



IoT Week Bilbao 2018

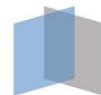
4-7 JUNE 2018, BILBAO (SPAIN)
EUSKALDUNA CONFERENCE CENTRE

How IoT can affect Machine Tool industry?

Iban Arriola
Senior Researcher

BILBAO, JUNE THE 7TH 2018

IK4  TEKNIKER
Research Alliance



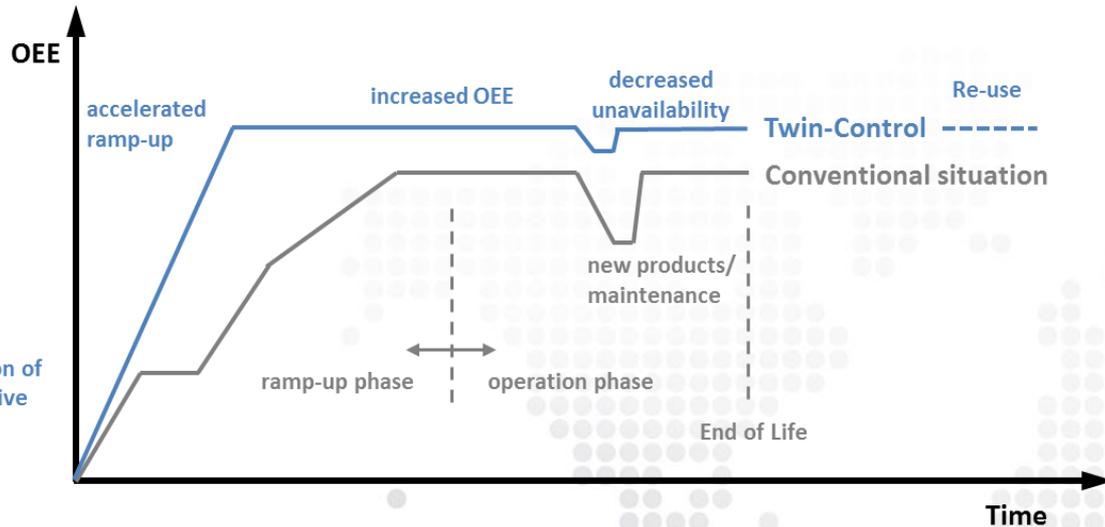
twinccontrol

IoT Forum



Introduction

- Main goal in Manufacturing → Increase the Overall Equipment Efficiency

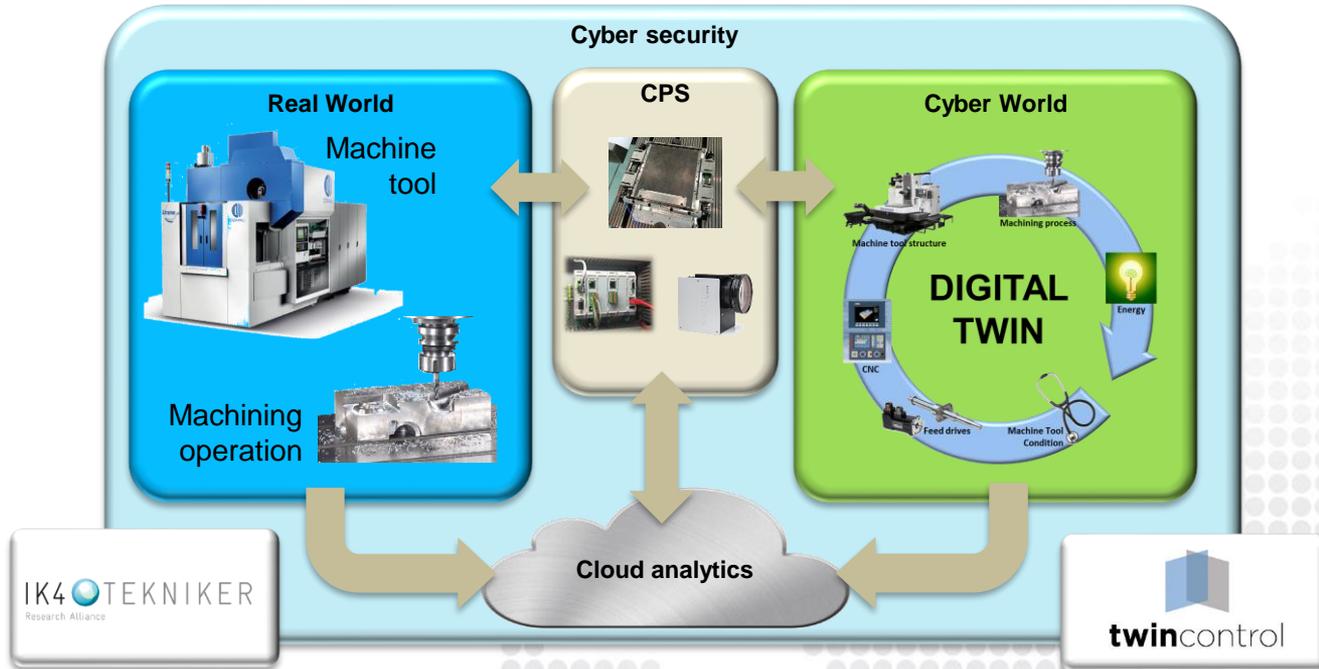


- Reduce machinery and process set-up time.
- Increase the reliability of the process
- Increase the machine up-time
- Reduce life cycle costs
- ...

Faster adoption of predictive tech. & secure set-up

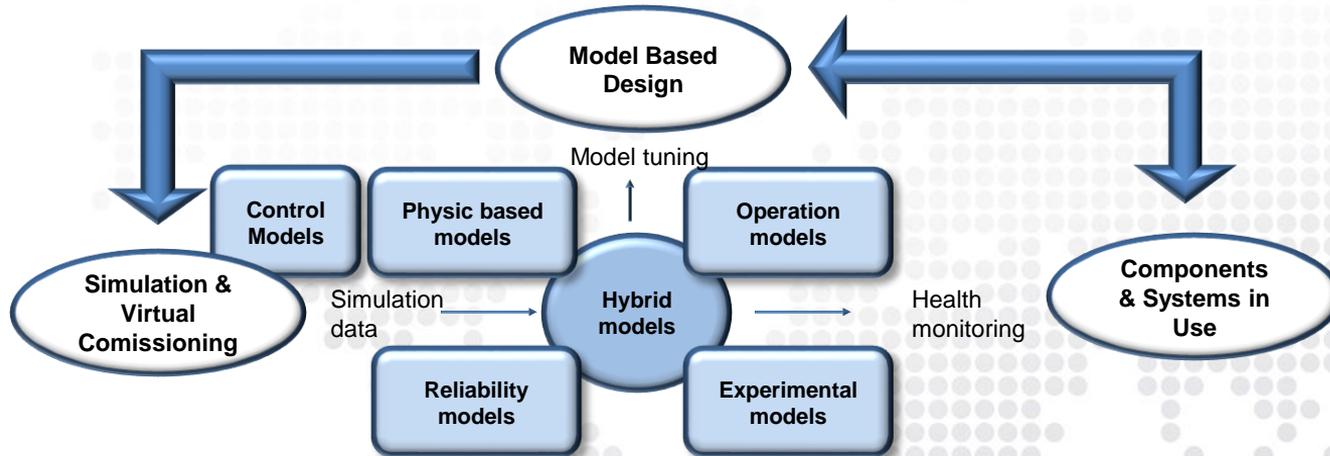
Introduction

- Machine Tool as a CPS



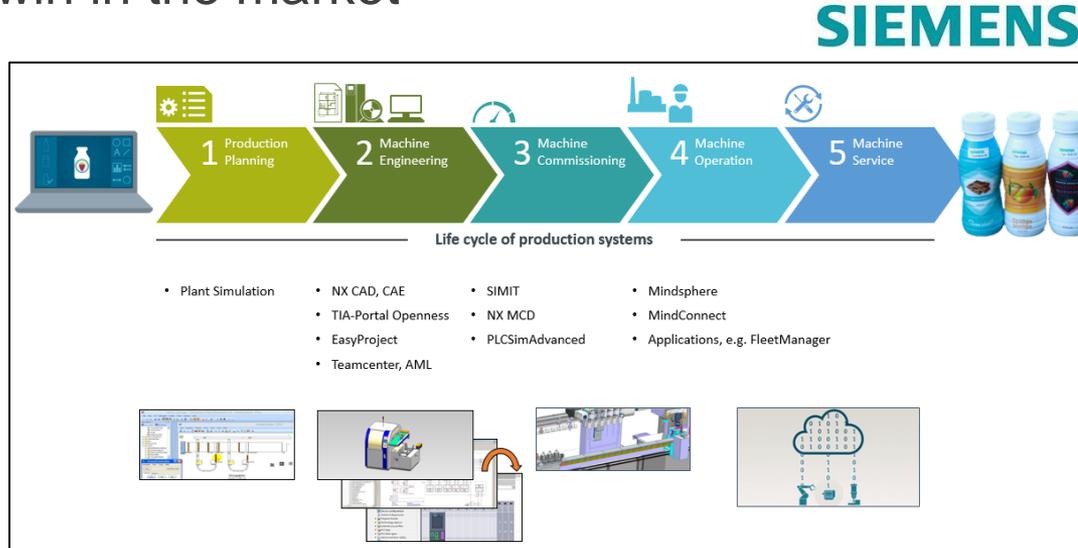
Digital Twin

- Virtual representation of machinery/processes with interaction with the real world:
 - Model optimization → tuning
 - Virtual Commissioning → reduction of the overall production stage of a product
 - Process control
 - References for health monitoring → improve the detection of anomalous performance
 - ...

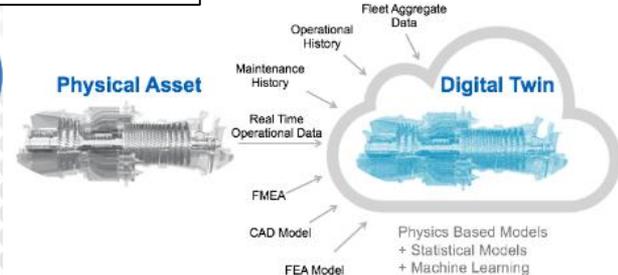


Digital Twin

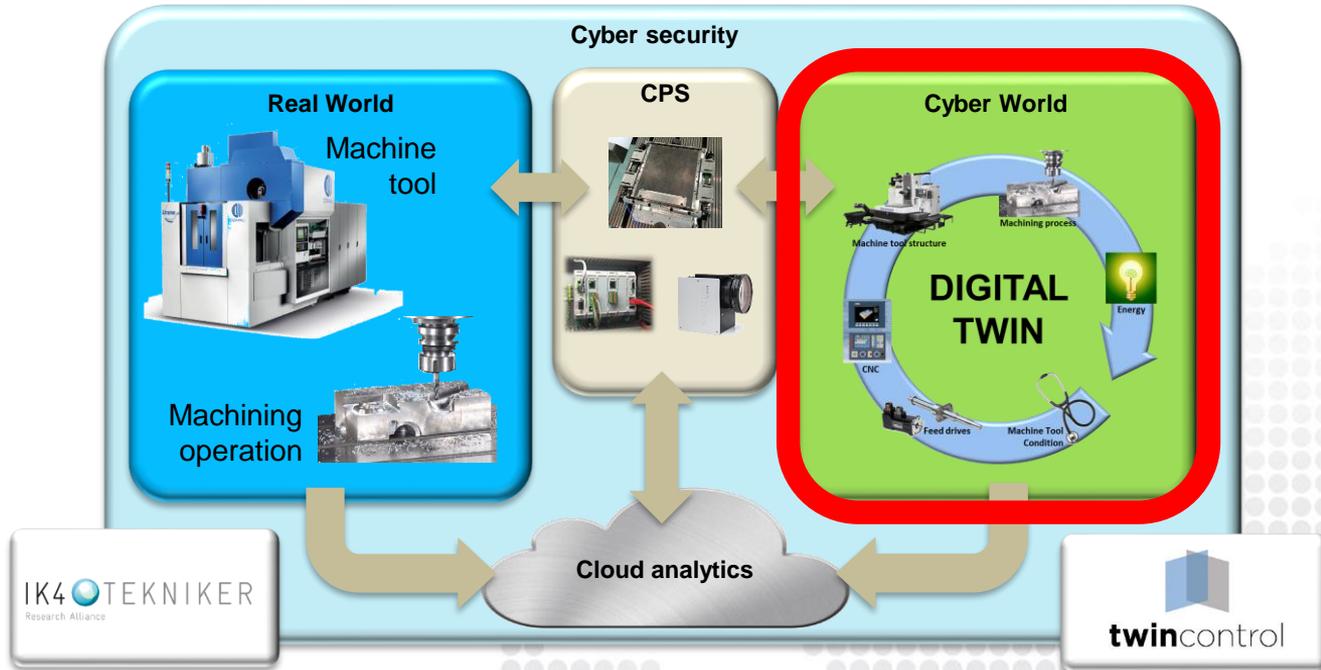
• Digital Twin in the market



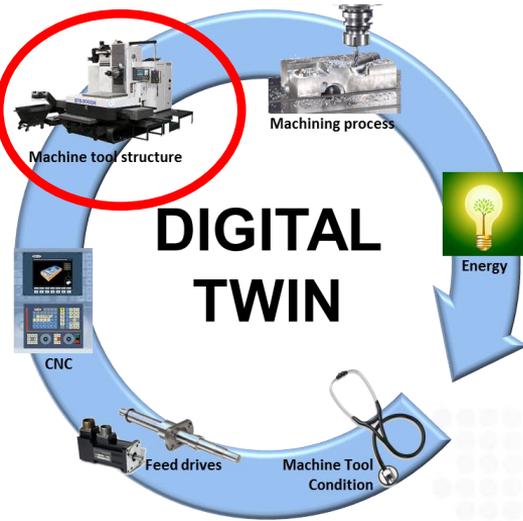
IBM



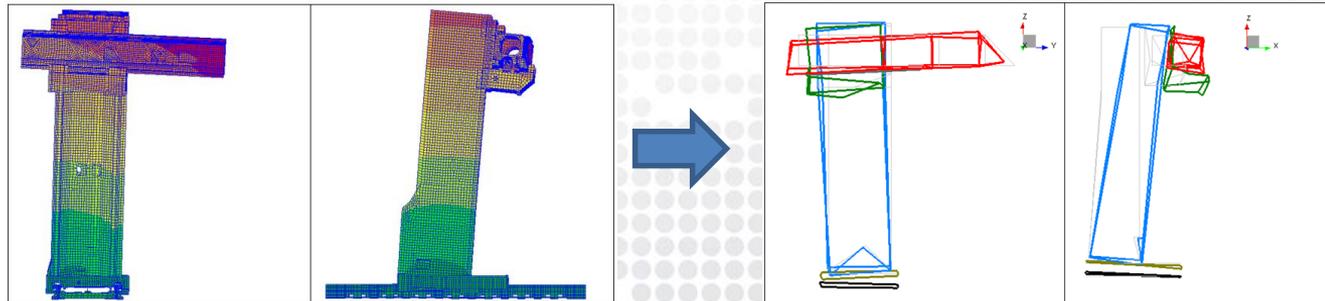
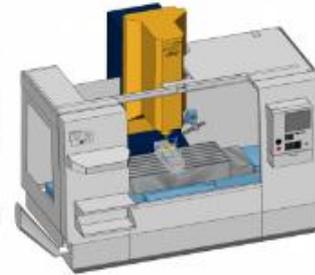
- Machine Tool as a CPS



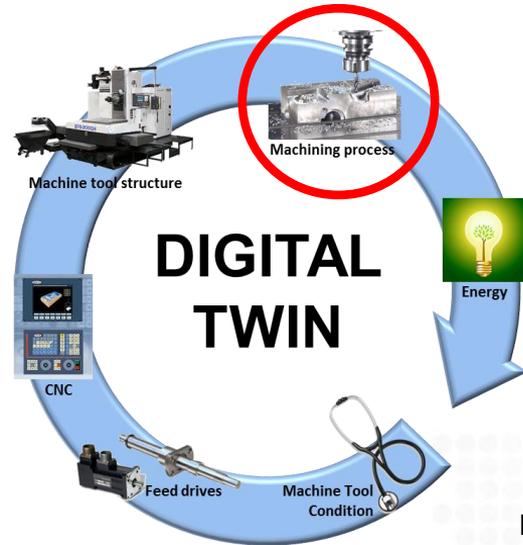
Digital Twin



- Machine Tool modelling
 - 3D design tools (CAD)
 - Rigid body models → Kinematics and component sizing
 - FEM analysis for structural optimization



Digital Twin

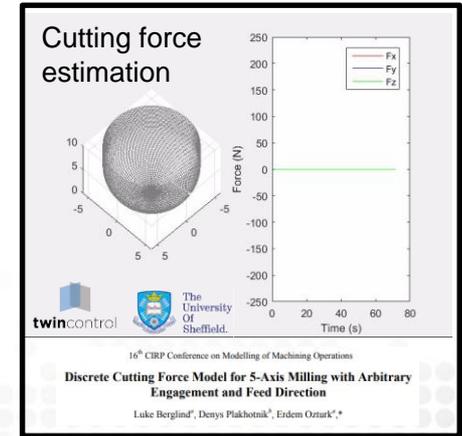
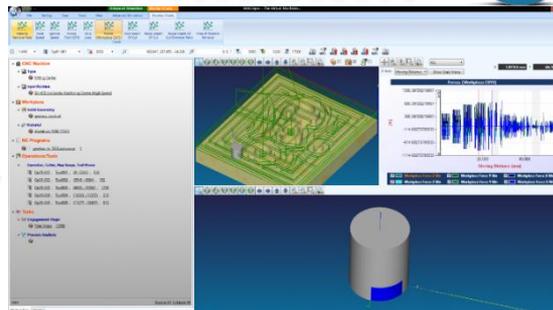


• Machining Process modelling

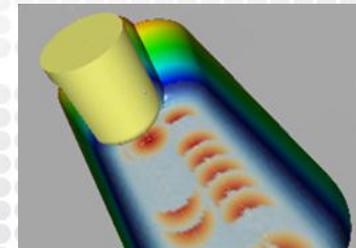
- Software available in the market: VERICUT, MACHPRO, etc.
- Tool path Simulation, Cutting force prediction, Stability analysis...

• Optimization

MACHPro → Feedrate scheduling



Visualization of process data over workpiece



Simulated and real data

Virtual Machine Tool

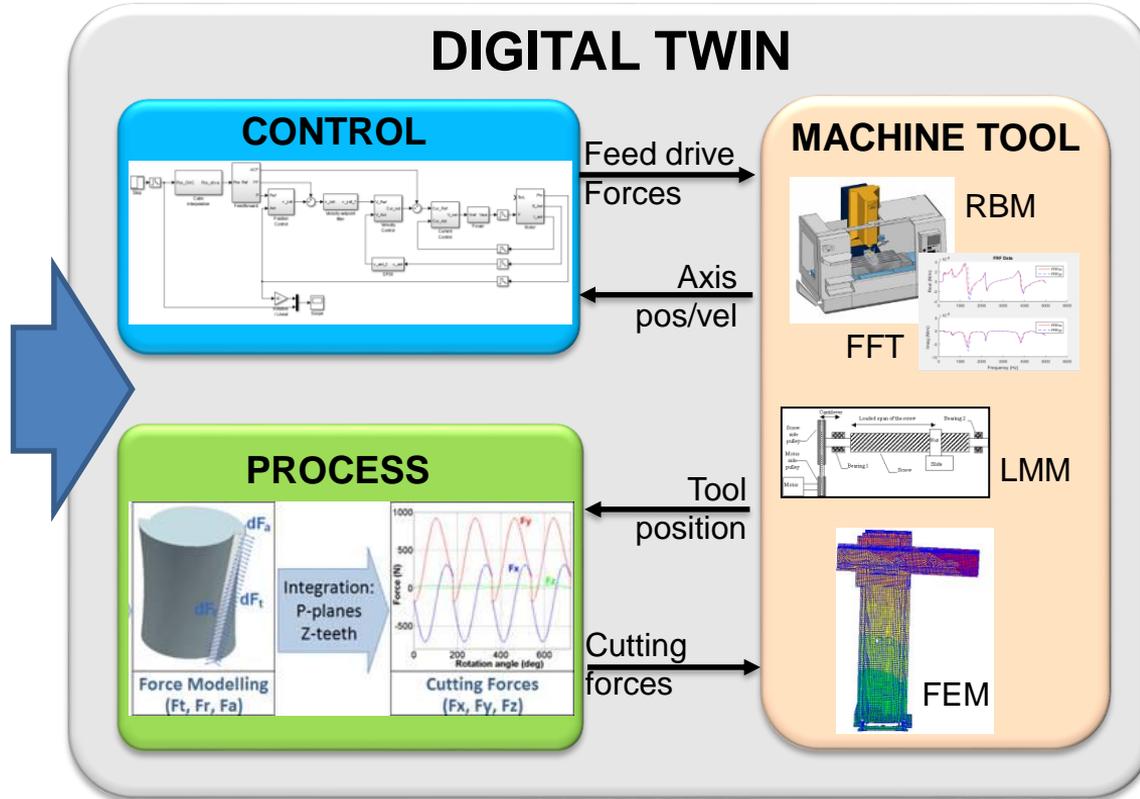
- Integration of machine dynamics, process, control and toolpath generation

Digital Twin

DIGITAL TWIN

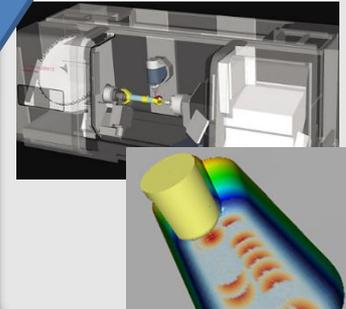


Process definition
(ISO code, CAM...)

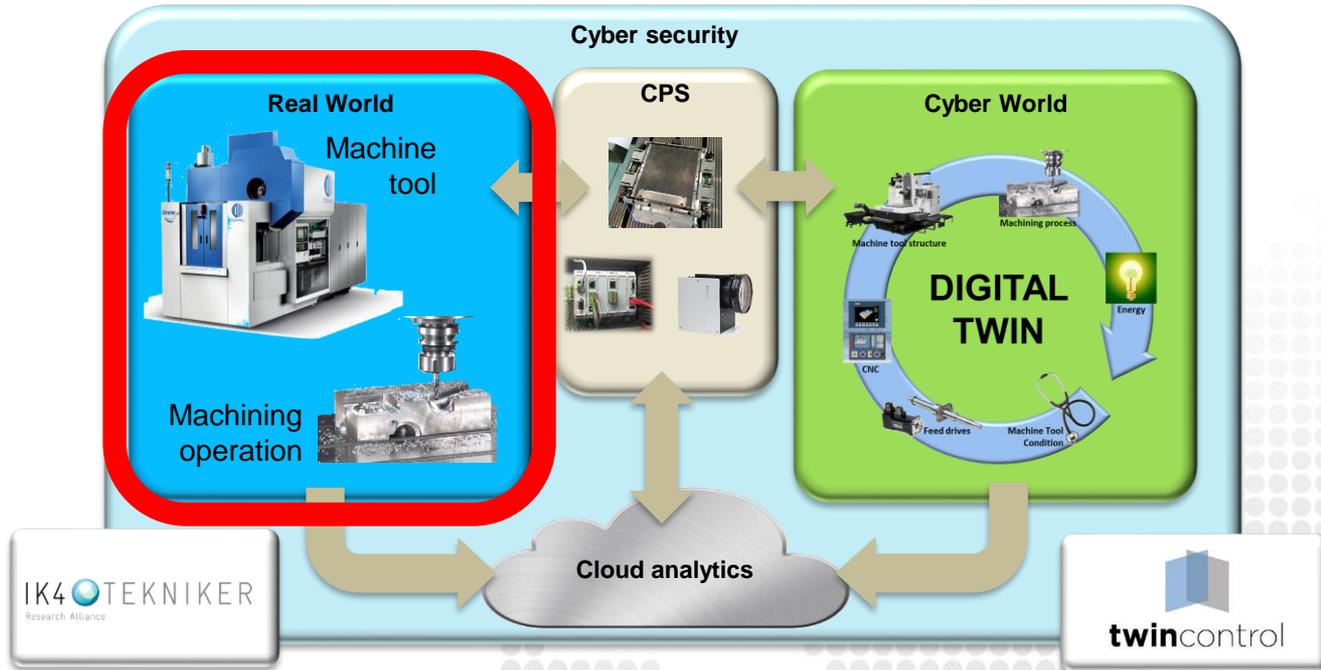


RESULTS

- Positions
- Part geometric errors
- Cutting forces
- Process stability
- Energy consumption
- etc

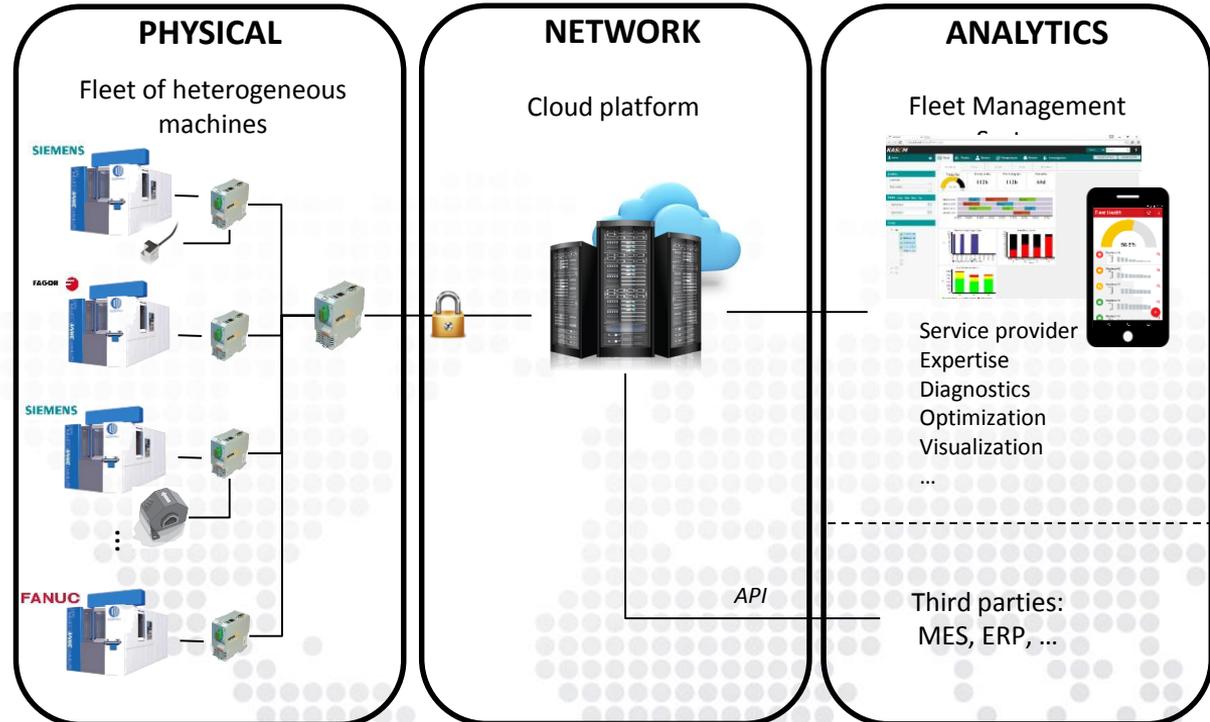
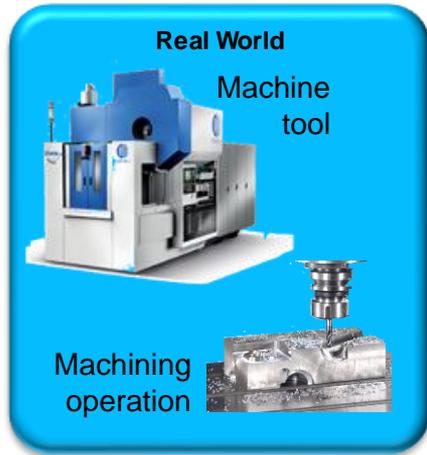


- Machine Tool as a CPS



Monitoring and data management

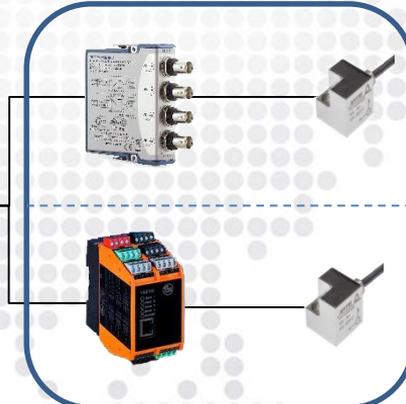
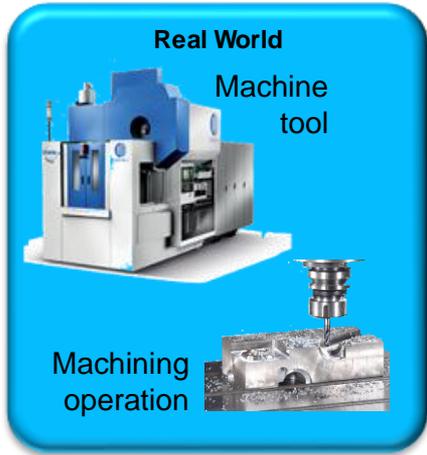
- Data monitoring and management architecture



Monitoring and data management

- Monitoring infrastructure - TEKNIKER

- Industrial micro-PC
 - Internal machine sensor monitoring (50-100 Hz)
 - Operating conditions (OPC - 1 Hz)
 - Local processing (Fingerprint, embedded models, etc)
 - Data upload to the cloud
- External sensors
 - Vibration analyses and others
 - Third party or ad-hoc hardware

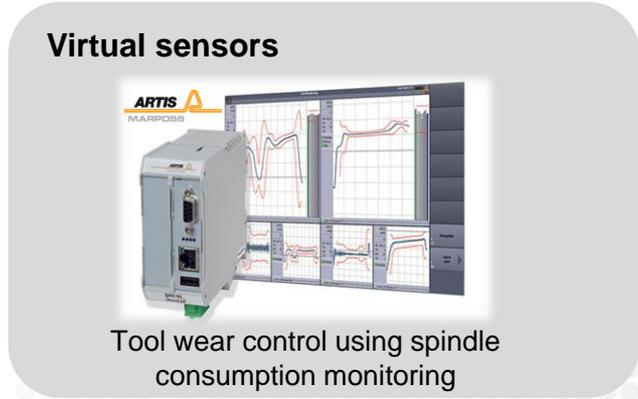
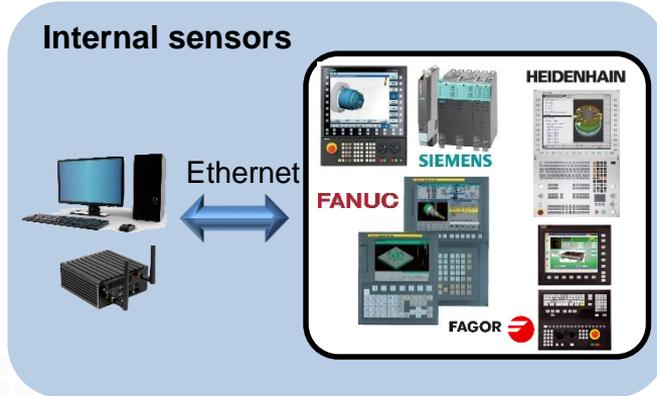
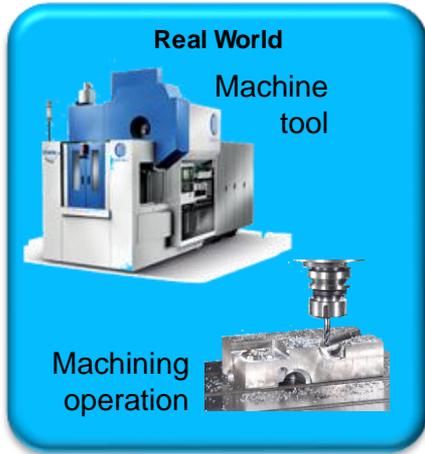


Ethernet

Ethernet

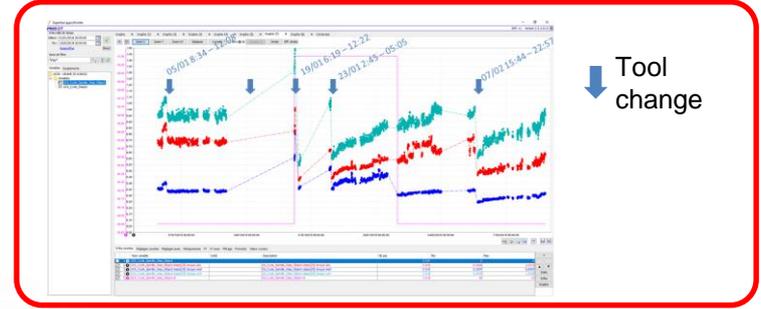
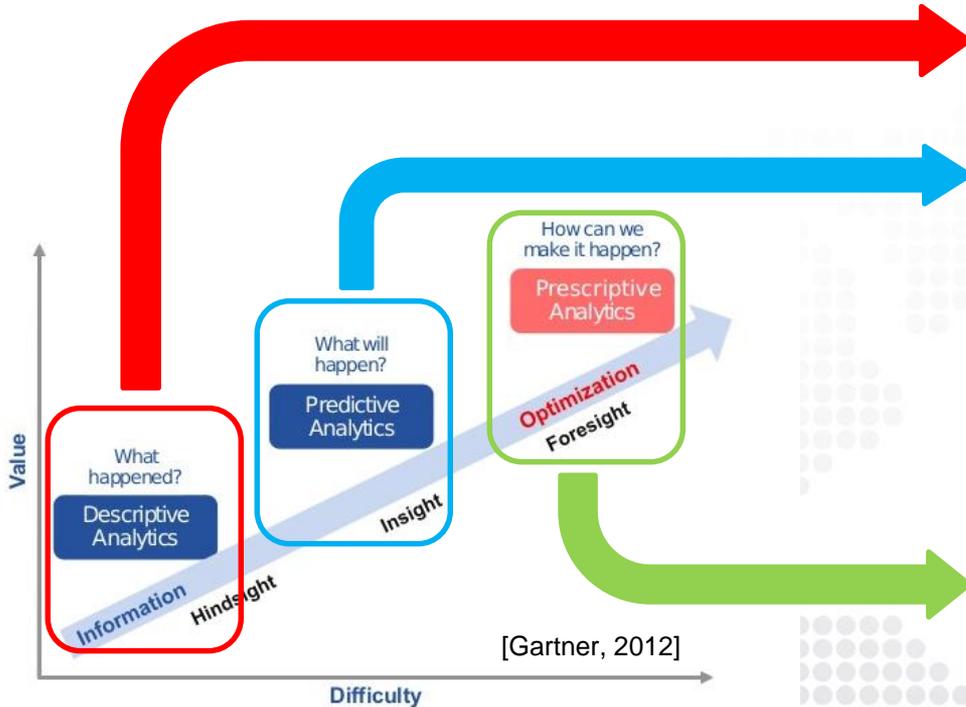
Monitoring and data management

- Data sources



Monitoring and data management

- Data analytics



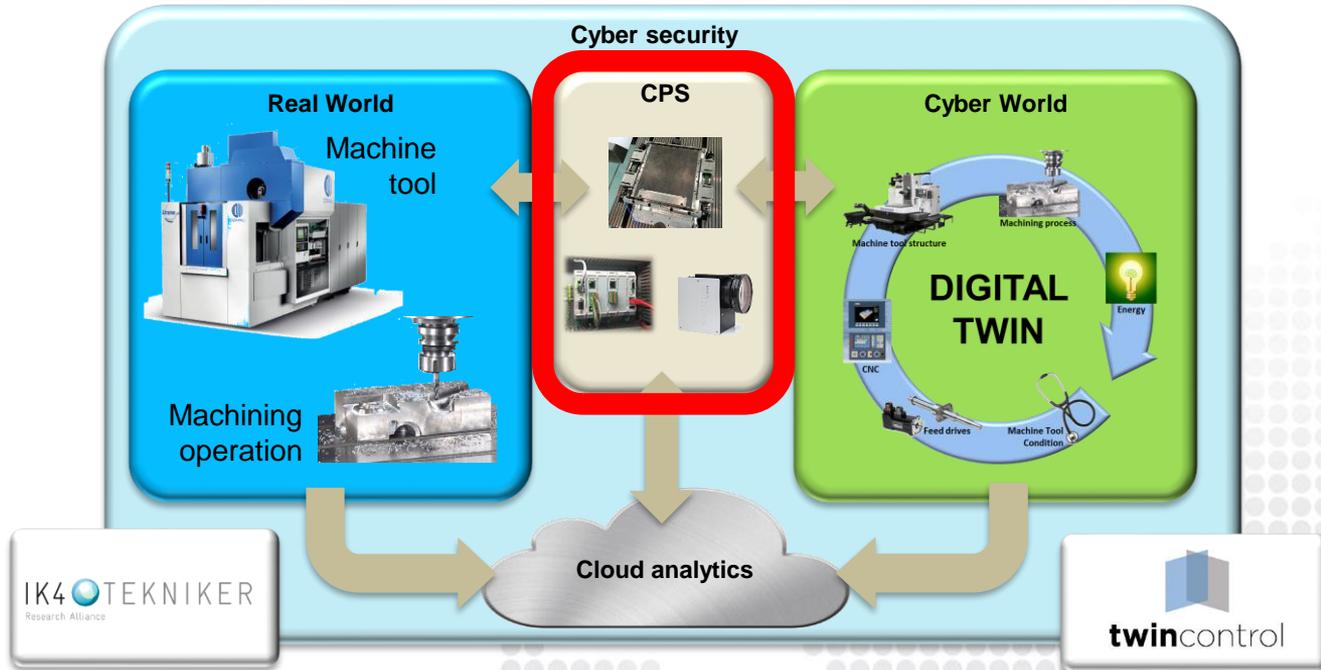
Learning of the wear curves and predict tool wear

Optimized tool usage
Minimization of tool breakage risk

Machining conditions adaptation according to tool wear and tool change events

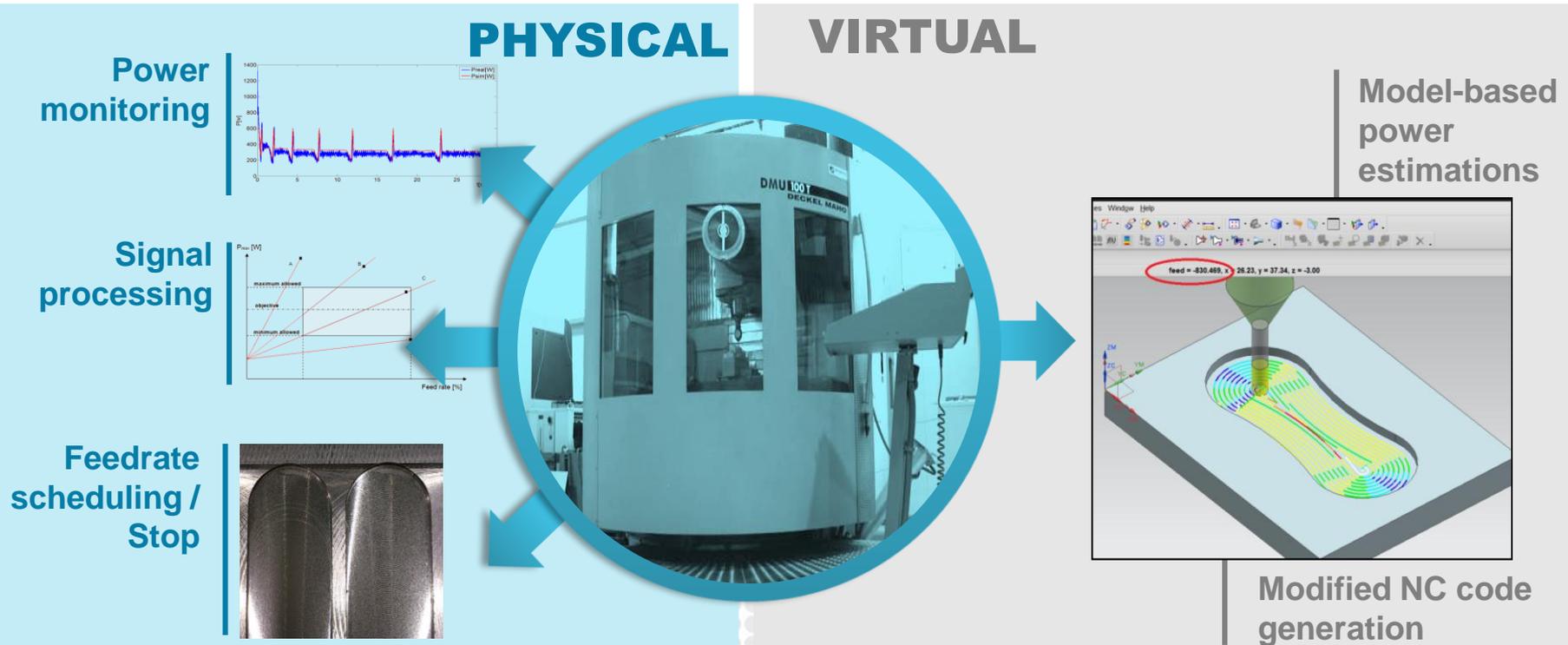
Automated tool management

- Machine Tool as a CPS



Cyber Physical System

- iCNC: Process optimization



Cyber Physical System

- CPSs for chatter suppression

CPS



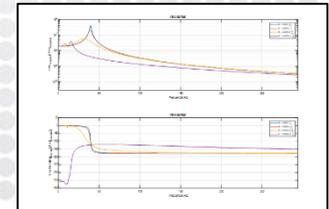
Accelerometer



Real time controller



Active Mass damper

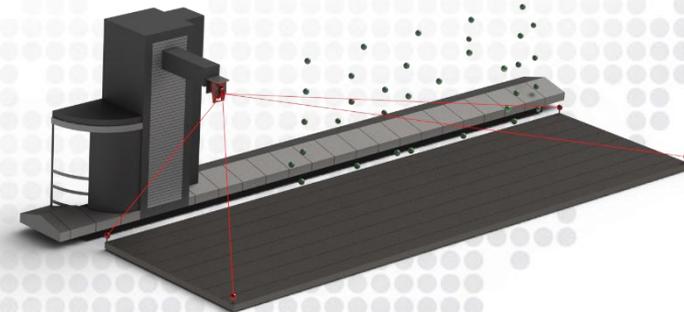
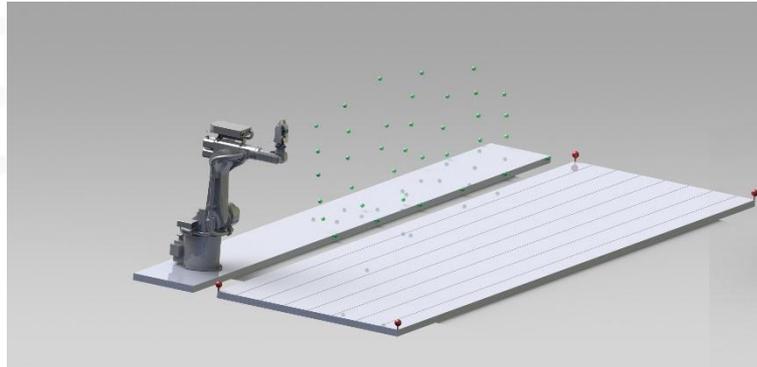


Cyber Physical System

CPS



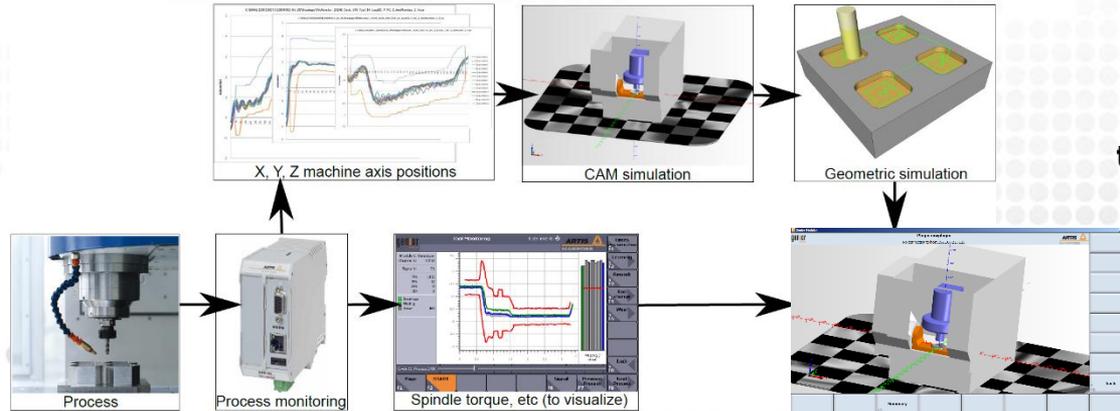
- Automatic MT geometric verification procedure
 - Installation of a laser tracker in the end-effector/tool
 - Reduction of verification time of big machines \rightarrow 75 %
 - Minimization of uncertainty due to thermal effects



Cyber Physical Systems

- Process supervision and adaptative control system
 - Integration of process and CNC Simulation models in the monitoring equipment
 - Usage of real data to:
 - Feed the models
 - Compare with simulated references

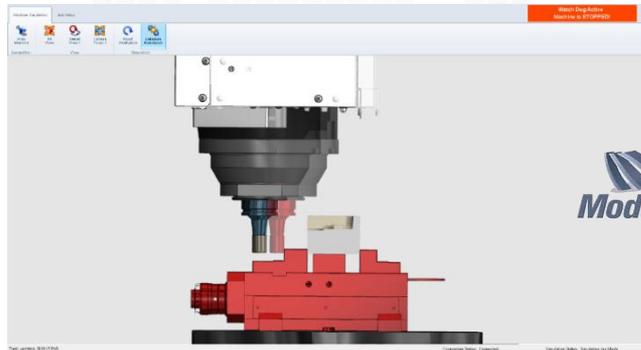
CPS



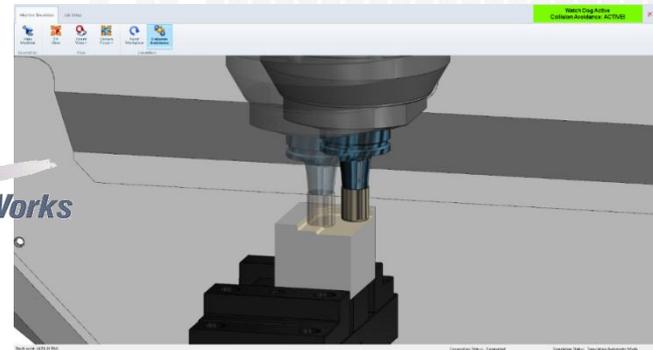
Cyber Physical Systems

- Process supervision and adaptative control system
 - Collision Avoidance System
 - Avoid machine crashes by look ahead simulation of NC code including:
 - Dynamic workpiece & fixture
 - Tool shape (including holder / adapters)
 - Realistic 3D machine model
 - Support of all operating modes: AUTO / MDI / JOG modes
 - Integration in CNCs or external hardware

CPS



ModuleWorks



Conclusions

- ICT advances enable the possibility to improve MT performance through all its lifecycle
- Simulation models getting closer to reality and with enhanced possibilities: Virtual Commissioning, health monitoring...
- Monitoring and data management: several products available but companies still reluctant to “share” data
- There are commercial partners ready to sell projects results: SAMTECH-SIEMENS, ARTIS, PREDICT, MODULE WORKS

SIEMENS


ModuleWorks


ARTIS
MARPOSS


PREDICT

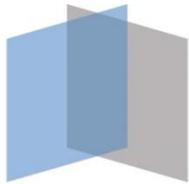

COMAU


gepro
systems


MESA


RENAULT

Thank you for your attention



twincontrol
(<http://twincontrol.eu/>)

Grant agreement
680725

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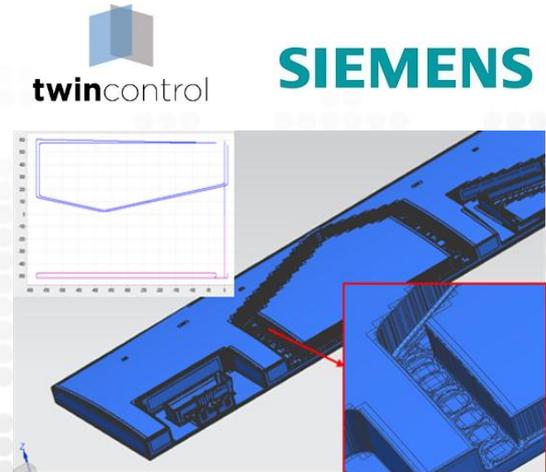
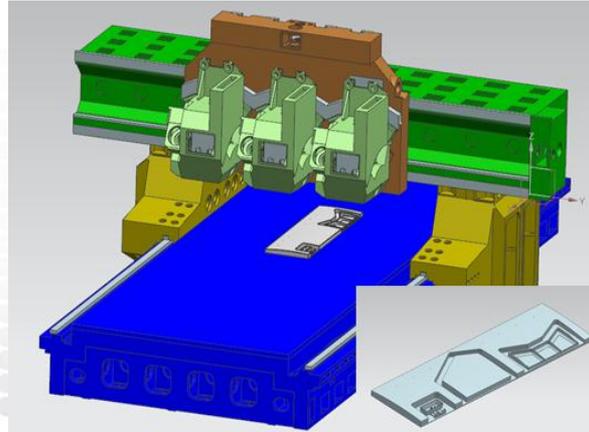
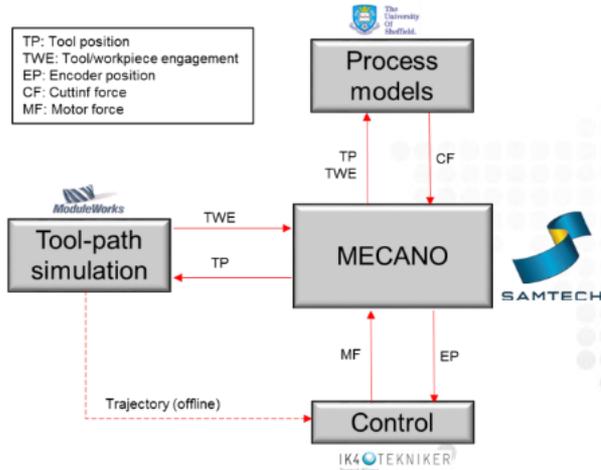
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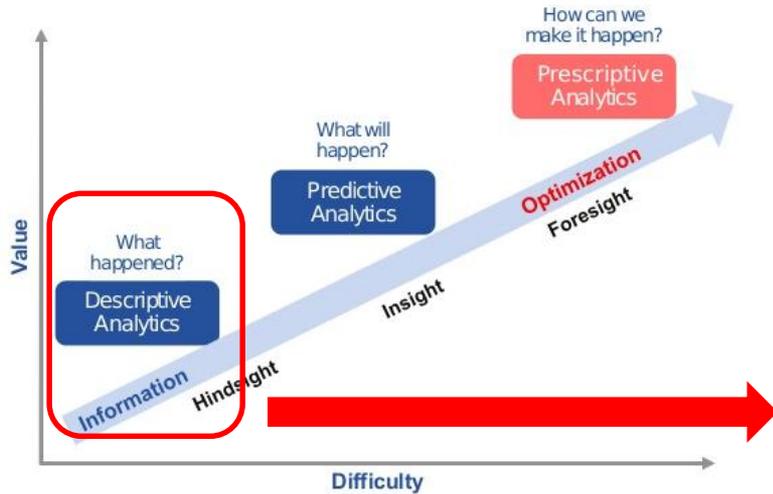
Digital Twin

- Virtual Machine Tool
 - Integration of machine dynamics, process, control and toolpath generation



Monitoring and data management

- Data analytics



Derived from: Gartner (December 2012)



Usage and MT characterisation test reports

