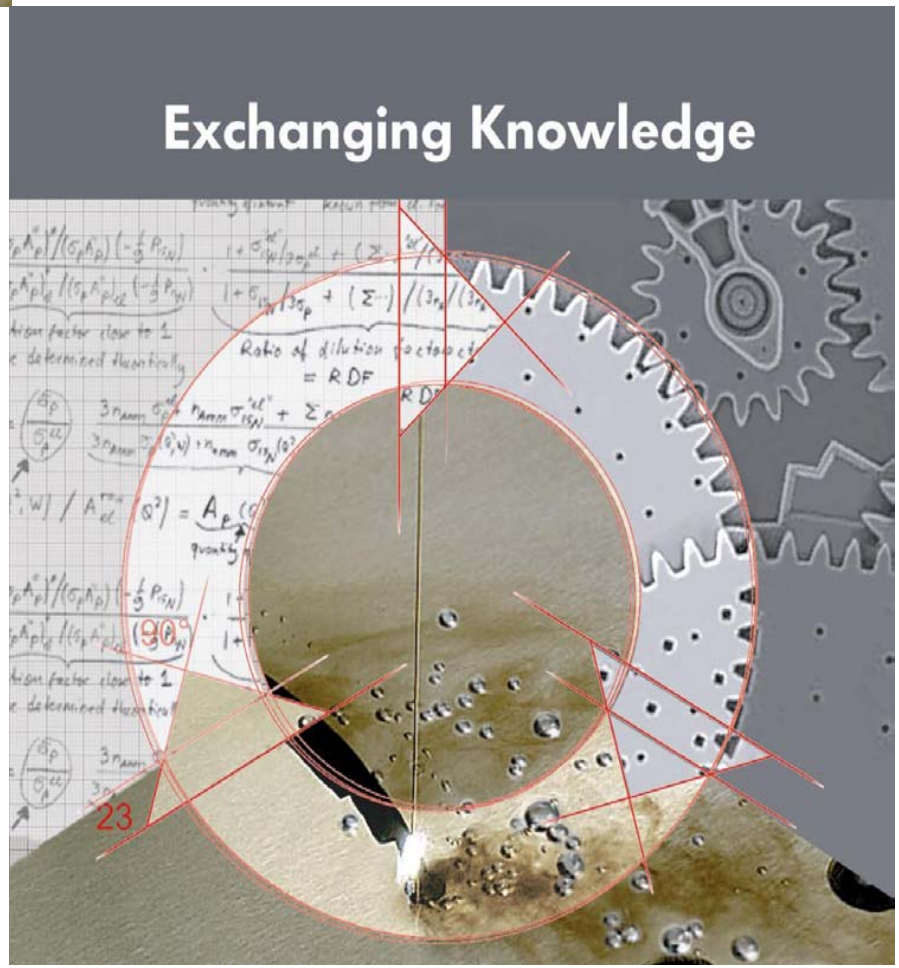
High-speed EDM / From CAD to Spark



step nc
IMS
INTELLIGENT MANUFACTURING SYSTEMS

STEP-NC DATA MODEL FOR WIRE-EDM MANUFACTURING

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EPFL, Switzerland

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EIG, Switzerland

STEP-NC DATA MODEL FOR WIRE-EDM MANUFACTURING

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The European STEP-NC consortium

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)

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The Swiss STEP-NC group

- AMT - Consulting
- CADCAMation – Software house
- Charmilles (AGIE) – Machine developers
- I-tech, EIG – Research
- STI-IPR-LICP, EPFL – Research
- Wyss SA – Machine tool user

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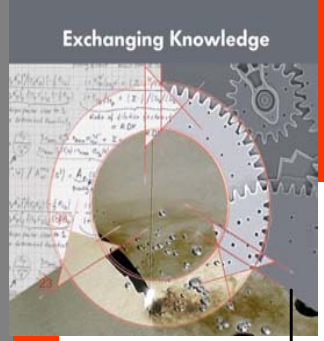


Project overview

Current situation

business level

shop-floor level

CAD/CAM

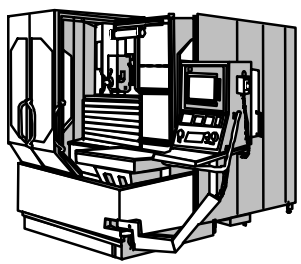
ISO 6983

Post Processer

Vendor specific ISO 6983

NC controller

NC machine



```
%
N05   G54
N10   G00 Z10.000
N15   G91 G0 Z200
N20   T5 D1 WW
N30   G90 M5
N35   G00 X0.000
N40   G00 Z5.000
N45   M08
N50   S3183.000
N55   M03
N60   F1477.000
```

- *Low-level information*
- *Simple movements and switching instructions*
- *Vendorspecific extensions*

New interface

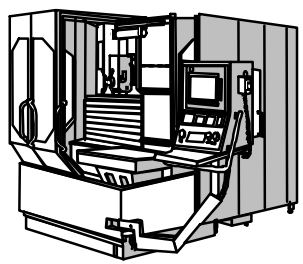
CAD/CAM

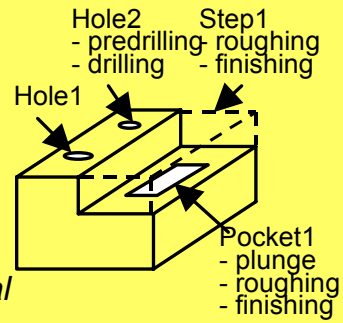
Bidirectional data flow

STEP-NC

NC controller

NC Machine






```
description{ filename=
    'ncfile.prg';
    date='20-01-1999';
}
const{placement1=
   axis2_placement_3d(..);
}
program()
{ set_placement(setup);
  exec plan.hole1drill;
  exec plan.pocket_plunge;
  exec plan.pocket_roughing;
```

- *High-level information*
- *Object-oriented description*
- *Use of STEP geometries*
- *Vendor-neutral*

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The three main objectives of STEP- NC for EDM?

Standardization of the data structure toward an integrated “digital” manufacturing company

(EDM is still a proprietary process, non-integrated to the shopfloor environment)

Optimization and security of the data flow

(EDM is still programmed through 2D data, and wire compensation is still approximated in 2D)

Intelligent on-line functions and performance improvements

(EDM is still difficult to use & to predict, & simulation is still poor)

Extending the Engineering Data Management integration & the Electro Discharge Machining capabilities

A. An International Standard for engineering data (geometry, topology, technology, …) and probably non-technical data (our vision)

- a **Product Lifecycle Management bus** for product description
- total **interoperability** "from art to part"
- flexibility for **customization** (global market)
- **cost reduction**...

B. Advanced functions for intelligent wire EDM CAM/SFP systems

- **breaking up the limits** of EDM technology (e.g wire cutting complex of ruled surface, nano-grinding of cutter, surface interpolation, …)

C. Feedback of NC modified programs

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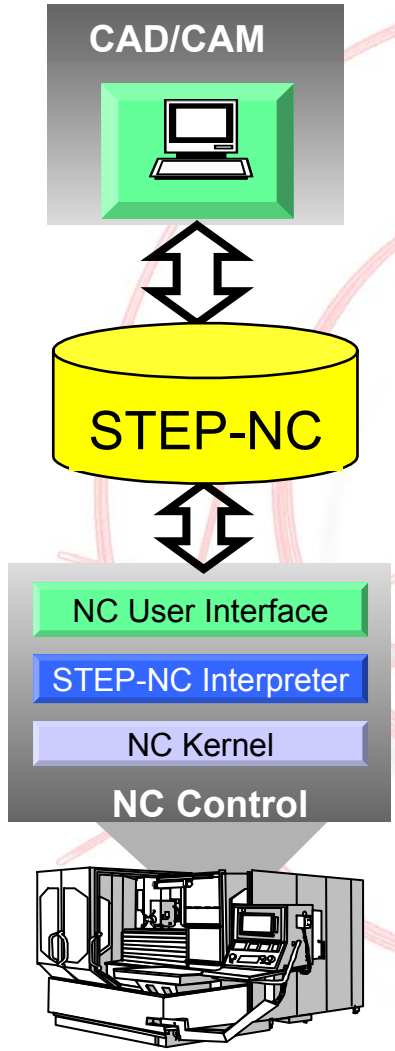
Benefits of STEP-NC

- 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



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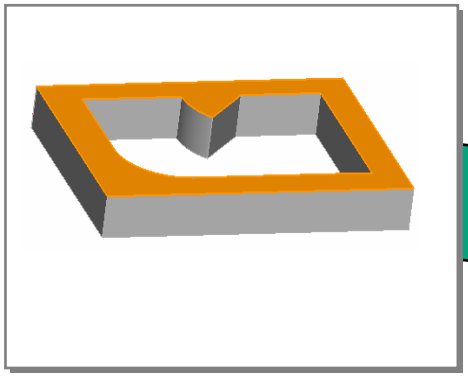
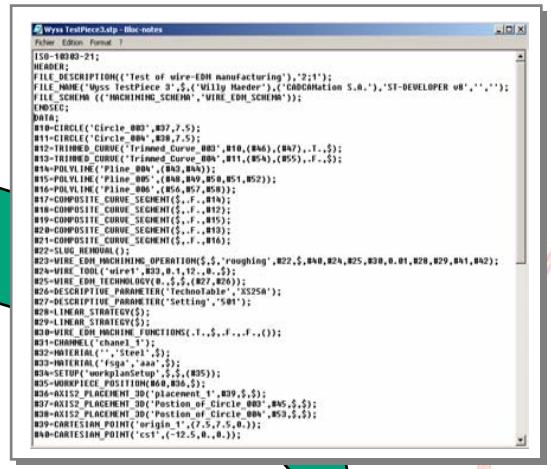
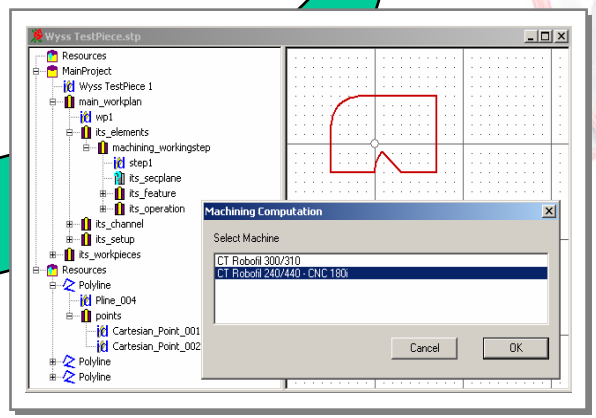
Wire EDM Process Chain



CAD system: SolidWorks
CAM system: AlphaCAM



STEP-NC file
ISO 14649



STEP-NC
interface

Charmilles ROBOFIL 440

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Achievements and directions

The first project succeeded in creating the initial EDM standard.

This is now in the process of being approved as an ISO standard

The second phase has the goal of exploiting the improved information level for intelligent manufacturing.

The initial algorithms have been determined and some experiments performed.

Improved algorithms at the controller level provides more information for machine operators to understand the geometry of the piece in the context of the manufacturing method.

The feedback mechanisms and handling algorithms are currently being defined.

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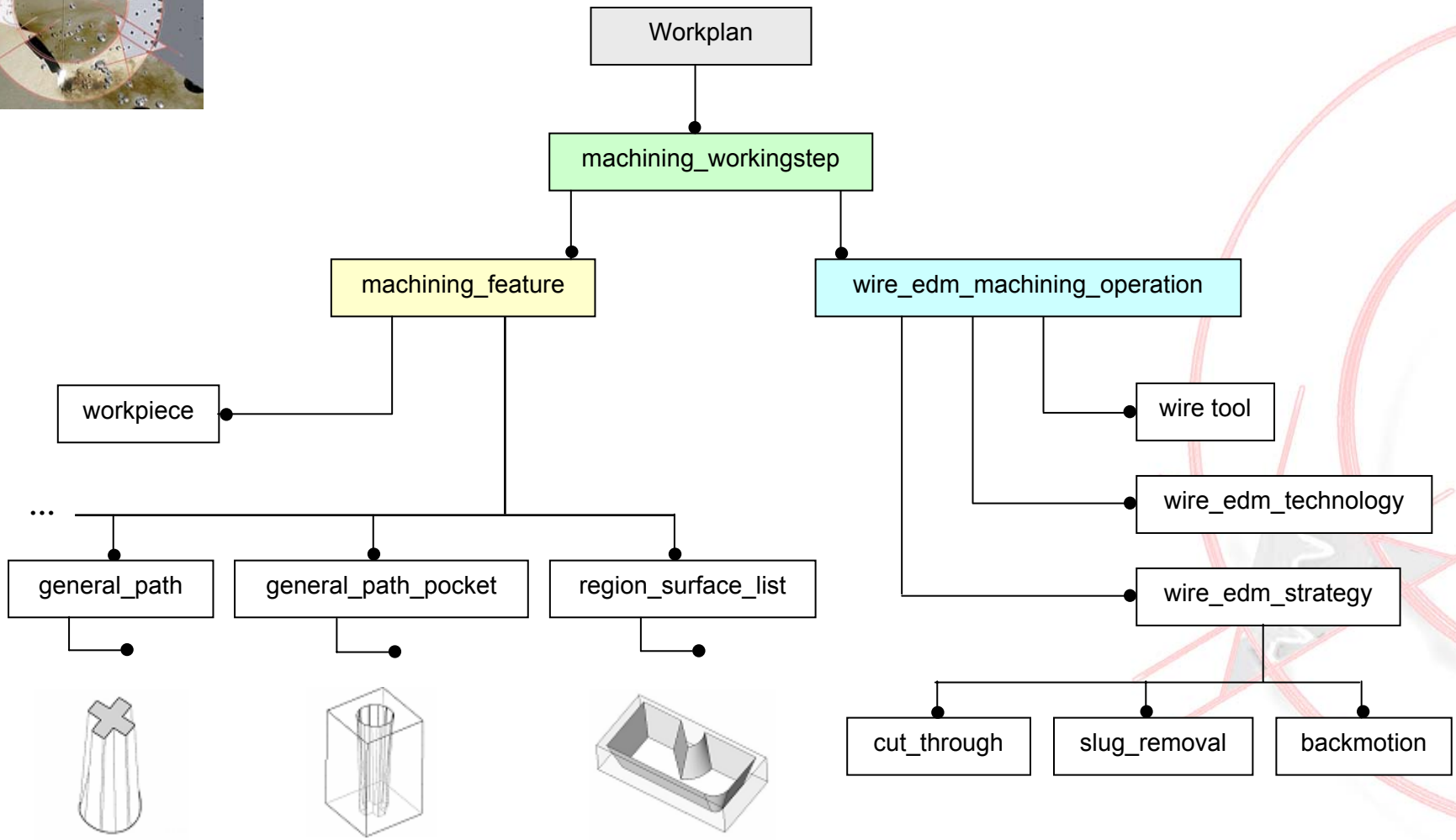
Wire EDM Data Model



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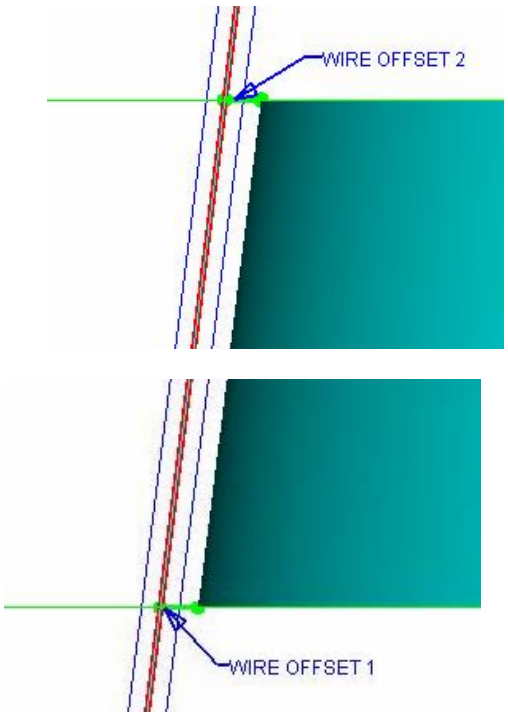
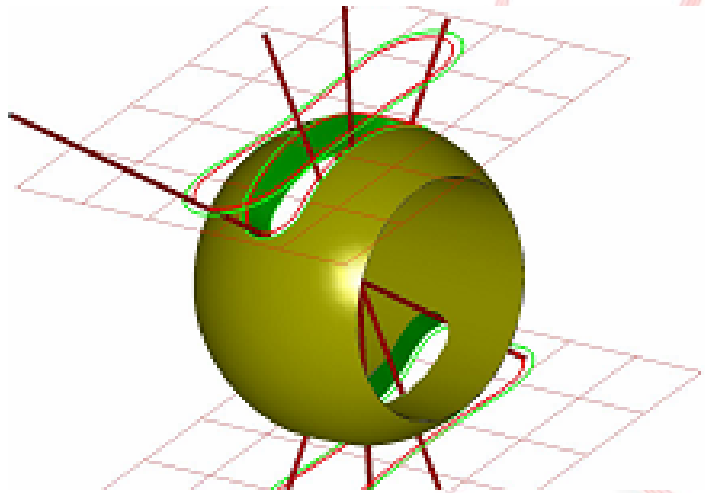
Advanced functions for wire EDM CAM/SFP systems

Wire offset calculation

Today : With the machining features described as two 2D contours in two planes (general_path), the wire offset is calculated in 2D with a constant distance.



Example in which this calculation is not applicable:



Geometrical features must be described by ruled surfaces

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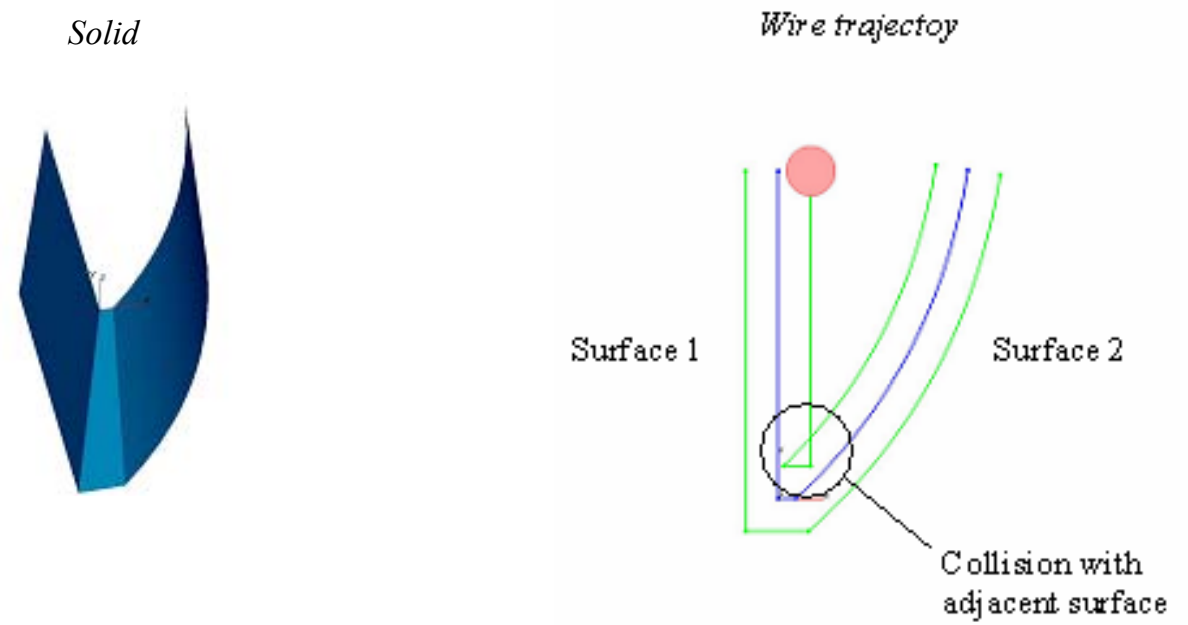
Advanced functions for wire EDM CAM/SFP systems

Collision detection of the wire with adjacent surfaces

Implementation of efficient collision detection and avoidance algorithms to generate the right offset wire path in order to generate the desired adjacent surfaces.



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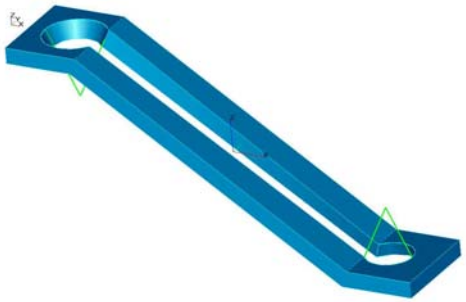
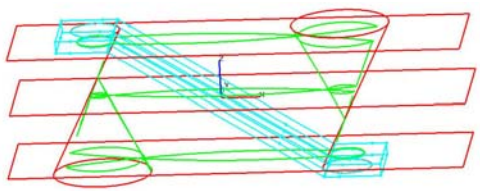
Intelligent functions for determining the path



- Instead of giving explicit paths it is possible to determine the paths from the faces to be cut.

- Full geometric description provides a basis for adapting control strategies to the capabilities and potentials of the machine.



- Control information evolves with the machine, reducing the time lag needed for CAM systems to catch up with developments.

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Feedback of modified NC programs for wire EDM

CAD/CAM 1

CAD/CAM 2

STEP-NC OODB

STEP-NC Server

STEP-NC format

EDM machine 1

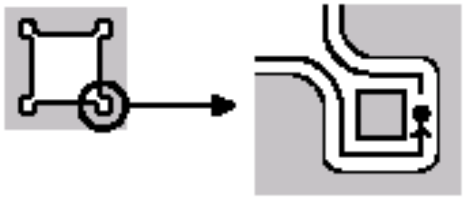
EDM machine 2

SFP system 1

EDM machine 3

SFP system 2

Managing user modifications



Path modification necessary

The small square should be totally eroded to prevent machining problems

- In EDM it is sometimes necessary to change toolpaths to avoid problems or to perform experiments with different parameters in order to get the desired result.
- Feedback allows operators to feed path changes back to the CAM system.
- Feedback also provides a tool for recording the history of part manufacture for subsequent analysis.

A STEP-NC scenario for the future

CAD

CAM

Technologies Cutting Tools

Technologies Cutting Tools

bi-directional

step nc

<WORKPIECE>
<ID>Test Part 2</ID>
. . .
</WORKPIECE>….

XML (WWW)

EXPRESS (STEP P21)

XML (WWW)

EXPRESS (STEP P21)

#1=WORKPIECE(. . .);
#2=SETUP(. . .);
#3=ROUND_HOLE(. . .);
#4=CUTTING_TOOL(. .);
. . .

Machine 1

Machine 2

Machine 3

Machine 4

Shop floor A

Shop floor B

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