NX CAM
Feature-Based Machining (FBM) Introduction

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NX CAM Development
### Traditional Manual CAM steps
- Define Workpiece
- Create operation 1
  - Select geometry
  - Select tool
  - Specify cutting & non-cutting parameters
- Define feeds & speeds
- Add UDE’s
- Generate tool path
- Create operation 2, 3, 4, 5, ... n
- Simulation & Verification
- Post processing

### Automatic FBM steps
- Define Workpiece
- Automatically Find Features
- Automatically Create Operations
- Generate tool paths
- Make changes as needed
- Simulation & Verification
- Post processing

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**What is Feature-based Machining (FBM)?**

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Siemens PLM Software
Example User Workflow
Find Features - Start
Example User Workflow
Find Features – Automatically finds 105 features
Example User Workflow
Create Feature Process - Creates 84 operations
Where is FBM being implemented?

Most customers start with 2½D Prismatic Machining

- Standard features appear in many different parts like
  - Mold bases
  - Machinery parts
  - Automotive parts
  - Aerospace parts
- Predominantly holes, pockets and slots
- Using OOTB parametric feature types
Turning, WEDM and Color & Attribute features were added in NX7.5
Feature Teaching was added in NX8.5

- Automatic Feature Recognition for your own, customer specific, (milling, drilling, turning, WEDM) feature types
Where can you implement FBM?

- Hole Making
- Floor/Wall Milling
- Cavity Milling
- Turning
- WEDM (2 and 4-axis Internal Trim and No Core)
- Thread Milling and Hole Milling
- Planar Milling
- Plunge Milling
- Z-Level Milling
- Fixed Axis Surface Contouring
- Variable Axis Z-Level Milling
- Variable Axis Surface Contouring (Streamline and Contour Profile)
FBM existing Limitations (1/2)

No support available yet for rule-based creation of sub-operations:
- Face Milling manual
- Generic Motion operation
- Turning Teach Mode operation
- Probing operation
FBM existing Limitations (2/2)

Focus is on face-based operations; drive geometry is not support yet
• Machining Areas used to limit machining to a subset of the feature’s faces

Only automatic boundary generation is supported for boundary based operation
• Machining Area support for boundaries is still on our to-do list
PMI support in FBM

- Dimension tolerances
  - Diameter tolerance
  - Radius tolerance
- Limits & Fits
- Surface Finish
- Thread
- Thread tolerances
- Face Color
- Face Attributes
Why are customers interested in FBM?

**Process Automation**
- Significantly reduce the time needed to create NC programs
- Productivity improvements of 10x have been documented

**Process Quality**
- Reduce the amount of mistakes in “simple” and “repetitive” NC programming tasks
- Spend more time on critical / non-standard tasks

**Process Standardization**
- Ensure that the “standard process” is used by default
- Support the standardization of cutting tools
Machining Knowledge Definition
How does it work?

Expert: configures the best practice machining processes
(Machining Knowledge Editor application)

NX CAM loads the appropriate Machining Knowledge

NC Programmer (NX CAM)

Features

Tool Database
Teamcenter Resource Manager or ASCII

Template Database
Teamcenter or native

Create Feature Process command
FBM – basic principles

- Operations are selected based on (customer specific) rules
  - Feature type
  - Feature parameters (dimensions, tolerances)
  - Product material & selected machine tool
- Tools are selected from the configured tool database
  - Tool type
  - Tool search parameters (from the tool database; not the internal tools)

- Once selected,
  - Operations are created by copying them from the selected template
  - Operation parameters can be overruled from the rules; this includes:
    - Cutting & non-cutting parameters, step overs, cut levels, etc.
    - Cycle parameters and UDE’s
    - Feeds & speeds
Turning example

Typically used for complex and reoccurring features that require several operations

- Cut region definition through containment
- As mentioned before, no support available yet for teach mode operations
Machining Feature – Machining Area Extension to Feature Teaching

- Machining Area is a User defined “name” associated with a set of faces and/or edges
- Defined using standard NX PMI Labels
- Machining areas can be used to define operations that work on a subset a feature’s geometry

For online live demo please use the following link:
  - Quickly add new feature definitions for feature-based machining

Page 18
Operation Teaching
Is available since NX8

1. Use NX CAM to generate machining rules from existing CAM operations and store in MKE

2. In the Machining Knowledge Editor (MKE), edit the machining rules to make them more general. Also add or optimize machining conditions & set the priorities
Operation Set Teaching – Introduced (as preview) with NX10.0.2
Uses part files with alternative operation sets per feature type

- Create a single “teach” part file per feature type
- Model a feature for each machining “variant”
- Recognize the features and create a feature group for each feature
- Per feature group, define the operations for that variant including:
  - Operation parameters
  - Tool
  - Cycle parameters
  - UDE’s, etc.
Object -> Teach Operation Sets… Conditions are defined in NX CAM

Feature Group conditions determine which variant to use
- Feature dimensions; Diameter <= 16.0
- Feature tolerances; Roughness < 3.2
- Feature color; Color = GREEN
- Feature attributes; ...

Operation conditions are used to match tool & operation parameters with feature parameters
- Tool.Diameter = Feature.Diameter_1
- Operation.DepthOfCut = 0.25 * feature.Depth
- Etc.
Operation Set Teaching Rules are stored in MKE; available for Create Feature Process
Operation Set Teaching - Benefits

- No need to learn an extra application; use NX CAM to define best machining practices
- Much faster ROI (Return on Investment) for initial FBM projects
- Much easier to make changes or add new / alternative processes (occasional use)

- Does not limit the future growth path or sacrifice any of the powerful MKE capabilities

- Does not require any additional licenses (just FBM_Author)

- Available as Preview from NX10.0.2 onwards
  - set UGII_CAM_FBM_ENABLE_TEACH_OPERATION_SETS=1
- Already used in production by selected customers
- Few additional enhancement required to streamline the workflow
How to implement FBM – Lessons learned (1/2)

- Use the OOTB rules to demonstrate the feasibility and get management buy-in for a small proof of concept
- Get basic training, study the OOTB rules to master the concepts
- DIY. This is your core business and your company’s best practice and know how; document, implement and optimize it by yourself
- Assign a CAM expert with IT affinity; not an IT expert that does not understand CAM
- Start with a small proof of concept (1-3 weeks) with a limited scope
- Test drive the entire process from start to finish (use holes first before you do this on your own feature types)
  - Knowledge Acquisition & Standardization
  - Implementation & Testing
- Have something working to demonstrate to your management
- Provide ROI details if required
- Learn how to estimate a larger project implementation
How to implement FBM – Lessons learned (2/2)

• Enhance the scope incrementally
• Make sure you have regression tests in place
  • Capture validated Create Feature Process results before you start making changes
  • Re-run your tests and compare the new outcome with the validated results
  • Contact me if you need help automating this
• Stick to the 80-20 rule; do not get lost in the exceptions
• Only automate what “everybody” accepts as good practice
• People need to be able to trust the automatic results
• Some of the benefits are lost again if users constantly need to validate the automatic results
Licensing

What license is required?

- No license required for end users
- “FBM Author” license is required for the definition of the company specific machining knowledge:
  - Save & Save As in Machining Knowledge Editor
  - Feature Teaching
  - Operation & Operation Set Teaching

FBM Author (NX31435) is available as add-on license
FBM Author is included in the Total Machining bundle
FBM & Teamcenter

- FBM uses the customer’s standard CAM configuration to define:
  - Operation templates
  - Cutting tools
  - Cycles & UDE’s
  - Machining Knowledge
  - Etc.

- It supports any mix of Native and Teamcenter.
- Most “managed” users store their machining knowledge xml in Teamcenter along with the operation templates and the cutting tools