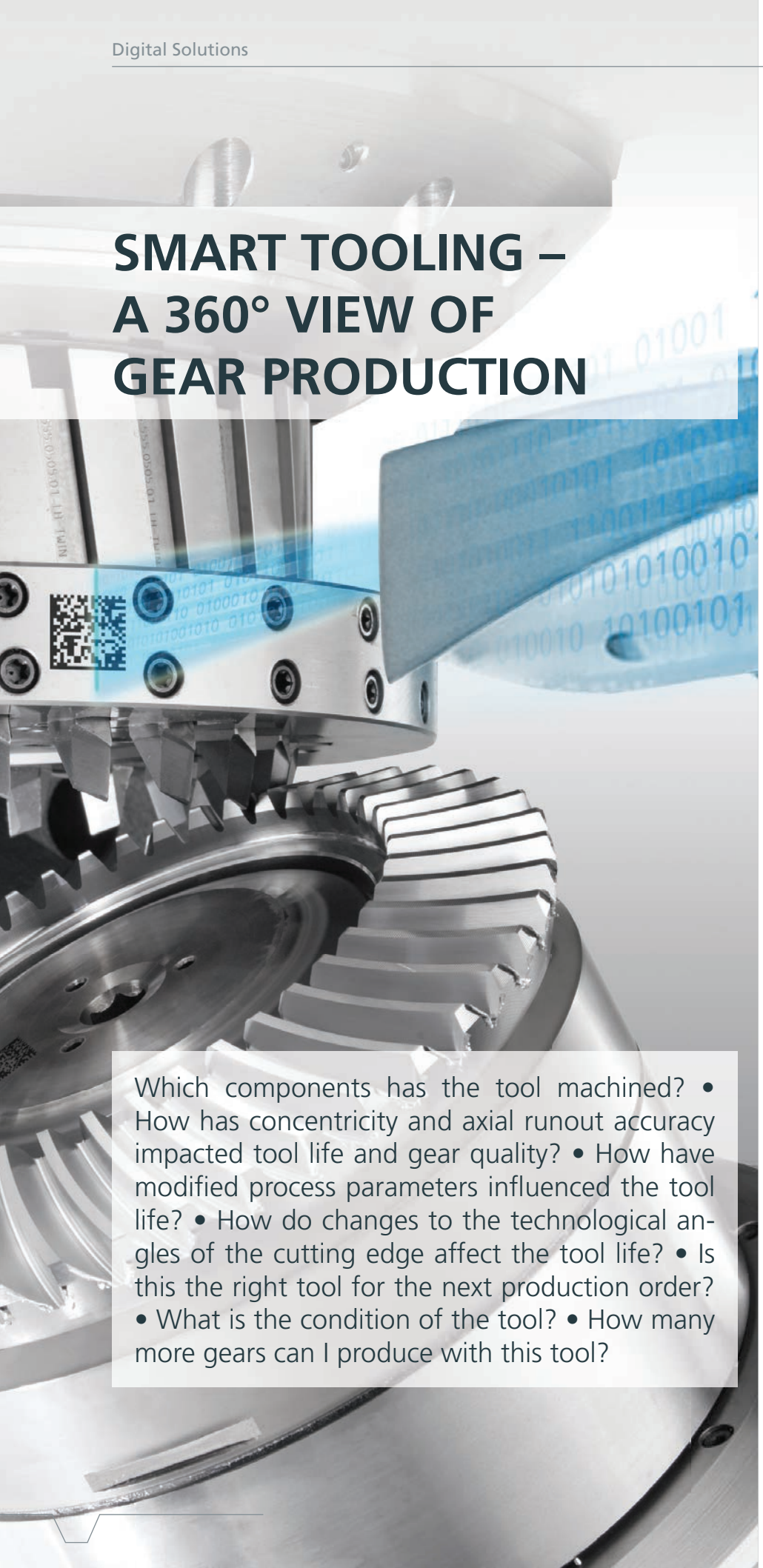
SMART TOOLING – A 360° VIEW OF GEAR PRODUCTION



Which components has the tool machined? • How has concentricity and axial runout accuracy impacted tool life and gear quality? • How have modified process parameters influenced the tool life? • How do changes to the technological angles of the cutting edge affect the tool life? • Is this the right tool for the next production order? • What is the condition of the tool? • How many more gears can I produce with this tool?

Today, it takes a lot of effort to answer all of these key questions for gear production by acquiring data manually and analyzing it subsequently. In gear production, the requirements for the volume of data needed and for its analysis far exceed what can be achieved with conventional tracking systems.

It Can All Be So Easy …

SmartTooling delivers these answers now – and it has never been easier, since data is collected and analyzed in a completely automated process, tailored to each customer's specifications. To ensure comprehensive data collection, not only is the production equipment integrated, so too are the machine tools and measuring machines, as well as the workflows on and off the machine. The production equipment is described to the desired level of detail by a digital twin and is kept in a central database, which is expanded during and after the gear machining process. This data enables identification, management, tracking and analysis functionalities. Particular emphasis is placed on analyzing productivity- and quality-relevant aspects.

High Quality, Reliable Processes

SmartTooling is an Industry 4.0 product with its roots in the manufacturing of bevel gears. Stringent requirements for technology and quality demand perfect coordination between machining centers, measuring machines, production equipment and workflows (see figure 1). As a way to resolve conflicting challenges posed by ultra-high quality standards, component variance and

productivity, the digital integration of all instances in a system such as SmartTooling enables three things: safety through assistance, transparency through comprehensive data acquisition and new optimization potential through data analysis. As a technology leader and system supplier, Klingelnberg creates unparalleled synergies in this regard. How does this benefit customers? The SmartTooling advantage yields improvements in planning on the one hand and efficiency in production on the other. This is true for productivity-driven mass production as well as variant-rich small-lot production.

As early as the machine setup stage, the operator is vulnerable to various potential causes of error due to manual work steps. Installing the wrong tools or clamping devices results in collisions, ultimately damaging the machine and the production equipment. The downtime resulting from these events then usually prevents on-schedule completion of production orders.

SmartTooling delivers the key competitive advantage in such situations. As soon as they are installed in an Oerlikon Bevel Gear Cutting Machine, tools and clamping devices are scanned and automatically verified to determine their suitability for the current production order. The machine will not accept an incorrect tool. In addition, geometries such as actual heights are automatically received by the machine and imported into the control unit. Manual input is no longer required. This saves time and prevents errors. Instructional messages assist the operator as needed to ensure proper setup. Screw size, torque, documented anomalies and highly customer-specific information are displayed immediately.

Fig. 1: SmartTooling components: In addition to production equipment, machine tools and measuring machines are also integrated, as well as the workflows on and off the machine.

Manual input is almost entirely unnecessary – saving time and preventing errors.

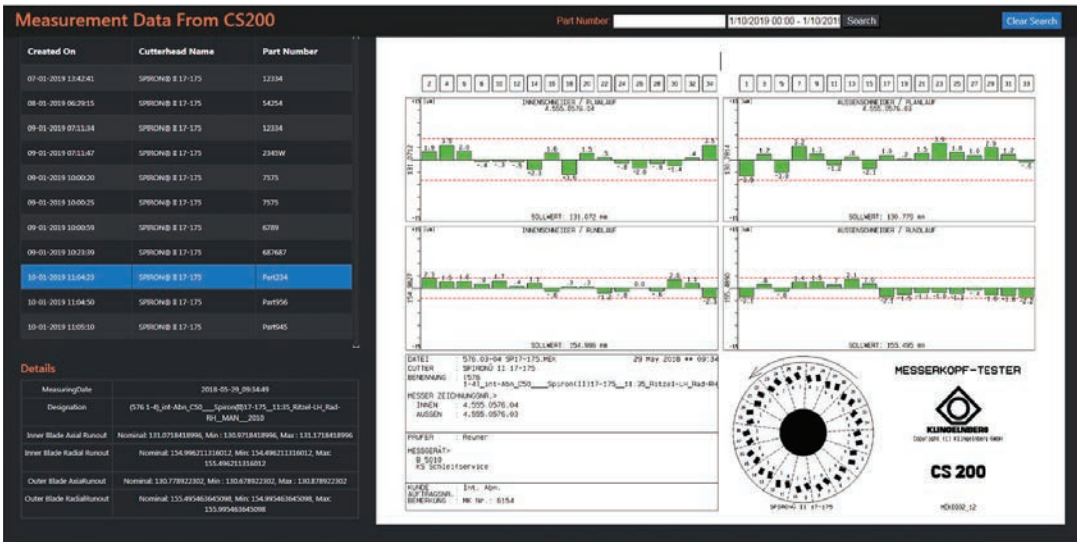


Fig. 2: The digital twin of the configured cutter head is enhanced on the CS 200 with axial runout and concentricity information. Effects on component quality and tool life are now visible during the course of production.

Significantly Reduced Production Costs

Standardized, automated verification of tool life quantity is also integrated, of course. This makes it possible to compare the available tool life quantity against the number of components to be machined. Selecting a tool with sufficient residual tool life quantity prevents production breaks, since rework during an ongoing production order is eliminated. If the tool must be used despite an insufficient residual tool life quantity, the standardized status indicator provides timely notice that a wear test of the production equipment is due – before concentricity errors in the clamping device or defects in the tool compromise the quality of the components. Rejects and rework of the components are avoided in this way.

SmartTooling provides a wealth of data that is automatically populated by the machines. As the data inventory grows, new information can be obtained about factors impacting the tool life quantity, and tool life forecasts can be specified as a result. Tool use becomes increasingly more efficient, and costs are reduced. If the tool must be replaced prematurely, the cause can easily be documented thanks to a selection of precategorized reasons for replacement in the machine control unit. Based on this information, the maintenance process can be initiated. The reasons for the replacement can also be analyzed and optimized in a targeted manner in the case of a conspicuously high frequency of occurrence.

SmartTooling delivers the critical advantage: a 360° view of gear production makes it possible to optimize and monitor processes at the next level.

Complete Connectivity

Anyone who has ever wondered how the setting accuracy of the cutter head will affect the component quality and tool life can now look to SmartTooling for answers, since the Oerlikon CS 200 type cutter head setting and checking device is also integrated into the SmartTooling network. The unbeatable advantage: SmartTooling generates a digital twin of the cutter head / blade set composition, which is enhanced during the further course of production with production data in the form of specifically determined concentricity and axial runout data (see figure 2).

Away from the machine, there is also the (free) SmartTooling app for Windows workstations and mobile Android devices. The app visualizes work-in-progress for the production equipment. Thus a variety of information can be viewed: tool status, anomalies reported on the machine, storage space and current application. In conjunction with a scanner, the app can also be used to uniquely identify production equipment. The app also aids in initializing the production equipment inventory in SmartTooling, that is, in generating the digital twin to any desired level of accuracy. At this point, the geometries are also defined; they are then automatically received by the machine during setup. With regard to the verification function on the machine, the app can be used to release production equipment in advance for specific components and machines.

Data – the Centerpiece of the System

Comprehensive data is the most valuable component of SmartTooling. The system comprises master data such as the digital image of the production equipment on the one hand, and production data that is generated during machining on the other hand – for example, on an Oerlikon cutting machine or when setting concentricity and axial runout on the Oerlikon CS 200 cutter head setting and checking device. This data is collected in a central database, namely GearEngine®. GearEngine® is a plug & play solution for integrating the central database into customers' production networks quickly and without complications. All data converges in GearEngine®. Individualized evaluations and reports visualize correlations.

Each production equipment component is given a certified DataMatrix mark according to the internationally established GS1 standard in order to establish an unambiguous link to the digital twin. This gives marked equipment a unique identity worldwide. Klingelnberg original equipment is ready for integration in SmartTooling – it receives a certified GS1 mark at the factory and is delivered along with a digital twin. Using the SmartTooling app, users can immediately view and explore the digital twins of their Klingelnberg tools.

Ready, Set, Integrate: It's That Easy

SmartTooling is readily integrated at any time. New Oerlikon cutting machines come already equipped with SmartTooling capability. Existing machines require a software update and a handheld scanner to capture the production equipment during installation and removal. The SmartTooling app is the software for workstations, tablets, smartphones or mobile scanner terminals.

Once all of these components are integrated into the production line, the task of collecting and analyzing data from all of the instances involved in gear production no longer seems at all daunting. With a 360° view of gear production, completely new methods emerge for optimizing and monitoring the processes at a new level. ◆

Compact

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For more information about SmartTooling, visit: www.klingelnberg.com/smarttooling. If you have any questions, e-mail us at: i40@KLINGELNBERG.com

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