Using STEP-NC for CAM/CNC Data Exchange

David Odendahl
Associate Technical Fellow
Boeing IT Tech Assurance
Presentation Outline

Global Product Data Interoperability Summit | 2015

- Your Speaker
- Traditional Data Flow
- Advanced Data Flow
- Applications for Advanced Data Flow
- Present/Future Efforts
Boeing
  • 1984-1985 Electronics Technician, Rockwell, El Segundo
  • 1985-1990 Maintenance Engineer, Rockwell, El Segundo
  • 1990-2005 Controls Engineer, Rockwell/Boeing, Tulsa
  • 2005-2015 CAD/CAM Development Boeing, Everett
  • 2011 Associate Technical Fellow, Boeing

Outside
  • ISO TC184/SC4/WG3 (STEP Manufacturing)
  • OMAC Machine Tool Workgroup
CNC Machine Tools

- Around since 1950s
- Ubiquitous in modern manufacturing
- Execute simple process data
Typical CNC Data

;T_9077451_105_MPF
MSG ("114W5414-2 1MF-05 T-9077451 03/18/02 11.23 STATUS=SOLD ")
N2G17G70G40
N38T2
N40G0X-12.Y-3.585
N42Z12.175
N46Z10.305
N48G1G94Z10.205F150.
N50Y-1.835
N52X5.F120.
N106Y-.4683F150.
N174G0X-23.5Y-15.5A0.C0.
N10650G74C0.0
N10656M2
Traditional CNC/CAM Data Flow

CL File
Modal Commands
Cutter Paths
Interpolation
Tolerances

Stock
Cutters
Tolerances
Final Part
High-Level Process Definition
Low-Level Process Definition

CAD/CAM A

Post Processor

MCD Files
Modal Commands
Axis Motion

Machine(s)

CAD/CAM B

Post Processor

MCD Files
Modal Commands
Axis Motion

Machine(s)

Post Processor

MCD Files
Modal Commands
Axis Motion

Machine(s)
About the Typical CNC Data Flow

The Good:
- Works
- Expected and familiar

The Bad:
- No high-level process information at machine
- Data standards are weak and primitive
- Reinforces existing practices
- Work-arounds are limited and non-standard

Consequently:
- Advanced CNC capabilities underutilized
- Data is non-portable
- Larger infrastructure required
- Equipment standardization not seen as important
Advanced CNC Data Flow

ISO 10303-238
(STEP-NC)

Stock
Cutters
Tolerances
Final Part
High-Level Process Definition
Low-Level Process Definition
What is AP238 or “STEP-NC”?

- A part of the ISO suite of STEP (Standard for the Exchange of Product Data) standards

- A standard way of transmitting *process and geometry* information to/from CNCs and CAM systems
STEP: SStandard for the Exchange of Product Data

Global Product Data Interoperability Summit | 2015

CAM and NC control

AP238

Inspection

AP219

CAD Definition

AP203

Annotations

AP232

BOM

Material

AP240

Process Planning

Automotive

AP214

Tools

Toolpaths

AP238

Geometry

Tolerances

AP219

Color

AP203

BOM

Material

AP240

Process Planning

Automotive

AP214

Tools

Toolpaths

AP238

Geometry

Tolerances

AP219

Color

AP203

Annotations

AP232
Advanced CNC Data Example
About Advanced CNC Data Flow

- **The Good:**
  - High-level process information available at machine
  - Well-defined, modern data structure, optimized for modern data storage/transmission capabilities

- **The Bad:**
  - Not yet in production use
  - Unexpected and unfamiliar
Archiving/Long Term Support

- Aircraft have long life spans, but must still be supported

- Support becomes more challenging over time
  - Aircraft no longer in production
  - Infrastructure no longer available

- Old, low-level process information (“G-code” data) of little use

- Using STEP-NC, process information is preserved

- Complete redevelopment of process avoided
1. Base process developed by Boeing in CATIA V5
2. Export process as STEP-NC
3. Improved process and cutter recommendations generated in MasterCAM
4. Export new process as STEP-NC
5. Merge processes and machine
Other Potential Applications

- Long-Term Archiving
- Part inspection
- Closed-loop machining
- Tool migration
- End Users
- Standardized machine behavior
- Reduced overhead for outsourcing/insourcing work
- Adaptive control
Active Participants

Standards Organizations
- ISO, NIST, OMAC

End Users
- Boeing, Airbus, GE, Scania

Technology Providers
- Scania, Iscar, Sandvik Cormorant, Okuma, Makino, STEP Tools, Mitutoyo

Academia
- RPI, KTH, Vanderbilt, Penn State, U of Bath

U.S. Government (DMDII)
Present Activities

Global Product Data Interoperability Summit | 2015

- Digital Manufacturing and Design Innovation Institute
  http://dmdii.uilabs.org/

- “Mind the Gap”

- “OOO”
“Mind the Gap”

Project Call DMDII-14-02

Purpose:
- Use standards to allow usage of third party services for CNC process optimization, NC code generation, and process planning

Participants:
- GE, STEP Tools, Inc, Boeing, Vanderbilt, Penn State, Boeing

Test part: Aircraft engine mount
• Project Call DMDII-14-06
• Purpose:
  • Use standards to allow usage of third party measurement services for real and virtual machining models

• Participants:
  • ITI, Mitutoyo, SystemInsights, STEP Tools, Inc

• Test part: Aircraft engine mount, Circle-Diamond-Square, Moldy
Upcoming Opportunities For Participation

- ISO TC 184/SC 4 Meeting, October 18-23, Baltimore, MD  [www.eccma.org](http://www.eccma.org) (Industry Day is October 21st)

- AP238 Edition 2

- Potential integration with AP242