

KTH Royal Institute of Technology

School of Industrial Engineering and Management

Department of Production Engineering

Computer Systems for Design and Manufacturing



**KTH Industrial Engineering
and Management**



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M.Sc., Ph.D Student

KTH, Royal Institute of Technology

Computer System for Design and Manufacturing



Machinist background

Employed at Scania since 1998

During 4 year worked with machining process optimizing and cutting tool evaluation at Scania.

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B.Sc., Ph.D Student

KTH, Royal Institute of Technology

Computer System for Design and Manufacturing



Machinist background

Has worked as CNC-operator and manufacturing engineer for about 10 years before entering studies at KTH. Graduated for B.Sc. in 2001 and after that working with education at KTH in the area of manufacturing engineering.



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About KTH, Computer System for Design and Manufacturing

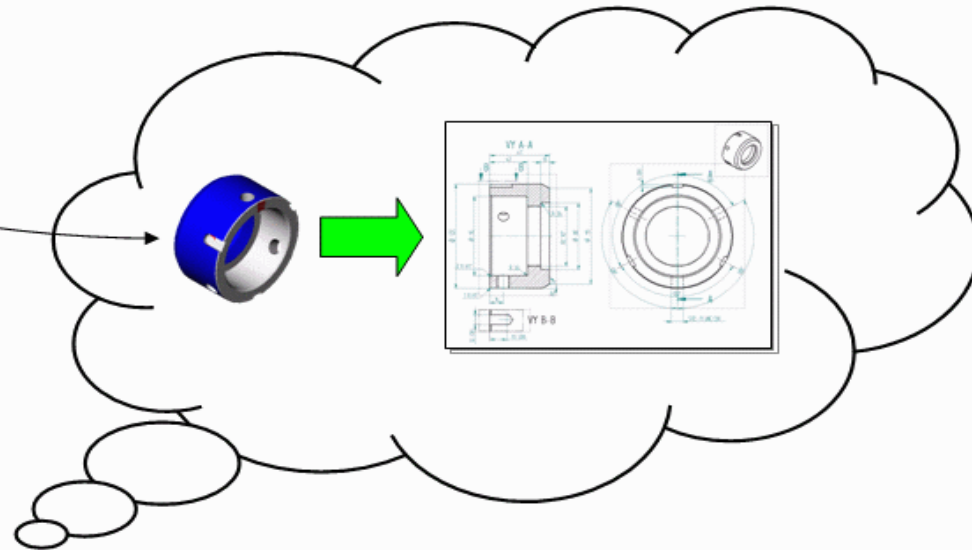


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- Computer System for Design and Manufacturing at KTH has since the late 1970-s been involved in research and development in the area of solid modeling and information modeling and its applications for design and manufacturing
- We have since the very beginning of the STEP standard being involved in its development and the development of other related standards
- During the recent years we have been deeply involved in the development of the ISO 13399 Standard for cutting tool data representation and exchange in close cooperation with Sandvik and Kennametal
- At present we are working with ISO 10303-238: STEP-NC and ISO 10303-239: PLCS concerning how to utilize these standard for expressing manufacturing knowledge through models of product, processes and resources

The main information carrier since...

The revolutionary idea



In 1801 Gaspard Monge wrote "**La Geometrie Descriptive**" as the first treatise on modern engineering drawings. Here he presented the **revolutionary** idea of projecting views of an object onto three planes and also add size specifications to the shape descriptions (NIST, The Grand Experience)

Monsieur Gaspard Monge

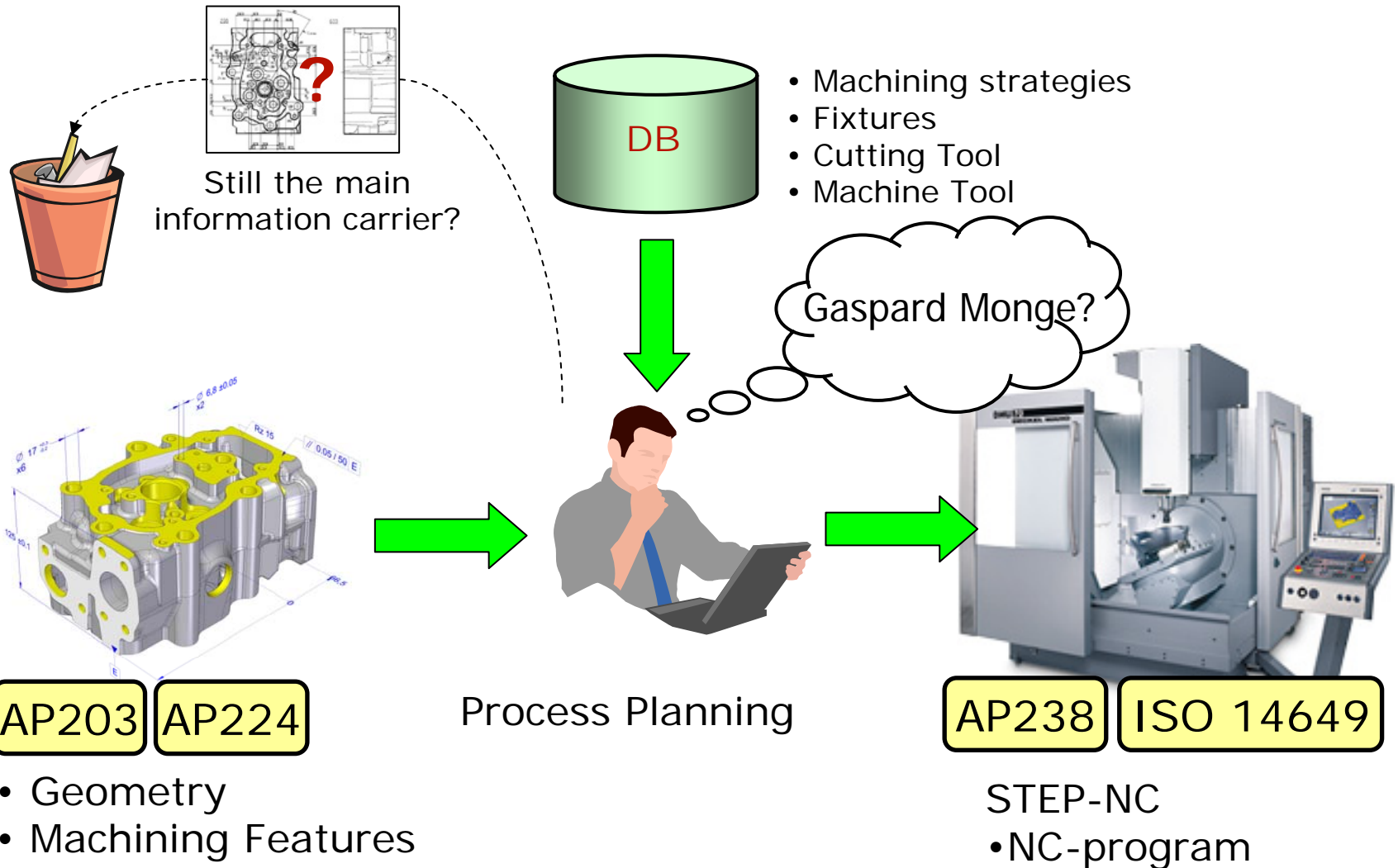


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Model-driven parts manufacturing



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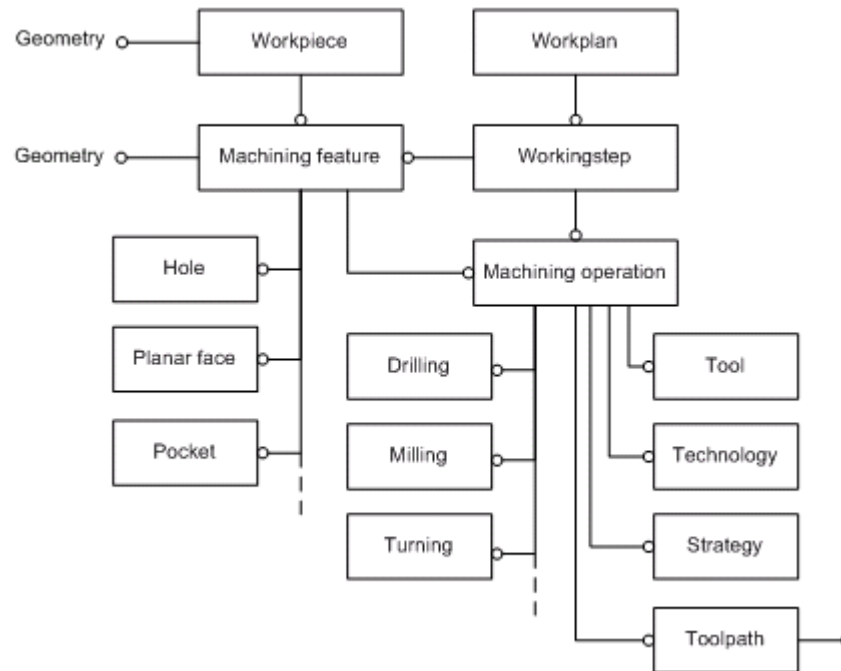
STEP-NC, a feature based concept

STEP-NC describes

- How to make this geometry from this part...
- by removing these "features" ...
- in this order...
- and with tools that fulfils these requirements.



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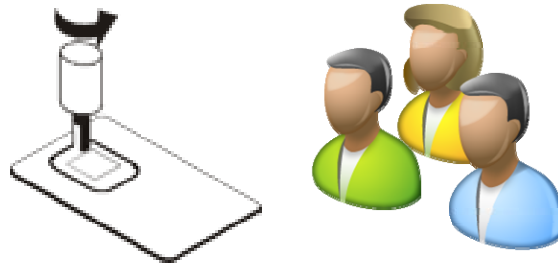
The **Workplan** defines a sequence of **Workingsteps** which associates a certain machining feature with an **Machining Operation**, which in turn describes which type of tool and machining process (drilling, milling, turning etc) that shall be used and its associated strategy.

STEP-NC implementation goals at KTH

- Make information transparent to operator
- Create understanding
- Motivate
- Enable “right from me”
- Enable feedback upstream



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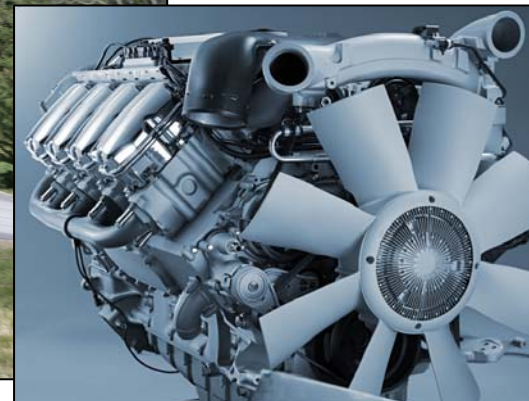
**STEP-NC implemented in a CNC
controller at Scania
(integrated front-end application)**



Case study: STEP-NC applied in heavy truck manufacturing

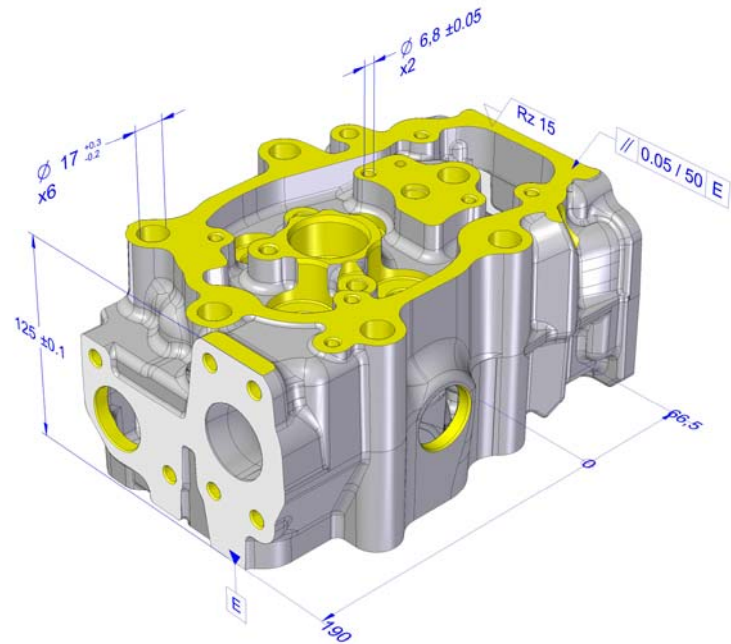


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Case: Scania Cylinderhead

- Typical powertrain component
- Pearlitic cast iron, 210 HB
- 450 000 produced cylinderheads during year 2007
- Machining features
 - Planar face
 - Hole
 - Thread hole
- Machining operations
 - Planar mill
 - Drill
 - Ream
 - Threading



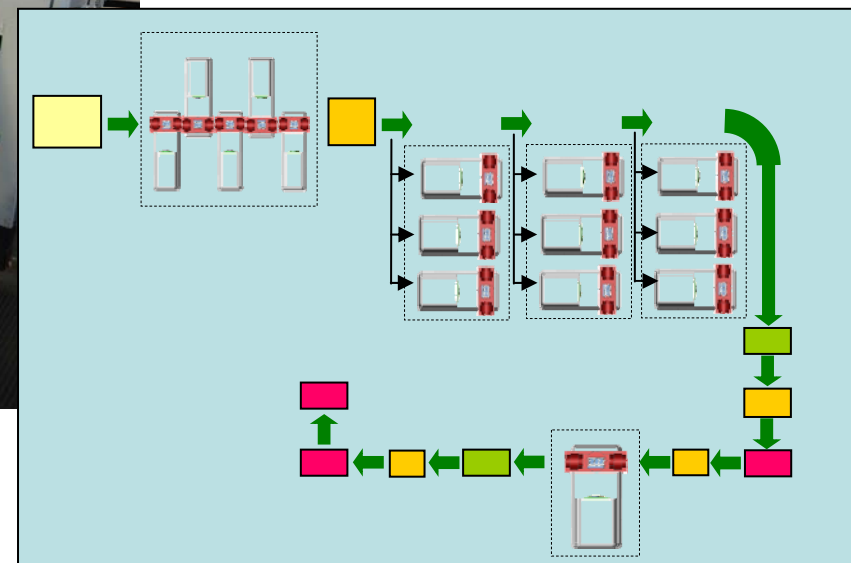
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Case: Scania Cylinderhead

- Machining line with several operations
- Work instructions are important



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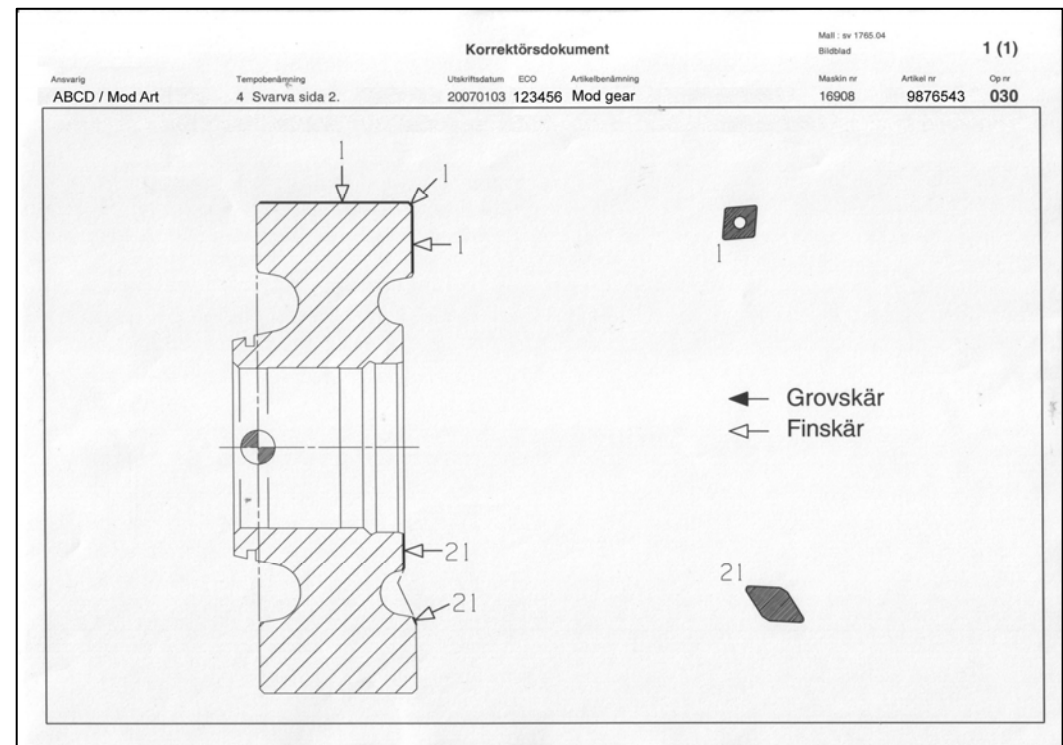
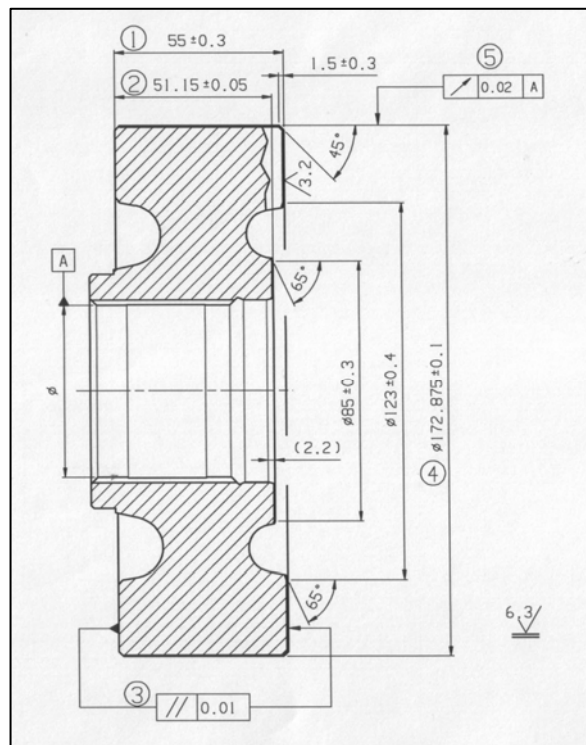


Machining descriptions

- Communicates important process information
- Creation and maintenance is time consuming, even when having an more automated creation process
- Describes the part at different stages of the manufacturing process
- Relationships between toleranced surface and used cutting tool



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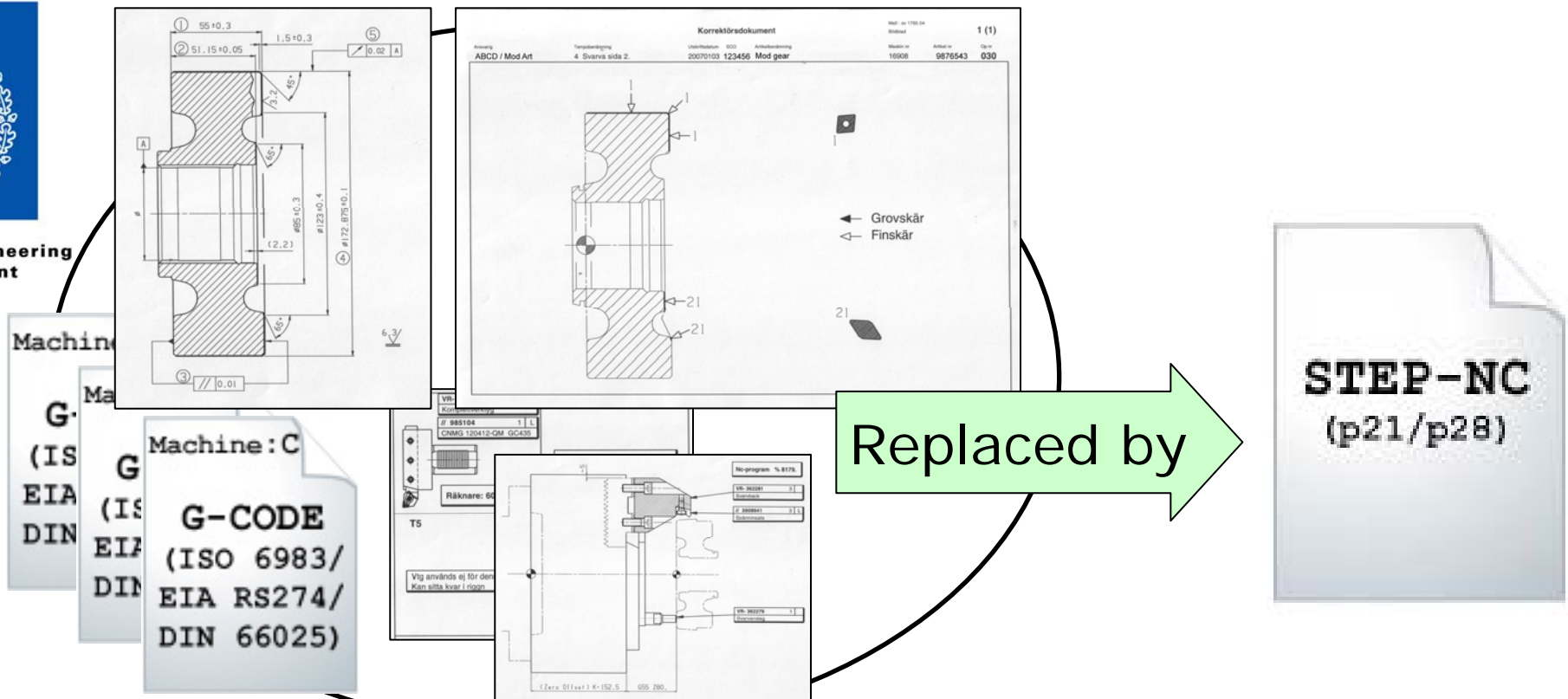


STEP-NC data

- STEP-NC is one coherent data source intended to replace today used expensive solutions
- No need for expensive and early information separation, generation and maintenance of documents



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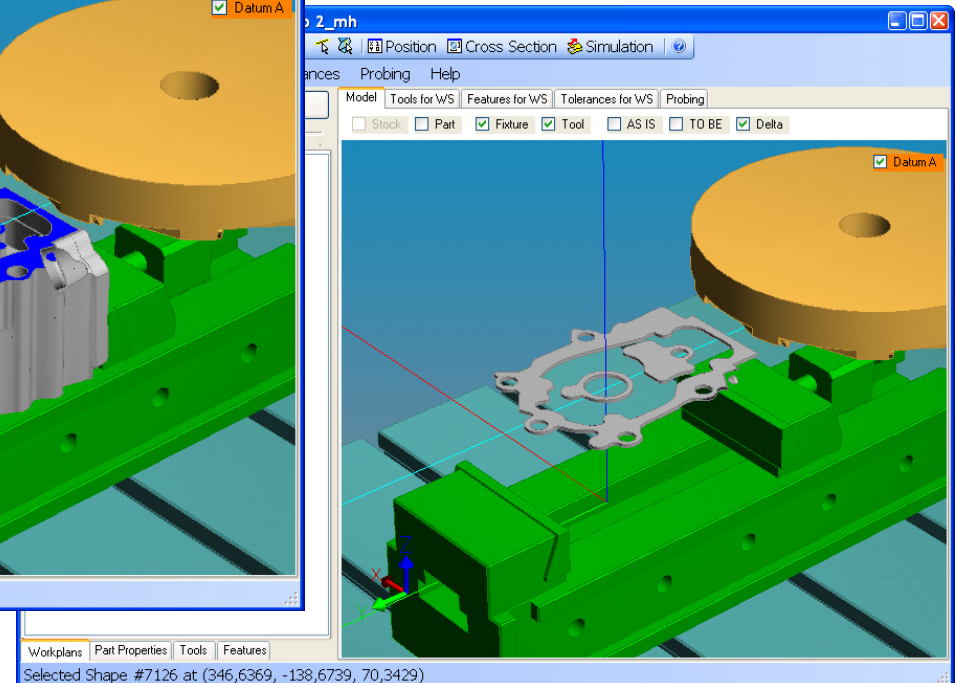
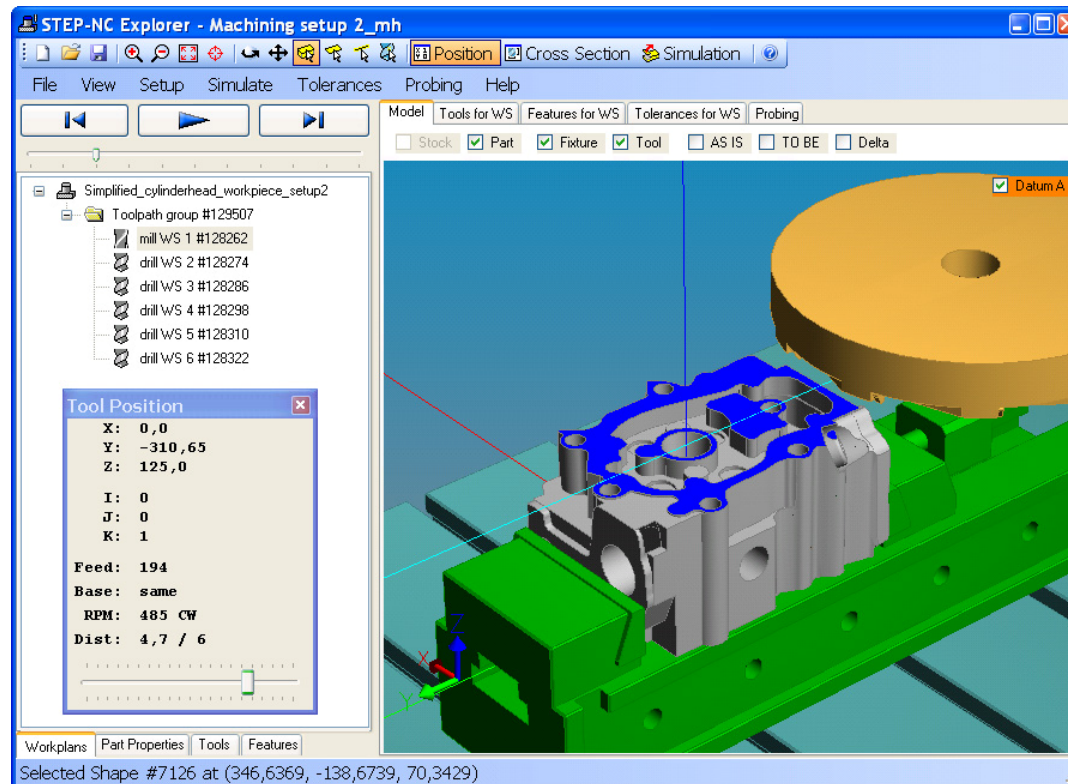


Machining description as a view of STEP-NC data

- Machining workplans and workingsteps
- Toolpath geometry with cutting speed and feed data
- Cutting tool and fixture models
- In-process geometry models of As-Is, To-Be and Removal volume



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Machining description as a view of STEP-NC data

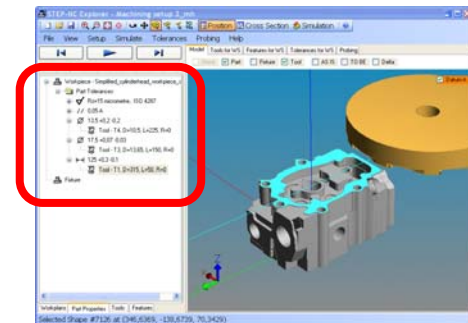
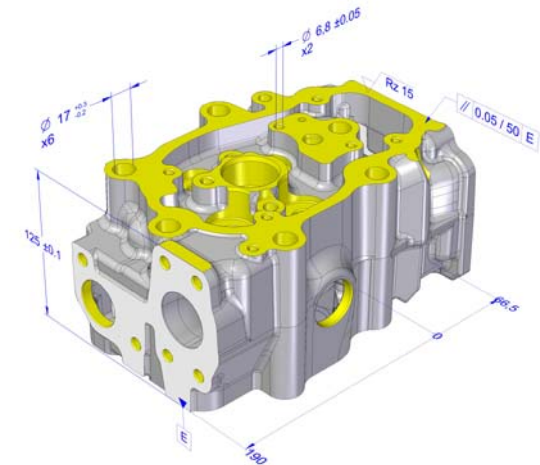
Part centric view

- STEP GD&T representation data
- Relationship between toleranced surface and used cutting tool



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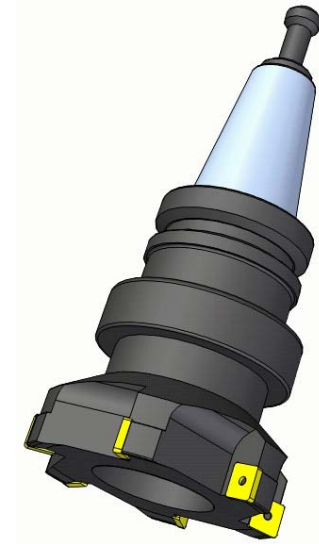
- [-] Workpiece - cylinderhead_workpiece
 - [-] Part Tolerances
 - + ✓ Rz=15 micrometre, ISO 4287
 - + // 0,05 A
 - = ∅ 13,5 +0,2 -0,2
 - Tool - T4, D=10,5, L=225, R=0
 - = ∅ 17,5 +0,07 -0,03
 - Tool - T3, D=13,65, L=150, R=0
 - = || 125 +0,3 -0,1
 - Tool - T1, D=315, L=50, R=0



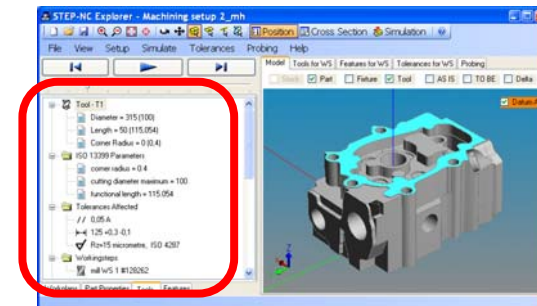
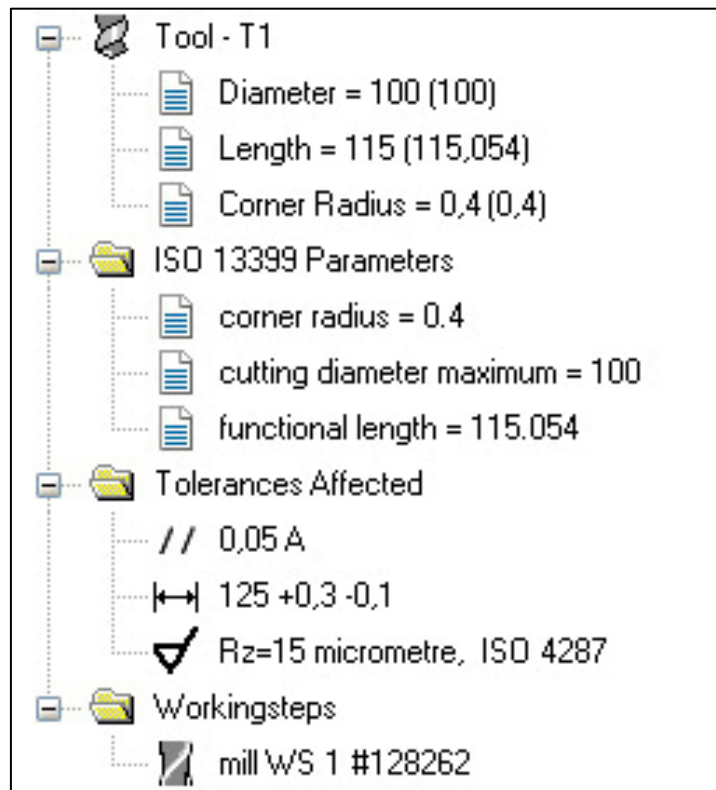
Machining description as a view of STEP-NC data

Tool centric view

- Cutting tool parameters, ISO13399
- Tolerances affected
- Used in workingsteps



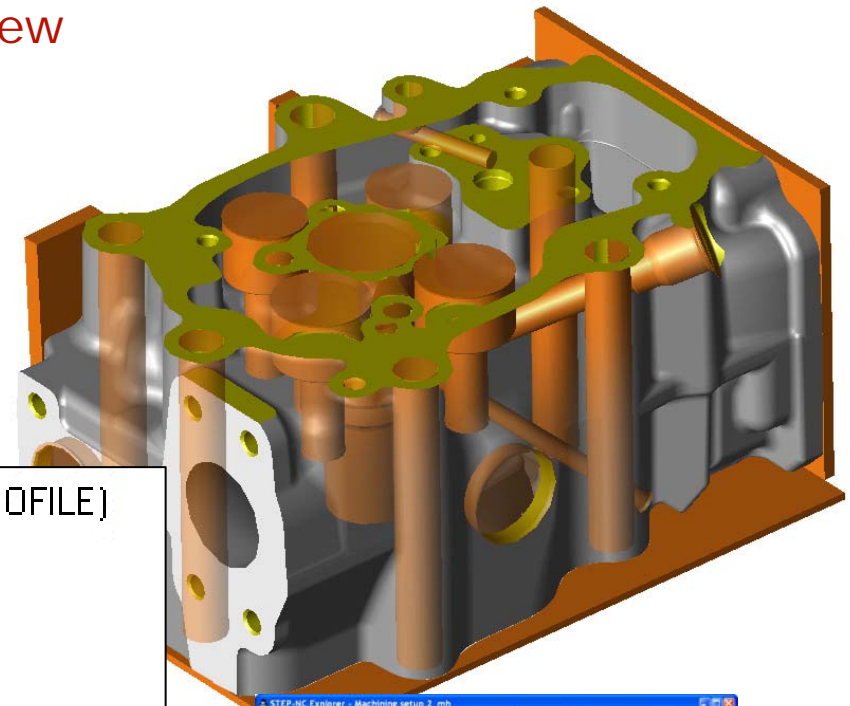
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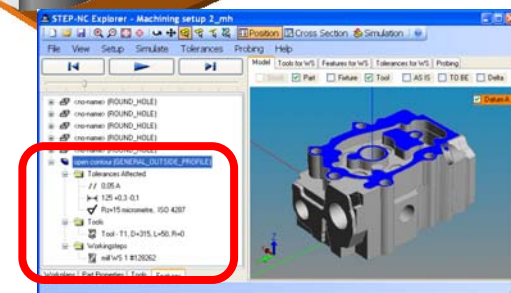
Machining description as a view of STEP-NC data

Manufacturing feature centric view

- Tolerances
- Used tools
- Workingsteps



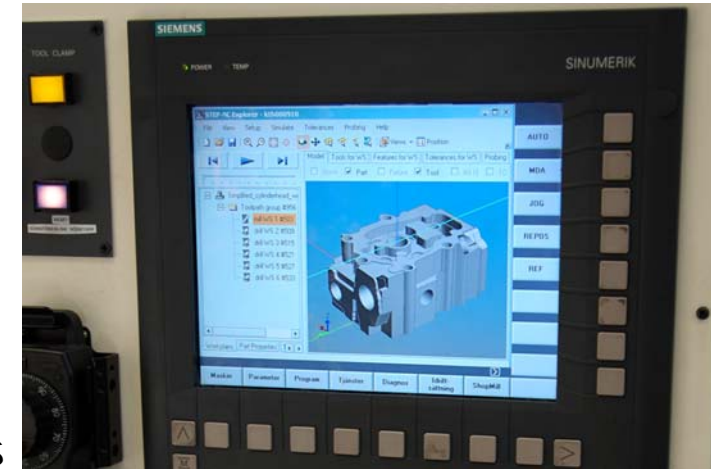
```
open contour (GENERAL_OUTSIDE_PROFILE)
├── Tolerances Affected
│   ├── // 0,05 A
│   ├──  $\pm$  125 +0,3 -0,1
│   └──  Rz=15 micrometre, ISO 4287
├── Tools
│   └──  Tool - T1, D=315, L=50, R=0
└── Workingsteps
    └──  mill WS 1 #128262
```



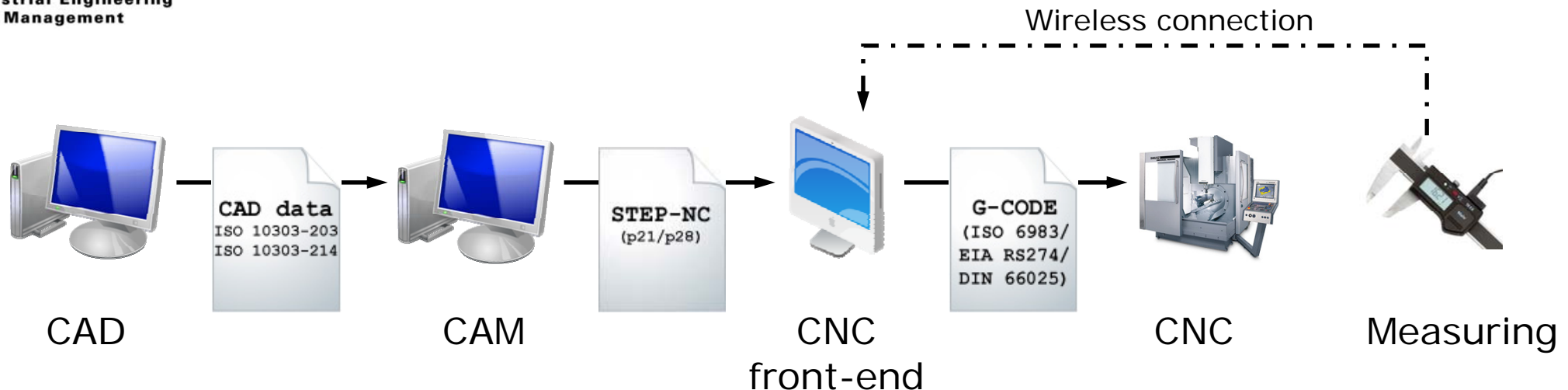
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Scania case study

- CAD data with GD&T representation
 - ISO 10303-214 (ed3)
- CAM data with manufacturing features
- CNC front-end application
 - STEP-NC interpreter
 - standalone or integrated in CNC



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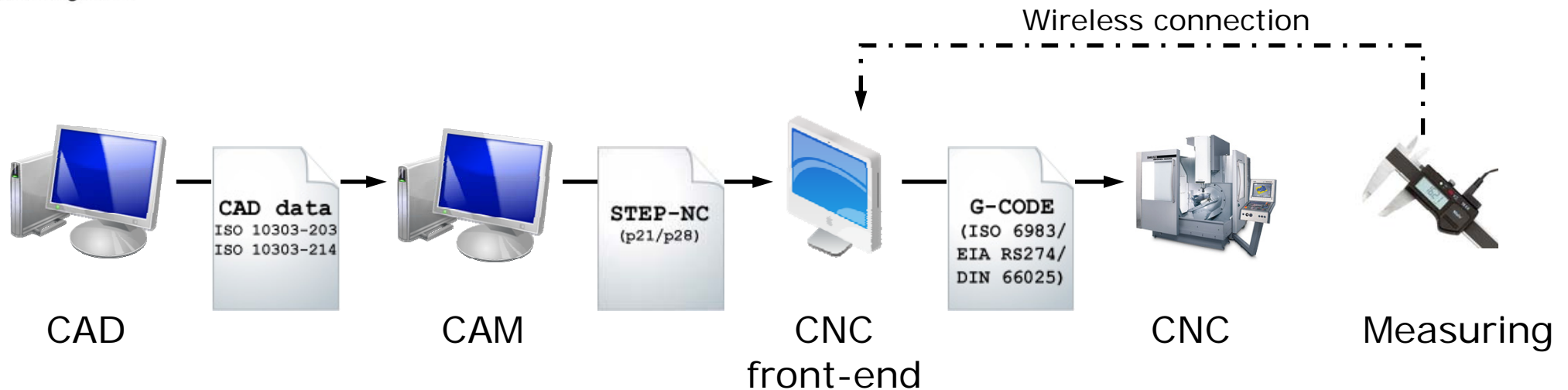
STEP-NC possible benefits today

CNC front-end solution

- Reduced need for expensive and early information separation, generation and maintenance of documents
 - Drawings
 - Used tool to surface chart
 - Setup sheets
- Simplification of postprocessor development and maintenance



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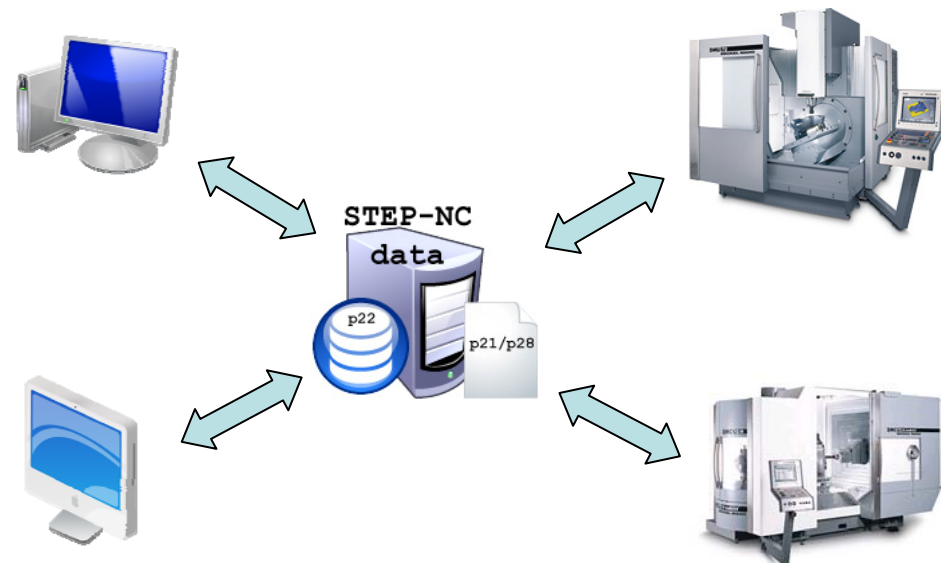


STEP-NC possible benefits today

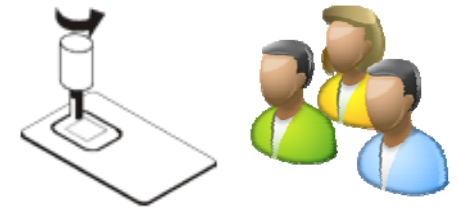
- Shorter time to manufacturing due to elimination of unnecessary extensive work to create machining descriptions
- Secured data quality due to use and reuse of one coherent data source
- Improved machining due to visualization of complete and detailed machining process for interaction and communication
- CAM to CNC/CMM - Reduced cost of postprocessor development
- CNC/CMM to CAM - Modification of machining or measuring processes
- CAM to CAM - Subcontractors can reuse an customers machining and measuring process



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STEP-NC implementation



Scania case study experience

- Make information transparent to operator
- Create understanding
- Motivate
- Enable “right from me”
- Enable feedback upstream



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