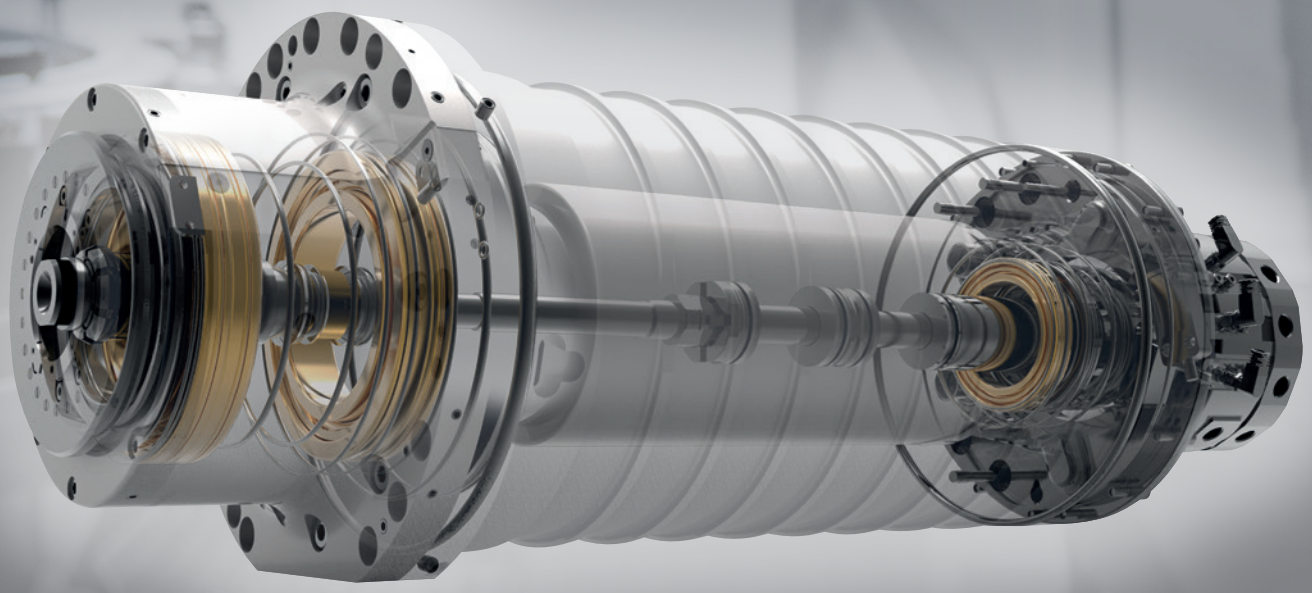
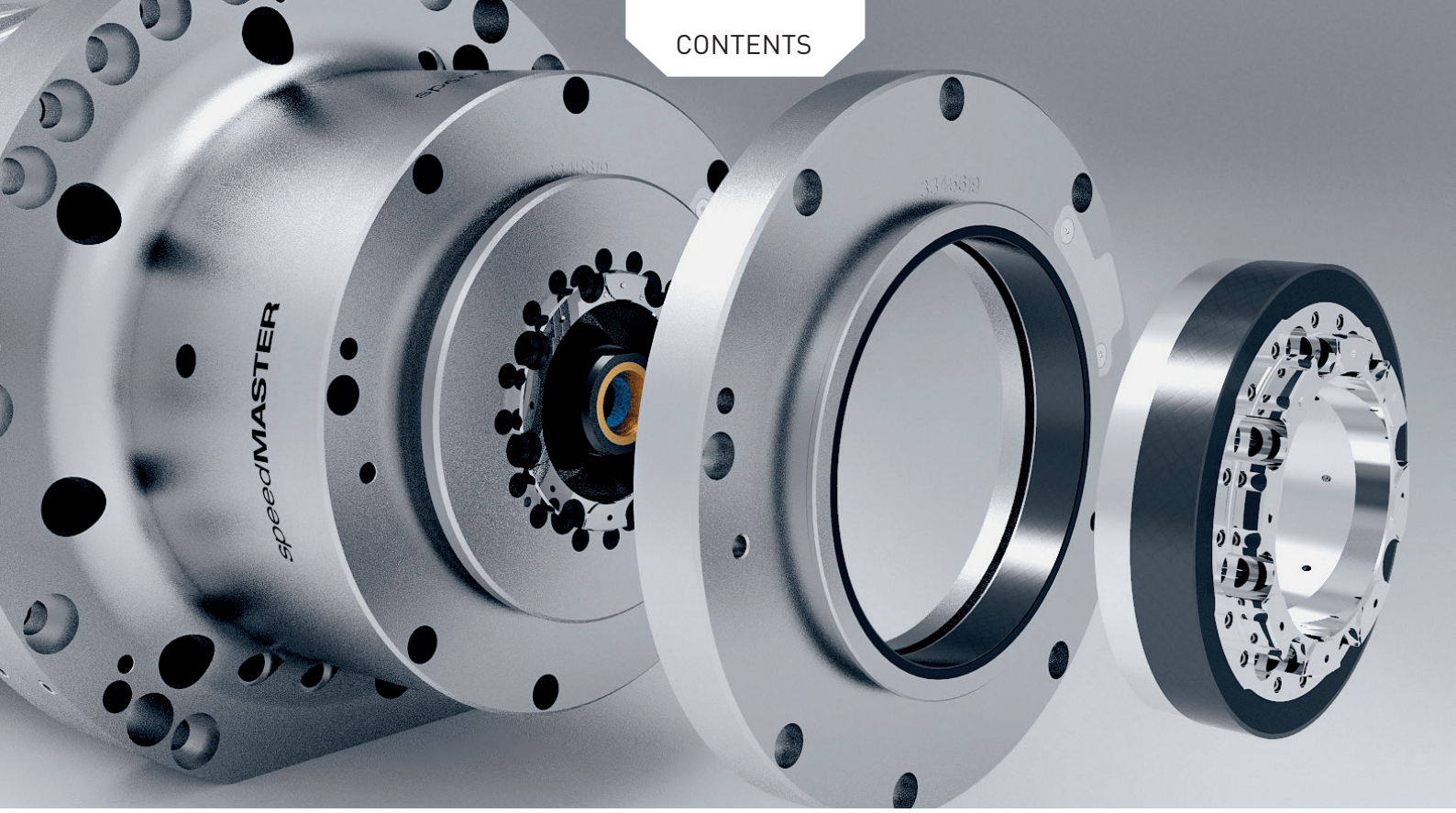
WORKPIECE

SPINDLE DRAWBAR



DMG MORI

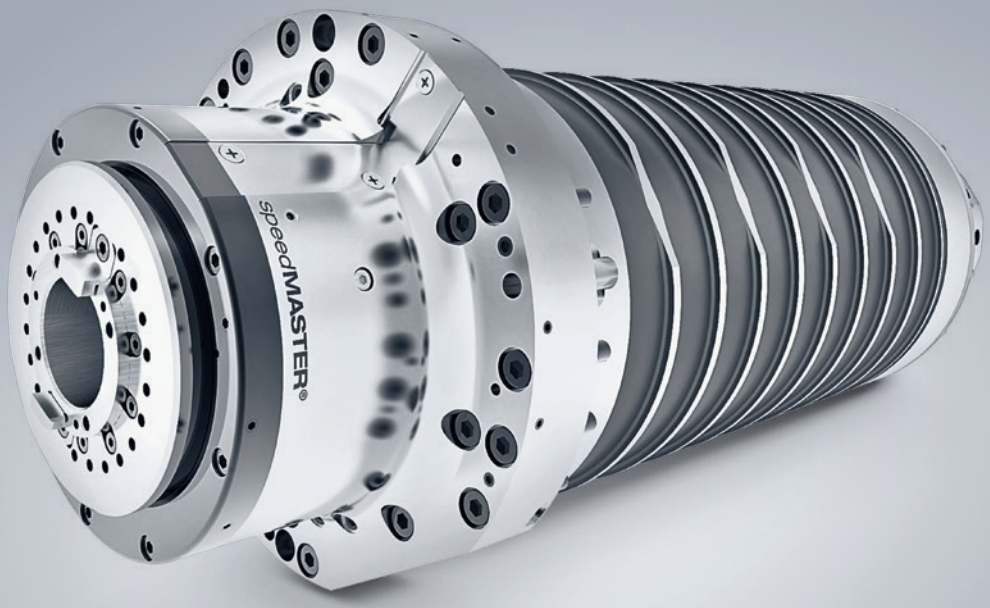
CONTENTS



THE HEART OF EVERY SPINDLE

Depending on the application, machine tools are available with a wide variety of spindles. What these spindles have in common is their centerpiece. The spindle drawbar inside has the respective connections at the ends and is a simple component at first glance. However, it is exposed to a large, permanent load, which requires a very resistant coating. Conventional manufacturing processes require an additional external processing step at this point. DMG MORI is taking a more efficient approach here with additive manufacturing.

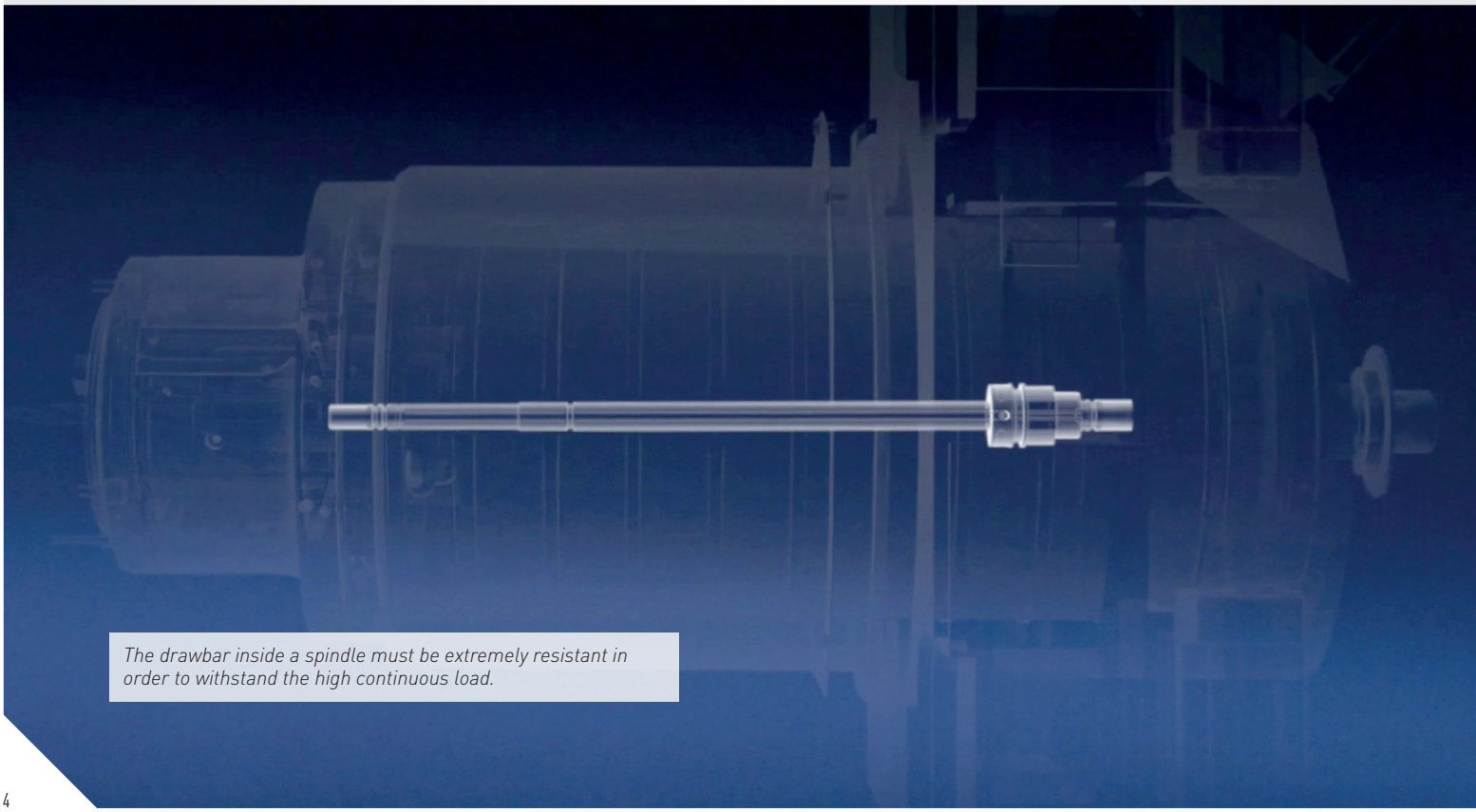
In the spirit of process integration, a key pillar of Machining Transformation (MX), DMG MORI combines turning and milling of the drawbar as well as the coating in the working area of the LASERTEC 3000 *DED hybrid*. This is because the machine combines 6-sided turn & mill technology with laser deposition welding using a laser head in a single clamping operation. This means that the resistant coating is applied additively and subsequently finished with the required surface accuracy in a final step of grinding, which is integrated as well. DMG MORI uses this spindle drawbar, which is manufactured entirely on one machine, in its own speedMASTER and powerMASTER spindles.



DMG MORI manufactures spindle drawbars for the speedMASTER spindles in an integrated process on the LASERTEC 3000 DED hybrid – including coating using DED technology.

SPINDLE DRAWBARS FOR HIGH-SPEED MILLING AND HEAVY-DUTY MACHINING

Whereas in the early years, spindles were driven by an external motor via a belt, nowadays gear or motor spindles are used. In the former, the motor is located at the end of the spindle and drives it via a gearbox. Motor spindles, on the other hand, have an internal electric motor that acts as a direct drive. A key component in both variants is the drawbar at the core of the spindle. It is surrounded by disk springs that move along the drawbar and are mounted at both ends. The spindle causes the drawbar to rotate – at speeds of up to 60,000 rpm in high-speed milling – and transmits the drive force of the spindle to the tool. In heavy-duty machining, powerful spindles achieve torques of over 1,000 Nm. In other words, the spindle drawbar is exposed to very high speeds and forces.



The drawbar inside a spindle must be extremely resistant in order to withstand the high continuous load.

STRUCTURE

Size and shape

As drawbars in motor and gear spindles transmit huge forces, they must be very rigid so that they bend as little as possible. The decisive factors for rigidity are the diameter, length and material. However, diameters that are too large increase the energy required for acceleration due to the higher mass moment of inertia. The vibration behavior is also relevant, as a drawbar can become unstable at critical speeds. In addition, there is an internal coolant supply, which is now standard on many spindles and is fed to the tool via a rotary feed-through in an axial bore in the drawbar. A separate bore for compressed air is also conceivable. The length, diameter and specific geometry of the spindle drawbar are determined by these factors and are therefore closely linked to the characteristics of the spindle – speed, power and torque.

Materials

Thanks to their high strength, steel and stainless steel are ideal materials for the manufacture of drawbar in spindles. Coating the surface also significantly increases its resistance to wear from the surrounding disk springs. Hard materials such as chrome are used here. However, the time and cost involved in coating is high and capacities for this process step are likely to decrease in the future. DMG MORI has therefore sought and found an alternative in additive manufacturing. On the LASERTEC 3000 *DED hybrid*, the spindle drawbar can initially be turned and milled as usual. The laser head mounted on the milling spindle is then used to apply a coating that gives the component a similar level of resistance to chrome plating. This is because DMG MORI uses high speed steel with a hardness of 62 HRC.

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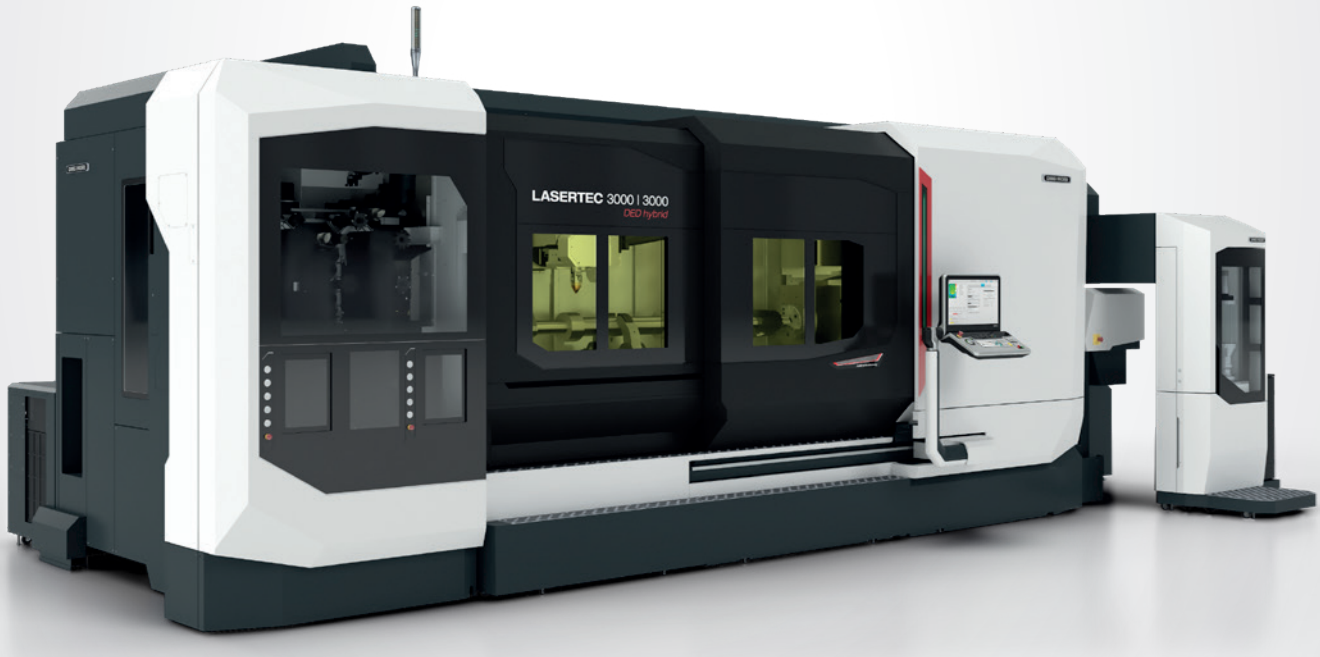
PRODUCTION IN HOURS INSTEAD OF DAYS

A look at the conventional production of spindle drawbars reveals a process that takes up to 14 days. This is because the turning and milling of the geometry was separate from the other steps. Finishing and grinding are carried out on separate machines. Heat treatment is required beforehand. Chromium plating at external service providers accounts for a large proportion of the time required. With the LASERTEC 3000 *DED hybrid*, DMG MORI is taking a much more efficient approach because the hybrid machine integrates so many process steps into one work area that the drawbar can be completely manufactured within two hours.



As a hybrid machine for 6-sided turn & mill complete machining, additive manufacturing and grinding, the LASERTEC 3000 DED hybrid combines all the steps required for the production of spindle drawbar in one work area.

Maximum process integration

The LASERTEC 3000 *DED hybrid* is based on an NTX 3000, a stable and powerful turn & mill center that machines complex workpieces completely in a single clamping operation. Travels of 675 x 300 x 1,562 mm and a workpiece weight of up to 1,150 kg provide sufficient space for a wide range of components. The turnMASTER spindles on the left has a speed of 3,000 rpm and a torque of 1,273 Nm, the right one 4,000 rpm and 828 Nm. This allows machining the solid materials for spindle drawbars productively. The complex geometry is realized by 6-sided turn & milling machining with maximum precision. The machine is equipped with a compactMASTER spindle for this purpose. It achieves a speed of 20,000 rpm and a torque of 123 Nm.

As a hybrid machine for additive manufacturing, the LASERTEC 3000 *DED hybrid* offers decisive added value in the production of spindle drawbars. DMG MORI can dispense with time-consuming and energy-intensive chrome plating and coat the components using laser deposition welding. For this purpose, the machine is equipped with a 3 kW laser oscillator with a spot diameter of ø 3 mm. The laser head is automatically inserted into the work area and applies an approximately 0.5 mm layer of high speed steel. The travel paths allow additive manufacturing of components up to ø 400 x 1,321 mm. The AM-Assistant monitors both the temperature and the powder flow to ensure that the coating is applied reliably. The result is a coating that gives the drawbar its high stability, as the tool steel has a hardness of 62 HRC. This coating also eliminates the heat treatment required in conventional manufacturing.

Additive manufacturing is a perfect example of process integration, a firm pillar in DMG MORI's Machining Transformation (MX) concept. The aim is to design manufacturing solutions that integrate as many steps as possible into one workspace.In the case of the spindle drawbar, DMG MORI goes one step further: The LASERTEC 3000 *DED hybrid* is also capable of grinding, so that the high-precision component can actually be machined to a final dimension.

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Thanks to holistic process integration, DMG MORI manufactures the drawbar for speedMASTER spindles within two hours in one working area. The original process required two weeks due to heat treatment and external chrome plating.

More sustainable manufacturing through process integration

The optimized manufacturing process for the spindle drawbar has a considerable impact in terms of energy efficiency. Chrome plating and heat treatment in particular had a negative impact here. As these process steps have been eliminated, energy consumption is now only around a third.

EXPLOITING THE POTENTIAL OF ADDITIVE MANUFACTURING

The example of the drawbar for speedMASTER spindles is an impressive demonstration of how conventional manufacturing processes can be sustainably optimized. The integration of several technologies in one workspace is a crucial basis for this. In this context, metallic 3D printing has great potential not only to optimize processes, but also to revolutionize them, because it enables completely new manufacturing approaches.

DMG MORI has set up the Additive Intelligence consulting unit for precisely such examples, which analyzes conventional machining process chains and designs holistic manufacturing solutions consisting of conventional CNC machining and additive manufacturing – both for customers and in-house. The production of complex machine tools includes a wealth of components whose manufacture benefits from this work. Additive Intelligence finds these applications and trains personnel in the plants so that the new manufacturing processes can be implemented.

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MORE ECONOMICAL MANUFACTURING SOLUTIONS WITH ADDITIVE MANUFACTURING

With over 20 years of experience in the additive manufacturing of metallic components, DMG MORI stands for innovative manufacturing technologies, global customer proximity and worldwide service. The machine tool manufacturer sees the ADDITIVE MANUFACTURING area as an important addition to the overall portfolio, because metallic 3D printing enables completely new manufacturing solutions. This applies both to laser deposition welding with the LASERTEC *DED* and LASERTEC *DED hybrid* machines and to additive manufacturing in the powder bed of the LASERTEC SLM machines. Both technologies are increasingly becoming a central component of integrated processes that reduce throughput times for complex workpieces, reduce material usage and optimize machine capacities.

DMG MORI complements its ADDITIVE MANUFACTURING offering with integrated software solutions that enable simple programming and operation of the machines. In addition, the Additive Intelligence team supports customers in the introduction and implementation of innovative process chains – from the identification of suitable applications and the engineering of components to the production of the first small series. Training courses for management, design and production round off the offering.

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