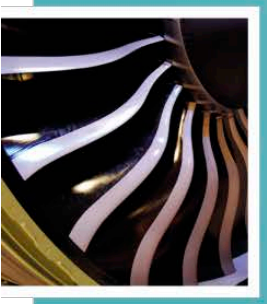
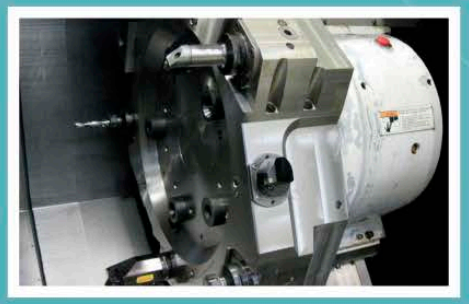
Terrific Workshop June 30
Cluster for Zero-Defect Manufacturing
IFaCOM – Intelligent Fault Correction and self Optimizing system
Milan,. June 30. 2013

Dr. Odd Myklebust, NTNU/SINTEF
IFaCOM Co-ordinator


IFaCOM

www.ifacom.org

Intelligent Fault Correction and self Optimizing Manufacturing systems
FoF NMP - 285489

IFaCOM Consortium

NTNU – Trondheim
Norwegian University of Science and Technology

DTU

EMA

WZL RWTH AACHEN

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

alesa monti efficiency + innovation

CADCAMation SA

LEUPHANA Institut für Produkt- und Prozessinnovation

Montronix®

+GF+

AgieCharmilles

GKN AEROSPACE

FIDIA

STRECON

INOSENS innovation in sensorik

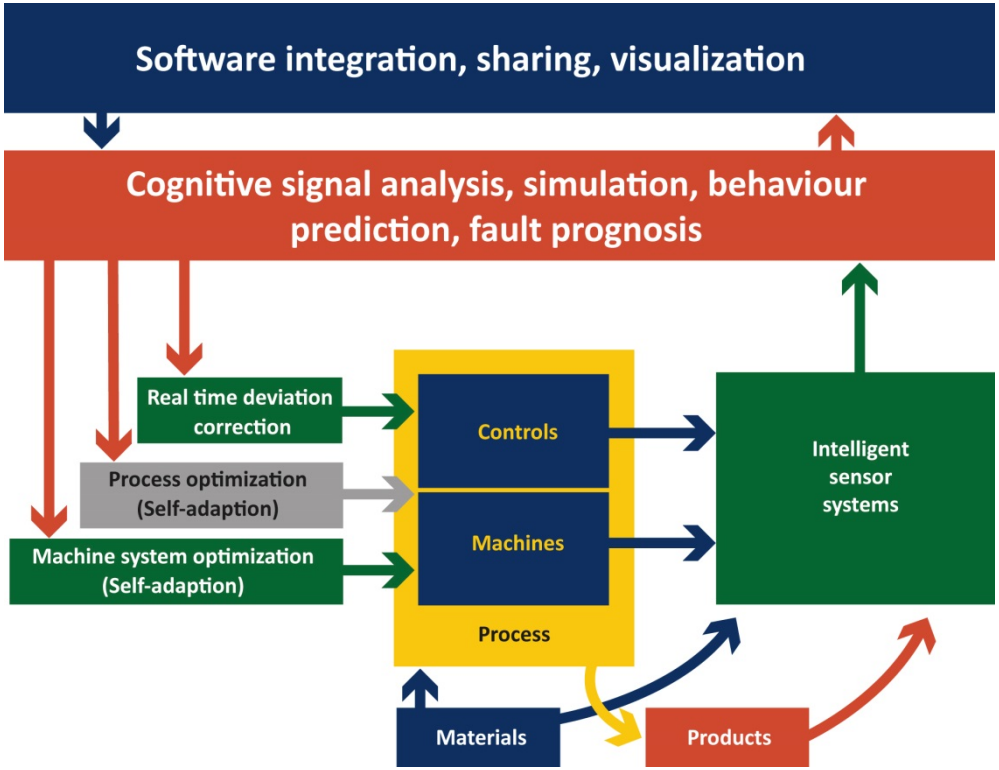
Norway
Denmark
Germany
Switzerland
Italy

5 Academic partners
5 End user (2 Aerospace, 3 Machine tools)
4 Technology Providers

COOPERATION

The vision of IFaCOM, *Intelligent Fault Correction and self Optimizing Manufacturing systems*

- Zero defect level of manufacturing for all kinds of manufacturing, with emphasis on production of high value parts, on large variety custom design manufacturing and on high performance products
- The whole system contains of three main loops:
  - The real time vital parameter control loop
  - The process optimization loop
  - The machine system optimization loop



The background of Zero Defecet Manufacturing

- ZDM - *A Total Quality Approach*
  - Can be seen as a Extension/further implementation of Total Quality Management
  - A continuous system oriented quality approach
  - Quality Techniques improvement e.g. 6 sigma (smaller batches and real time measuring)
  - From product to (manufacturing) processes focus
- Reduction of losses by extensive quality control and the increase of efficiency in manufacturing applicable for many industries (in particular in the traditional sectors)

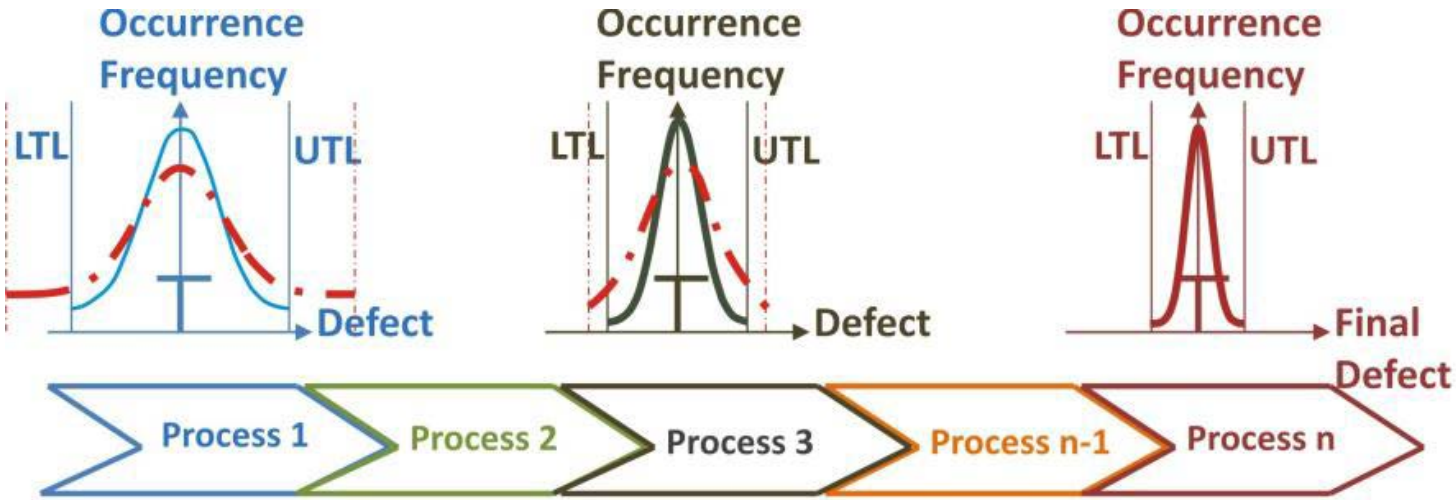
Goals of the Zero Defect Manufacturing

- System approaches for monitoring and data processing of dimensional fluctuations
- Efficient simulation tools and methods to predict the manufacturing system behaviour which can be utilised for efficient operation planning to be combined with in-process monitoring
- Innovative solutions for intelligent manufacturing systems, in support of customising and build-to-order strategies
- Extensive integration capabilities in production equipment of intelligent, autonomous, and self–adaptive devices (integrated, self-powered sensors and actuators) at low cost for process monitoring, control and quality management.

Expected impact of Zero Defect Manufacturing

- The development of innovative solutions for **zero-defect manufacturing** is of strategic relevance for Indusry, especially in the domains of parts manufacturing with (conventional) technologies such as machining, cutting, forming, coating and others.
- The **reduction of losses** by extensive quality control and the increase of efficiency in manufacturing are expected in many industries, in particular in the traditional sectors.
- Safeguarding and creation of **high-skilled jobs** in European Industry

Dynamically adjusted quality targets in multi-stage process chains



From the system viewpoint, **data collection, data presentation and root cause reasoning** needs to be determined to **allow continuous monitoring of the performance of the different process stages to master propagation of defects within or between processes** and **increase the robustness of processes.**

Software solutions

- Fault Diagnosis, identification of sensitive parameters i.e. Knowledge discovery, Optimization and decision making of the processes
- Self-adaptive system for in-process real time control of vital quality parameters
- Intelligent Fault Diagnosis and Prognosis System (long time optimization)

Hardware/Sensor approaches

- Method for selection and characterization of commercially available sensor systems
- Method for identification of sensor system location
- Optimization of sensor performance
- Characterization and implementation into industrial demonstrators
- Selection and testing of sensor systems to enable the implementation of the industrial DEMOs

IFaCOM Five Enduser for the demonstrators

- Aerospace cluster: Implement Zero Defect Manufacturing solutions in production lines
- Machine Tool cluster: Improve products so that the products are able to obtain Zero Defect Manufacturing results

- **ALESAMONTI** : Compensate MT errors, automatic SPC for small batch, tool wear monitoring
- **CHARMILLES** : Predict and correct error occurrences in WEDM process

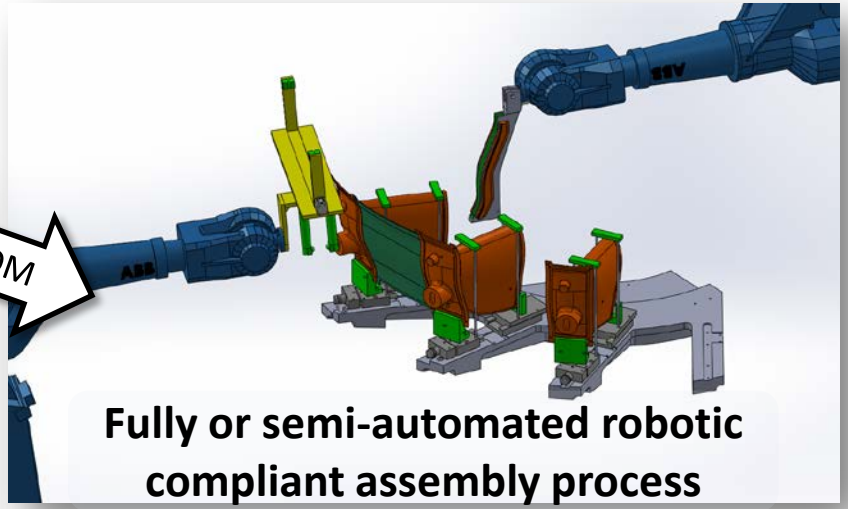
- **STRECON** : Monitor status of RAP process and control process with monitored data and recorded data from past operations
- **GKN** : Automate Aerospace component assembly process
- **EMA** : Optimize investment casting process for obtaining better final results

Before and after IFaCOM
A Zero defect Manufacturing demonstator example GKN AEROSPACE

- Extensive human subjective influence
- Manual process results in a varying anount of built in stress in sturecture affecting downstream processes
- Minimal feedback of assembly data
- Ingoing material with large variance
- Weld defects during the weld up sequence

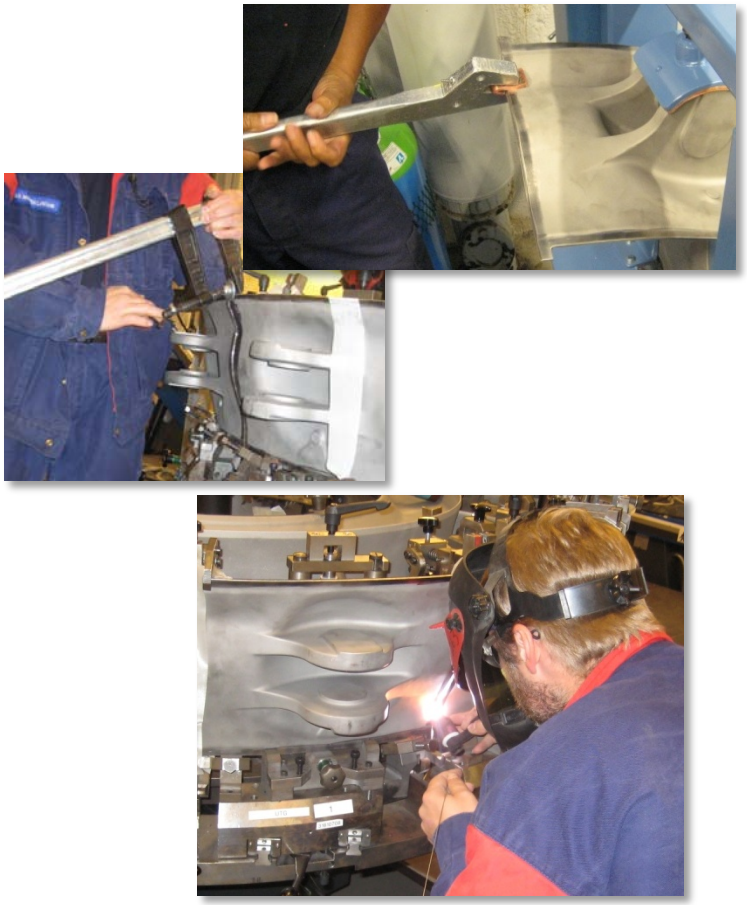
IFaCOM

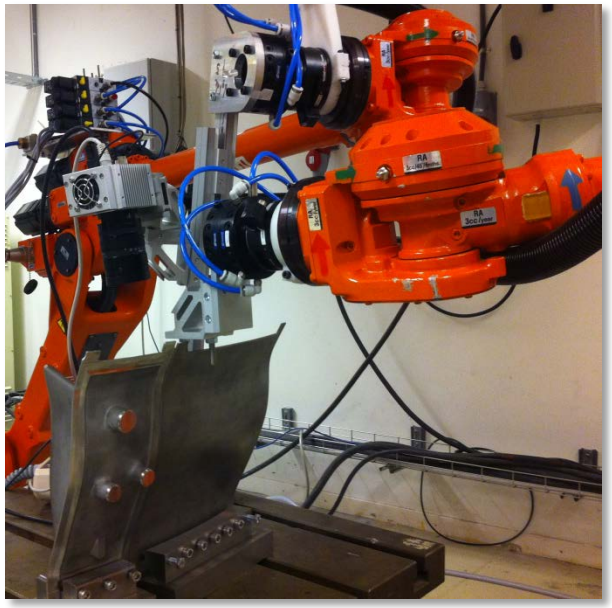
- Standard workflow and method
- Much more uniform stress state in the structure
- Ample amount of automatic feedback from production, possibility of in-depth process analysis
- Ability to deal with variance of ingoing material
- Reduction of weld defects



Fully or semi-automated robotic compliant assembly process

Current assembly process and IFaCOM solution





Reduction of errors by 50%

Long term: 90%


KUKA

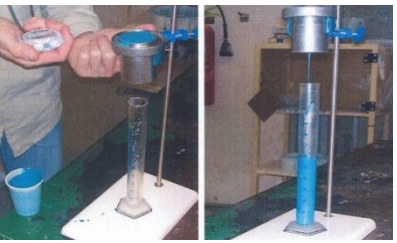
Before and after IFaCOM

A Zero defect Manufacturing demonstator example **EMA**

" Optimize investment casting process for obtaining better final results: reduction of the scrap rate due to the ceramic inclusion in the investment casting"

Before IFaCOM

- Ceramic inclusions caused mainly by an ineffective control of the mixtures and the ceramic shell
- Extensive human influence in the control of the ceramic slurry in the investment casting process
- No optimal data integration



Manual process

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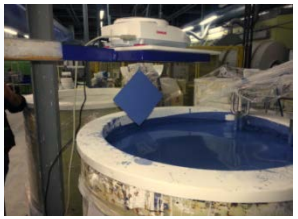
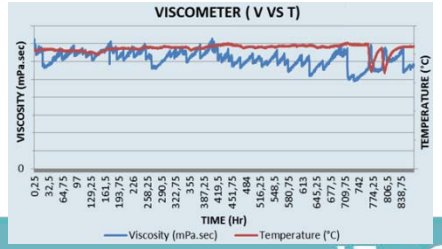
New equipments introduction (automatic & semi-automatic), more effective control, scrap reduction





COOPERATION

Before and after IFaCOM
A Zero defect Manufacturing demonstator example
STRECON

- Pre IFaCOM polishing was blindfolded meaning that a post- polishing quality assesment is made.

- Post IFaCOM online surface roughness assesments are made to determine the appropriate stoptime – avoiding overpolishing and the consequential potential defects.
- (As benificial side effect is that performance is improved since no unnecessary machine time is wasted.)

Before and after IFaCOM
A Zero defect Manufacturing demonstator example
Charmilles

- Lines and marks marks may appear sporadically on the surface of the workpiece at the finishing stage of the WEDM which is the last machining stage
- Therefore, it results in costly rejects

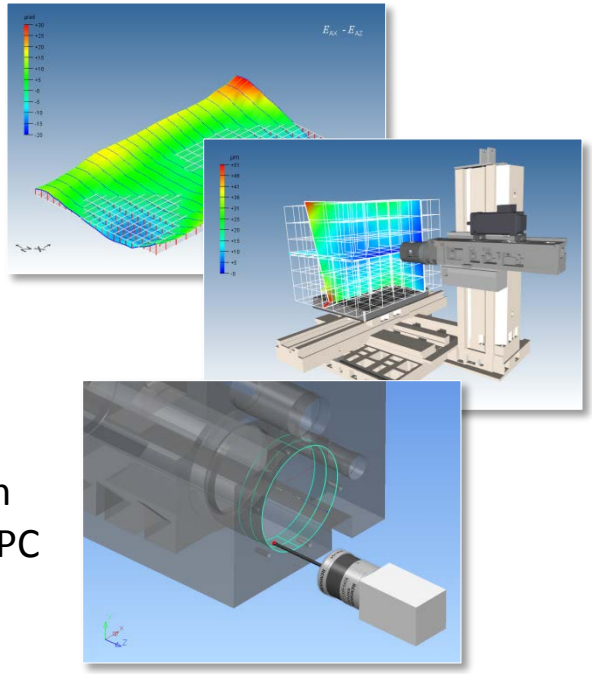
- IFaCOM system will:
  - Proactively predict the occurence of lines and marks
  - Propose on-line process parameter adjustments to prevent the occurrence of lines and marks

Before and after IFaCOM
A Zero defect Manufacturing demonstator example — ALESAMONTI

- Machine tool geometric errors are only periodically compensated, in unloaded state, at given ambient temperature
- Residual geometric errors are transferred to the workpiece
- Fitting between structural components needs to be performed at the assembly line, applying hand scraping

IFaCOM

- Quasi real-time compensation of MT geometric errors
- Prediction of workpiece errors
- On-machine inspection applying small-batch SPC



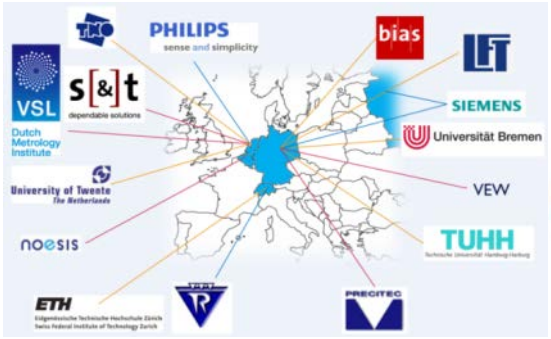
IMPACT

- ❑ 50% reduction of geometric tolerances on structural component features
- ❑ 50% reduction of hand scraping costs
- ❑ 15% reduction of heavy components handling and transportation
- ❑ 5% reduction of overall order execution time

Zero-defect manufacturing Cluster

4ZDM: ZERO-DEFECT Manufacturing Clustering & Networking Initiative

ZDM
Zero Defect Manufacturing



11 countries &
58 partners…

16 end-users
18 tech providers
24 RTD/Univs.

Cluster cross-cutting issues

*1- Co**mmon targeted sectors** or market applications: medical, transport, energy, industrial.*

*2- C**ommon manufacturing processes**: chip removal, laser ablation, electrical machining, replication, additive manufacturing, extrusion, assembly.*

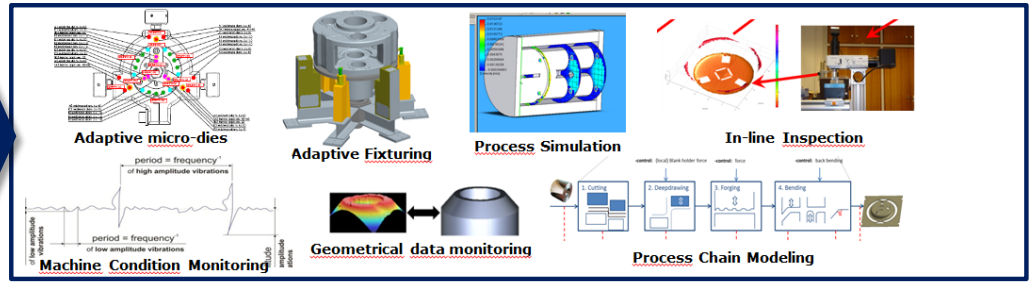
*4 - **Share technological approaches** within Zero-Defect manufacturing.*

*5- **Share industrial needs and demonstrator cases** (exploitation activities). Share obtained research results (dissemination activities).*

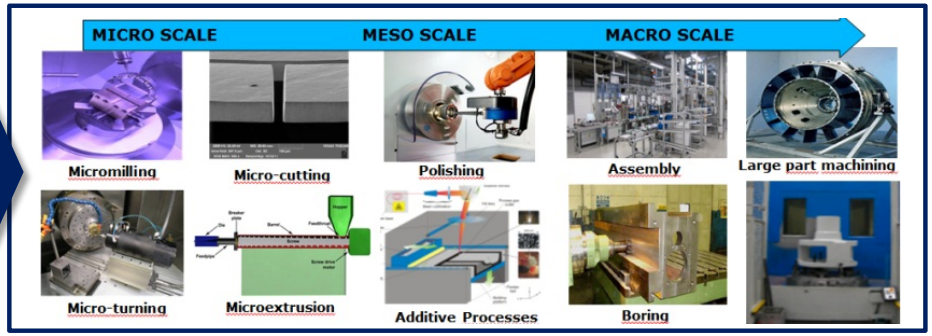
*6 – **Contribute to international standardization** activities.*

Technical cross-cutting issues

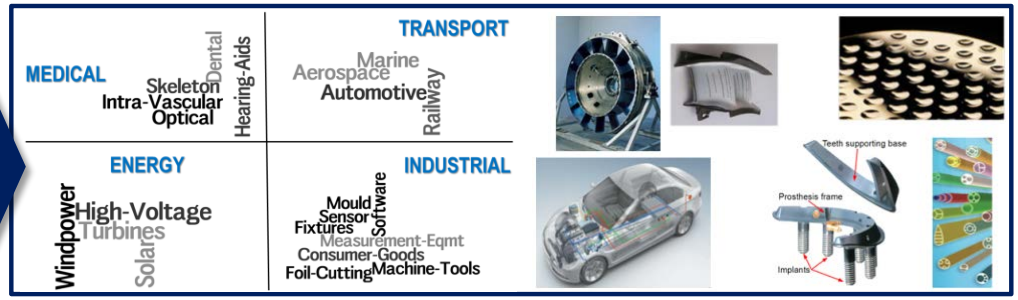
ADRESSED RESEARCH FIELDS



ADRESSED MANUFACTURING PROCESSES



4 TARGETED MARKETS



Zero-defect manufacturing, EU-FoF cluster

4ZDM: ZERO-DEFECT Manufacturing Clustering & Networking Initiative

www.4ZDM.EU