Virtual Machining

New level of security, flexibility and productivity

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hyperMILL Virtual Machining Center

Existing concepts

Motivations for
Tool for the complete process

- Design
- Preparation
- Programming
- Simulation
- Verification

CAD → CAM → PP

Machine + Part

- Milling
- Drilling
- Process
- Turning
- Tools
- NC Control
hyperMILL – strong in 5axis machining

- Pioneering in 5axis technology
- 5X simultaneous for mold & die
- Vertical applications for Blade, Multiblade, Tires….
5 Axis simultaneous programs / GROB 350

Optimized with repositioning moves close to geometry

How to successfully postprocess and run these programs
CAD/CAM - Programming relative to workpiece

Programming stays independent from Machine

Advantage
- Simple checks
- Machine change possible

Limitations
- No warning about kinematic problems
- Start – , End- and connecting moves may not all be checked
Classic simulation on Cutter Location file

Postprocessor NC output

Machine simulation on CL Data
CL Data Verification

**Advantage:**
- Quick check of kinematic situation
- Quick collision check of all data inside program

**Limitations:**
- Security issues:
  - Check on different formats of data
  - Errors in post not identified
  - Verification based on many assumptions
CAD/CAM – NC Output & external NC Simulation
Advantage:
- Checking of all movements including approach linking and retract moves
- Includes checking and identifying of errors caused by postprocessor

Limitations:
- Requires interfaces for tool, part and fixture data
- No direct link to programming file (unidirectional)
- In case of changes, 2 systems need to be adjusted
External NC-Simulation – Risks

High efforts and possible errors

- CAM – NC Verification and Machine synchronized?
- Same program
- Same tools
- Fixtures
New approach: CAM based virtual machining

VMC integrated postprocessor

Bidirectional!
Virtual Machining: The concept

Virtual Machine

Virtual PLC

Virtual CNC

Virtual NC-Code

0 BEGIN PGM LINEAR MM
1 BLK FORM 0.1 Z X+0 Y+0 Z-20
2 BLK FORM 0.2 X+100 Y+100 Z+0
3 TOOL DEF 1 L+0 R+10
4 TOOL CALL 1 Z S4000
5 L Z+250 R0 FMAX
6 L X-10 Y-10 R0 FMAX
7 L Z-5 R0 F1000 M3
8 APPR LT X+5 Y+5 LEN10 RL F300
9 L Y+95
10 L X+95
11 CHF 10
12 L Y+5
13 CHF 20
14 L X+5
15 DEP LT LEN10 R0 F1000
16 L Z+250 R0 FMAX M2
17 END PGM LINEAR MM
Virtual Machining Center

After integrated post run
NC simulation exclusively for hyperMILL VNC generated NC Files
Complete checking of all movements
Tools for tool path analysis
Very easy for Machine Operators and CAM users
Virtual Machining Center - Functions

NC-based verification and simulation
Stop points (direct and virtual definition)
Collision check
Stock removal
Adjustable limits for Simulation
Release process for NC Programs
Virtual Machining Center - Analysis

Graphical analysis of axis

Quality checks
NC Optimizer

Detecting
&
Solving
Automatically
Common approach for Simulation

**Only checking**

- No changes are usually applied to NC
- Crashes can be detected
- No automatic solving of problem
Idea of VNC Optimization

Solving problems

■ Considering travel space and collision
■ Automatic modification
■ Enabling 5axis technology
NC-Optimizer: Automatic selection of correct solution

Solves problems considering travel space and collision situation
VMC-Integrated NC-Optimization

- Automatic identification of collision free and workspace violation free solution
- Considering preferred solutions
- Automatic pre positioning / look ahead
- Automatic splitting of tool path for rewinds
- Rewinds collision free and smooth
- Repositioning with optimized rapids interpolated in machine kinematic

Enabling limited machines to be fully used in 5axis
VMC-Integrated NC-Optimization

Without NC - Optimization

With NC-Optimization

Head-Head Kinematic

- Despite axis limitations the machine performs 5 axis operations
- Look-ahead identifies correct solution
- Repositioning collision free
VMC-Integrated NC-Optimization – Auto rewind

- Continuous spiral split to match limited axis
- Smooth retract and approach
VMC-Integrated NC-Optimization

- Automatic positioning of rotary axis to output 3X collision-free tool path
VMC-Integrated NC-Optimization

Without NC Optimization

With NC Optimization

- Auto-Rewind:
  Splitting and repositioning with smooth retract and approach moves
Like a blimp over the manufacturing industry

**Industrie 4.0**
2007 Workshop with 50 Participants

What happened

- All programs were ok
- The operator started the programs in the wrong sequence
Common workflow

CAM Island → Communication → Machine Island

NC Documentation
PDF / XLS ......
1983

2013
VMC - Connected Machining combines *hyperMILL* and Machine
Connected Machining – 1: Program Transfer

- Moves programs directly into control memory
- Fast and safe

Avoiding:
- Loading and starting the wrong program
Connected Machining – 2: Synchronization

- Direct compare virtual data – real data
- Cross-checking origin
- Synchronizing tool data
- Checking of critical machine parameters

Avoiding:
- Mismatches in tools
- Errors due to misunderstanding in origin position
Connected Machining – 3: Running programs

■ First run directly controlled from VM
■ Start / Stop Program
■ Override G0 / G1 / RPM
■ Halt (F=0), Resume

■ Advantages
■ Ease of use unlinked from NC control user interface
■ Avoid running to and from machine
Connected Machining – 4: Synchronization

- Synchronizing axis positions of virtual machine with real machine
- Updating current status (Block number, coolant, RPM, feedrate)

**Advantages**

- Quick tracing of effects in certain areas
- General monitoring also from distance
Starting from a concrete demand
Outlook for functions driven by Connected Machining

Problem solving

- Controlled retract after stop
- Controlled reentry program
Outlook for functions driven by Connected Machining

Optimizations

- Adaptive speed and feed optimization
- Adaptive geometrical optimization (step down)
Summary
VMC - Connected Machining

- Faster and Safer:
- Direct Program Transmission
- Adjust Machine Data (Zero point, tool table)
- Checks critical machine parameters (tolerances, modulo parameter)
- Compared kinematic parameters
- Read-back current position