Energy considerations in Virtual Commissioning

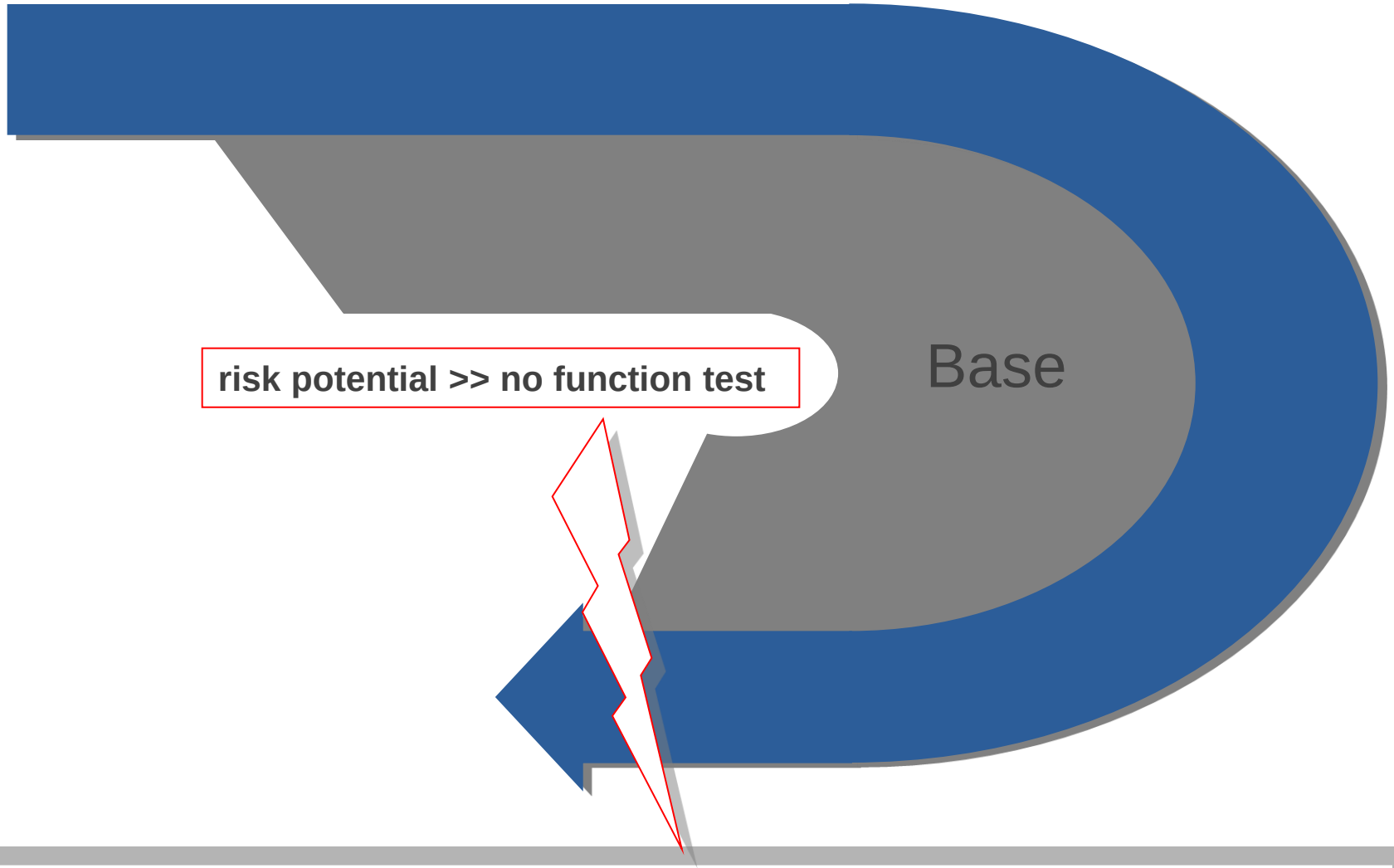
Anton Strahilov (Rücker EKS), Felix Damrath (DAIMLER AG)

1. Introduction
2. Virtual Commissioning as phase of the plant engineering process
3. Further potential of Virtual Commissioning
4. Energy considerations of electric and pneumatic components
5. Summary and outlook

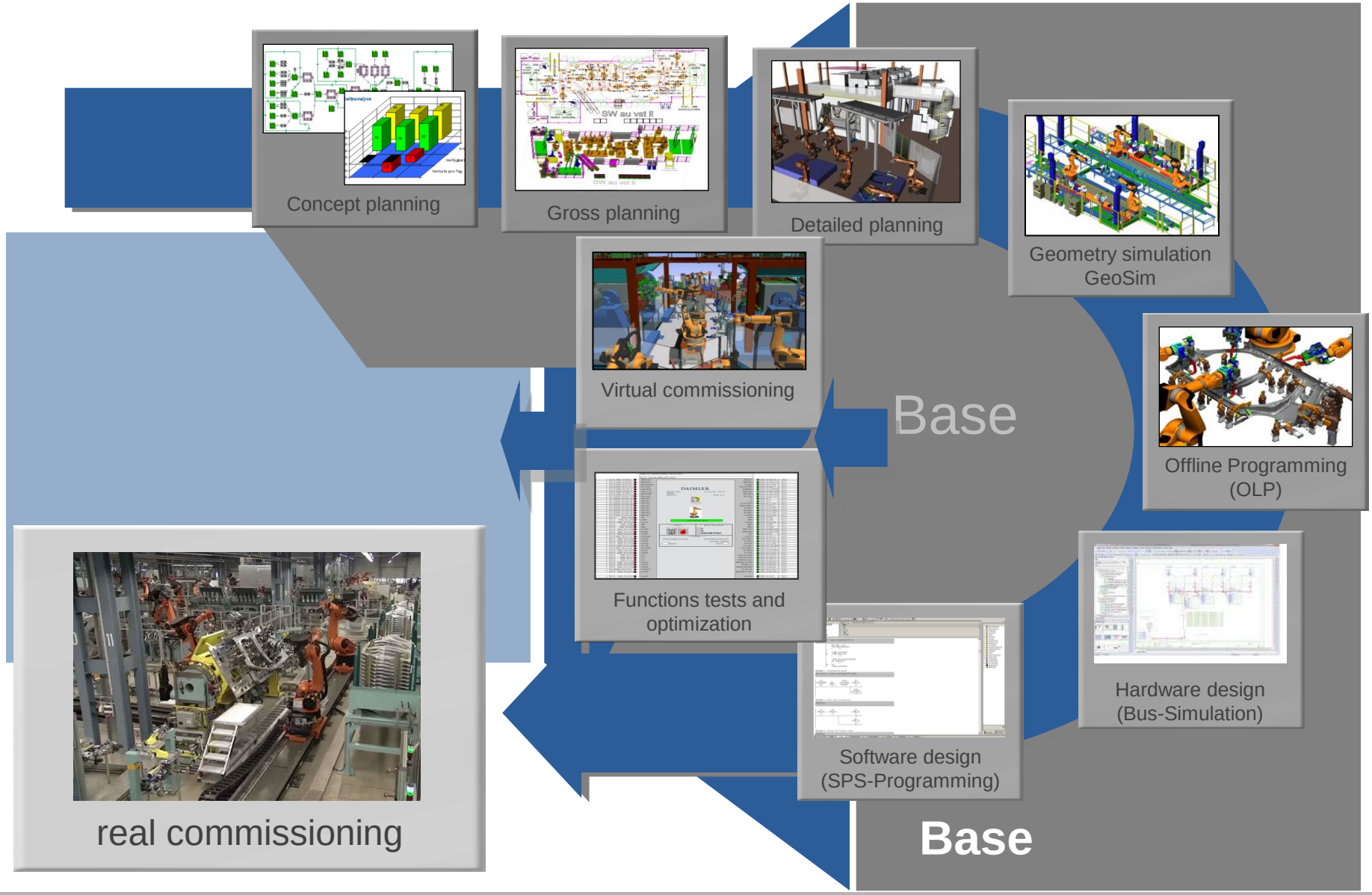

We build plants as lang as cars ...

Agenda

1. Introduction
2. Virtual Commissioning as phase of the plant engineering process
3. Further potential of Virtual Commissioning
4. Energy considerations of electric and pneumatic components
5. Summary and outlook


risk potential >> no function test
Base

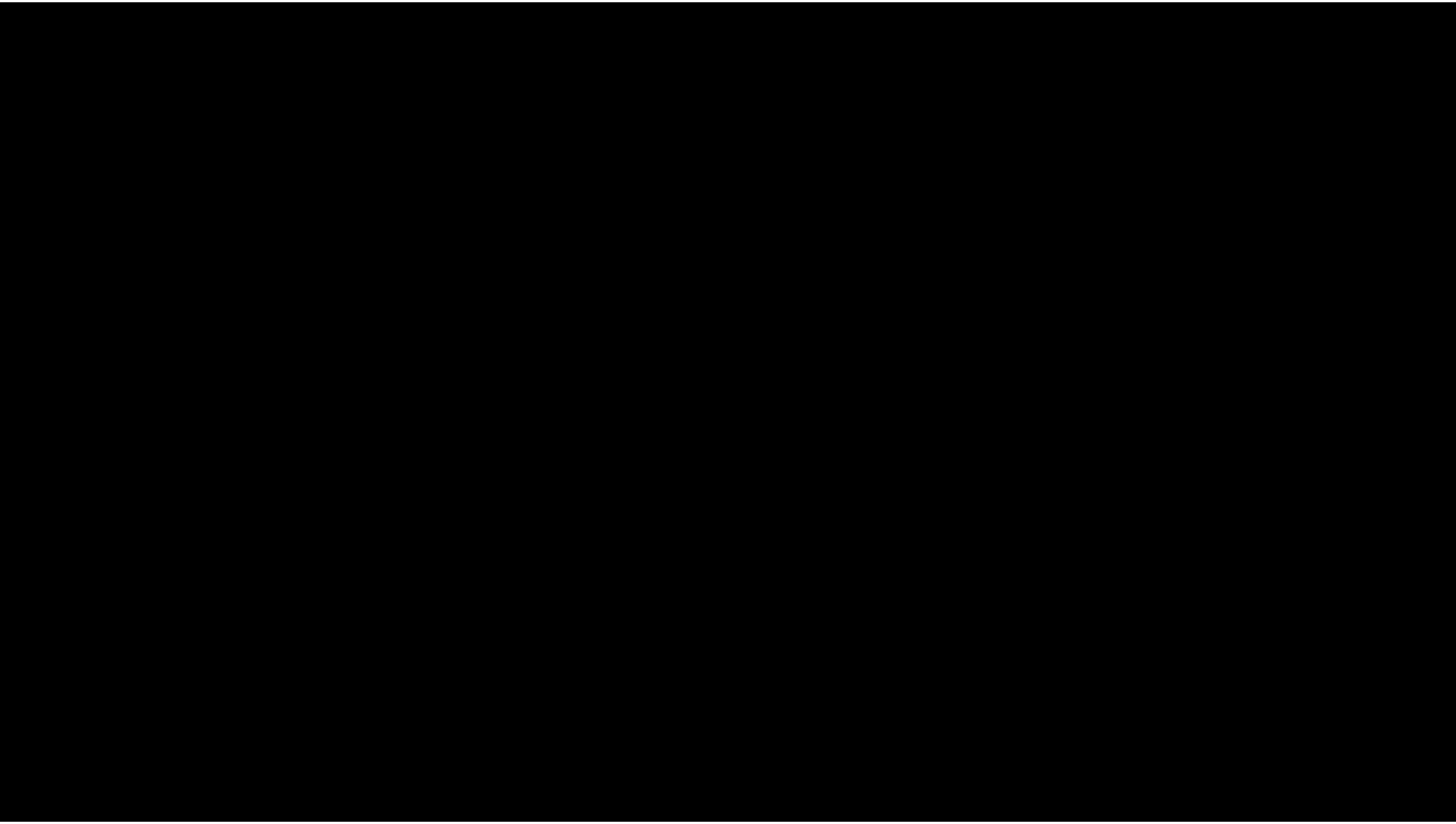
Virtual Commissioning as phase of the plant engineering process



Agenda

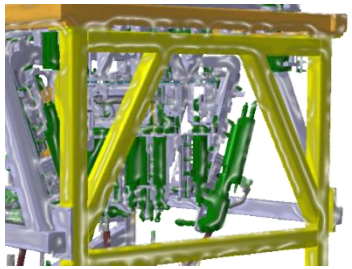
1. Introduction
2. Virtual Commissioning as phase of the plant engineering process
3. **Further potential of Virtual Commissioning**
4. Energy considerations of electric and pneumatic components
5. Summary and outlook

Further potential of Virtual Commissioning – separation of the components

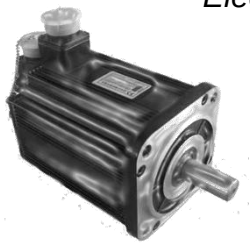


RÜCKER EKS GMBH

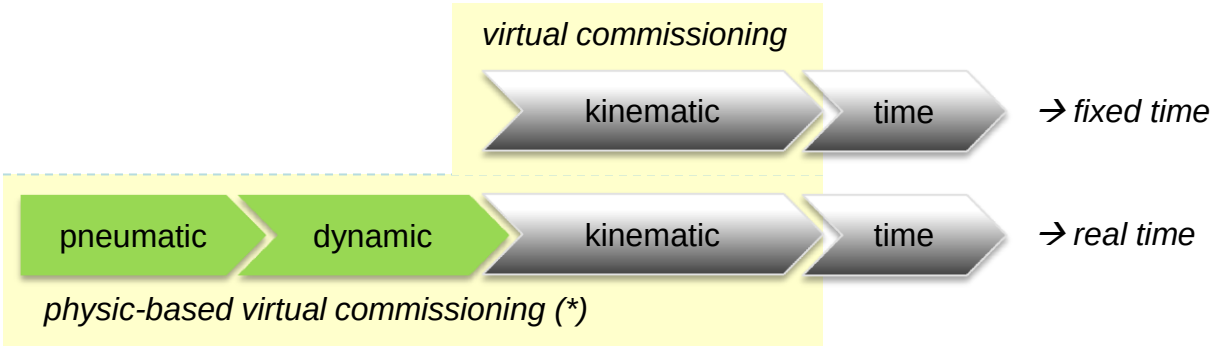
Simulation plant **Real plant**

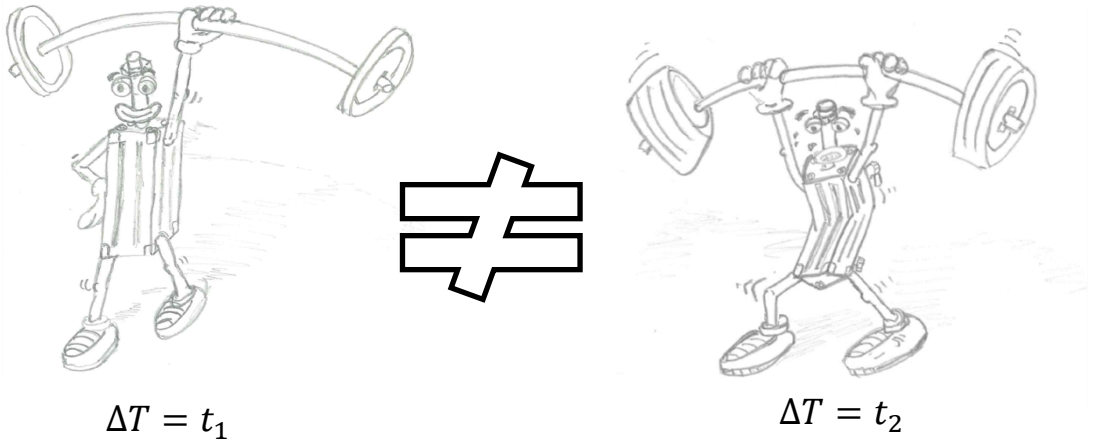


Electrical components



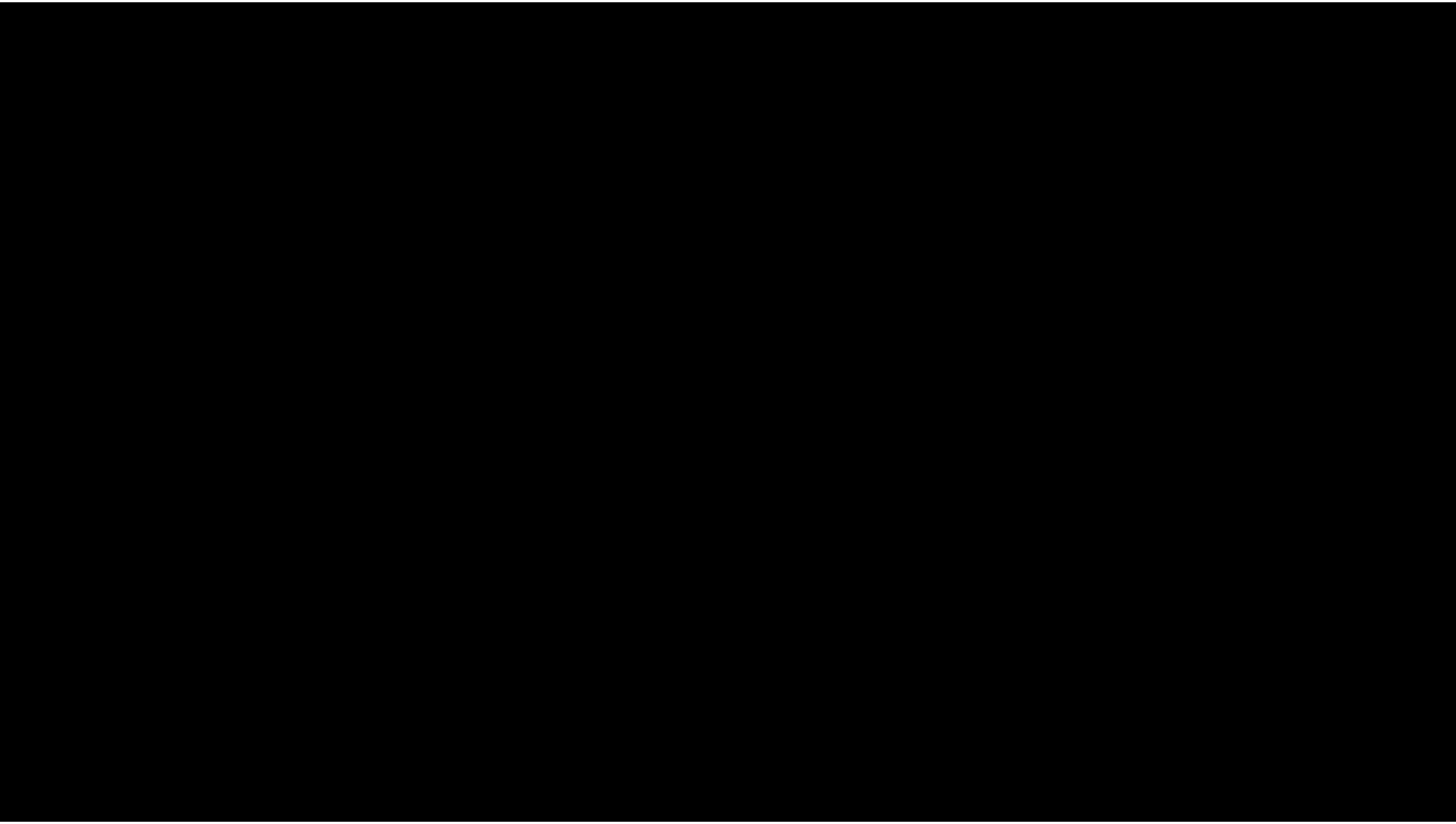
Pneumatic components





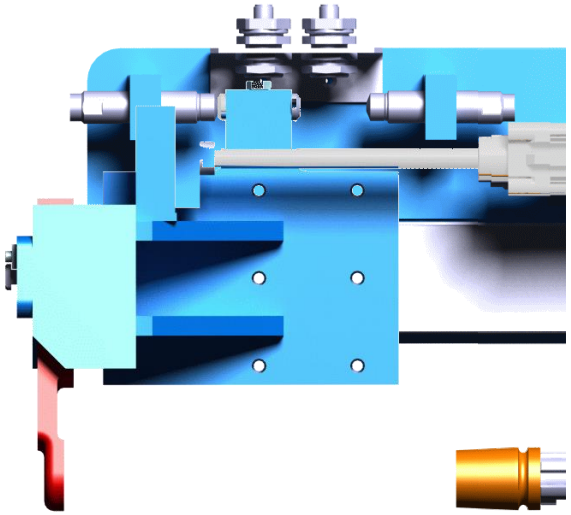
** Simulation of kinematics and dynamics of the components (force, speed, acceleration etc.)*

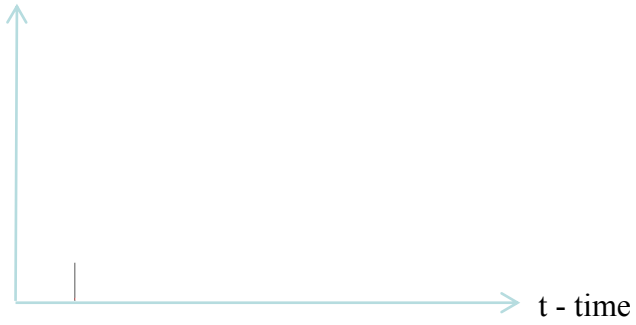
Further potential of Virtual Commissioning - realistic moving time



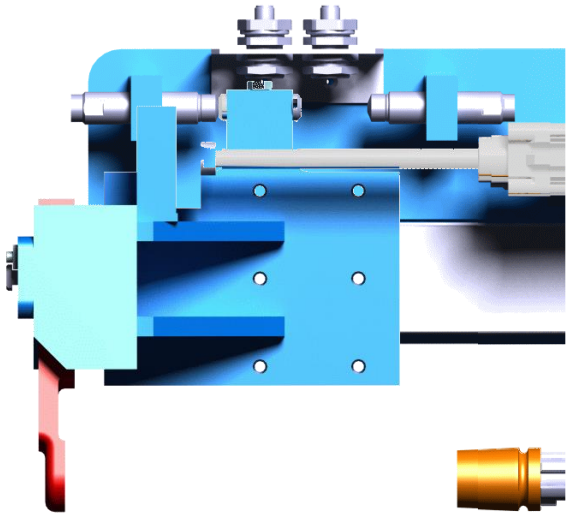
RÜCKER EKS GMBH

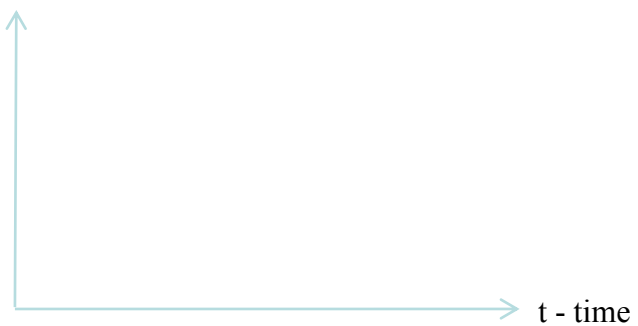
Now





Physic-based





Electrical components

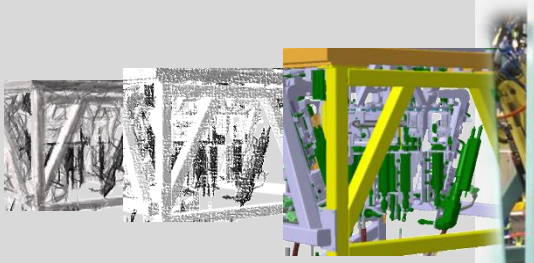
Pneumatic components

I. Phase

Now

virtual commissioning

electric → dynamic → kinematic → **energy**



physic-based virtual commissioning

pneumatic → dynamic → kinematic → **energy (*)**

II. Phase

electrical consumption

** The electrical energy consumption depends on the air consumption*

Agenda

1. Introduction
2. Virtual Commissioning as phase of the plant engineering process
3. Further potential of Virtual Commissioning
4. Energy considerations of electrical and pneumatic components
5. Summary and outlook

Electrical components

Energy consumption

$$W_{el}{}^{m} = \int_{t1}^{t2} \sum_{i=1}^{6} P_i{}^{m}(t)\, dt = \int_{t1}^{t2} \sum_{i=1}^{6} c_1 \boldsymbol{M_i}^2 + c_2 \dot{\boldsymbol{q}}\, \boldsymbol{M_i}\, dt$$

$M_i \downarrow \longrightarrow W_{el} \downarrow$

$W_{el}{}^{m}$ = mechanic work required for the movement of the robot‘s axes without payload

Pneumatic components

Creation

Conditioning

Distribution

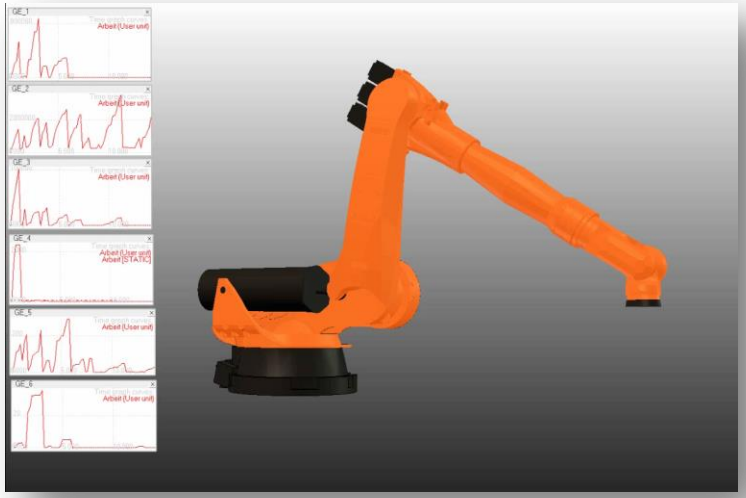
Consumption

W_{el}

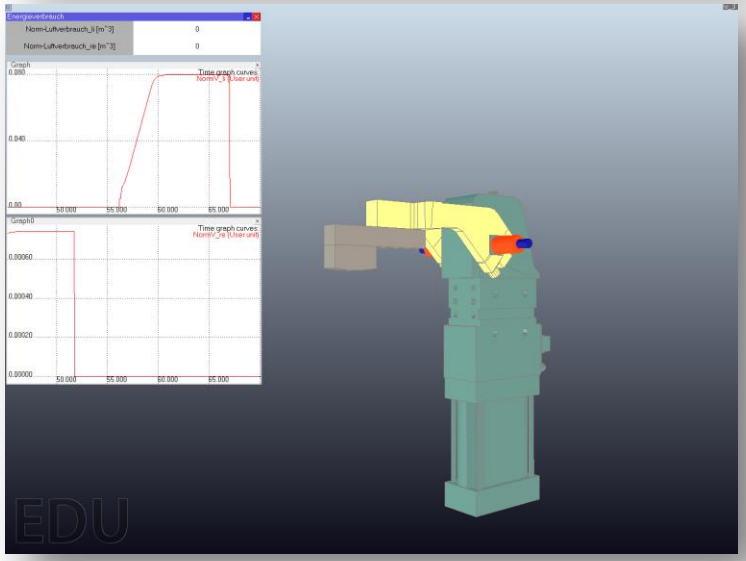
$W_{pneu} \downarrow \longrightarrow W_{el} \downarrow$

$$W_{pneu} = \int_{t1}^{t2} Q(t) * p(t) dt$$

Electrical components

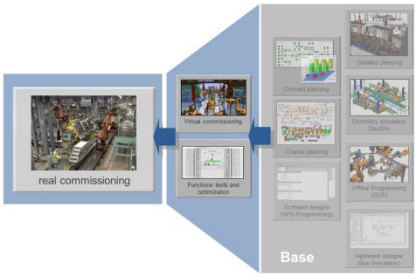


Pneumatic components

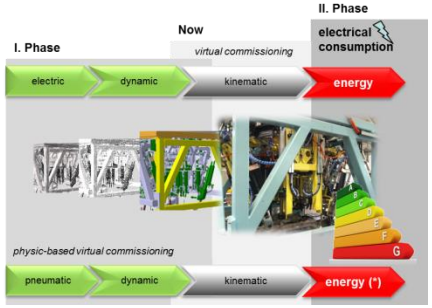


Agenda

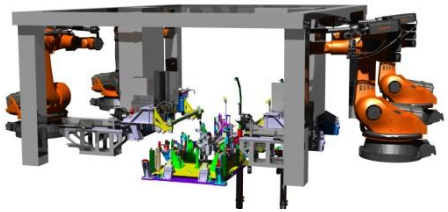
1. Introduction
2. Virtual Commissioning as phase of the plant engineering process
3. Further potential of Virtual Commissioning
4. Energy considerations of electrical and pneumatic components
5. Summary and outlook

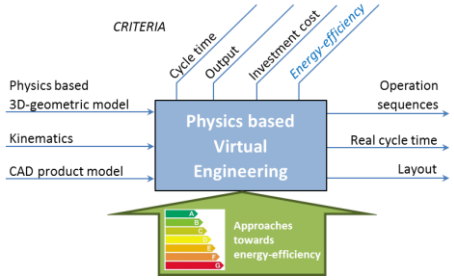


- Virtual Commissioning is an essential stage in the development process of automated production systems for the automotive industry
- Further improvements can be achieved by using physics based simulation to gain more realistic simulation results (collision-detection, accurate takt-time determination)



- Physics based simulation enables calculating and simulating mechanical energy consumption of pneumatic and electrical components based on 3D-CAD data
- Feasibility of simulating energy consumption could be tentavely demonstrated, validation of simulation results still remains





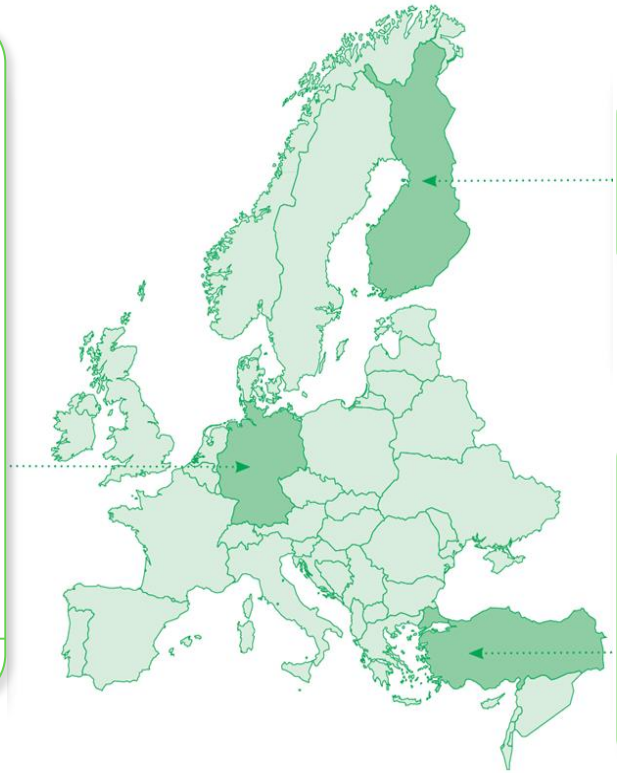
- Validation of physics based simulation results (measurements on real demonstrators are currently ongoing)

- Currently physics based simulation of energy consumption is solely available for single components
  → apply simulation approach to an entire production system

- Analyze state-of-the-art energy-saving approaches in manufacturing for application in Virtual Commissioning
  → establish energy efficiency as subordinated criterion in Virtual Commissioning

- Is it possible to automate the implementation process of energy saving apporaches?
  → analyzing design of the production system and suggest energy saving approaches automatically?

AVANTI: Test methodology for virtual commissioning based on behaviour simulation of production systems



Germany

Finland

Turkey

ITEA 2
INFORMATION TECHNOLOGY FOR EUROPEAN ADVANCEMENT

- Funded by:

  Bundesministerium für Bildung und Forschung

- Duration:
  09/2013 – 02/2016

- More information:
  http://avanti-project.de/

AVANTI: Test methodology for virtual commissioning based on behaviour simulation of production systems

Increase **efficiency and level of maturity** in **system development processes** by **automated creation of virtual production systems**

From a geometrical component module …	→	… to a standardized mechatronic component module
From a complex programmed production equipment animation …	→	… to a realistic physics-based production equipment simulation
Instead of manual simulation of test scenarios …	→	… automated test generation and execution
Instead of media changes during data exchange …	→	… to a seamless standard-based CAx process chain

Thank you very much for your attention.

Questions?

Anton Strahilov

Rücker EKS
Software development

@: Anton.Strahilov@ruecker.de

Felix Damrath

Daimler AG, Mercedes Benz Cars
Production-oriented Product Validation

@: Felix.Damrath@daimler.com