



Standardisation of the Manufacturing Process : the STEP-NC project

December 10. 2003

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EIG HES-SO

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2. The Need for a New Standard
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STEP

- STEP (**S**Tandard for **E**xchange of **P**roduct 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 than 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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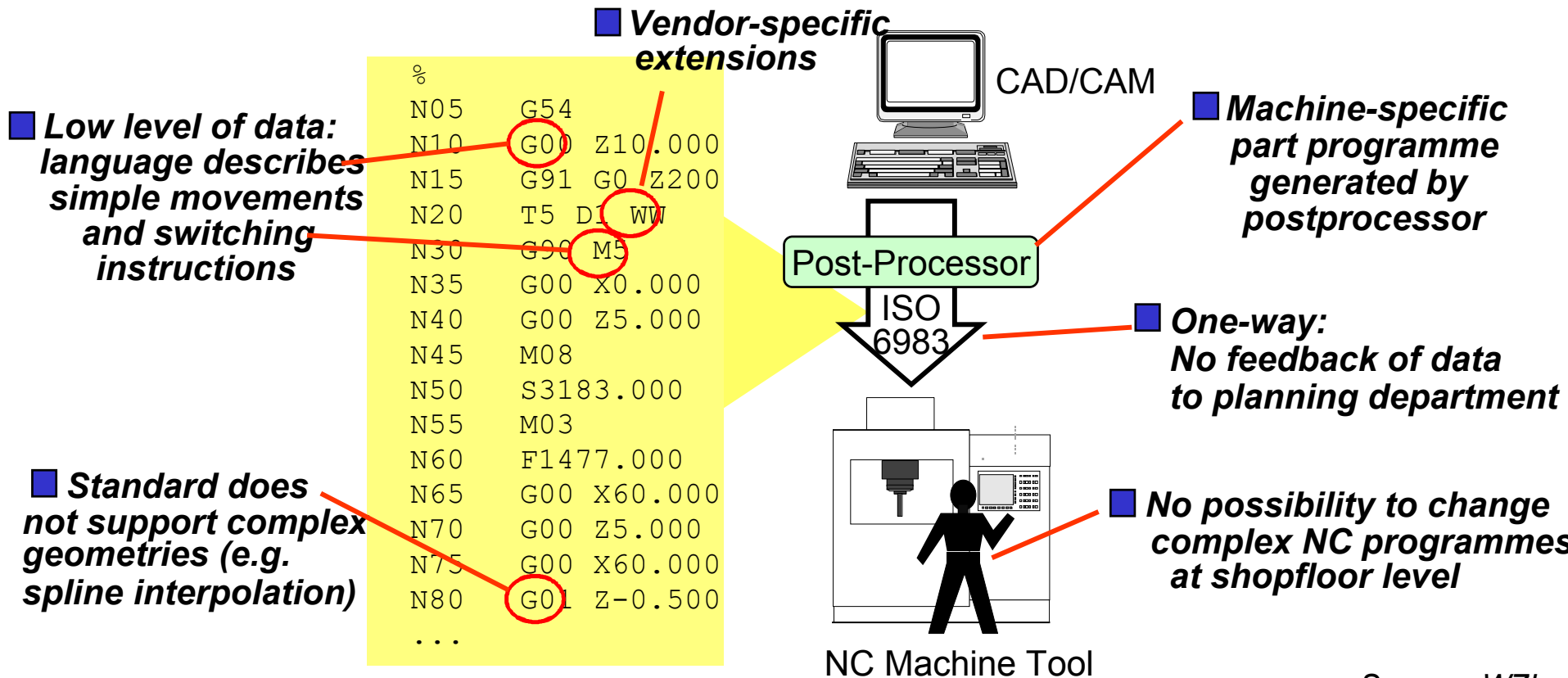
ISO 6983

- 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



Source : WZL



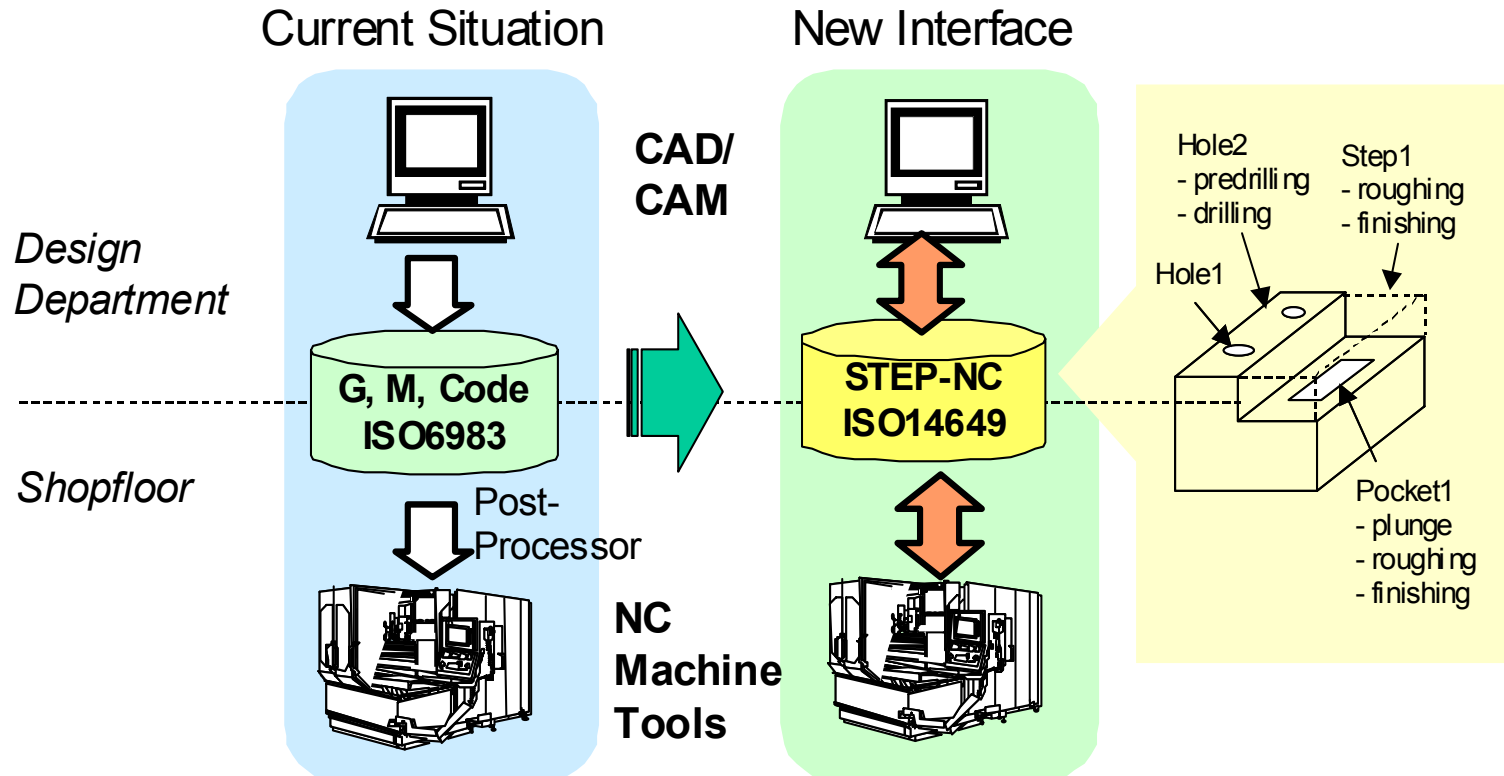
To improve the interface between planning and shopfloor, a new data model is needed, not just an extension of ISO 6983!

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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

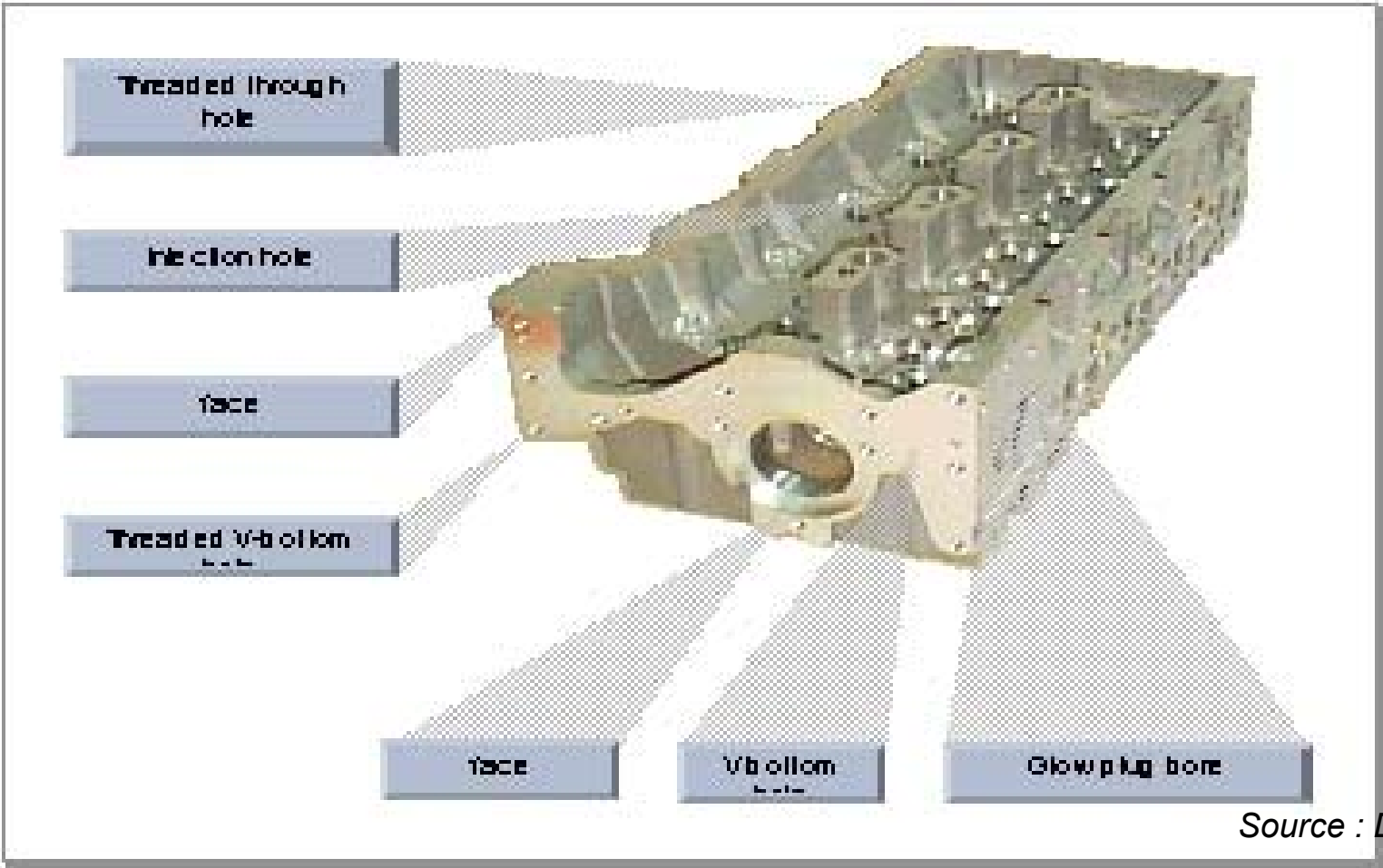


Source : WZL

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

Features on an Engine Part



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

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));
```

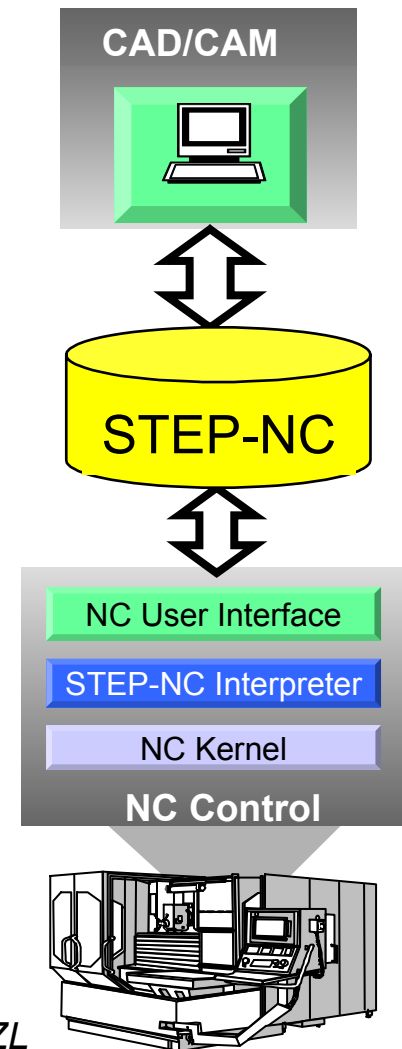
.

```
#35=Machining_workingstep(.....);
```

```
END-ISO-10303-21;
```

Benefits of STEP-NC

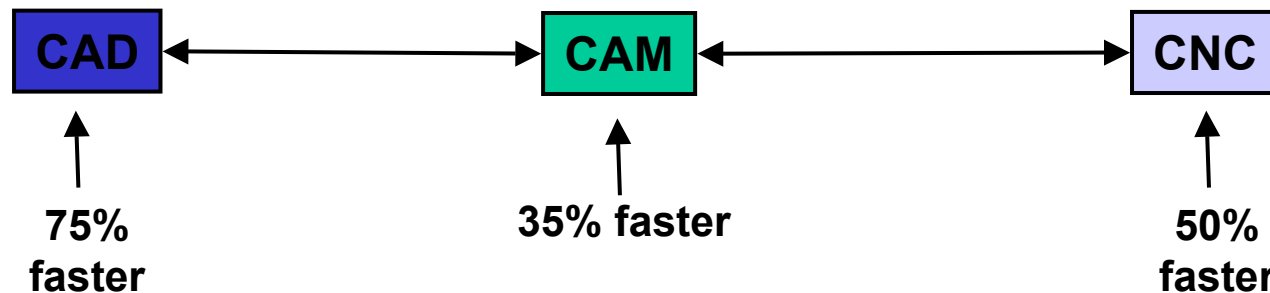
- A closed process chain from CAD to CNC
- No geometry programming
- No post-processing
- A complete product model in the CNC
- Easy editing at the shop floor
- Upload of CNC file and easy reuse
- An open solution, open for customers cycles
- Well suited to e-engineering



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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STEP-NC projects

- European “Optimal” project (1994-1997)
- EP29708 Esprit “STEP-NC” (1999-2001)
- IMS “STEP-NC” project (2002-2004)

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-CHARMILLES (CH)

Starrag (CH)

**CAM
Manufacturer**

Open Mind (D)

Dassault (F)

CADCAMation (CH)

Association

CECIMO (B)

Consulting

AMT (CH)

Enduser

DaimlerChrysler (D)

Volvo (S)

Franci (I)

Progetti (I)

Derendinger (CH)

Wyss (CH)



**Research
Institute**

WZL (D)

ISW (D)

EPFL (CH)

EIG i-tech (CH)

Source :
CECIMO,
WZL

-
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Prototypes Implemented

- Milling
 - Siemens
- EDM
 - Agie-Charmilles

Prototype : Milling



Source :
Siemens

Feature display, compound feature

The screenshot displays the Siemens CAD software interface for configuring a compound feature. The main window is titled "Center Drilling Workingstep - WS_s3_holeM12_center".

Processing Sequence Tree:

- complete_workplan
 - workplan_setting1
 - workplan_setting3
 - WS_s3_face_rough
 - WS_s3_face_finish
 - WS_s2_gop_rough
 - WS_s3_gop2_rough
 - WS_s2_gop_finish
 - WS_s3_gop2_finish
 - WS_s3_chamfer
 - WS_s3_hole10_center
 - WS_s3_hole10_drill
 - WS_s3_hole10_ream
 - WS_s3_hole18_center
 - WS_s3_hole18
 - WS_s3_hole20_drill
 - WS_s3_holeM12_center**
 - WS_s3_holeM12_drill
 - WS_s3_M12_tap

Center Drilling Workingstep - WS_s3_holeM12_center:

- Mach. Oper.: center_drilling, center
- Manu. Feature: round_hole, HoleM12
- Feed: 3000.0
- Override:
- Spindle: 18000.0
- Override:
- Coolant: ON
- Z-Pos: 0.00
- X-Pos: 0.00
- Y-Pos: 0.00
- Z-Security: 25.00
- Tool: Center
- Retract Plane: 20.00
- Cutting Depth: 2.00
- 10.00 Diameter

Replicate Feature - rectangular_pattern:

- Feature: pattern_M12
- Z-Pos: 33.00, X-Pos: 113.00, Y-Pos: 82.90
- List of Locations:

X=	Y=	Z=
0.00	0.00	0.00
35.36	35.36	0.00
70.71	70.71	0.00
0.00	50.00	0.00

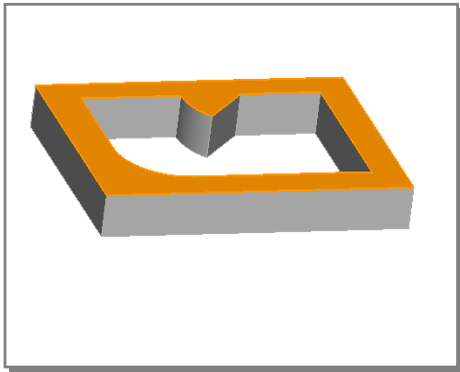
Compound Feature:

- Feat: compound_feature_M12
- Depth: 30.00
- Z-Pos: 0.00, X-Pos: 0.00, Y-Pos: 0.00

Buttons: FILE, DISPLAY, EDIT SEQUENCE, EDIT TOOLS, EDIT EXECUTABLE, CODE GENERATION, OPEN PROJECT, CLOSE, SAVE, SAVE AS.

Source :
Siemens,
OpenMind

Wire EDM process



CAD system: SolidWorks
CAM system: AlphaCAM

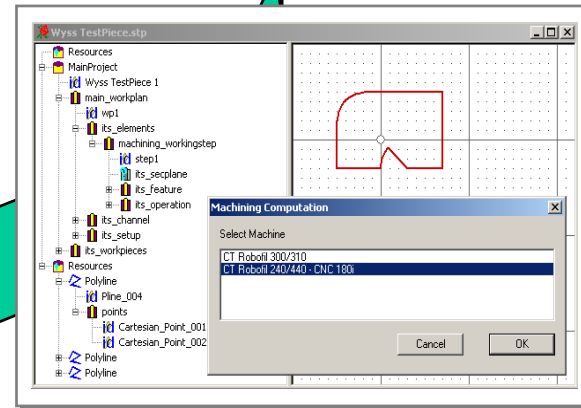
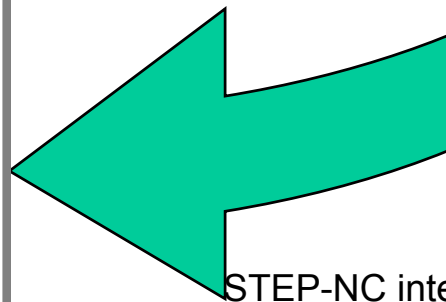
```

Wysa TestPiece3stp - file notes
Title: Edition: Final
ISO-10803-21:
HEADER:
FILE_DESCRIPTION('Test of wire EDM manufacturing','21');
FILE_NAME('Wysa TestPiece 3',$(Willy Haever),$(COMBINATION S.A.),$(SI-DEVELOPER wb),'');
FILE_SCHEMA('MACHINING_SCHEMA','WIRE_EDM_SCHEMA');
ENDSEC;
$Date:
$10=CIRCLE('Circle_000',807,7,5);
$11=CIRCLE('Circle_000',809,7,5);
$12=TRIMMED_CURVE('Trimmed Curve_000',810,(806),(807),.1,.);
$13=TRIMMED_CURVE('Trimmed Curve_000',811,(806),(805),.1,.);
$14=POLYLINE('PLine_000',$(808,809));
$15=POLYLINE('PLine_000',$(808,809,808,805));
$16=POLYLINE('PLine_000',$(806,807,808));
$17=COMPOSITE_CURVE_SEGMENT($,f.,816);
$18=COMPOSITE_CURVE_SEGMENT($,f.,817);
$19=COMPOSITE_CURVE_SEGMENT($,f.,815);
$20=COMPOSITE_CURVE_SEGMENT($,f.,813);
$21=COMPOSITE_CURVE_SEGMENT($,f.,810);
$22=SLUG_REMOVE($);
$23=WIRE_EDM_MACHINING_OPERATION($,'roughing',822,$,808,824,825,830,0.01,820,829,841,842);
$24=WIRE_TOOL('wire1',820,0.1,12,0,.);
$25=WIRE_EDM_TECHNOLOGY($,827,826);
$26=DESCRIPTIVE_PARAMETER('Technolable','02258');
$27=DESCRIPTIVE_PARAMETER('Setting','501');
$28=LINEAR_STRATEGY($);
$29=LINEAR_STRATEGY($);
$30=WIRE_EDM_MACHINE_FUNCTIONS($,f.,f.,f.,f.);
$31=CHANNEL('channel_1');
$32=MATERIAL('Steel',$);
$33=MATERIAL('Fsga',aaa,$);
$34=SETUP('workplanSetup',$,$,835);
$35=WORKPIECE_POSITION(800,800,$);
$36=AXIS2_PLACEMENT_3D('placement_1',809,$,$);
$37=AXIS2_PLACEMENT_3D('Position of Circle_000',805,$,$);
$38=AXIS2_PLACEMENT_3D('Position of Circle_000',809,$,$);
$39=CARTESIAN_POINT('origin_1',(7,5,7,5,0,));
$40=CARTESIAN_POINT('cut',(-12,5,0,0,));
    
```

STEP-NC file
ISO 14649



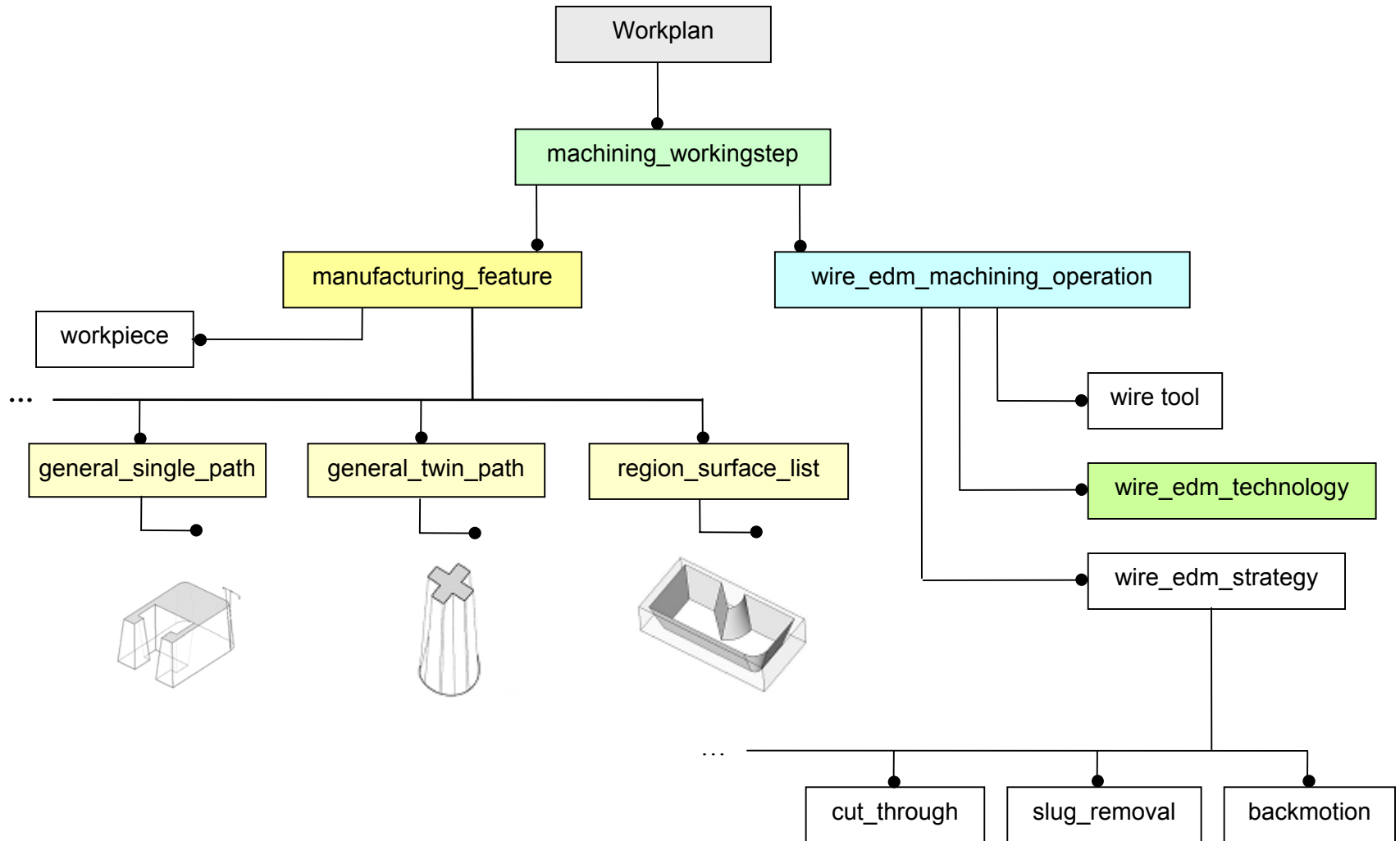
Charmilles ROBOFIL 430



STEP-NC interface **TestEDM** prototype software **EPFL**

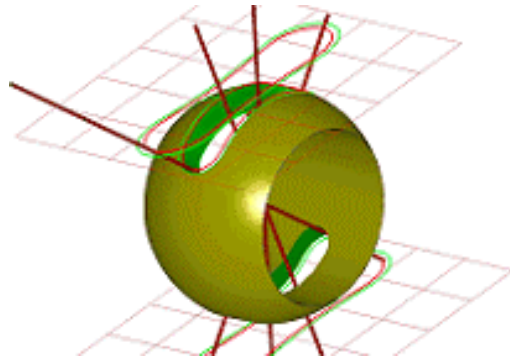
Source :
Cadcamation,
EPFL

Standardization: Data Model Wire-EDM

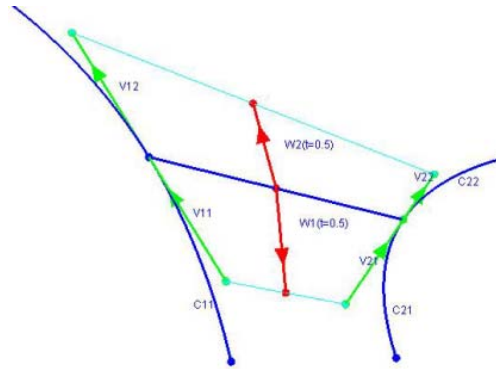


Application wire-EDM: Implementing new geometrical features

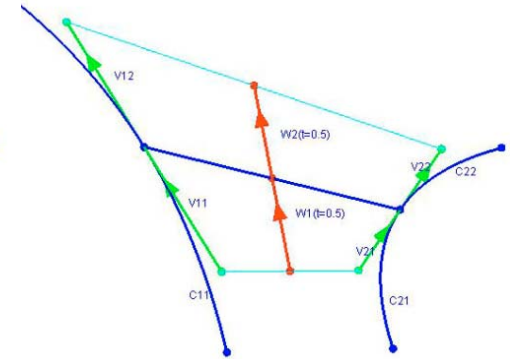
● Use of ruled surfaces features



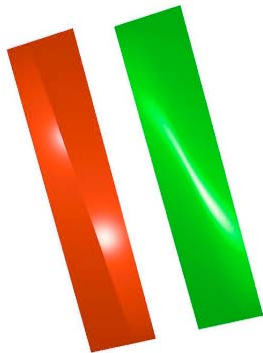
Example of 3D offset calculation



Surface continuity condition not satisfied



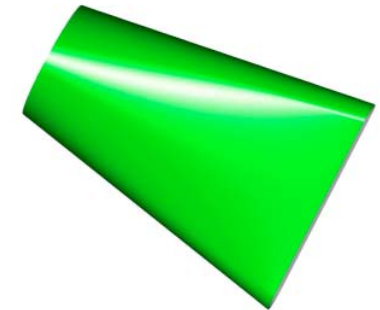
Surface continuity condition satisfied after re-parametrisation



Example of tangent transition on ruled surfaces



Tangent discontinuity up to 12.0 degrees with uniform parameterization



Tangent continuity with non-uniform parameterization

More information?

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