

Differences between shop floor manufacturing – tool and mold making – mass production

Principles and application of SINUMERIK Operate

Differences between shop floor manufacturing – tool and mold making – mass production

1 General information about CNC milling

2 CNC programming

3 CNC basic milling functions

4 2½ D contours, planar operations

5 Freeform surfaces

6 CAD / CAM process chain

7 Automation

1 CNC milling Introduction

Milling

- A fixed workpiece is usually machined by a multi-toothed, rotating tool
- The tool performs the cutting movement
- Interrupted circular cutting movement
→ short chips
- Almost all geometries can be manufactured

In...



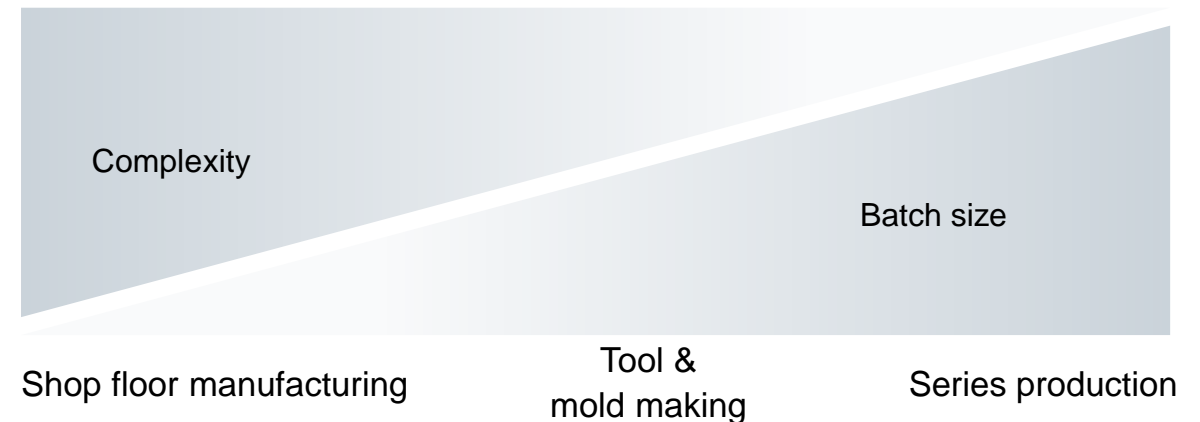
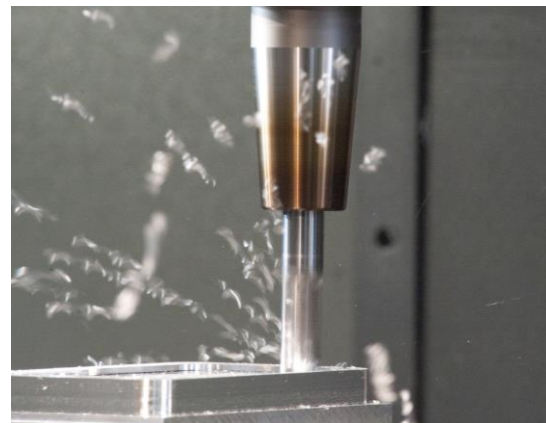
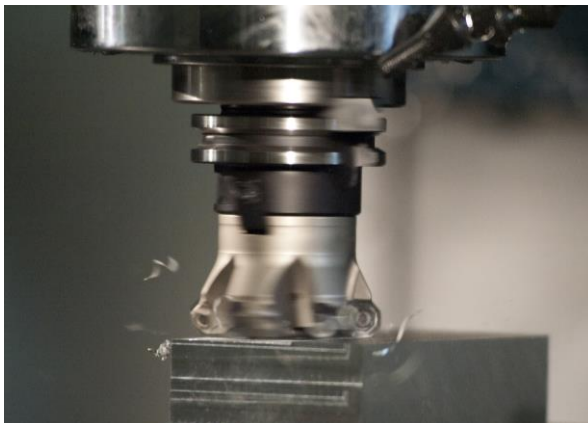
Shop floor manufacturing



Tool & mold making

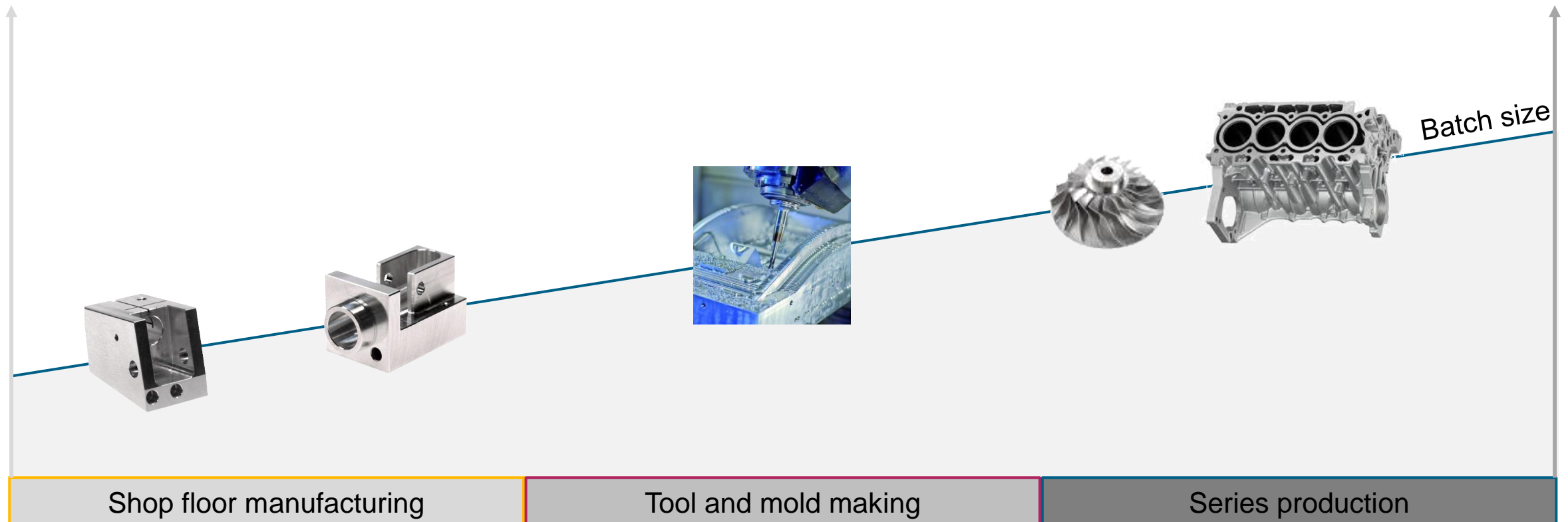


Series production
(e.g. automotive industry)



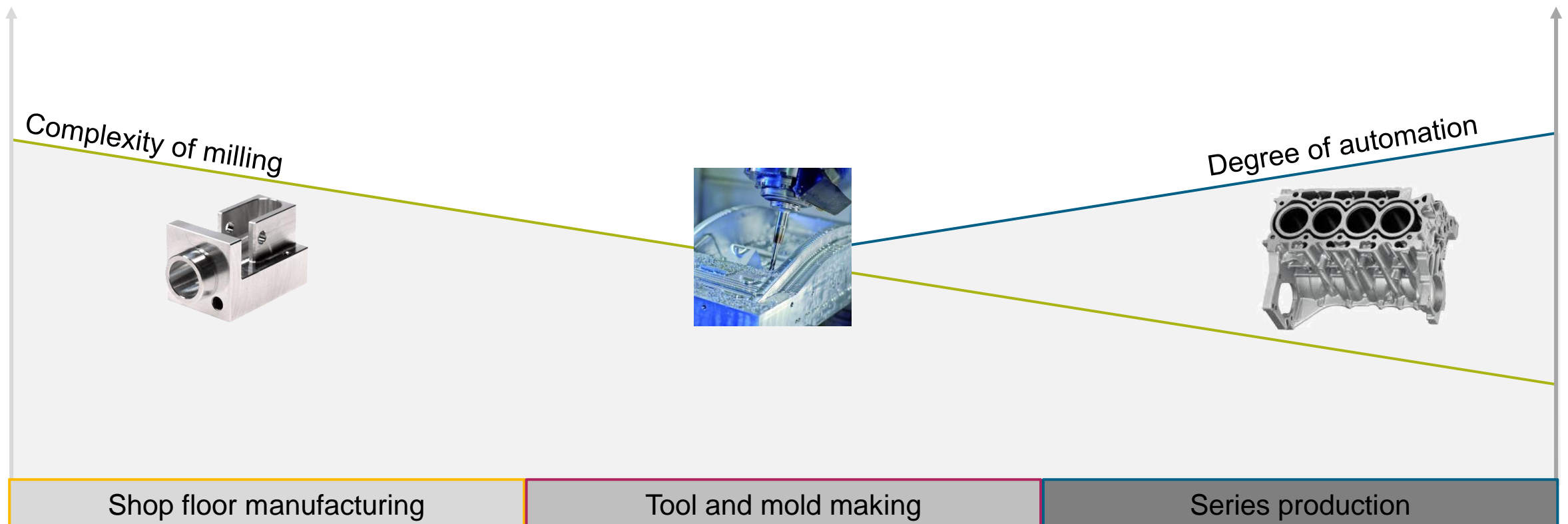
1 CNC milling Basics (1)

Milling with CNC machines is used in both single part production and mass production – the technology is identical, but the process requirements are different



1 CNC milling Basics (2)

The complexity of milling is subject to technological changes as the batch size decreases. On the other hand, the degree of automation is increasing. All applications thus place demands on the performance capability of the respective machine tool and special tools

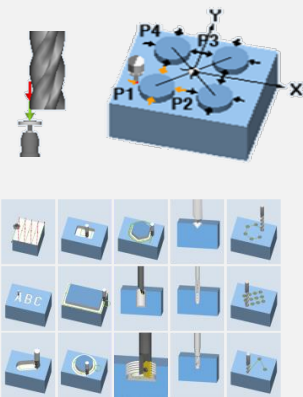


1 CNC milling Basics (3)

CNC SINUMERIK offers a comprehensive range of functions for all milling applications

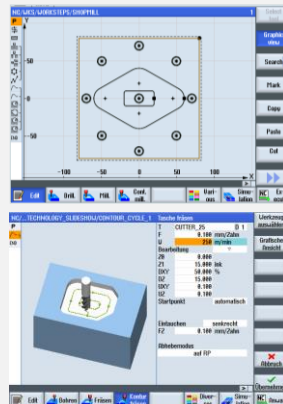
Basic milling functions

- Setup functions
- Tool management
- Drilling and milling cycles



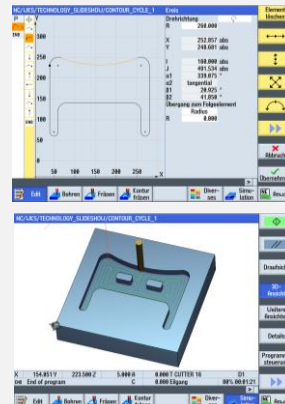
CNC programming

- Graphically interactive programming
- DIN/ISO programming



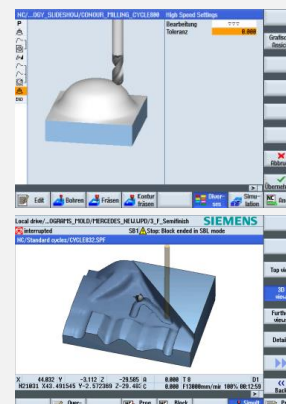
Contour milling

- Geometry calculator
- Contour machining cycle
- Residual material detection



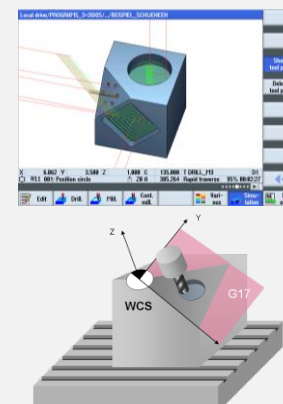
Freeform surfaces

- Advanced Surface. Top Surface



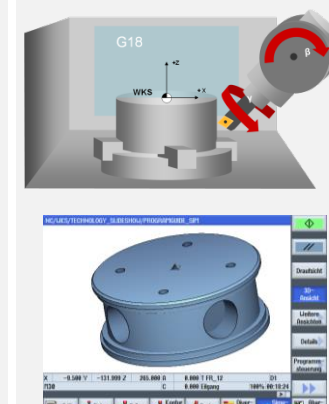
Transformations

- 3+2-axis machining
- Dynamic 5-axis machining
- Cylinder surface machining



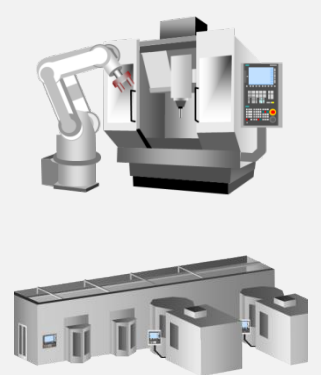
Milling-turning

- Any orientation of the main and secondary cutting edge
- Turning cycles



Automation

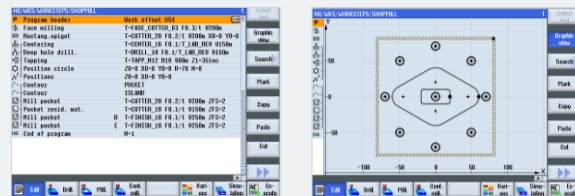
- Multiple clamping
- Workpiece transport system
- Robot connection



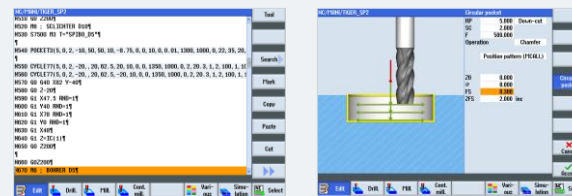
2 CNC programming SINUMERIK programming methods

Depending on the batch size, company organization, type of production and training of the personnel, all programming methods are used in practice

Machine-level programming ShopMill / programGUIDE



ShopMill



programGUIDE

CAD/CAM, programming systems, production planning

- Integrated CAD/CAM/CNC process chain, networked manufacturing including ERP, MES (SAP, Teamcenter, Sinumerik Integrate, etc.)
- Production simulation, use of digital twins
- Individually adapted postprocessors
- No or only minimal changes allowed or possible by the operator in the part program

Challenges

Small batch sizes – permanent change of components, require coherent and intelligent CNC functions

Mass production – no change of components, requires fast cycle times, minimum idle times, little CNC operation

3 CNC basic milling functions

Setup functions

- Measure tool
- Measure workpiece
- Prepare blank
- T,S,M
(Tool, Spindle, M functions)

Tool management

The powerful SINUMERIK tool management system ensures a highly productive manufacturing process combined with simple and intuitive operation.

- Up to 1000 tools can be managed
- Tool life monitoring
- Operator-friendly loading/unloading function

Drilling and milling cycles

The powerful SINUMERIK tool management system ensures a highly productive manufacturing process combined with simple and intuitive operation

Theoretically, simple components can be produced with little CNC functionality or even conventionally. Due to increasing cost pressures, a comprehensive range of functions is also necessary for setup and processing in the field of workshops

4 2½ D contours, planar operations

Geometry/contour calculator

- Integrated contour calculator for geometry input at the CNC
- Programming without pocket calculator or CAD system thanks to automatic calculation of partially defined geometric elements

Contour cycle, Island contours

- Automatic generation of motion sequences for machining freely defined geometries without a CAD-CAM system
- Machining strategies: path milling, contour pockets, contour spigots
- Removal of residual material from contour pockets with islands

Residual material detection

- Automatic detection of residual material when machining contour spigots and contour pockets
- Matching machining strategy

4 2½ D contours, planar operations DXF viewer/reader

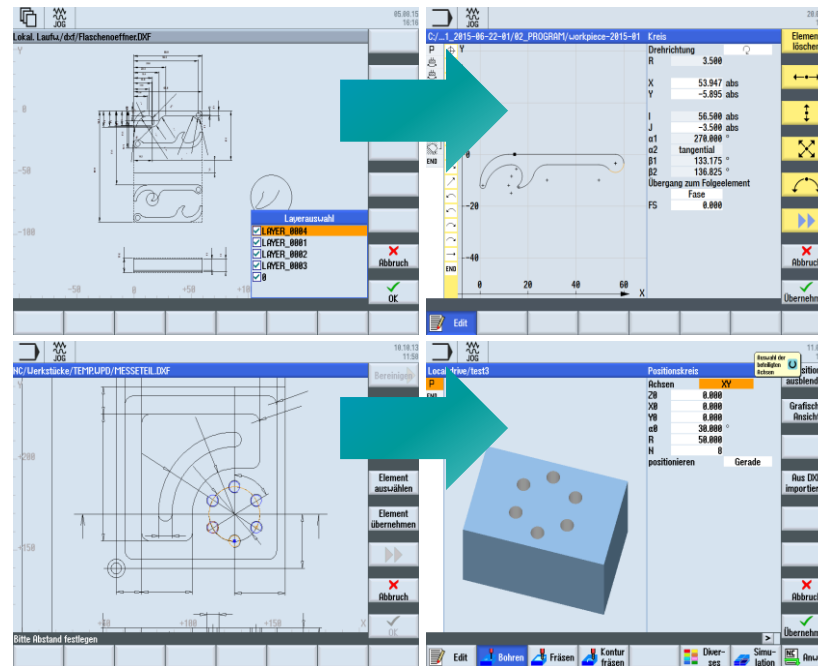
SIEMENS
Ingenuity for life

Get the picture fast

Visualization of 2D CAD data at the push of a button

Fully integrated

Operator control via SINUMERIK operator panel, with and without a mouse



For every geometry:

Efficient conversion of any geometry into SINUMERIK contours

Quick to the point:

Efficient conversion of any position into SINUMERIK position patterns

The SINUMERIK DXF Viewer/Reader visualizes 2D CAD data and supports the conversion to SINUMERIK contours and position patterns – quickly, conveniently, directly at the machine

Freeform surfaces Tool and mold making

In **tool and mold making** (mold & die), fixtures, tools, molds (injection molding, punching, electrodes, etc.) are manufactured for use in industrial production

The following **success factors** in tool and mold making are decisive for achieving the optimum result:

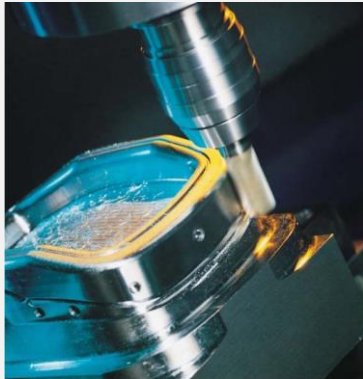
- Mastery of the entire process from work preparation to the machine
- Surface quality
- Motion control
- Selection of the right tool
- Mechanical system
- CNC functions



Types of freeform surface machining

3-axis machining

- Vertical tool orientation



3+2-axis machining

- Any statically positioned tools

Dynamic 5-axis machining

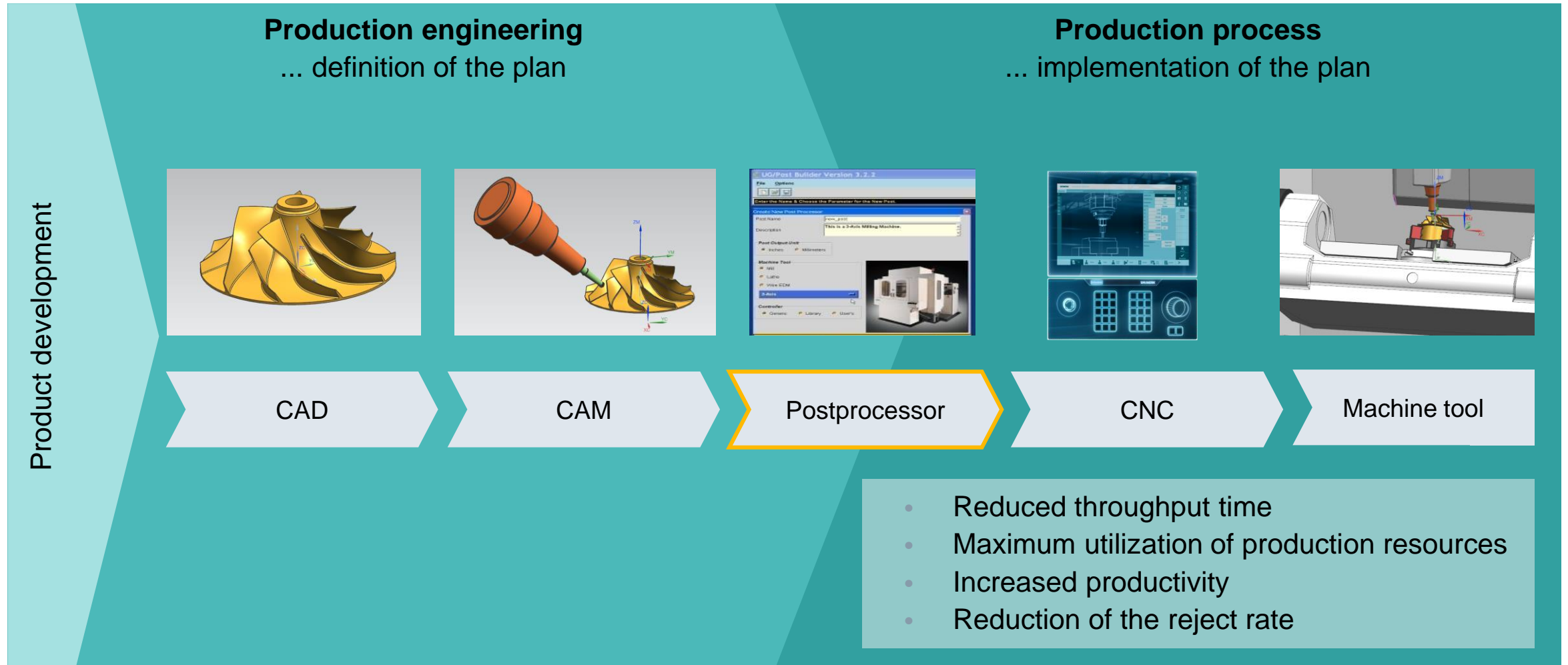
- Dynamically positioned tools
- Tool Center Point programming
- Programming of orientation vectors



In addition to classic 3-axis freeform surface machining, SINUMERIK CNCs also support machining with statically and dynamically oriented tools

6 CAD / CAM process chain Manufacturing process from the blank to the component

SIEMENS
Ingenuity for life

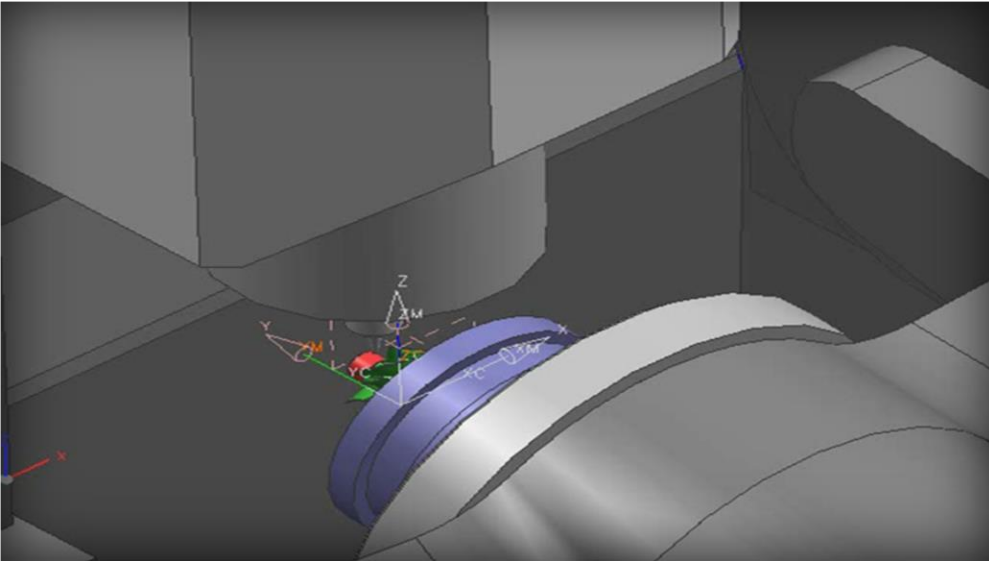


6

CAD / CAM process chain CAM → Postprocessor

SIEMENS
Ingenuity for life

From the plan...



...to production



CAD / CAM process chain

Who supplies the postprocessors?

CAD/CAM software producers

- only offer postprocessors for their own systems

Advantages

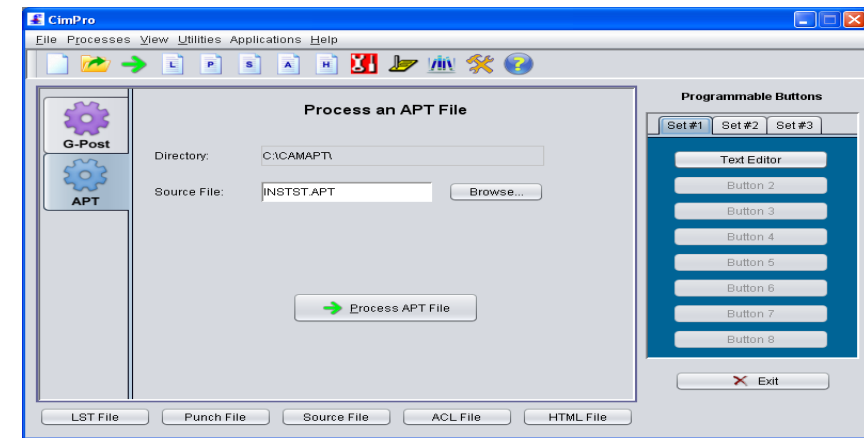
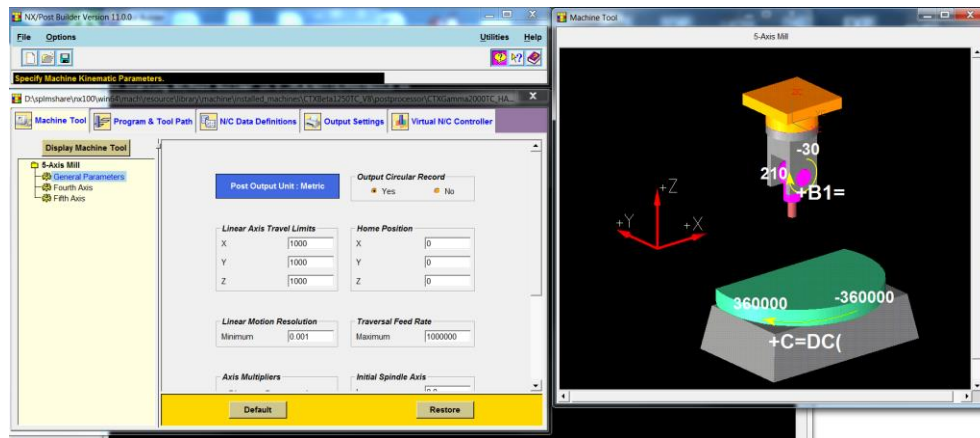
- The producers know their own CAM software best

Independent software producers

- offer pure postprocessor development tools

Advantages

- One postprocessor can be used for different systems
- e.g. ICAM Canada or gpost

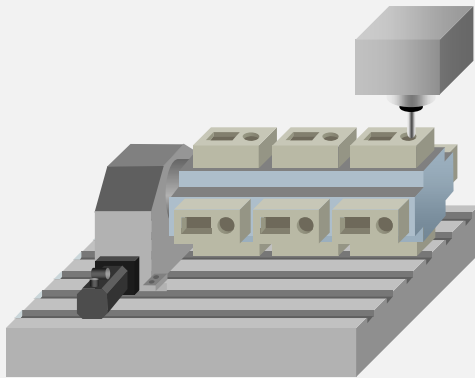


Automation

The fully automated workpiece flow

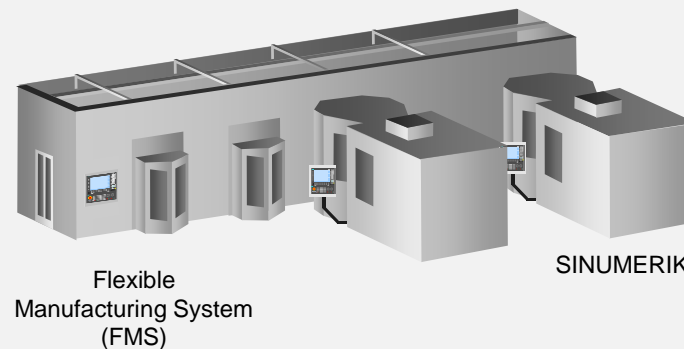
Multiple clamping

- Several clamping operations in one working area
- Use of reversible clamping systems



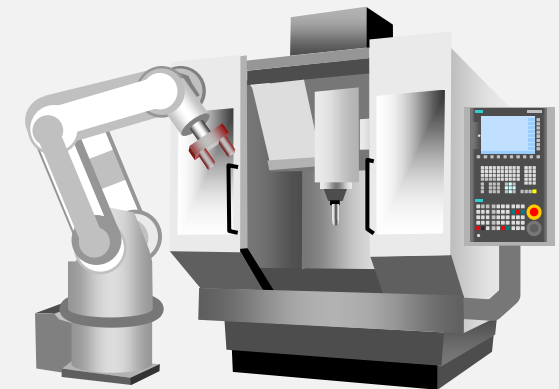
Workpiece transport system

- Automatic feeding and discharge of workpieces via a transport system
- Mainly for horizontal machining centers



Robot connection

- Blank part feeding and finished part removal via a handling robot
- Mainly for special applications



Different automation concepts which are tailored to the individual milling machine concept automate the workpiece flow, thus increasing production efficiency

Flexible manufacturing systems in series production

Flexible manufacturing systems link machine tools and are divided into:

- **Transfer lines**

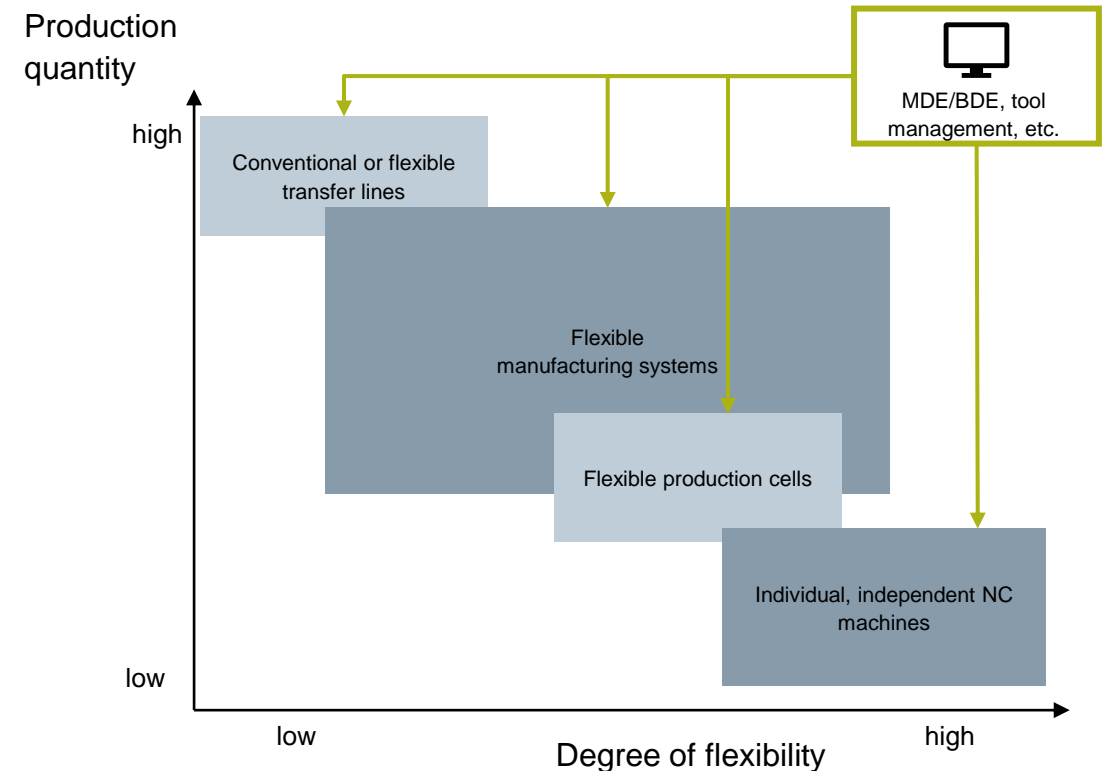
- Interlinkage of cutting and non-cutting processes
- Usually designed individually for a single workpiece

➡ High productivity, limited flexibility

- **Flexible production lines**

- Interlinkage of single or multi-spindle flexible machining cells
- Gantry robots coordinate the material flow

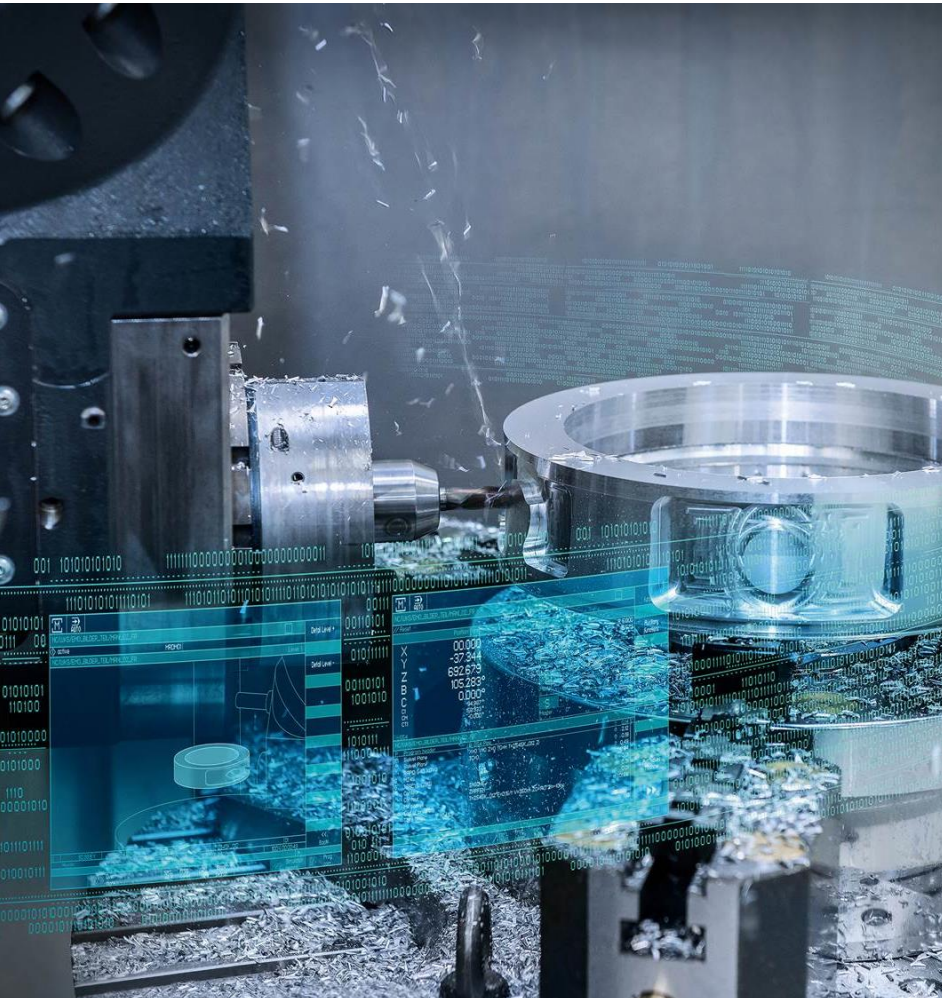
➡ High productivity, high flexibility



Source: [CNC Manual](#)

Thank you for your attention!

SIEMENS
Ingenuity for life



Milling with CNC machines is used in both single part production and mass production – the technology is identical, but the process requirements are different!

Digital Experience and Application Center Erlangen

Frauenauracher Strasse 80

91056 Erlangen, Germany

[siemens.com/cnc4you](https://www.siemens.com/cnc4you)