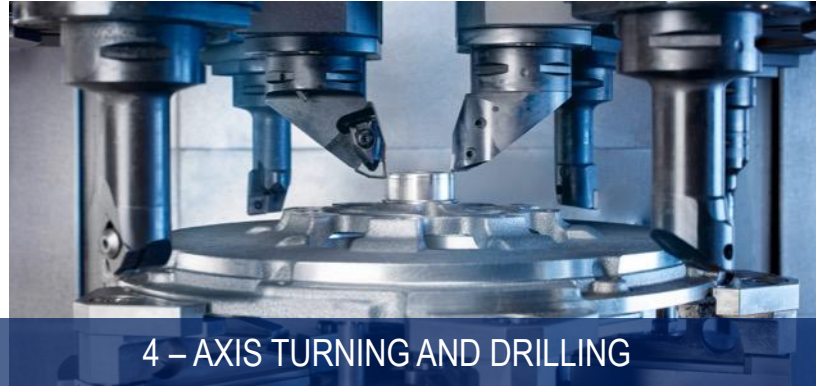


MANUFACTURING SOLUTIONS FOR PRECISE METAL COMPONENTS.

VMC-SERIES



UP TO 5 AXIS



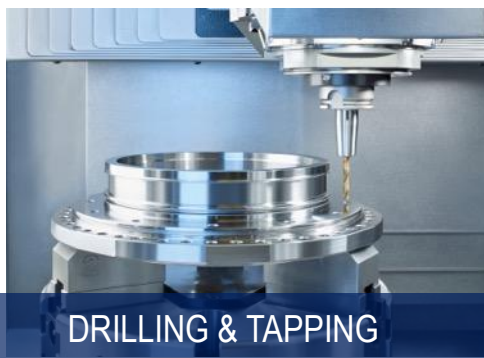
4 – AXIS TURNING AND DRILLING



TAILSTOCK



TURNING – SOFT & HARD



DRILLING & TAPPING



MILLING



SKIVING

VMC 450-5MT Production

Methods For Manufacturing Of High-Precision Gear Profiles (Internal and External)



Gear Hobbing

- » External Gears
- » High productive
- » Flexible
- » Smaller modules on VMC



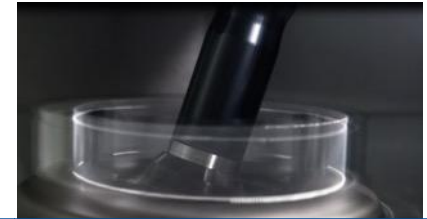
Gear Broaching

- » Internal Gears
- » High productive
- » Inflexible - high tooling costs
- » Special machine!



Gear Shaping

- » Internal & External Gears
- » Less productive
- » Very flexible
- » Special machine!

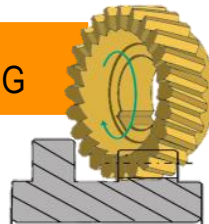
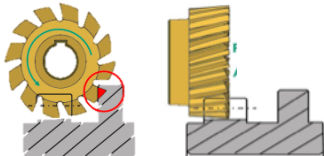


Gear Shaping

- » Internal & External Gears
- » 5x more productive than shaping
- » Very flexible
- » VMC450-5MT

Challenge: Looking for a more productive way to produce internal gears?

Solution: Use SKIVING



SKIVING ON VMC450-5MT

MACHINING AREA



SKIVING ON VMC450-5MT

Complete Machining And Shortening Of Process



Strategic workpieces



Proven Technologies

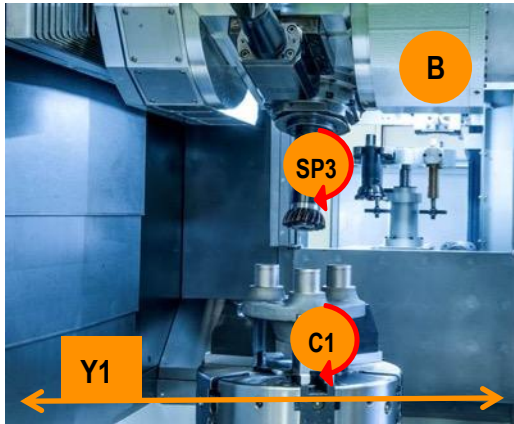


NEW: Skiving

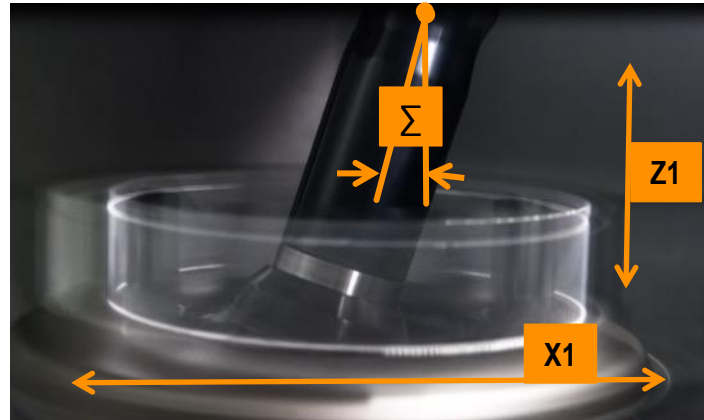


SKIVING ON VMC450-5MT

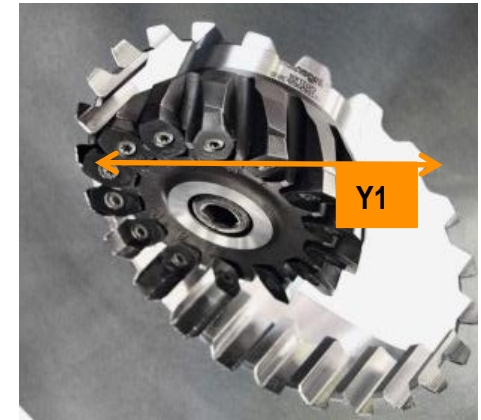
Skiving Package: Machine Requirements For Technology Skiving



- » Main spindle (C1) and milling spindle (SP3) designed as direct drives (electronical gear)
- » Axis coupling and perfect synchronization
- » High-resolution incremental encoders



- » Rigid B- Axis (high performance) for the tool axis crossing angle Σ (15° - 25°) creates the clearance angle
- » X1 with axis locking clamping for rigid tool positioning
- » Z1 axis = feed direction



- » Y1 axis for tool positioning
- » Y1 axis for tool infeed

SKIVING ON VMC 450-5MT

Range Of Workpieces / Gears



INTERNAL AND EXTRENAL INVOLVENT GEARS

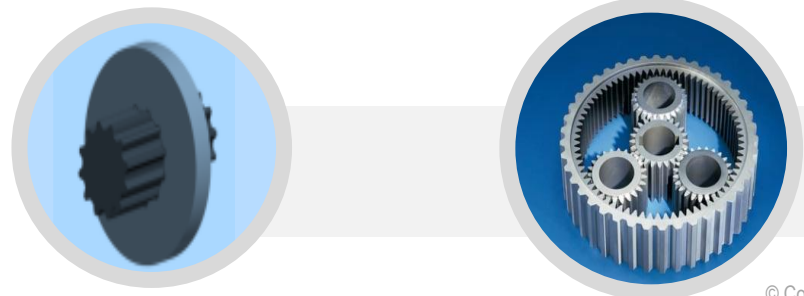
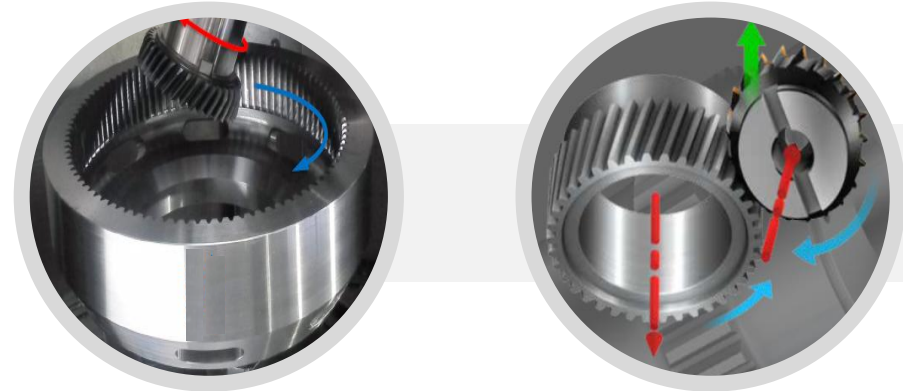
- » Straight gears / Helical gears
- » Max. gears: ID Ø 450 mm / OD Ø 310 mm
- » Internal: Tool and workpiece rotating in the same direction
- » External: Tool and workpiece rotating in the opposite direction

Splines for shaft and hub connection acc. to ISO 4156

- » **Module 5** - Tooth height (module x 1,2) = 6 mm
- » Finish skiving with tolerance < 9 (no heat treatment)

Running gears power and motion transmission

- » **Module 3** - Tooth height (module x 2,2) = 6 mm
- » Pre-Skiving on VMC450-5MT for heat treatment



SKIVING ON VMC 450-5MT Tooling

Technology: Tool Cutting Materials



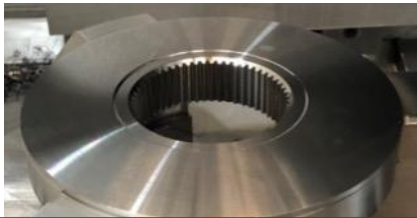
Coated Powder Metal Steels (PM)
Skiving Mills < IT8
Cutting speed 100-160 m/min



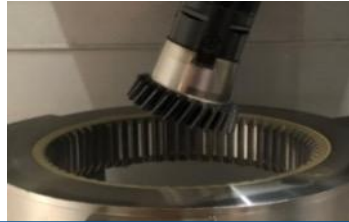
Coated Solid Carbide
Skiving Mills < IT8
Cutting speed 120-200 m/min



Inserted Skiving Mills (Module 4 and larger) IT8/IT9
Cutting speed 160-260 m/min (dry machining)



Gear - Module 1,5
3-5 passes



Gear Module 2,2
7-11 passes



Spine Module 4
7-11 passes



Gear Module 4
14-16 passes

SKIVING ON VMC 450-5MT

Proven Solutions: Planetary Carrier



Workpiece Data's:

- » Material: 42CoMo4
- » Workpiece Ø: 280 mm (Ø145-310 mm)
- » Splines: Module 4 - N135x4x9H



Measuring



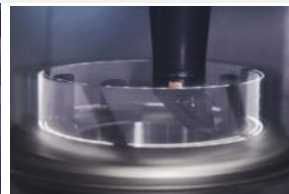
Milling



Roughing pins



ID turning



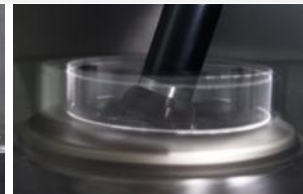
Finishing pin



Grooving



Skiving



SKIVING ON VMC 450-5MT Complete

Machining And Shortening Of Process Chain



Power Skiving Technology Data's

- » Module 4 DIN 5480
- » Cutting speed: 160 m/min
- » Cycle time: 150 sec.
- » Quality: IT8
- » Number of passes: 7

Cut 1. $a_p = 2,0 \text{ mm}$ / $f = 0,25 \text{ mm/U}$

Cut 2: $a_p = 1,5 \text{ mm}$ / $f = 0,22 \text{ mm/U}$

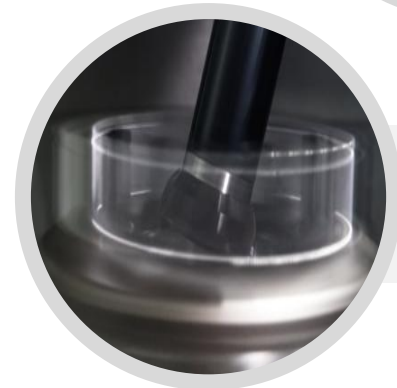
Cut 3: $a_p = 1,2 \text{ mm}$ / $f = 0,18 \text{ mm/U}$

Cut 4: $a_p = 0,8 \text{ mm}$ / $f = 0,14 \text{ mm/U}$

Cut 5: $a_p = 0,6 \text{ mm}$ / $f = 0,10 \text{ mm/U}$

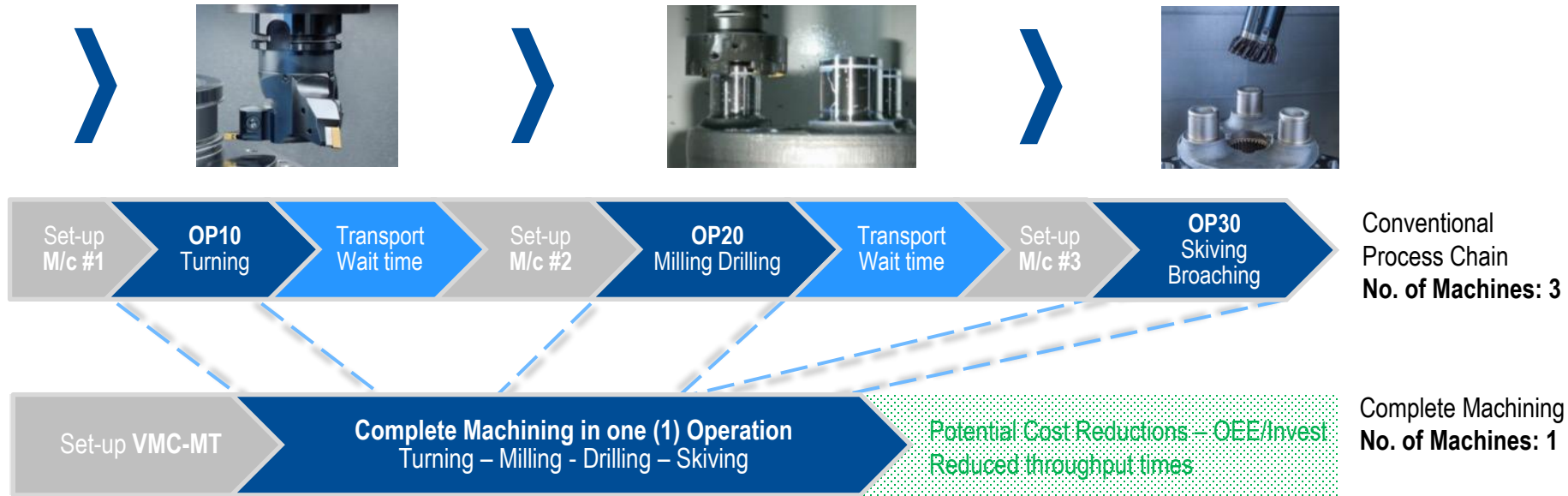
Cut 6: $a_p = 0,2 \text{ mm}$ / $f = 0,10 \text{ mm/U}$

Cut 7: $a_p = 0,1 \text{ mm}$ / $f = 0,06 \text{ mm/U}$



SKIVING ON VMC 450-5MT

Complete Machining And Shortening Of Process Chain: Proven Solutions



Overall Equipment Effectiveness

$$OEE = VF \times LF \times QF$$

VF ... Availability factor = VMC450-5 MT Technical Availability 95%

LF ... Output factor = Reduction of time-consuming retooling (ATC)

QF ... Quality factor = Best quality due to elimination of re-clamping errors



SKIVING ON VMC 450-5MT

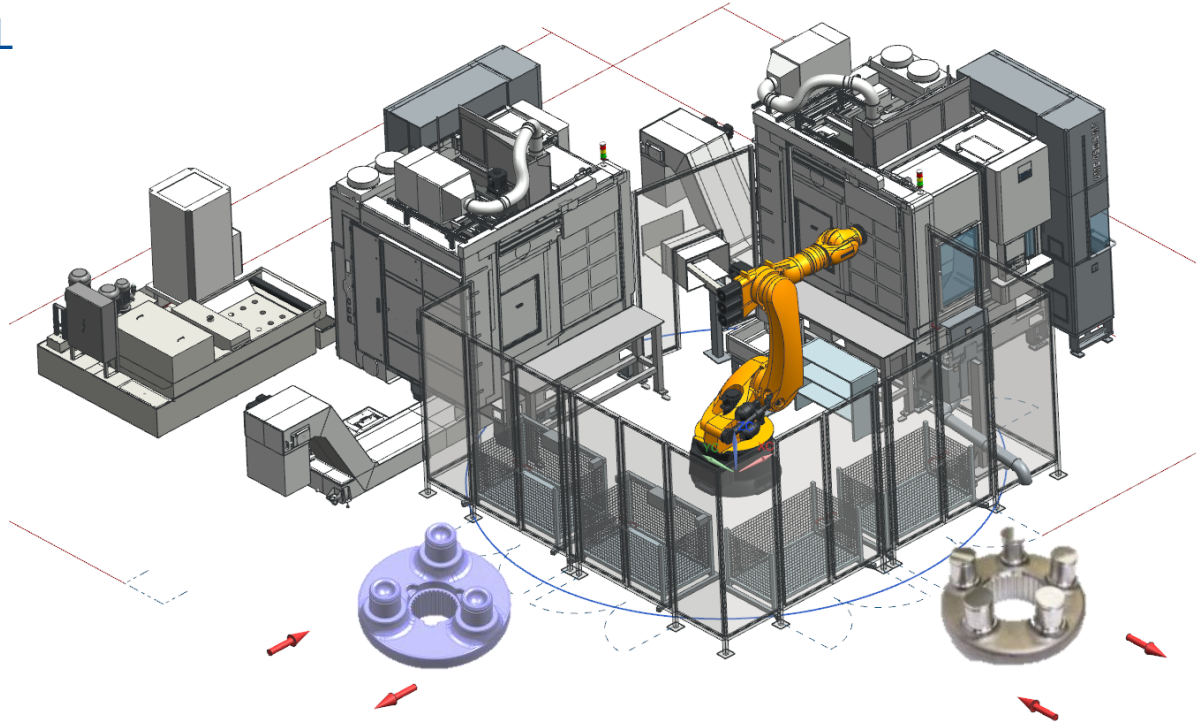
Complete Machining And Shortening Of Process Chain: Proven Solutions



AUTOMATED MANUFACTURING CELL FOR PLANETARY CARRIERS

- » 2 x independent VMC450-5MT
- » Connected in one Automation - Robot
- » For two different workpieces

For a maximum
productivity
and flexibility of
workpiece
families



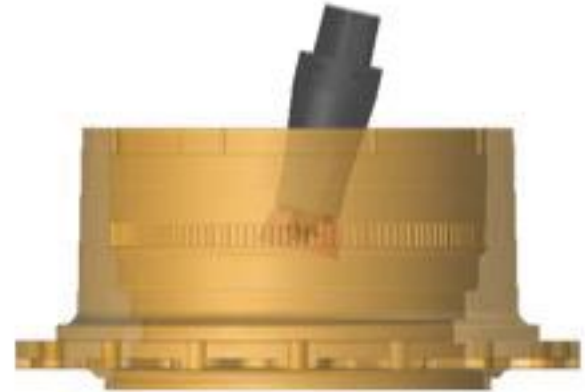
SKIVING ON VMC 450-5MT

Complete Machining And Shortening Of Process Chain: Proven Solutions



Final Drive Housing

- » Machines: OP10: VMC450-MT
OP20: VMC450-5MT
- » Material: GGG60
- » Dimension Ø/H/W: 533mm / 246mm / 97kg
- » Splines: N354 x 3 x117 x 30 x 9H
- » Cycle time Skiving: 1,86 min. (10 passes)
- » Cycle time OP20: 13,62 min



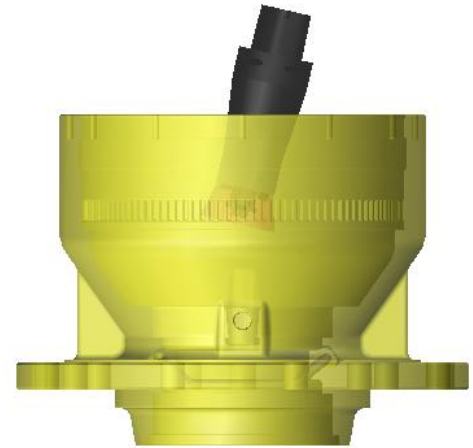
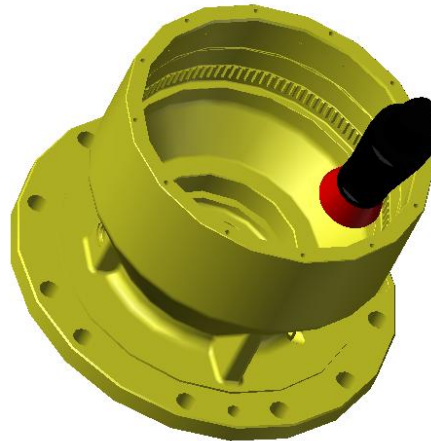
SKIVING ON VMC 450-5MT

Complete Machining And Shortening Of Process Chain: Proven Solutions



Output Housing

- » Machines: OP10: VMC450-5MT
OP20: VMC450-MT
- » Material: GGG60
- » Dimension Ø/H/W: 478mm / 348mm / 95kg
- » Splines: N339 x 3 x 112 x 30 x 9H
- » Cycle time Skiving: 1,86 min. (10 passes)
- » Cycle time OP10: 13,82 min



SKIVING ON VMC450-5MT

Complete Machining And Shortening Of Process Chain: Proven Solutions



The advantages of Power Skiving:

- » High tooth gear tooth quality
- » Low surface roughness
- » 50% reduction in cycle time compared with gear shaping

The advantages of complete machining:

- » Reduction of time-consuming retooling, transport and storage times
- » Less floor space requirement
- » Less capital lockup (one machine for several processes)

