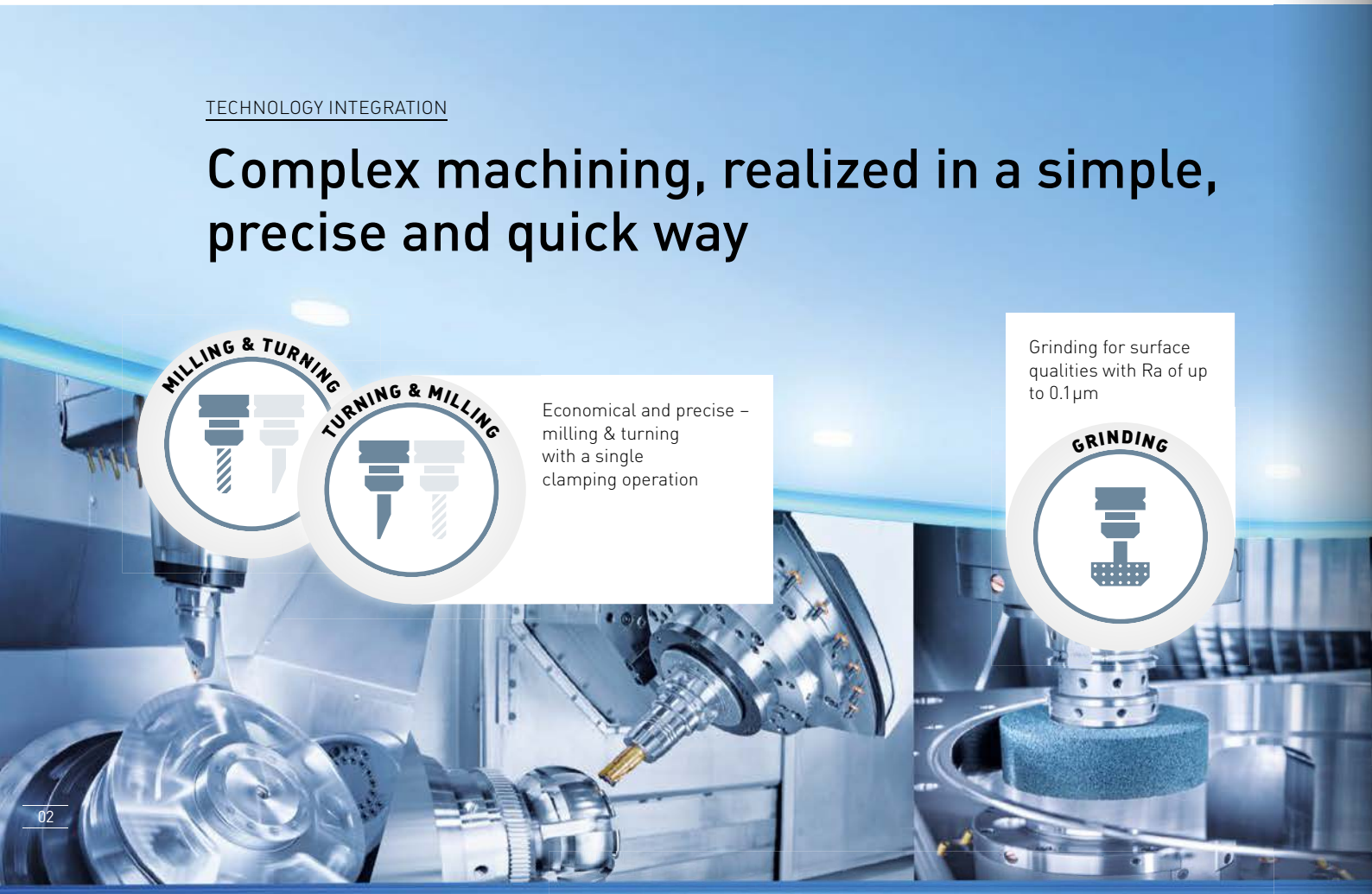
DMG MORI

TECHNOLOGY INTEGRATION

COMPLETE MACHINING

TECHNOLOGY INTEGRATION

Complex machining, realized in a simple, precise and quick way



Economical and precise – milling & turning with a single clamping operation

Grinding for surface qualities with Ra of up to 0.1 µm

Optimum combination – *µPrecision* and grinding

µPrecision

3µm

Complex machining geometries, realized in a simple way

VERZAHNUNG

55 exclusive DMG MORI technology cycles – program up to 60 % faster

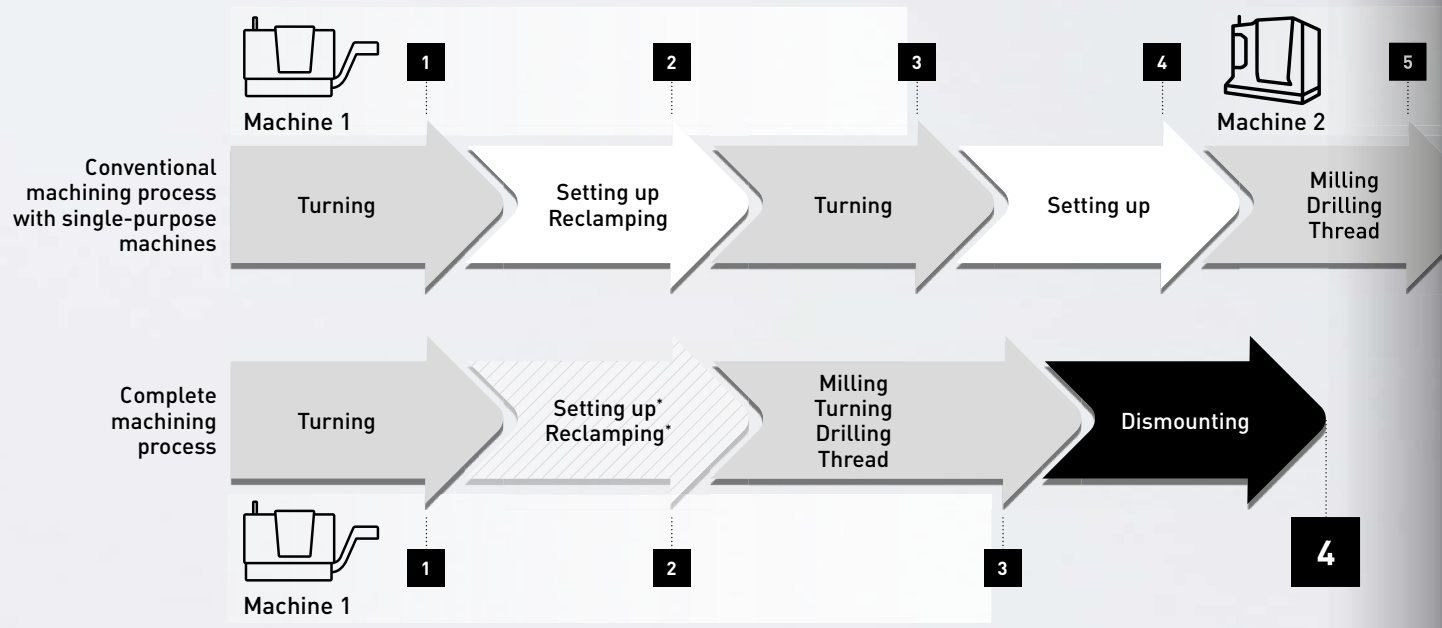
TECHNOLOGY CYCLES

TURNING & MILLING TECHNOLOGY INTEGRATION

Economical and precise – milling & turning with a single clamping operation

The milling & turning combination is the guarantee for maximum precision which also saves time. The innovative applications are supported by many useful software and hardware options and features.

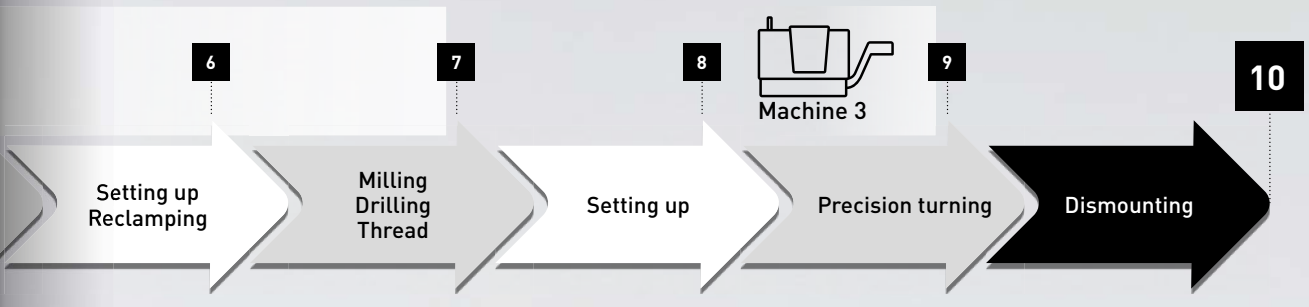
300 % MORE PRODUCTIVITY WITH COMPLETE MACHINING



*not required with turning & milling machines.

> 20 YEARS
OF EXPERIENCE
IN MILLING & TURNING/
TURNING & MILLING
APPLICATIONS

+ Maximum productivity – complete machining on a single machine with a single clamping operation
+ Lower investment costs and reduced space requirements thanks to the use of just one machine
+ Exclusive DMG MORI Mill-Turn cycles for safe and reliable processes
+ Faster machining times and reduced logistics due to the elimination of downtimes and work steps – lower unit costs and greater precision
+ Unbeatable range of machines for any requirement: 6 conceptionally different milling machines and 3 conceptionally different turning machines



Complete machining:
_ One machine
_ Four machining steps

300 %
more productive

Conventional process:
_ Three machines
_ Ten machining steps

TECHNOLOGY INTEGRATION OF MILLING ON TURNING MACHINES

Milling of complex workpieces up to 5-axis simultaneous machining

+ **Greater accuracy and lower process costs** by means of complete machining with a single clamping operation
+ One **tool carrier as an NC-controlled B-axis**
+ Machining of complex workpieces up to 5-axis simultaneous machining
+ **ShopTurn 3G** for workshop-oriented programming directly on the machine
+ **5-axis simultaneous machining** by means of technology cycle for 5-axis interpolation on main spindle and counter-spindle (optional)
+ **0.001° resolution of the direct measuring system** in the B-axis for the best finishes with 5-axis machining
+ Maximum dynamics thanks to 100 rpm B-axis swiveling speed
+ Optionally as high-speed version with 20,000 rpm

±120°

OIL / GAS INDUSTRY

Valve
CTX gamma 2000 TC
Material: GGG70
Workpiece dimensions: ø 350 mm × 495 mm
Machining time: 56 min.
Highlight: 6-sided complete machining

DRIVE TECHNOLOGY

Part of a ship's camshaft
CTX gamma 2000 TC
Material: 42CrMo4
Workpiece dimensions: ø 150 mm × 370 mm
Machining time: 66 min.
Highlight: 6-sided complete machining

Technology integration of milling on turning machines

+ NTX
+ CTX beta TC
+ CTX beta TC 4A
+ CTX gamma TC

Flexibility – The added value compared to any universal turning machine

100 % TURNING

+ Maximum turning diameter of up to 700 mm thanks to large traveling column axis strokes
+ Maximum torque of up to 4,000 Nm at the main spindle
+ 6-sided complete machining thanks to the optional counter spindle

100 % MILLING

+ Y-stroke of up to 420 mm for off-center machining thanks to traveling column concept with maximum stability
+ Maximum milling capacity thanks to the compactMASTER with up to 120 Nm (NTX / CTX beta TC) / 220 Nm (CTX gamma TC) and up to 20,000 rpm (12,000 rpm as standard)
+ 5-axis simultaneous machining for machining free-form surfaces (with optional DMG MORI technology cycle)

100 % TOOLS

+ Up to 180 tools for maximum flexibility during machining, and the shortest setup times
+ Disk magazine with 24 (CTX beta TC) / 36 locations (CTX gamma TC) as standard
+ Low-cost standard tools due to freely indexable B-axis with swiveling range of up to ± 120 ° and maximum accuracy (position spread < 1 µm)

TECHNOLOGY INTEGRATION OF TURNING ON MILLING MACHINES

Mill-Turn drives with direct drive technology for components weighing up to 7,000 kg

Available for

+ DMU / DMC monoBLOCK
+ DMU / DMC H monoBLOCK
+ DMU / DMC duoBLOCK
+ DMU / DMC Portal
+ DMU eVo
+ DMF

Unique technology

+ Mill-Turn drives with direct drive technology – speeds of up to 1,200 rpm, output of up to 68 kW, torque of up to 20,000 Nm, max. table load of up to 7,000 kg
+ 5X torqueMASTER as B-axis with 8,000 rpm, max. 52 kW and 1,800 Nm
+ Oil mist separator and laminated glass safety windows as standard with duoBLOCK and Portal
+ Grooving, parting, chip removal, thread cutting etc.
+ Determining checking and monitoring imbalance
+ Storage, output and forwarding of measurement data

TOOLS

Use of multi-cutting tools with up to nine cutting edges (optional)

TABLE TECHNOLOGY

Powerful Mill-Turn table with direct drive technology

SOFTWARE CYCLES

Exclusive software cycles for optimum user support
(e. g. balancing, measuring etc.)

SPINDLE PORTFOLIO

Impressive range of spindles for any application up to 1,800 Nm

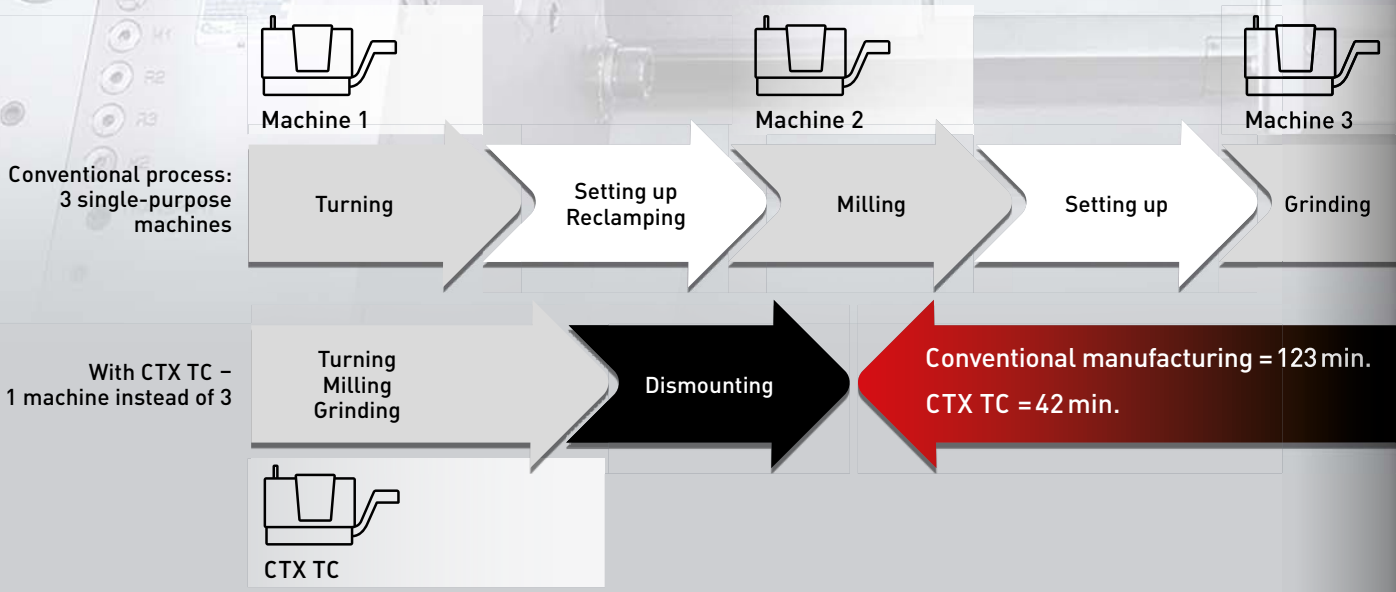
GRINDING

TECHNOLOGY INTEGRATION GRINDING

Grinding for surface qualities with Ra of up to 0.1 µm

Grinding with a single clamping operation makes maximum precision possible and the best finish quality with maximum cost-effectiveness at the same time. An integrated acoustic emission sensor guarantees maximum process reliability, whereas the integrated dressing cycles reduce the wear of the grinding disk to a minimum. The grinding is supported in the best possible way by means of dialog-assisted programming, which makes comfortable and efficient machining possible for the customer. The guarantee of maximum user-friendliness, precision and reliability.

65 % LESS THROUGHPUT TIME



HIGHLIGHTS

+ Turning, milling and grinding in one setup
+ Process reliability and cost-effectiveness by omitting special machines and with reduced grinding allowance
+ Simple set-up and optimized start-up with the aid of structure-borne noise sensors
+ Best finish quality by integrating the grinding technology

WORM SHAFT

Dimensions: ø175×380 mm
Material: 16MnCr5

Dismounting

> 65 %
more productive

Carrying out the grinding with a single clamping operation makes maximum precision possible and provides the best finish quality with maximum cost-effectiveness at the same time.

Technology integration
Grinding on turning machines

+ CTX beta TC
+ CTX beta TC 4A
+ CTX gamma TC

Technology integration
Grinding on milling machines

+ DMU/DMC monoBLOCK
+ DMU/DMC duoBLOCK
+ DMU/DMC Portal

TECHNOLOGY INTEGRATION OF GRINDING ON TURNING MACHINES

Grinding technology on turning machines

+ Grinding cycles for interior, exterior and face grinding, polygon and oval grinding, and dressing cycles
+ In-process measurement in parallel to production time using fully integrated measuring clamp
+ Best finish quality by integrating the grinding technology

Available for

+ CTX beta TC
+ CTX beta TC 4A
+ CTX gamma TC

TOOL AND BALANCING TECHNOLOGY

+ Exclusive tool technology from our DMQP partners (HAIMER & TYROLIT)
+ Quick grinding disk replacement thanks to ring holder
+ Standardized grinding disk holder with IKZ

INTERNAL COOLANT SUPPLY

+ IKZ-capable tool holders for best possible flushing of the contact area with cooling lubricant pressure of 80 bar
+ 1,300 l coolant system, with filter system including centrifuge for particles > 5 µm
+ Work area wall flushing as protection from chips

STRUCTURE-BORNE NOISE SENSORS

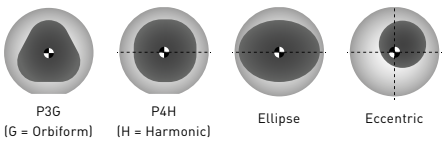
+ Spindle-integrated to minimize downtimes
+ Makes dressing and grinding possible without air cutting
+ Available for main and counter spindle

IN-PROCESS MEASUREMENT

+ Measure live diameter during grinding
+ Relative or absolute measurement (depending on measuring clamp)
+ Measurement repeatability up to 0.8 µm

POLYGONAL, OVAL & ECCENTRIC GRINDING

+ The ideal solution for polygonal shaft / hub connections with 3 or 4 edge polygons



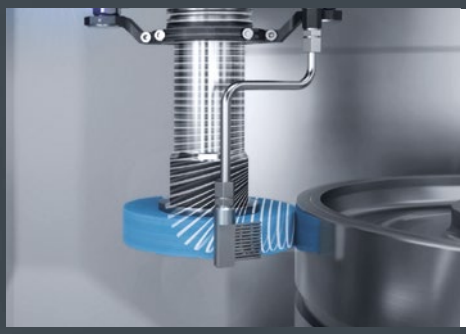
GRINDING TECHNOLOGY INTEGRATION ON MILLING MACHINES

Grinding technology on milling machines

+ Grinding cycles for interior, exterior and face grinding and dressing cycles
+ External Coolant Sypply nozzle unit optionally available for best possible flushing of the grinding gap

Available for

+ DMU / DMC monoBLOCK
+ DMU / DMC duoBLOCK
+ DMU / DMC Portal

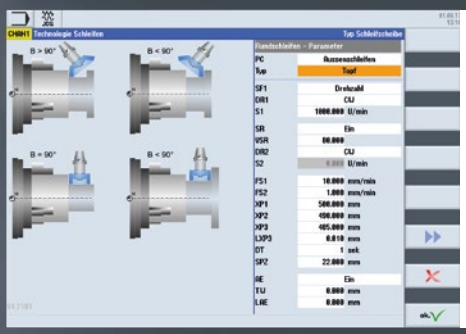


ACOUSTIC EMISSION SENSOR

+ Spindle-integrated to minimize downtimes
+ Makes dressing and grinding possible without air cutting
+ Visualization of contact between grinding tool and component directly on the control

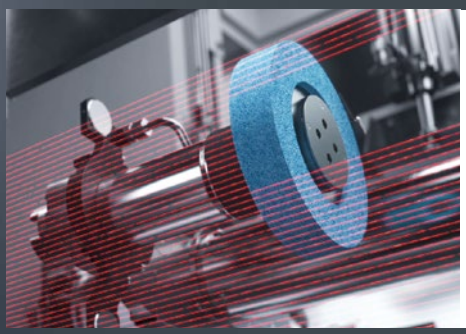
INTERNAL COOLANT SUPPLY

+ ICS-capable tool holders for best possible flushing of the contact area with coolant lubricant pressure of 80 bar
+ 1,300 l coolant system, with filter system for particles > 5 µm
+ Work area wall flushing as protection from chips



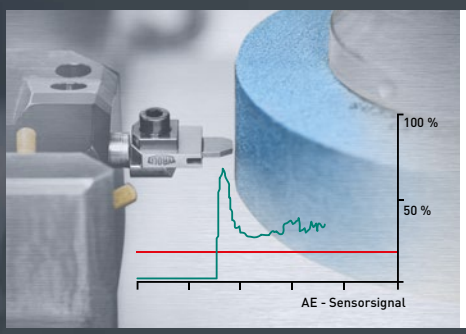
GRINDING TECHNOLOGY CYCLES

+ Intuitive dialog-assisted programming of grinding and dressing cycles
+ External cylindrical grinding, internal cylindrical grinding, surface grinding, taper grinding, plunge-cut grinding
+ Dressing with or without acoustic emission
+ Flat grinding cycle for grinding long components or distances



SAFETY MEASURES

+ Maximum safety for the operator and the machine thanks to automatic checking of the grinding disk diameter with DMU/DMC duoBLOCK and DMU/DMC Portal
+ Speed limitation depending on the tool diameter
+ Manual switch for confirming the tool diameter when a manual tool change takes place



DRESSING UNIT

+ Stationary or rotating dressing unit for dressing a wide range of tool materials with DMU/DMC duoBLOCK and DMU/DMC Portal
+ First cut detection using acoustic emission sensor
+ Dressing of complex disk contours possible

TECHNOLOGY INTEGRATION OF HIGH PRECISION ON MILLING MACHINES

Optimum combination – *µPrecision* and grinding

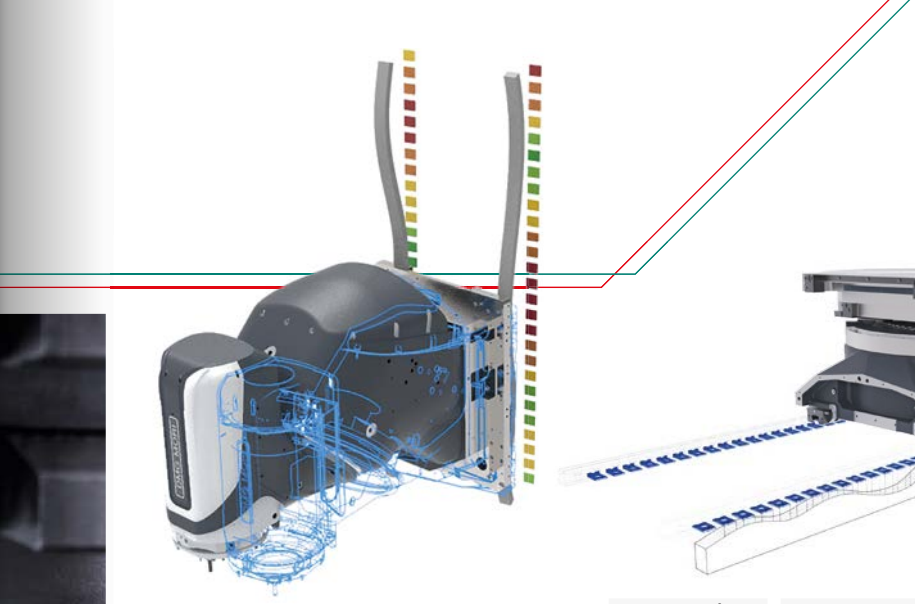
The high-precision variant *µPrecision* with a volumetric accuracy of up to 13 µm is globally unique. It is based on finely adjusted linear guideways. Because in order to achieve a perfect machining result in the entire working area, a high degree of precision with regard to the flatness, perpendicularity and straightness of all linear axes is required.

MAXIMUM POSITIONING ACCURACY
P_{max} ≤ 3 / 3 / 3 µm
(X/Y/Z)*

HIGHLIGHTS

+ **Maximum precision by means of finely adjusted linear guides** (flatness and straightness ≤ 3 µm)*
+ **Positioning accuracy of up to 3 µm**
+ **Volumetric accuracy of ≤ 13 µm***
+ **Individual optimization at installation site** – Compensation of heat expansion and volumetric compensation (VCS) under individual framework conditions
+ **Unbeatable dynamics** with up to 6 m/s² and 60 m/min
+ **Reference-guided temperature control** of all of the relevant heat generating machine components

*Specifications on the example of the DMU 80 P duoBLOCK



FINE ADJUSTMENT WITH ADJUSTMENT PLATES

Accuracy increase of up to 80 %

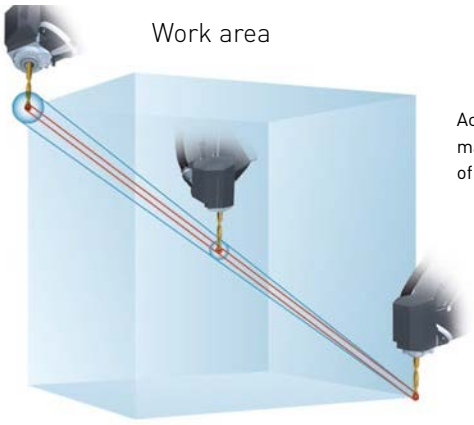
		DMU 80 P/FD DMC 80 U/FD	DMU 125 P/FD DMC 125 U/FD	DMU 160 P/FD DMC 160 U/FD
Positioning accuracy of the linear axes in X/Y/Z	µm	3/3/3	4/3/4	4/4/4
Positioning accuracy of round axes A/B/C	ws	5/4/4	5/4/4	5/4/4
Straightness and flatness of the linear axes	µm	3/3/3	4/4/4	6/6/6
Volumetric accuracy*	µm	13	15	20

*after room compensation has taken place; only linear axes taken into consideration

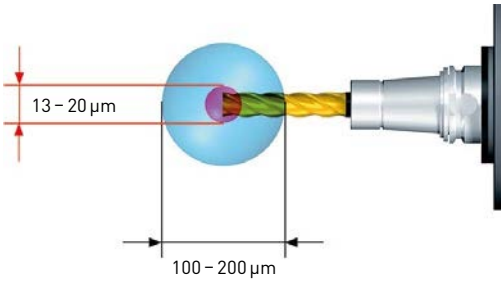
Scope of package *µPrecision*

+ All measures of the **accuracy package** (coolant temperature control, thermo-shield, VCS Complete etc.)
+ **Finely adjusted linear guideways in X/Y/Z**
+ Coolant system with **reference-guided temperature control** and **reference-guided powerful cooling system**
+ **VCS measurement** (Volumetric Compensation System) incl. volumetric measurement and compensation of the machine work area (linear axes) at the installation site of the customer
+ **Spindle Growth Sensor (SGS)**
+ **Compensation point increase** in all axes
+ **Geometric tolerances limited** by up to 80 %
+ **High-precision OMP 600 measuring probe**

Work area



Accuracy valid in the overall machining range, regardless of the spindle position.



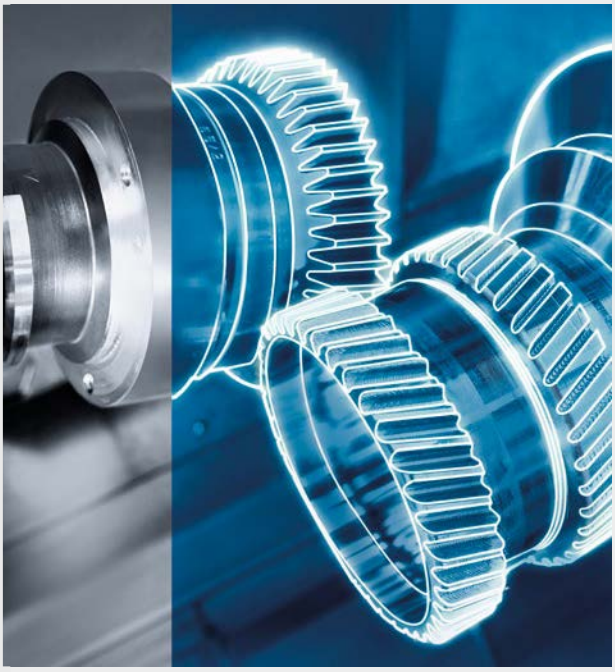
GEARING TECHNOLOGY INTEGRATION

Complex machining geometries, realized in a simple way

The technology integration of the gearing makes the entire process chain for flexible and productive manufacturing of gearing on universal machining centers possible.

HIGHLIGHTS

+ Manufacture of gearing on universal machining centers
+ Maximum flexibility thanks to requirement-oriented utilization of the machine with milling, turning and gearing operations
+ No special machines needed to manufacture gearing
+ Simple programming thanks to technology cycles or specially developed programming software



GEARING – DMG MORI TECHNOLOGY CYCLES

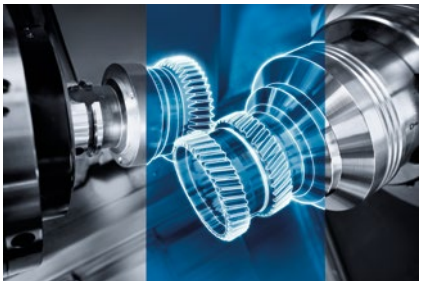
+ **FAST:**
  60 % faster thanks to dialog-assisted entry of the gearing parameters
+ **SIMPLE:**
  Automatic calculation of NC program based on the gearing parameters
+ **RETROFITTABLE:**
  Pure software solution – integration in new and existing machines

gearMILL

+ Low-cost and efficient manufacture of the most popular gear wheels with any tooth profiles, both in soft and hard machining
+ Gearing milling with standard tools ≥ MODULE 3
+ Gearing quality ≥ 5

GEARING TECHNOLOGY INTEGRATION

Gearing made easy

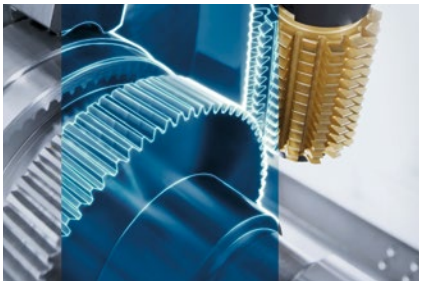


Available for CTX TC, CTX TC 4A, NTX, DMU eVo, DMF, DMU / DMC duoBLOCK (only with FD)

gearSKIVING 2.0

+ Straight and helical external or internal spur and spline gears up to module 11
+ Herringbone gearing with tooth offset on turning & milling machines*
+ Crowned gearing by mathematical transformation of the 6th virtual axis on TC and monoBLOCK machines

*on CTX TC with counter spindle



Available for CTX TC, CTX TC 4A, NTX, DMU eVo

gearHOBBING

+ Spur, helical, curved gearing and worm gears possible
+ Hobs and disk milling cutters can be used
+ Tool service lives maximized by "shifting" the milling cutter
+ Achievable quality ≤ DIN 7

Available for CTX TC, CTX TC 4A

crownHOBBING

+ Manufacture of Hirth gearing by means of impact milling on turning & milling machines
+ Automatic calculation of tool path movements
+ Position-oriented tooth pairings by determining the angle position of the gearing on the component

ALL-IN GEARING PACKAGE

Use our All-In package with 5 technology cycles for the entire range of gearwheel machining – Exclusively for our CTX TC machines.

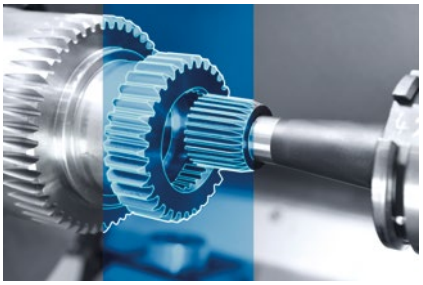
+ gearSKIVING 2.0
+ gearHOBBING
+ crownHOBBING
+ gearBROACHING
+ gearSHAPING

30 % PRICE ADVANTAGE

Available for CTX TC, CTX TC 4A, NTX

gearBROACHING

+ Broaching of internal and external gearing with dialog-assisted programming
+ One-toothed to four-toothed cutting tools with clear tool definition
+ Compensation parameters for the displacement of the tool holder



Available for CTX TC, CTX TC 4A

gearSHAPING

+ Manufacture of straight internal and external gearing on components using the gear shaping manufacturing procedure

Available for CTX TC, CTX TC 4A

gearHONING

+ For fine machining of gearing after skiving
+ Maximum finishing and shape quality with regard to concentricity, flank and profile

GEARING TECHNOLOGY INTEGRATION

DMG MORI gearMILL

With the modular DMG MORI gearMILL service package consisting of a standard machine, standard tools, measuring module and special DMG MORI gearMILL gearing software, DMG MORI provides its customers with an efficient process chain with which the most popular gearwheels can be manufactured in an efficient and cost-effective way with any gear profiles using both soft and hard machining. In addition to the DMG MORI gearMILL technology, the 5-axis machines of the DMG MORI concern are at the heart of the success. Furthermore, the milling & turning machines of the DMU FD and DMC FD series make integrated manufacturing of rotation objects to be geared and also entire pinion shafts.

Available for turning machines

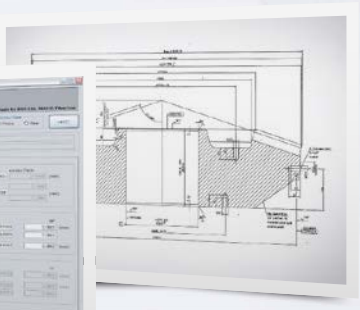
+ NTX
+ CTX TC

Available for milling machines

+ DMU / DMC monoBLOCK
+ DMU / DMC duoBLOCK
+ DMU / DMC Portal
+ DMU eVo
+ DMF

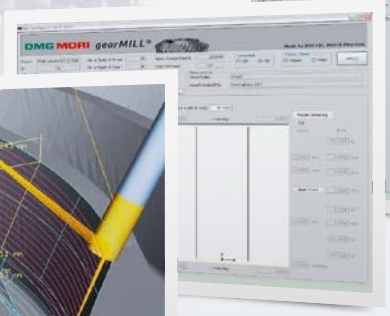
SOFTWARE FOR MANUFACTURING GEARWHEELS

Process chain
with DMG MORI gearMILL

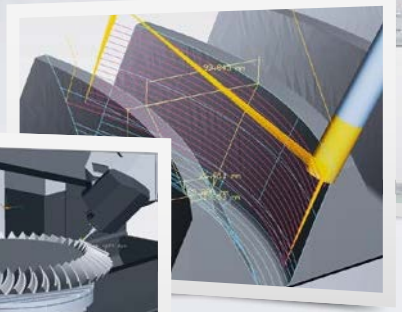


1. Drawing

2. Calculation

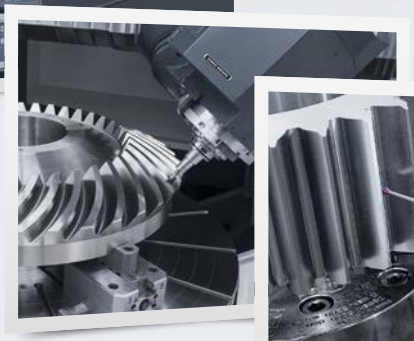


3. Modification



4. CAM

5. Simulation



6. Machining

7. Measuring (in the process)

8. Measuring (external)

SPUR GEAR

+ Spur toothed
+ Helically toothed
+ Complex profile and flank modification
+ Herringbone gearing
  (with and without center groove)

BEVEL GEAR

+ Spur toothed
+ Helical toothed
+ Hypoid
+ Axis angles other than 90°
+ Klingelnberg Zyklo-Palloid®
+ Gleason, FORMATS & SGT

WORM GEAR

+ Individually modifiable contact pattern
+ Profile ZA
+ Profile ZN
+ Profile ZI

DMG MORI TECHNOLOGY CYCLES

55 exclusive DMG MORI technology cycles – Complex machining, easily realized

+ Safe and reliable processes
+ Clear product range structure, program up to 60 % faster
+ Fault minimization by means of dialog-controlled programming
+ Technology integration, e. g. gearSKIVING and grinding
+ Technology know-how stored directly in the cycle

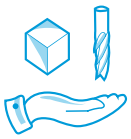
60 %
FASTER THANKS TO DIALOG-ASSISTED PROGRAMMING

More information about the technology cycles can be found at:
techcycles.dmgmori.com

4 Application areas

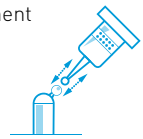
1 15 HANDLING CYCLES

+ Simplifies machine operation – e. g. immersion of the B-axis
+ Automates processes – e. g. counter-spindle tip
+ Protects from operating errors with increased safety – e. g. turret head steady rest



2 9 MEASURING CYCLES

+ Increases machining accuracy – e. g. 3D quickSET
+ Opens up new measuring options on bulky component geometries – e. g. L-measuring probe
+ Increases transparency in QA processes – e. g. gearMILL with in-process measurement



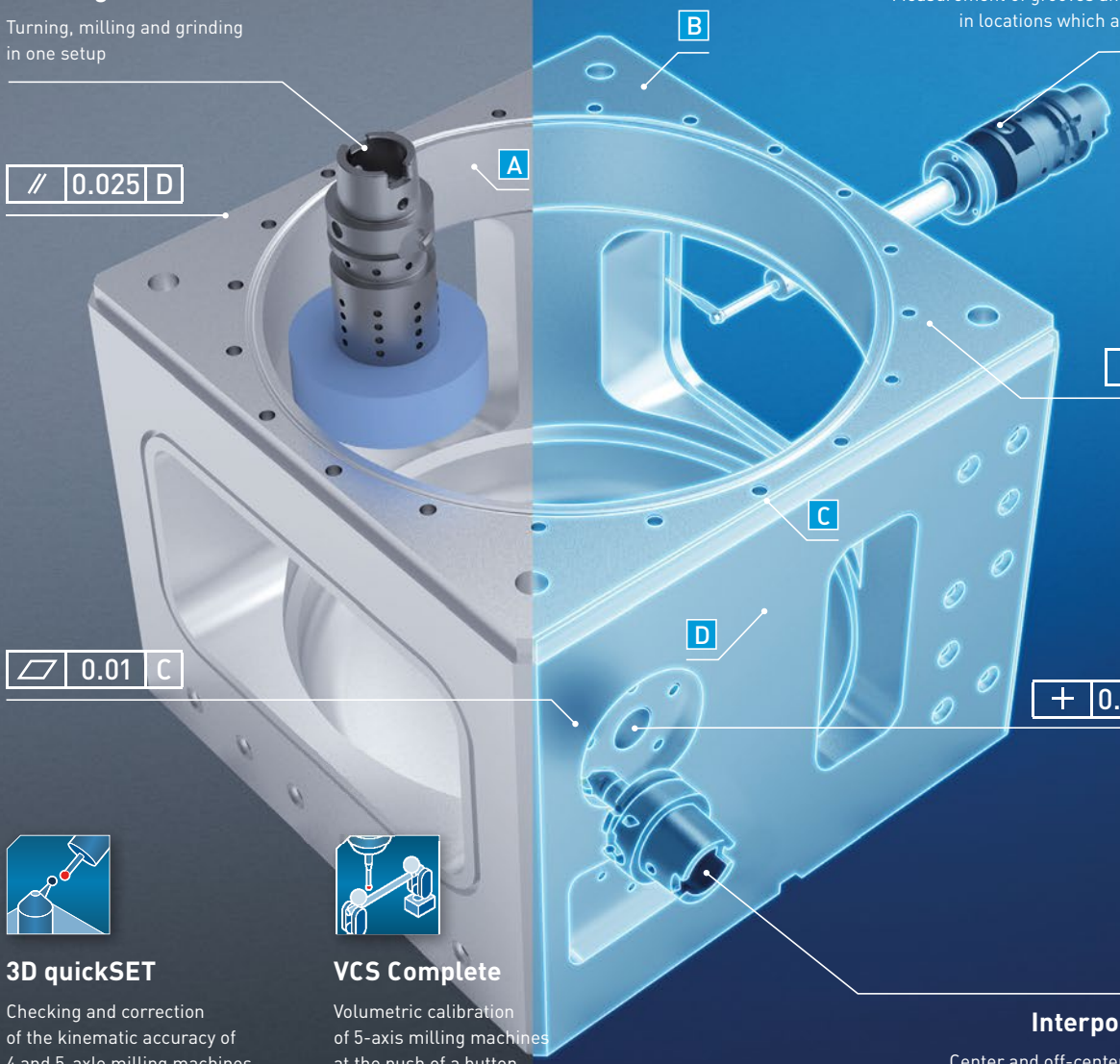
Grinding

Turning, milling and grinding in one setup

EXAMPLE WORKPIECE FOR THE USE OF TECHNOLOGY CYCLES

L-measuring probe package

Measurement of grooves and bars and diameter in locations which are difficult to access



3D quickSET

Checking and correction of the kinematic accuracy of 4 and 5-axle milling machines and turning/milling machines

VCS Complete

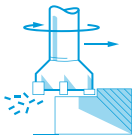
Volumetric calibration of 5-axis milling machines at the push of a button

Interpolation turning

Center and off-center turning operations by means of axis interpolation, e.g. for manufacturing sealing surfaces

3 23 MACHINING CYCLES

+ Integrates new machining processes – e.g. gearSKIVING
+ Extends machine capability – e.g. grinding
+ Simplifies complicated programming tasks – e.g. Multi-threading 2.0



3 8 MONITORING CYCLES

+ Increases machine safety – e.g. MPC – Machine Protection Control 2.0
+ Increases process reliability – e.g. Easy Tool Monitoring 2.0
+ Adapts processes for eliminating vibration – e.g. MVC – Machine Vibration Control

CUSTOMER STORY – SKF USA INC.

AUTOMATION & TECHNOLOGY INTEGRATION AT ITS BEST

The proud team from SKF in Sumter in front of the three automated DMU 340 FDs.

Thanks to the integration of milling, turning, grinding and gear cutting, components for thin-section bearings can be completely finished.

The history of SKF begins in 1907 in Gothenburg, Sweden. The Swedish engineer Sven Gustaf Wingqvist, one of the founders, had previously invented the self-aligning ball bearing. The company quickly established itself with an extensive range of products and services in the fields of rolling bearings, seals, lubrication and mechatronics. Today, SKF is represented worldwide and supports customers from almost all industries. Whether aerospace, medical, semiconductor, automotive or the energy sector – the experts always realize optimal and individual applications. Regular investment in innovative manufacturing technology contribute to long-term competitiveness in production – including at the US site in Sumter. There, complete production of thin-section bearings was implemented on three automated DMU 340 FD machines. DMG MORI has integrated grinding and gear milling by means of gearSKIVING as well as autonomous and process-reliable tool handling by TH-AGV.

Performance and precision with machines from DMG MORI

"Our products enable precise, low friction operation of rotating equipment and machine elements." according to Marcus Jakob, Director of Operations at SKF in Sumter. "Focus on reduced energy consumption for all our customers puts

DMU 340 FD:
MILLING, TURNING, GRINDING AND GEAR CUTTING

exciting challenges ahead of us". That's why SKF continuously invests in further development of its rolling bearings, slewing rings and seals, he said. "Customer demands are increasing, while tighter tolerances, reduced cost and higher performance are on the daily wish list, which means we have to adapt our production accordingly".

To keep up with this development, SKF is constantly putting manufacturing to the test, according to Mr. Jakob. "On one hand, we need high-precision multi-tasking machining centers, and on the other – to remain ahead of our competition – we depend on very efficient, solid and well-engineered manufacturing processes." With CNC machine tools from DMG MORI, SKF has had the best experience in terms of performance and precision for many years.

Thus, the machine tool manufacturer was also on the short list in Sumter when machining centers were to be purchased for the production of thin-section bearings up to 3,000 mm in size. "The decisive factor for the three DMU 340 FDs was the machining versatility through technology integration," recalls Marcus Jakob. "This is because, in addition to 5-axis milling and turning in one workspace, the XXL machining centers are also equipped with the exclusive DMG MORI technology cycles Grinding and gearSKIVING. This allows us to perform all machining steps on any of these models for which we previously needed at least two additional machines." In addition, he says "there has been a drastic reduction in throughput times in grinding and gear milling."

High machine utilization thanks to robot loading

The real benefit for SKF is to maximize machine tool utilization. "Technology integration has also allowed us to eliminate waiting times that were previously unavoidable when changing to different machines," says the Director of Operations. He also states that setup of components has been accelerated with the help of robotic automation from Fastems. The model for this process was a plant that he had previously established in his role as Aerospace Process Development Manager: "There, it involved robot-assisted production of smaller bearing rings for the aerospace sector." In Sumter, he says, "SKF extended this principle to XXL machining on top of adding best in class workholding and automation principles. While automation ensures continuous manufacturing operation and maximizes the utilization of the machining centers, our team can fully concentrate on preparing new orders and quality control."

TH-AGV: autonomous and process-safe tool handling

Another issue SKF addressed during this project was tool management. With the TH-AGV, DMG MORI also had a product in its product range that supports the automation of this process. "60 tool changes per shift is a huge, time consuming task," explains Marcus Jakob. "The TH-AGV ensures autonomous transport of all tools to the respective machine." The TH-AGV can accommodate tools weighing up to 50 kg with diameters of 400 mm and lengths of 380 mm. The maximum loading weight with 16 tools is 480 kg. The safety of people and

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Technology integration on the three DMU 340 FDs with milling, turning, grinding and gear cutting takes us to a new level of productivity. With this, we have created flexible redundancy with zero setup and reduced processing times.

Marcus Jakob
Director of Operations
SKF

EXCLUSIVE TECHNOLOGY CYCLE
360° TECHNOLOGY COMPETENCE

TURNING, MILLING AND GRINDING

+ Turning, milling and grinding in one clamping
+ Grinding cycles for internal, external and face grinding as well as dressing cycles
+ Static or rotating dressing unit for d ressing a wide range of tool materials with the aid of structure-borne sound sensor technology
+ AKZ nozzle unit optionally available for best possible flushing of the grinding gap

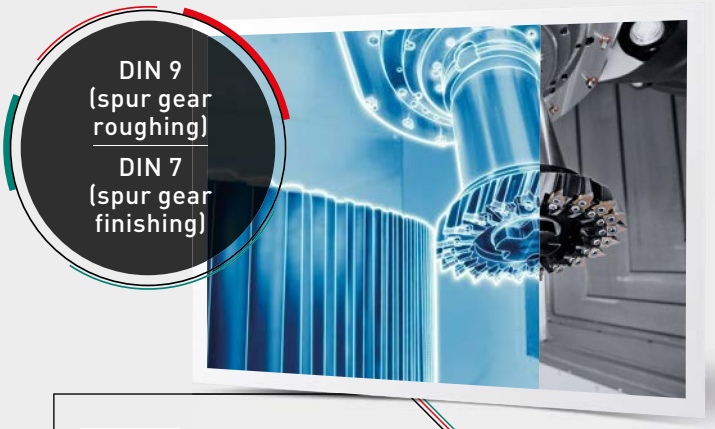
The autonomous tool handling with the TH-AGV is ingenious. We save 60 manual tool changes per shift here. Every tool must be 100 % measured, managed and in the right place at the right time. This is guaranteed.

Marcus Jakob
Director of Operations
SKF

EXCLUSIVE TECHNOLOGY CYCLE gearSKIVING

gearSKIVING – UP TO 8 × FASTER THAN GEAR SHAPING

+ Straight and helical external or internal spur gears and splines
+ For external and internal gears
+ Synchronized rotation of tool and workpiece
+ Module 2 – 10 possible



More information about DMG MORI technology cycles:
techcycles.dmgmori.com

machines is ensured by scanners and sensors that permanently monitor the AGV travel path.

Central tool management with MCC LPS from DMG MORI

A decisive factor in tool management is process reliability. In central tool management, SKF uses RFID chips to assign tools to the respective orders and machines. "Thanks to end-to-end digitization from tool presetting to machining, we can be sure that no incorrect tools are changed nor incorrect offsets entered into the controller." Here also, the TH-AGV assumes an important role. Via WLAN, the DMG MORI Master Computer MCC LPS IV transmits the transport orders to the TH-AGV, which then reliably delivers the tools to the correct machine.

Process optimization follows a group-wide role model

Both with technology integration on a machine and the extended automation, SKF is breaking completely new ground.

Kenneth McFadden is a machine operator from the SKF team responsible for one of the DMU 340 FDs.

Consequently, this process first has to be introduced to the respective teams," admits Marcus Jakob. However, the optimized processes have quickly convinced everyone involved; reason enough to continue on this path in the future. Specifically, he is thinking about a DMU 210 FD that will work according to the same principle. "These technical solutions in France and Sumter naturally serve as a good role model within the entire SKF Group."

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Tool loading station

+ Transfer station on the CTS and on the machine for batch setup of 8 tools
+ Tools up to 50 kg and 650 mm in length

Tool handling – TH-AGV

+ Automated transport of 16 tools (2×8 sets) between the CTS (central tool storage) systemand the machine
+ 480 kg total load on the transport unit

SKF FACTS

+ Founded in Gothenburg, Sweden, in 1907
+ Extensive range of products and services in the fields of roller bearings, seals, lubrication and mechatronics
+ Customers in the aerospace, medical, semiconductor, automotive and energy sectors, among others

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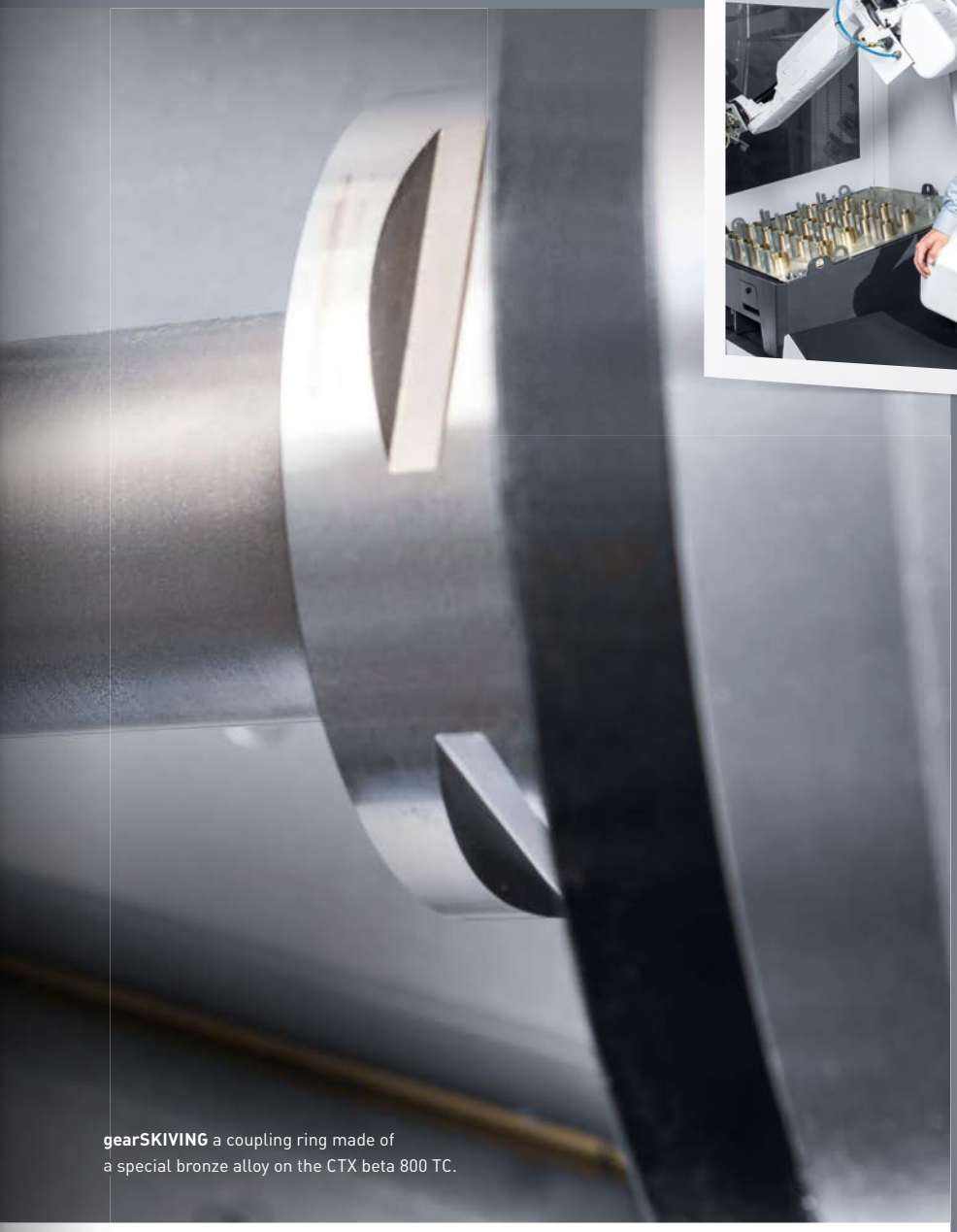
CUSTOMER STORY –
MASCHINENFABRIK MÖNNINGHOFF GMBH & CO. KG

RESILIENCE THROUGH TECHNOLOGY INTEGRATION

Example of various coupling rings, which are used in tooth clutches or tooth brakes, for example.

Innovative drive technology from Maschinenfabrik Mönninghoff GmbH & Co. KG has been the benchmark for quality and reliability since 1916. The 125 company employees develop and manufacture a diverse range of couplings, brakes, linear actuators and complete system solutions for customers in almost every sector – from agriculture through robotics to the food industry. After 105 years at the original location in Bochum, Mönninghoff has now built a new, modern plant to ensure the continuation of opti-



gearSKIVING a coupling ring made of a special bronze alloy on the CTX beta 800 TC.

The gear cutting cycles from DMG MORI now enable us to completely machine our workpieces on one machine, even faster and to the same quality as on our special machines.

***Charlotte Finger**, managing partner with **Timon Lubek,** head of production Maschinenfabrik Mönninghoff GmbH & Co. KG*

mal operation along the entire process chain. In production, the company has been relying on machine tool technology from DMG MORI since 2010. Further investments in machining centers and turning machines followed the installation of an NT 4300. The latest acquisition is a CTX beta 800 TC with Robo2Go. Mönninghoff also uses numerous DMG MORI technology cycles for their gear production.

Design and manufacture of complex drive components

"The structural transformation in the Ruhr district over the last few decades meant we had to come up with something new," explains Charlotte Finger, managing partner of Mönninghoff. Until the 80s, the company had generated over 90 percent of its sales in mining. Since then, it has continued to develop a special niche in drive technology.

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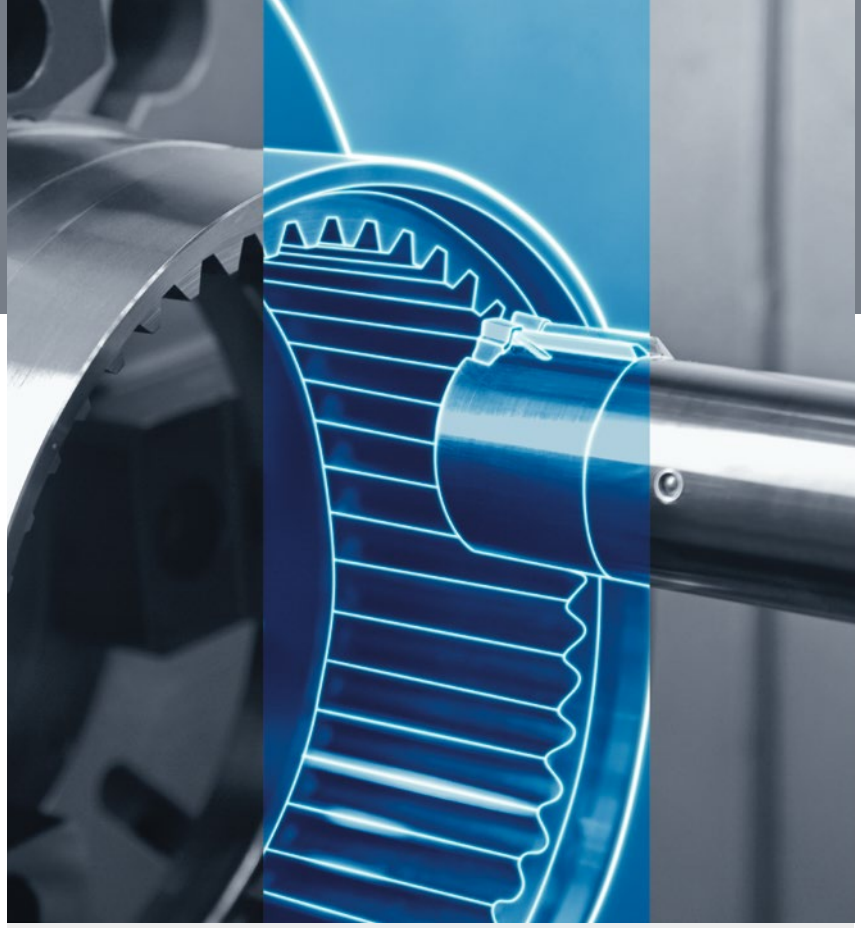

EXCLUSIVE TECHNOLOGY CYCLE
gearBROACHING

POSITION-ORIENTED PRODUCTION OF GEARING ON THE MAIN AND COUNTER SPINDLE

+ Internal and external gears
+ Ideal for workpieces with shoulders or interference contours due to runout
+ Compensation parameters for deflection of the tool holder
+ Available for machines with SIEMENS/CELOS with SIEMENS

After Mönninghoff had outsourced special gear manufacturing to another firm – Chemnitzer Zahnradfabrik – in 1992, the company was free to concentrate on its core expertise: The design and manufacture of sophisticated and complex coupling and braking systems. "These are almost exclusively special solutions, which we often develop in cooperation with our customers," explains Charlotte Finger. Mönninghoff is well known throughout industry for this expertise and is generally involved in project developments at an

AUTOMATION SOLUTION AND TECHNOLOGY INTEGRATION ARE THE IDEAL WAY FOR US TO SUSTAINABLY INCREASE OUR CAPACITY.

early stage. For a long time now, the company has not considered itself simply a supplier but rather a technology partner for its customers.

Robo2Go: Multi-machine operation and consistent quality in 3-shift operation

While Mönninghoff is preserving this specialist expertise for future generations by in-house training, with currently six junior trainees employed, the focus is also on continuous modernization of production. The proof lies in regular investment in CNC technology from DMG MORI – the latest being a CTX beta 800 TC with Robo2Go. Timon Lubek, head of production, explains the reason behind the acquisition: "Our goal is to achieve the highest possible machine utilization

The Robo2Go stacking magazine offers sufficient capacity to enable around-the-clock production with the CTX beta 800 TC.

across all three shifts. Supported by the Robo2Go, our team is even able to operate several machines at the same time." It offers easy handling and is the ideal automation for medium-size batches. Timon Lubek considers quality to be another argument in favor of automated manufacturing: "As manual reclamping is no longer necessary, it is easier to achieve accuracies down to tens of microns." Components made of different materials including steel, aluminum and bronze are part of the daily work.

Automation and Technology Cycles from DMG MORI

Maschinenfabrik Mönninghoff is taking new initiatives in its manufacturing together with those who ultimately work with the modern technology. Timon Lubek says: "It is important to include in purchasing decisions the employee who is to be responsible for operation, as the person can contribute their experience and are in a position to recognize the added value quickly." This was the case with the Robo2Go and applies equally to the subject of technology integration.

Mönninghoff makes use of a range of DMG MORI Technology Cycles, which enable special processes such as gear cutting to be carried out on conventional CNC machine tools.

Optimal machine utilization thanks to gear cutting cycles from DMG MORI

"Our coupling components all have different gear teeth, which used to be manufactured using special gear cutting machines," explains Timon Lubek. "The Technology Cycles from DMG MORI allow us to machine the same products, switching rings for example, on conventional turn-mill centers like the CTX beta 800 TC to the same quality on the same machine and sometimes even faster. The experience of the Mönninghoff specialists has repeatedly been incorporated into the continued development of the Technology Cycles. Manufacture of gear components now only requires a maximum of two clampings.

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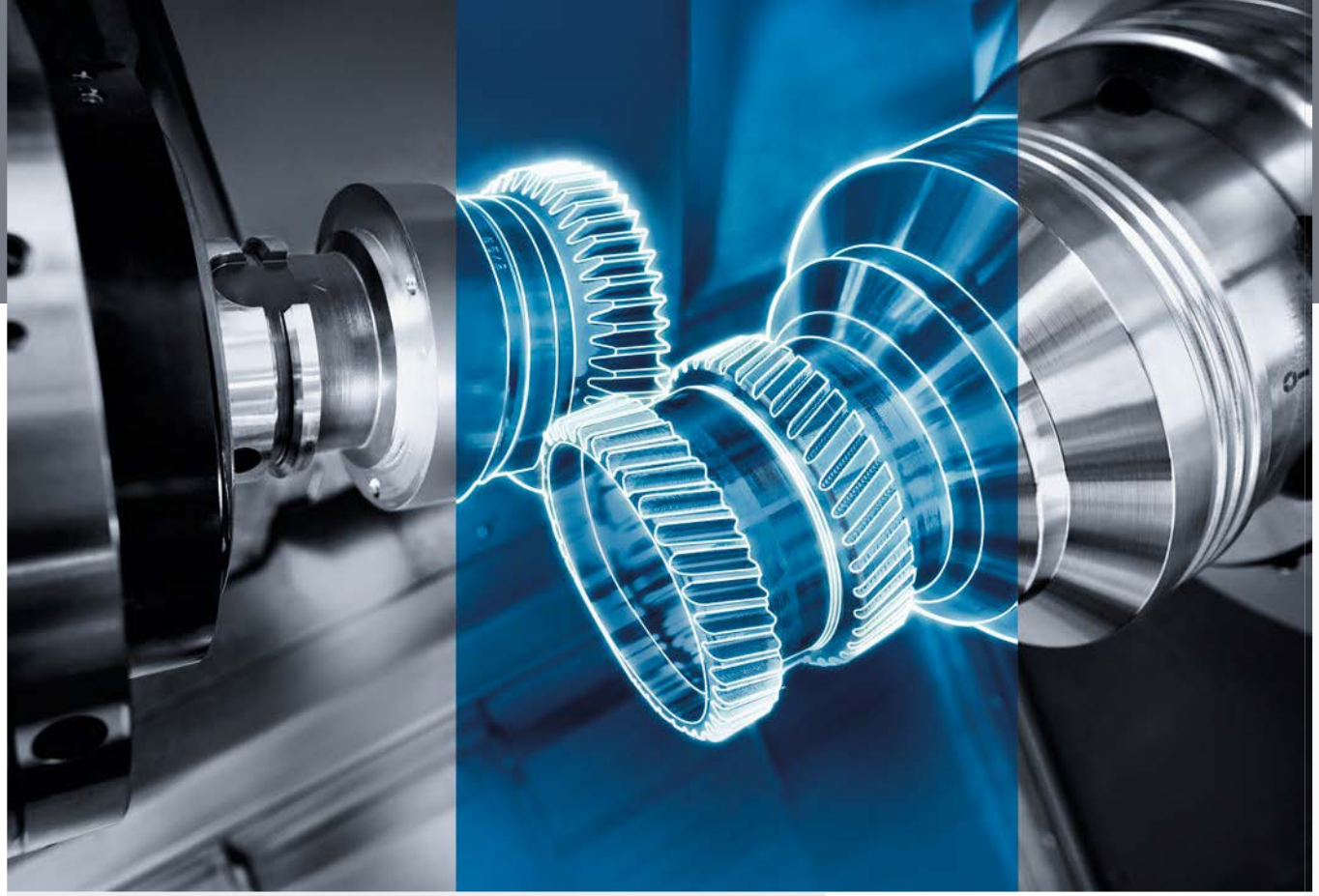

EXCLUSIVE TECHNOLOGY CYCLE
gearSKIVING

UP TO 8 TIMES FASTER THAN GEAR SHAPING

+ Straight and helical external or internal spurs and splines
+ Internal teeth possible without an angle head
+ Synchronization and tool path controlled by the cycle
+ Available for machines with SIEMENS/CELOS with SIEMENS and MAPPS/CELOS with MAPPS
+ **TURN & MILL and DMF**
  – Herringbone teeth with offset*
  – Crowned gears by mathematical transformation of the 6th virtual axis* on TC & DMF machines

*NTX & CTX TC with counter spindle and SIEMENS

This results in shorter throughput times, reduced internal transportation and less waiting time. The high flexibility is another benefit: "If there are times we don't need to produce gears, the machine can be used for other purposes to make sure it's utilized in the best way possible."

gearSKIVING 2.0 and DMQP tools from Horn

gearSKIVING 2.0 is one Technology Cycle that Mönninghoff uses intensively. It can be deployed to manufacture straight and helical external or internal spur gears, splines and also herringbone gears on turn-mill centers. The cycle controls the synchronization and the tool path. "This makes us ten times faster than when broaching," adds Timon Lubek. He points out the tools they use are from Horn. The tool manufacturer is a long-term and DMQP-certified technology partner of DMG MORI. Crown gears are also manufactured by fly cutting on turn-mill machines such as the CTX beta 800 TC. The automatic

CTX beta 800 TC

+ **100 % TURNING:**
  Workpieces up to ø 500 × 800 mm
+ **100 % MILLING:**
  compactMASTER up to 20,000 rpm and 120 Nm
+ **100 % TOOLS:**
  For up to 80 tools

Robo2Go

+ Rapid changeover from chuck to shaft part tray
+ Load capacity 12, 25 and 35 kg
+ Shaft ø 25 – 150 mm,
  Chuck parts ø 25 – 170 mm
+ Workpiece teaching in < 15 min

calculation of the tool path is taken care of by the crownHOBBING Technology Cycle, which DMG MORI implemented in a second phase. Gear shaping takes place in a third phase using the gearSHAPING Technology Cycle. Timon Lubek adds: "Automation solutions make 6-sided complete machining of components like these easier. It also enables quality control to be integrated right from the first component."

The integration of technology is very important to Mönninghoff. This is the reason why Timon Lubek values the long-term partnership with DMG MORI: "In order to be even more successful, we use practically every technology cycle that provides us with added value in programming and machining – from gear cutting and generation through to broaching and grinding. And in cases where this isn't enough, we jointly develop new bespoke cycles that enable us to machine our special components, or make it easier to do so." The company would like to maintain this in the future, not only to ensure it can manufacture efficiently, but also to be a technology leader. Charlotte Finger also sees a lot of potential in the new manufacturing possibilities: "Automation solutions and technology integration are the ideal way for us to sustainably increase capacity and thus keep our production site in Germany competitive."

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MASCHINENFABRIK MÖNNINGHOFF FACTS

+ Founded in Bochum in 1916
+ 125 employees
+ Development and manufacture of clutches, couplings, brakes, linear actuators and complete system solutions
+ Customers include those from agriculture, robotics and the food industry

Mönninghoff

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Complete machining

DMG MORI Technology Excellence

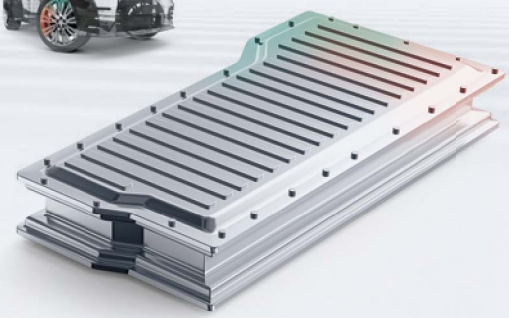
DMG MORI realizes holistic and process-encompassing turnkey solutions in its Excellence Centers worldwide for the leading industries of Aerospace, Automotive, Die & Mold, Medical and Semiconductor. The experts from DMG MORI support the customer at an early stage during the development phase.

Aerospace

Number One in Aerospace Excellence – from the project idea to the realization of integrated solutions over the entire process chain.

Automotive & E-Mobility

Holistic milling and turning portfolio – DMG MORI provides optimum solutions for flexible and efficient production in car manufacturing.



Die & Mold

With more than 50 years of experience, DMG MORI provides its customers with holistic support for industrial tool and mold manufacturing.

The company collaborates with its customers to develop individual and holistic complete solutions for automated and digitalized production.

Semiconductor

In the key technology for digitalization, DMG MORI provides you with the correct machine concepts for optimized process procedures in the manufacturing of high-precision components made from advanced materials.

Medical

DMG MORI supports its customer during all phases – from Greenfield consultancy, process development to providing advice on regulatory topics such as ISO13485 or FDA.

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