International Congress on Sustainable Manufacturing 2017

SmartAssembly – Benefits of I4.0 at the example of a smart workbench

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Agenda

- China 2025
  - China 2025 & Industry 4.0
  - Products
- Requirement Engineering
- SmartAssembly solution
- Benefit of Industry 4.0 features

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Power of Chinese Manufacturing

28 *Mio. cars*

No.1
Automotive manufacturing

1.4 *bn. KW*

No.1
Power-generation Equipment manufacturing

50 *Mio. Ton*

No.1
Ship building

1.1 *Mio. Machines**

No.1
Machine tools manufacturing

808 *Mio. Ton*

No.1
Crude Steel manufacturing

Remark:
All figures are 2016 officials from NBS
*total no. consists of 783K machine tool cutting and 318K machine tool forming.

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Industry 4.0 - the Enabler of ‘Made in China 2025’ | Strategy

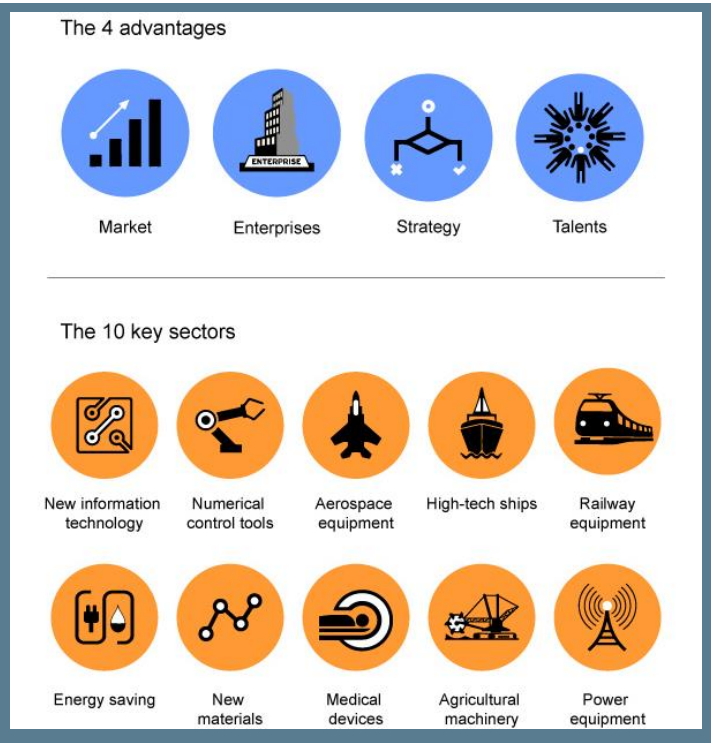
3 Stages

2025
One of the strong global manufacturing power

2035
Mid-level among the strong manufacturing power

2045
Leading manufacturing power

2 Pillars



GRAPHIC BY ZHANG RUIQI/PEOPLE'S DAILY ONLINE

1 Goal

Manufacturing Transformation & Upgrading
=
Industry 4.0

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Market situation and success factors

Market situation 2015	Success Factors China 2025	Project target
▪ Labor intensive industry with maturity between I2.0 and I3.0 ▪ 'Low variety, high batch' ▪ High ppm rates ▪ No connectivity ▪ High stock ▪ Extremely cost driven ▪ Fast and extremely volatile	▪ Higher productivity ▪ Improve training and skillset labor work force ▪ 'Higher variety, smaller batch' ▪ Quality improvement ▪ Real-time & preventive service ▪ Low inventory	Development of ▪ A smart workbench ▪ For 18 types of hydraulic valves ▪ For the transition of the Chinese manufacturing 2015 → 2025 ▪ Under consideration of the local market requirements

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Requirement Engineering

Manual assembly

18 Types

Increased Productivity

Improved quality with reduced failure rate

Efficient and flexible production system

Virtual representation in real time

Connectivity with open standards

People as key player

Digital life-cycle management

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SmartAssembly solution | 2015

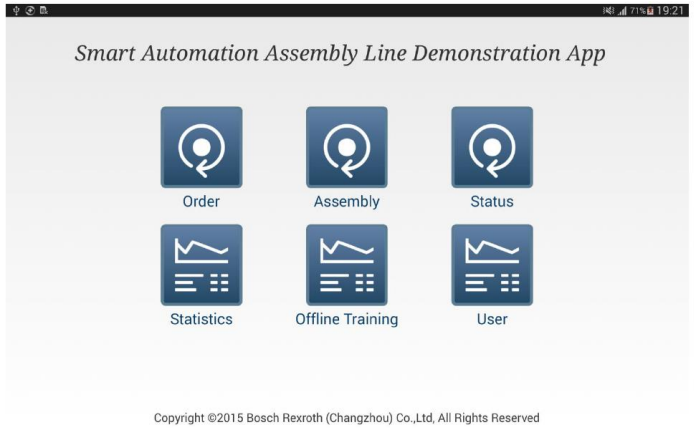
Productivity
- Offline training program

Manufacturing concept
- Integration of 18 valve types

Connectivity
- PLC

Quality
- Pick2Light

Visualization
- Local App



Digitalization
- Local order management

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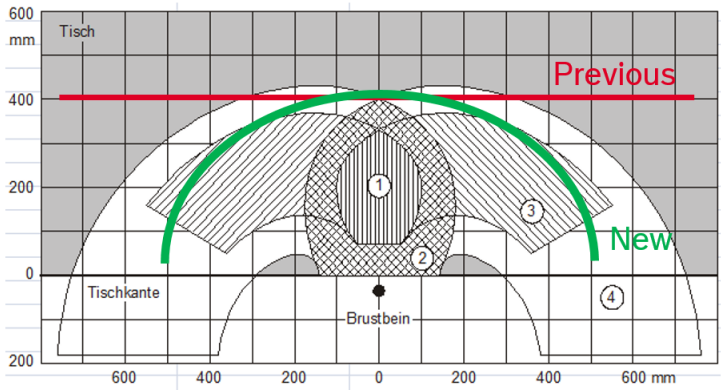
SmartAssembly solution | 2016

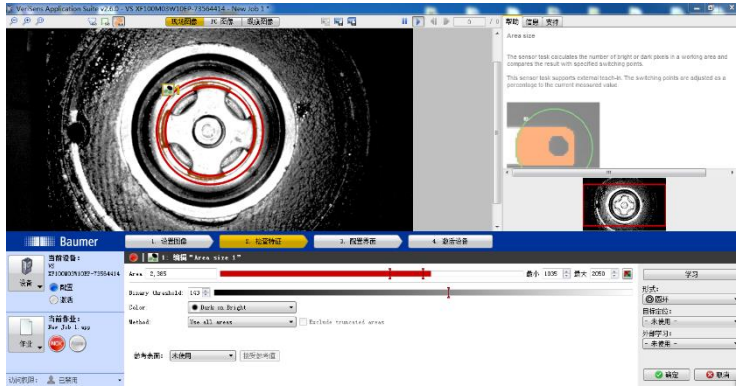
Productivity
- MTM
- Ergonomic optimization



Manufacturing concept
- Value stream design

Connectivity
- Local network

Quality
- Quality control by camera
- Torque control



Visualization
- Real-time local data

Digitalization
- Data analysis

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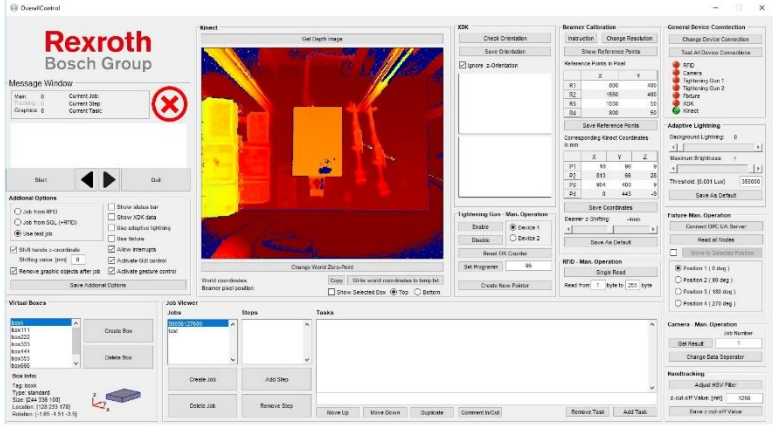
SmartAssembly solution | 2017

Productivity
- Sensor integration
- SmartSetup

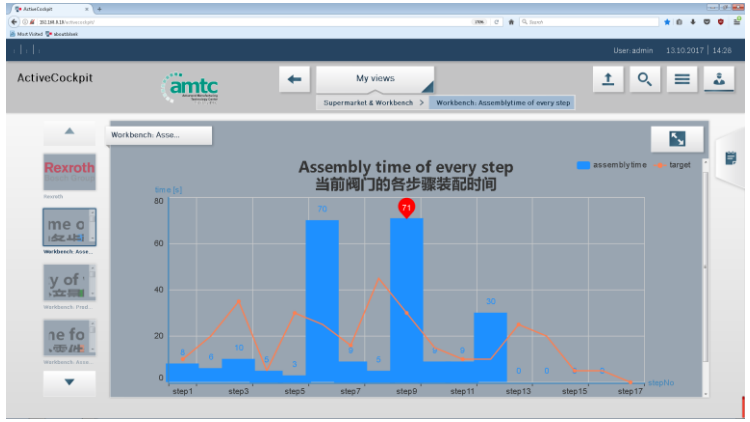


Manufacturing concept
- Stock management

Connectivity
- Integration into SmartManufacturing network

Quality
- Hand tracking
- Worker feedback

Visualization
- Real-time data on ActiveCockpit



Digitalization
- Global order management

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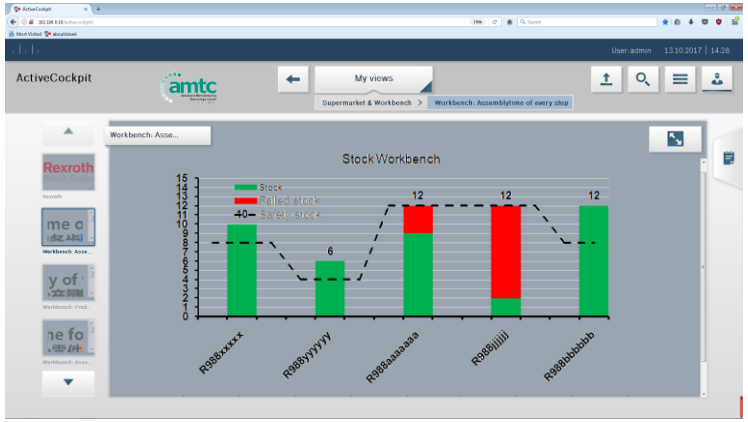
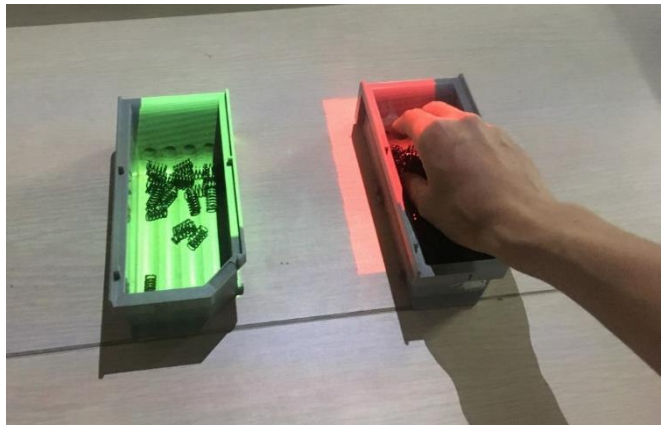
Productivity
- Sensor integration
- SmartSetup

Manufacturing concept
- Stock management



Connectivity
- Integration into SmartManufacturing network

Quality
- Hand tracking
- Worker feedback



Visualization
- Real-time data on ActiveCockpit

Digitalization
- Global order management

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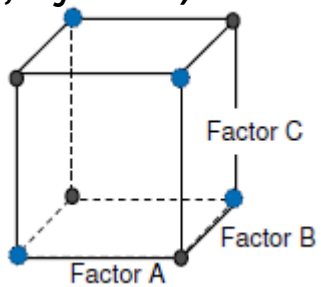
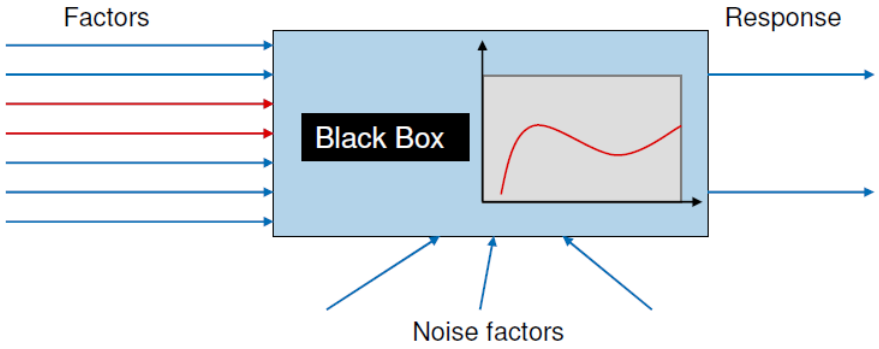
Benefits of I4.0 | Test planning

- Input factors
  - Information gathering (Paper, Tablet)
  - Pick aid (Numbering, Pick-to-light)
  - Camera (off, on)
  - Number of valve types assembled (1, 3, 5)
  - Learning program (off, on)

- Response
  - Time (per assembly step, pick, information gathering, error, tightening gun, system)
  - Assembly errors
  - Video captured (2x)
  - Short survey





→ Fractional factorial design chosen
- Reduction of required different experimental setups from 24 (full factorial design) to 12

- 63 test persons attended (ø age 25,8 years; ø height 173,4 cm)
- 10 valves per test person

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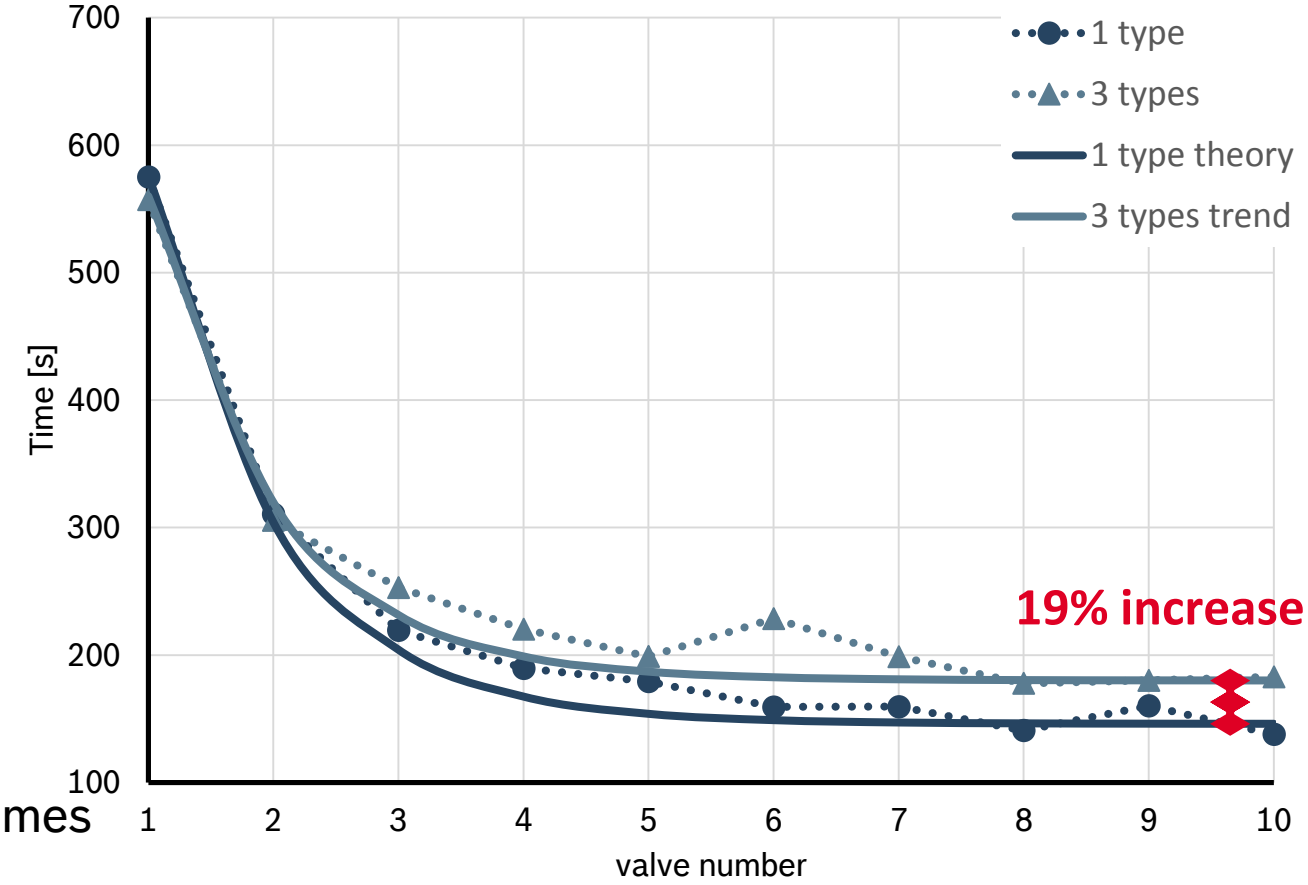
Benefits of I4.0 | Flexibility

Learning Curve

- 1 type

- 3 types



- Learning curves as expected. Steep decrease in the first valves and stable times in the end

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External

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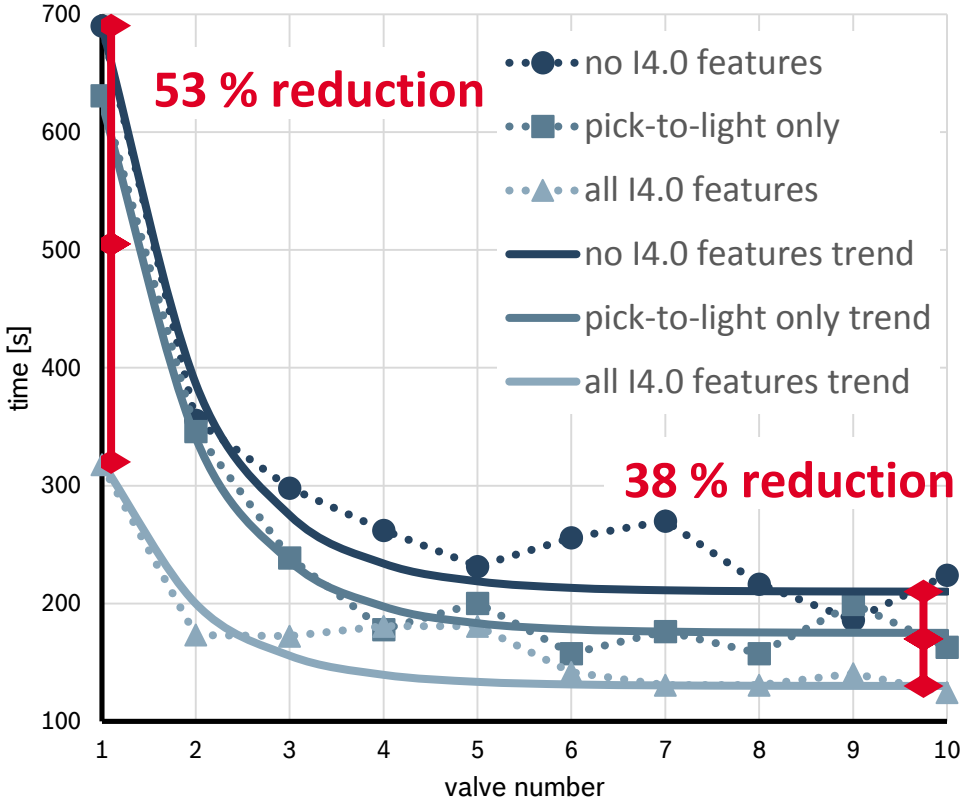
Benefits of I4.0 | Productivity

Productivity increase

no industry 4.0 (I4.0) features
features

all industry 4.0 (I4.0)



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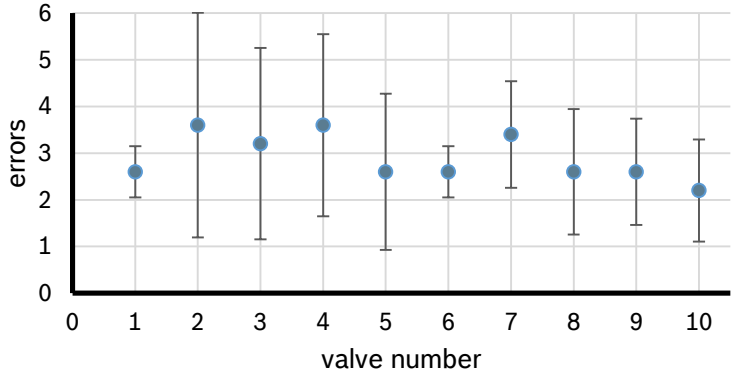
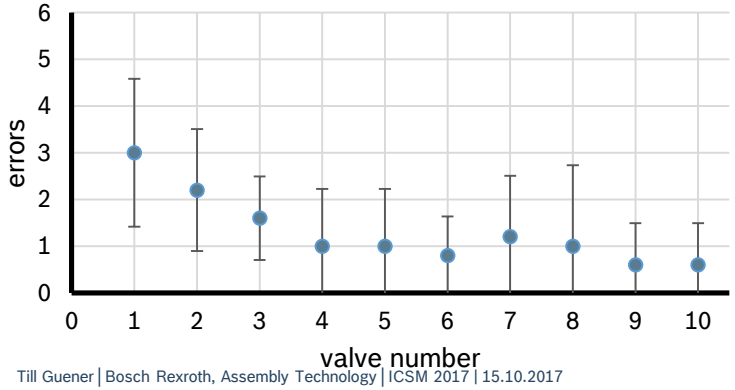
Benefits of I4.0 | Quality

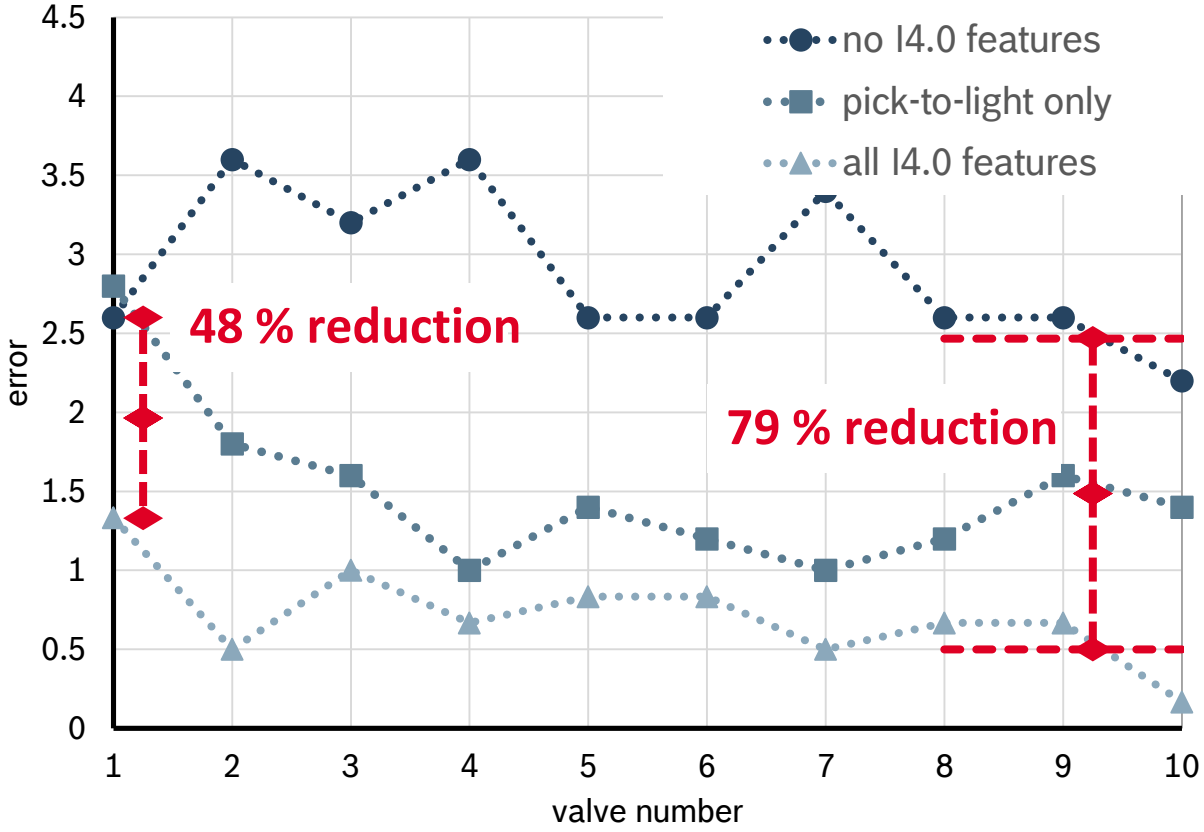
Quality

V4 by valve number (errors)



V8 by valve number (errors)





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Benefits of I4.0 | Summary

Productivity
- Significant improvements for assembly time
- Increased flexibility in production order
- Quick setup of process modules for new tasks

Digitalization
- Global and centralized order management on ActiveCockpit
- Virtual description of manufacturing and assembly processes

People as key player
- Mastering complexity through improved ways of visualization and operation
- Individual integration of the employee in the work process

Quality
- Drastic reduction of assembly failures
- Worker feedback ensures continuous improvement and learning

Virtualization
- Seamless integration and processing of all data along the value stream
- Fast reaction times due to easy evaluation and optimization of scenarios

Manufacturing concept
- Reduced inventory due to virtual stock management
- Key performance improvements due to value stream design

Connectivity
- Guaranteed quality and reliability of real-time data
- Ad hoc connection of people, processes and machines

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Thank you for your attention.

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