Case study

Oscillation-assisted turning of forgings at Schaeffler AG

Chip breaking problems in turning processes of forgings

The machining of hot formed blanks plays an important role in large-scale production in the automotive industry. For example, ductile materials are used for forgings, which often lead to poor chip breaking behavior during subsequent machining. Particularly in turning processes with continuous cutting engagement, the material behavior leads to the sometimes sporadic formation of long chip shapes and tangled chips.
Insufficient chip breaking also caused process uncertainties and machine downtimes during the turning of forged wheel bearing blanks at Schaeffler AG. Tool breakages occurred during both external and, in particular, internal machining (**1**). During internal machining, the chips could not be removed reliably. In the turning process, chip jamming occurred between the tool, boring bar and workpiece. Another consequence of the poor chip formation was the accumulation of chips around the chuck. These chip piles hindered the automatic component change and led to clamping errors (**2**) due to jammed chips. The biggest problem in the process resulted from the formation of chip piles (**3**) in the work area, which posed a collision hazard, hindered automatic workpiece handling and interrupted the automated removal of chips. The removal of the chip piles from the work area had to be carried out manually by the operator and required the repeated stopping of the production process, which led to a reduction in the machine availability of the manufacturing cell and thus to non-productive times.

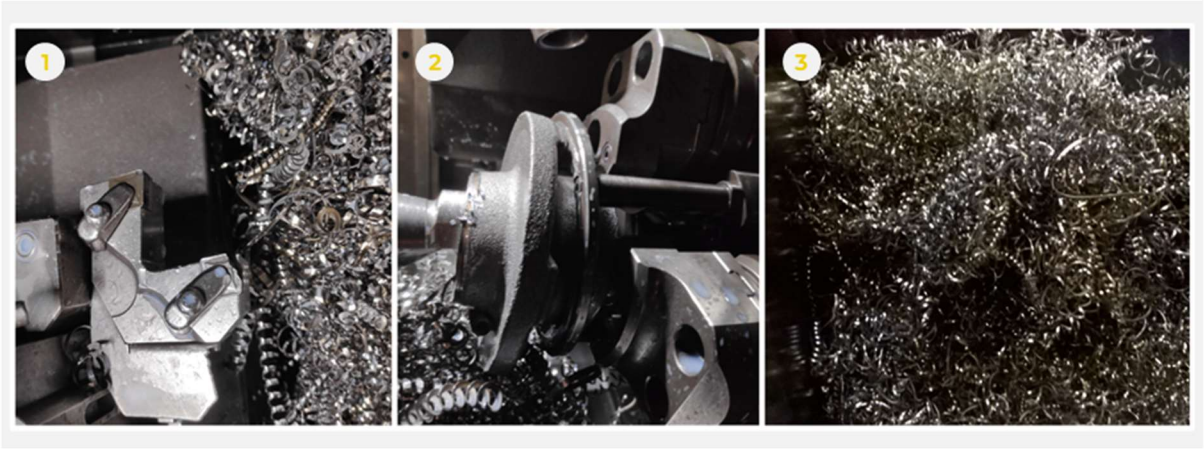

Figure 1: Process uncertainty due to insufficient chip breaking in wheel bearing production [1]

Use of VibroCut *oscillate* for internal turning of wheel bearings

In a project between Schaeffler AG and the Fraunhofer Institute for Machine Tools and Forming Technology IWU, an oscillation system with its own drive was developed and integrated into a machine tool for machining wheel bearings in a Schaeffler production plant. This oscillation system enables the conventional turning process to be supported with a defined oscillation movement in the feed direction. As a result, weak points are

VibroCut GmbH
Annaberger Str. 240
09125 Chemnitz
info@vibrocut.de
www.vibrocut.de

specifically introduced into the chip as it runs off, causing the chip to break. The retrofittable unit achieves amplitudes of up to 0.4 mm at a maximum frequency of up to 100 Hz. The integration into the machine control not only enables the oscillations to be switched on and off via the NC program, but also allows the performance characteristics to be changed for different cutting operations. In the application, the internal machining of a wheel bearing ring was superimposed with an oscillation in the frequency range 81 Hz to 88 Hz with an amplitude of 0.19 mm in order to achieve robust chip breaking. The internal turning process was carried out with a standard cutting insert on a boring bar (Ø32 mm) with feed rates of 0.4 to 0.5 mm and cutting depths of up to 3 mm.

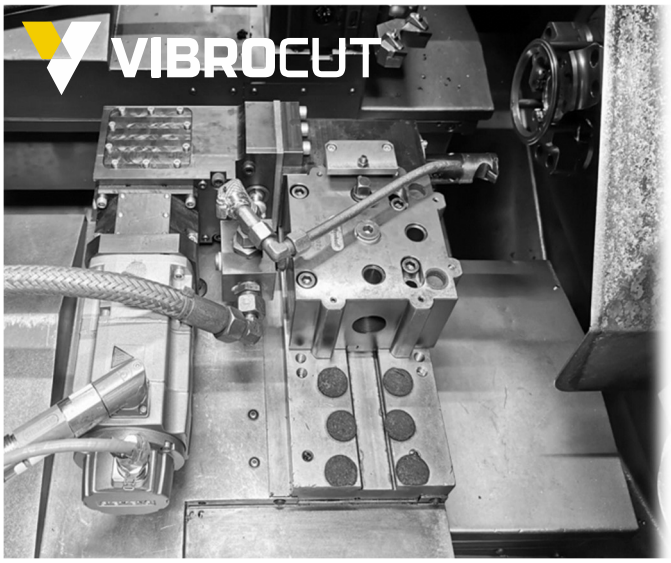

Figure 2: VibroCut oscillate with its own drive [1]

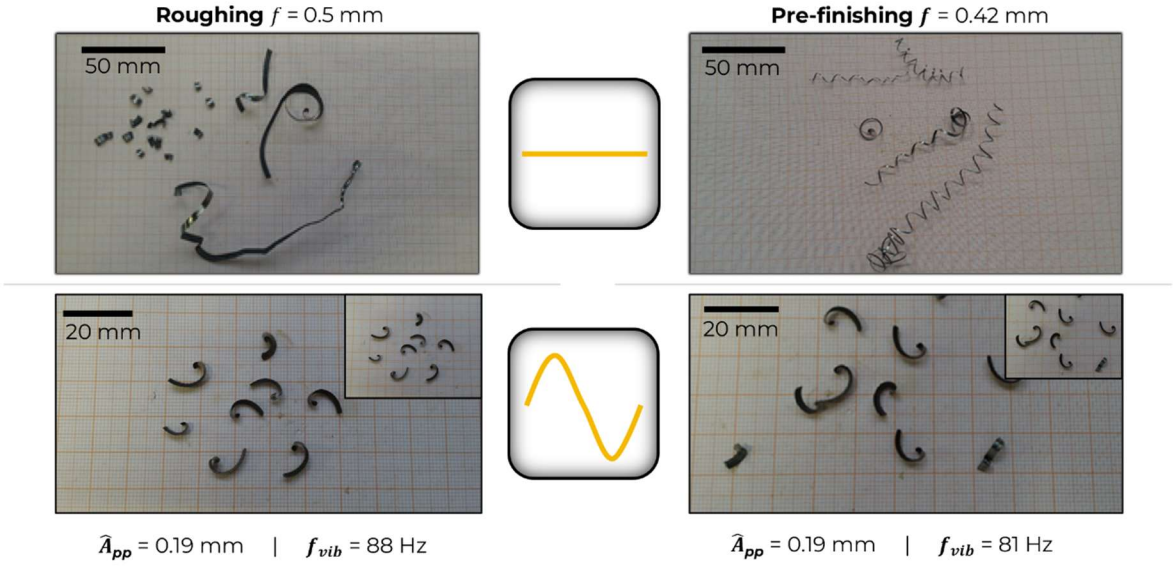

Figure 3: Optimization of chip breaking behavior with low-frequency oscillation systems [1]

Figure 3 at the top shows the chip shapes produced in the conventional turning process, which could not be safely removed from the inside of the component. The oscillation-assisted turning with an amplitude of 0.19 mm significantly improved the chip breaking behavior (Figure 3 at the bottom). Both in the roughing and pre-finishing processes, significantly shortened chip shapes could be produced. These could be safely removed from inside the workpiece out of the working area of the machine.

VibroCut GmbH
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09125 Chemnitz
info@vibrocut.de
www.vibrocut.de

The measurement of the workpieces produced with oscillation assistance showed that both the required shape and position tolerances as well as the surface roughness could be maintained.

Customer benefits

By supporting the turning process of the wheel bearing components with oscillations, short chips could be produced for the roughing and pre-finishing process. This is the basis for increasing machine availability. When using the oscillation system, the conventionally set process parameters such as feed rate and cutting speed and therefore the cycle time and the tool were not changed. On this basis, the system contributes to increasing economic efficiency in the series production of wheel bearings.

"The potential of the oscillation systems can be seen in the reduction of non-productive times in production as well as disruptions caused by chips in the interlinking systems." [2]

Dr.-Ing. Holger Pätzold
Schaeffler Technologies AG & Co. KG
Senior Expert
Process Development
Industrial Engineering Operations Bearings

As a result of the inspection of machines and components, machine availability was increased by up to 5% [3].

Bibliography

[1] M. Schwarze and H. Paetzold, „Schwingungsunterstütztes Drehen für einen definierten Spanbruch," in *Thementag Intelligente Komponenten für den Maschinenbau*, Chemnitz, 2022.

[2] O. Georgi, M. Schwarze and H. Paetzold, „Schwingungsunterstützte Zerspanung," in *cUPdate - Leistungszentrum Smart Production and Materials*, Webinar, 2022.

[3] M. Schwarze, C. Rüger, O. Georgi, H. Rentzsch and H. Paetzold, „Actuator and Process Development for Vibration Assisted Turning of Steel," *Advances in Manufacturing Technology XXXIV,* pp. 64-69, 2021.

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Further information

VibroCut *oscillate* is a patented system developed by VibroCut GmbH. We act as a product and technology provider as well as an integration partner for the use of oscillation -assisted machining in your production. We sell our oscillation systems as tool holders for equipping new and existing machines and offer related services.

Figure 4: Tool holders L-Line and T-Line

The VibroCut *oscillate* tool holder causes the cutting edge of the tool to move in a defined manner, which is aligned with the feed axis of the turning process. The driven location of the turret is used to generate the oscillation. The oscillation frequency can then be programmed directly in the NC code via the turret drive. Solutions with an additional self-sufficient drive can be implemented on a customer-specific basis. The innovative, robust design of VibroCut *oscillate* enables unique performance parameters. Due to the innovative drive concepts, customers can choose between different oscillation directions. The T-Line and L-Line each enable movement across or along the tool axis in the turret. With the arrangement of the tools and the oscillation directions, all common operations ranging from longitudinal, facing, or grooving processes to centric drilling on lathes can be superimposed with n oscillation. Both new and existing machines can be equipped with different sizes via the standardized tool holder interfaces such as VDI or BMT.

Feel free to contact us directly or find more information on our website:

VibroCut GmbH
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www.vibrocut.de

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www.vibrocut.de