STEP-NC Update

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STEP-NC Summary

- STEP-NC is the ISO 10303 (“STEP”) part that models production information for machining (AP-238)
- It is a feature-based model of machining operations (drill a hole, mill a pocket, machine a surface) intended to replace the 50-year-old “G code” way of programming
- It is integrated with STEP, so that raw stock and finished part geometry and feature tolerances, for example, are available to the machine tool at run time to enable “smart machining”
- Pilot projects over many years have shown benefits
- We need commercial support by CAM software and CNC machine tools now

Relevance to MBE and TDP

- STEP-NC is a rich data model for machining operations that is the “model base” for the production part of the enterprise
- STEP-NC is a published format that is portable across machines from different vendors and can be sensibly archived or outsourced later

What STEP-NC Looks Like


```
- <iso_10303_28_terse xmlns="urn:oid:1.0.10303.238.1.0.1" xmlns:exp="urn:oid:1.0.10303.28.2.1.1" xmlns:xsi="http://ww
    schema="integrated_cnc_schema">
  - <exp:header>
      <exp:name>Boxy_Part_3-Axis_Machining_7_Setups_NIST</exp:name>
      <exp:time_stamp>2010-06-11T16:54:07-04:00</exp:time_stamp>
      <exp:author>STEP-NC Maker 3.0</exp:author>
      <exp:organization />
      <exp:preprocessor_version>ST-DEVELOPER v13</exp:preprocessor_version>
      <exp:originating_system>Various</exp:originating_system>
    </exp:header>
    <!--  ***********************************************
     * Application object: PROJECT (id10)
     * MAIN_WORKPLAN: id10, id11, id12, id155534
     * ITS_WORKPIECES [*]: id10, id13, id2612
     * ITS_ID: id10, id14, id15, ['Mastercam Export']
      -->
    <Product_definition id="id10" Id="" Description="" Formation="id14" Frame_of_reference="id16" />
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    </Process_product_association>
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    <Machining_project_workpiece_relationship id="id13" Id="" Name="" Description="" Relating_product_definition="id10" Relatec
    <Product_definition_formation id="id14" Id="" Description="" Of_product="id15" />
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    <Product_definition_context id="id16" Name="CNC Machining" Frame_of_reference="id17" Life_cycle_stage="manufacturir
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    <Product_context id="id18" Name="CNC Machining" Frame_of_reference="id17" Discipline_type="manufacturing" />
```
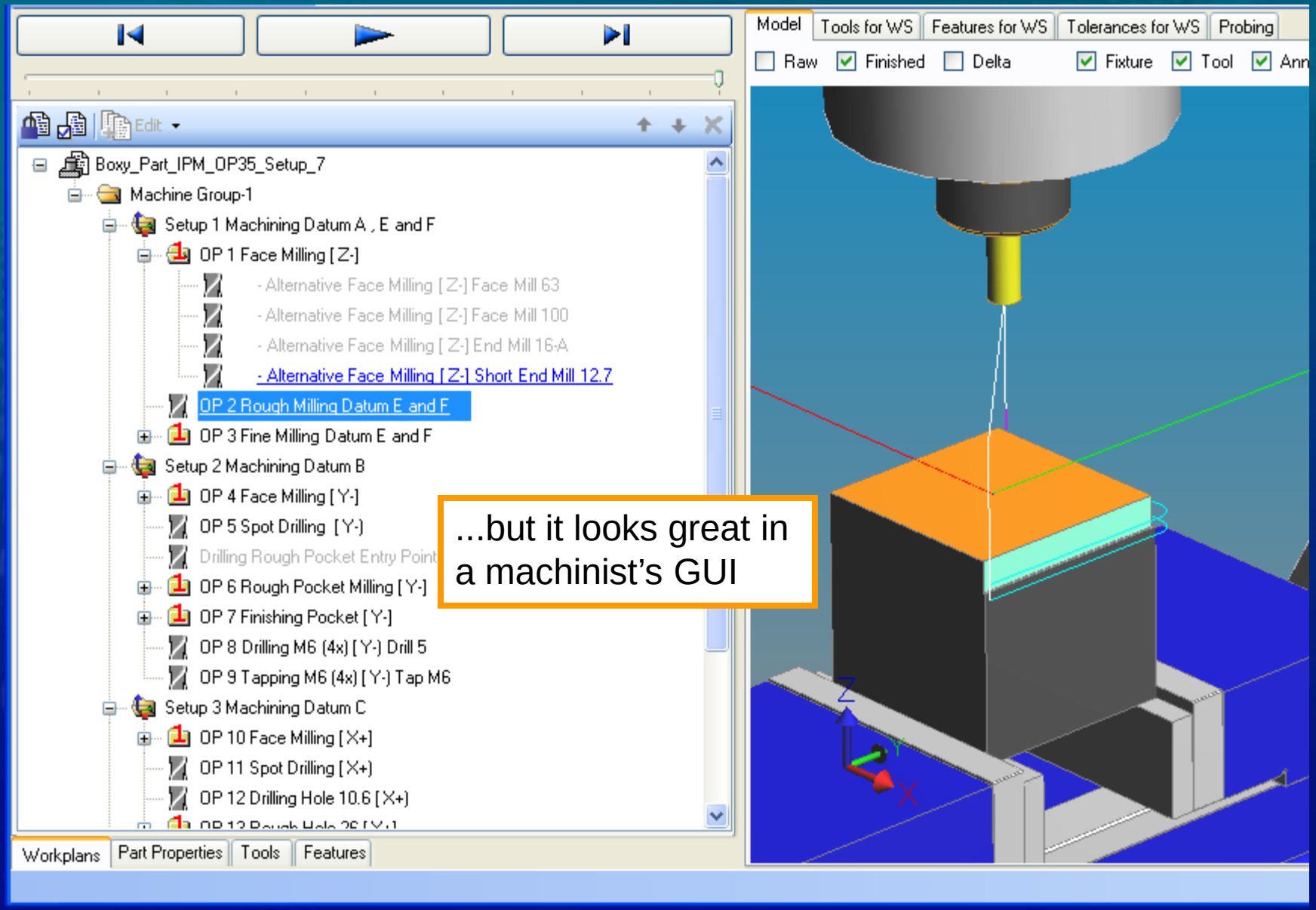


Not a hand-editable format...

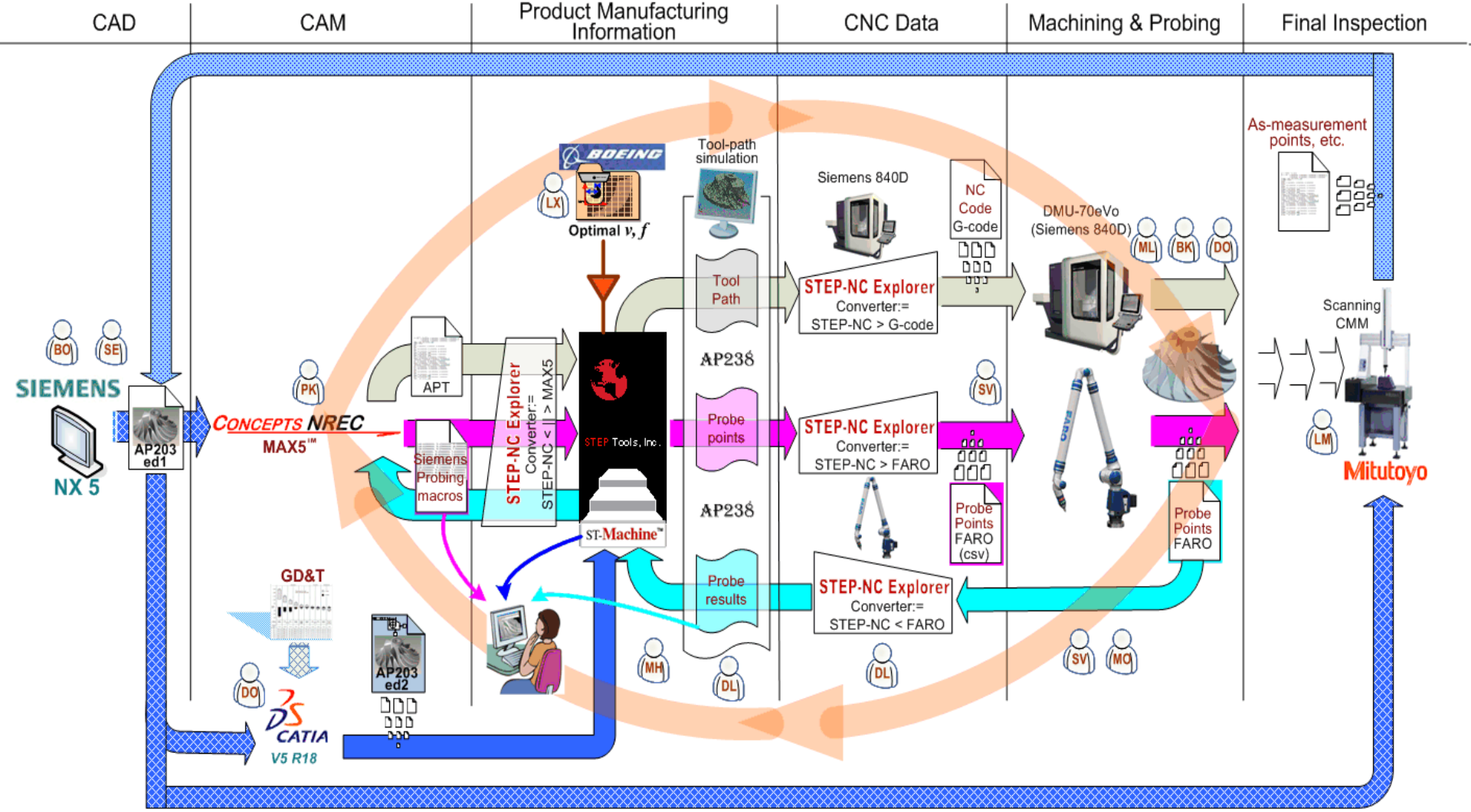


...but it looks great in a machinist's GUI

What's Been Done

- Pilot projects over the past ten years have shown various benefits of STEP-NC
- Little DoD participation – mostly large end-users like Boeing Commercial Aircraft
- Commercial support through third-party software such as STEP-NC Machine from STEP Tools Inc.
- Prototype vendor support via custom plug-ins: Catia, MasterCAM export; Fanuc import
- ISO 10303 AP-238 is a published International Standard (IS); pilots are demonstrating new features intended for Edition 2

Closed-Loop Machining at CCAT – a Snapshot



Closed-loop for machining

Design data — AP203

Design data + GD&T — AP203 ed2

Tool path data

Probe points

Probe results

CMM Feedback

BK - Brian Kindilien, CCAT
BO - Bengt Olsson, Sandvik
DL - David Loffredo STEP Tools, Inc.
DO - David Odendahl, Boeing
LM - Larry Maggiano, Mitutoyo
MO - Mike O'Brien, Boeing
LX - Leon Xu, Boeing
MH - Martin Hardwick, STEP Tools, Inc.
ML - Matthew Lloyd, CCAT
PK - Peter Klein, Concepts Nrec
SV - Sid Venkatesh, Boeing
SE - Stenake Ekstron, Sandvik

Last update: 14/08/2008
Created using Visio Professional 2003

Manufacturing Engineering Laboratory
NIST

STEP-NC Machine - Boxy_Part_3-Axis_Machining_7_Setups_v5

File View Setup Simulate Tolerances Probing Help

Views Motion Collision Position Feeds Cross Section Simulation

< Back Open Files Forward > Go to STRL

Edit

- Setup 3 Machining Datum C
  - OP 10 Face Milling [X+]
  - OP 11 Spot Drilling [X+]
  - OP 12 Drilling Hole 10.6 [X+]
  - OP 13 Rough Hole 26 [X+]
  - Engraving [X+] Spot Drill 10
  - OP 14 Finishing Hole 26 [X+]
- Setup 4 Machining of face opposite to Datum B
  - OP 15 Face Milling [Y+]
  - OP 16 Spot Drilling [Y+]
  - OP 17 Drilling 10.6 [Y+]
  - OP 16 Rough Circle Milling Hole 26 [Y+]
  - OP 19 Finishing Hole 26 [Y+]
- Setup 5 Machining of face opposite to Datum C
- Setup 6 Machining of face opposite to Datum A
- Setup 7 Machining Datum A
  - OP 31 Spot-Drilling [Z-]
  - Drilling Rough Pocket Entry Point
  - OP 32 Rough Pocket Milling [Z-]
  - OP 33 Finishing Pocket [Z-]
  - OP 34 Drilling M6 (4x) [Z-] Drill 5
  - OP 35 Tapping M6 (4x) [Z-] Tap M6

Workplans Part Properties Tools Features

Model Tools for WS Features for WS Tolerances for WS Probing

Raw Finished Delta Fixture Tool Annotations

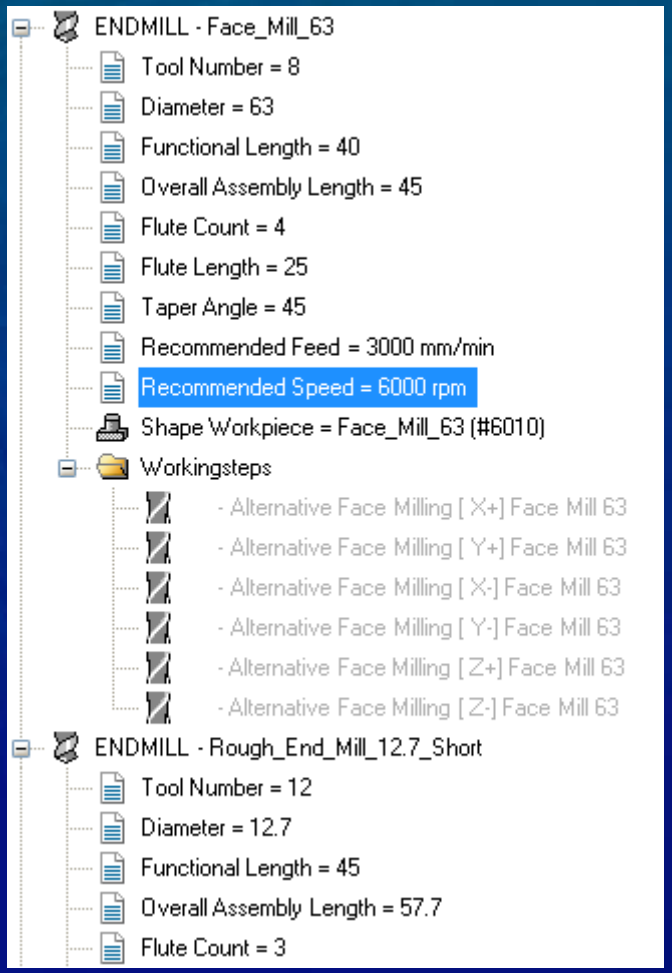
Datum A
Datum B
Datum C

Testing of multiple setups and tool requirements done at NIST in June 2010

Movie

Tooling Requirements

- STEP-NC references the ISO 13399 cutting tool model
  - that model is for the description of actual tools
  - STEP-NC uses same terminology for tool requirements, with ranges of acceptable values and reasons for selection



Upcoming Events

- Open Modular Architecture Controller (OMAC) meeting at ARC's Annual Forum in Orlando, February 7-10
- Spring STEP-NC demo, location TBD, probably CCAT in Hartford
- Plan: use AP-238 IS version as jump-start for new features, stimulate vendor implementation

What We Need To Do

- Priority #1: Get commercial support for STEP-NC by CAM, CNC vendors
- Use DoD as a customer and show value of STEP-NC for MBE and TDP
  - MBE value: speed up setup time for low-volume production; optimize speed and feed
  - TDP value: move production data between facilities, customize for local operations
- Let’s get DoD on board and make standard production data formats a reality