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# EMAG Industry 4.0 Solutions

## Optimized production with Industry 4.0 solutions

Industry 4.0 is all about networking – including both networking between several system components, and networking between machines and the people who direct the value chain. EMAG's new Industry 4.0 solutions connect sensor, operating and production data with the analysis and process knowledge of EMAG engineers to offer our customers the best solutions.

- » Monitoring
- » Analytics / evaluation / control
- » Service and maintenance
- » Operations planning and scheduling

## MONITORING



### MultiMachineMonitor

**Full control of all machines on a single device**

Display the control screen of one or more machines on an external device such as a tablet, laptop or PC.



### MachineStatus

**The whole manufacturing process at a glance – all relevant manufacturing and energy usage data available anywhere, anytime**

Clearly-prepared display of operating and energy efficiency data from one or more machines on an external device such as a tablet, laptop or PC.



### eQC Flux

**Measurement of the inductor foot voltage as well as of the magnetic flow**

Different error sources (e.g. loading with the wrong workpiece geometry, incorrect material, etc.) are determined through the analysis of the inductor foot voltage and the production process is amended accordingly.



### eQC RFID

**Inductor check and status monitoring**

Before manufacturing begins, eQC RFID checks to ensure that the right inductor has been selected for the chosen machining program and also determines the condition of the tool. Additionally, the RFID chip in the inductor can monitor the performance data, remaining tool life and planned intervals.



### eQC Quench Viscosity Monitoring

**Real-time monitoring of the quenching medium during the hardening process**

eQC Quench Viscosity Monitoring is a test procedure based on an ultrasonic sensor which constantly monitors the viscosity of the quenching medium and provides accurate information on its quality.



## **SolidProcess** Optimization of the gear hobbing process through post-process measuring

Software for quality assurance of the gear hobbing process through post-process measuring of the toothing with feedback of the measurements and automatic correction of the feed.



## **ToolStatus** Detailed data collection and analysis of tool service life

Reading of tool data made available from a presetting device. This data is then fed back to the presetting device to aid in the evaluation of the service/tool life quality.



## **LifetoolAnalytics** Tool wear always under control

Optimize the use and management of tools with LifetoolAnalytics, which monitors the lifetool tool for overloading and determining the state of wear.



## **ToolStatus+** Tool inspection performed by an integrated laser measuring bridge

After a tool has been in use, it is automatically measured (cutting edge assessment) with the help of a laser measuring bridge which is integrated in the machine. Deviations due to wear are recorded.



## **EC Data** Workpiece tracking through operating, process and quality data

EC Data facilitates the traceability of every single workpiece within one or more manufacturing systems. All of the information regarding machining results is saved and documented along with the operating and process data of the machines.

# SERVICE AND MAINTENANCE



## **Remote Experts** Service-on-demand instead of on-site

Fifty percent of the time, EMAG Remote Experts can find a solution without sending a service engineer on site.



## **Fingerprint** EMAG Fingerprint allows you to increase the availability of your machines and improve productivity, reducing workpiece costs

Fingerprint will run a detailed machine analysis that will allow EMAG service engineers to provide you with information on the performance of the machine axes.

# OPERATIONS PLANNING AND SCHEDULING



## **ProcessSim** Virtual material flow of complex manufacturing systems

Realistic illustration of all the material flow processes of manufacturing systems.



## **VirtualMachine** Quickly and safely implement complex manufacturing processes and optimize existing processes

Simulation of NC programs for the digital protection and inspection of complex machining processes.



## MultiMachineMonitor

Complete monitoring of all production machines using a single device

The EMAG MultiMachineMonitor is a simple but ingenious tool for monitoring one or more EMAG machines. The control interface of the machines equipped with the MultiMachineMonitor is mirrored to an end device of your choice for quick and straightforward monitoring. With the MultiMachineMonitor, the NC screen (HMI interface) of one or more machines is transferred via EMAG Wifi SecureConnect to any device (tablet, laptop or PC). Users are then able to navigate the HMI interface and access all

submenus of the control unit. However, no machine functions can be triggered in order to eliminate operator errors.

The MultiMachineMonitor software for networked production can be installed on an unlimited number of devices and machines, providing a relatively easy and cost-effective solution for production monitoring.





# Benefits

- » Transparent production
- » All machines in production are shown on a single end device for an easy overview of the production status for each machine
- » Optimizing machine utilization through uniform parameters
- » Quick overview of all service and maintenance tasks on the machines
- » Easy planning of service tasks and machine downtime
- » Planning of tool changes, development of tool-changing strategies
- » Option of using other Industry 4.0 products based on EMAG Wifi SecureConnect



# Possible end devices



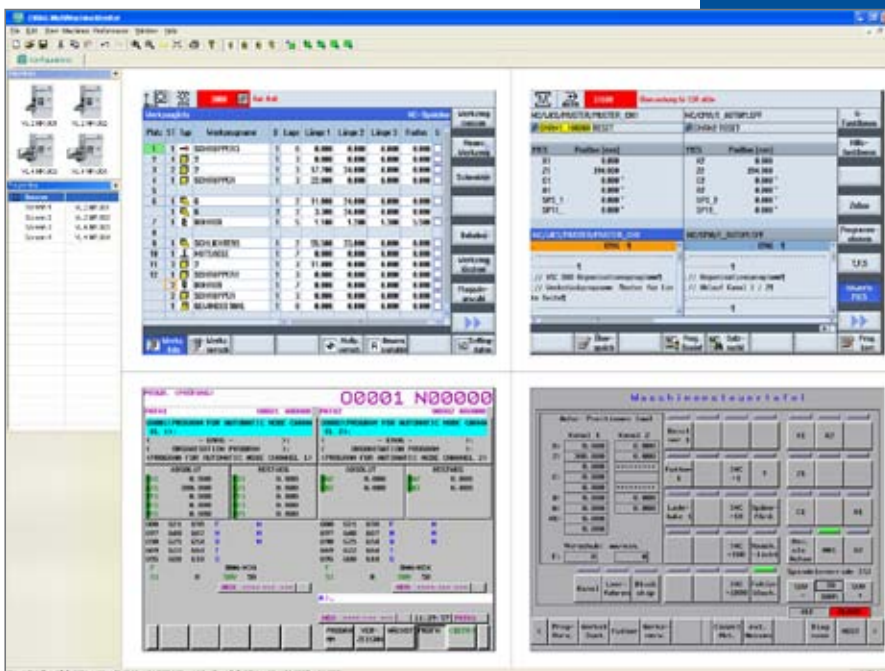
Tablet



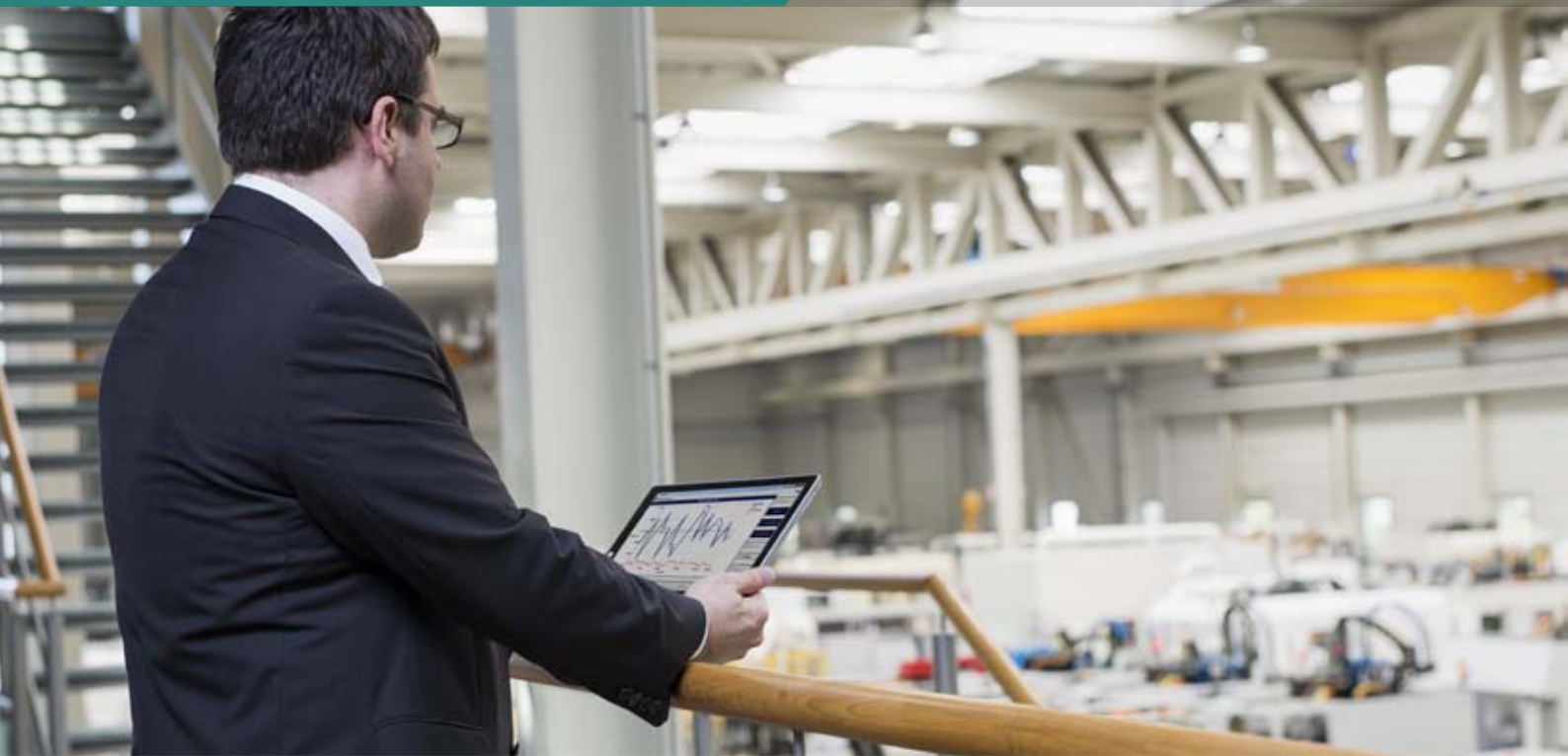
PC / Laptop

# System requirements

- » Windows 7 or higher
- » Siemens Sinumerik Operating System or Fanuc, 30b or higher
- » WLAN router EMAG Wifi SecureConnect
- » All EMAG machines from YOM 2015



MultiMachineMonitor with display of four machines, two with Siemens and two with Fanuc control units



## MachineStatus

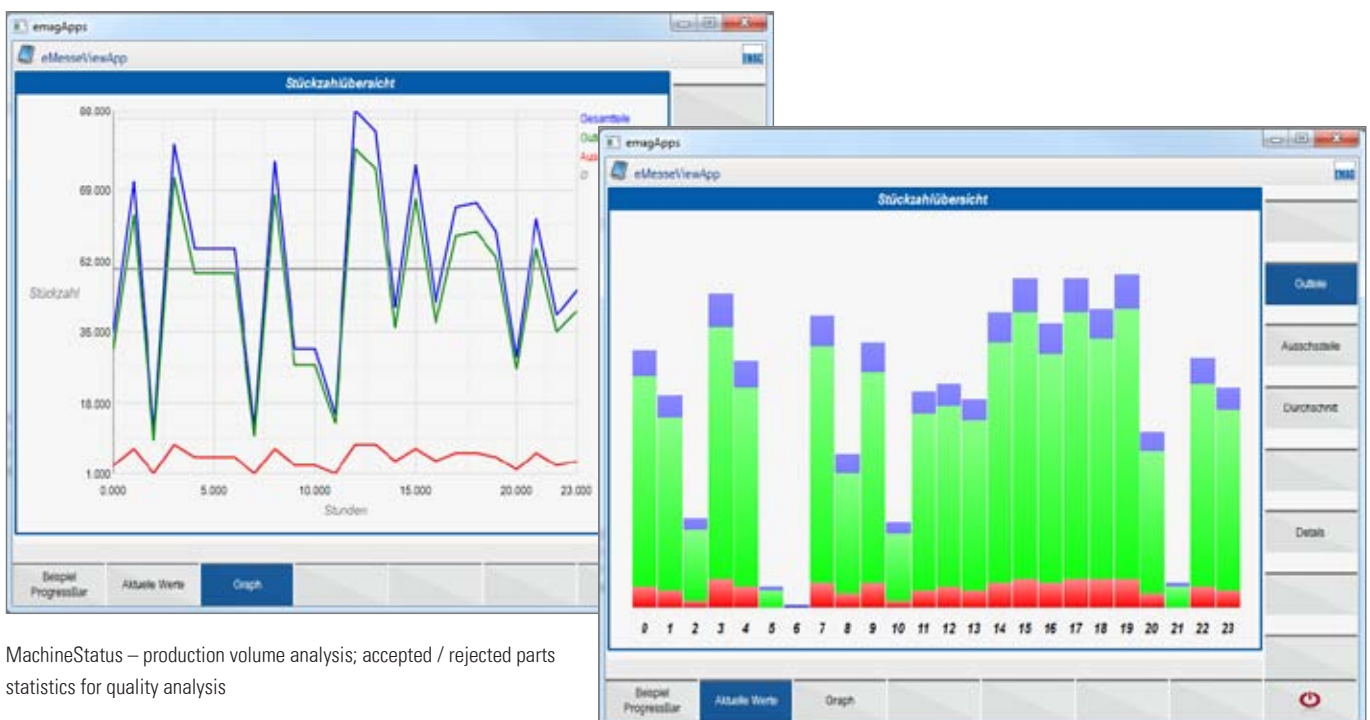
Your entire production at a glance – all relevant production and energy efficiency data clearly displayed making it easily available at any time

MachineStatus provides an organized display of operating and energy efficiency data for one or several EMAG machines. On a tablet, laptop, or desktop computer – the system can be adapted to fit any requirements.

MachineStatus offers a rapid overview of all the machines in your production, providing you with key figures and analytics. The key

indicators provided by MachineStatus allow clear conclusions to be drawn about the productivity and efficiency of machines, as well as communicating with the user the operating status, operating data and energy consumption of the machine.

With MachineStatus, users have a software solution at their disposal that supplies detailed information on production volumes, cycle times, and measurement results, as well as power and air consumption.



MachineStatus – production volume analysis; accepted / rejected parts statistics for quality analysis



## Benefits

- » All operating and production data displayed clearly and available at any time
- » Statistics available for accepted/rejected parts for quality analysis
- » Efficiency comparisons across production shifts
- » Comparison of machine efficiency including benchmarking
- » Tool wear analysis, which may encompass multiple jobs
- » Energy efficiency analysis for both individual machines and across multiple operations



## Possible user devices



Tablet



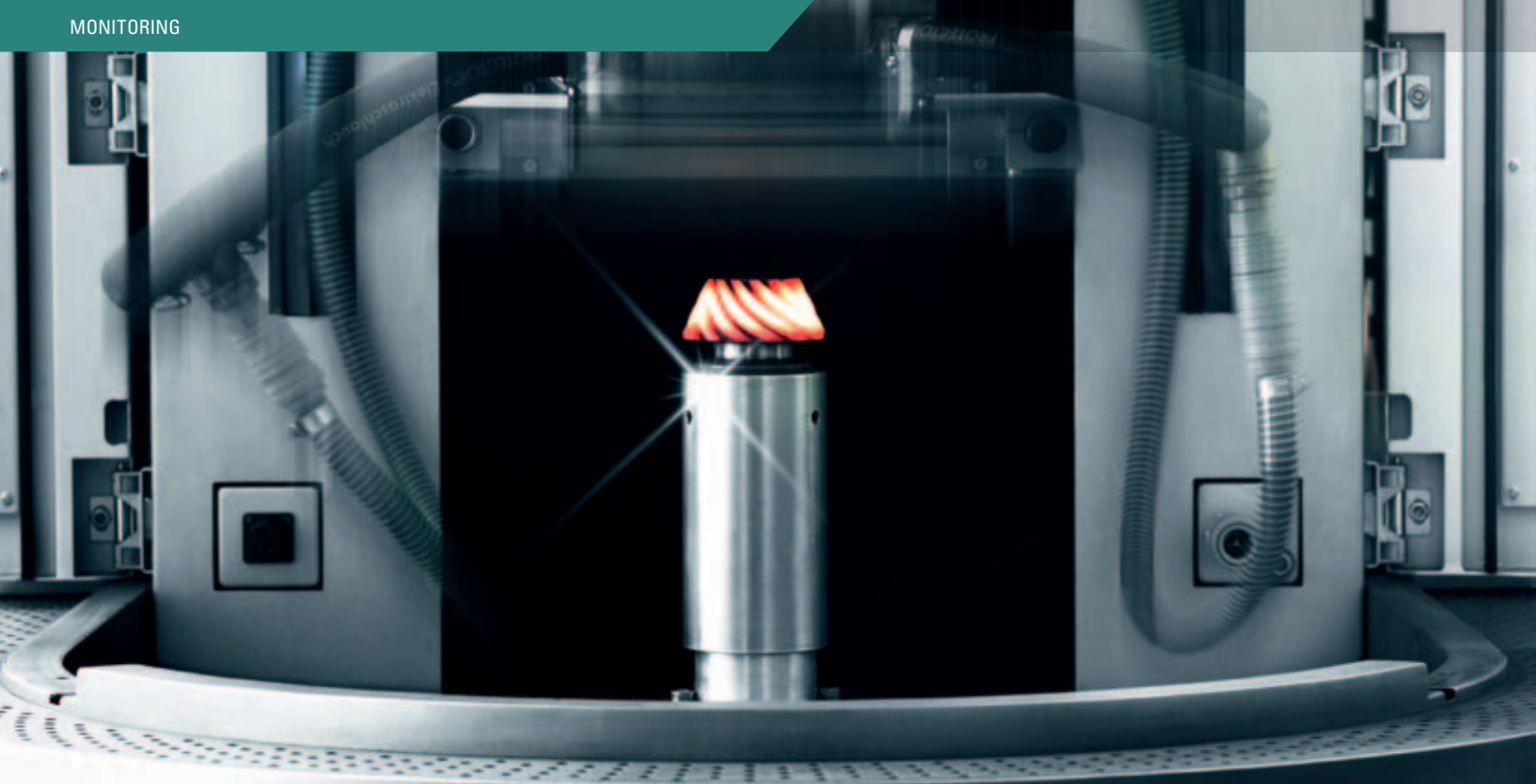
PC / Laptop

## System requirements

- » Windows 7 or higher
- » Siemens Sinumerik or Fanuc 30b (or newer) operating systems
- » EMAG WiFi SecureConnect wireless router
- » All EMAG machines from YOM 2015 all later

## MachineStatus is comprised of four components:

- 1** EMAG WiFi SecureConnect, a wireless router for secure networking between the machine and the users devices.
- 2** MachineStatus-Operate, the analysis software itself, which is installed on the NC control and makes the data available to the users devices.
- 3** MachineStatus-Sensor, a data tracker for energy consumption analysis.
- 4** MachineStatus-Device, the software that prepares the analysis data for display, which can be installed on any device desired by the user.



## eldec Quality Control – eQC

Optimizing and monitoring of processes to boost the productivity of induction hardening machines

The combination of modules in the eldec Quality Control package are designed to compliment each other and guarantee customers a fully monitored hardening process. An optional process database is available to save data from the eQC modules, which ensures the seamless documentation of process data.



### eQC RFID

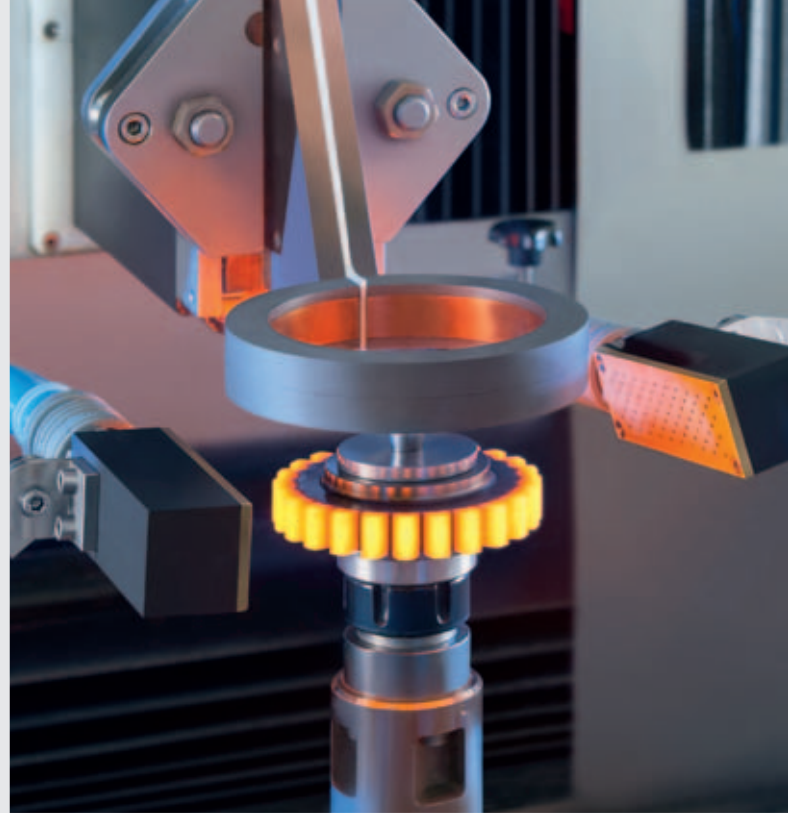
Inductor checking and status monitoring

eQC RFID is used before the start of production to verify if the correct inductor has been inserted for the preselected machining program, and to monitor the tool status. To do so, the system reads important performance data, such as remaining tool life and impending maintenance intervals, from an RFID chip in the tool. After the hardening process is completed, the relevant operating data is written to the RFID chip. For this purpose, a read-write unit is installed in the connection system of the machine. In the event of tool faults or errors, the process will not start again. Information on production tolerances for the inductor can also be included, allowing automatic repositioning of axes if necessary.



## Benefits

- » Increasing process reliability
- » Minimizing operator error
- » Improving the machining quality
- » Documentation of all process data
- » Optimizing the hardening results
- » Reducing machine breakdowns



### eQC Flux

Measuring inductor base voltage and magnetic flow

eQC Flux monitors both the inductor base voltage and the magnetic flow. With these parameters, a wide range of error sources can be analyzed, such as faulty workpiece geometries or improper materials, and appropriate remedial action can be taken.



### eQC Quench

Viscosity monitoring of quenching medium

The quality and stability of the hardening process are also greatly influenced by the condition of the quenching medium. It changes during the process, since the polymer chains it contains will gradually break up under the influence of light and heat. Therefore, the quality of the quenching medium must be checked regularly to maintain the production of quality components. Presently, this is often still done by measuring the light refraction index. However, this does not indicate the condition of the polymer chains and is therefore inaccurate. The testing method offered by eldec is based on an ultrasonic sensor that continuously monitors the viscosity of the quenching medium, and provides very precise information regarding its quality.







## SolidProcess

To optimize the hobbing process, post-process measurement of the toothing is taken and measurement feedback is used to provide automatic correction.

Gears usually have to be produced in large batch sizes. To keep the quality of parts constant, EMAG KOEPFER has developed SolidProcess, a software solution to enable continuous and automated optimization of the tooth cutting processes.

Prozess		K1	HAND
Verfahren Prozess-Stabilisierung		Intervall	
Soll - Kugelmass		44.850 mm	
Messkugeldurchmesser		2.000 mm	
Zulässige Abweichung +		0.060 mm	
Zulässige Abweichung -		0.060 mm	
Aktueller Messwert		0.060 mm	
Aktuelle X-Korrektur radial		0.005 mm	
X	40.209	Y	90.000
Z	36.555	A	10.667
B	121.897	C	251.868
H	6.553	V	6.553
<div style="display: flex; justify-content: space-between; align-items: center;"> <span>▲ Prozess</span> <span>Reset</span> </div>			

SolidProcess screenshot for monitoring of the hobbing quality results

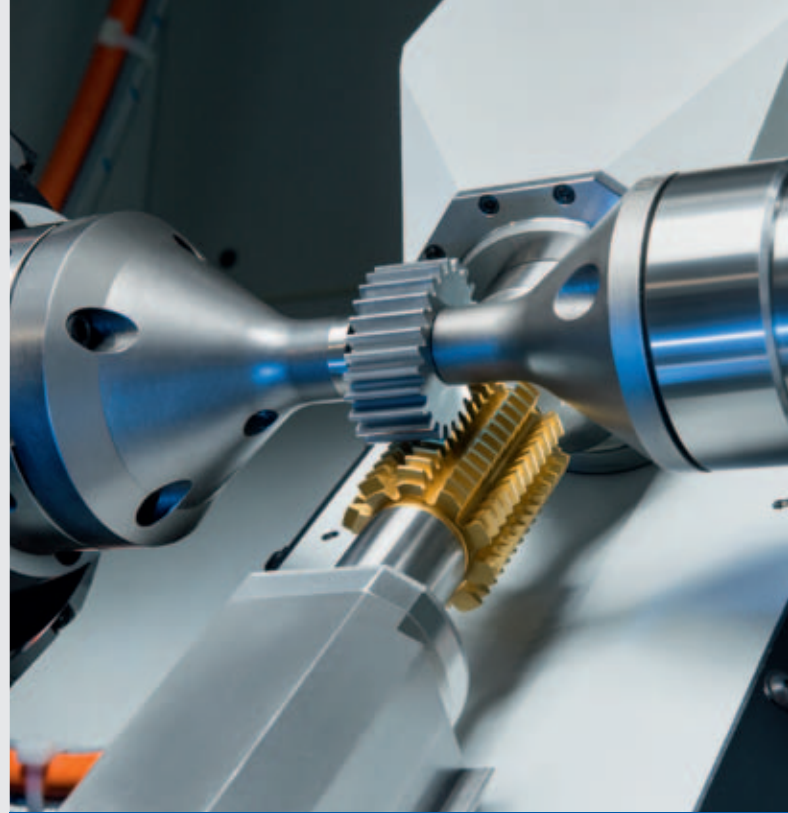
## Post-Process Toothing Measurements and Automatic Correction

SolidProcess is used to continuously record measurements of the dimension over balls or the base tangent length of machined workpieces. The gear hobbing machine may be equipped with a measuring device, or the measurement can be done using external measuring systems. The data obtained is then compared with the nominal dimension and the tolerance limits that are saved in the machine control.

A measuring device integrated into the machine (or alternatively an external one) measures the hobbled teeth, either continuously or in intervals, during production. The nominal dimension and the tolerance limits are entered in the machine control. The machine control software assesses the measurement and corrects the infeed (the X-axis) automatically as needed. All the assessment factors and measuring intervals can be defined individually for each application.

## Benefits

- » Stable tooth cutting processes
- » Documentation of all measurement results for quality assurance
- » Easier compliance with tight tolerances, e.g. for soft finish-hobbing, allowing the hard fine-machining processes to be optimized through precise pre-machining
- » Reduction of negative effects from tool wear on tooth cutting
- » Closed-loop quality assurance system – manual correction no longer required
- » Optimum cutting results assured



## Dry hobbing of a helical gear

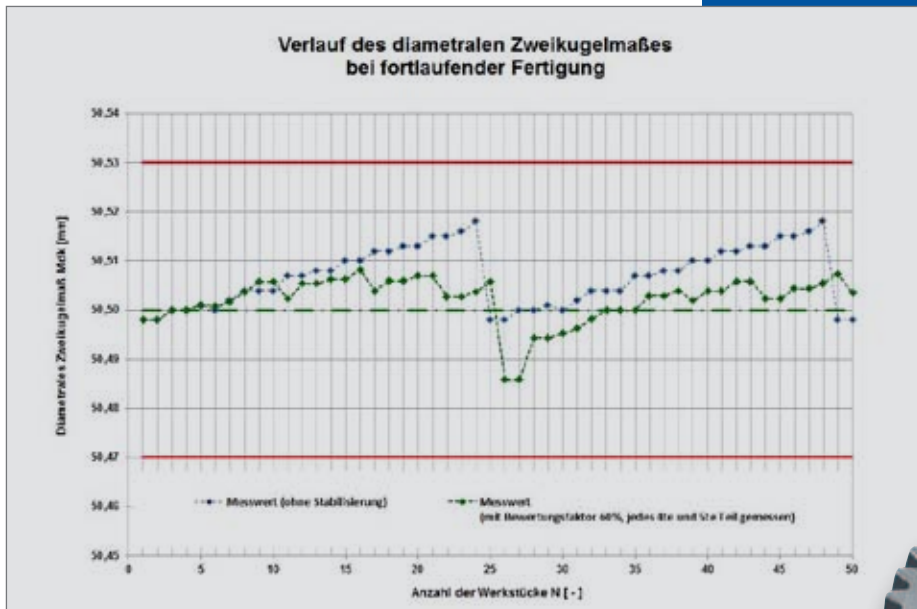
Representation of the process curve (blue line) and stabilized (green line). Measured the two-ball dimension, nominal size 50, 50 +/- 0,03.

Process **without** SolidProcess: Cpk = 1,24

Process **with** SolidProcess Cpk = 1,95

## System requirements

- » Measuring device in the EMAG KOEPFER gear hobbing machine
- » Control: Siemens 840 D, Fanuc 32i, BWO 920, BWO Vector







## LifetoolAnalytics

Optimum use of tools,  
optimized tool management

With LifetoolAnalytics, production losses caused by worn machine tools are a thing of the past. LifetoolAnalytics provides monitoring of driven tools for overload and state of wear, and thus allows for optimum planning of service times and tool changes.

LifetoolAnalytics is a module that uses an NFC system to monitor driven tools. The tool is equipped with an NFC chip that records operating data during the machining process. LifetoolAnalytics records hours in operation, rotational speed ranges and temperatures. This data is then saved to the NFC chip on the

driven tool. It can be read and analyzed via NFC sensors, by a tool preset device, tool management system, or even a smartphone or tablet.

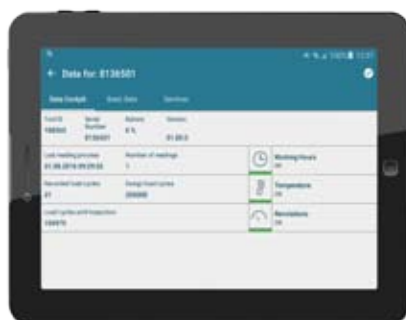
Operating data from the NFC chip and comparison values directly from the analytics database will then be automatically sent to the end device of your choice.

A comparison with other data from the analytics database makes it possible to determine the tool's wear condition. Simple operation was a priority throughout software development. For example, the overview page shows a rough status report that allows an initial assessment by a traffic light system. If required, a detailed analysis can be issued, which provides further options for optimization.

## Possible end devices



Smartphone



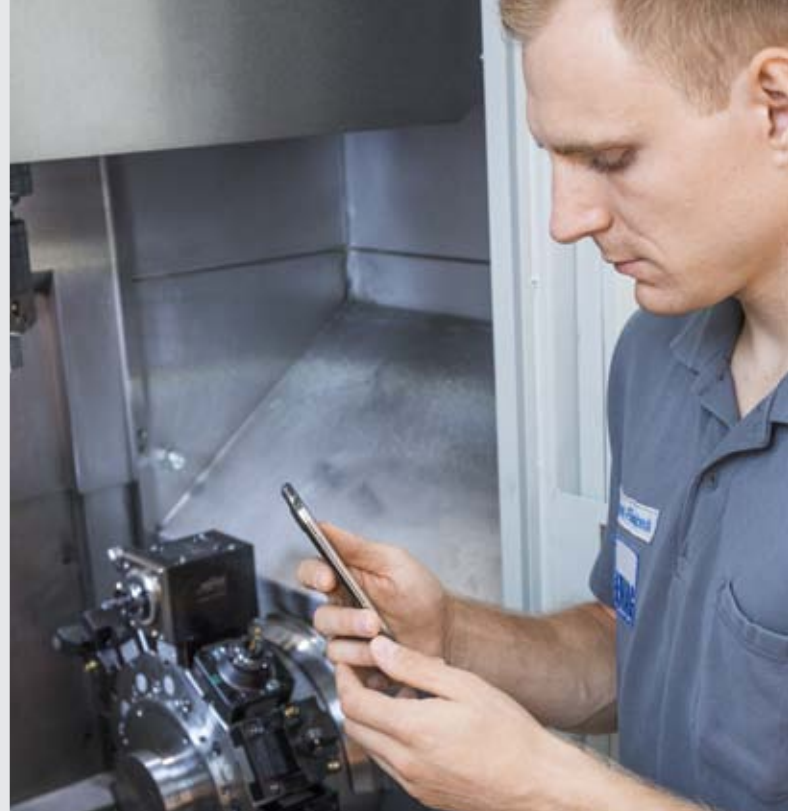
Tablet



Tool preset device

## Benefits

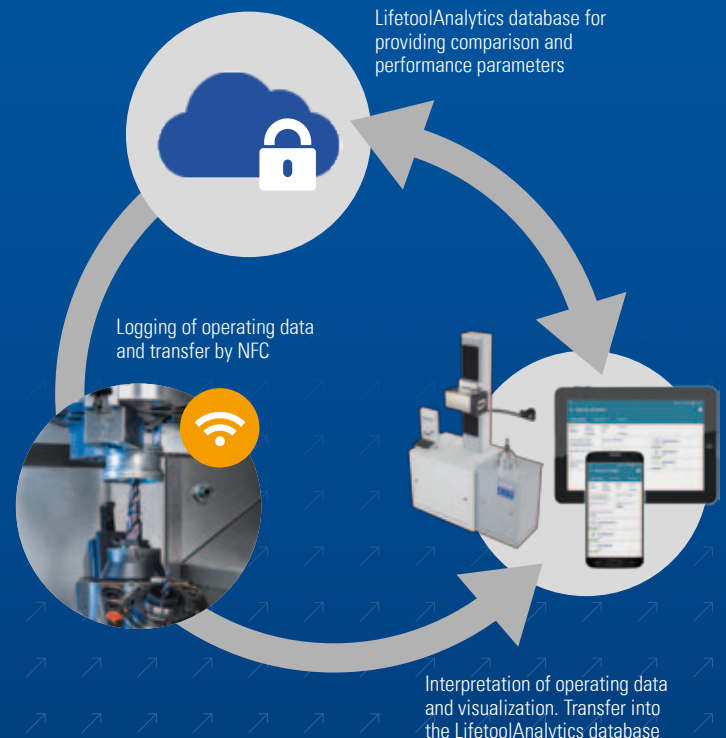
- » Boost of production efficiency
- » Optimizing preventive maintenance
- » Reducing the amount of scrap
- » Increasing production reliability
- » Minimizing crashes
- » Preventing unscheduled production downtimes
- » Extending lifetime of tools
- » Reducing material consumption in production
- » Reducing wear of the drive components of driven tool, such as bearings and gears



LifetoolAnalytics gives a quick and clear overview of the condition of the tools that are currently in use.

## System requirements

- » One EMAG LifetoolAnalytics sensor for each driven tool
- » Depending on requirements:
  - Tool preset device with NFC support
  - Smartphone or tablet with Android 4.0 or higher
- » Internet connection to connect to the Analytics database





## EC Data

Workpiece tracking of operating, process and quality data in complex machines and manufacturing systems

EC Data is a software package that provides traceability of production and quality data for a workpiece. When production lines consist of several machining units, data is collected centrally and then made available on an SQL server for further processing. EC Data also provides export interfaces for Q-DAS, Excel, and many other systems.

EC Data provides traceability for every single workpiece. This includes the storage of all machining results and the documentation of operating and process data for the machines.

EC Data controls the naming and data management, even across multiple manufacturing systems. The result is a history for each workpiece that includes all relevant technical production information.

Production results remain available even years later, ensuring seamless quality control and documentation. For example, workpiece identification allows parts that were removed from the manufacturing process for external quality control to be introduced back into the manufacturing process. Since the full machining history is available, the workpiece will be automatically transported to its next production step for completion.



Layout of a manufacturing system, including visualization of parts flow and of production status



## Benefits

- » Meets the requirement for data traceability
- » Logging of process and operating data for machines and manufacturing systems
- » Support for offline stations (measuring stations, batch processes, etc.)
- » Use of IT standards (Ethernet, SQL server, etc.)
- » Export function (\*.xml, \*.csv, Q-DAS, etc.)
- » Advanced data management, use of mobile clients
- » Simple project configuration and start-up
- » Individual adjustments possible

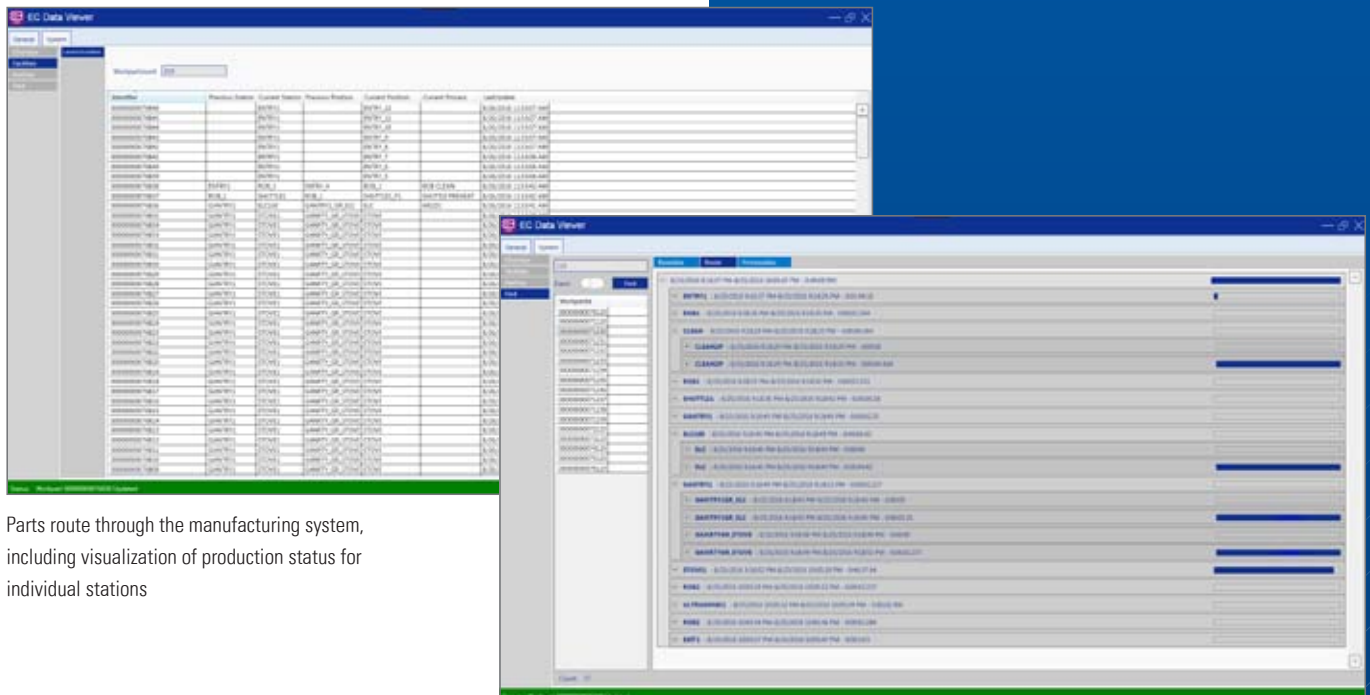


## EC Data software modules

- » EC Data NC: Software for generating the operating, process, and quality data; one required per control unit
- » EC Data PC: Collecting of operating and process data for individual machines, results visualization
- » EC Data DB: Server for data concentration and storage

## System requirements

- » EMAG machine tools with SINUMERIK 840D sl control panels
- » ETHERNET infrastructure for connecting the machine tool (provided by customer)
- » Specific workpieces with unique identifiers (e.g. DMC) and corresponding readers at the machines; alternatively, integration in revolving workpiece carrier systems using RFID chips.
- » Server infrastructure provided by customer if necessary



Parts route through the manufacturing system, including visualization of production status for individual stations

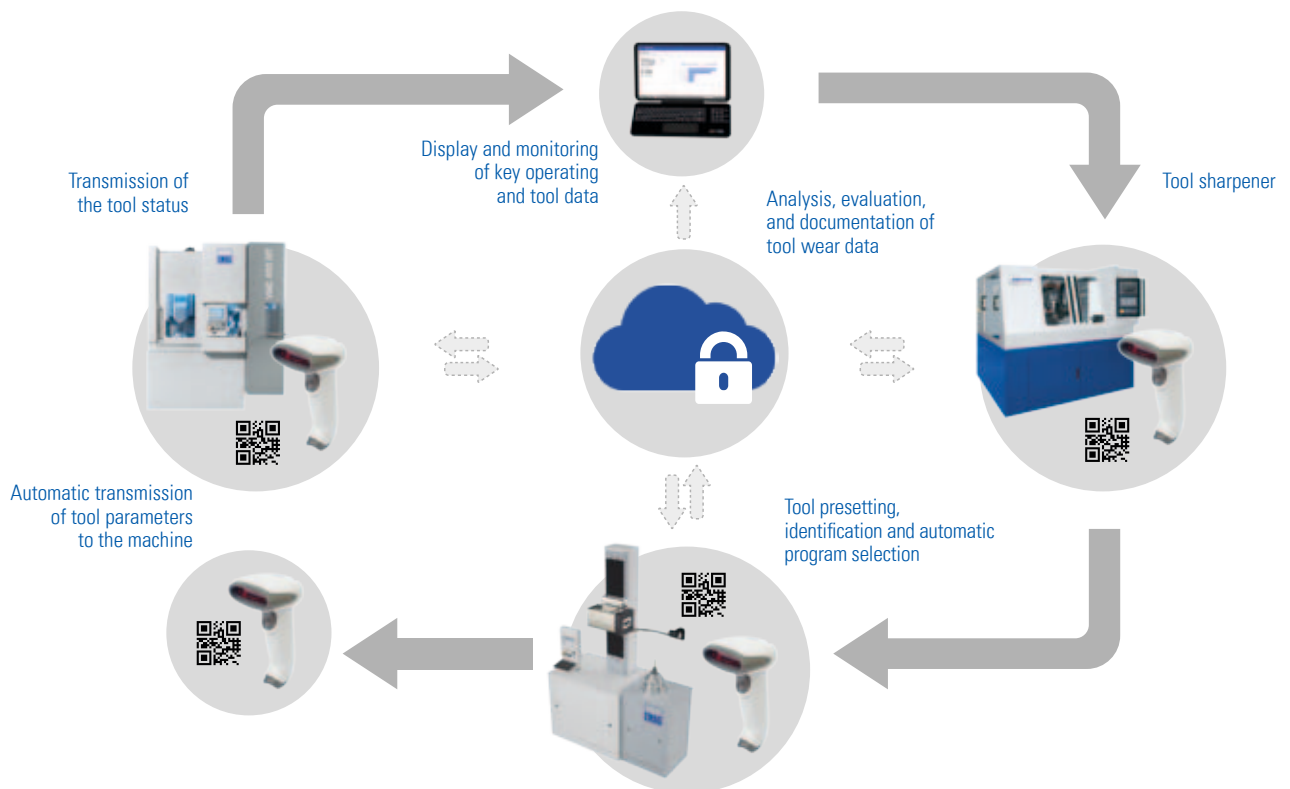
Production history of the machined workpiece in table form



## ToolStatus and ToolStatus+

With ToolStatus, relevant data is constantly analyzed to keep your tool life up to date.

The condition of tools is critical for the machining quality and productivity of a machine. In order to effectively plan your production, it's important to be up to date on the status of your remaining tool life. EMAG's ToolStatus and ToolStatus+ provide a solution that makes this planning much easier.



### ToolStatus

Information flow and process diagram



## Benefits

- » Utilization of the full tool life in tooling processes, and optimization of tool costs
- » Reduction of entry errors in tool data
- » Minimization of downtime caused by unplanned tool changes
- » Optimization of production processes and tool change processes
- » Transparent production
- » Needs-based tool change (as required by wear)
- » Tool compensation according to wear – working together with machine-integrated measuring probe
- » Tool breakage monitor



### ToolStatus

ToolStatus tremendously simplifies tooling for EMAG machines. The machine is equipped with a software program and a hand-held scanner. Every tool is fitted with a QR code or barcode, allowing definitive identification and tracking. The operating data of every scanned tool is entered directly into the machine's control via an external data source (Internet or USB). Manual entry of tool data is completely eliminated, ruling out any chance of entry errors.



### ToolStatus+

ToolStatus+ takes tool monitoring a step further with the integration of a laser measuring bridge. After a tool is used, it is measured automatically (recording the cutting edges) by a machine-integrated laser measuring bridge before being transferred from the machining area to the tool magazine. The tool's cutting edge dimensions are compared to the values previously measured, and the changes resulting from wear are saved after transfer to the tool magazine.

## System requirements

- » 840D sl with Sinumerik Operating System, software 4.5 or higher
- » Customer database with tool data from tool presetting



ToolStatus+

Checking of tools with machine-integrated laser measuring bridge



## Remote Experts

The efficient way to achieve higher machine availability and lower servicing costs

This service-on-demand package gives you the most efficient way of detecting and eliminating faults, and providing fast, expert help in the case of malfunctions:

- » Worldwide online support and access to EMAG experts
- » Machine linked via secure online connection (EMAG VPN)
- » 24/7 telephone support via our service hotline
- » 24/7 spare part service
- » Quarterly documentation of machine status

### For new machines

The components required for Remote Experts (NIC, control system with Assistance Call function) are part of the basic equipment of every machine with a Siemens 840D control with at least PCU 50 V2 and 512 MB RAM. Activation of Remote Experts can be added as an option to the machine order.

### Retrofit on machines built in 2004 and later

EMAG machines built in 2004 and later with Siemens 840D control and at least PCU 50 V2 and 512 MB RAM include an integral NIC (Network Interface Card). If connected as a standalone machine (not part of a network), a mobile broadband router needs to be fitted. Installation and commissioning is performed by an EMAG service technician.

### Retrofit on machines delivered prior to 2004

EMAG machines delivered prior to 2004 have to have a mobile broadband router or an NIC fitted. Installation and commissioning has to be performed by an EMAG service technician, who will also update control software and hardware accordingly.



## Many Advantages – Impressive Benefits

### Service-on-demand instead of service-on-site

- » In many cases (past experience suggests up to 50%) Remote Experts can lead to a solution
- » If a service call is required, the service technician will be well informed about the problem and will be able to bring the appropriate spare parts
- » Reduction in number of on-site service calls by technicians
- » Breakdown, maintenance, and repair costs minimized
- » Reliable identification of required spare parts and spare parts ordering
- » Regular reports provide information on the reliability and performance capacity of the machine.
- » Fast fault detection and targeted response through reliable fault log and unambiguous remote diagnostics
- » Direct access to expert(s)
- » Language and communication problems eliminated
- » Once activated, the machine control is directly connected to the EMAG Server
- » Fast and secure online connection to support team

### EMAG experts are on hand for rapid, targeted, centralized support in all phases of a machine's life.

#### Installation phase (commissioning)

- » Immediate expert assistance when needed for faster, troublefree commissioning

#### Warranty period

- » Support during the "breaking in" period
- » Continuous monitoring and regular machine evaluations
- » Online expert support or targeted technician service calls when needed

#### Operational phase (after expiration of warranty)

- » Optimization support and expert know-how when needed (without travel time or wait time)
- » Cost-effective implementation of software improvements and control updates
- » The most efficient way of detecting and eliminating faults
- » High availability ensured
- » Breakdown, maintenance, and repair costs minimized
- » Reduction in servicing costs and capacities





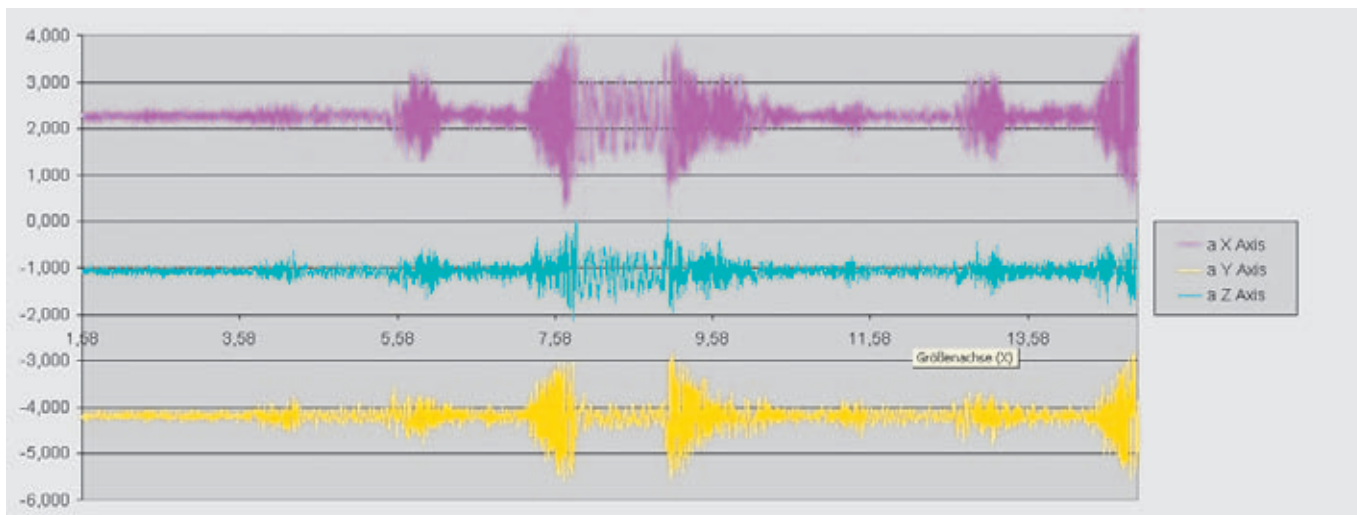
## Fingerprint

Assessment of machine condition— at any time

Fingerprint increases your machine availability and productivity, and thereby reduces costs per unit.

Currently, the condition of machine tool axes is either determined based on gut feeling or a lengthy measuring process. Accurate data for preventive maintenance is often unavailable or takes a lot of effort to obtain.

This makes it difficult to plan ahead for maintenance, and wear-based replacement of components is often impossible. With Fingerprint, the EMAG Service team is able to diagnose and evaluate the condition of mechanical components. The best part is that there is no need for lengthy disassembly and reassembly in order to compile a machine assessment. The data supplied by Fingerprint provides an up-to-date status report of the machine with regard to the behavior of the machine axes.





## Benefits

- » Increasing machine availability and productivity
- » Cost savings per unit
- » Higher machine availability by status-oriented maintenance
- » Longer machine life
- » Status history available
- » No lengthy disassembly and reassembly required for analysis
- » Verifiable results with parameters

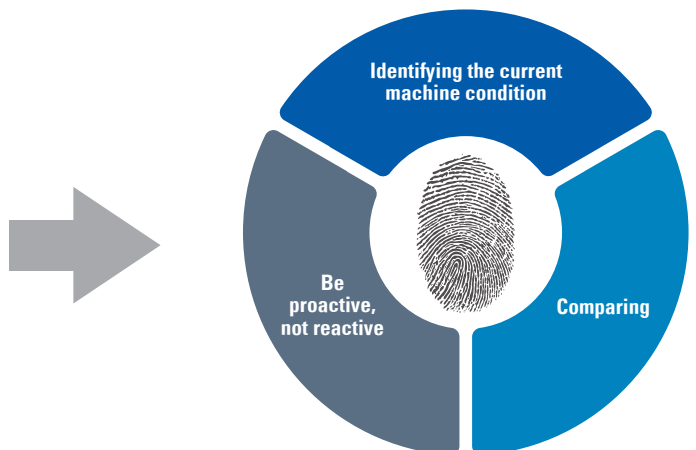
### Increase your machine availability and productivity!

As part of a detailed machine analysis with Fingerprint, an EMAG service engineer will compile diagnostics to evaluate the behavior of the machine axes.

By means of 3D-acceleration and vibration sensors, the movements of the axes are analyzed and plotted. Evaluating this data provides reliable conclusions about the condition of mechanical assemblies and components.



The reference data for Fingerprint is compiled from the EMAG database. This Fingerprint will later be used as a reference for inspection and fault analysis.



Fingerprint enables you to create an accurate analysis in a very short period of time. This information provides the basis for status-oriented maintenance that helps to save time and money.





## ProcessSim

Optimizing manufacturing systems –  
material flow simulation for maximum  
productivity

Realistic 3D modeling and simulation of all machining processes and the material flow of manufacturing systems.

ProcessSim is the ideal tool for investigating the productivity of manufacturing systems when they are in the planning phase. ProcessSim gives you concrete information about the availability and efficiency of the manufacturing system.

It simulates both the material flow and the machining processes, including the automation systems used. This provides you with evidence of the cycle time and output of the manufacturing system at a very early stage of the project.

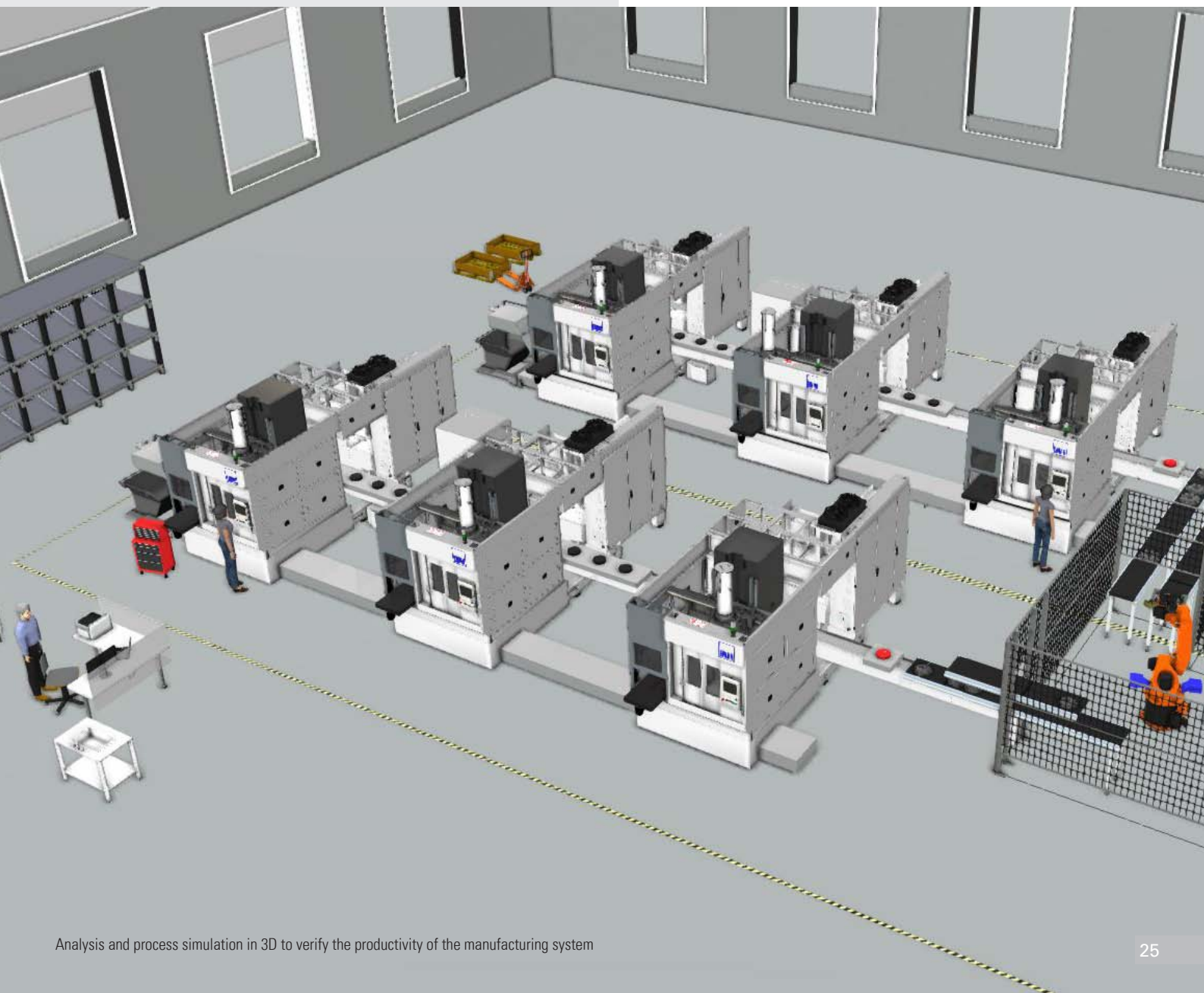
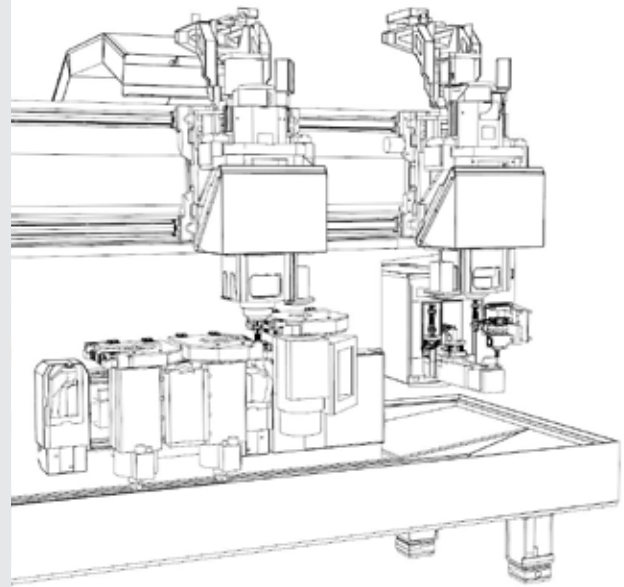
The 3D accessibility analysis also allows for the examination of the machines ease of maintenance. Furthermore, ProcessSim also gives you the option of exploring tool change and retooling strategies to ensure optimum operation of the manufacturing system.



Simulation of the process and the parts flow

## Benefits

- » Verification of the manufacturing design before the investment and implementation
- » Early detection of areas where optimization is needed
- » Verification of the cycle time, output, and accessibility
- » Optimization of tool change/retooling strategies
- » Planning of ramp-up strategies





## VirtualMachine

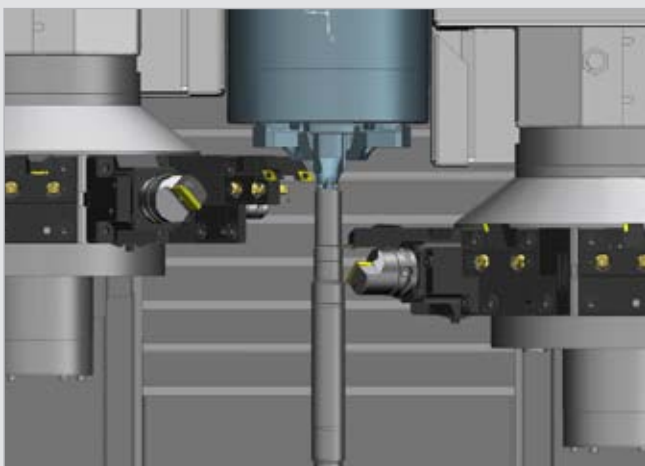
Simulation of NC programs to check complex machining processes

### Quick and reliable setup of complex production processes

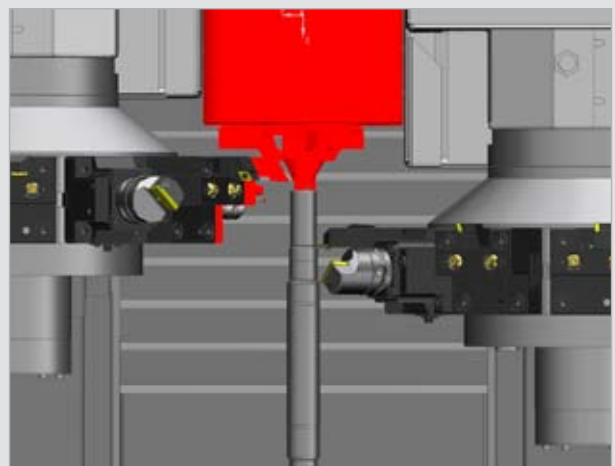
When it comes to the complexity of workpieces and their machining processes, the digital safeguarding method is increasing in importance for both the product development and production processes. An important tool in digital safeguarding is the machining simulation software package VirtualMachine. It validates complex machining processes.

In fact, with its VirtualMachine software EMAG offers the chance to both simulate and validate complex machining processes.

Simulation on EMAG's VirtualMachine enables a detailed observation of production processes, making it possible to optimize them long before the first real part is set up on an EMAG machine. This allows new workpieces to be set up quickly and reliably, already fully optimized.



Simulation without collision



Simulation with collision



# Benefits

- » Collision checking and collision monitoring
- » Quick and simple setup of new workpieces by verifying the process on the computer
- » Simulation under realistic conditions with an actual Siemens 840 D control
- » Tooling times minimized by checking the process on the computer
- » Process optimization, leading to increase in productivity
- » Optimized 3D model including all the machine parameters required for the simulation



## HMI of VirtualMachine

The user can run all the applications in the HMI, as on a standard Siemens 840D. The user can also load external programs from a local directory into the HMI and then run them there.

## System requirements

- » Siemens NX9
- » VNCK 4.4
- » Windows 7 or higher

At home in the world.

#### EMAG Salach GmbH

**Salach**  
Austrasse 24  
73084 Salach  
Germany  
Phone: +49 7162 17-0  
Fax: +49 7162 17-4027  
E-mail: info@salach.emag.com

**Frankfurt**  
Martin-Behaim-Strasse 12  
63263 Neu-Isenburg  
Germany  
Phone: +49 6102 88245-0  
Fax: +49 6102 88245-412  
E-mail: info@frankfurt.emag.com

**Leipzig**  
Pittlerstrasse 26  
04159 Leipzig  
Germany  
Phone: +49 341 4666-0  
Fax: +49 341 4666-114  
E-mail: service-LZ@emag.com

**Munich**  
Zamdorferstrasse 100  
81677 München  
Germany  
Phone: +49 89 99886-250  
Fax: +49 89 99886-160  
E-mail: info@muenchen.emag.com

**Austria**  
Glaneckerweg 1  
5400 Hallein  
Austria  
Phone: +43 6245 76023-0  
Fax: +43 6245 76023-20  
E-mail: info@austria.emag.com

**Denmark**  
Horsvangen 31  
7120 Vejle Ø  
Denmark  
Phone: +45 75 854854  
Fax: +45 75 816276  
E-mail: info@daenemark.emag.com

**Sweden**  
Glasgatan 19B  
73130 Köping  
Sweden  
Phone: +46 221 40305  
E-mail: info@sweden.emag.com

**Hungary**  
Gerenda 10  
1163 Budapest  
Hungary  
Phone: +36 30 9362-416  
E-mail: lbujaki@emag.com

**Czech Republic**  
Lolkova 766  
103 00 Praha 10 – Kolovraty  
Czech Republic  
Phone: +420 731 476070  
E-mail: mdlis@emag.com

**Poland**  
ul. Krzycka 71A / 6  
53-020 Wrocław  
Poland  
Phone: +48 728 389 989  
Fax: +48 601 371 353  
E-mail: info@poland.emag.com

**Turkey**  
Sanayi Cad. No.: 44  
Nish Istanbul Sitesi D Blok  
D: 155 Yenibosna – Istanbul  
Turkey  
Phone: +90 532 694 54 44  
E-mail: kcoc@emag.com

#### Market Companies

##### EUROPE

**ZETA EMAG Srl**  
Viale Longarone 41/A  
20080 Zibido S. Giacomo (MI)  
Italy  
Phone: +39 02 905942-1  
Fax: +39 02 905942-21  
E-mail: zetaemag@emag.com

**NODIER EMAG INDUSTRIE**  
2, Parc des Fontenelles  
78870 Bailly  
France  
Phone: +33 130 8047-70  
Fax: +33 130 8047-69  
E-mail: info@nodier.emag.com

**ZETA EMAG Srl**  
Sucursal en España  
Pasaje Arrahona, nº 18  
Polígono Industrial Santiga  
08210 Barberà del Vallès (Barcelona)  
Spain  
Phone: +34 93 7195080  
Fax: +34 93 7297107  
E-mail: info@emh.emag.com

**EMAG UK Ltd.**  
Chestnut House,  
Kingswood Business Park  
Holyhead Road  
Albrighton  
Wolverhampton WV7 3AU  
Great Britain  
Phone: +44 1902 37609-0  
Fax: +44 1902 37609-1  
E-mail: info@uk.emag.com

**EMAG OOO**  
ul. Akademika Chelomeya 3/2  
117630 Moscow  
Russia  
Phone: +7 495 287 0960  
Fax: +7 495 287 0962  
E-mail: info@russia.emag.com

##### AMERICA

**EMAG L.L.C. USA**  
38800 Grand River Avenue  
Farmington Hills, MI 48335  
USA  
Phone: +1 248 477-7440  
Fax: +1 248 477-7784  
E-mail: info@usa.emag.com

**EMAG MEXICO**  
Maquinaria EMAG Mexico S de RL de CV  
Av. Hercules 301 Nave 1  
Polígono Empresarial Santa Rosa  
76220 Santa Rosa Jauregui, Queretaro  
Mexico  
Phone: +52 442 291 1552  
E-mail: swieland@emag.com.mx

**EMAG DO BRASIL**  
Edifício Neo Corporate Offices,  
CJ 1503  
Rua Enxovia, 472  
04711-030 São Paulo SP  
Brazil  
Phone: +55 11 38370145  
Fax: +55 11 38370145  
E-mail: info@brasil.emag.com

##### ASIA

**EMAG (China) Machinery Co., Ltd.**  
Building A3 & B7 Cangneng  
Europe & America Technology Park  
No. 8 Loujiang Rd. (N.)  
215400 Taicang  
Jiangsu, China  
Phone: +86 512 5357-4098  
Fax: +86 512 5357-5399  
E-mail: info@emag-china.com

**EMAG (Chongqing) Machinery Co., Ltd.**  
No. 10<sup>th</sup> Lailong Road  
Yongchuan District  
402160 Chongqing  
China  
Phone: +86 23 49783399  
Fax: +86 23 49783388  
E-mail: info@emag-china.com

**TAKAMAZ EMAG Ltd.**  
1-8 Asahigaoka Hakusan-City  
Ishikawa Japan, 924-0004  
Japan  
Phone: +81 76 274-1409  
Fax: +81 76 274-8530  
E-mail: info@takamaz.emag.com

**EMAG INDIA Pvt. Ltd.**  
Technology Centre  
No. 17/G/46-3, Industrial Suburb,  
2<sup>nd</sup> Stage, Yeshwantpur,  
Bengaluru – 560 022.  
India  
Phone: +91 80 42544400  
Fax: +91 80 42544440  
E-mail: info@india.emag.com

**EMAG KOREA Ltd.**  
Rm204, Biz center, SKn Technopark,  
124 Sagimakgol-ro, Sangdaewon-dong,  
Jungwon-gu, Seongnam City,  
Gyeonggi-do, 462-721  
South Korea  
Phone: +82 31 776-4415  
Fax: +82 31 776-4419  
E-mail: info@korea.emag.com



www.emag.com