Standardisation of the Manufacturing Process: the STEP-NC project

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Contents

1. STEP and STEP-NC
2. The Need for a New Standard
3. The New Standard (STEP-NC)
4. The Projects
5. Project Team
6. Prototype Results
1. STEP and STEP-NC
2. The Need for a New Standard
3. The New Standard (STEP-NC)
4. The Projects
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STEP

• STEP (Standard for Exchange of Product Data) was initiated by CAD users in 1984, with the intention of
  – improving CAD data exchange
  – replacing IGES, SET and VDAFS

• It is now an International Standard (ISO 10303) for exchange of
  – Geometry and topology
  – Assembly and configuration information

• More then one million CAD stations use STEP
  – All major CAD systems have STEP interfaces
STEP and STEP-NC

• STEP-NC extends STEP for CAM and CNC control
• Currently under deliberation by ISO TC184/SC1 as a Draft International Standard (DIS) called ISO 14649
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ISO 6983

- Developed many decades ago
- Doesn’t meet modern NC technology requirements
- Uses low-level codes to describe tool movements (G01 for a straight line) and switching instructions (M5)
Problems with ISO 6983

- No support of complex geometries (e.g. spline)
- No support of 5 axis milling, high-speed cutting
- Creates large programs, difficult to handle
- Changes are difficult to manage
- One way: from CAD to shop-floor. No feedback
- CAD description has to go through a post-processor specific to the machine (5,000 exist)
- Degrades information
Current situation of NC programming

- Low level of data: language describes simple movements and switching instructions
- Standard does not support complex geometries (e.g., spline interpolation)
- Vendor-specific extensions
- Machine-specific part programme generated by postprocessor
- One-way: No feedback of data to planning department
- No possibility to change complex NC programmes at shopfloor level

To improve the interface between planning and shopfloor, a new data model is needed, not just an extension of ISO 6983!

Source: WZL
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Goals for STEP-NC

• Enable a fast-track process chain from CAD to product realisation
• Provide an effective link between CAD/CAM and CNC
• Enable exchangeability of programs
• Build on geometry from CAD; and add a description of what to do: “drill a hole”
• High-level description of machining process - instead of tool movement G01 x y
The Project Target

Current Situation

Design Department

CAD/CAM

G, M, Code ISO6983

Post-Processor

NC Machine Tools

Shopfloor

New Interface

STEP-NC ISO14649

Hole1
- predrilling
- drilling

Hole2
- roughing
- finishing

Pocket1
- plunge
- roughing
- finishing

Source: WZL
The New Interface: STEP-NC (ISO 14649)

• What does the well-structured interface look like?
  – Workingsteps
    • describe the sequence of work
  – Object oriented description of features
    • features are: hole, plane, profile, pocket, ..
  – Operations
    • tell the control how to do that
Status of STEP-NC (ISO 14649)

- The drilling and milling datasets are described in a data model using a special language which can be processed directly by software tools.

- ISO 14649:
  - Part 1: Overview and fundamental principles
  - Part 10: General Process Data
  - Part 11: Process Data for Milling
  - Part 111: Tools for Milling

- In preparation:
  - Part 12: Turning
  - Part 13: EDM
  - Part 14: Contour cutting of wood and glass
  - Part 15: Inspection
Features on an Engine Part

Source: DC
Program Structure

File:

Header
#1=Project(Workplan #10);
#10=Workplan(#20,#35,#71,.....);
.
#20=Machining_workingstep( , #21(Feature),#22(Machining));
#21=Round_hole(‘Hole M6’,,,,,,,);
#22=Drilling(#..(Tool),,,#..(Technology),#..(Machine_functions));
.
#35=Machining_workingstep(......);
END-ISO-10303-21;
Benefits of STEP-NC

- A closed process chain from CAD to CNC
- No geometry programming
- No post-processing
- A complete product model in the CNC
- Easy editing at the shop floor
- Upload of CNC file and easy reuse
- An open solution, open for customers cycles
- Well suited to e-engineering

Source: WZL
STEP-NC : Target

- 35% reduction in CAM planning time
- 75% reduction in number of drawings sent from CAD to CAM
- 50% reduction in machining time for small to mid sized job lots

Source: Step Tools
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5. Project Team
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STEP-NC projects

- IMS “STEP-NC” project (2002-2004)
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Project Team

• From a European Project
  – Belgium, France, Germany, Italy, Sweden, Switzerland

• to a global IMS Project
  – Europe
  – Korea
  – Switzerland
  – USA
EP29708 Project
Members

Control Manufacturer
- Siemens (D)
- OSAI (I)

Machine Tool Manufacturer
- CMS (I)
- AGIE (CH)
- Starrag (CH)

CAM Manufacturer
- Open Mind (D)
- Dassault (F)
- CADCAMation (CH)

Research Institute
- WZL (D)
- ISW (D)
- EPFL (CH)
- EIG i-tech (CH)

Association
- CECIMO (B)

Consulting
- AMT (CH)

Enduser
- DaimlerChrysler (D)
- Volvo (S)
- Franci (I)
- Progetti (I)
- Derendinger (CH)
- Wyss (CH)

Source: CECIMO, WZL

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Prototypes Implemented

- Milling
  - Siemens
- EDM
  - Agie-Charmilles
Prototype : Milling

Source : Siemens
Feature display, compound feature

Source: Siemens, OpenMind
Tool display and sequence editor

Source: Siemens, OpenMind
Simulation of pocketing

Source: Siemens
Prototype: Wire EDM

SolidWorks CAD system

AlphaCAM CAM system

STEP-NC data generator

AlphaCAM API

STEP-NC part 21 file

Implementation in CAM system

Front-end PC with STEP-NC interface

Post-processor for AGIE

180i W PC-based CNC

AGIE AGIECUT

Charmilles Technologies ROBOFIL 340

2 different implementations in CNC

Source: Cadcamation, i-tech EIG
The new Wire EDM controller
Wire EDM results

CAD system: SolidWorks
CAM system: AlphaCAM

Charmilles ROBOFIL 430

STEP-NC interface
TestEDM prototype software

STEP-NC file
ISO 14649

Source: Cadcamation, EPFL
More information?

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