Machining centres ■ Tool life ■ Vibration compensation

# Smooth operation, long life

Tools often reach the end of their service life early as a result of vibrations during heavy machining. Vibration-optimised machining centres are counteracting this, as has been confirmed by tests where an 80-mm sprocket milling cutter was used to create slots and pockets in titanium.

by Benjamin Braun and André Heinzelmann

The amount of difficult-to-machine high-strength materials is increasing, such as in the aerospace sector. In order to continuously reduce the production costs in this sector and withstand the pressure on costs, all opportunities must be exploited and alternative methods must be sought. New developments, such as additive manufacturing, are being permanently driven forward in order to achieve additional savings with the cost of materials. However, this method is not applied to highly-stressed components with their special safety requirements.

1 Heavy machining in action: A 600-mm side milling cutter works on an HVC head on a Burkhardt+Weber machining centre. The tool requires that the machine has an extremely high torque in the lowest speed range (© Burkhardt+Weber)

## Make savings through extended tool life

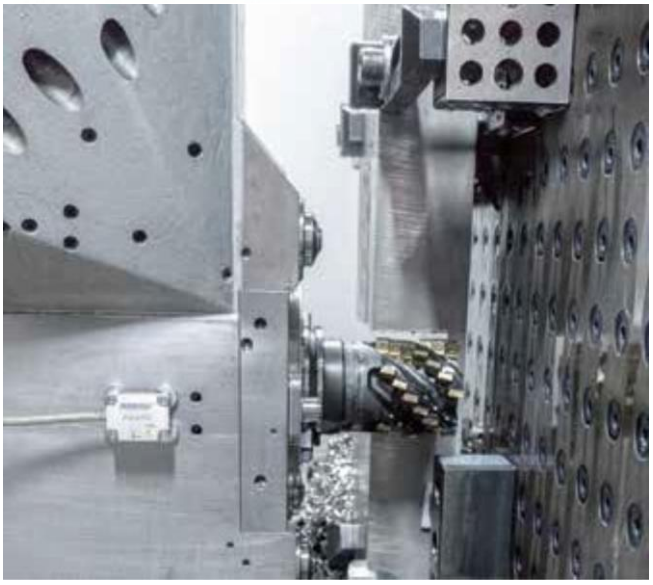
All in all, there is no way of avoiding classic machining. However, is an increase in cutting performance, reduced non-productive time and perfected CAM programming enough to reach the targeted efficiency goal? Considering that with many components in heavy machining up to 98 per cent of the raw material ends up in the chip container at the end, it quickly becomes clear that the reduction in production costs must be achieved through other measures. The level of potential savings as a result of an extended tool life is simple to explain.

If you consider, for example, the cost structure of a very tough cutting insert, such as those used in heavy machining, the effect of reduced vibration upon the entire production process is clear. In brief: When vibrations can be avoided, the wear and tear of the tool decreases and ultimately increases process safety.

The mass and the dampening of the machine tool could be increased of course; unfortunately this is not that easy. Ultimately the machine dynamics suffer as a result of such measures, and the reduced tool costs increase due to the extended machining time.

In order to identify which vibrations impact upon the heavy machining process and what the optimal ratio is between rigidity and machine dynamics, machine tool manufacturer Burkhardt+Weber (BW) started a series of tests with different machine configurations. The process workflow was ever constant machining with a D80 five-bladed sprocket cutter with 80 mm diameter. During machining, whereby slots and asymmetric pockets were produced in titanium workpieces, the vibrations were recorded and compared in a benchmarking process. The tests were carried out on a machining centre with flat guides, a machining centre with linear roller guides and a machining centre with linear roller guides and encapsulated machine frames.

2 Z-axis and stands of a flat-guided machining centre. The extremely powerful dimensioning of the components is aimed at eliminating vibrations across the entire system (© Burkhardt+Weber)



3 As part of testing to produce slots using a five-bladed 80-mm sprocket cutter, there were machining processes with virtually no measurable vibrations (© Burkhardt+Weber)

## Configurations on the test bed

Prior to testing, the BW experts dealt with the clamping problem – a procedure that is generally recommended for machining tasks. Only when the tool clamping technology is completely stable is it eliminated as a possible source of vibrations. When it comes to localising vibrations, it is helpful to look at the flow of forces during machining. The component that is subjected to the most stress here is the work spindle.

At BW, an HVC head with 1,600 Nm torque, 41 kW gear spindle and water-cooled main drive were used for the tests. BW gear spindles are extremely powerful, especially in the lower speed range

– a prerequisite for effective heavy machining. Generously proportioned spindle bearings and membrane clamping over a large bracing diameter are additional components that counteract vibrations.

The counterpart of the work spindle is the machine table. Due to its low construction and the resulting low centre of gravity, BW tables withstand very high tilting and tangential moments (60,000 and 40,000 Nm respectively). FEM-optimised components and a well thought through construction are also aimed at eliminating vibrations.

If you continue to trace the flow of forces, you arrive at the other important machine components: the guides. There are differing expert opinions with regard to the design. BW is one of the few manufacturers that has both roller and flat-guided machining centres in its portfolio. The reason for this is the required flexibility that the company wishes to retain in the future too.

An outcome of the tests: There are very minor differences between the different guide types. However, even a minor difference can be the key to success when implementing a project. Essentially there is no general answer to the question "roller-guided or flat-guided?". In order to make a decision, the proportion of heavy machining within the entire machining process needs to be considered first of all. If this is higher than 70 per cent, it is recommended that the less dynamic flat guides are used, since these also offer better dampening properties. If there is predominantly five-axis simultaneous machining, a linear roller guide offers the required dynamics.

In order to set the degree of dampening to an economically sensible optimum level, BW works with a partial pour out of the machine frame both for the flat-guided MCR and the roller-guided MCX series. The tests also demonstrated the benefits of this. The measurements for this configuration produced vibration values. A further benefit of flat guides is their long service life.

## Adjusting the feed motion of the load

In order to satisfy the hotspots and forging allowances in high-strength materials, BW machines have a self-developed torque and feed force monitoring where required. With the "adaptive control" option, the feed can be reduced when a defined force limit is reached or can be increased to a defined limit when the required value is not reached.

The tests confirmed that the tested machines are capable of responding to the different requirements in the industrial environment. Taking into account the test results, inter-disciplinary teams at the BW head office in Reutlingen are continuing to develop the machining centres. The spectrum currently ranges from highly-customised machining centres to turnkey systems. The manufacturer's customer services ensure high availability following commissioning. ■

## INFORMATION & SERVICE

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