

ABB Robotics, April 2015

RobotStudio® Machining PowerPac Increased engineering efficiency

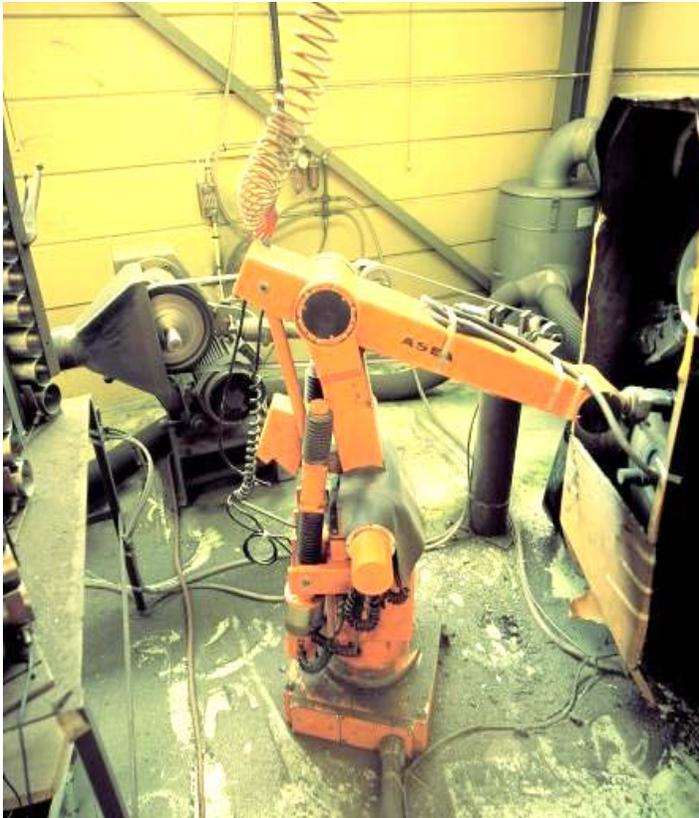
Agenda

- Introduction
- RobotStudio Machining PowerPac
 - CAM Converter
 - Machining
- Benefits
- Summary

Introduction

40 years of robotized machining

IRB 6 sold by
ABB in 1974 to
Magnusson in
Genarp, Sweden



- The world's first electrical robot, sold in 1974, was for grinding and polishing of stainless steel tubes
- ABB was an innovator and has become #1 in robotized finishing
- We intend to remain the leader

Introduction

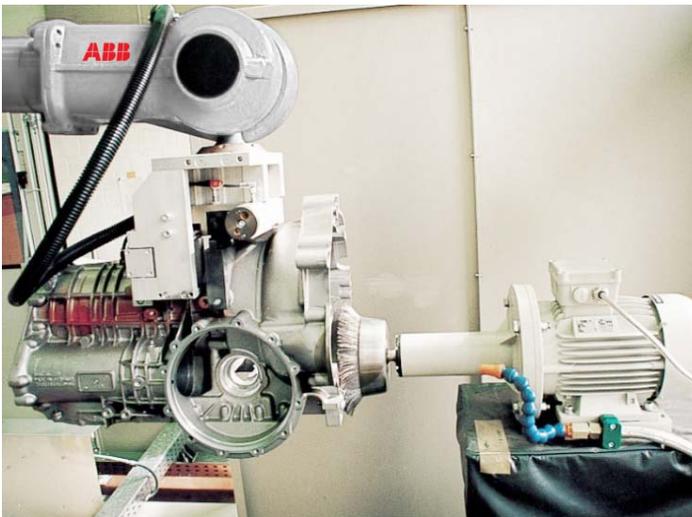
Benefits of robot-based machining



- Consistent high product quality
- Reduced tooling costs
- High availability
- Safe environment with less injuries
- Attractive and rewarding workplace
- Positive, high-tech image
- Improved recruitment possibilities
- Long-term profitability

Introduction

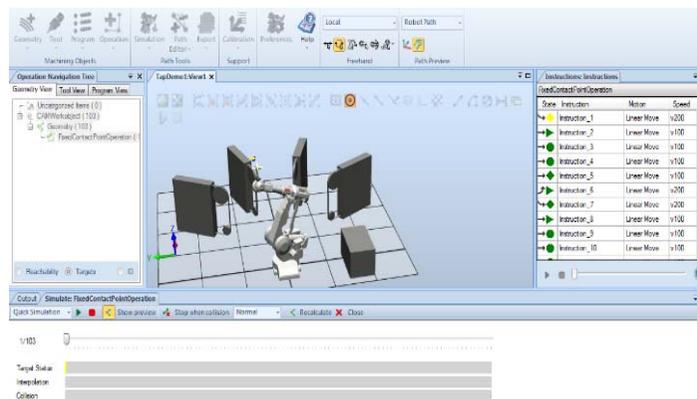
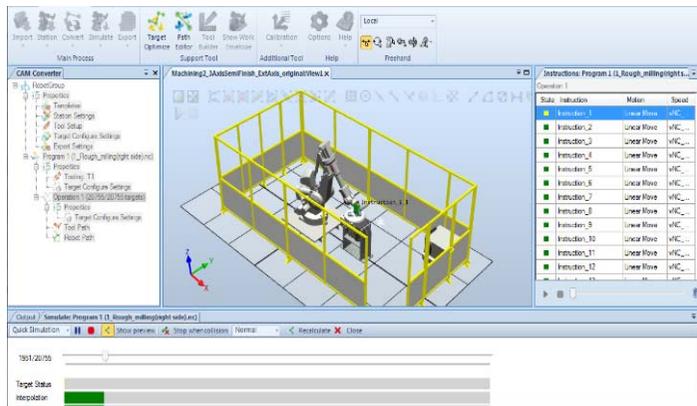
Challenges for robotized machining



- Short production batches
 - Quick change over time is required
- Traditional programming is time consuming
- Traditional programming is difficult to handle complex geometry surface
- Many parameters affecting the process result
- Accuracy requirements in the process

RobotStudio Machining PowerPac

Outline: a superior offline programming tool for machining applications



- Software for offline programming of machining applications
- Contains functions for
 - Transform CNC code to RAPID
 - Generate robot path based on CAD model
 - Path & target adjust and optimization
 - Tool posture controller
 - Customized export
 - VC simulation

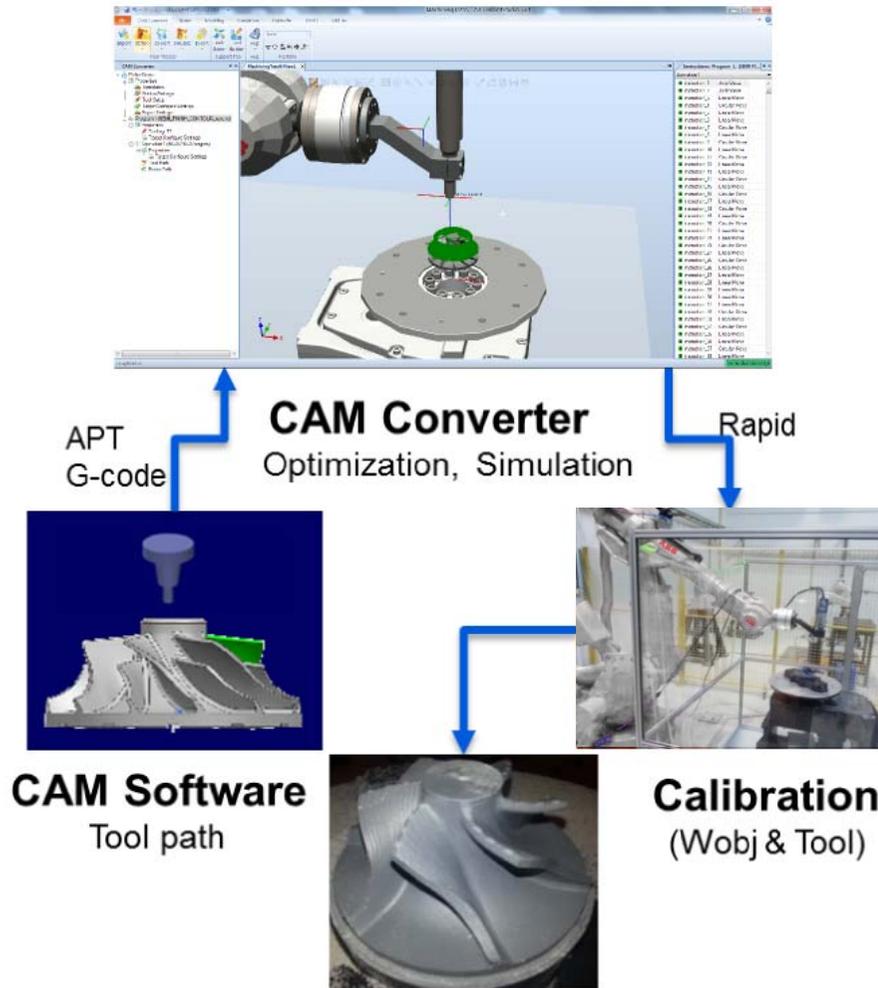
Features Outline

- CAM Converter
 - Convert CAM G-code to robot RAPID language
 - Support G-code ISO 6983, DIN 66025 and APT-CL
- Machining
 - Create tool model and specify contact information
 - Create path curve based on CAD model
 - Create path based on path curve and set target configuration
- Path and target optimization
- Path and target modification
- Path simulation (Quick simulation & VC simulation)
- Template based program export to RAPID or RW Machining FC
- Calibration

Overview CAM Converter

CAM Converter

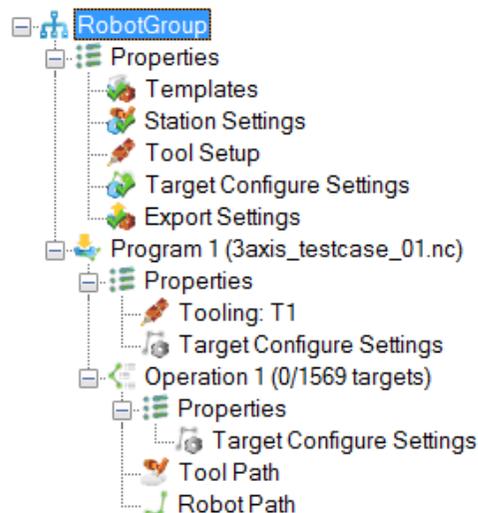
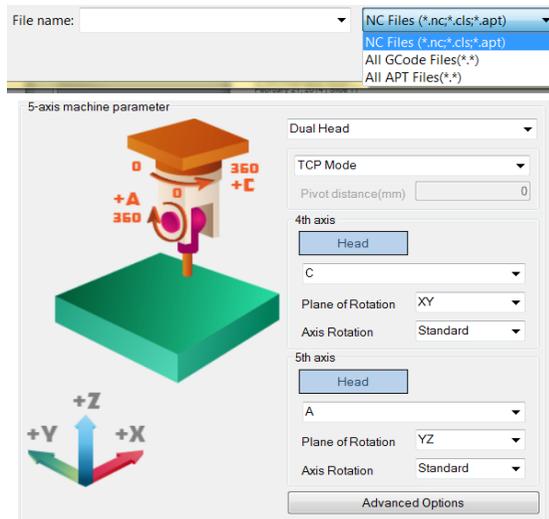
Key functions



- Import standard APT/ISO G-Code
 - Fully support 5-axis G-code
 - Extendable with template
- Station setup
 - Support external axis (both positioner and linear track)
 - Optimize the workpiece/wobj location
- Convert tool path to robot path
 - 3 strategies of target configuration and external axis interpolations (both positioner and linear track)
- Simulation
 - New quick simulation and collision check in RS
- Export RAPID
 - Extendable with template
- Performance
 - Support >500K point, much faster than the benchmark software

CAM Converter

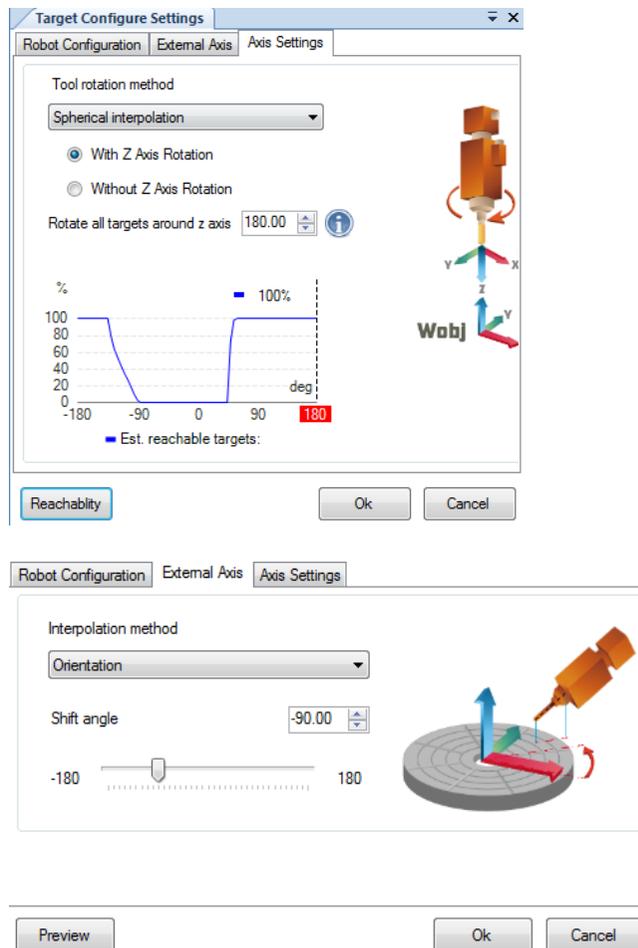
Convert CNC Toolpath to RAPID



- Strong Parser
 - Support both ISO G-code and APT file
 - Based on ISO CNC code, handle different CAM export
 - Support 5 axis G-code with easy settings
- Advanced Functions
 - CAM style post tree
 - Modify targets manually
 - Create cutter and tool data

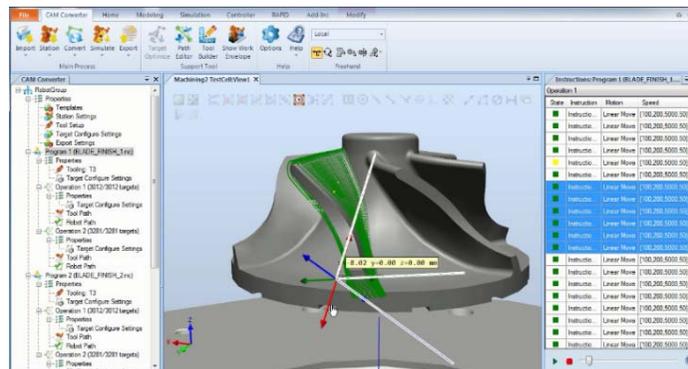
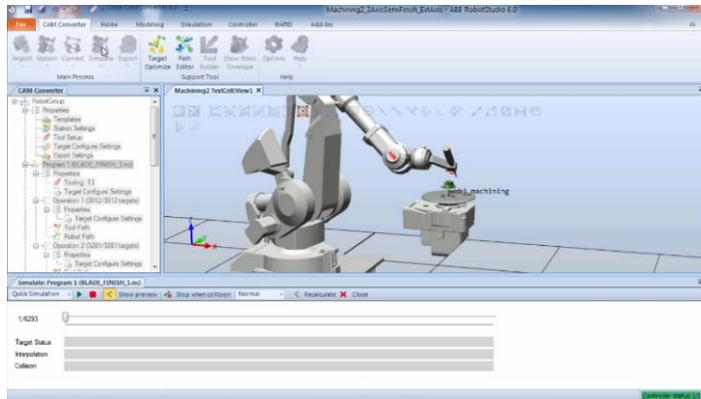
CAM Converter

Convert CNC Toolpath to RAPID



- Multi-strategies
 - Based on the imported CNC point and robot system layout, to calculate target configuration.
 - Movement interpolation between robot and positioner.
- 3D preview
 - Show target configuration based on user settings.
- Estimated result
 - An estimated converter result can show how many targets can succeed based on the current user settings..

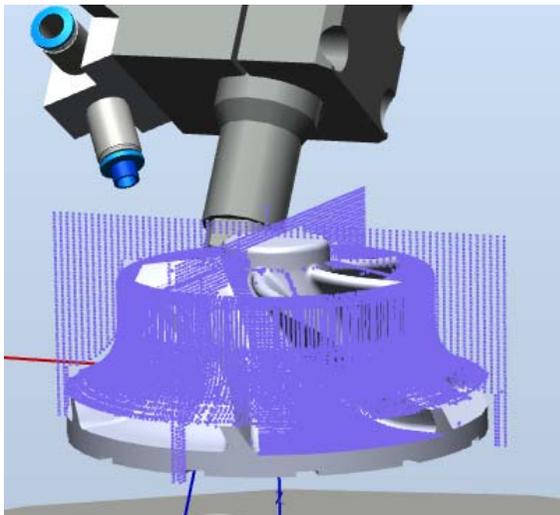
CAM Converter Simulation and Path Editor



- Quick and accurate Simulation
 - Interpolation targets check
 - Collision check
 - Virtual controller simulation
 - Less than 3 min to simulate >100 000 targets
- Powerful Path Editor
 - Insert, delete & set positions
 - Show detailed information as tool-tip
 - Dynamically update path in 3D view
- Flexible Export
 - Auto-split RAPID program
 - Edit and modify template for customized needs

CAM Converter Summary

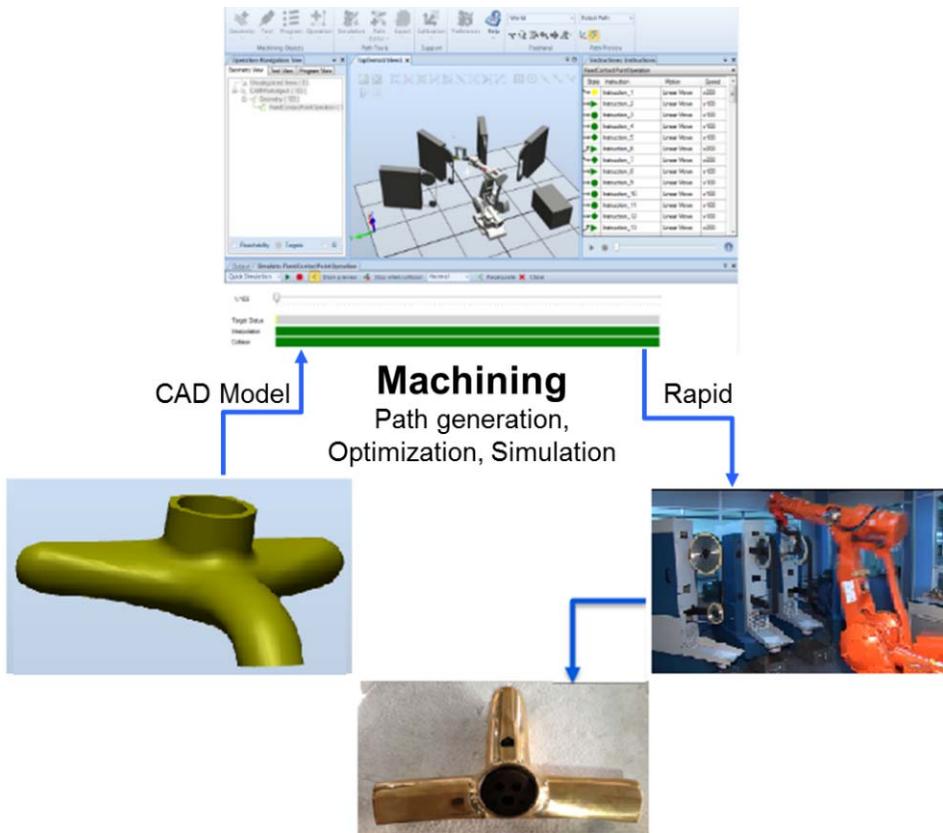
```
SEMI_FINISH_CONTOUR_new.nc (-D...Code\02_3Axis_Semi_Contour) - GVIM
1. SEMI_FINISH_CONTOUR_new.nc
9 :7 T2 M06
10 N8 T2
11 N9 G90 G54
12 N10 G94 G90 G00 G43 X-2.782 Y-27.923 Z230.0
13 N11 Z122.401
14 N12 G01 X-1.78 Y-18.318 Z119.807 F1200.
15 N13 G03 X18.397 Y0.0 I1.79 J18.3
16 N14 G01 X18.373 Y.882 Z119.809
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18 N16 G03 X-11.124 Y14.653 I-18.36 J-1.046
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20 N18 G03 X-5.398 Y-17.586 I11.647 J-14.237
21 N19 G01 X-4.715 Y-17.781 Z119.809
22 N20 G03 X-1.883 Y-18.307 I4.855 J18.244
23 N21 G01 X-1.78 Y-18.318 Z119.807
24 N22 X-1.828 Y-18.779 Z119.734
25 N23 G03 X4.026 Y-18.425 I1.804 J18.746
26 N24 G01 X4.702 Y-18.262 Z119.735
27 N25 G03 X7.544 Y-17.29 I-4.754 J18.547
28 N26 G01 X7.84 Y-17.161 Z119.734
```



- Parse G-code to RAPID based on different machine setup
- Easy learning for CAM users with the CAM-style post tree
- Accurate and quick simulation
- Support multi-tool in the same station
- Easily set target configuration and create Robot path
- Powerful export functionality based on user-defined template
- Easy to reuse the best practice since the auto-load/save function

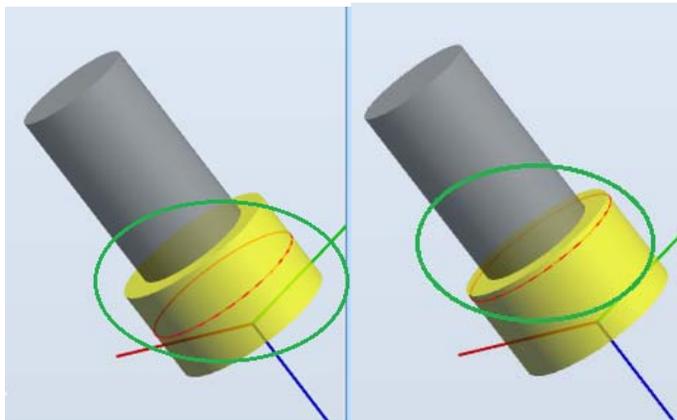
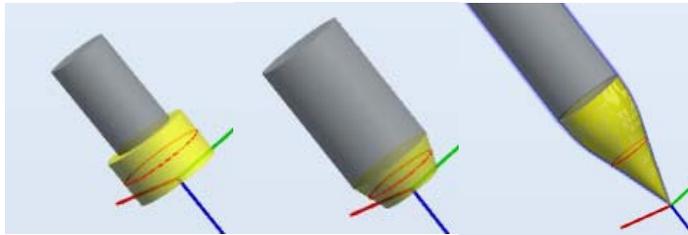
Overview Machining

Machining Key functions



- Use common tools from library
 - Support user-defined contact points
- 5 strategies to create path curves based on the CAD model
- Tool axis control
- Flexible non-process move setting strategies
- Create WAVE paths to reduce tool wear
- Path Edit
 - 2 strategies to do smooth tool axis interpolation
 - Support smooth tool contact point adjustment
- Simulation
 - Quick simulation and collision check
 - Precise virtual controller simulation
- Export RAPID via customized templates
- Flexible programming steps

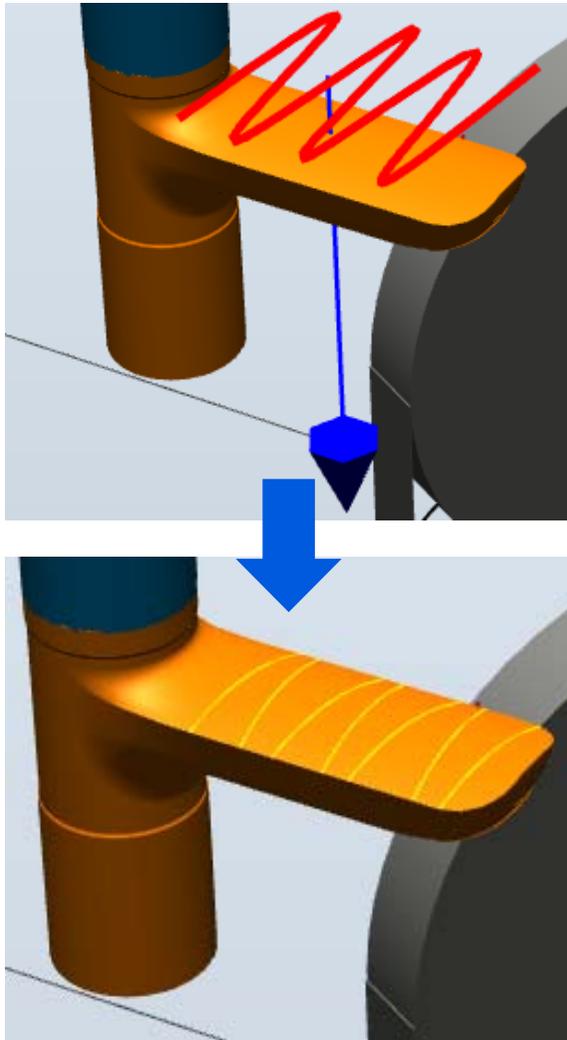
Machining Tool Libraries



Create tools out of most common machining tools library

- Use different tool shapes as templates
- Export/Import tool definitions to library for reuse
- Define tool contact point independent from TCP

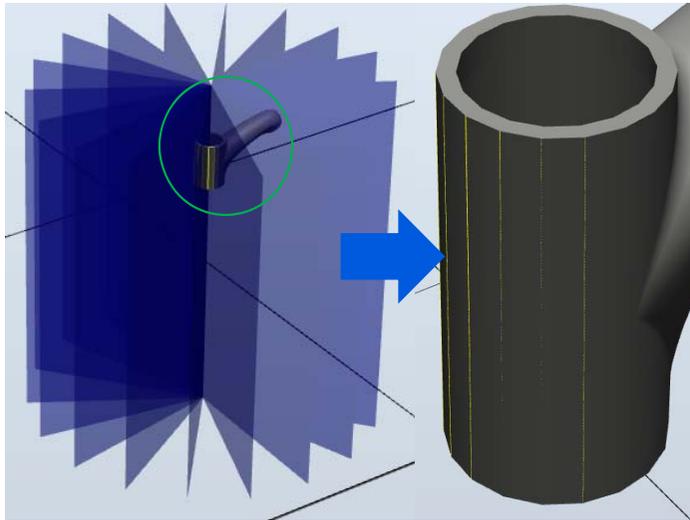
Machining Path Curves by Projection Geometry



Generate path curves from projection

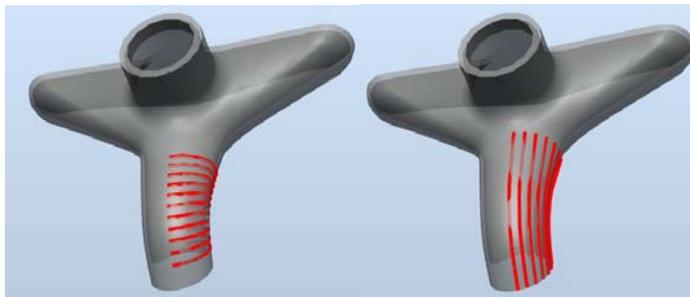
- Use predefined or individual patterns
 - Polyline
 - Spline
 - Parallel lines
- Define pattern intervals, angles etc.

Machining Path Curves by Intersection and ISO Geometry



Generate path curves from intersection planes

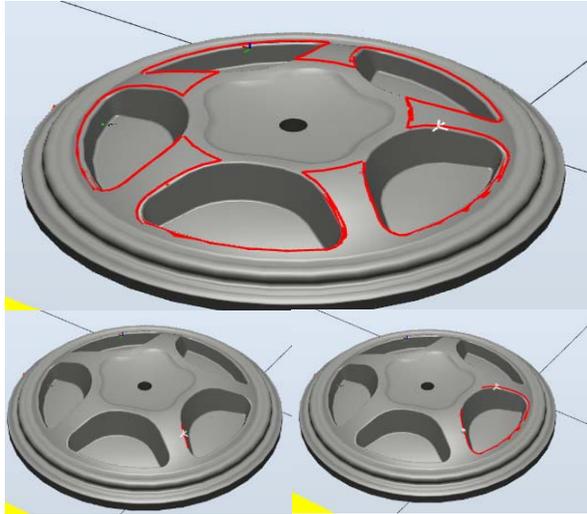
- Parallel planes
- Cylinder planes



Generate path curves directly from the iso-parametric curve

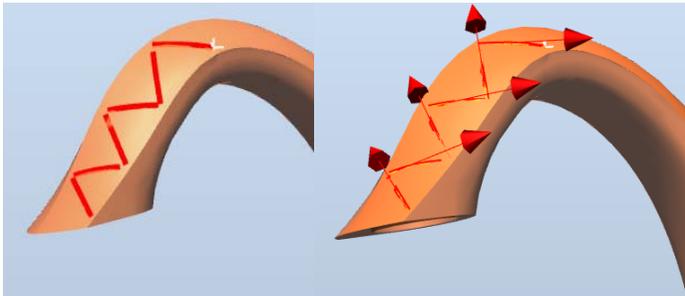
- Customize by setting range and count of curves

Machining Path Curves by Surface Edges and Customizing



Generate path curves from surface edges

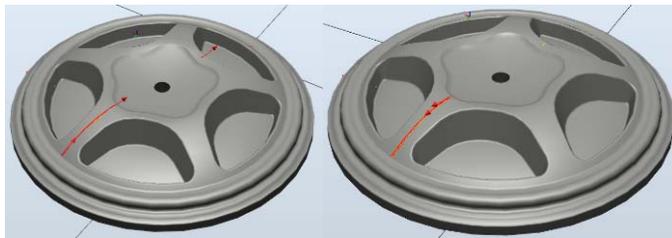
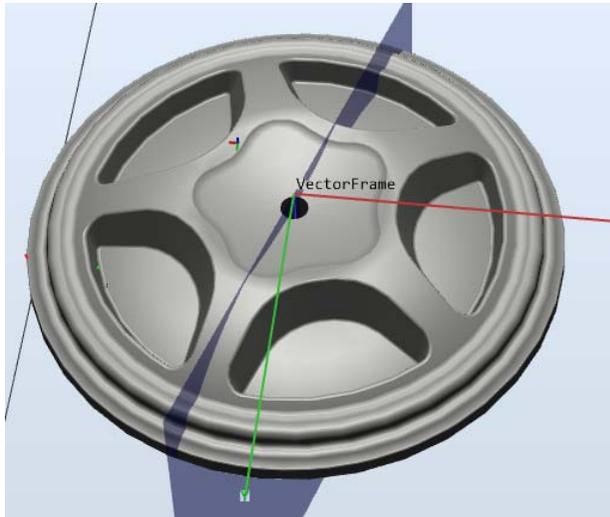
- Single Edge
- Tangent Edge
- Boundary



Generate customized path curves in demanding applications

- Pick user specific targets on surface to generate highly individual path

Machining Customized Path Curves



Edit feature curves to flexible
customize path curves

- Split feature curve
- Reverse feature curve
- Delete feature curve
- Re-Order

Machining Path Editor



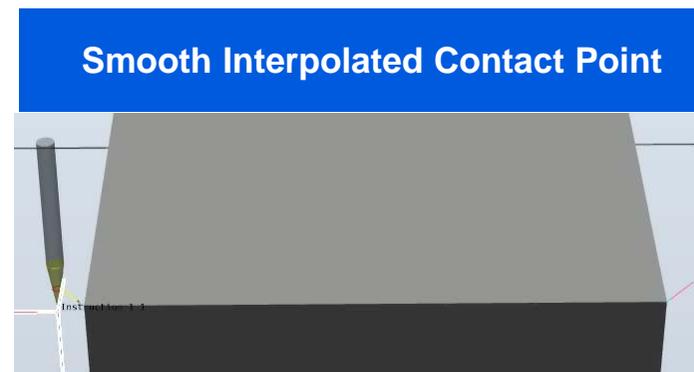
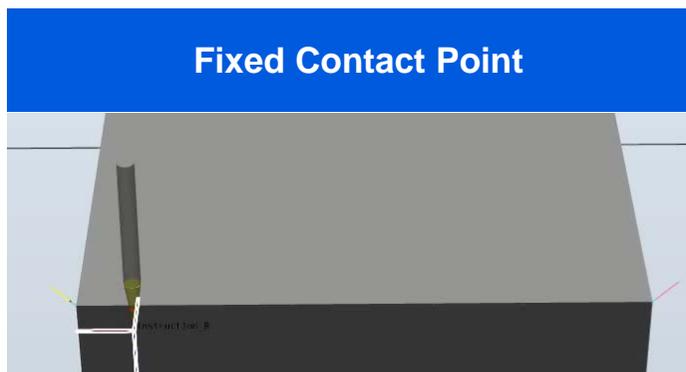
- Advanced path editor
 - Modify/add/delete target(s)
 - Change contact point of tool for target(s)
 - Change tilt angle of tool for target(s)
 - Support smoothly change for above functions
 - Support smooth tool axis
 - Modify speed for target(s)

Machining Contact Point Adjustment

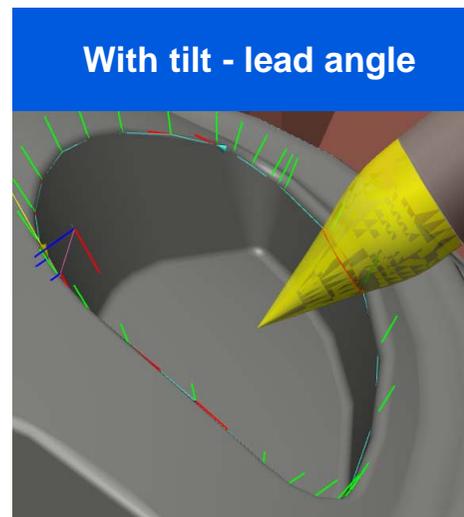
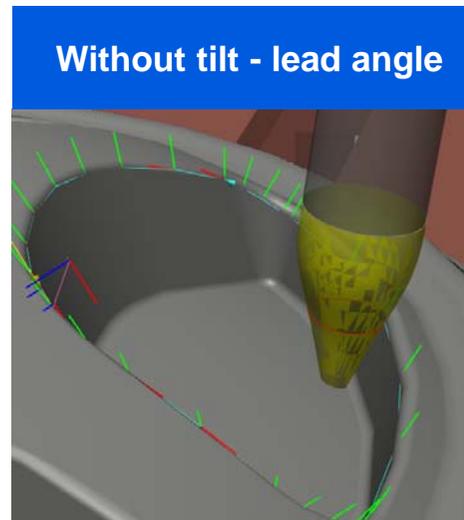


Specify different contact points on tool along the path

- Avoid collisions
- Smoothly change contact point



Machining Lead - Tilt Angle



Control tool axis settings
and keep specified tool
posture to the part surface

- Lead angle
- Tilt angle

Machining WAVE Paths

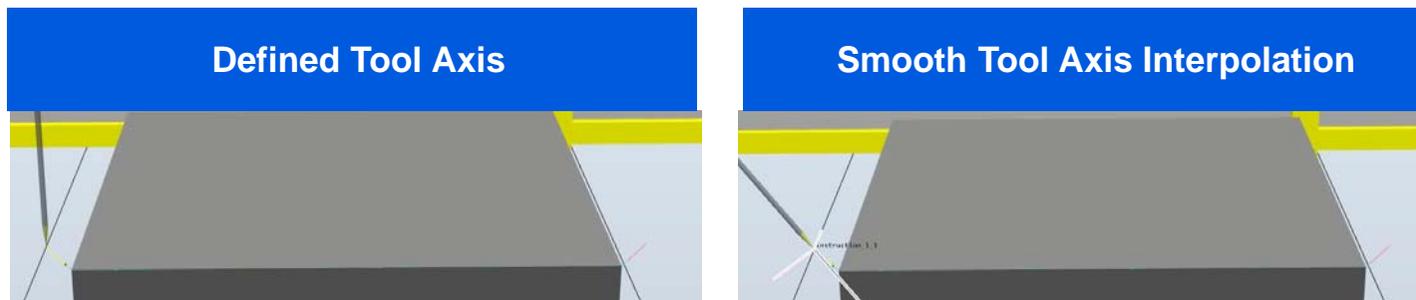
WAVE path function makes the tool machine a part with a defined area instead of a single contact point during the whole process

- Reduce tool wear and extend tool life time
- Define different contact points on tool for different processes



Machining Tool Axis Interpolation

Tool Axis Interpolation generates a path with smooth tool axis changes along the specified path



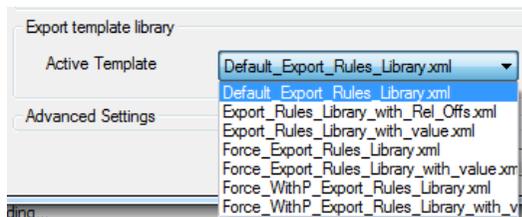
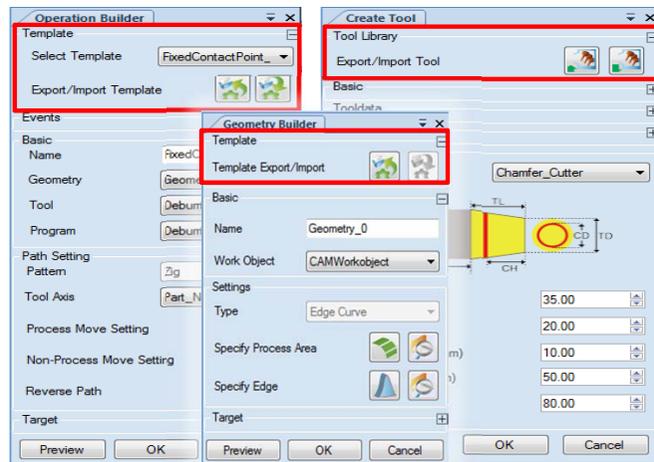
Machining Transfer Paths

Create flexible transfer strategies to support different machining process requirements

- Approach or Depart
- Lift Safe Height
- Direct



Machining Templates and Libraries

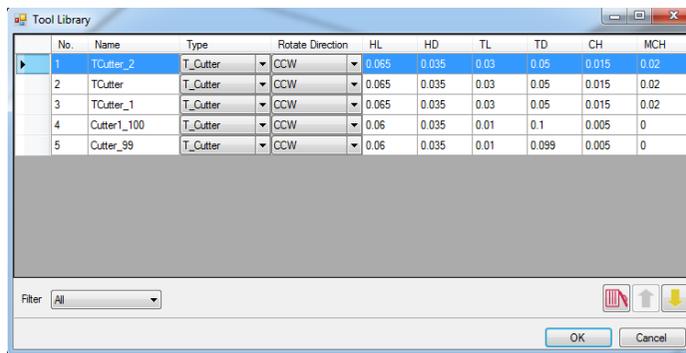


```
9 MoveL Instruction_1T1, v200,  
10 MoveL Instruction_2T1, v200,  
11 MoveL Instruction_3T1, v100,  
12 MoveL Instruction_4T1, v100,  
27 MoveL Offs(reltool(Instruction_1T1,relnx  
28 MoveL Offs(reltool(Instruction_2T1,relnx  
29 MoveL Offs(reltool(Instruction_3T1,relnx  
30 MoveL Offs(reltool(Instruction_4T1,relnx  
31 MoveL Offs(reltool(Instruction_5T1,relnx
```

Utilize templates to reuse process data and customize export of RAPID program to save programming time

- Export and Import Geometry parameters
- Export and Import Tool parameters
- Export and Import Operation parameters
- Select and customize RAPID code to be exported

Machining Templates and Libraries

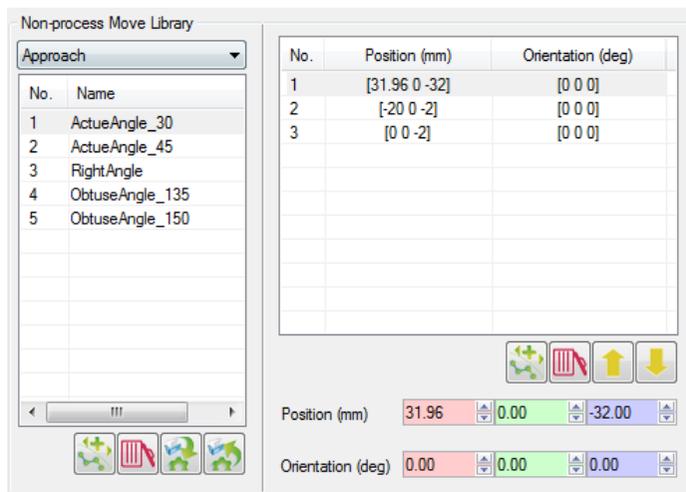


The Tool Library dialog box displays a table with the following data:

No.	Name	Type	Rotate Direction	HL	HD	TL	TD	CH	MCH
1	TCutter_2	T_Cutter	CCW	0.065	0.035	0.03	0.05	0.015	0.02
2	TCutter	T_Cutter	CCW	0.065	0.035	0.03	0.05	0.015	0.02
3	TCutter_1	T_Cutter	CCW	0.065	0.035	0.03	0.05	0.015	0.02
4	Cutter1_100	T_Cutter	CCW	0.06	0.035	0.01	0.1	0.005	0
5	Cutter_99	T_Cutter	CCW	0.06	0.035	0.01	0.099	0.005	0

Utilize libraries to reuse common tools and non-process movements to save programming time

- Add, Delete or Edit Tools

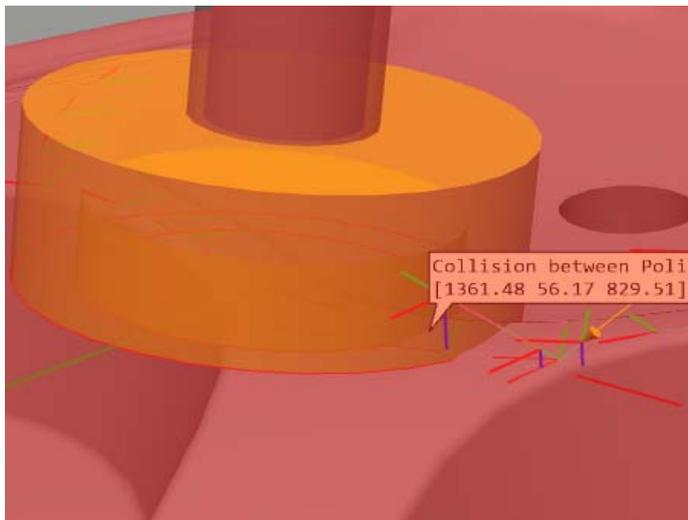
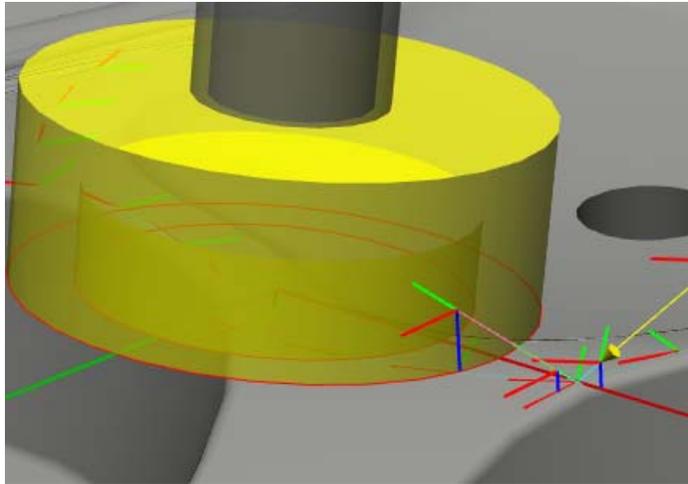


The Non-process Move Library dialog box displays a table with the following data:

No.	Name	Position (mm)	Orientation (deg)
1	ActueAngle_30	[31.96 0 -32]	[0 0 0]
2	ActueAngle_45	[-20 0 -2]	[0 0 0]
3	RightAngle	[0 0 -2]	[0 0 0]
4	ObtuseAngle_135		
5	ObtuseAngle_150		

- Add, Delete or Edit non-process move settings

Machining Collision Check



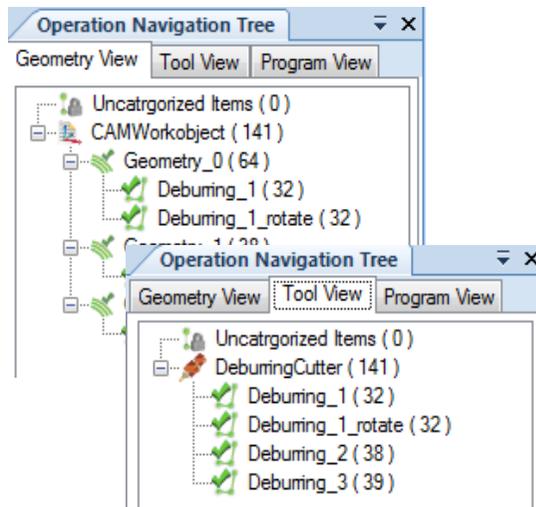
Enable collision check to supervise tool and workpiece and foresee collision during processing

- For soft tools e.g. in polishing applications user can set a certain amount of collision that is required before exposing the alarm.

Summary

Benefits

Reduced programming time

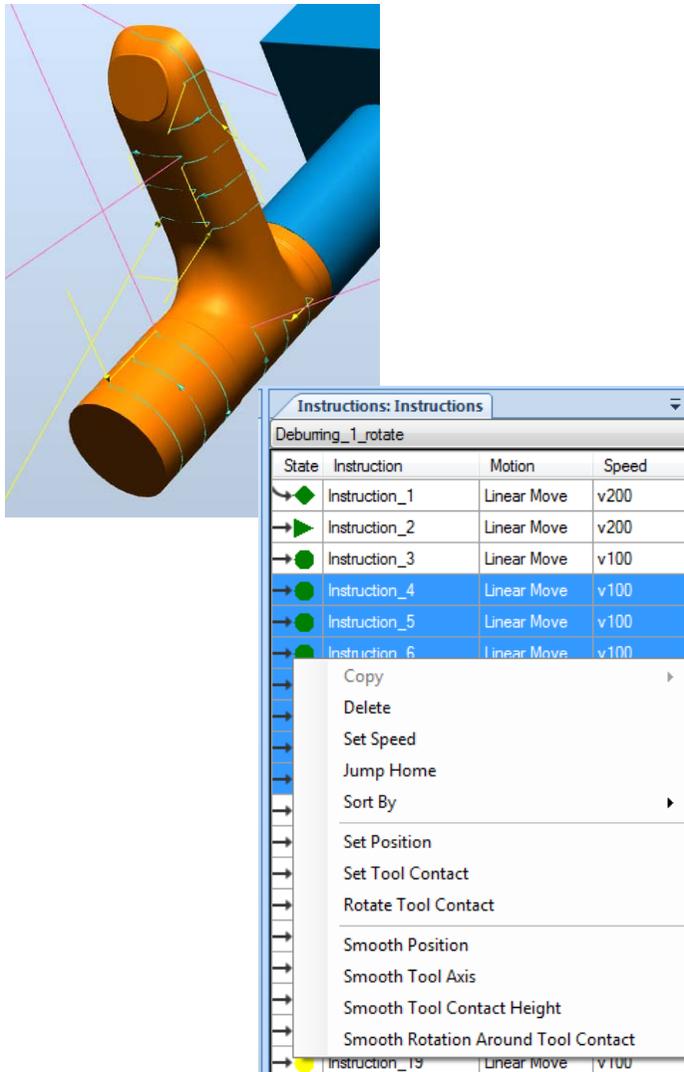


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SEMI_FINISH_CONTOUR_new.nc (~\D...Code\02_3Axis_Semi_Contour) - GVIM
1. SEMI_FINISH_CONTOUR_new.nc
9 : 7 T2 M06
10 N8 T2
11 N9 G90 G54
12 N10 G94 G90 G00 G43 X-2.782 Y-27.923 Z230.
13 N11 Z122.401
14 N12 G01 X-1.78 Y-18.318 Z119.807 F1200.
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27 N25 G03 X7.544 Y-17.29 I-4.754 J18.547
28 N26 G01 X7.84 Y-17.161 Z119.734
```

- Flexible programming steps based on CAM style navigation tree
- Robot path generated directly from CAD model
- Parse G-code to RAPID based on different machine setups
- Easily set target configuration and create robot path
- Quick simulation to verify the robot path
- Powerful export functionality of process parameters based on user-defined templates

Benefits

Precise Machining Paths



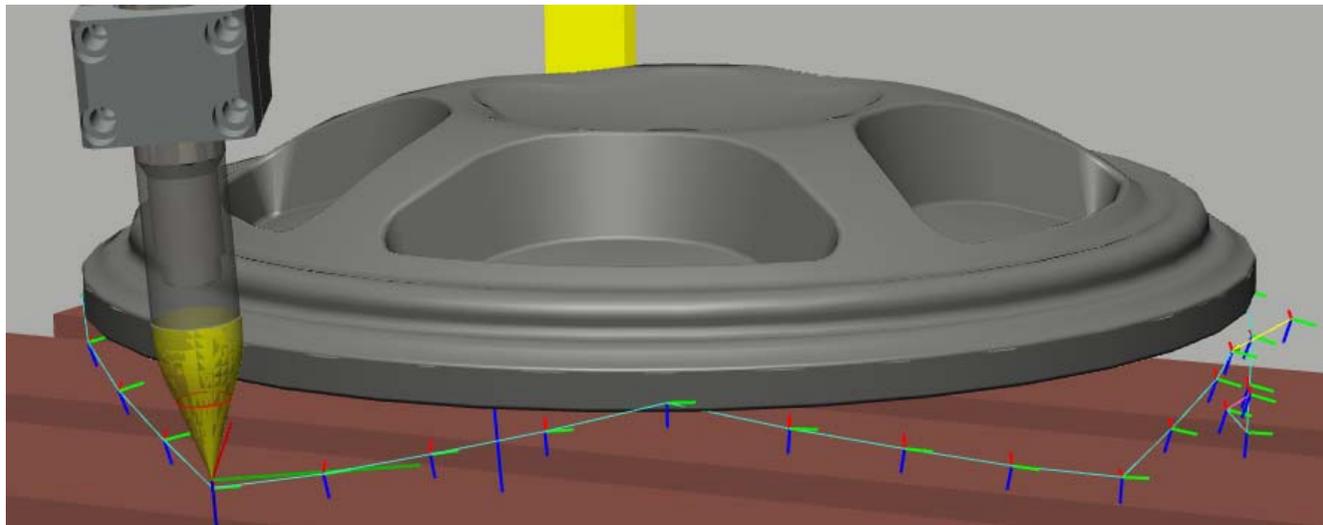
- Generate precise paths from CAD model in particular for freeform surfaces
- Generate precise paths out of G-code
- Dynamically preview the path
- Customize robot path/target
- Find the best robot posture and corresponding configuration
- Regenerated paths based on editable processes parameters
- Optimize robot path

Benefits

Extended Tool Life

Extend the life time of machining tools

- Efficiently utilize tooling
- Reduce tool wear and changeover time
- Create flexible contact points or areas



Summary

- Reduce programming time
 - Engineering and commissioning efficiency
 - More cost efficient handling of short batches
- In control of the process parameters
 - Easy to create and modify parameters
- Extended tool lifetime
- Improved path accuracy
- Improve product quality
- Seamless integration with RobotWare and RobotStudio

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