
Source: Daimler AG

# Trends in Manufacturing Execution Systems (MES)

**- How digital manufacturing and MES merge -**



Neuss, October 12, 2009

# Contents







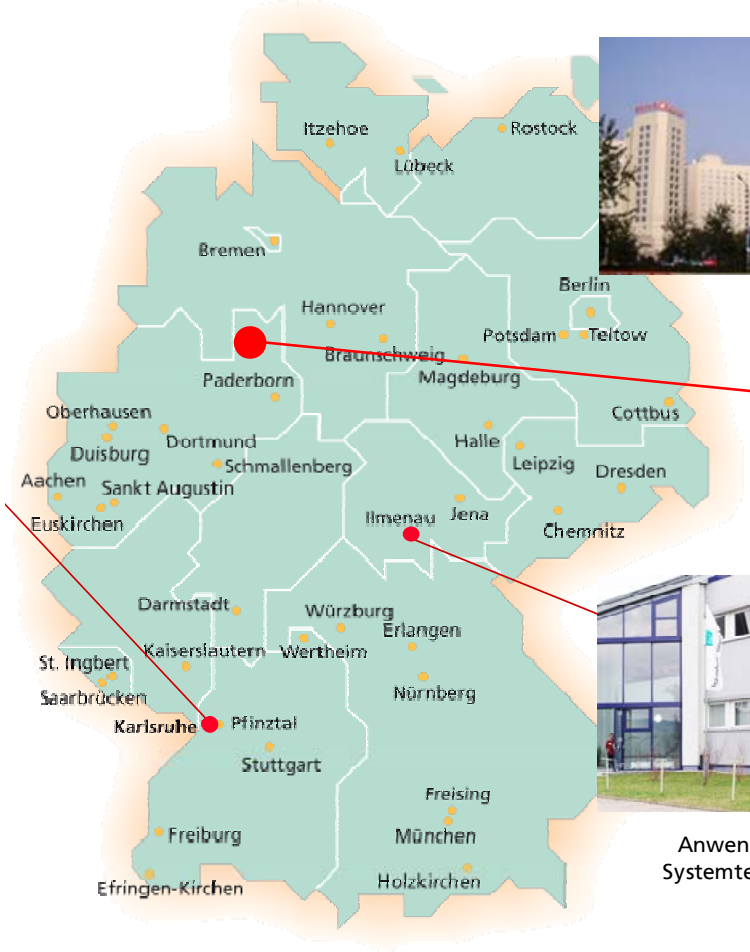


Fraunhofer IITB

# 1. Short introduction to Fraunhofer IITB

- **Applied research**
- **56 institutes**
- **40 locations in Germany**
- **12 800 employees**
- **1 Billion € budget**

- **IITB: 20 mio. € budget**
- **Staff: 195**




Representative
Peking

**Competence center**
**Industrial Automation**

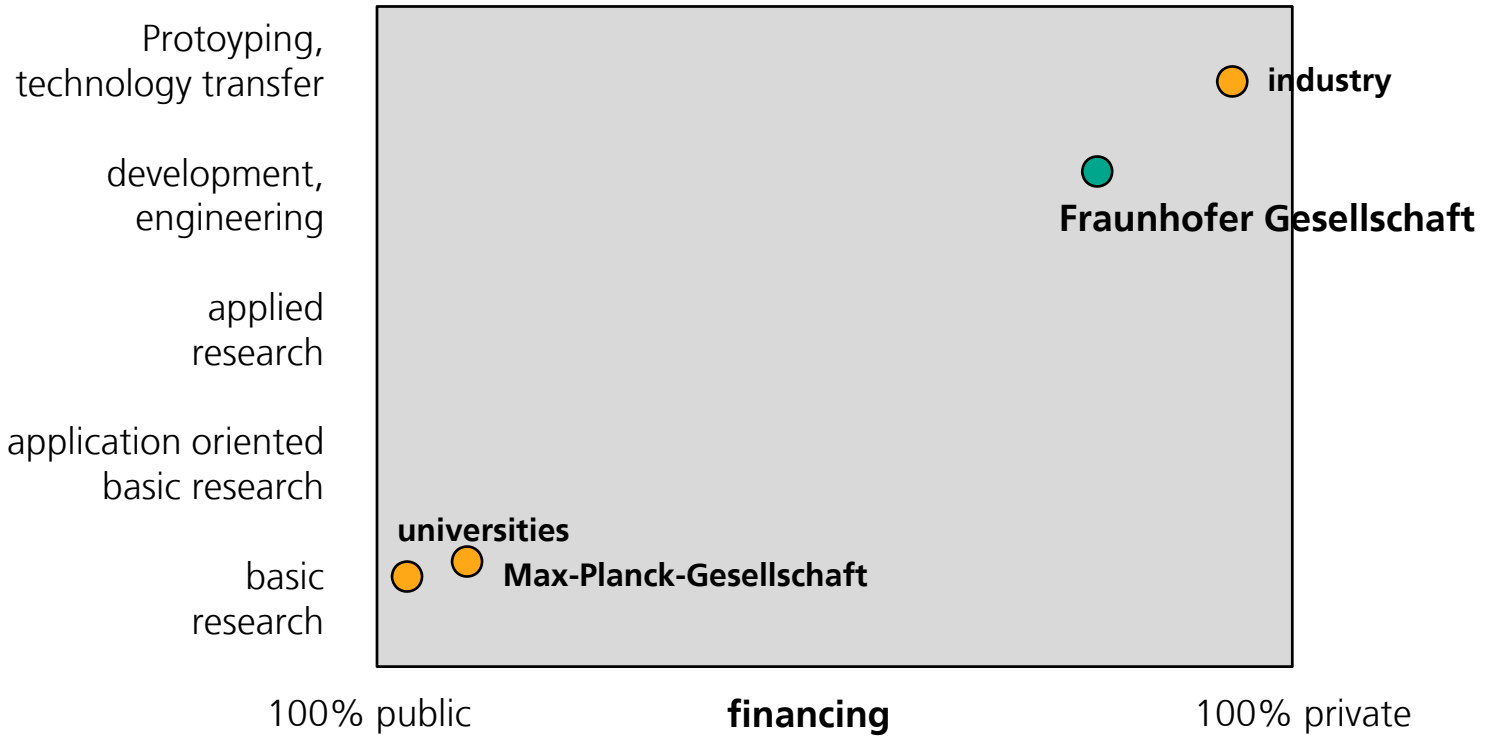
Anwendungszentrum
Systemtechnik Ilmenau



Fraunhofer
IITB

# 1. Short introduction to Fraunhofer

## R&D-process and how it is financed in Germany





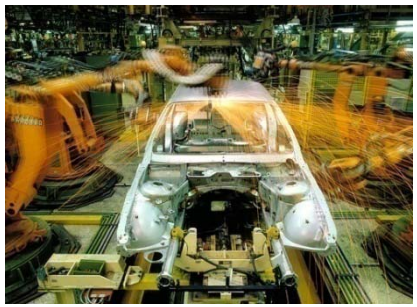





Fraunhofer IITB

# 1. Services and products of IITB's business unit PMC

ProVis.Agent®



FLS-NEXT
THE NEXT GENERATION

INNOVATIONSPREIS 2007
initiative mittelstand
AUSZEICHNUNG WEB 2.0

## Production monitoring

- Shared realtime applications for facility monitoring
- Business intelligence tools for KPI calculation
- Control rooms, visualization, SCADA-functions, OPC-solutions

## Digital engineering

- Plug-and-work-methods for facilities and MES
- Solutions for virtual commissioning and approval with MES
- Standards for consistent exchange of engineering data

## Innovative MES-components

- Optimization algorithms for manufacturing
- Advanced planning and scheduling
- MES consulting







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# 1. Examples for current projects

Annealed (1.250°C) steel slab, app. 150 t, process control and monitoring system made by FhG-IITB

- **Production monitoring system ProVis.Agent, Daimler AG, plants Bremen, Sindelfingen and Woerth, in body, paint, assembly incl. hotline and service**
- **Production monitoring & control system for 20 annealing furnaces, ThyssenKrupp Stahl AG, Duisburg plant incl. hotline and service**
- **Development of IO-Module (‚Primary Data Manager - PDM') incl. PLC-connection via 'Integra-channel' for Siemens, business unit A&D**
- **Logistic concept for engine factories (Z-Car engine, 6-cyl. Diesel engine) for Daimler at Berlin and Koelleda plant; reduction of procurement time from LLZ to assembly line**
- **Concept and prototype for a plug-and-work connection of digital factory tools and MES components in cooperation with Daimler's AutomationML initiative**
- **Advanced planning and scheduling tool for different customers in discrete manufacturing, e.g. Micronas AG**
- **Concept and realization of a central control room in a press shop of an automotive plant**







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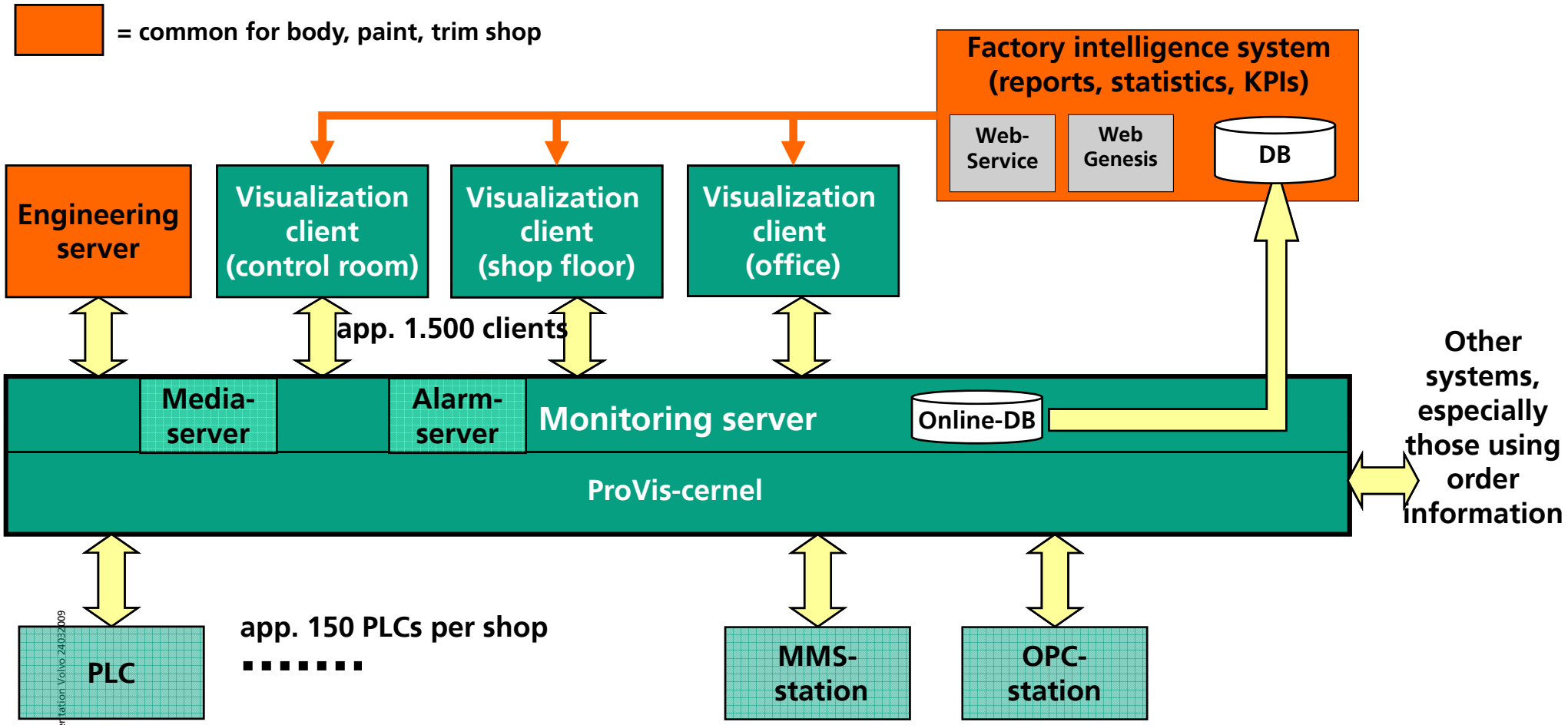
# 2. Production monitoring in discrete manufacturing processes

ProVis.Agent®







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# 2. Central monitoring and control room

**Control room C-class trim shop Daimler AG, Bremen plant**

**Picture: Daimler**

**In the Bremen plant ProVis.Agent monitors and controls app. 450 PLCs of app. 2.000 facilities in body, paint and assembly; 1.560 users access the webbased reporting system.**

**Control room press shop Daimler AG**

**Picture: Jungmann Systemtechnik**

**In the press shop ProVis.Agent is used as an integration platform for facilities, IT-systems and cameras. It visualizes the entire process from coil delivery to scrap disposal.**







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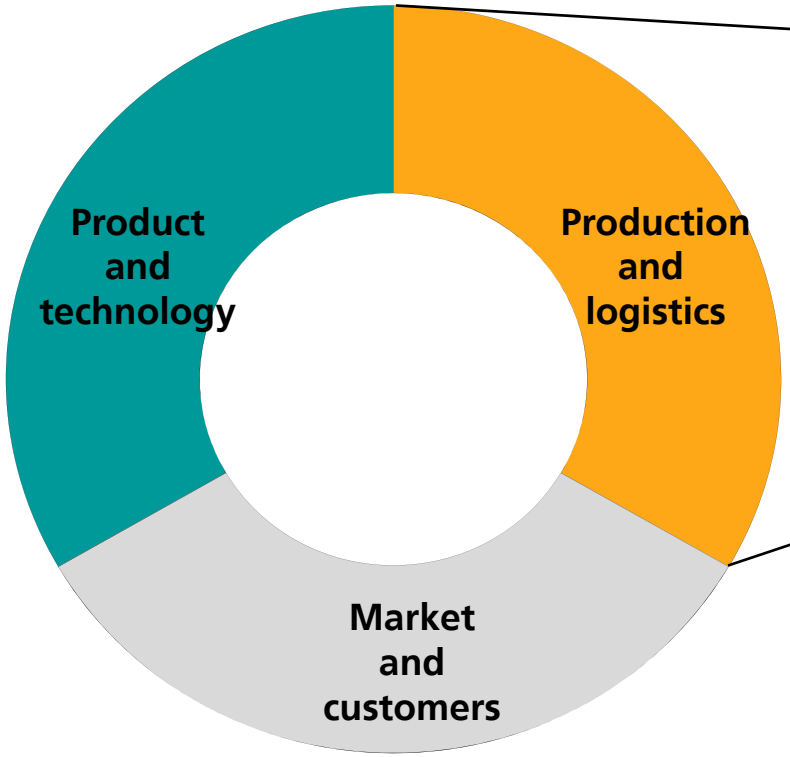
# 3. Core factors for successful manufacturing companies (source: Bischoff, J.; et.al.: Automobilbau mit Zukunft)




**Three key success factors for future (automotive) production:**

1. **Adaptivity**
2. **Realtime ability**
3. **Production in networks**







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# 3. Visions: the future of Manufacturing Execution Systems

1. **Future MES will be integrated with the digital factory, e.g. supporting permanent planning ability**

2. **MES are going to be vertically integrated with the shop floor level applying standard plug-and-work-mechanisms**

3. Simulation will become a frontend to enable real time simulation for decision support regarding unexpected changes on the shopfloor

4. Horizontal integration concerning MES means service-oriented architectures and comprehensive data management

5. MES will become completely scalable down to the support of self-organizing manufacturing („RFID instead of factory data acquisition“)

6. Future MES are „human-centered“ concerning supply of information according to the user's task and role

7. Correlations between different data bases found by methods like data mining will lead to 'automatic control' of processes.





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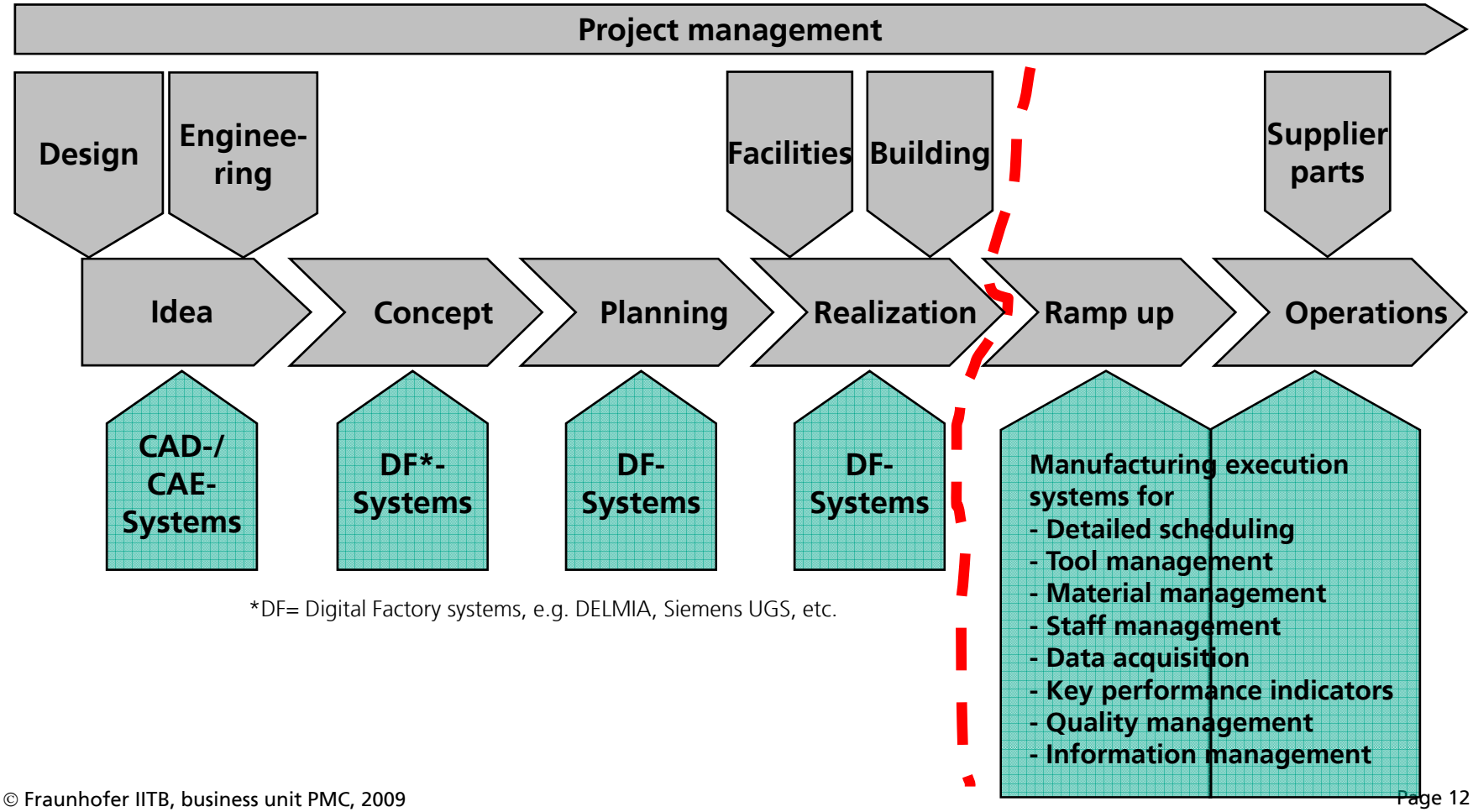
# 3.1 Reference model for factory planning: connection of planning and operations




*DF= Digital Factory systems, e.g. DELMIA, Siemens UGS, etc.







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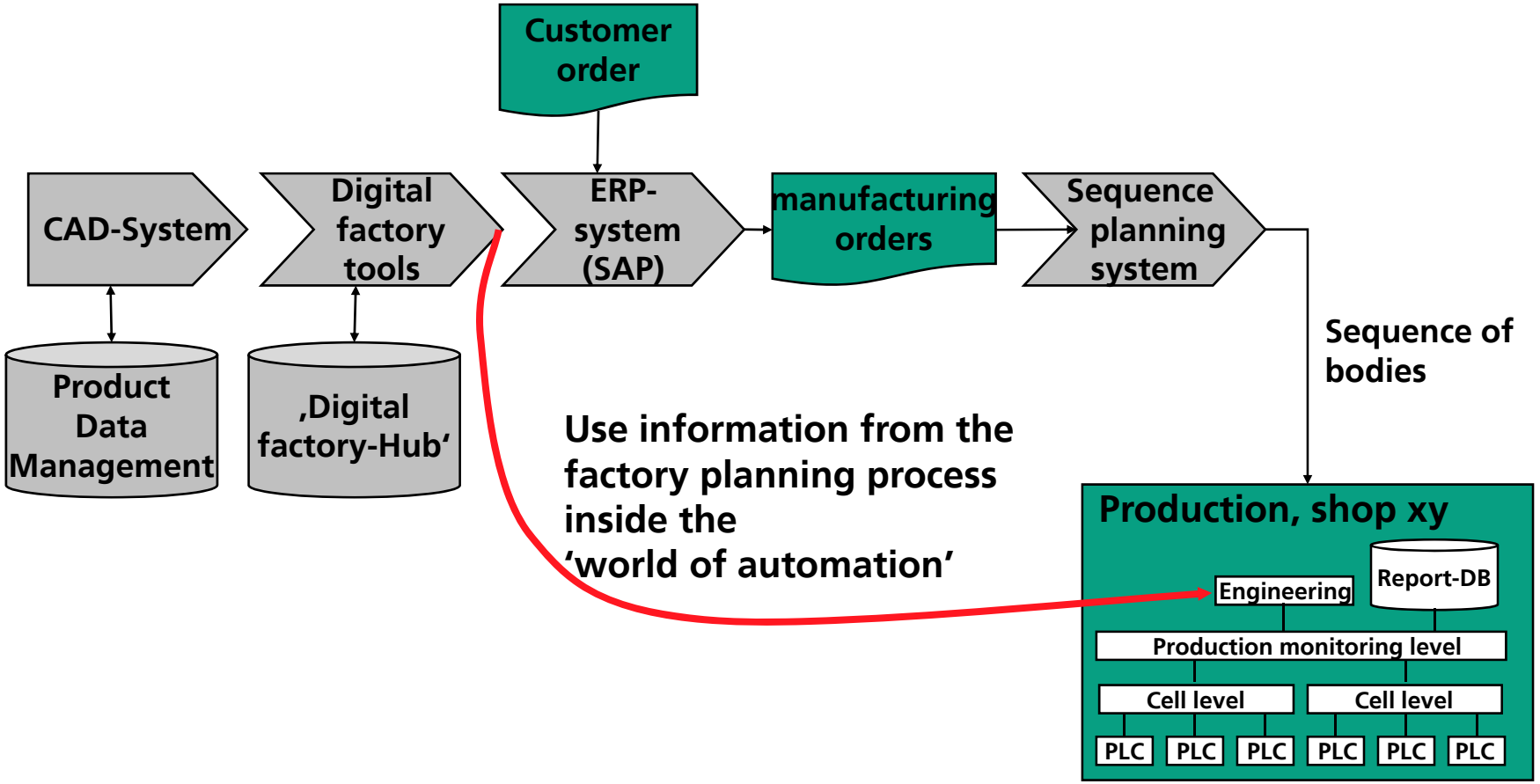
# 3.1 Main idea for connection of planning and operations







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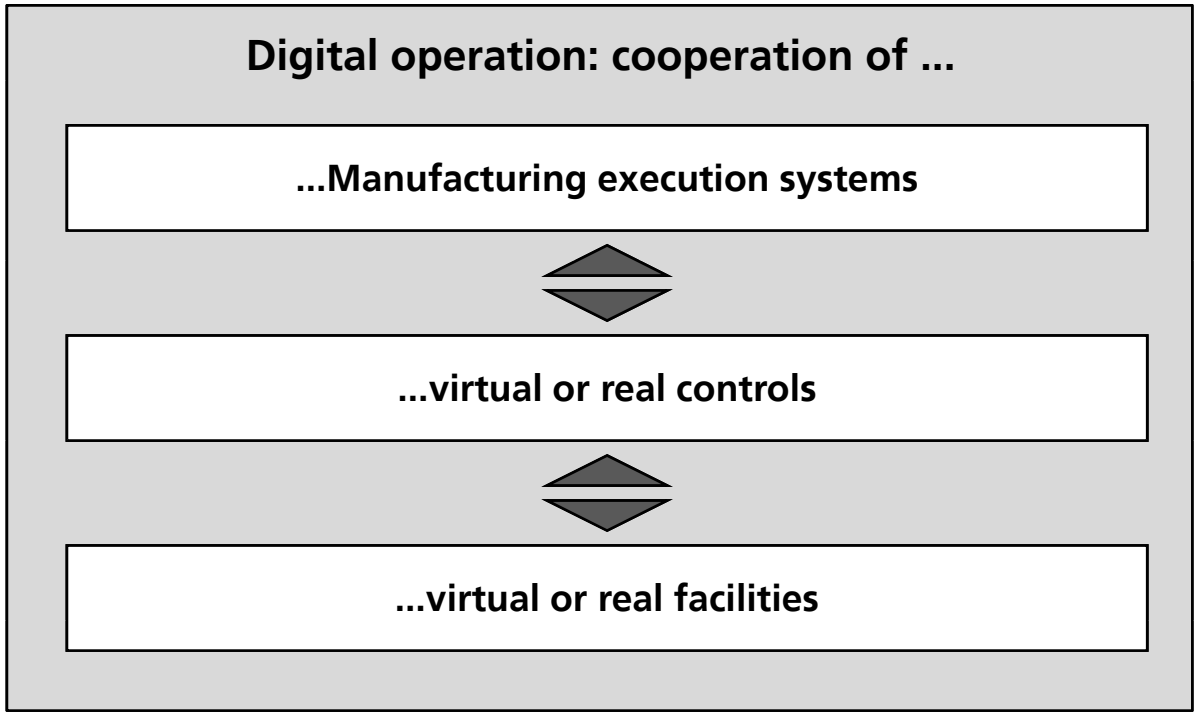
# 3.1 Current activities concerning digital operation







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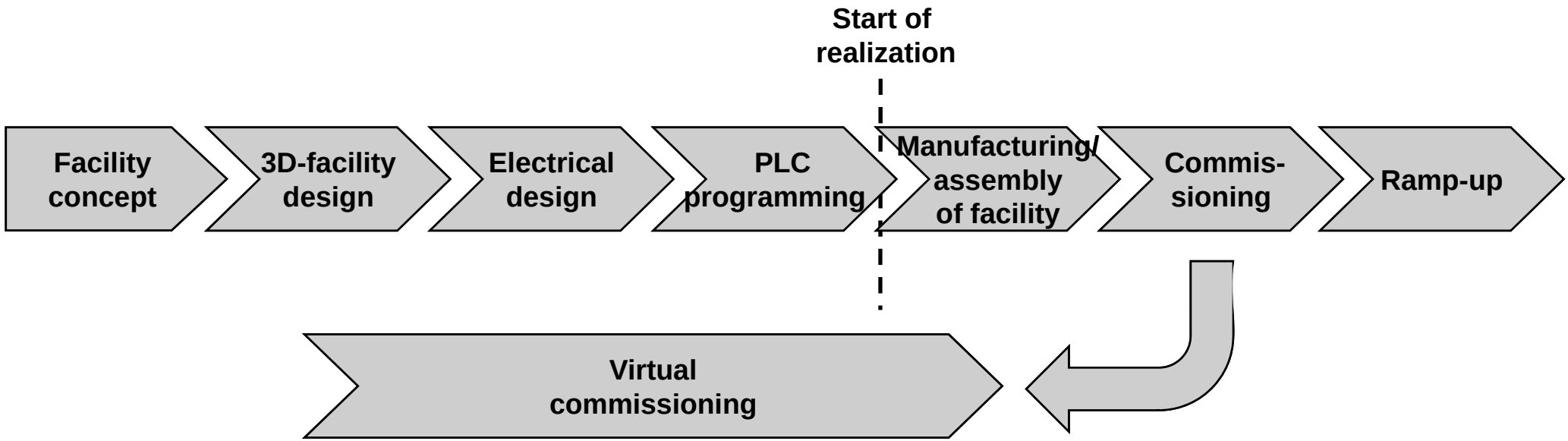
# 3.1 Virtual commissioning







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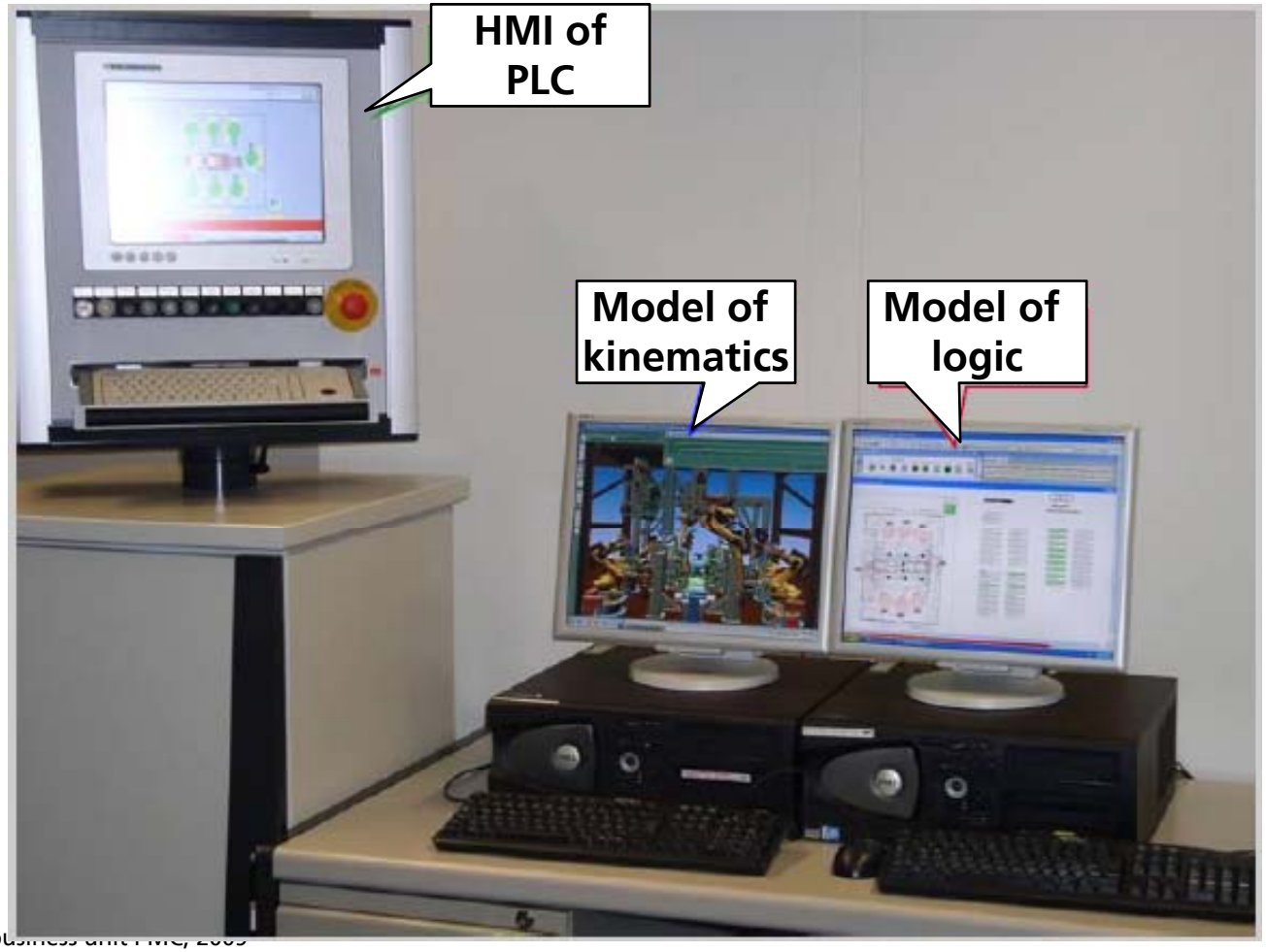
# 3.1 Actual working place for virtual commissioning (source: AUDI)





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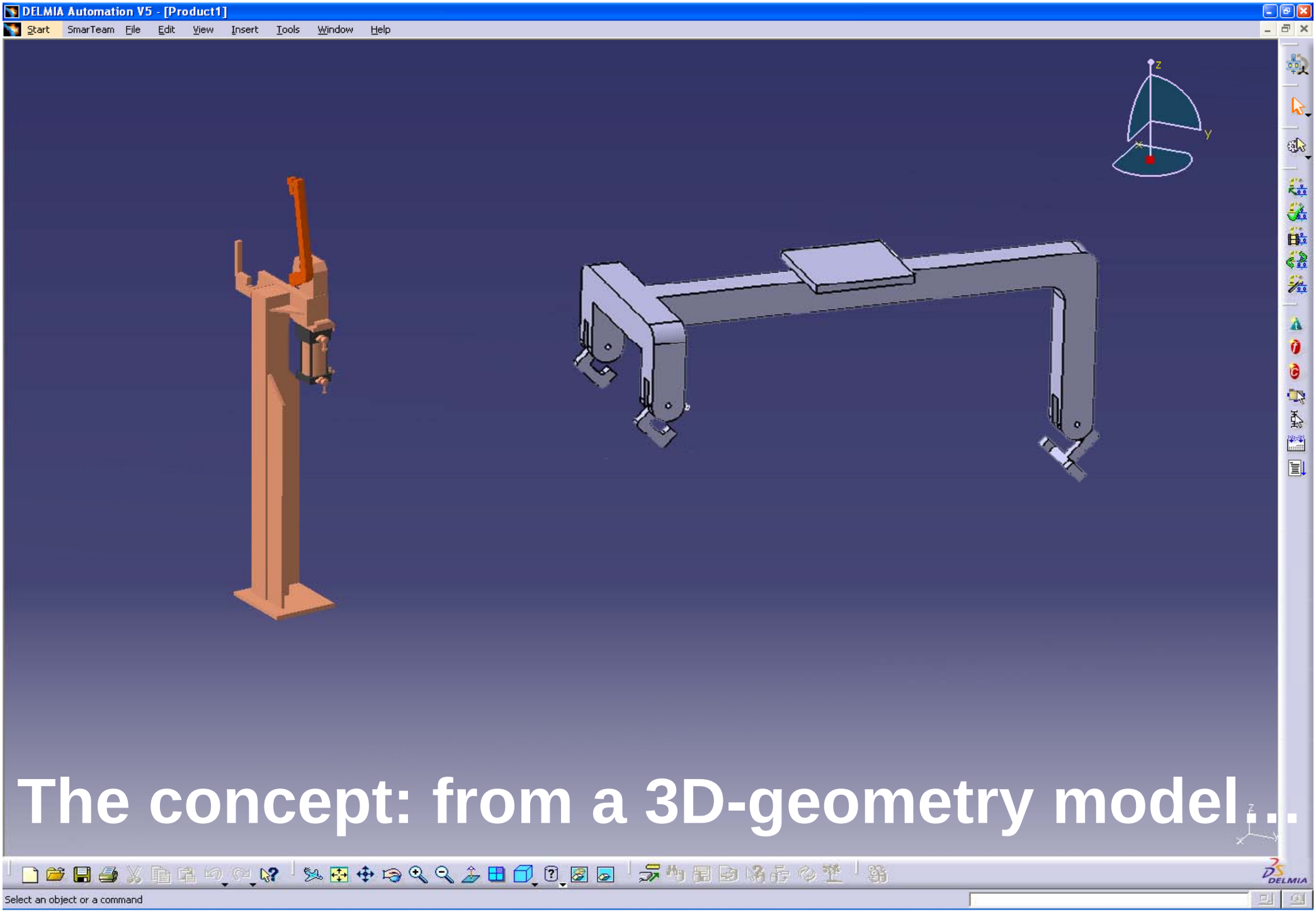
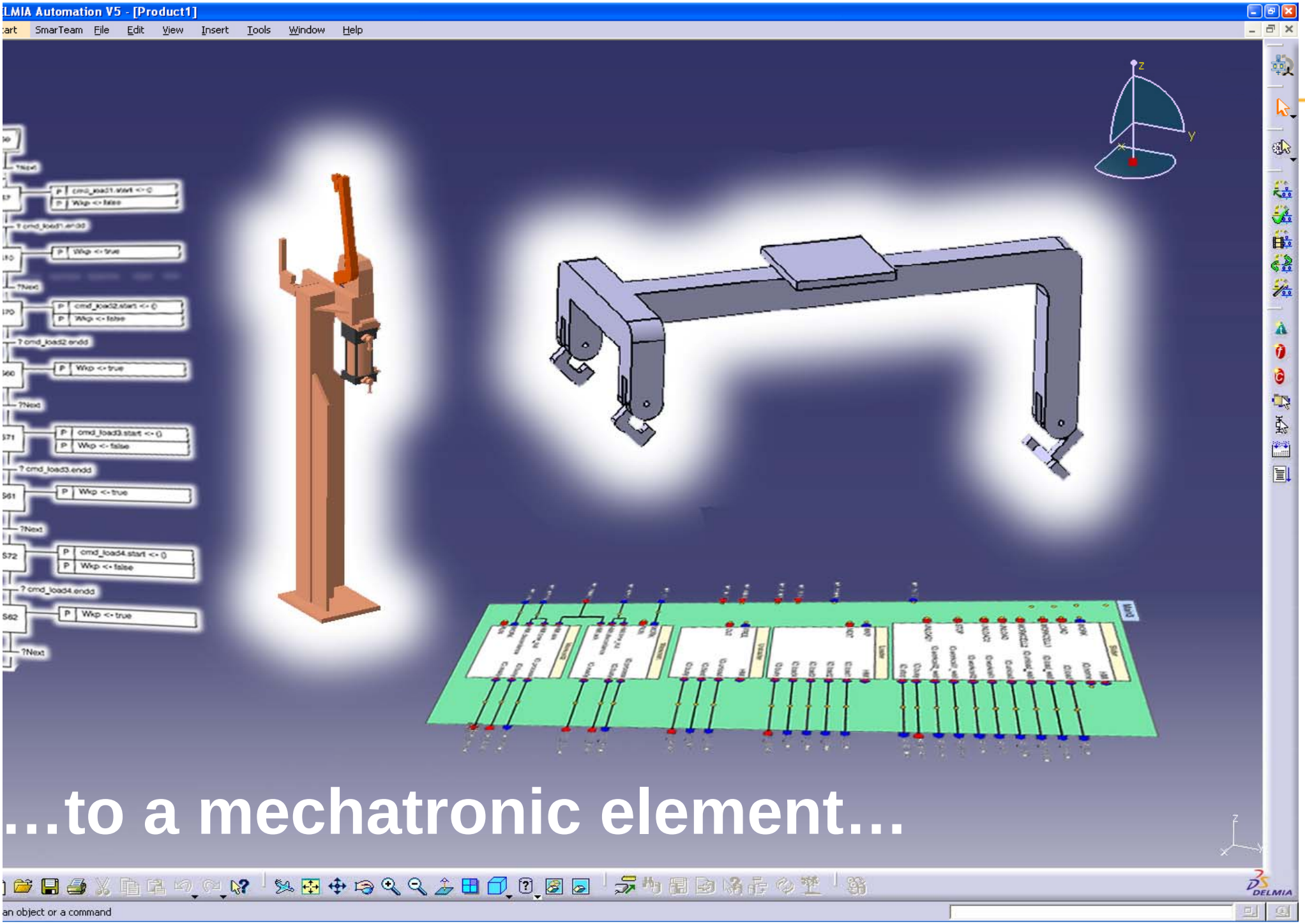
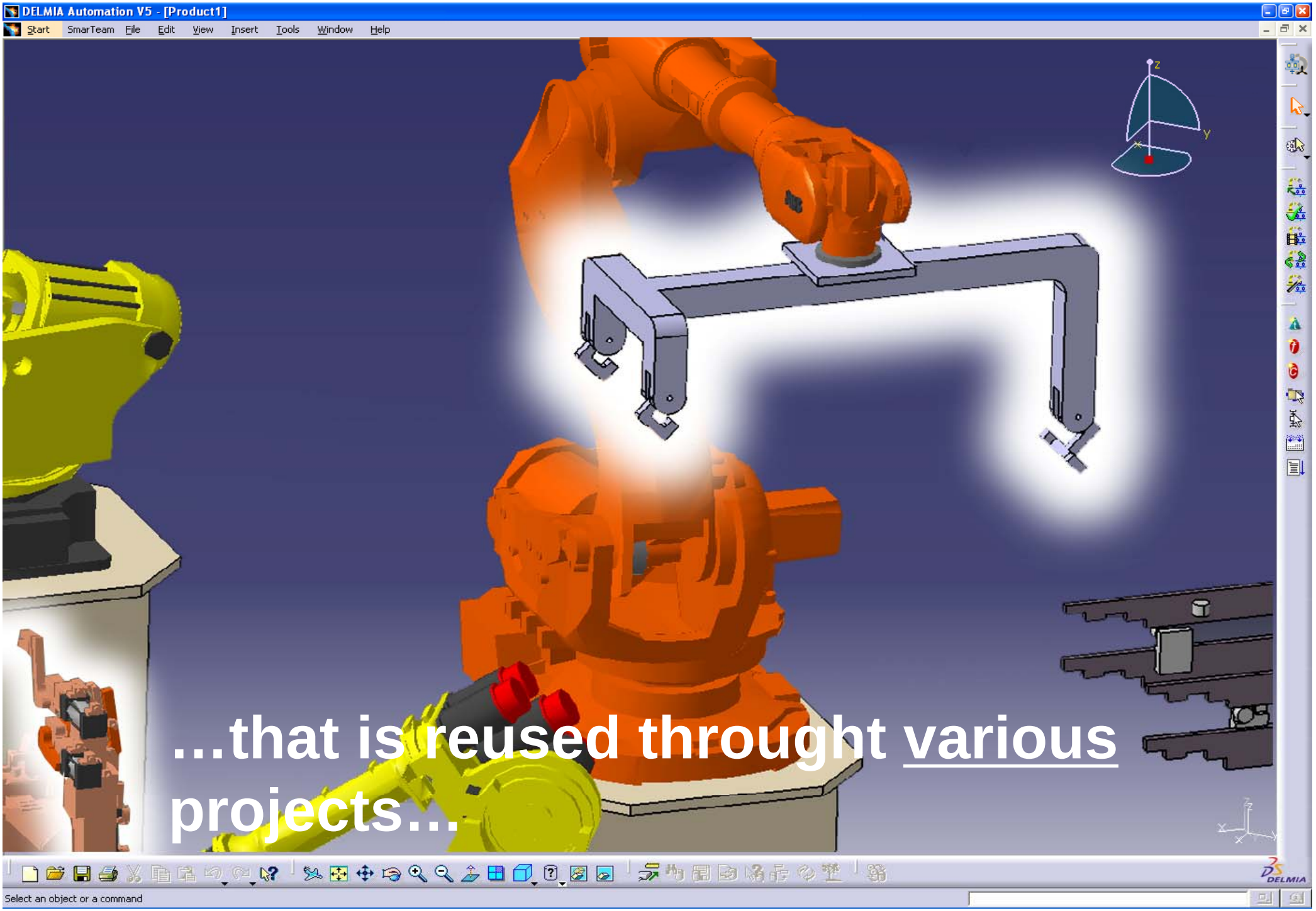
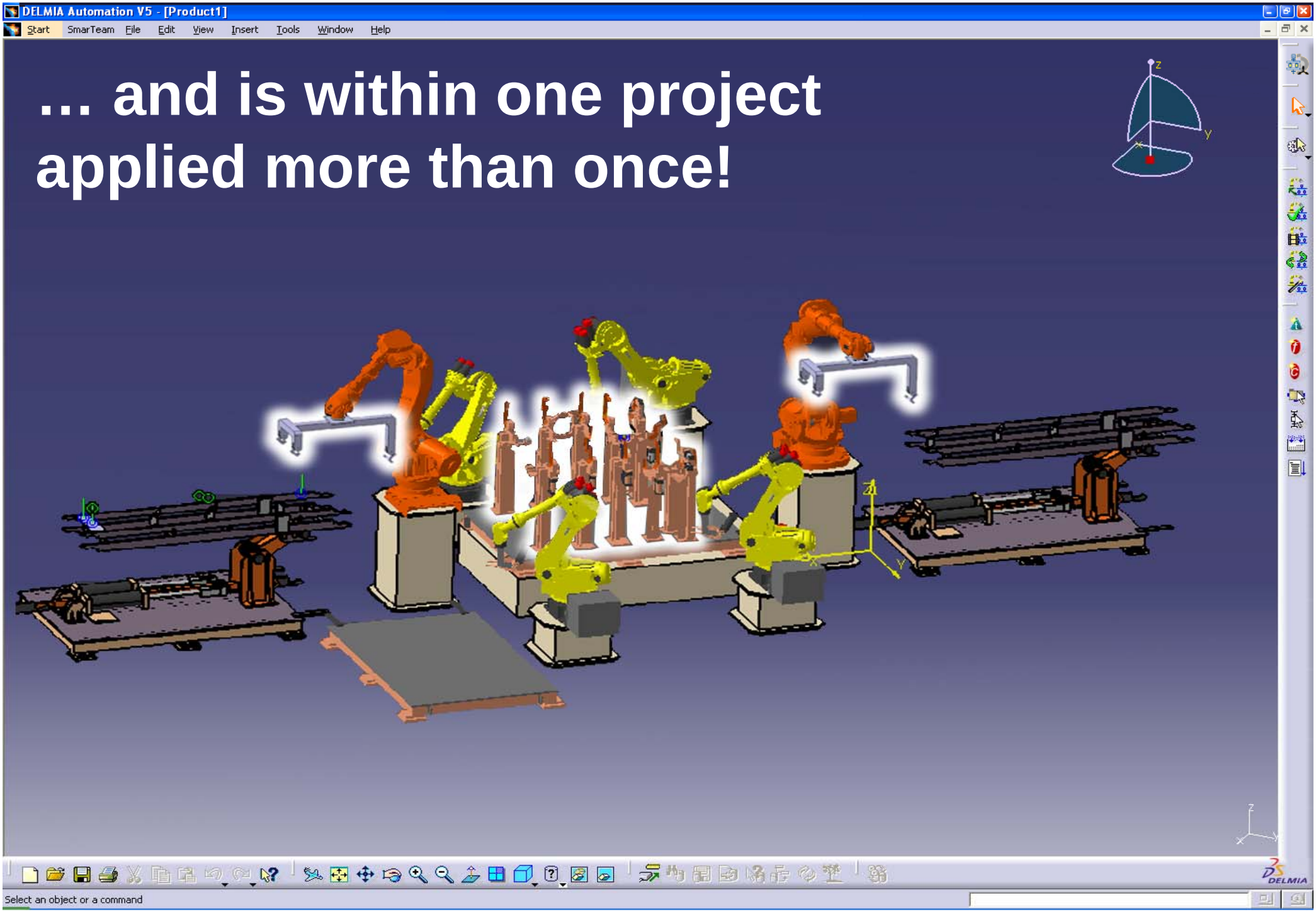



# The concept: from a 3D-geometry model…

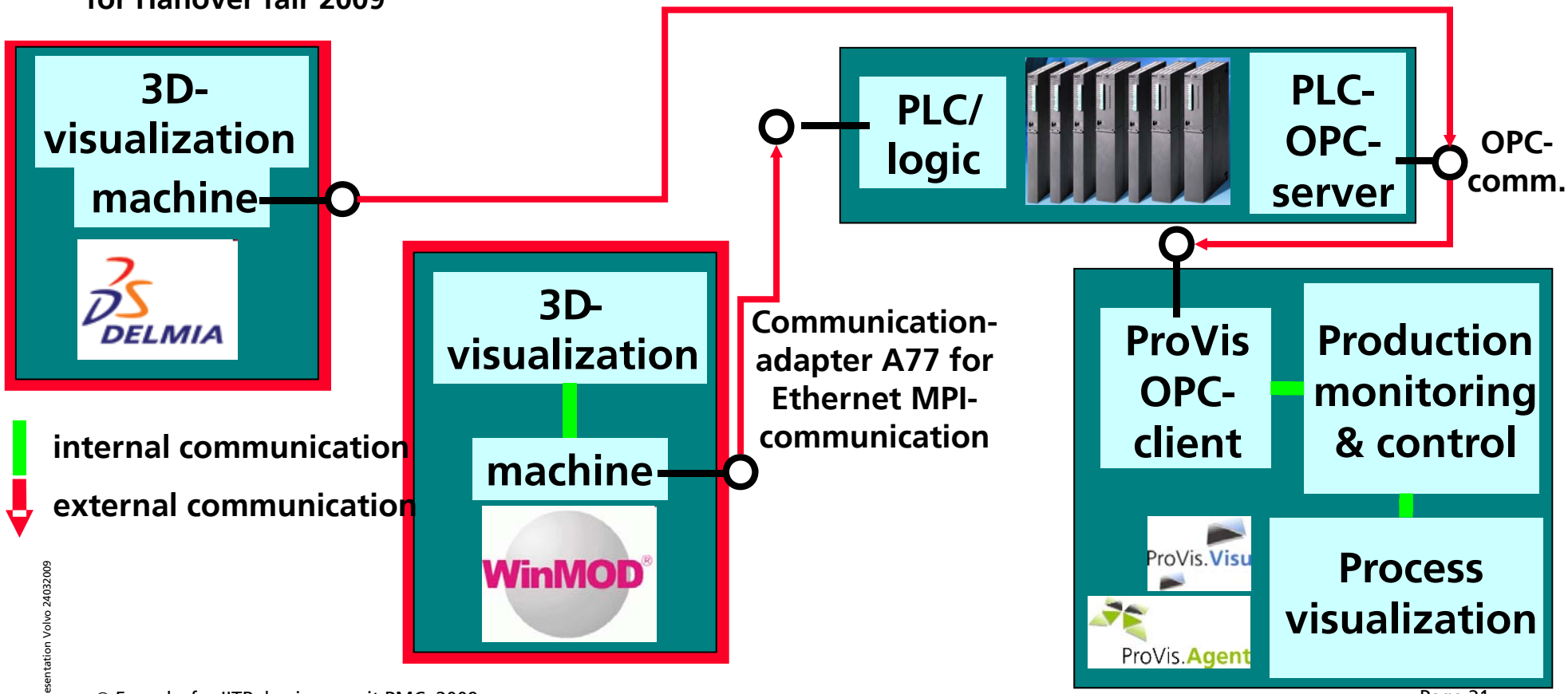

LMIA Automation V5 - [Product1]
SmarTeam File Edit View Insert Tools Window Help
...to a mechatronic element...


DELMIA Automation V5 - [Product1]
Start SmarTeam File Edit View Insert Tools Window Help
…that is reused throught various projects…
Select an object or a command


DELMIA Automation V5 - [Product1]
Start
SmarTeam
File
Edit
View
Insert
Tools
Window
Help
... and is within one project
applied more than once!
Select an object or a command

# 3.1 Monitoring & control connection with digital factory

**HiL-WinMod-Simulation with Siemens S7-300 and Delmia Automation-HiL-Simulation with S7-300 for Hanover fair 2009**







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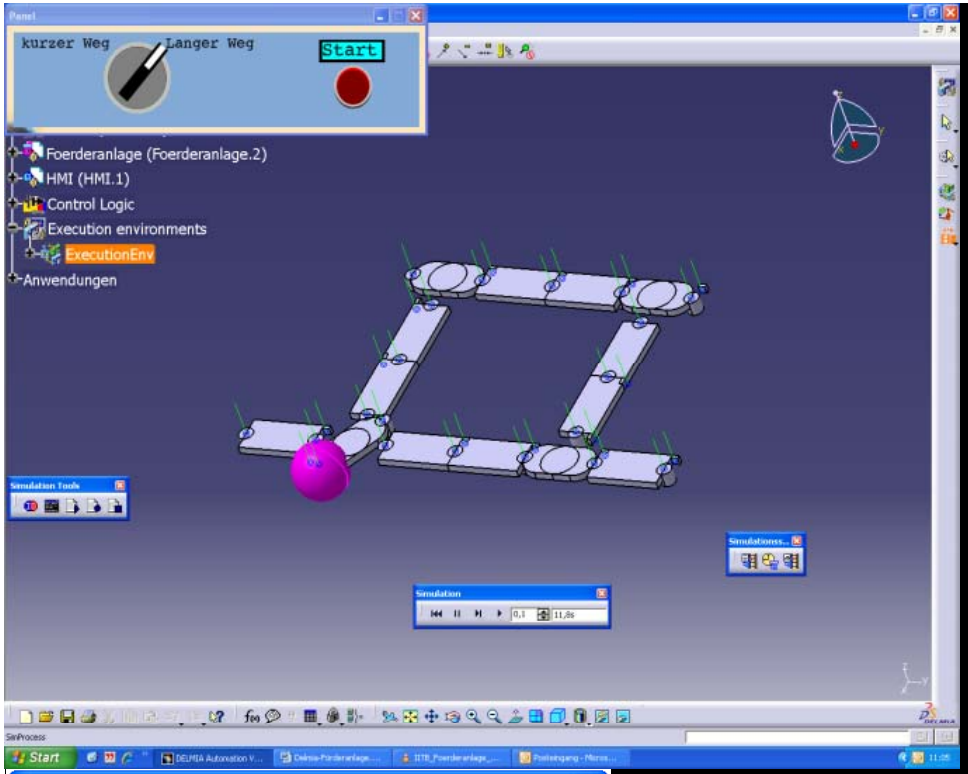
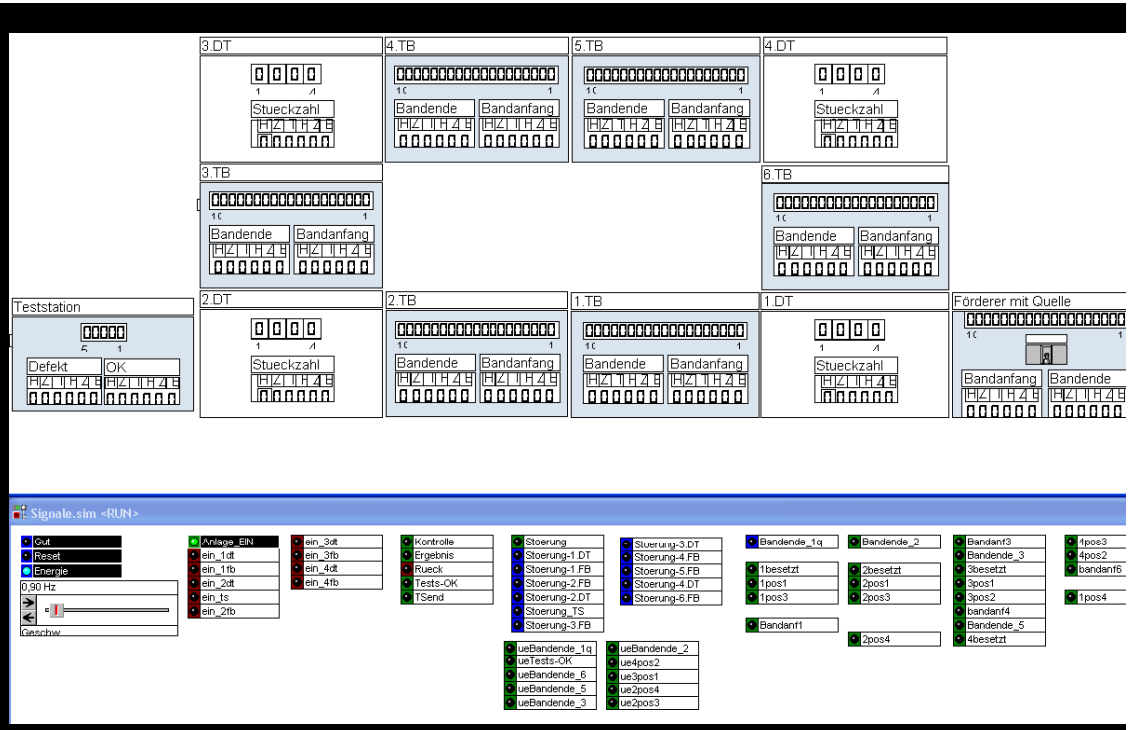
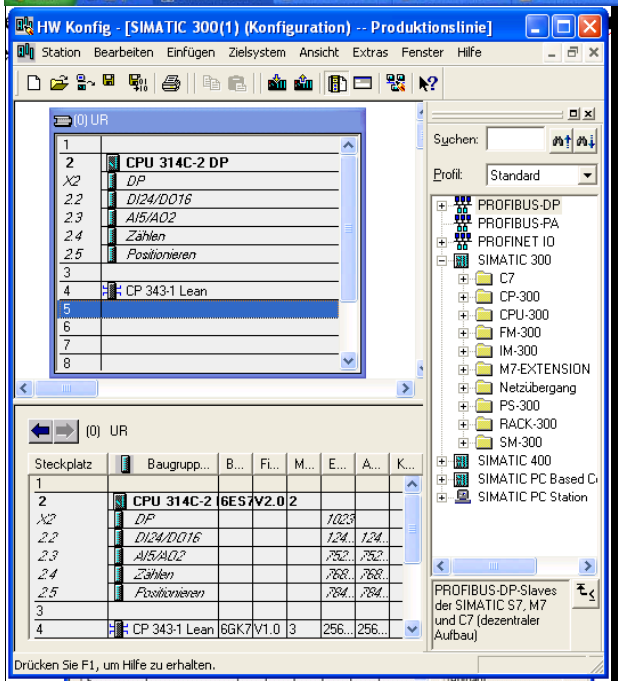
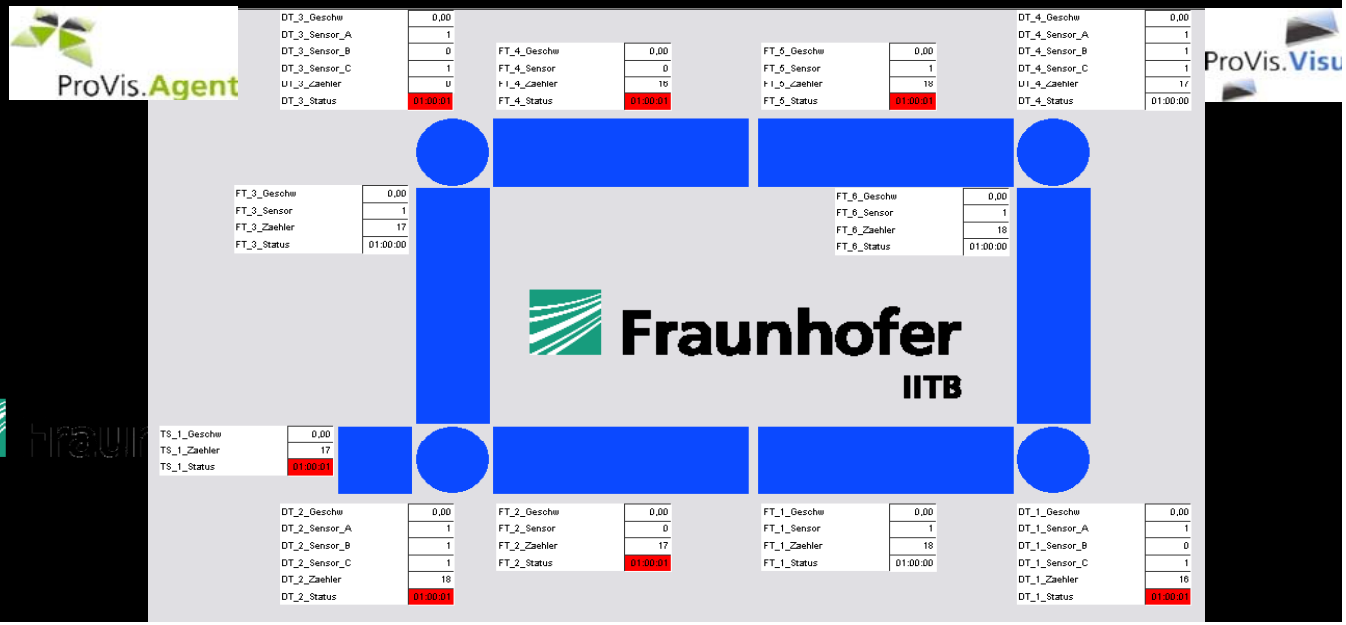
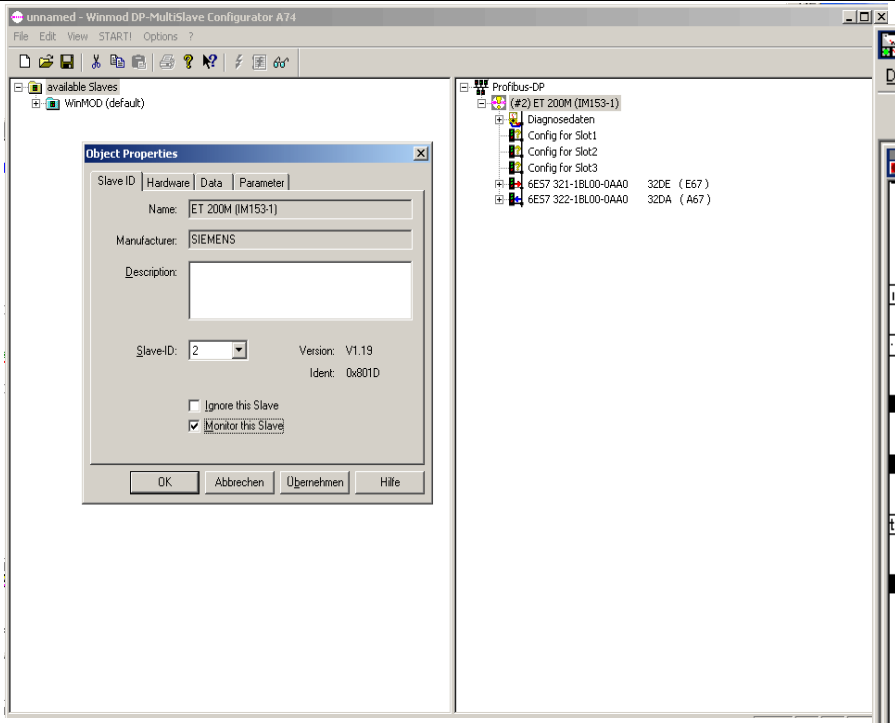

kurzer Weg
Langer Weg
Start
Foerderanlage (Foerderanlage.2)
HMI (HMI.1)
Control Logic
Execution environments
ExecutionEnv
Anwendungen


3.DT
4.TB
5.TB
4.DT
Stueckzahl
Bandende
Bandanfang
3.TB
6.TB
Teststation
Defekt
OK
2.DT
2.TB
1.TB
1.DT
Förderer mit Quelle
Signale.sim <RUN>

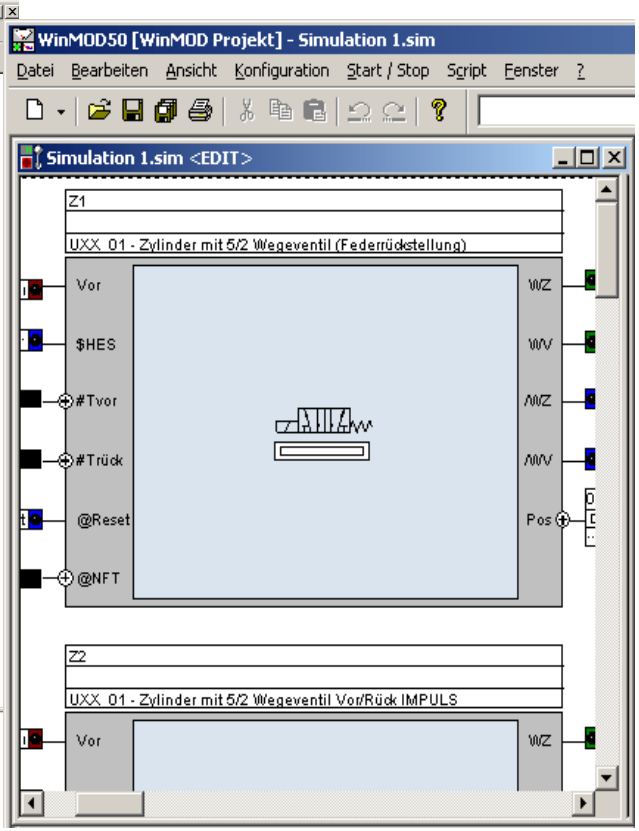

HW Konfig - [SIMATIC 300(1) (Konfiguration) -- Produktionslinie]
Station Bearbeiten Einfügen Zielsystem Ansicht Extras Fenster Hilfe
(0) UR
CPU 314C-2 DP
DP
DI24/DO16
AI5/AO2
Zählen
Positionieren
CP 343-1 Lean
Steckplatz
Baugrupp...
Suchen:
Profil: Standard
PROFIBUS-DP
PROFIBUS-PA
PROFINET IO
SIMATIC 300
C7
CP-300
CPU-300
FM-300
IM-300
M7-EXTENSION
Netzübergang
PS-300
RACK-300
SM-300
SIMATIC 400
SIMATIC PC Based C
SIMATIC PC Station
PROFIBUS-DP:Slaves der SIMATIC S7, M7 und C7 (dezentraler Aufbau)
Drücken Sie F1, um Hilfe zu erhalten.


ProVis.Agent
ProVis.Visu
Fraunhofer
IITB

# 3.1 Project structure in WinMOD

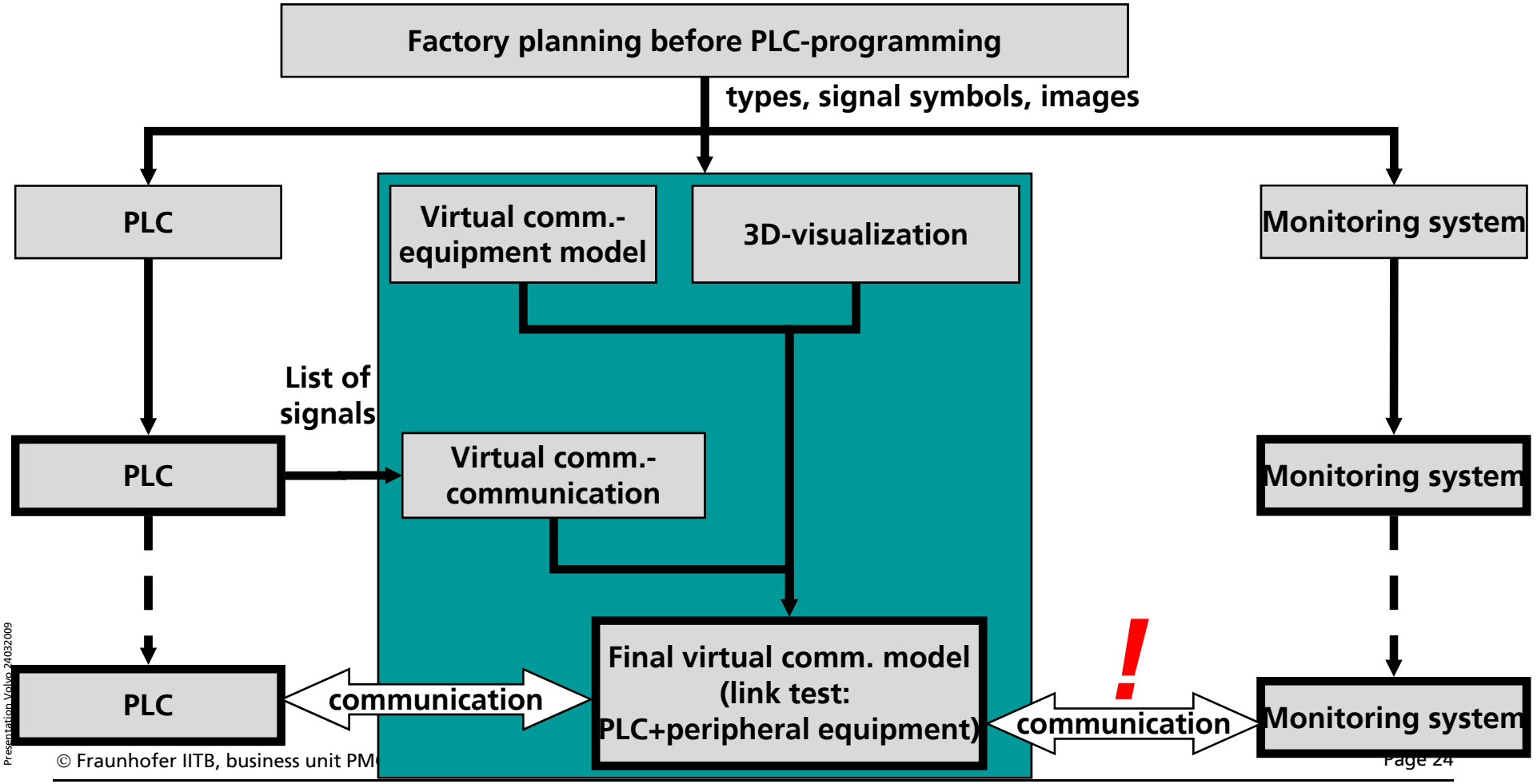



- **Peripherietreiber (z.B. OPC, Ethernet MPI, Profibus)**
- **Globale Operanden (interne Operanden, Eingänge der Hardware, Ausgänge der Hardware, Konstanten)**




- **vSteuerung (Schrittketten)**
- **Simulationsdateien (Simulationsverhalten)**

# 3.1 Workflow for simulation





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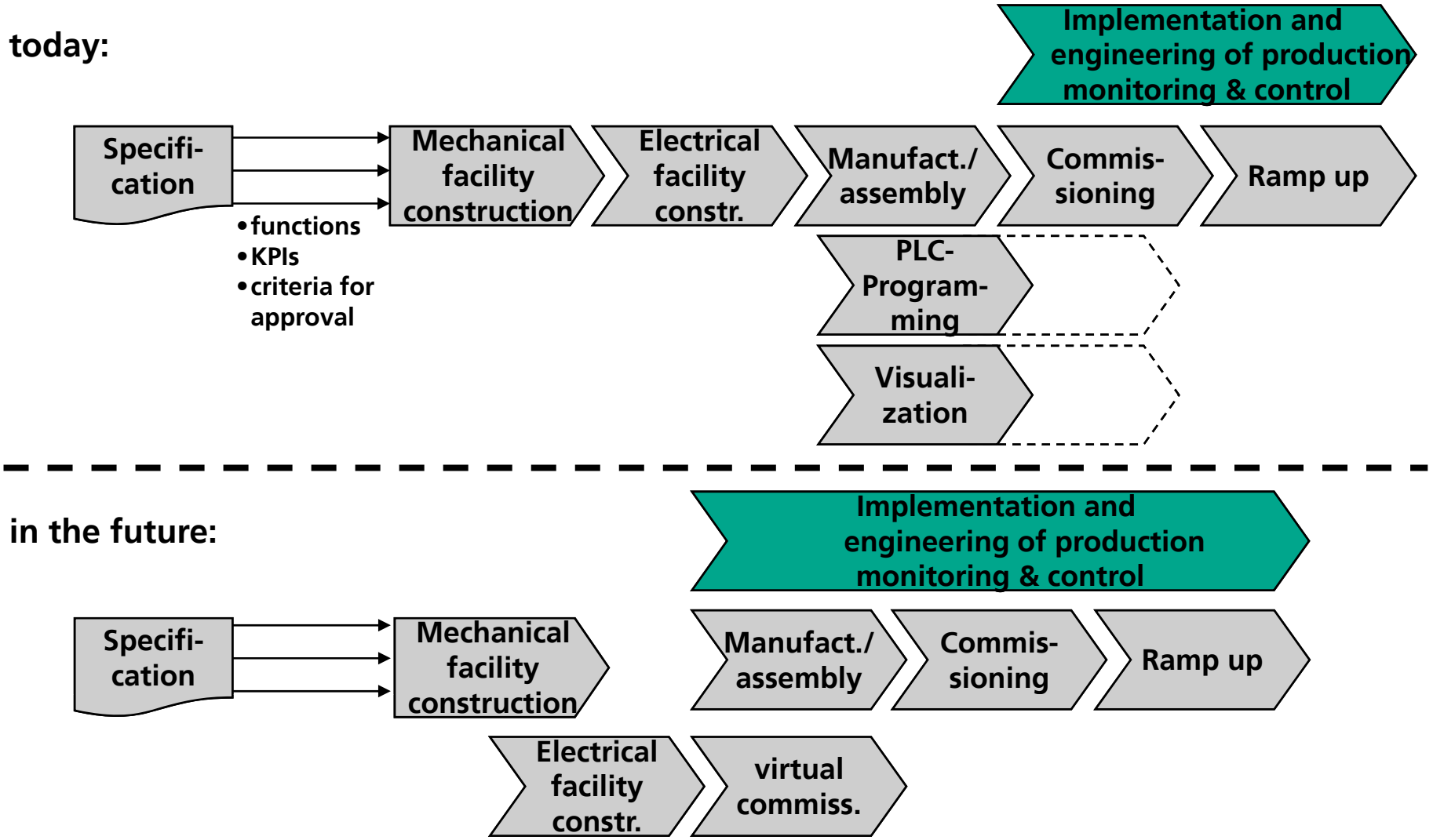
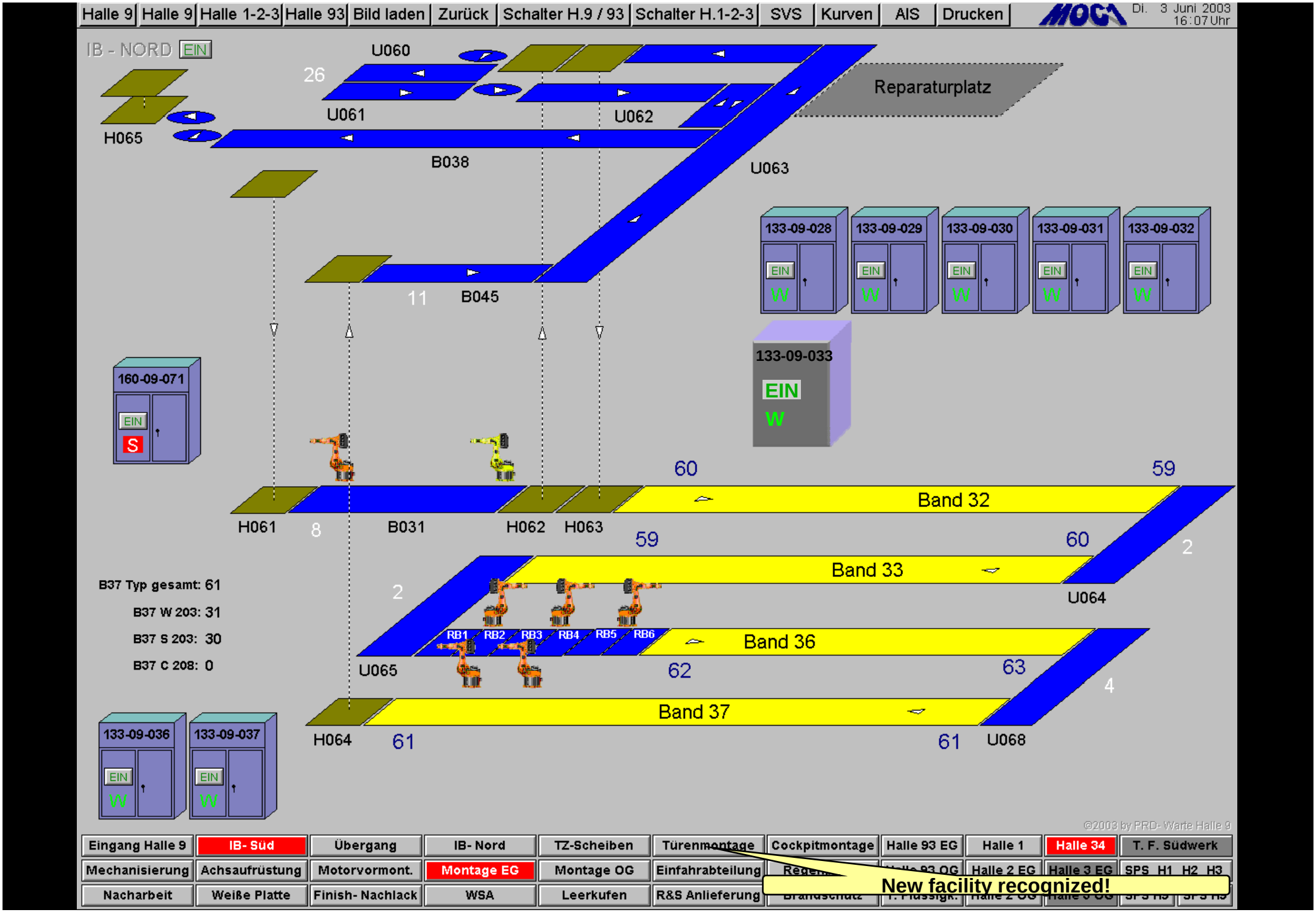
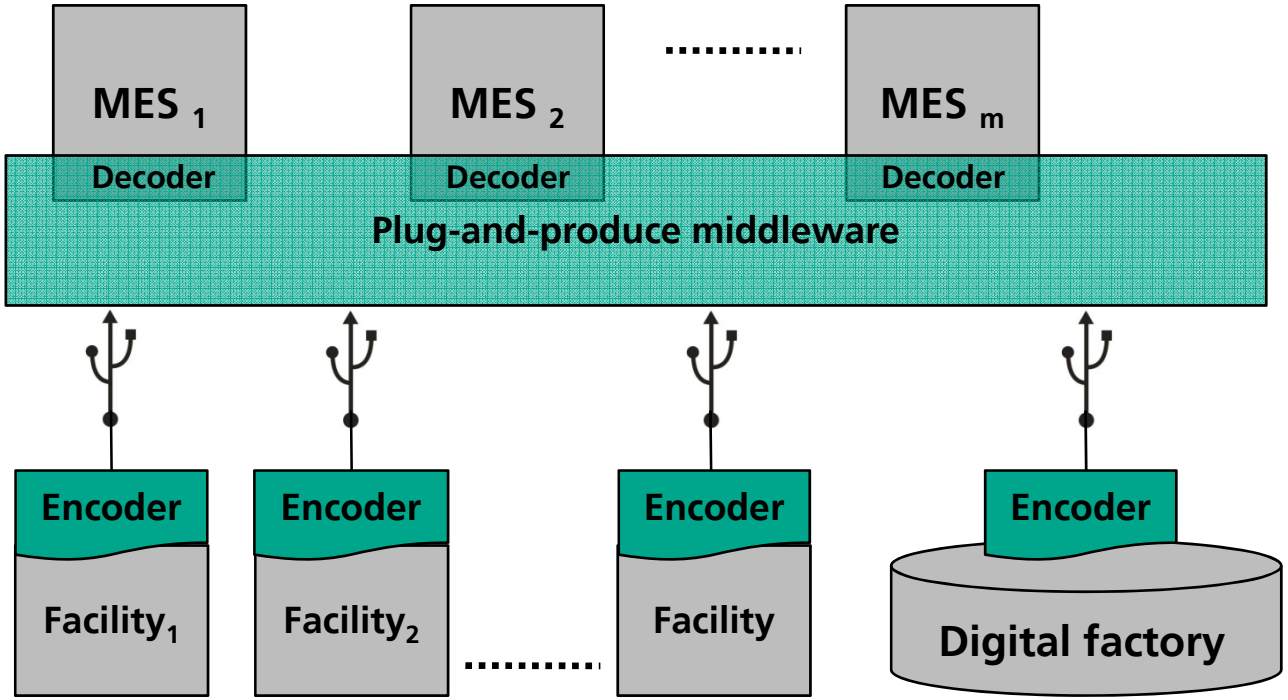
# 3.1 Benefits from early connection of planning and operation

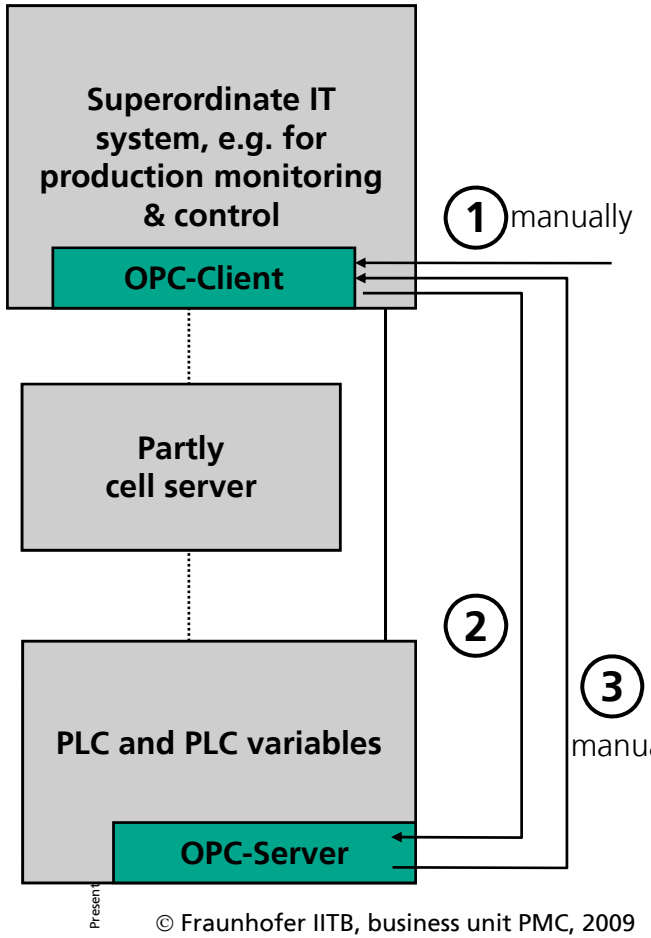



Halle 9
Halle 9
Halle 1-2-3
Halle 93
Bild laden
Zurück
Schalter H.9 / 93
Schalter H.1-2-3
SVS
Kurven
AIS
Drucken
MOCA
Di. 3 Juni 2003
16:07 Uhr
IB - NORD
EIN
U060
26
U061
U062
H065
B038
U063
Reparaturplatz
133-09-028
133-09-029
133-09-030
133-09-031
133-09-032
133-09-033
160-09-071
11
B045
60
59
Band 32
H061
8
B031
H062
H063
59
60
2
Band 33
U064
2
B37 Typ gesamt: 61
B37 W 203: 31
B37 S 203: 30
B37 C 208: 0
RB1
RB2
RB3
RB4
RB5
RB6
Band 36
U065
62
63
4
Band 37
H064
61
61
U068
133-09-036
133-09-037
©2003 by PRD- Warte Halle 9
Eingang Halle 9
IB- Süd
Übergang
IB- Nord
TZ-Scheiben
Türenmontage
Cockpitmontage
Halle 93 EG
Halle 1
Halle 34
T. F. Südwerk
Mechanisierung
Achsaufrüstung
Motorvormont.
Montage EG
Montage OG
Einfahrabteilung
Halle 2 EG
Halle 3 EG
SPS H1 H2 H3
Nacharbeit
Weiße Platte
Finish- Nachlack
WSA
Leerkufen
R&S Anlieferung
New facility recognized!

# 3.2 Required components for plug-and-work methodology



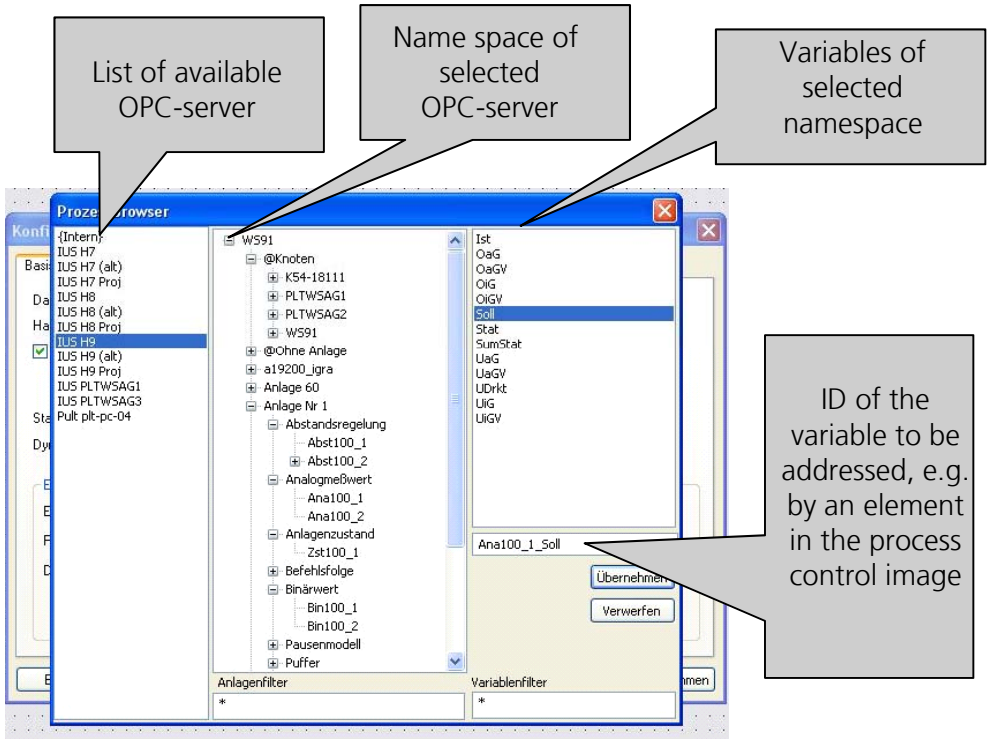
# 3.2 Current status of engineering systems for MES components




1 **Announcing PLC; OPC-Client must know the IP address or name of computer and name of OPC-server**

2 **Browsing using hierarchical set of variables of OPC-server**

3 **Linking variables provided by equipment with variables of super ordinate IT system**





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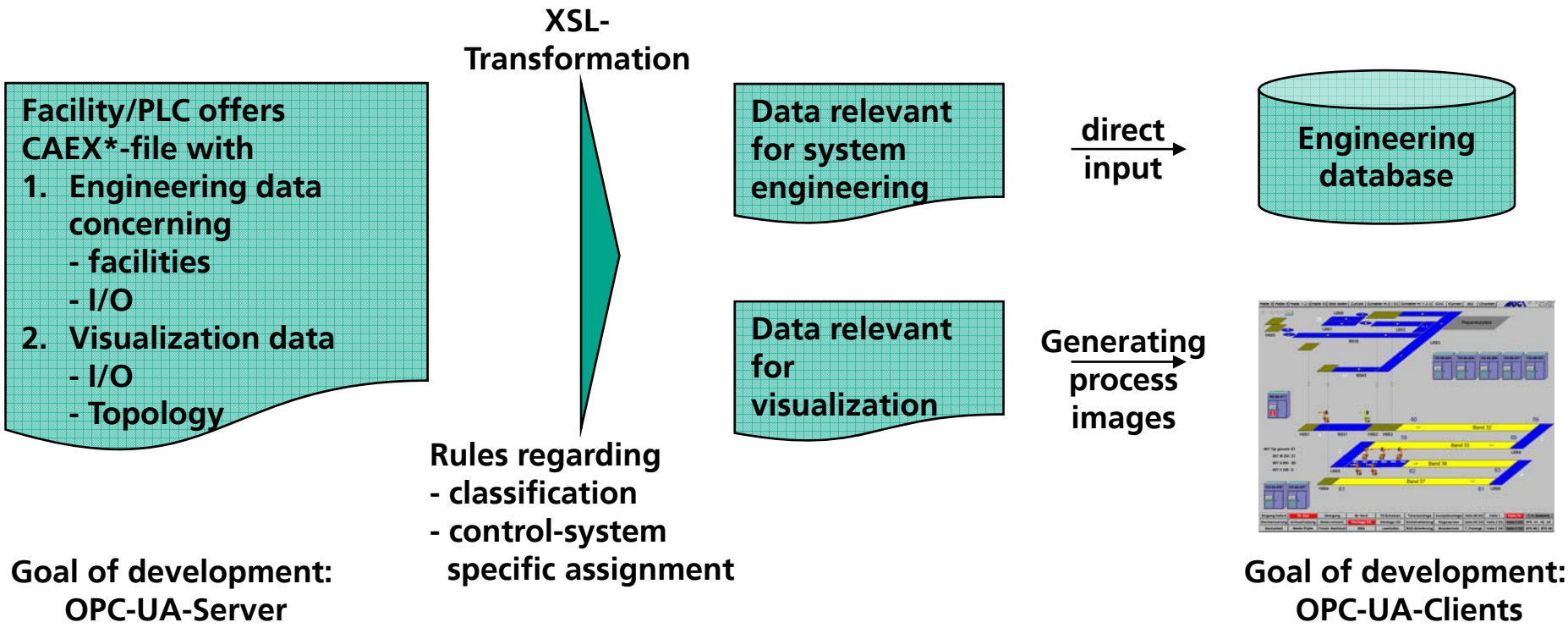
# 3.2 Plug-and-work approach




*CAEX: Computer Aided Engineering
Exchange according to IEC-PAS-62424







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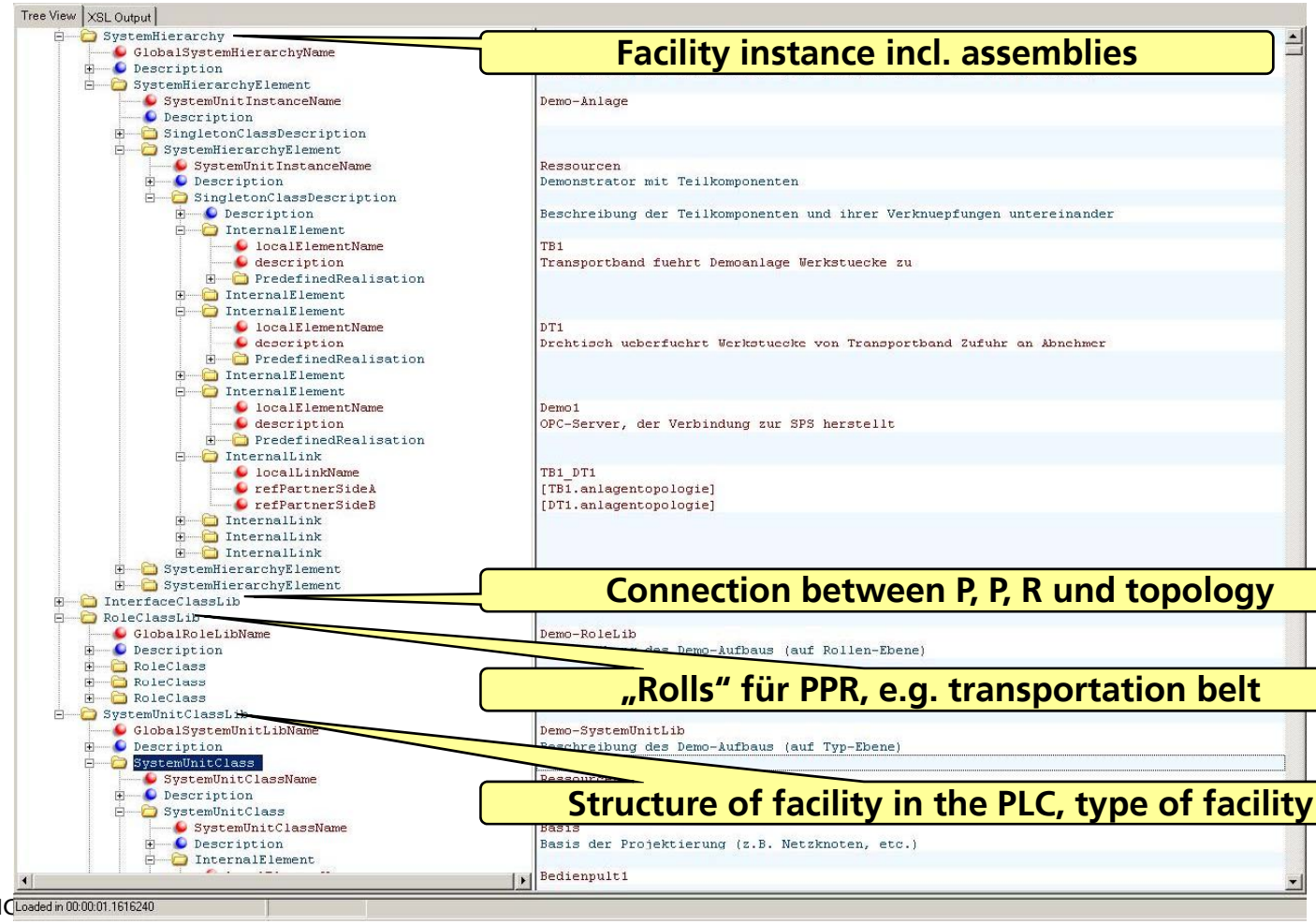
# 3.2 Plug-and-work approach

**Facility/PLC offers CAEX-file**

**CAEX is also the describing and exchange format within AutomationML*, where Fraunhofer IITB is one of the partners**

***see www.automationml.org for details**





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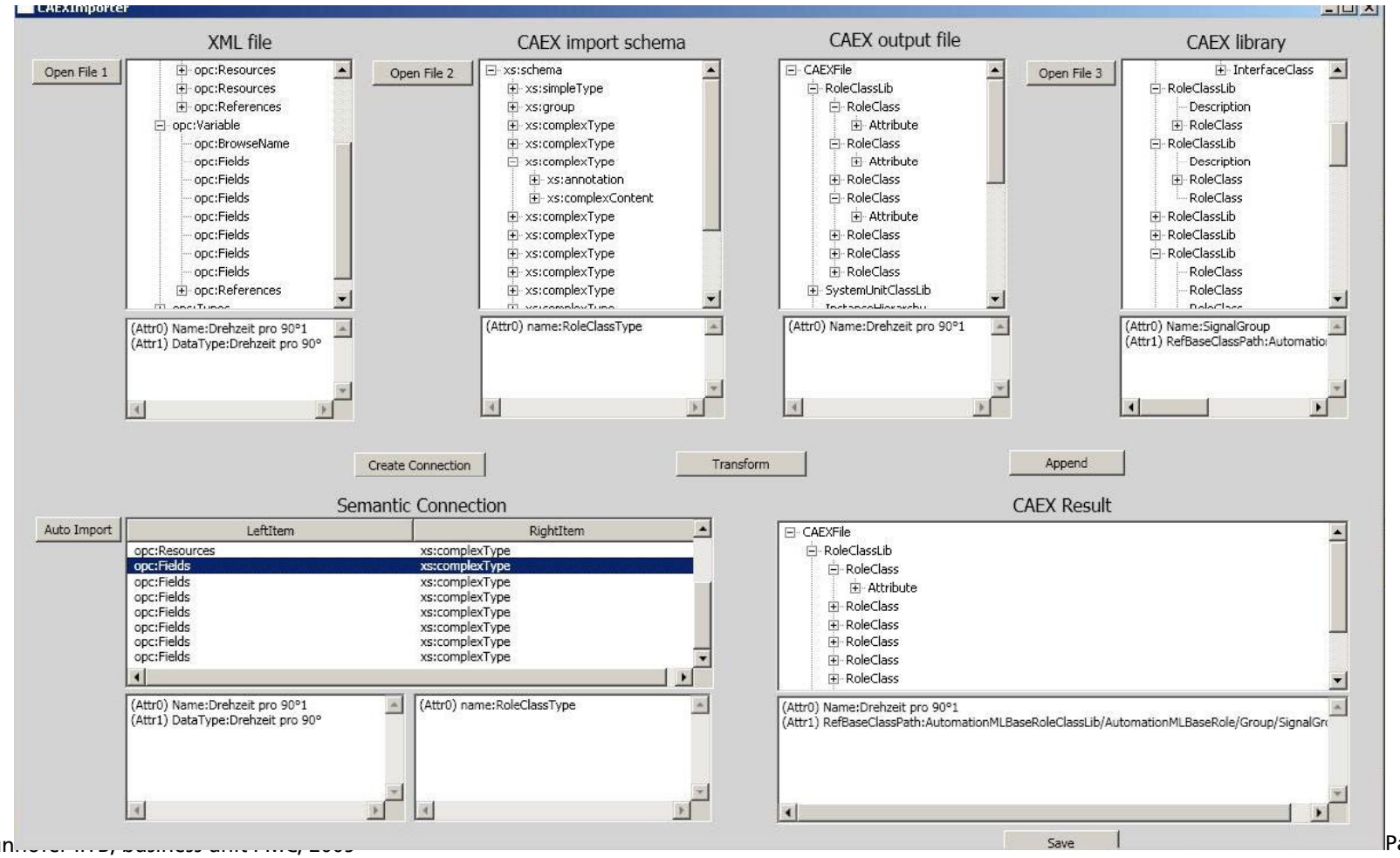
# 3.2 Plug-and-work tool







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# 3.2 Example for plug-and-work effects

**Data relevant for visualization**

**Example of a demonstrator:**
**- TS1: test station**
**- DT1: turn table**
**- TB1: transportation belt 1**
**- TB2: transportation belt 2**
**+ various variables and values**

**completely! generated from self description of facility including topology information from layout planning**

**Next steps:**
**- link to different E-CAD-tools**
**- test with real facility**








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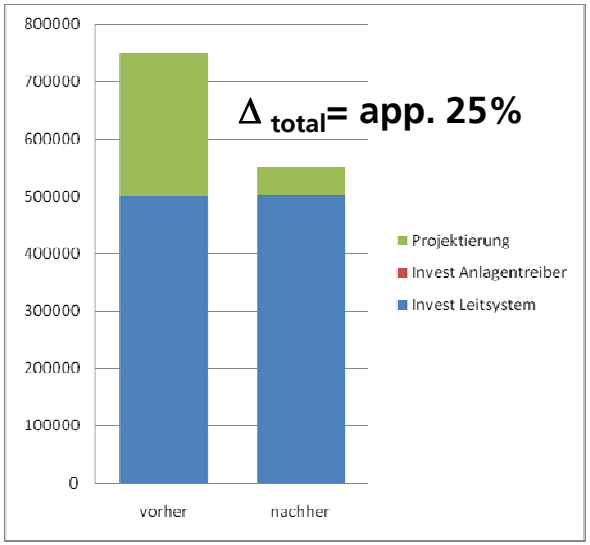
# 3.2 Example for plug-and-work benefits

Potential for cost savings by ‚plug-and-work' (Values based on experience of IITB)




**Potential for savings at MES-/Monotoring-systems or HMI; example ProVis.Agent®**

**Assumptions:**

| | |
|---|---|
| **Invest monitoring system:** | **500.000 €** |
| **Monitored PLCs per system:** | **250** |
| **Efforts per PLC for Image-, IO- and facility engineering** | **2-5 days** |
| **=> Total engineering efforts** | **app. 500 days** |
| **Cost per day engineering:** | **500 €** |
| **total cost engineering:** | **250.000 €** |
| **Potential for savings by plug-and-work: app. 80%** | **200.000 €** |







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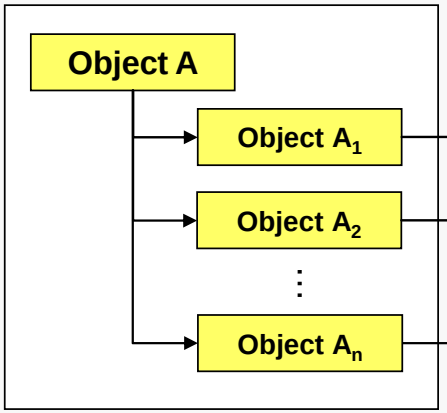
# 3.2 AutomationML (IEC DKE K941 Group)


## AutomationML
Engineering data

### CAEX IEC 62424
**Top level format**

**Plant topology information**
- Plants
- Cells
- Components
- Attributes
- Interfaces
- Relations
- References

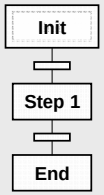



**COLLADA**

Geometry
Kinematics

**PLCopen XML**

Behaviour
Sequencing




**Further XML Standard format**

Further aspects of engineering information

DAIMLER
KUKA
SIEMENS
ABB
zühlke
empowering ideas
Fraunhofer IITB
OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
Universität Karlsruhe (TH)
NETALLIED SYSTEMS





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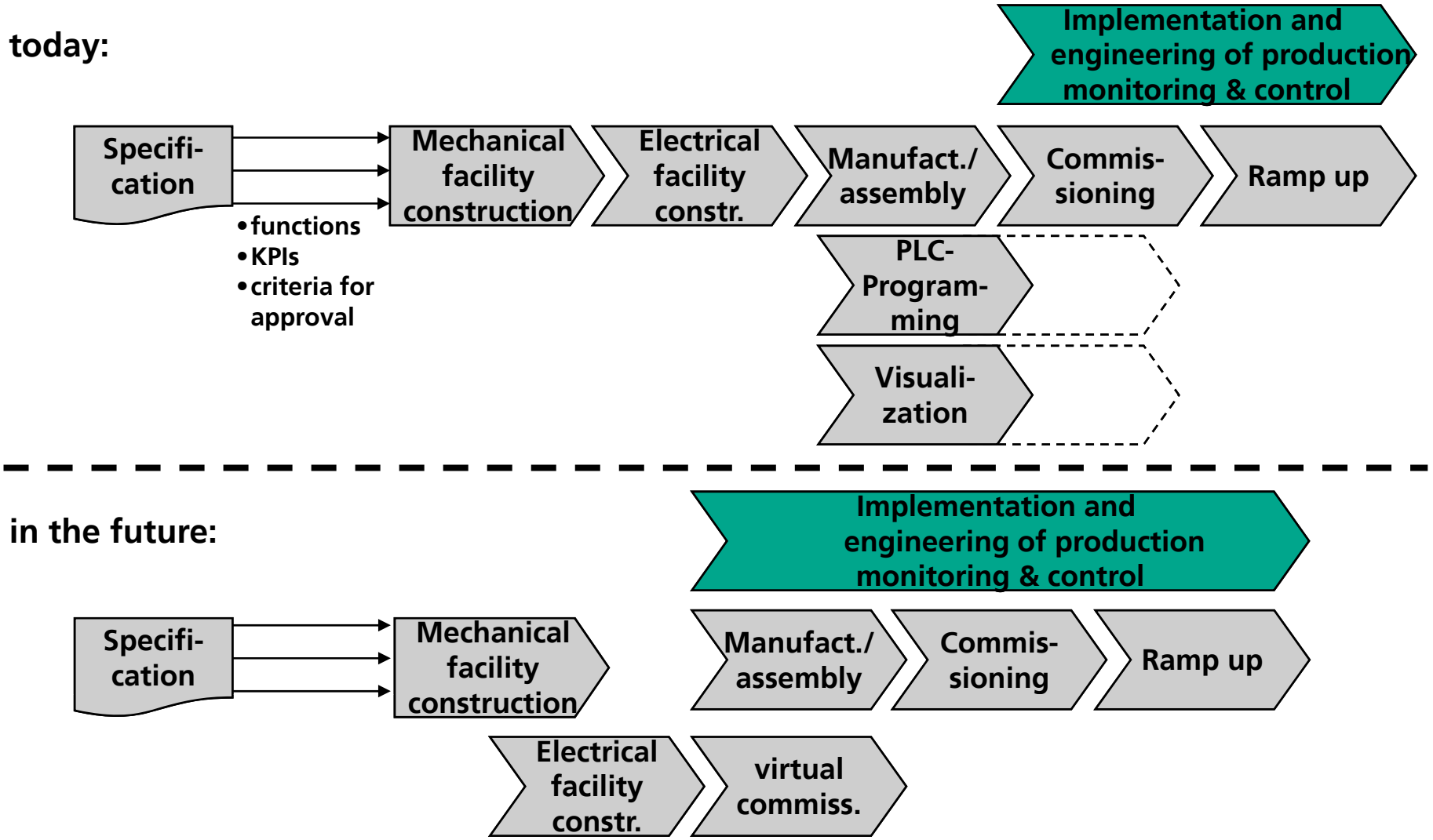
# 3.2 Benefits from early connection of planning and operation



# If you want to kow more...
# June 8 - 9, 2010

karlsruher leittechnisches kolloquium

www.klkblog.de

www.mes.fraunhofer.de

# Imprint

## Trends in Manufacturing Execution Systems (MES)

**- Examples from projects in discrete and automotive manufacturing -**

Neuss, October 12, 2009

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www.mes.fraunhofer.de

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Fax: +49-721-6091-413