

Standardisation of the Manufacturing Process : the STEP-NC project

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STEP

- STEP (*ST*andard for *E*xchange of *P*roduct *D*ata) 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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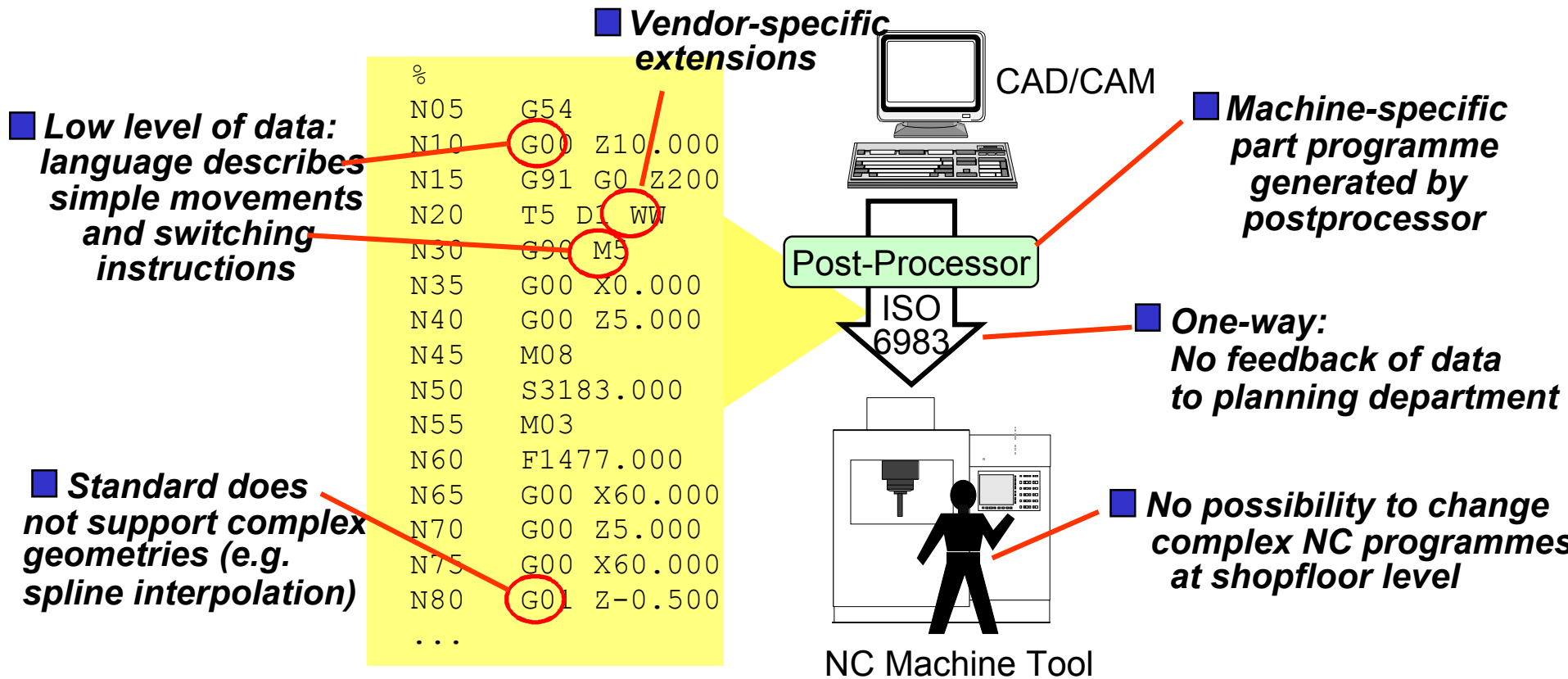
ISO 6983

- 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



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

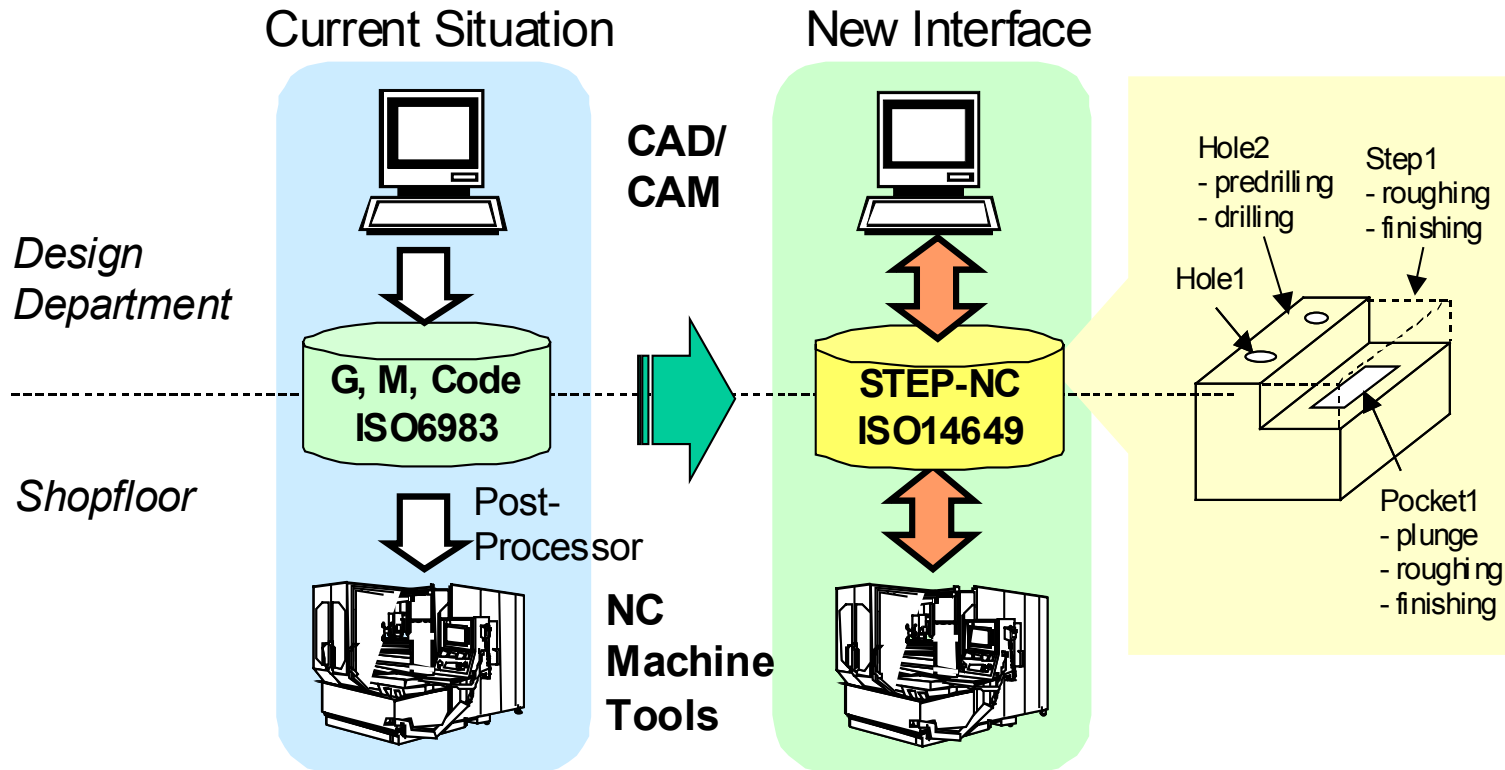
Source : WZL

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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



Source : WZL

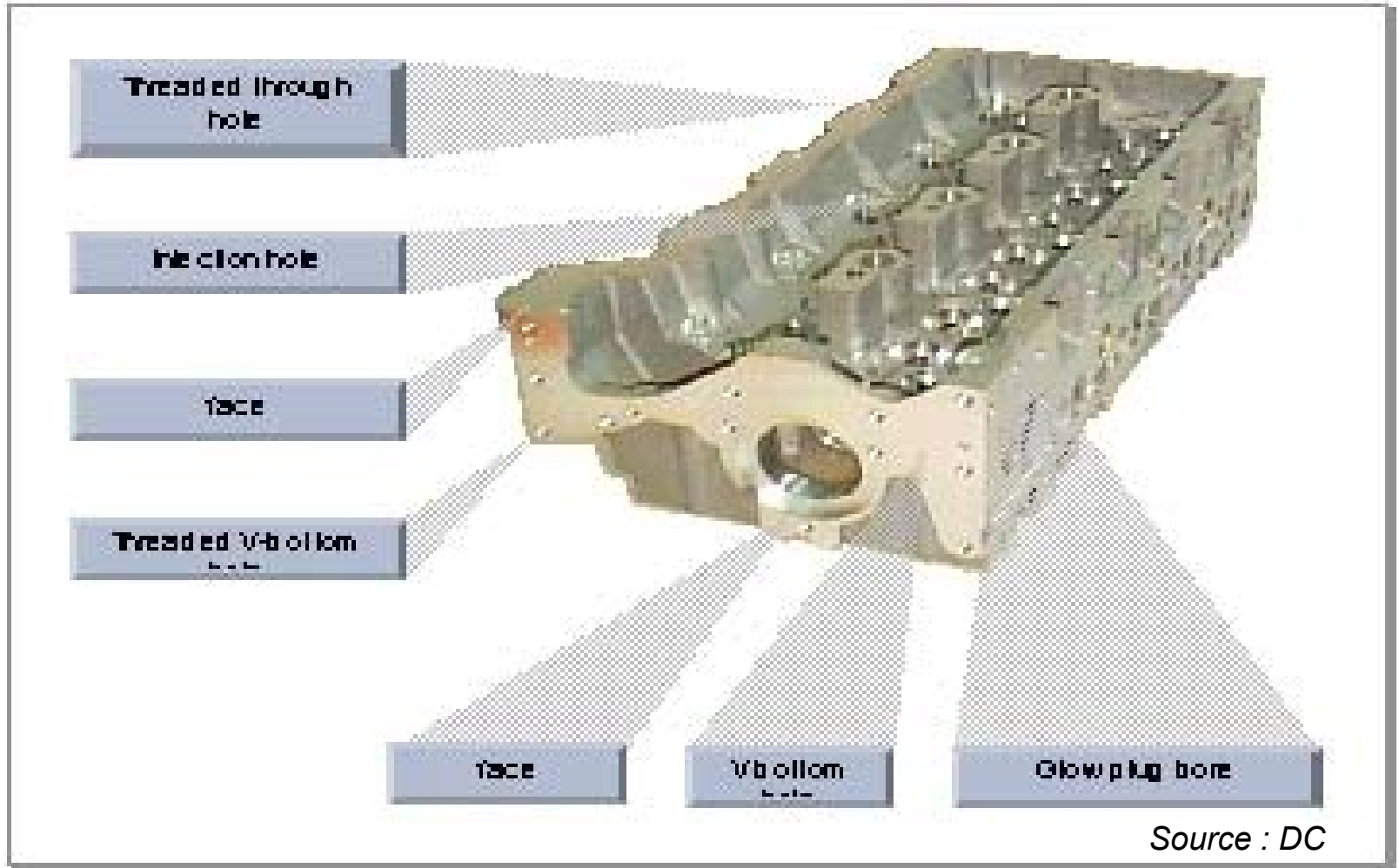
The New Interface : STEP-NC (ISO 14649)

- 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



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));
```

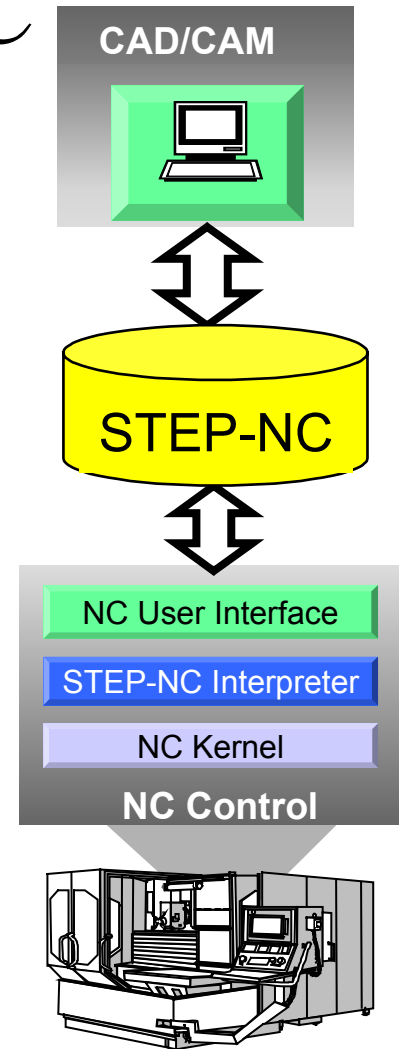
.

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

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

Benefits of STEP-NC

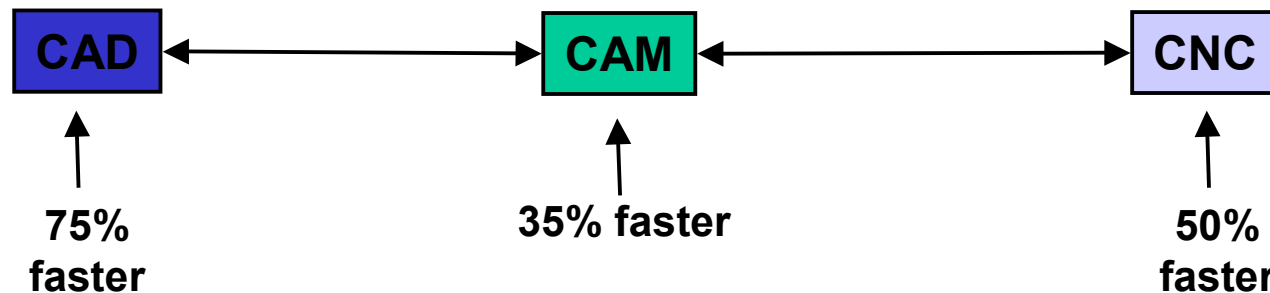
- A closed process chain from CAD to CNC
- No geometry programming
- No post-processing
- A complete product model in the CNC
- Easy editing at the shop floor
- Upload of CNC file and easy reuse
- An open solution, open for customers cycles
- Well suited to e-engineering



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)

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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

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)

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)

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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 with several dialog boxes open:

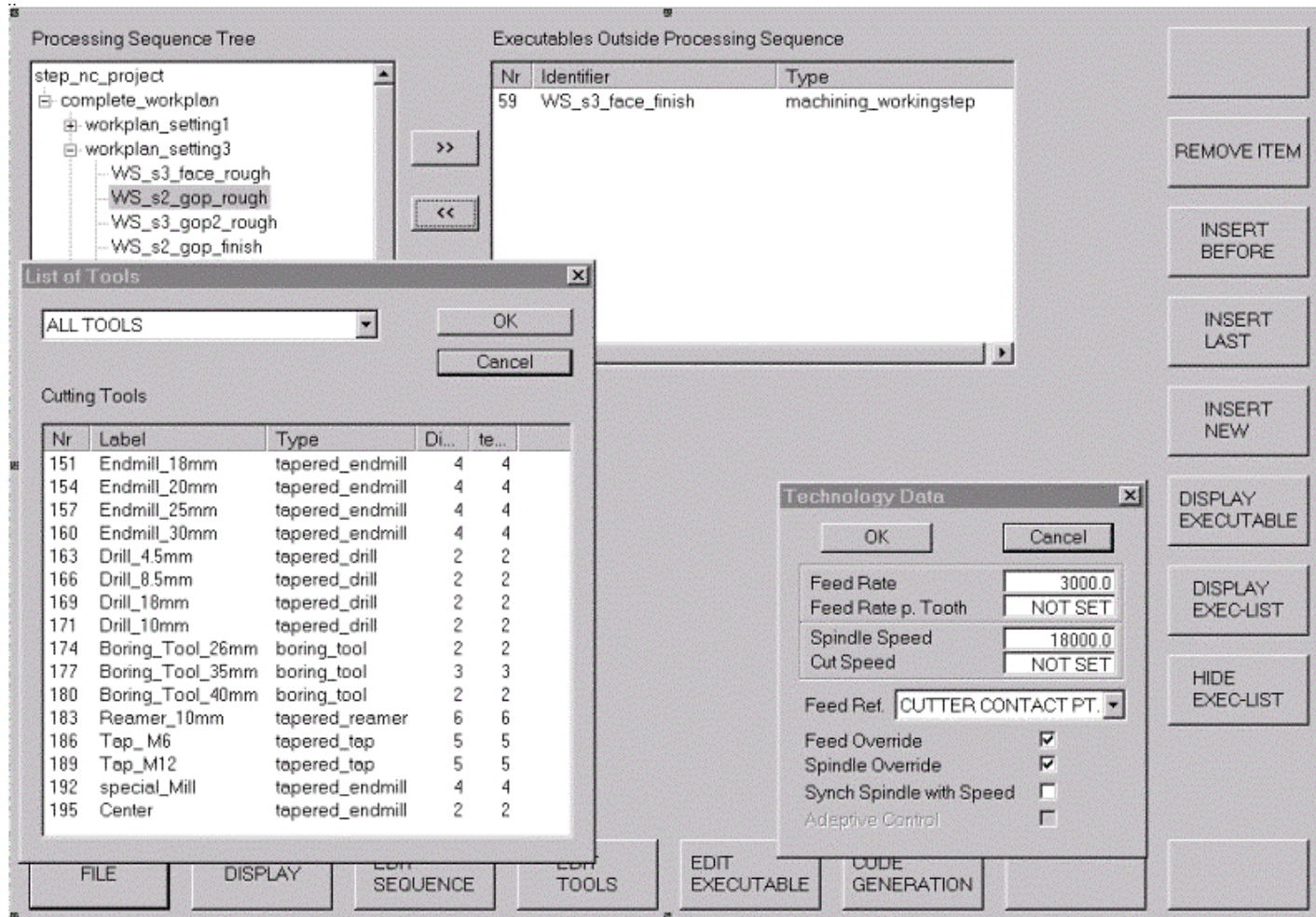
- Processing Sequence Tree:** A hierarchical list of worksteps. The workstep `WS_s3_holeM12_center` is highlighted with a red box.
- Center Drilling Workingstep - WS_s3_holeM12_center:** A dialog box for configuring a center drilling operation. It includes fields for Mach. Oper. (center_drilling), Manu. Feature (round_hole), Feed (3000.0), Spindle (18000.0), Coolant (ON), Z-Pos (0.00), X-Pos (0.00), Y-Pos (0.00), Z-Security (25.00), Tool (Center), Retract Plane (20.00), and Cutting Depth (2.00). A 3D model of a drill bit is shown with a diameter of 10.00.
- Replicate Feature - rectangular_pattern:** A dialog box for replicating a feature. It shows Feature (pattern_M12) and coordinates (Z-Pos: 33.00, X-Pos: 113.00, Y-Pos: 82.90). A table lists the locations for replication:

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

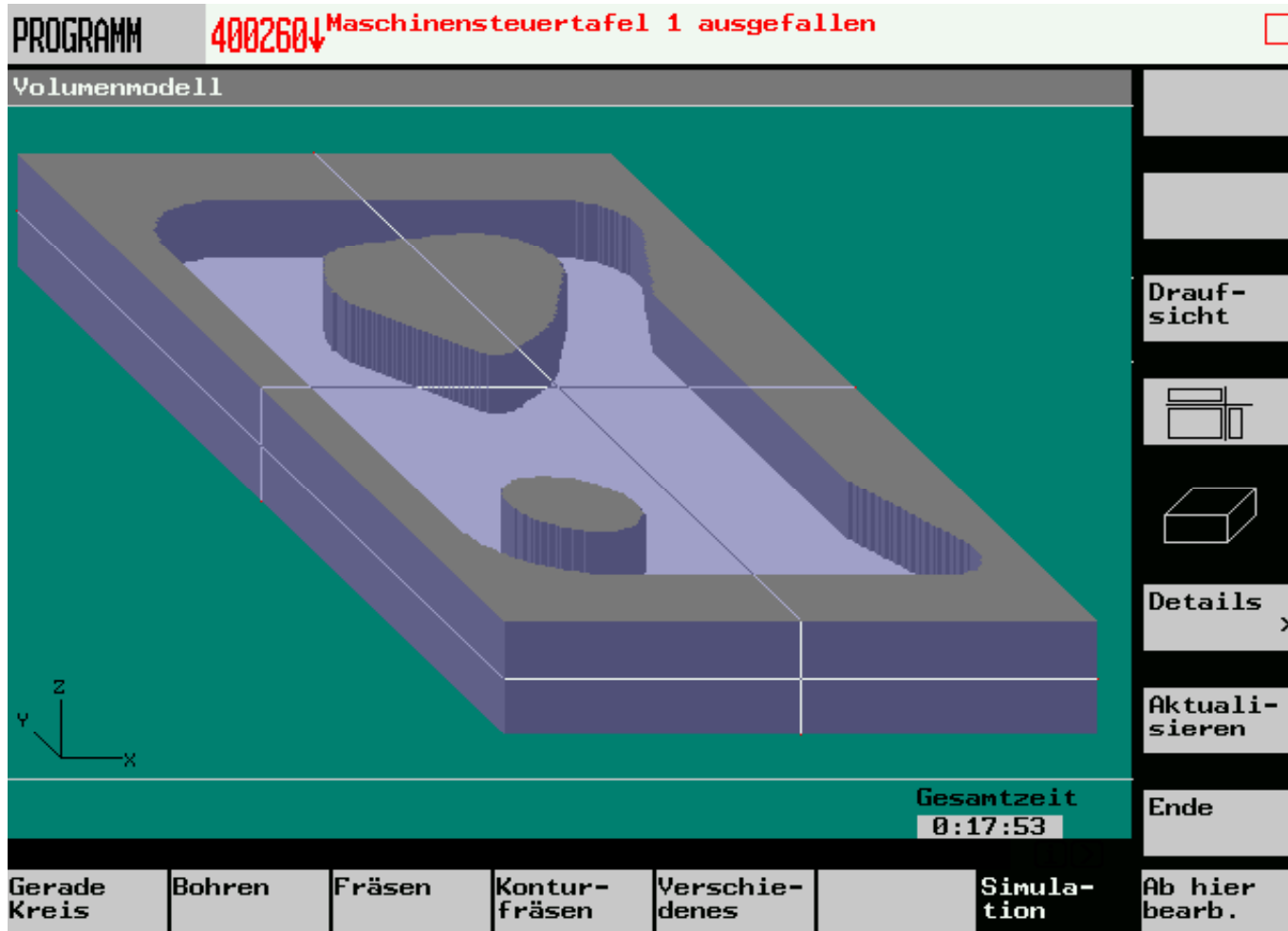
- Compound Feature:** A dialog box for creating a compound feature. It shows Feat. (compound_feature_M12) and Depth (30.00). Coordinates are Z-Pos (0.00), X-Pos (0.00), and Y-Pos (0.00).

At the bottom of the interface, there are buttons for FILE, DISPLAY, EDIT SEQUENCE, EDIT TOOLS, EDIT EXECUTABLE, CODE GENERATION, OPEN PROJECT, CLOSE, SAVE, and SAVE AS.

Tool display and sequence editor

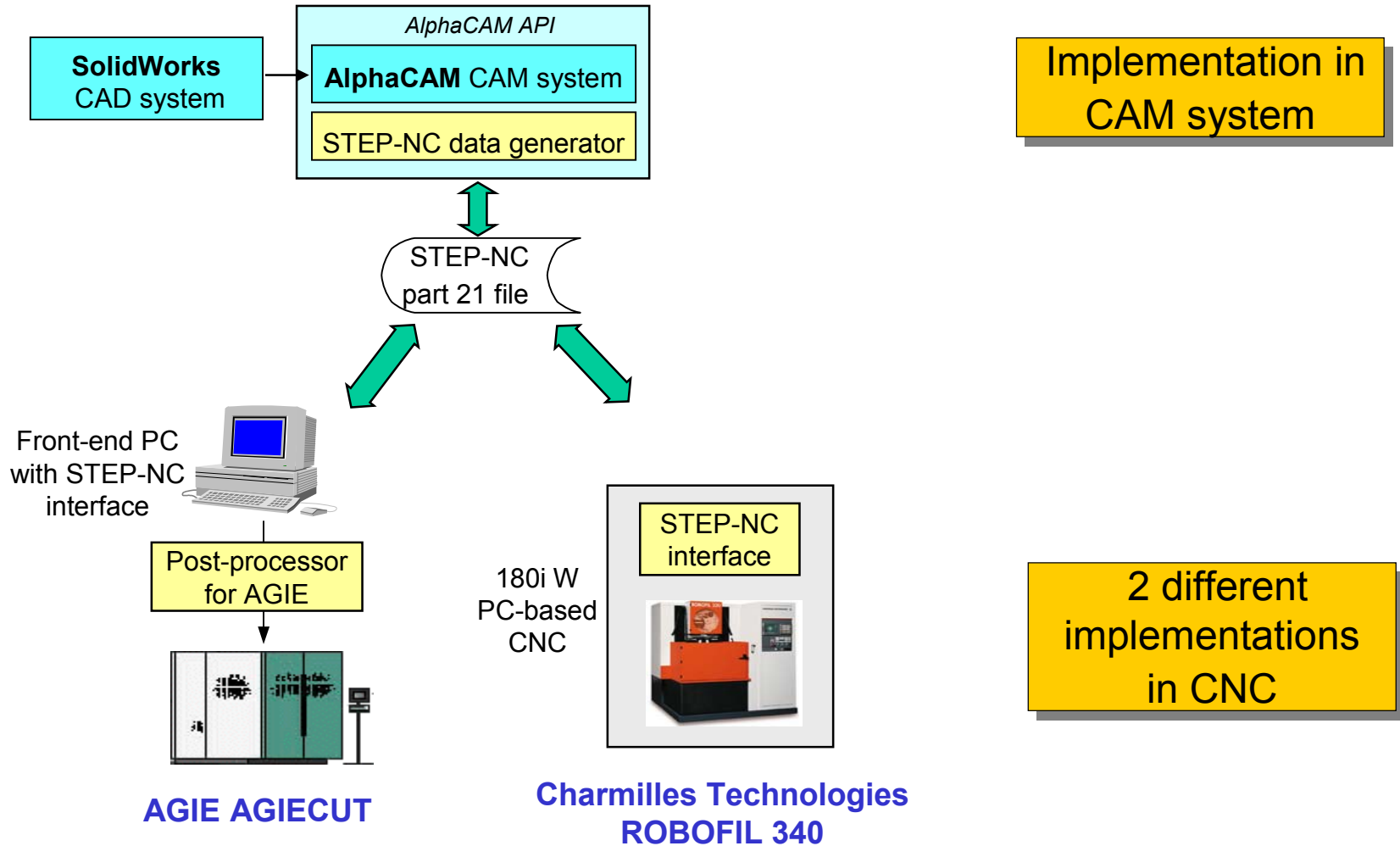


Simulation of pocketing



Source : Siemens

Prototype : Wire EDM

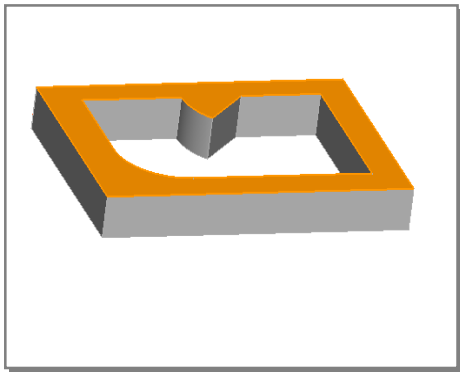


Source : Cadcamation, i-tech EIG

The new Wire EDM controller



Wire EDM results



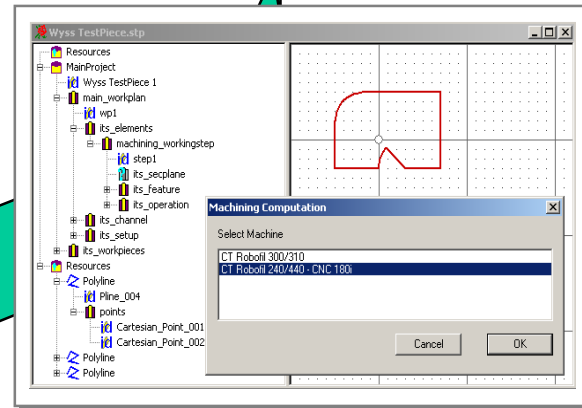
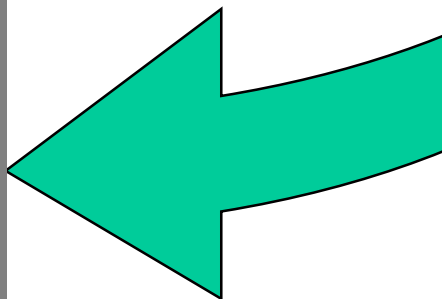
CAD system: SolidWorks
CAM system: AlphaCAM

```
Wyss TestPiece3.stp - file notes
ISO-1000-21:
HEADER:
FILE_DESCRIPTION('Test of wire EDM manufacturing','21');
FILE_NAME('Wyss TestPiece 3','Willy Haefliger','COMBINATION S.A.','SI-DEVELOPER v8','','');
FILE_SCHEMA('MACHINING_SCHEMA','WIRE_EDM_SCHEMA');
ENDSEC;
DATA:
#10=CIRCLE('Circle_000',807,7,5);
#11=CIRCLE('Circle_000',809,7,5);
#12=TRIMMED_CURVE('Trimmed Curve_000',#10,(#N4),(#N7),,1,);
#13=TRIMMED_CURVE('Trimmed Curve_000',#11,(#N4),(#N5),,1,);
#14=POLYLINE('PLine_000',(#N2,#N4));
#15=POLYLINE('PLine_005',(#N8,#N9,#N5,#1,#N2));
#16=POLYLINE('PLine_006',(#N6,#N7,#N5));
#17=COMPOSITE_CURVE_SEGMENT($,F,);
#18=COMPOSITE_CURVE_SEGMENT($,F,);
#19=COMPOSITE_CURVE_SEGMENT($,F,);
#20=COMPOSITE_CURVE_SEGMENT($,F,);
#21=COMPOSITE_CURVE_SEGMENT($,F,);
#22=SLUG_REMOVAL();
#23=WIRE_EDM_MACHINING_OPERATIONS($,'roughing',#22,$,#N4,#24,#25,#26,#,0,01,#29,#N1,#N2);
#24=WIRE_TOOL('wire',#23,0,1,12,0,);
#25=WIRE_EDM_TECHNOLOGY($,,$,#27,#26);
#26=DESCRIPTIVE_PARAMETER('Technolable',03258);
#27=DESCRIPTIVE_PARAMETER('Setting',501);
#28=LINEAR_STRATEGY($);
#29=LINEAR_STRATEGY($);
#30=WIRE_EDM_MACHINE_FUNCTIONS($,,$,,$,,$,,$);
#31=CHANNEL('channel',);
#32=MATERIAL('Steel',);
#33=MATERIAL('Fsga',aaa,);
#34=SETUP('setup/setup',,$,$,#35);
#35=WORKPIECE_POSITION(#N6,#36,$);
#36=AXIS2_PLACEMENT_3D('placement',1,#39,$,$);
#37=AXIS2_PLACEMENT_3D('Position of Circle_000',#N5,$,$);
#38=AXIS2_PLACEMENT_3D('Position of Circle_000',#N5,$,$);
#39=CARTESIAN_POINT('origin',1,(-7,5,7,5,0,));
#40=CARTESIAN_POINT('cst',(-12,5,0,0,));
```

STEP-NC file
ISO 14649



Charmilles ROBOFIL 430



STEP-NC interface
TestEDM prototype software

Source : Cadcamation, EPFL

More information?

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