

FAMOUS

Future **A**dvanced **M**anufacturing **O**ver
Ubiquitous **S**ystem

FP7 - IMS
ManuFuture platform

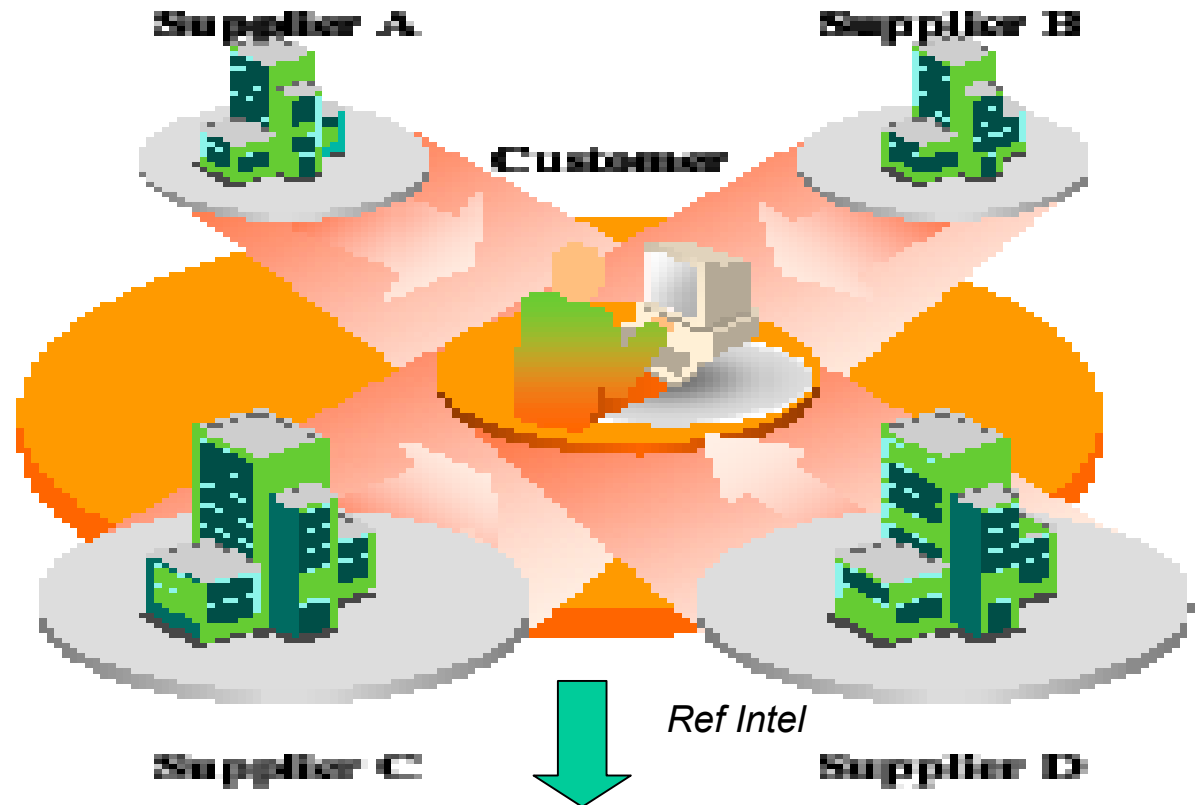
Challenges for european manufacturing

- **Large company** to meet **globalisation**
 - **Global** « brand-name » player.
 - **OEM integrator** capable to **CTO** (configure-to-order) according to customer requirements.
 - **Adaptive & Interoperable SCM** (supply chain model).
- **SMEs** to meet **customisation**
 - **Customer-centric, Innovative & Flexible** supplier, capable to **BTO** (build-to-order)
 - **Coop-petition** (with/against emerging countries)
 - Enabling **knowledge & ICT** integration

The industrial critical issues within the global economy

1:

The future is
**Customer-
centric &
« Coopetition »**



Part to be **delivered as defined by the customer by multiple
« distributed » workshops**

- **final feature : 3D geometry and tolerance** (*Airbus*)
- **data accuracy** for co-engineering (no translation) (*UGS*)

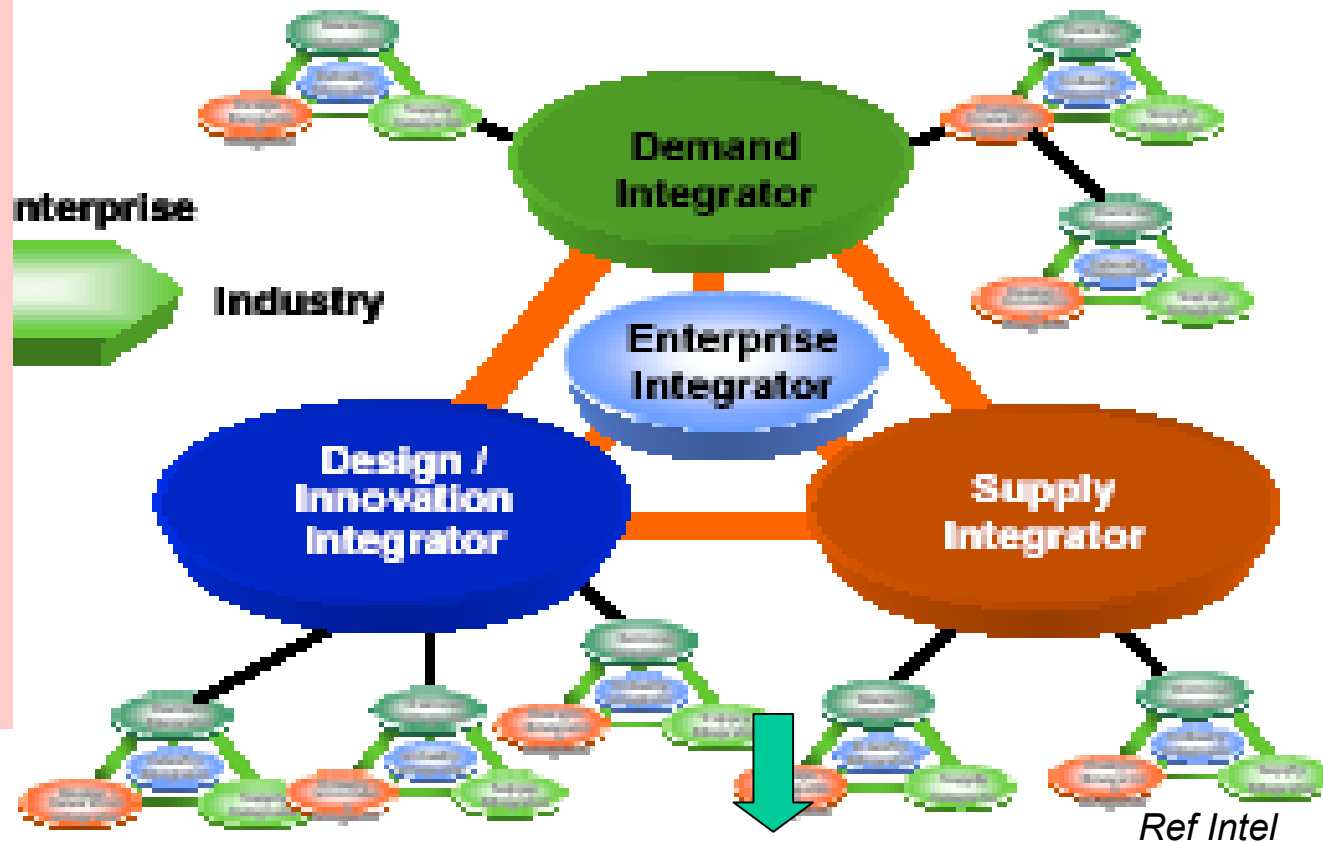
The industrial critical issues within the global economy

2:

The future is
« **horizontal
integration** »

**Digital Factory
and
Interoperability
for global
manufacturing
and security**

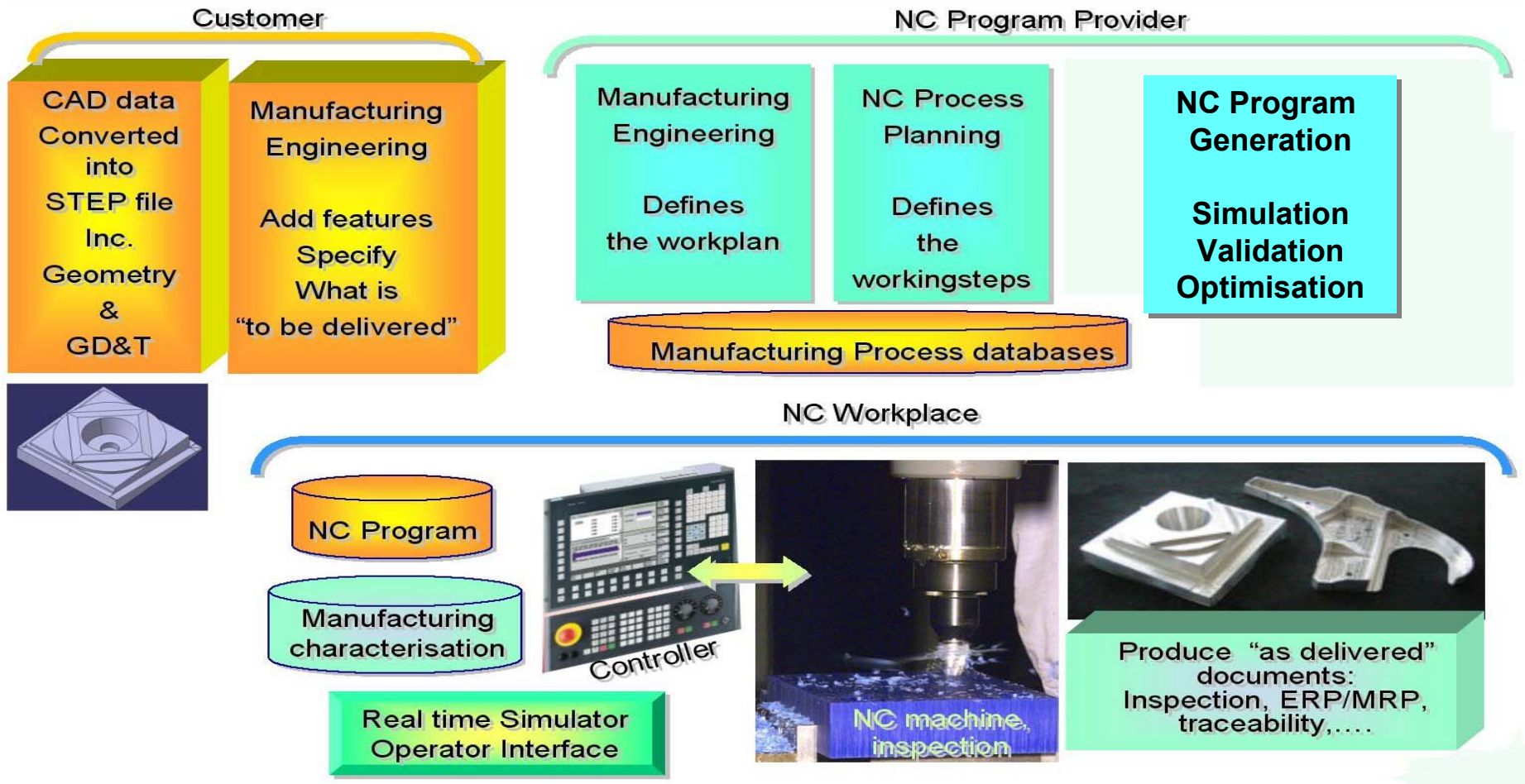
New Economy Competitive Model



STEP-NC can be simultaneously used to do work in different places (extended enterprise)

Vision : the future of manufacturing for aerospace driver

A business driven process



Vision : the future of manufacturing for aerospace driver

Requirements

- **To reduce the time-to-market between the definition and the machining of the first part and subsequent parts**
- **To improve machining shop performance**
- **To enable life cycle management & support**
- **Concurrent Engineering, Manufacturing and Support for integrated process**

Vision : the future of manufacturing for aerospace driver

- **Define the “to be delivered” package**
 - **Use of 3D CAD data without any changes.**
 - **Catalogue of features**
 - **Choice of preferred technology**
 - **Traceability and inspection reports required**
 - **Quality assurance accreditation**
 - **Cost plan**

Requested improvements :

- ▶ Final Features are defined by CAD
- ▶ Proof of Manufacturability
- ▶ Long-term archiving of the manufacturing data
- ▶ Wider selection of machining shops
- ▶ Ability to change or to choose the most suitable technology

FAMOUS Project Rationale & Philosophy

A successfully innovating and competitive European manufacturing industry must be

digital, knowledge-based, adaptive, networked

In compliance with the future manufacturing paradigm

« Design anywhere, Build anywhere, Support anywhere »

enabled by

Ubiquitous Networks

... Ubiquitous networks ?

... to seamlessly deliver information &
services

« Anytime, Anywhere »

to all kinds of devices & objects

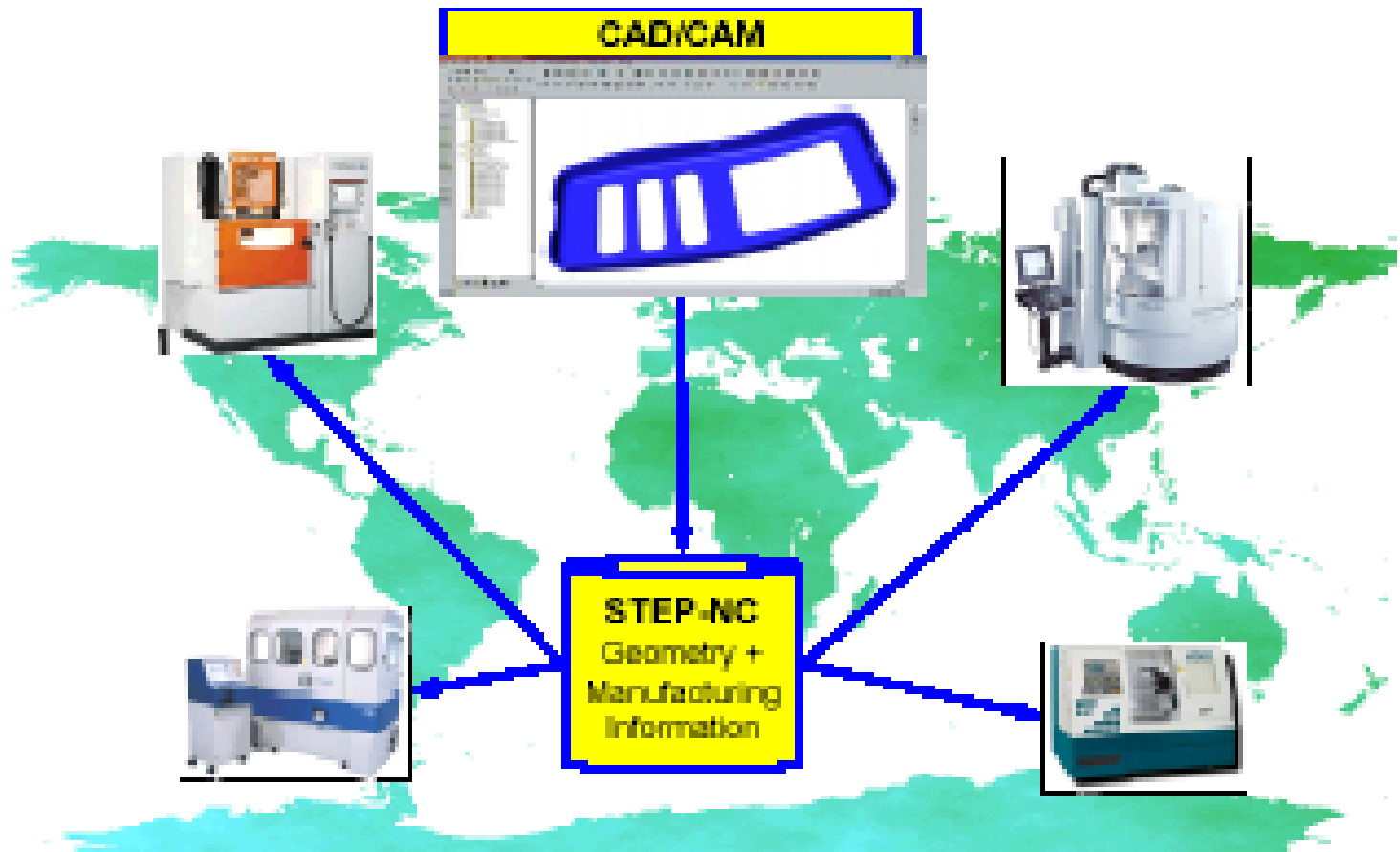
...Ubiquitous-values for the future manufacturing industry ?

- **Connecting people & machines** for better product lifecycle management, greater community power, business intelligence
- **Visible & Comprehensible Knowledge** (versus Explicit Knowledge) for intelligent & holonic processes implementation (**Smart Machining, simulation,...**)

The FAMOUS Goal

Future Advanced Manufacturing Over Ubiquitous System

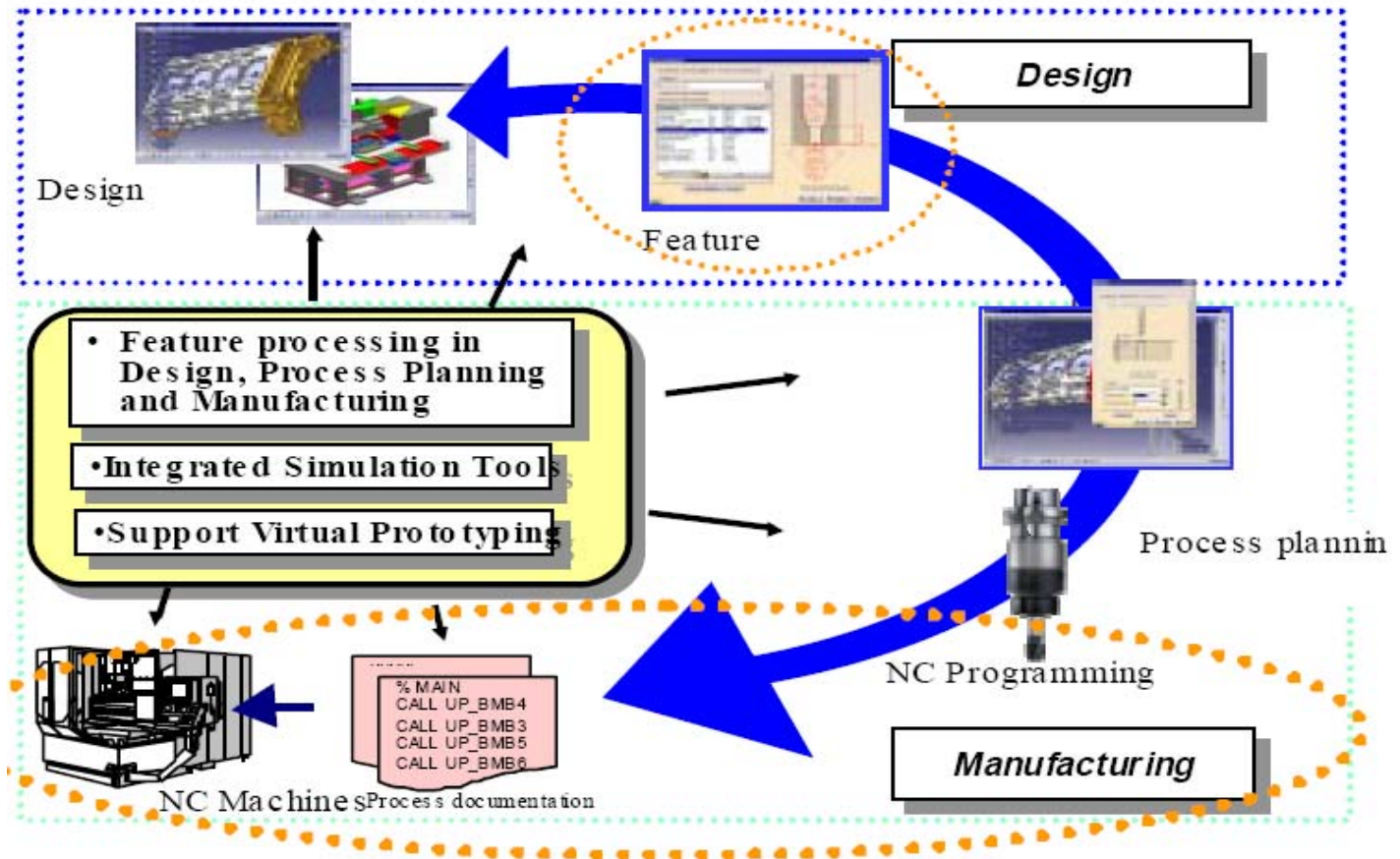
The Ubiquitous Manufacturing network



...and its augmented capability: The ubiquitous feature-based workcell for Smart Machining

Vision:

- Integrated End to End Process
- Bi-directional Process Chain



The two expected issues...

- **Standardized & full representation**
 - towards a ubiquitous manufacturing database.

• **STEP-NC
feature-based
machining
system
towards a
smart
machining
workcell**

...for the **two** dimensions of **integration**

- **Horizontal dimension** (*processes*): definition of a **repository data-hub for standardized manufacturing information & protocol** allowing the **seamless integration** throughout the **supply chain** and the **Product life cycle** (u-manufacturing, extended enterprise, collaborative processes,...)
- **Vertical dimension** (*technology*) : **end-to-end knowledge-based technology** towards **smart machining** equipped with a new breed of **STEP-NC controller** allowing **direct machining**

Factors of Competitiveness

From products to products-related services
(« Servation »)

From efficient design requirements to smart
manufacturing process

Predictive (Virtual) manufacturing & maintenance

Effective cost planning & time-to-market reduction

Flexible manufacturing & BTO capability, etc...



Relevant exploitation values for manufacturing SMEs suppliers



Vertical integration values :

- Extended functionality (accuracy) to produce complex parts
- Cost saving (min 35% expected)
- Portability of applications
- Customisation and users issues

Horizontal integration values :

- Design anywhere, build anywhere, support anywhere
- Additional process control capability
- Interoperability
- Data longevity
- Complete product & process data definition

Pre- requisites for U-manufacturing & Smart Machining

- **STEP-NC** is the enabling « IT bus » for next paradigm based on a **universal (NC) manufacturing platform**
- **Solid feature-based machining** thanks to 3D modeling, simulation technology and optimised on-line algorithms.
- **Knowledge-based machining** : capturing best practices through cognitive database.
- **SOA** (Service oriented Architecture) enabled by **SOAP** (simple object access protocol) and **XML/Java** interface...
- **Traceability** through product and manufacturing information models in compliance with **RFID**

The ubiquitous STEP-NC based machining system

Next « Manufacturing STEP n' See »

Speci a STEP-compliant controller prototype

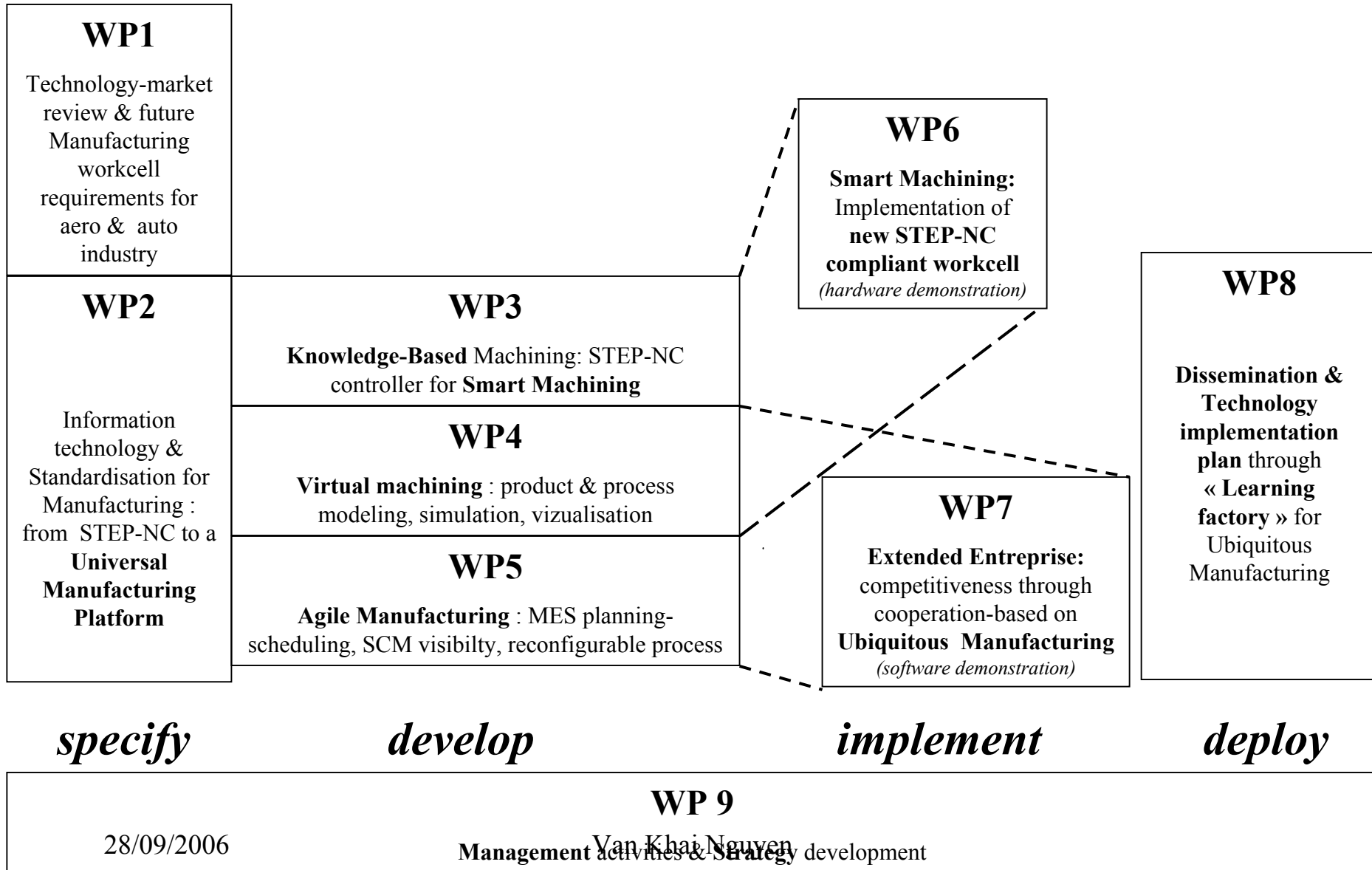
Vertical integration

- **Free-form feature-based design to & for NC « programming »**
- **Machining surface** formalism for Advanced Tool Path representation
- **Polynomial interpolation** for Direct machining controller
- **Optimised tool path calculation for HSM**

Horizontal integration

- **Specification/characterization of machine-tool towards virtual machining**
- **CNC-driven simulation for Manufacturing Data Validation**
- **Process Feed-back loop and tracking of information for PLM (predictive)**
- **WEB-based manufacturing services**

Workpackages structure



WP1

Technology-market review & future Manufacturing workcell requirements for aero & auto industry

- State-of-art review in **manufacturing interoperability** and actual market analysis about **CAD/CAM/CNC integration**.
- Aerospace & Automotive **OEMs requirements** for the future **Supply Chain Model** in the global economy
- Specification of **advanced manufacturing scenarios** based on major industrial companies input

Deliverable : report and questionnaire

WP2

Information technology & Standardisation for Manufacturing : From STEP-NC to a Universal Manufacturing STEP-NC Platform

- **Digital Manufacturing Enterprise** : definition of the integrated information model spanning across the entire and **extended enterprise** and addressing multiple tiers of applications (plant automation systems, manufacturing execution systems, and enterprise applications)
- **Review and Extension of STEP-NC (ISO 14649) to :**
 - **Universal Manufacturing Execution Platform** : to realise the novel vision of a paradigm shift in CAD/CAM/CNC based on semantic and knowledge-based innovative technologies and standards.
 - **Smart NC milling process information model** (to-be-delivered, as-delivered documents, machine-tool information model and its characterisation,...)

*Deliverable : Technical reports and data structure definition and repository for machine-tool,
Standardization activities within ISO TC184/TC39*

WP3

Knowledge-Based Machining: **STEP-NC** controller for **Smart Machining (Milling)**

- To Reinvent the **(STEP) NC Machining-Inspection** process supporting the entire life cycle requirements, from « art to part ».
- To validate & develop the intelligent **STEP-NC controller** that enables manufacturers to characterize, monitor, and improve the accuracy, reliability and productivity of machining operations.
 - Description of 3D complex features based on **functional surfaces**.
 - **Direct Machining** based on advanced tool path description and interpolation through **STEP-NC machining surface** formalism and algorithms
 - **Reconfigurable, process-focused & self-optimised** STEP-NC controller architecture.

Deliverable : Description of STEP-NC based controller for direct machining API components specification and development

WP4

Virtual machining : product & process modelling, simulation, visualisation

- Introduction to **Virtual machining system** : its definition and scope for visualization and simulation
- STEP-NC based visual machining and simulation:
 - Characterization of machine-tool and its performance data
 - Analysis and visualisation of the STEP-NC part description through the (virtual) NC kernel
 - Manufacturing data validation: Simulation and verification through a virtual NC machine

Deliverable : Specification and developement of API for virtual machining system

WP5

Agile Manufacturing : MES planning-scheduling, SCM visibility, reconfigurable process

- Definition of an **integrated production system based on STEP-NC** to manage a shopfloor equipped with several machines and handling systems
- **Manufacturing execution system** : supervision and control of the STEP-NC based production program
- **Global production planning system** based on STEP-NC data organisation for supply chain visibility, and optimisation of resource utilisation
- **Tracking of product information** based on bidirectional data flow and management of product lifecycle on a local, regional and global scale.

Deliverable : Specification and development of application interfaces

WP6

Smart Machining: Implementation of new STEP-NC compliant workcell

- Integration and **development of the new STEP-NC controller**
- Integration of new **on-line algorithms for direct machining interpolation**
- Definition and implementation of a test **industrial STEP-NC workcell**

*Deliverable : Implementation of the first and real integrated STEP-NC machine-tool
Demonstration*

WP7

Extended Enterprise: competitiveness through cooperation-
based on

Ubiquitous Manufacturing

- Set-up a network of STEP-NC enabled shopfloors on a global scale
- Definition of manufacturing scenarios & « intra & inter-entreprise » business to demonstrate the paradigm « design anywhere, build anywhere »
- Definition and implementation of an **ubiquitous manufacturing network scenario** on a global scale

Deliverable : Demonstration scenarios at different places (USA, Europe, Asia)

WP8

Dissemination & Technology implementation plan through « **Learning factory** » for Ubiquitous Manufacturing

- During the project, dissemination via conference, paper, web,...
- Beyond the project : technology transfer plan through the « **learning factory** » (to be set-up) and its adapted infrastructure (immersive e-learning) as advanced manufacturing laboratory...
- To be commonly supported by a public-private consortium

Deliverable : realisation of the dissemination process definition & organisation of the learning factory infrastructure & policy

WP9

Management activities & **Strategy** development

- Not only management of the project
- A steering committee will be set up and has two missions :
 - « Think tank » to develop new businesses enabled by STEP-NC & ubiquitous manufacturing
 - Actions deployment towards implementation of the ubiquitous networks and its related standards

References to previous projects

- STEP-NC IMS & EU Esprit projects (*respective consortium*)
- Machine-tool information model (*NIST*)
- In-house MES (*MCM*)
- KOBAS : SOA and customised MES (*consortium*)
- OPTIMAL & HIMILL real-time milling (*Fidia & CADCAMation*)
- « Machining surface » driving concept (*ENS-Cachan*)
- « Rule-surface driving » concept for wire-EDM (*CADCAMation, eig*)
- 5-axis optimized strategy (*Open-Mind*)
- Virtual Machining & NC-driven simulation (*ETHZ + BTH-Sweden*)
- High-degree interpolation (*EPFL*)
- Direct machining controller... (*OMAC*)

Expressed interests

- **Industries (including SMEs & software dev):**

Airbus, Volvo, MCM, FIDIA, OSAI, TTS, CADCAMation, FAST, Siemens, Missler, Mikron, Sandvik, LSC group, ACSE spa, ...

- **Research and universities :**

EPFL, EIG, ENS-Cachan, Bath university, EC-Nantes, Politechnico-Milano, SUPSI, WZL, KTH, CETIM, VTT, ...

Expected partners ?

- SAP, Matra-automobile, Dassault systèmes
- end-users SMEs

Expected International partners (IMS regions & China)

- Korea : Postech, automotive builder,...
- Japan : Manufacturing Engineering Research
- USA : BOEING, Step-tools
- China : CNIS

Project basic information

- FAMOUS
- Call : FP 7, IST (or NMP) 1st Call, early 2007
- Instrument : Integrated project
- Budget : 20 millions EUR
- Participants : 25 EU, 10 other regions
- Duration : 4 years (2007-2011)

Suggested WP & task distribution

- WP1: Airbus, BOEING, Volvo, VTT, CADCAMation,...
- WP2: Bath, EPFL, Postech, Step-tools, ...
- WP3: Siemens, EIG, ENS-Cachan, EC-Nantes
- WP4: TTS, SUPSI, KTH, ...
- WP5: MCM, Politechnico-Milano, Postech, EPFL,
- WP6: Fidia, Siemens, Osai, FAST, ...
- WP7: Postech, (SAP),...
- WP8: CADCAMation, ACSE, Postech, Step-tools, Cetim,...
- WP9: Airbus, CADCAMation.

Next steps

- Interested organisations should fill the interest form, to be returned before **november 15th**
- Core team meeting in Geneva, **november 20th**
- Preparatory meeting of the potential consortium : mid December
- Final consolidating document : January **26th, 2007**

Point of contact

Van Khai Nguyen (Ing. EPFL)

CADCAMation SA / EIG

Vankhai.nguyen@hesge.ch

Tel : 004179 2053041

Some Bibliography

- Feature-Based surface design & machining (J.C.Cavendish & S. P. Martin / General Motors research labs)
- A new concept for the design and the manufacturing of free-form surfaces (C.Lartigue, E.Duc,.../ ENS-Cachan)
- Rapid & Flexible Prototyping Through direct Machining (Franck Wei li,.../ BYU)
- FutMan : the future of manufacturing in Europe (2015-2020)
- Adaptability and interoperability in CNC manufacturing (S Newman,...University of Bath)
- Development of a machining simulator considering tool deflection and machine behaviour (J.Y Hascoët,.../ECN)
- Ubiquitous PLM using Product embedded information devices (D Kiritsis/ EPFL)
- Build anywhere using visual machining (step-tools)
- Trends in NC programming for Moldmakers (A Christman)
- Siemens Virtual production services (Eastec 2006)
- Characterisation of Machine tools using XML (NIST)
- Manufacturing Data Validation through simulation (G Shao,...NIST)
- Information model for machine-tool performance tests (Y.T Lee, ...NIST)
- STEPNC, the end of G-codes (MMS online)
- Strengthening competitiveness through Production networks (EC, FP6, IST priority)
- Standardization of the manufacturing process. IMS/EU Step-nc project (J richard, VK Nguyen,.../cadcamation)
- ...