Virtual Commissioning of Automotive Systems

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Workshop
VIRTUELLE INBETRIEBNAHME
Technische Universität Dresden
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- Comau Virtual Commissioning experience
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- COMAU presentation
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ADVANCED **BODY WELDING SYSTEMS** AND INNOVATIVE **SUB-ASSEMBLY LINES**

**PRODUCTS**
- FRAMING SYSTEMS
- ACCUMULATED PALLET CONVEYOR (APC)
- BREAK-AWAY END EFFECTOR
- VISION SYSTEMS (RECOGNISENSE)
- WELDING GUNS (VERSAGUN)
- LINE FEEDING

**FLEXIBLE SOLUTIONS**
- VERSAROLL
- VERSAPALLET TRANSFER SYSTEM

**TECHNOLOGIES**
- LASER WELDING / BRAZING / CUTTING
- PLASMA CUTTING
- ROLLER HEMMING
FLEXIBLE MACHINING SYSTEMS
FOR POWERTRAIN COMPONENTS:
A MODULAR APPROACH COMBINING THE
EXPERTISE IN METALCUTTING PROCESS
AND SYSTEM INTEGRATION WITH HIGH
QUALITY MACHINING MODULES

ASSEMBLY STANDARD MODULES
LEAN MANUFACTURING COMPLIANT
FOR ENGINES, TRANSMISSIONS AND
COMPONENT FROM MANUAL TO SEMI-
AUTOMATIC OR AUTOMATIC, ROBOTIZED,
SERIAL AND PARALLEL CELLS

TESTING SOLUTIONS
HIGH CUSTOMIZED SYSTEMS
BASED ON DIFFERENT
CUSTOMER NEEDS

WORLDWIDE POWERTRAIN MANUFACTURING SYSTEMS PROVIDER
MASTERING THE THREE PROCESSES: MACHINING, ASSEMBLY AND TEST

FROM THE CONCEPT TO THE CUSTOMER CARE
A WIDE RANGE OF INTEGRATED ROBOTIZED SOLUTIONS

HIGH PERFORMANCE SMART TECHNOLOGY

• A COMPLETE RANGE OF INNOVATIVE ROBOTS FROM 6 TO 800 KG PAYLOAD
• RELIABLE AND POWERFUL C5G CONTROL UNIT
• USER-FRIENDLY PROGRAMMING TERMINAL ALSO AVAILABLE IN WIRELESS VERSION
• PROCESS-ORIENTED SOFTWARE DEDICATED TO EACH APPLICATION
• A COMPLETE SET OF APPLICATION EQUIPMENTS AND ACCESSORIES
• PLUG & PLAY STANDARD ROBOTIZED CELLS FOR ARC WELDING APPLICATIONS

APPLICATION FIELDS

• SPOT WELDING
• ARC WELDING
• HANDLING/PALLETIZING
• PRESS-TO-PRESS AUTOMATION
• GLUEING
• FOUNDRY
References
Comau in the World

U.S.A.  R&D
MEXICO  R&D
BRAZIL  R&D
ARGENTINA  R&D
INDIA  R&D
CHINA  R&D

U.K.  R&D
FRANCE  R&D
GERMANY  R&D
ITALY  R&D
POLAND  R&D
ROMANIA  R&D
RUSSIA  R&D

MANUFACTURING PLANT  OFFICE  R&D  R&D CENTER
• COMAU presentation
• Comau Body Welding business
• Comau Virtual Commissioning experience
• Conclusions
Automotive Body-Shop Layout
## Supply volumes for a whole Body In White program

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Number of lines developed</td>
<td>9</td>
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<tr>
<td>Line builders</td>
<td>COMAU, OLCI, TMS, CPA, TKD, KUKA, KGR, Nothelfer, AMS</td>
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<td>SCP cabinets</td>
<td>50</td>
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<tr>
<td>PLC</td>
<td>140</td>
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<tr>
<td>HMI terminals</td>
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<tr>
<td>Digital Input/Output</td>
<td>32,000</td>
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<tr>
<td>Safety Input/Output</td>
<td>10,000</td>
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## Resources involved in whole Body In White program

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<tbody>
<tr>
<td>Standard development HW</td>
<td>3 Engineers / 4-5 months</td>
</tr>
<tr>
<td>Standard development SW</td>
<td>6 Engineers / 5 months</td>
</tr>
<tr>
<td>Engineering HW</td>
<td>4 Engineers / 3 Months</td>
</tr>
<tr>
<td>Engineering SW</td>
<td>5 Engineers / 3 months</td>
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<tr>
<td>Commissioning</td>
<td>10 Engineers / 6-7 months</td>
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Comau BRIC (Basic Robot Integrated Configuration)
Body-Shop Commissioning Main Constraints

Current Constraints to be Addressed

● Industrial market requires more and more a very short commissioning time (time to market) and a reduction of the overall commissioning cost (cost efficiency) to reach the full production rate of manufacturing lines

● Complexity of production system is increasing and new requirements in terms of flexibility and modularity are a must in the automotive market

● A standard manufacturing approach is not generally pursued to the date, due to the custom specific point-to-point solutions

● Automotive enterprises operate on heterogeneous IT systems and data warehouses, of which some are still legacy ones
• COMAU presentation

• Body-Shop Commissioning & Ramp-up

• Comau Virtual Commissioning experience

• Conclusions
AS IS: Actual design flow

- Mechanical engineering
  - Mechanical drawings
  - Mechanical composition

- Cycle diagram drawing
  - Sequence of operations (SOP)

- Hardware engineering
  - Electrical drawings

- PLC Sw engineering
  - PLC Sw logic

- Mechanical groups construction
  - Machinary assembly

- Electrical cabinets construction

- Commissioning on COMAU site

- Commissioning on customer site

- HMI Sw engineering
  - HMI screens
TO BE: Long term design flow

- Mechanical engineering
  - Cycle diagram drawing
  - Theoretical Cycle diagram validation
  - PLC Sw generation
  - PLC Sw validation
  - I/O mapping
  - I/O mapping
  - Virtual Commissioning
  - Cycle & Cycle time validation
  - Commissioning on customer site

- Hardware Engineering
  - Mechanical groups construction
  - Electrical cabinets construction
  - Machinery assembly

- PLC Sw validation
  - Validated SOP

- Valied PLC Sw logic

- HMI Sw engineering
Virtual commissioning introduction

3D Mechanical engineering (Robcad)

Mechanical engineering (SOP)

Virtual commissioning test

Software behaviour

Hardware Design

Software Design

Field emulator behaviour

Creation of Simulation model (LIBRARY ARE NECESSARY !!)

Eng. phase (SOP)

SOP = Sequence Of Operations
Comau experience in VC

<table>
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<tr>
<th>Customer</th>
<th>System</th>
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<tr>
<td>Comau Project (Ford)</td>
<td>Framing</td>
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<td>Chrysler</td>
<td>Underbody</td>
</tr>
<tr>
<td>Ford</td>
<td>Bodyside</td>
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<tr>
<td>Ford</td>
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</tbody>
</table>
• COMAU presentation
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Main outcomes from COMAU experience

• **Comau experience (PROs):**

  • More than 4 years of development experience with Delmia / Siemens platforms
  
  • Reduction of commissioning time on customer’s site
  
  • Simulation is used especially to validate “critical stations” to reduce additional engineering activities
  
  • Reduction of commissioning time at customer’s site, due to fewer errors in systems design.
  
  • Better quality of products and processes, thanks to the possibility to evaluate contemporarily different alternative solutions
Main outcomes from COMAU experience

• **Comau experience (CONs)**:
  - Specific trainings required. A wide and profitable use of virtual simulation in Engineering requires a dedicated team.
  
  • Expensive h/w equipment to run the simulation tools, along with the yearly cost of licenses.
  
  • Process simulation software is not ready for full VC, many open issues and bugs on the software to be addressed
  
  • Hard to identify if the number of hours spent on VC is the same or more that hours saved on the floor.
  
  • VC and Real Commissioning often overlap so it is difficult to reduce the engineering phases
  
  • Cost benefits metrics not fully satisfactory (hard to be identified)
Next steps

- Full commitment of COMAU in evaluating next VC applications
- Continuous relationship with VC main players
- VC test cells as part of COMAU innovation plan
- Identification of partners for common roadmaps
BACKUP SLIDES

COMVANTAGE PROJECT
• COMAU presentation

• Body-Shop Commissioning & Ramp-up

• Comau Virtual Commissioning experience

• ComVantage R&D Program

• Conclusions
ComVantage EU R&D Program

Title: COMVANTAGE
Collaborative Manufacturing Network for Competitive Advantage

BU involved: BWA

Funding Agency: European Commission - FP7-FoF-ICT-2011.7.3

Funding Scheme: Collaborative Project

Main Objectives: The proposed idea of ComVantage aims at developing an interorganisational collaboration space that is shared during production time and beyond. This Virtual Factory allows suppliers, transport services, maintenance services and customers to subscribe and share information according to the specific user roles summing up in numerous collaborative spaces and sub-spaces that are restricted to specific users and time based constraints.

Expected Results: ComVantage will provide standardized interfaces that serve as adapters to business software such as ERP or lightweight software. Implementing ComVantage in various business environments, it will increase lean communication, agile and highly efficient production processes, cost control and a low carbon footprint.

Timetable: 2011 – 2014 (36 months)

Overall Budget: 10.977.016 € (7.337.292 € funding)

Partners:
- SAP (DE)
- COMAU (IT)
- NEXTEL (ES)
- ISN (SL)
- DC21 (AU)
- E4Y (DE)
- BOC-IB (ES)
- UNIVIE (AU)
- BGU (ISR)
- TUD (DE)
- INNO (ES)
- EVIDIAN (FR)
ComVantage Framework cont’d

- **PLANT ETHERNET (PRODUCTION VLAN)**
- **SCP**
- **PLC**
- **SCALANCE SWITCH**
- **PC LINE**
- **DB**
- **OPC communication**
- **REMOTE CONNECTION FOR COMMISSIONING SUPPORT**
- **PRODUCTION LINE**

**Linked Data**

- Transport Actors
- In-feeding Transport Vehicles
- Finalising Vehicles
- Finalising Substitutes
- In-feeding Provider Substitutes
- Retail Provider Substitutes
- Products on social networks
- IoT on real-life Data
- End Consumer Integration

**OPC communication**
ComVantage Comau’s Implementation Strategy

**Mockup 10/2012 → M14**

- **Specification def. and refinement**
  - Application
  - Infrastructure

- **Main Partners involved**
  - COMAU
  - TUD
  - RST
  - SAP

**Intermediate prototype 02/2013 → M18**

- **Demo Application**
  - Data read from the field
  - GUI development

- **Main Partners involved**
  - COMAU
  - TUD
  - RST
  - SAP

**Enhanced prototype 06/2013 → M22**

- **Demo Application**
  - Secured access implementation
  - GUI refinement

- **Main Partners involved**
  - COMAU
  - TUD
  - RST
  - SAP
  - Innovalia

**Final Demo 05/2014 → M33**

- **Demo Application**
  - Secured access implementation
  - GUI refinement

- **Main Partners involved**
  - COMAU
  - SAP
  - RST
  - TUD
  - Innovalia

**Final**

- Mobile app refinement
- CycleTime validation
- Graph&Video comparison

**Final**

- Mobile app refinement
- CycleTime validation
- Graph&Video comparison
Cycle Time Validation and Remote Video Access

Key Features

- System to Log I/O (used in the station cycle) in an easy way (transparent for PLC program)
- System to “mix” video (coming from real station in production) and I/O log file to:
  - Analysis of Cycle Time in detail
  - Understand of missing/wrong sequence movement
  - Central support with specialists team with saving on time and trip costs

Business Benefits

- Line installation engineering support Improvement
- Reduction of time and cost on commissioning
- Easy analysis of real cycle time
ComVantage App User Interface

Cycle Time Validation

Remote Video Access
• COMAU presentation

• Body-Shop Commissioning & Ramp-up

• Comau Virtual Commissioning experience

• ComVantage R&D Program

• Conclusions
Conclusions

Breakthrough Innovation and Potential Economic Impacts

- The ComVantage framework will allow:
  - to collect and organize data coming from the field
  - to manage this information in an extended enterprise environment, and
  - to present it on a wide range of devices (from smart phones, to tablets, to fixed terminals)

- ComVantage’s main purpose is to allow a reduction in time and cost of the commissioning and ramp-up of manufacturing plants. As a by product ComVantage will grant also plant improvements in maintenance and diagnostic areas.

- Overall the lean and integrated communication architecture will assure a reduction of manufacturing engineering costs.

- Automatic tools to certify the cycle time and other manufacturing process parameters will give to a tool making company like Comau the opportunity to develop addition services business.