KTH Royal Institute of Technology

School of Industrial Engineering and Management
Department of Production Engineering
Computer Systems for Design and Manufacturing

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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.

KTH
VETENSKAP
OCH KONST

**KTH Industrial Engineering and Management**

About KTH, Computer System for Design and Manufacturing

- 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

KTH VETENSKAP OCH KONST

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The main information carrier since…

The revolutionary idea

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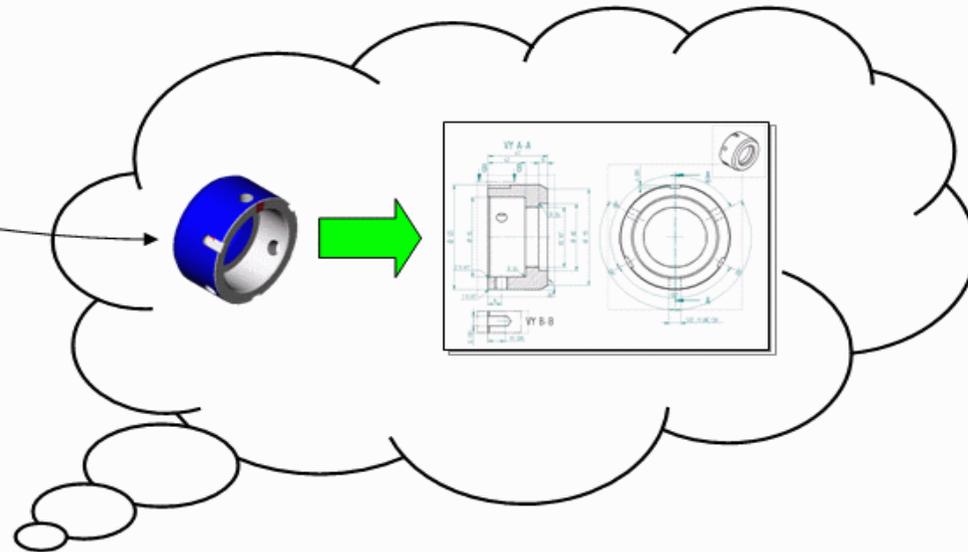
In 1801 Gaspard Monge wrote "La Geometrie Descriptive" as the first treatise on modern engineering drawings. Here he presented the revolutionary idea of projecting views of an object onto three planes and also add size specifications to the shape descriptions (NIST, The Grand Experience)

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Model-driven parts manufacturing

? Still the main information carrier?
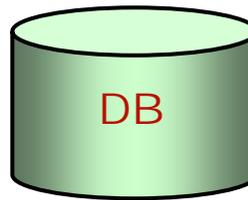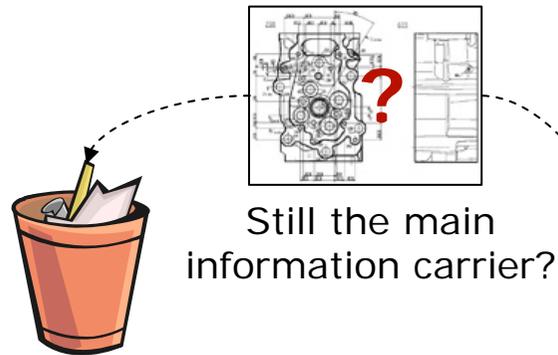
DB
• Machining strategies
• Fixtures
• Cutting Tool
• Machine Tool

Gaspard Monge?

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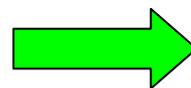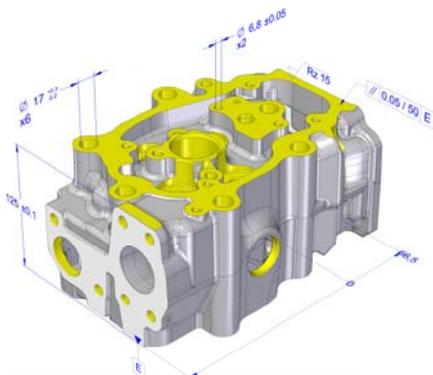
AP203 AP224

• Geometry
• Machining Features

Process Planning

AP238 ISO 14649

STEP-NC
•NC-program

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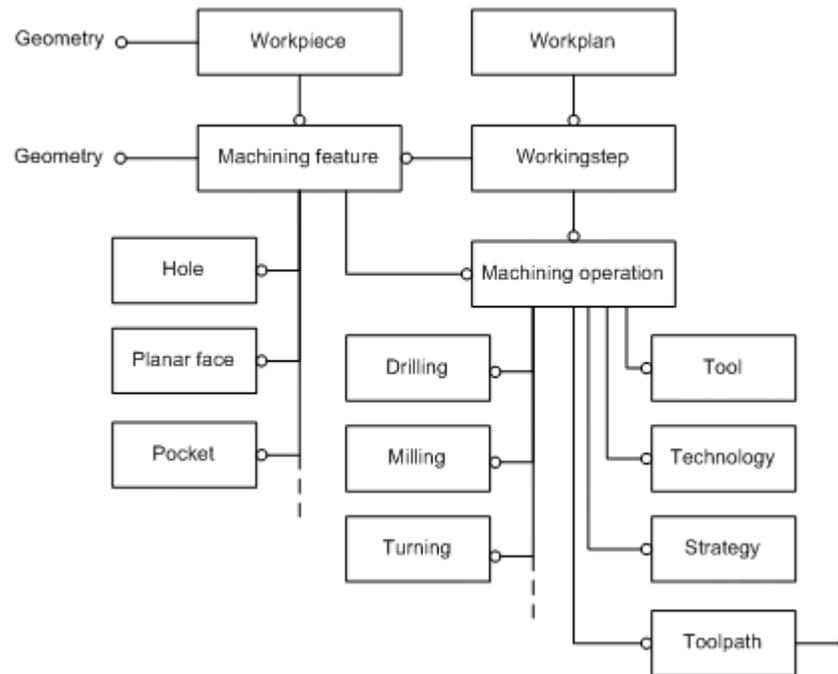
The **Workplan** defines a sequence of **Workingsteps** which associates a certain machining feature with an **Machining Operation**, which in turn describes which type of tool and machining process (drilling, milling, turning etc) that shall be used and its associated strategy.

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
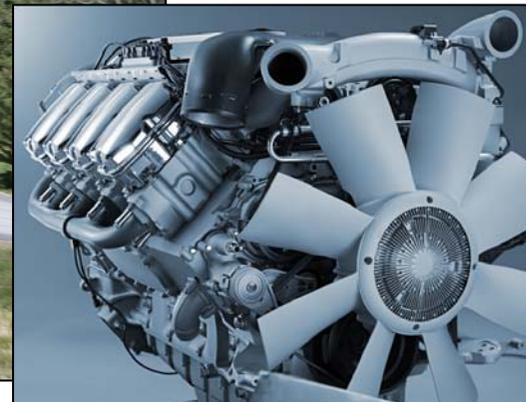
Case: Scania Cylinderhead

- 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

Case: Scania Cylinderhead
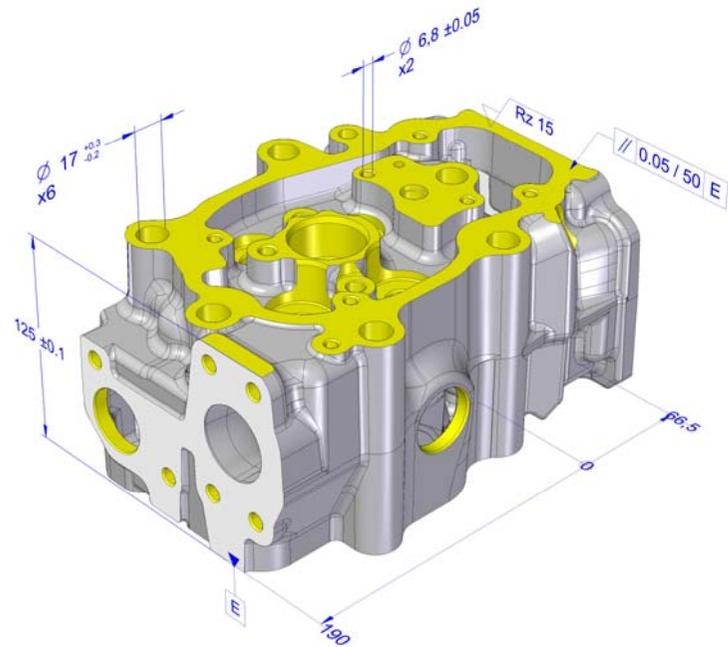
- Machining line with several operations
- Work instructions are important

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
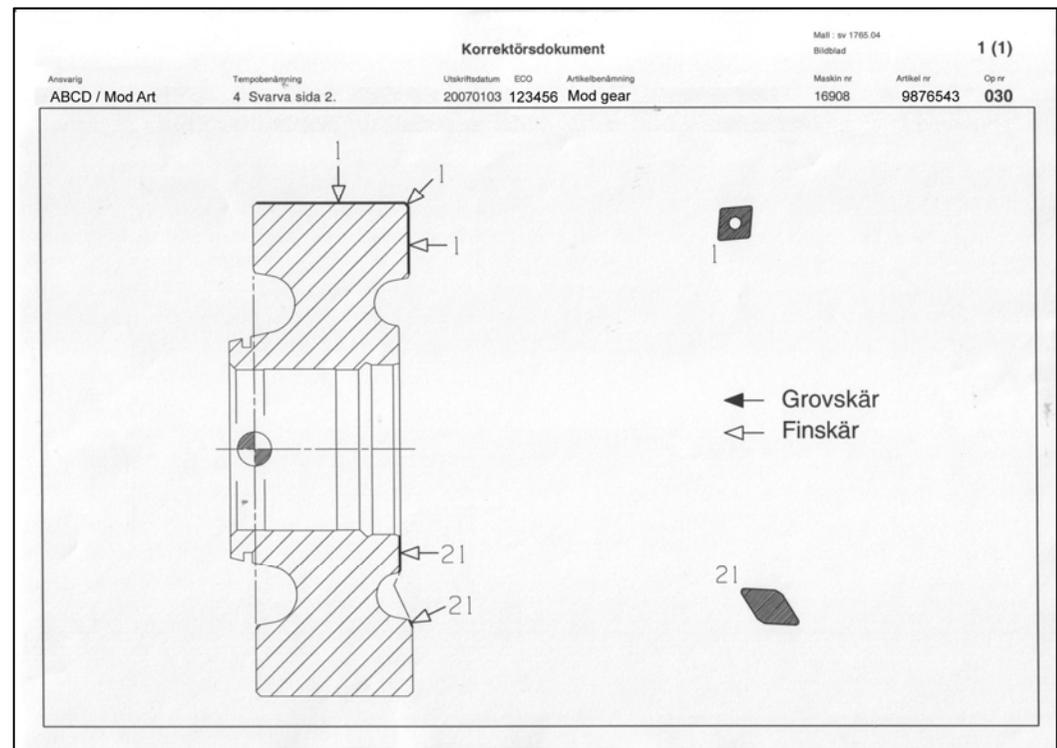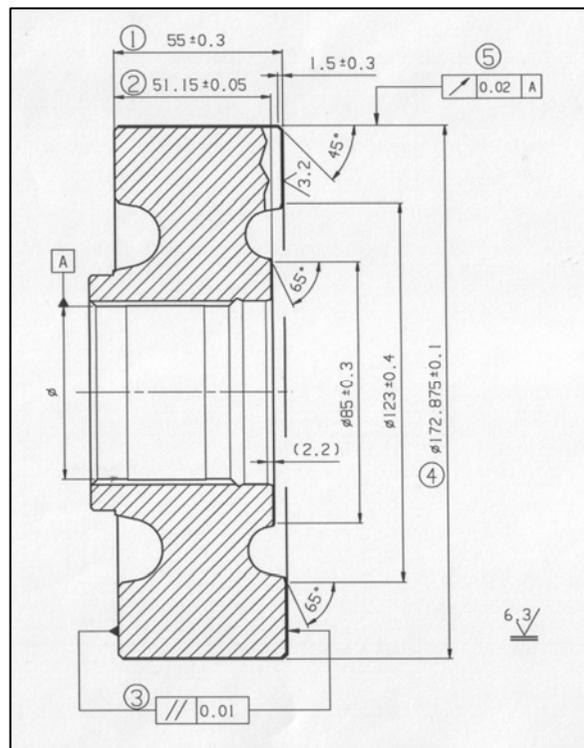
STEP-NC data

- 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

Replaced by
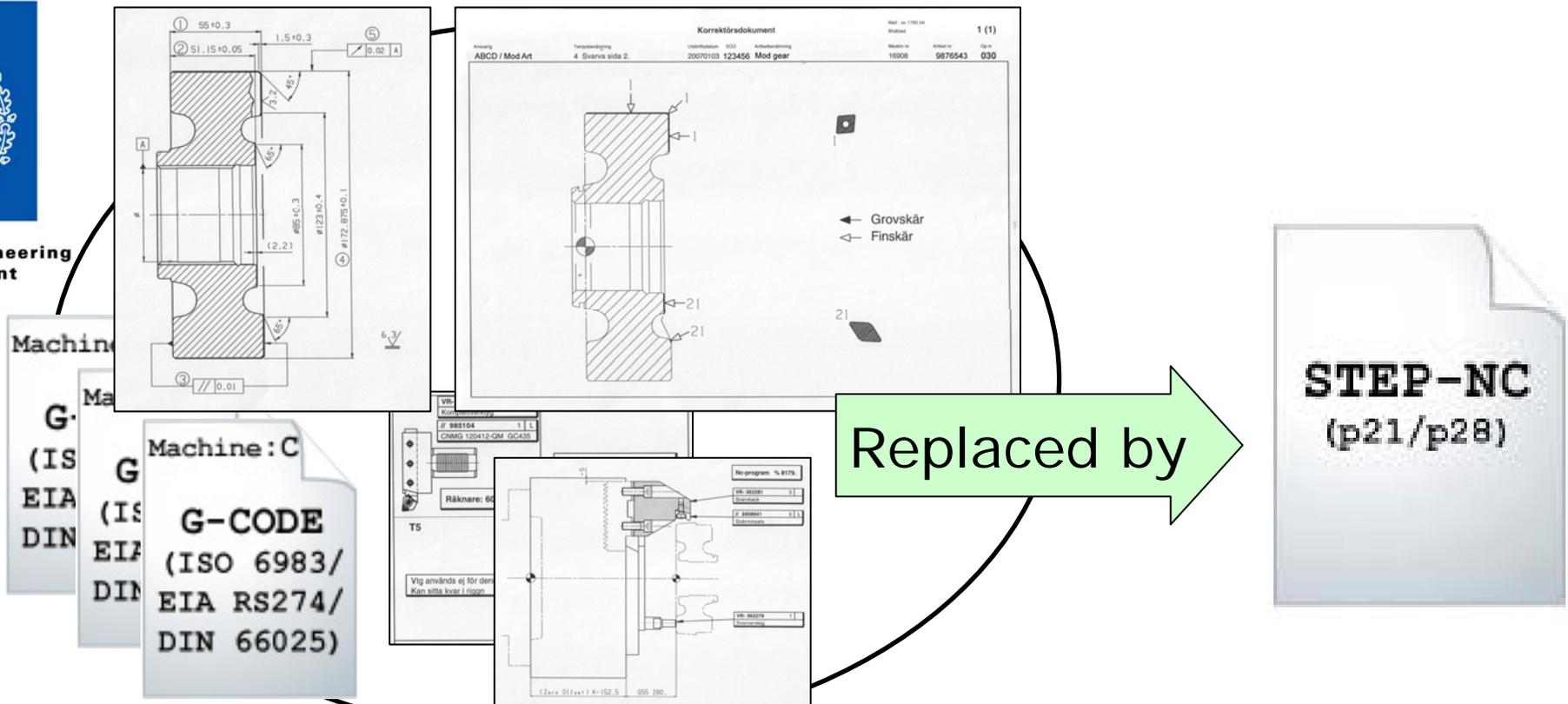
## Machining description as a view of STEP-NC data

- 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
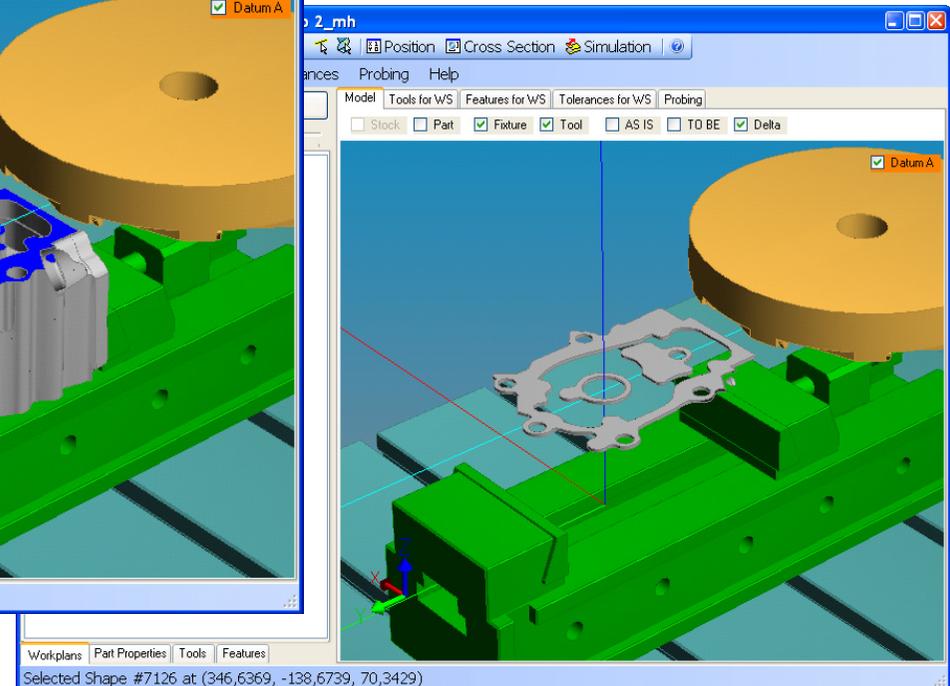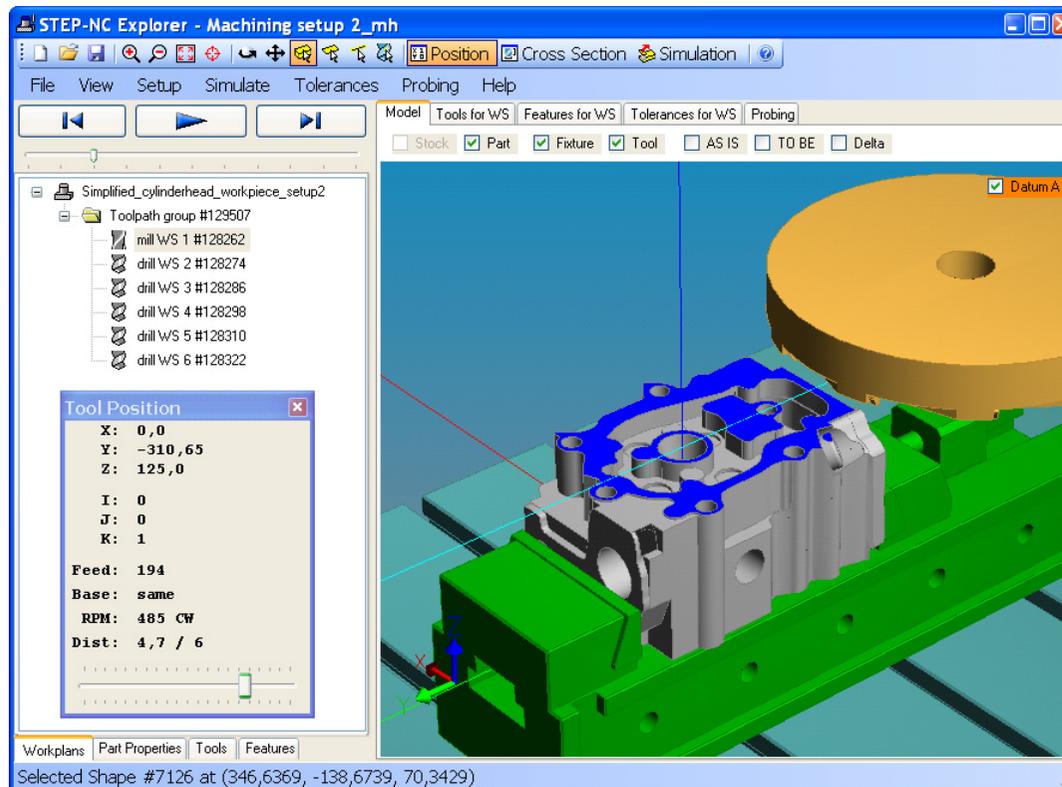
Machining description as a view of STEP-NC data

Part centric view

- STEP GD&T representation data
- Relationship between toleranced surface and used cutting tool
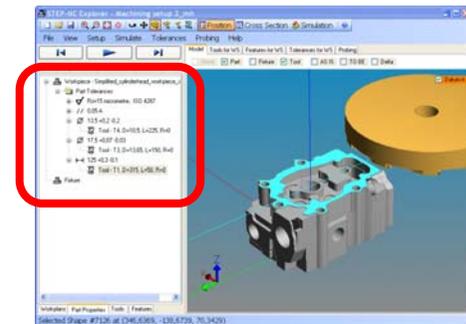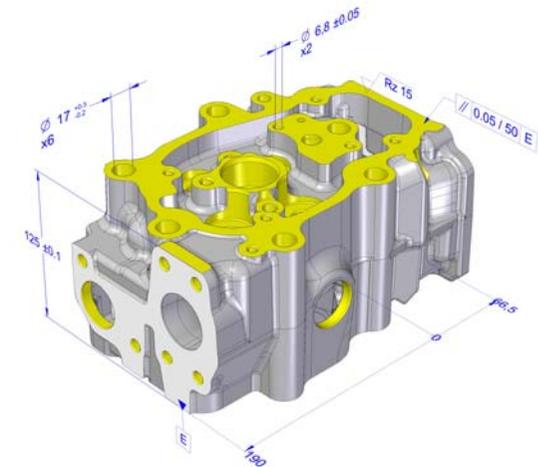
Machining description as a view of STEP-NC data

## Tool centric view

- Cutting tool parameters, ISO13399
- Tolerances affected
- Used in workingsteps
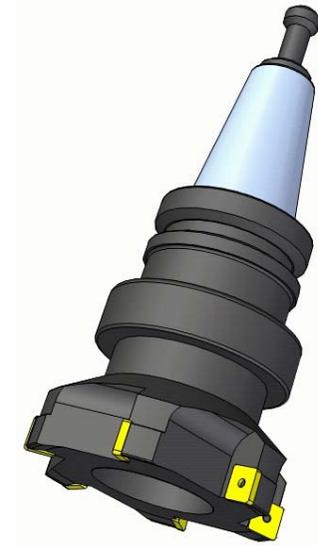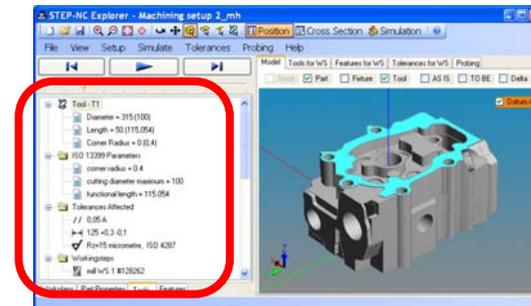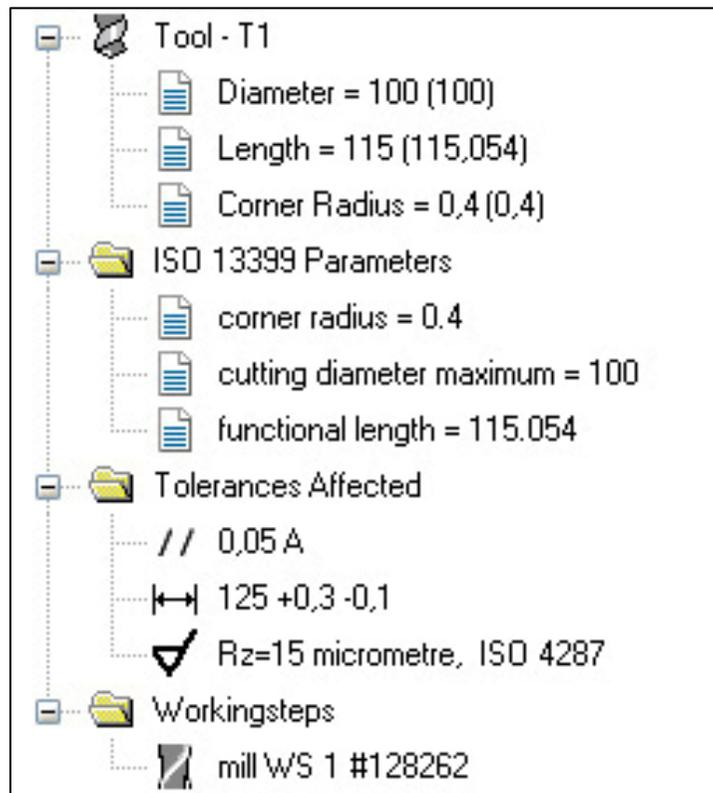
# Machining description as a view of STEP-NC data

Manufacturing feature centric view

- Tolerances
- Used tools
- Workingsteps
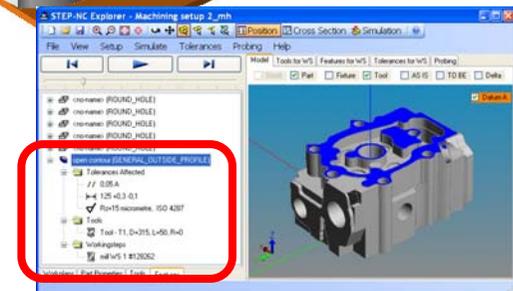
Scania case study

- 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

Wireless connection

| CAD | | CAM | | CNC front-end | | CNC | Measuring |

CAD data
ISO 10303-203
ISO 10303-214

STEP-NC
(p21/p28)

G-CODE
(ISO 6983/
EIA RS274/
DIN 66025)
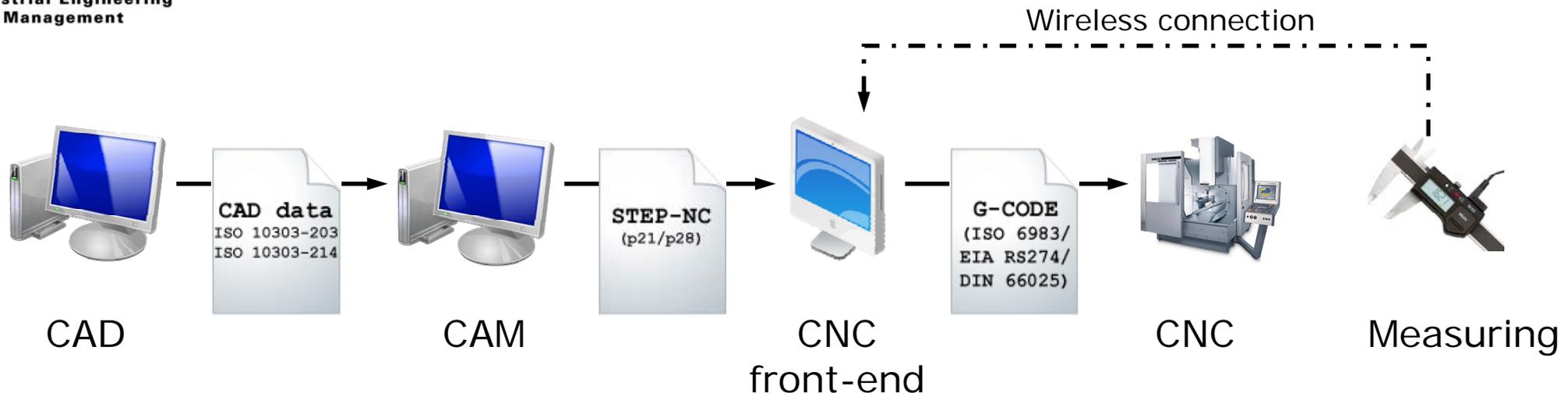
STEP-NC possible benefits today

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

Wireless connection

CAD → CAD data (ISO 10303-203 / ISO 10303-214) → CAM → STEP-NC (p21/p28) → CNC front-end → G-CODE (ISO 6983/ EIA RS274/ DIN 66025) → CNC → Measuring
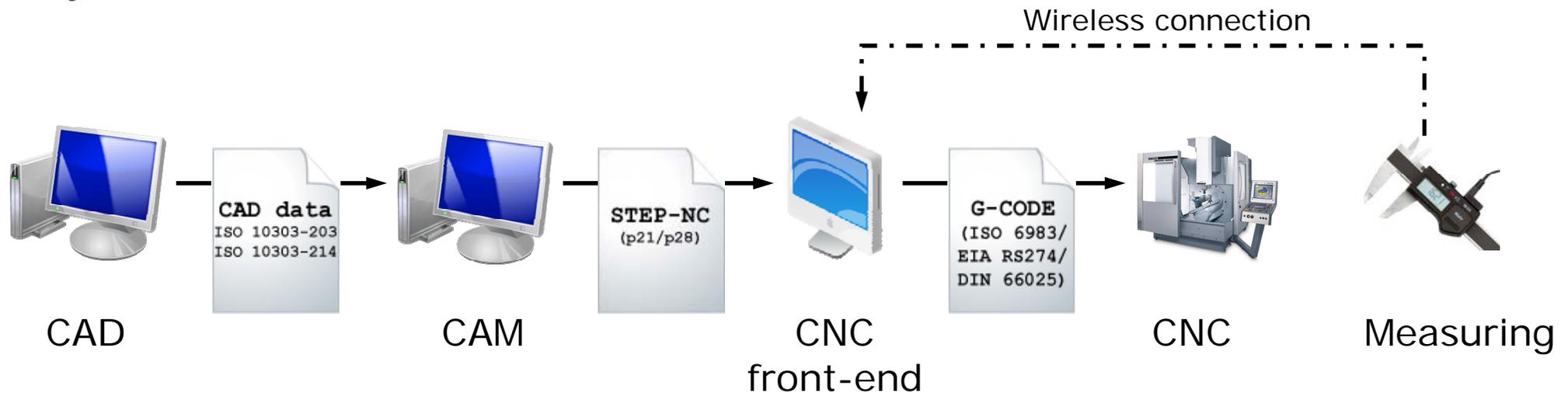
STEP-NC possible benefits today

- 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
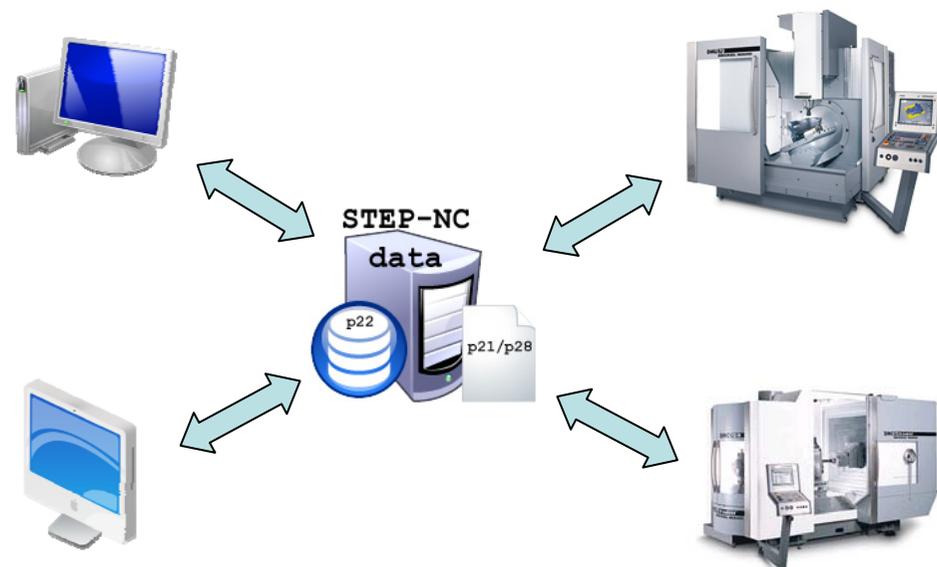
STEP-NC implementation
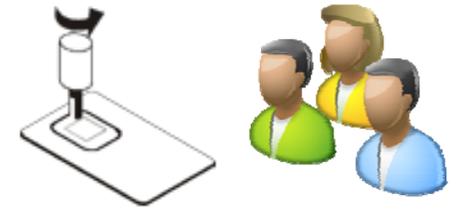
Scania case study experience

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