and carbide, and in other materials such as CBN, CVD-D in some cases. Layered materials, such as full-head PCD on carbide applications, can also be produced without measurable transitions in the flute. The diameters currently available are in the range of 0.5 to 3 millimeters. Only drilling tools were considered within the study; milling tools will be integrated in a further step.

### PROGRAMMING BY CUSTOMERS

A key part of the study was to offer an interface that would be very easy for the customer to understand and highly efficient, in the form of a web application. The customer can order a tool in just a few steps:

- Visit the website
- Select the tool category
- Select the material to be machined
- The system suggests a tool
- The customer confirms or can change machining parameters

No details of machine parameter settings are given. No laser knowledge is required.

An engraved tool identification is then entered, as well as the quantities and required delivery time. The price for the selected order is displayed immediately,



**“AN AUTONOMOUS PRODUCTION CHAIN ENABLES EVEN MEDIUM-SIZED COMPANIES TO PRODUCE TOOLS IN MULTIPLE-SHIFT OPERATION WITH HIGH EFFICIENCY, WITHOUT ADDITIONAL PERSONNEL.”**

*Jan van Frankenhuyzen*

depending on the required delivery period. As soon as all steps are complete, the customer confirms the entries made.

**AUTONOMOUS MACHINE**

The customer’s input data are forwarded to a central server of the van Frankenhuyzen company or to a cloud service. The connected LASER LINE ULTRA machines from Ewag AG are configured so that they search the server for new orders at regular intervals. When a suitable order is found, the machine checks whether a suitable blank is available. The automation cell has been equipped with a storage area integrated into the machine for this purpose.

A pallet system with eight pallet spaces in combination with a hydraulic chuck can supply the machining cell very efficiently. Six pallets hold cylindrical blanks in the diameter range of 0.5 to 3 millimeters with a constant shaft diameter of six millimeters. Each pallet contains up to 300 blanks. The two remaining pallets are used for finished parts.

When the tool has been completely machined and is deposited in the storage area on the finished parts pallet, the machine starts searching for a suitable new order on the cloud service. No operator is required for this operation, except for loading and unloading the storage area and for regular service operations.

**PRODUCTION OF THE FUTURE**

Both companies, Ewag AG and van Frankenhuyzen B.V., are convinced that the future of tool machining in the area of laser technol-

ogy will be shaped by such control models. Basically all tool geometries which can be produced directly in solid material, can be integrated into the new system. This works particularly well, because in laser machining only the laser beam is required, and no typical process-relevant elements like grinding wheels and coolants.

*With the automation solution developed by EWAG and Frankenhuyzen spiral tools with diameters of 0.5 to 3 millimeters can be machined*



Photo: Claus Doid



Friday, 10th May 2019, 11:45 am

# ACHIM KOPP

Achim Kopp is Managing Director of Kopp Schleiftechnik, a manufacturer of cutting tools for milling and drilling of metals and plastics



## Key to successful change: Fulfilling the highest tool requirements in terms of quality and service with high-tech and passion

### Short Summary

High-tech and passion alone are not enough to cope with quickly changing tool requirements

It is the interaction of the factors of technology and processes on the one hand and people on the other, i.e. management, employees, customers and business partners

The better these factors are interlinked, the better the interaction between high-tech and passion will work, and the more successfully change can be managed

IT WAS THE DESIRE FOR INDEPENDENCE that led our company founder Helmut Kopp to make the transition from employee to entrepreneur at the end of the 1960s. He saw his market in the professional regrinding of milling and drilling tools for metalworking. So he founded his start-up, as we would call it today.

The demands on cutting tools and the customers' service requirements were relatively simple then. The milling or drilling tool had to be cleanly reground, but in most cases it already was. And so the focus was purely on the technical side. From the hand-operated, conventional tool grinding machine to semi-automatic, still mechanically controlled machines, NC machines through to the present high-tech CNC tool grinding machine, we at Kopp-Schleiftechnik have pursued and influenced tool grinding development over the past almost 50 years.

### FROM HANDICRAFT TO HIGH-TECH

New and high-performance materials constantly have to be processed in industry today, machining processes must be optimized and work steps combined, highly complex contours have to be machined, and production tolerances are becoming ever narrower. In addition, there are huge demands on accompanying processes. For example, the labeling of tools for traceability or an exact description and documentation of the production process for quality control is becoming increasingly important.

And last but not least, the individual service requirements of customers have to be met: Shortest delivery times, stocking of special tools, support of customers in the area of tool logistics, application consulting et cetera.

### SOLUTIONS, NOT PRODUCTS

Modern machining facilities are essential to produce or regrind high-precision milling and drilling tools. Which tools are to be machined, are they series or individual tools? Which dimensions and tolerances are primarily involved? How complex are the tool geometries?

This in turn involves the topic of tool design. There is a broad spectrum of starting conditions. Today, the tool manufacturer is often not provided with a perfect tool drawing by the customer. Instead, the customer sends his machining request or machining task to the tool manufacturer, for example a component to which a special circular contour must be applied. Often the tool manufacturer will then look for the ideal tool together with the customer. So not products, but solutions are required.

When a tool manufacturer has an integrated system of design program, simulation software, machine tools, measuring and labeling technology available, this hugely simplifies and accelerates the manufacturing process and is at the same time a quality factor that should not be under-

**“AN ACTIVE  
CORPORATE CULTURE  
SUPPORTED BY THE  
VALUES OF EVERYONE  
INVOLVED IN THE  
COMPANY IS  
WHAT DETERMINES  
OUR SUCCESS.”**

*Achim Kopp*

estimated. Where previously a simulation was performed directly on the first blank and on the machine, so by trial and error as it were, today you have a continuous process chain from drawing through to finished precision tool.

In addition to the machine there are other technical factors that are important in tool production:

- Ambient conditions in production, such as the central oil supply
- Air-conditioned production facilities, where room temperature and grinding oil temperature in the machine are matched to each other
- Cleverly controlled production processes
- Digital support, to ensure that the interconnected processes run as smoothly as possible

**THE HUMAN FACTOR**

Despite the finest technology, despite all the automation and digitalization: If you don't have the right employees, nothing else really matters.

For us at Kopp-Schleiftechnik this means: Everything starts with good training. But the transfer of knowhow, abilities and skills should not be limited to vocational training. Further training is also essential for skilled personnel. Particularly today, in our fast-paced world, where complexity and speed

are developing so rapidly, skilled personnel must be continually further educated, trained and qualified to meet the changing requirements in grinding technology and accompanying processes. This takes place both inhouse at Kopp and with our strategic partners, for example machine manufacturers such as WALTER.

**ACTIVE CORPORATE CULTURE**

At Kopp we go one step further. An active corporate culture supported by the values of everyone involved in the company is what determines our success. Involving employees in decision-making processes, assigning responsibility, communicating openly and, above all, dealing with each other respectfully, these are things that generally determine whether or not an employee has a strong emotional tie to his or her employer.

And ultimately this is exactly what is transmitted from the employee to the customer or business partner. We have found time and again that, despite all the modern and digital means of communication available, personal contact is still always best when it comes to building and maintaining long-term business relationships.