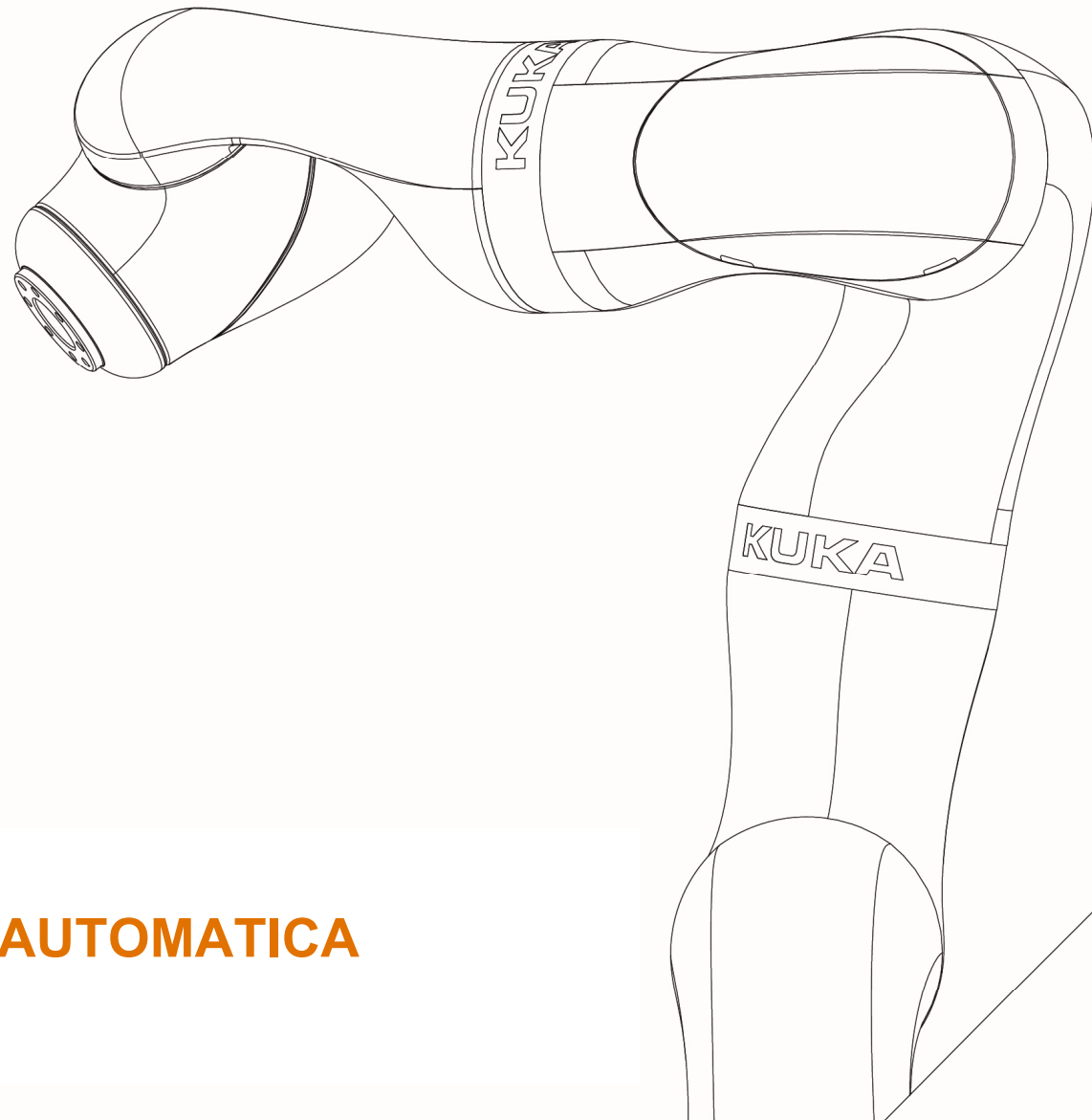


KUKA



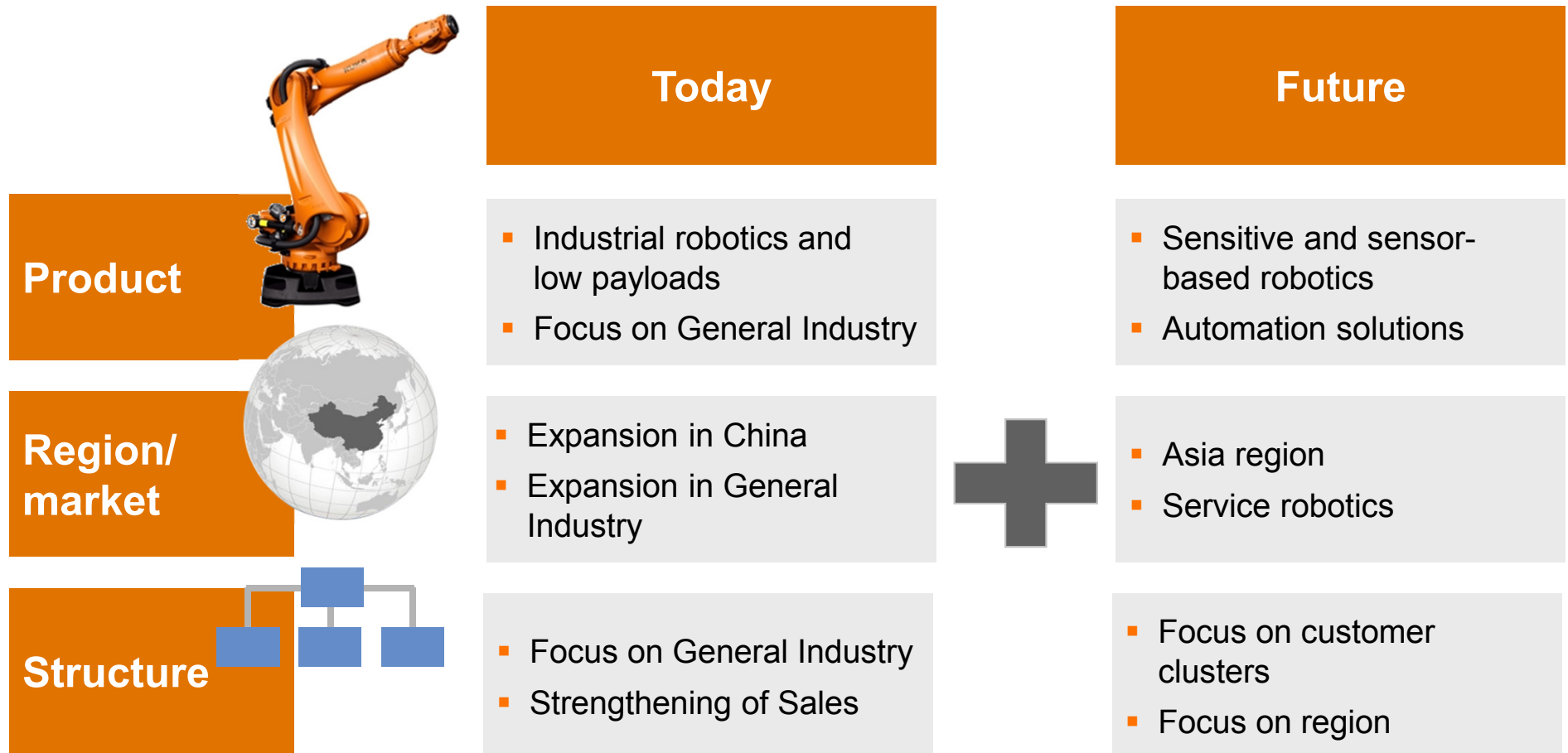
Dr. Till Reuter
CEO KUKA AG

Capital Market Day AUTOMATICA
June 03, 2014



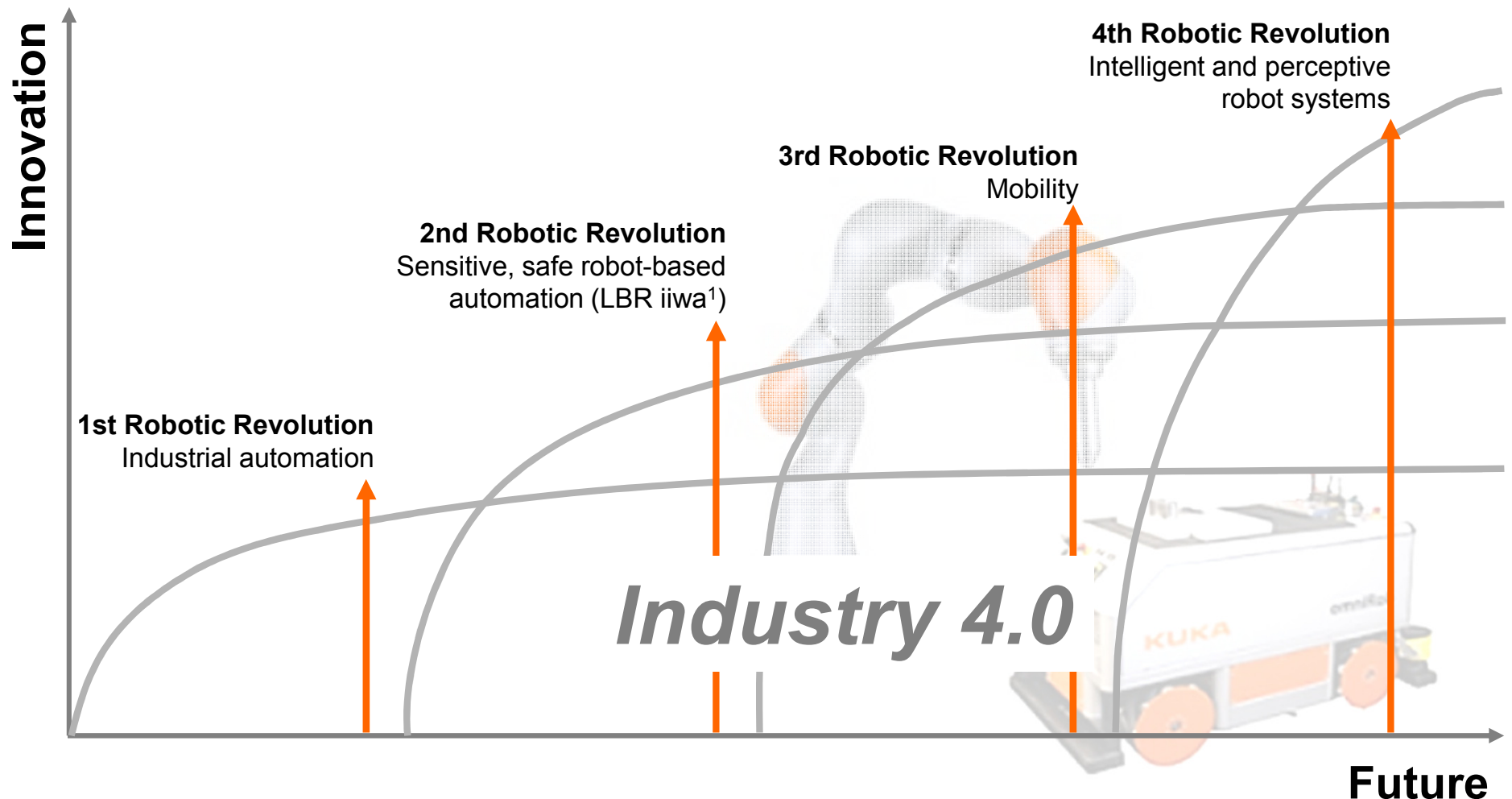
Development of KUKA Group

Growth through change



Development of robots

New technologies are opening up new markets

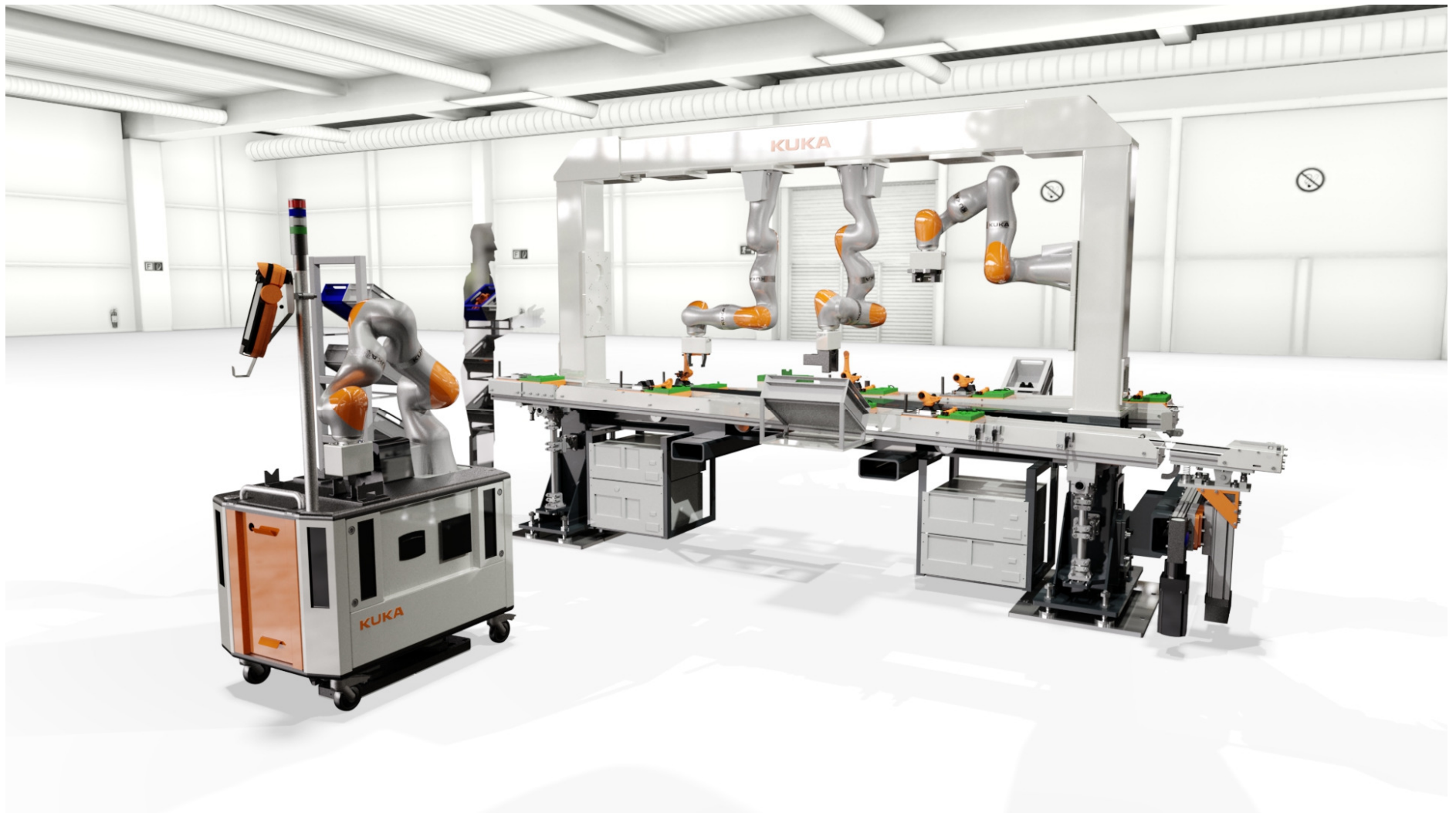


1) LBR iiwa – Leichtbauroboter intelligent industrial work assistant



Service robotics with LBR iiwa¹

Revolution in production

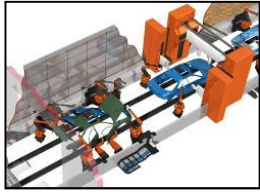


1) LBR iiwa – Leichtbauroboter intelligent industrial work assistant



Service robotics with LBR iiwa¹

High potential in the automotive sector

	Power train	Press shop	Body Shop	Paint shop	Final assembly
					
Number of robots per segment	40-100	7-15	400-600	40-50	10-20
Robot applications	<ul style="list-style-type: none"> ▪ Handling ▪ Assembly ▪ Welding ▪ Machining 	<ul style="list-style-type: none"> ▪ Handling ▪ Press linking 	<ul style="list-style-type: none"> ▪ Spot welding ▪ Laser welding ▪ Gluing ▪ Riveting ▪ Handling ▪ Body transfer ▪ 	<ul style="list-style-type: none"> ▪ Painting ▪ Sealing 	<ul style="list-style-type: none"> ▪ Assembly ▪ Handling
Degree of automation	<ul style="list-style-type: none"> ▪ Medium to high 	<ul style="list-style-type: none"> ▪ High 	<ul style="list-style-type: none"> ▪ Very high 	<ul style="list-style-type: none"> ▪ High 	<ul style="list-style-type: none"> ▪ Very low

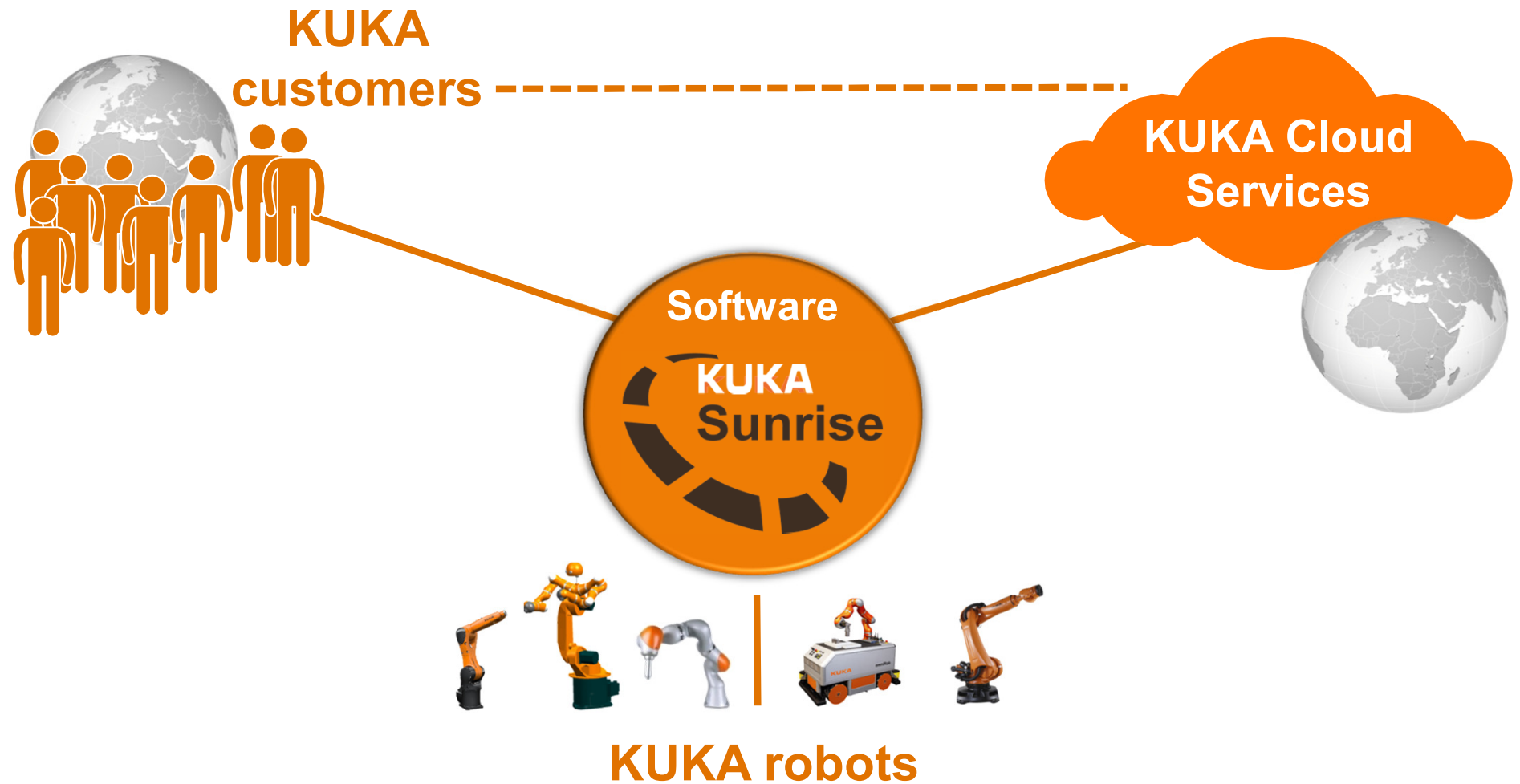
Based on production of 200,000 cars per year

1) LBR iiwa – Leichtbauroboter intelligent industrial work assistant



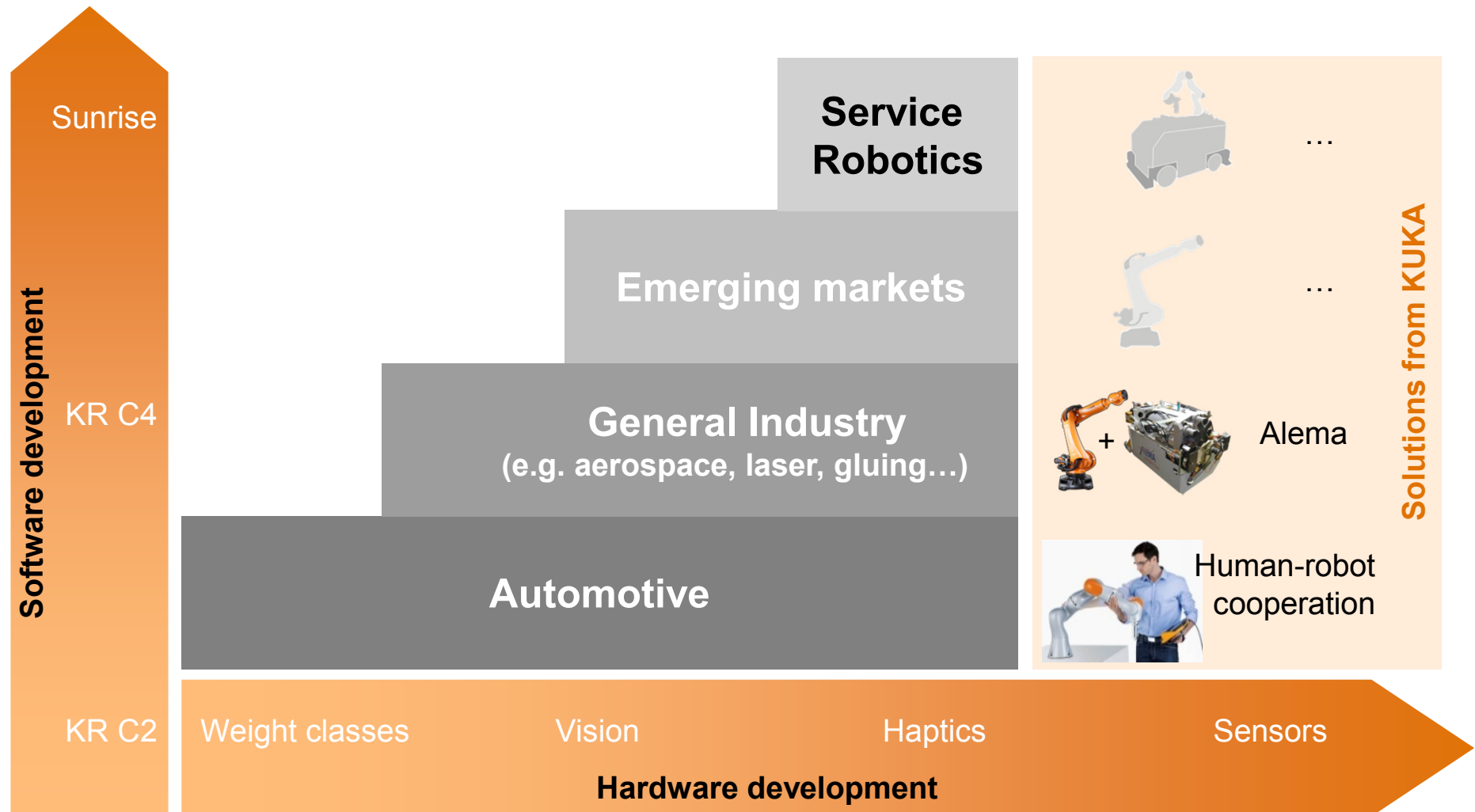
KUKA software

Sunrise opens up new markets for KUKA



KUKA development

Hardware – Software – Solution – Processes



Disclaimer

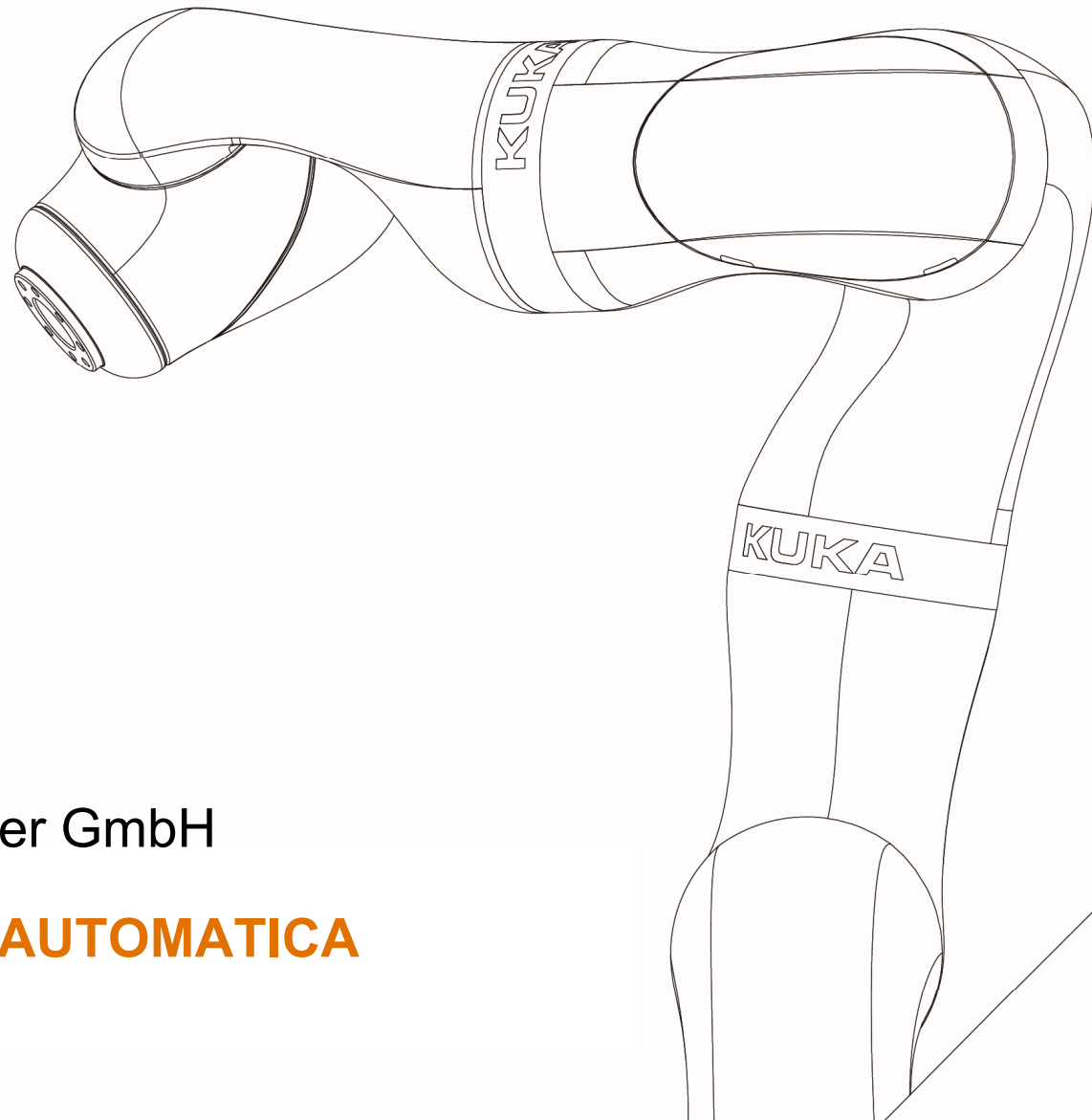
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These factors may include, for example, changes in the overall economic situation, exchange rates and interest rates, and changes affecting individual markets. KUKA Aktiengesellschaft provides no guarantee that the future development and the future results actually achieved will correspond to the assumptions and estimates stated here and accepts no liability if they should fail to do so.

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KUKA



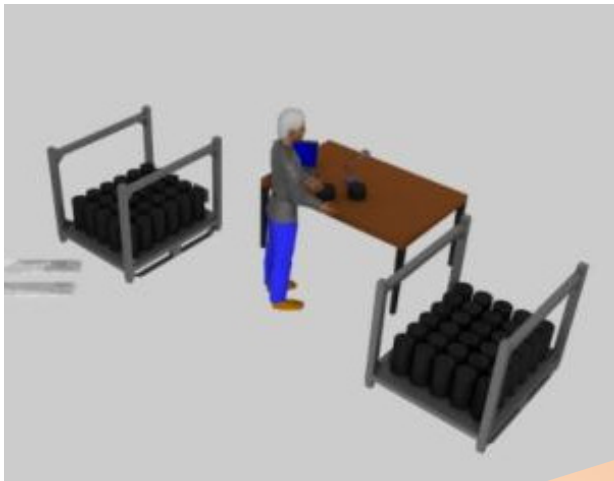
Manfred Gundel
CEO of KUKA Roboter GmbH

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June 03, 2014

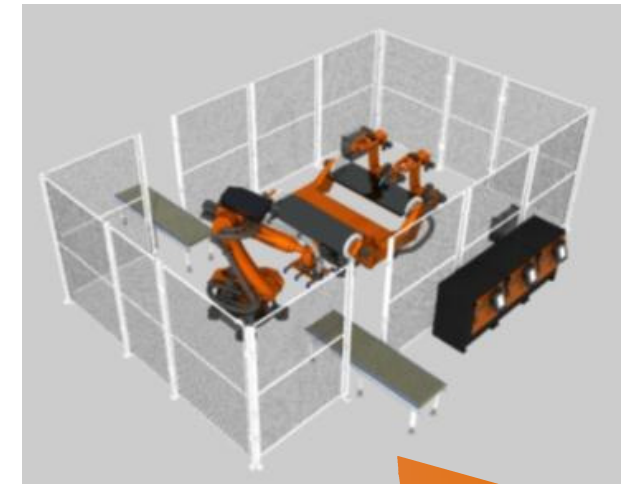
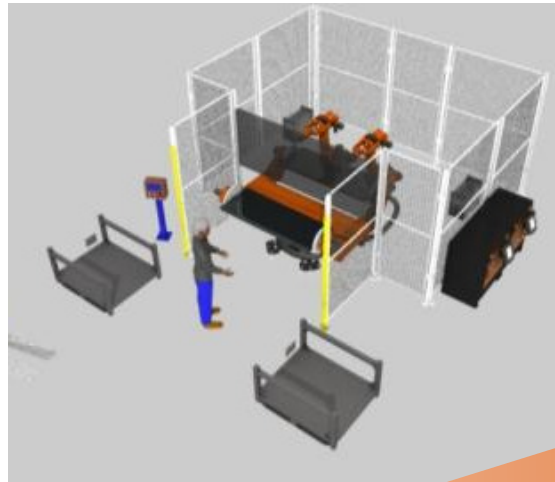


Automation

Evolutionary stages of automation



Assembly

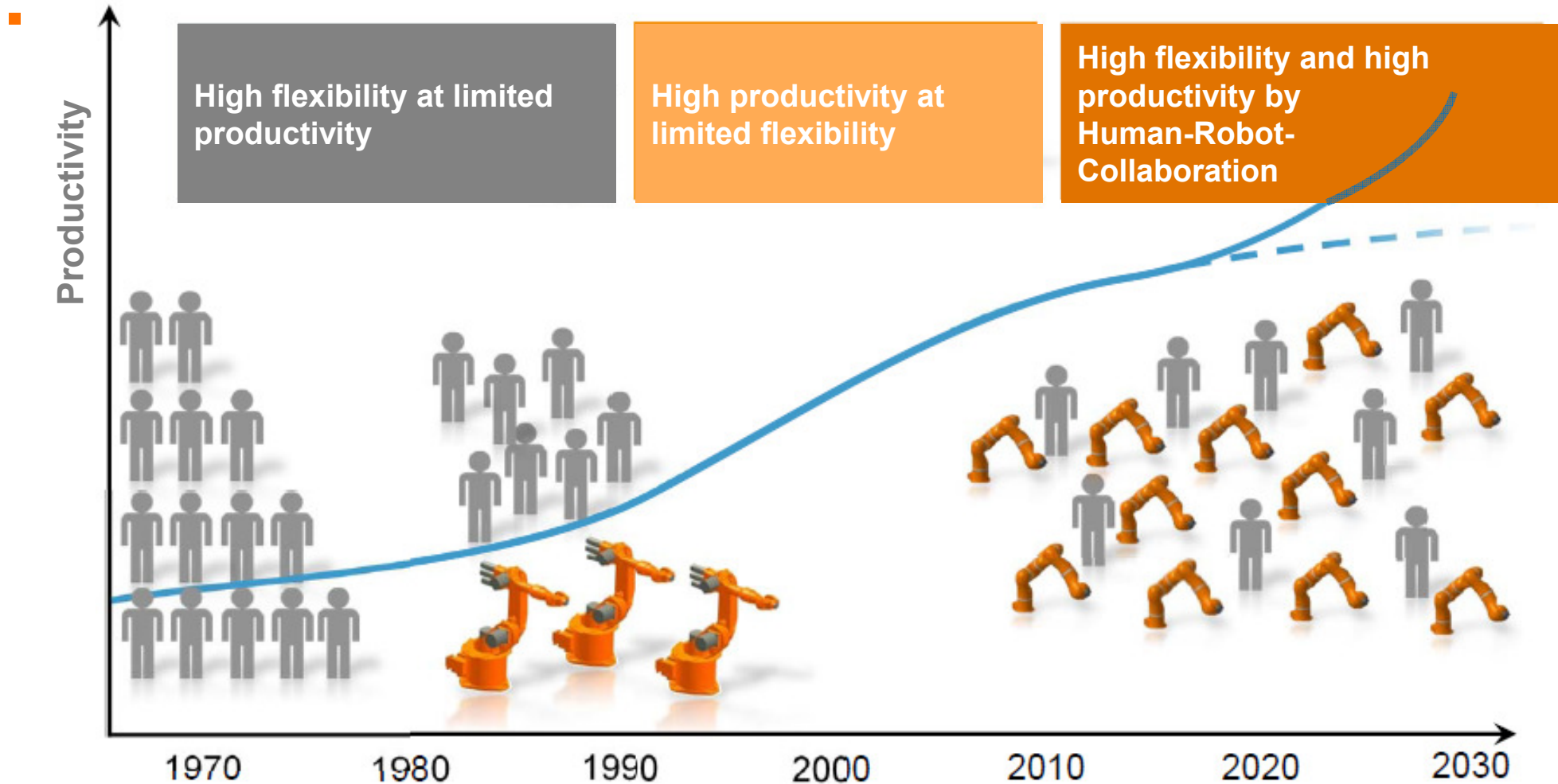


Bodyshop



Automation

Collaboration boosts flexibility and productivity



Quelle: Daimler



Collaboration

Do we need protection principles for HRC¹?

MOVIE



Collaboration

What protection principles do exist for HRC¹?

1. The robot always keeps its distance from humans
2. The robot can come into safe contact with humans



The KUKA LBR iiwa² was specially designed to come into safe contact with humans

1) Human robot collaboration
KUKA Aktiengesellschaft

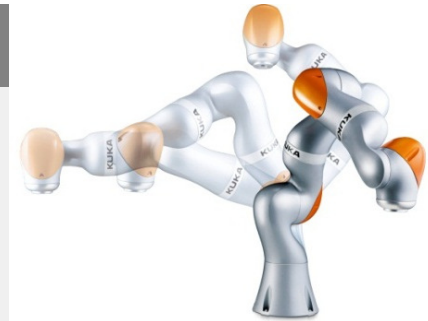
2) LBR iiwa – Leichtbauroboter intelligent industrial work assistant
page 13

Lightweight robot

Functions of the LBR iiwa¹

Position controller

- The LBR iiwa moves to the programmed position “stubbornly” with high accuracy



Stiffness controller

- The LBR iiwa behaves like a spring with stiffness and damping parameters in cartesian or axis-specific mode
- Activation of a defined force



Gravity compensation

- The LBR iiwa behaves as if weightless; movement results from application of the slightest external force
- Manual guidance and teaching by demonstration

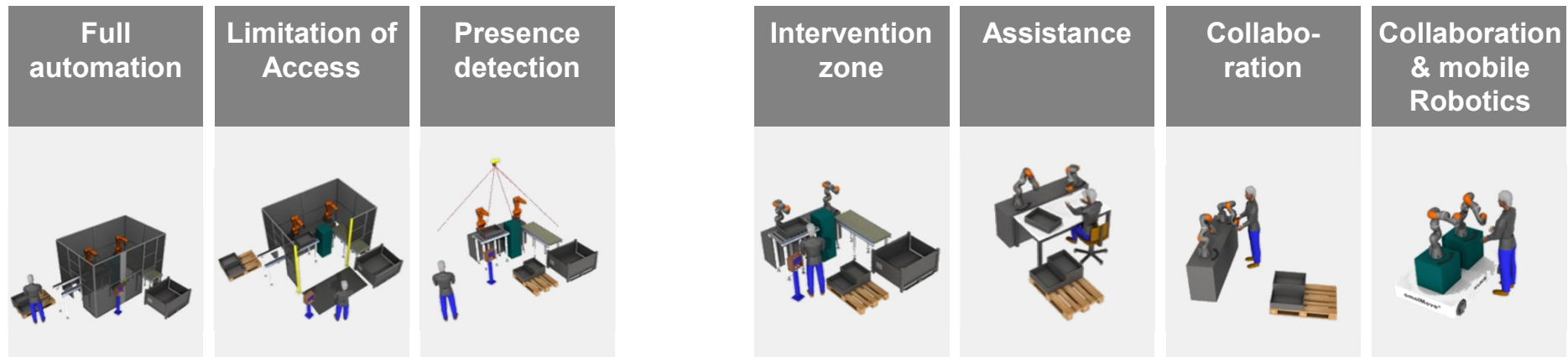


1) LBR iiwa – Leichtbauroboter intelligent industrial work assistant
KUKA Aktiengesellschaft



Automation

KUKA masters all scenarios of HRC¹



Industrial robots



Lightweight robot: LBR iiwa²

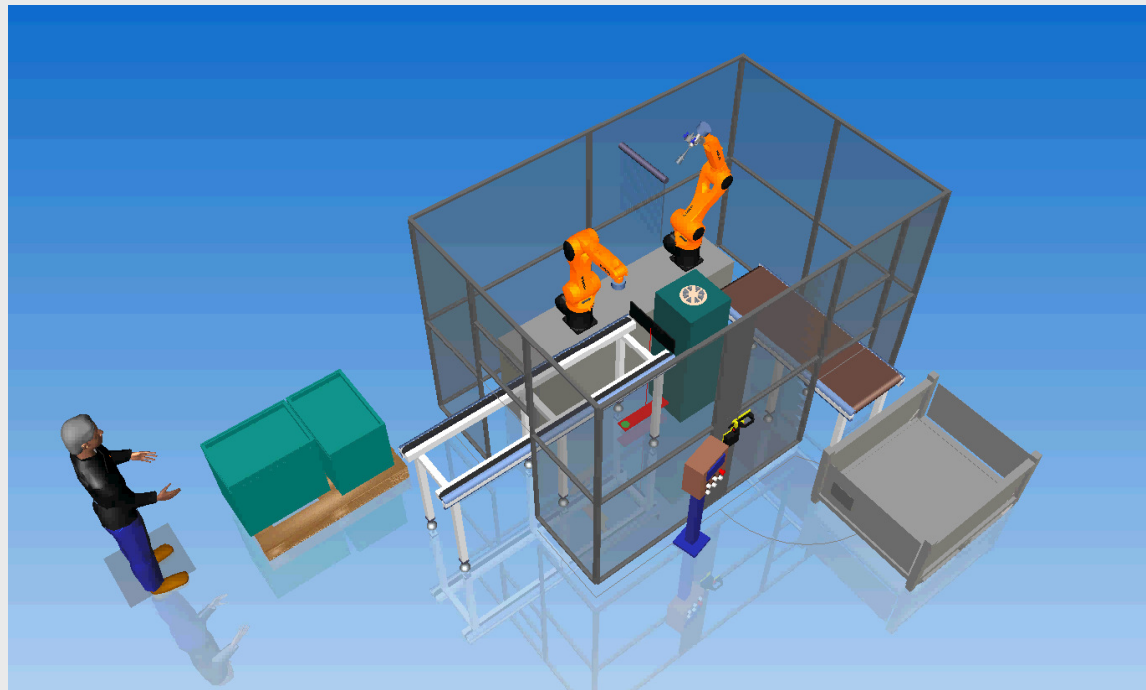
1) Human robot collaboration
KUKA Aktiengesellschaft

2) LBR iiwa – Leichtbauroboter intelligent industrial work assistant
page 15



Scenarios of HRC¹

Full automation (state of technology)



No persons in the workspace

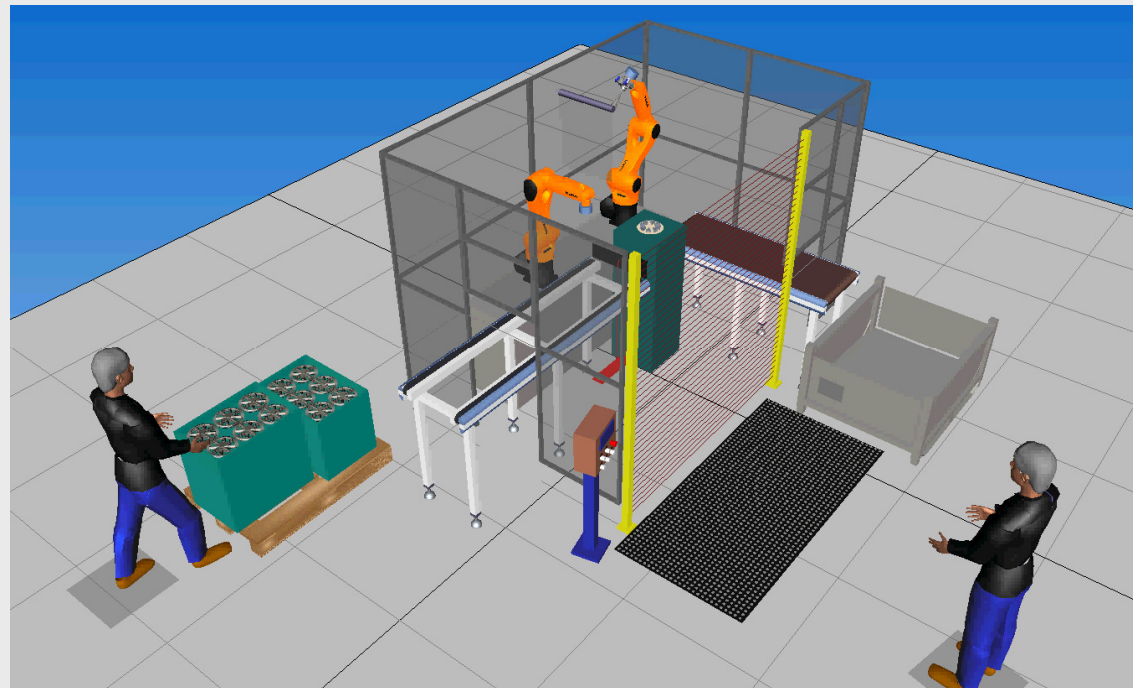


No contact



Scenarios of HRC¹

Limitation of Access



No persons in the workspace

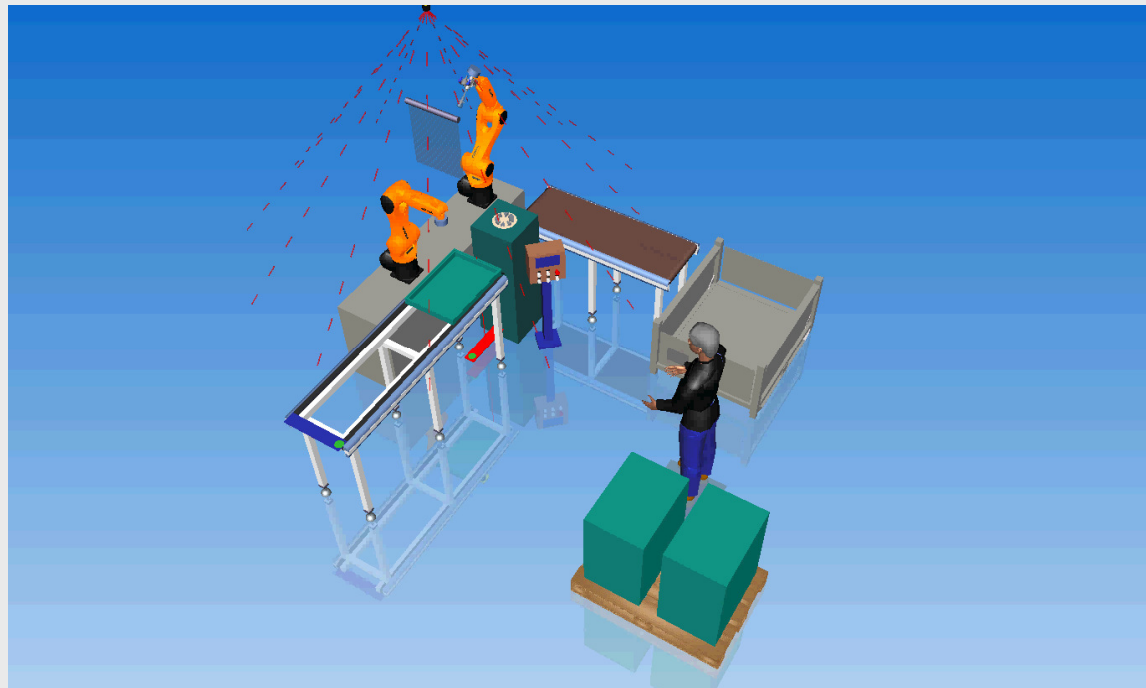


No contact



Scenarios of HRC¹

Presence detection



Humans in workspace for a short period

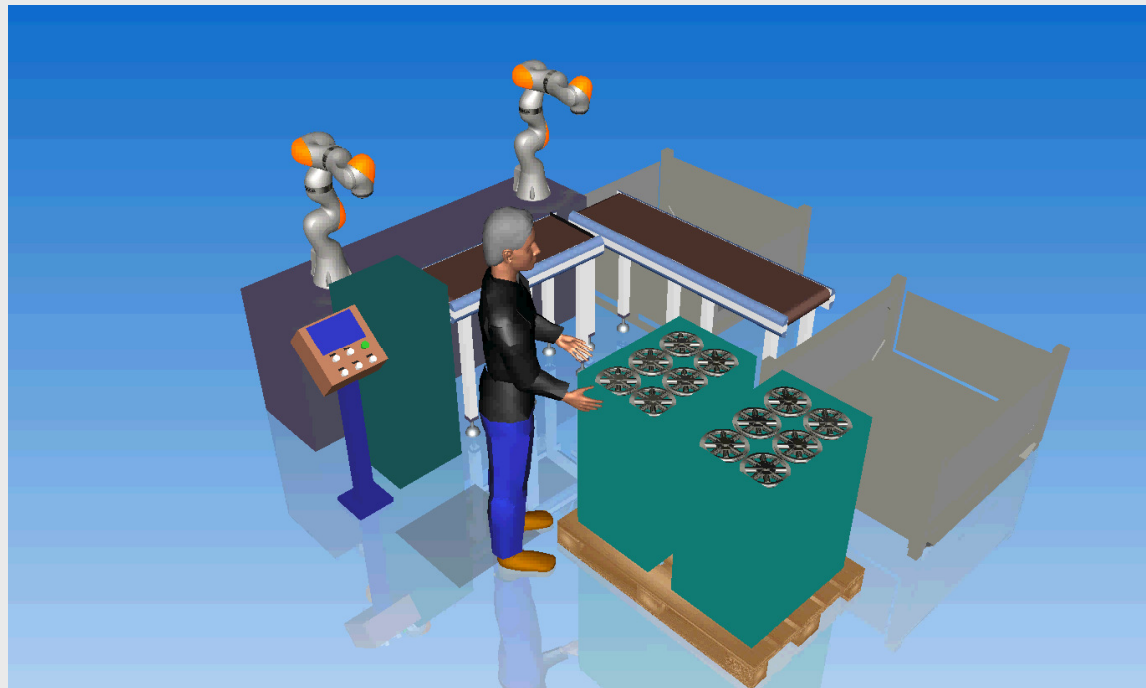


Only when robot is at standstill



Scenarios of HRC¹

Intervention zones



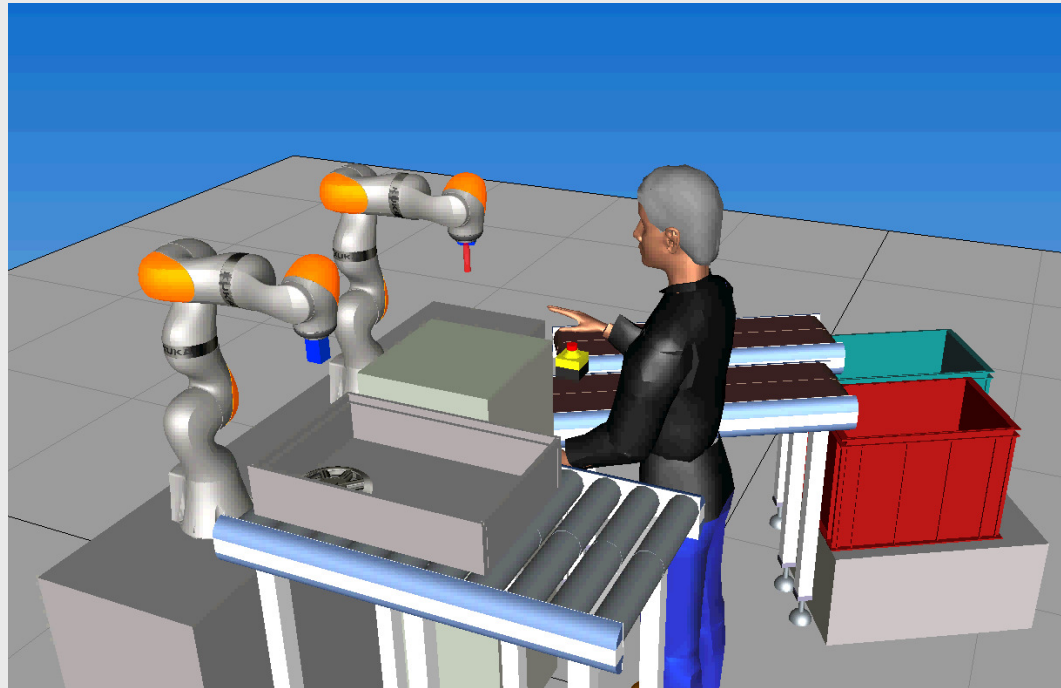
Continuous interaction



Only when robot is at standstill



Scenarios of HRC¹ **Assistance**



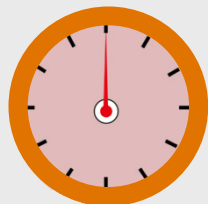
Continuous
interaction



Contact is
possible



Scenarios of HRC¹ Collaboration



Continuous
interaction



Unlimited
contact

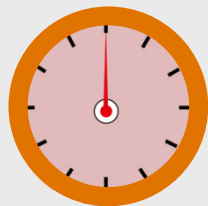
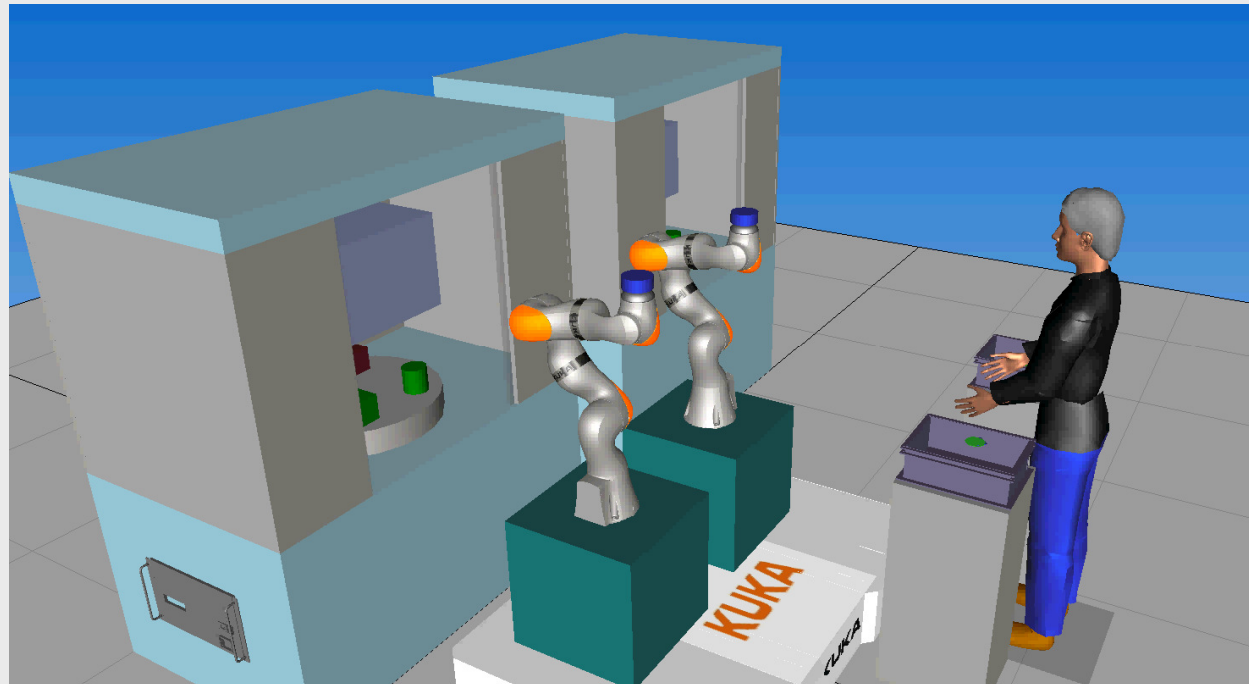


Collaboration



Scenarios of HRC¹

Collaboration & mobile Robotics



Continuous interaction



Unlimited contact



Collaboration



Mobility

1) Human robot collaboration
KUKA Aktiengesellschaft



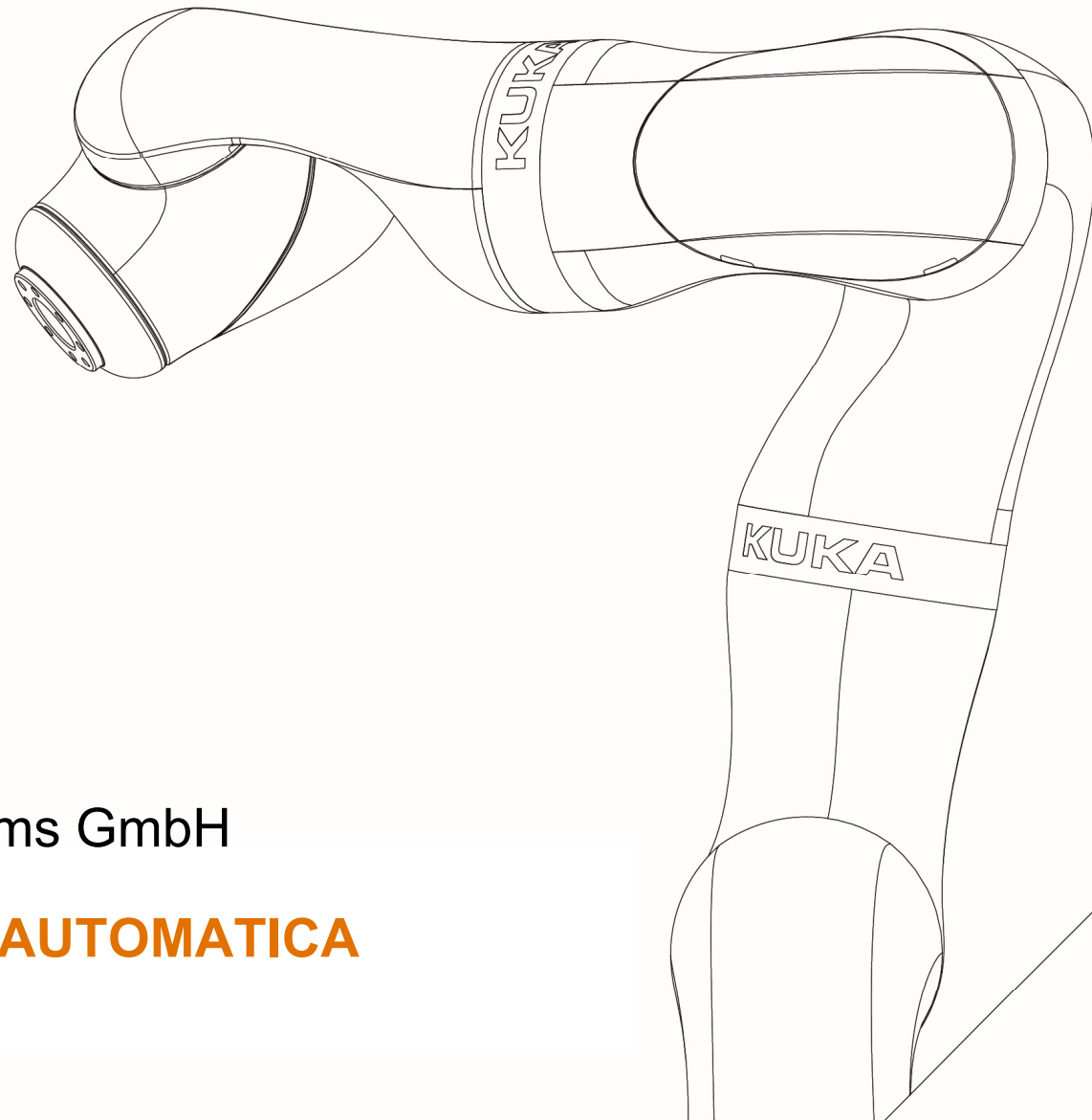
Vision: Arena 2036

New production concepts

MOVIE



KUKA



Frank Klingemann
CEO of KUKA Systems GmbH

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June 03, 2014



Factory of the future

Innovations at KUKA



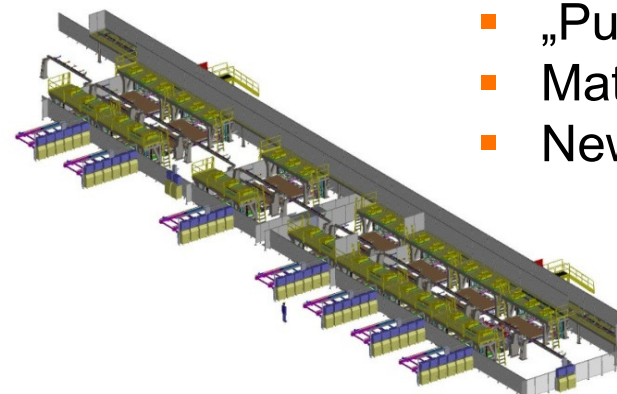
Human-robot collaboration



Efficient use of energy and resources

- Guidelines for rating energy efficiency
- Energy simulation tool

New system concepts



- „Pulse“
- Matrix body shop
- New standards



Factory of the future

Innovation focus at KUKA Systems



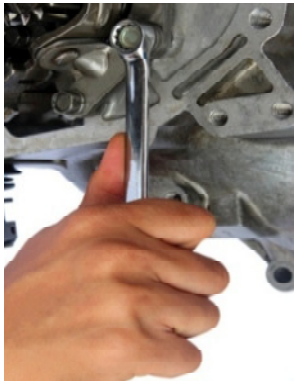
Human-robot collaboration

MOVIE



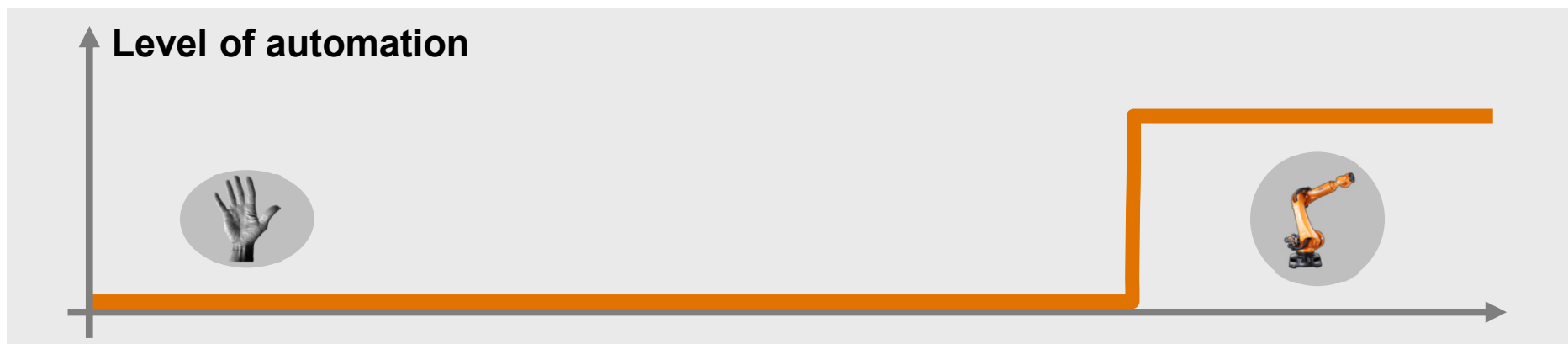
Factory of the future

Production today



Manual
manufacturing

Full
automation



Factory of the future

Production tomorrow



Manual
manufacturing

HRC¹



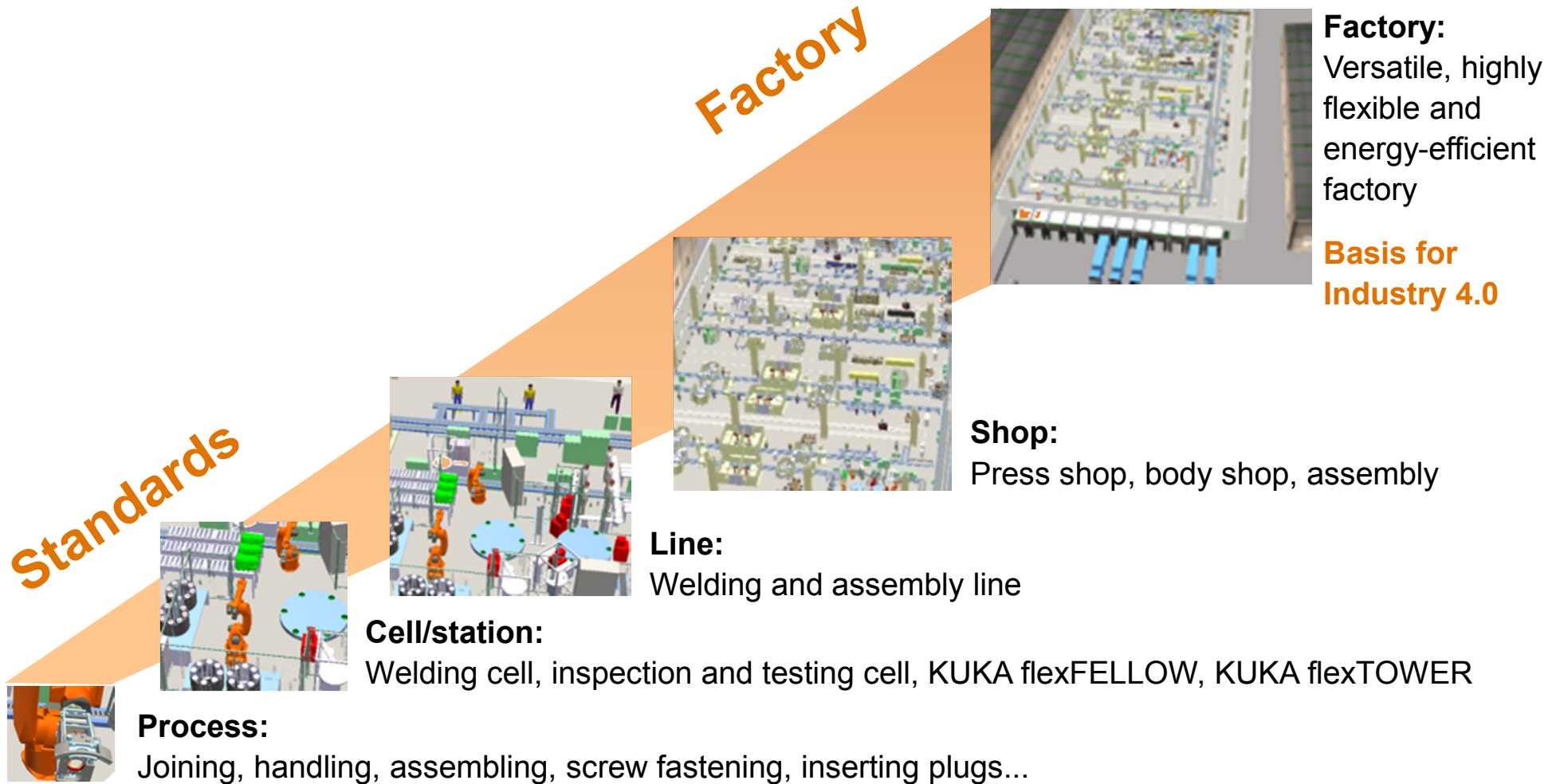
Full
automation



1) Human robot collaboration
KUKA Aktiengesellschaft

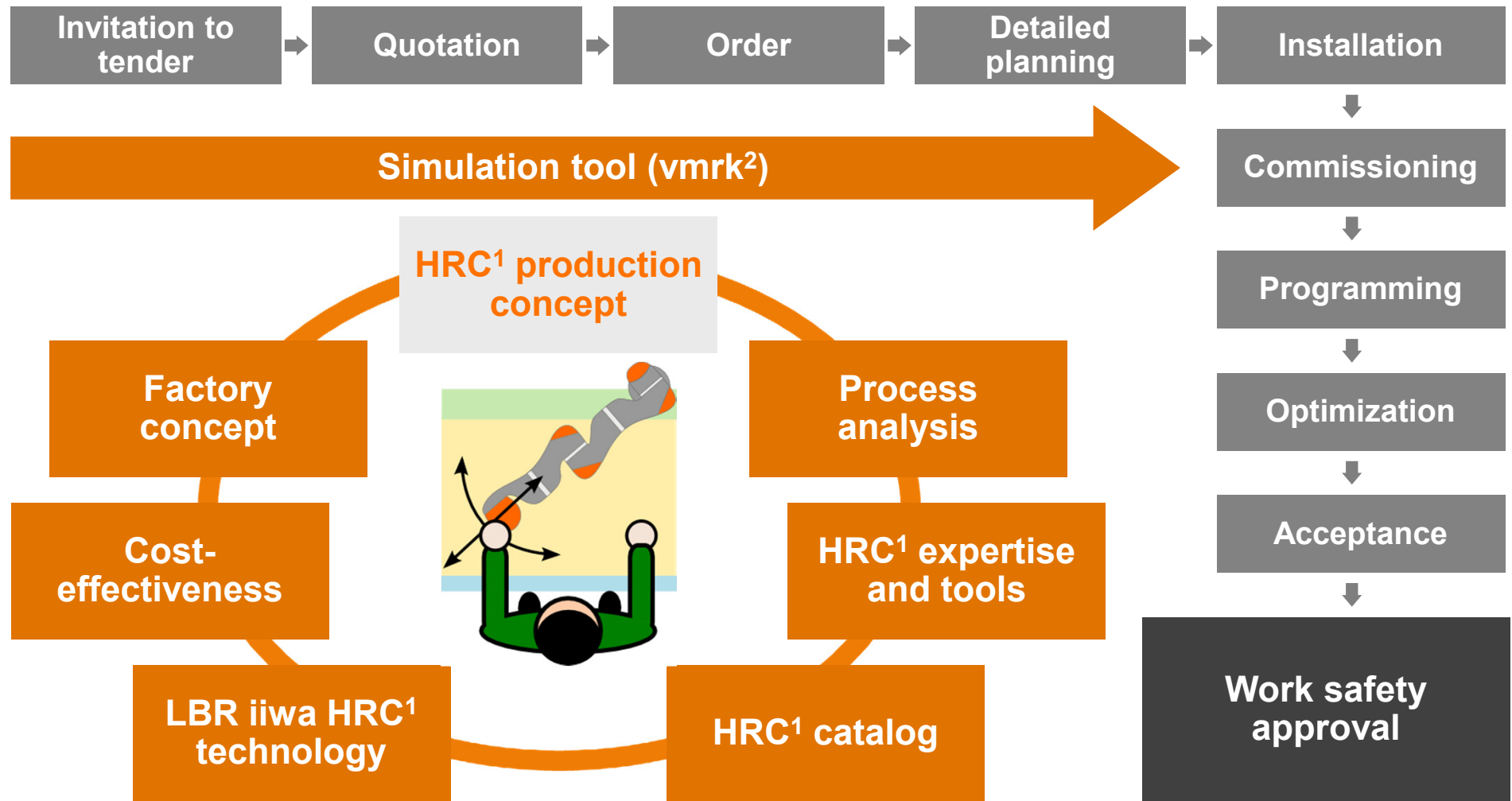


Factory of the future Design principles



Applications with the LBR iiwa

The road to HRC¹ solutions



1) Human robot collaboration
KUKA Aktiengesellschaft

2) vmrk-Komponenten: v – Geschwindigkeit (velocity), m–Masse (quantum), r–Radius (radius), k–Körperzone (human body part)

Applications with the LBR iiwa¹

Solutions in the field of service robotics

Cost-effectiveness calculation based on KUKA flexFELLOW



¹) LBR iiwa – Leichtbauroboter intelligent industrial work assistant
KUKA Aktiengesellschaft



Applications with the LBR iiwa¹


Operation as KUKA flexFELLOW

Operation with human workers

Secondary tasks **result in** interruptions of production

- Spot checks of geometric quality (3 parts measured per 50 parts)
- Personal allowance
- Intermittent logistical interruptions



	Manual 	KUKA flexFELLOW 
Gross cycle time	82 s	63 s
Parts per hour	44	57
Parts per shift (7.5 h)	330	430 

Secondary tasks	Interruption to production	
	Manual	KUKA flexFELLOW
Quality spot checks	X	
Logistics	X	
Personal allowance	X	
Breaks/lunch	X	
Change of cutting dies	X	X
NOK parts	X	X

1) LBR iiwa – Leichtbauroboter intelligent industrial work assistant
KUKA Aktiengesellschaft



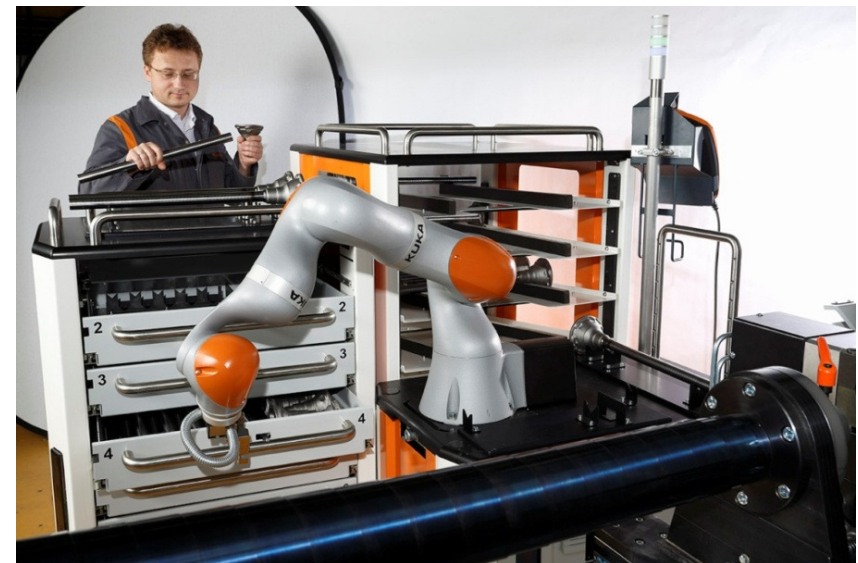
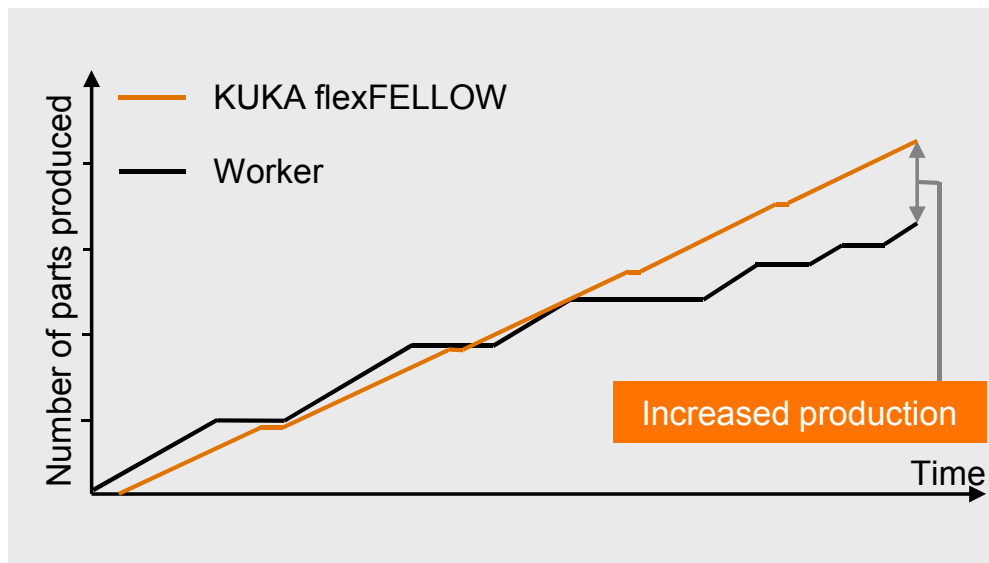
Applications with the LBR iiwa¹

Advantages of KUKA flexFELLOW

Operation of KUKA flexFELLOW with LBR iiwa¹

Secondary tasks **do not** result in interruptions to production

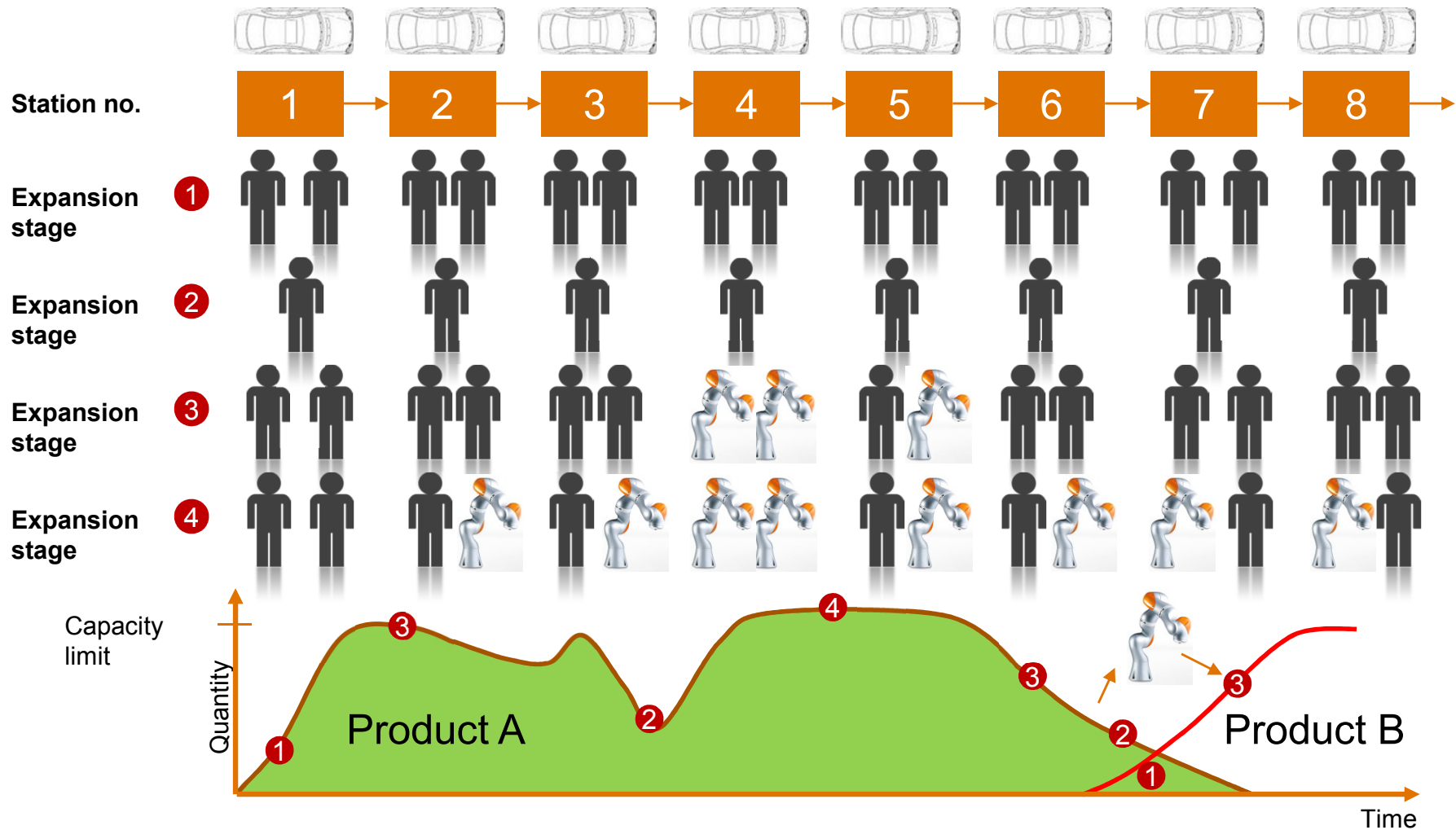
- Released machine capacity
- Released worker capacity



- Customer's production increased by approx. 30%
- Return of investment < 2 years

Competitive advantage for Systems

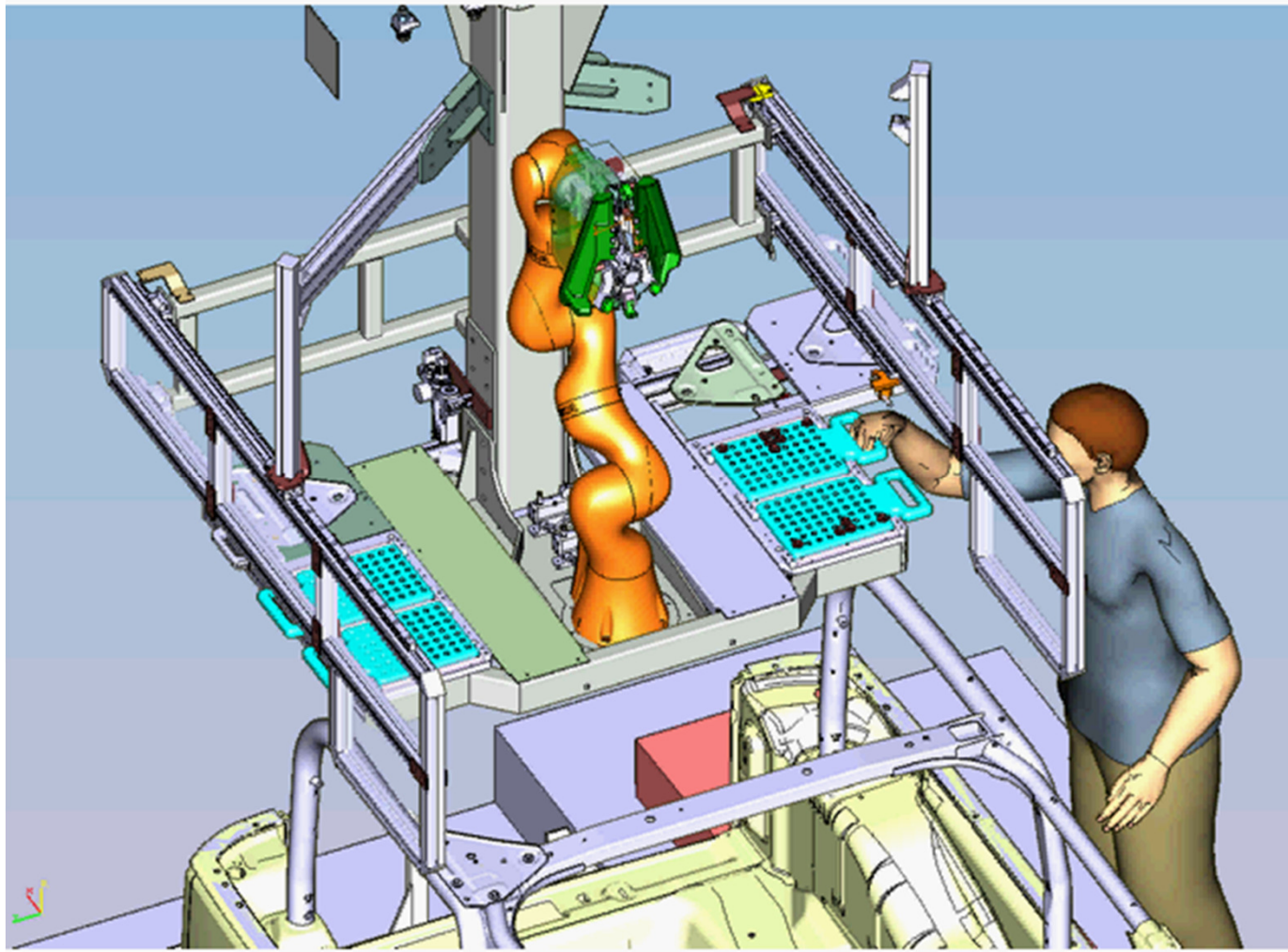
Goal: Spontaneous and scalable automation



Qualitative representation



KUKA flexFELLOW operation I Example: KTPO¹



Customer advantages

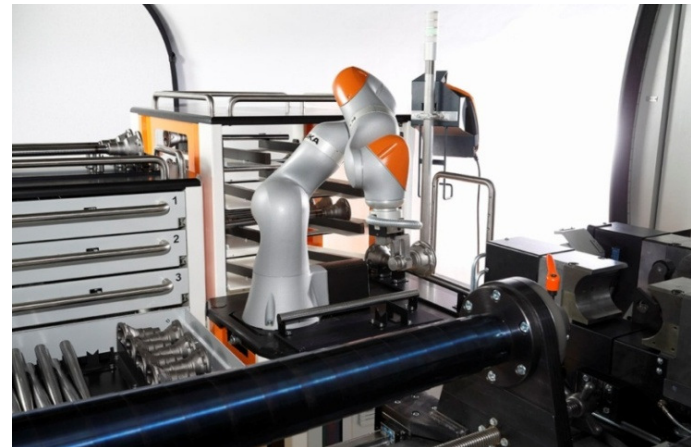
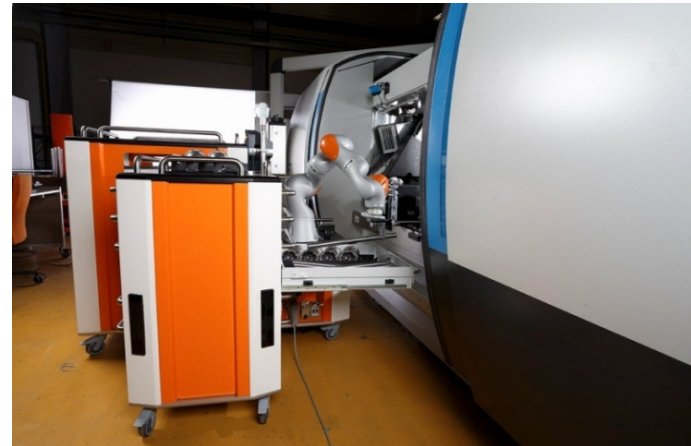
- Avoidance of non-ergonomic work
- Fast material provision
- Permanent setpoint/actual value comparison for process optimization and quality assurance

1) KTPO: KUKA Toledo Production Operations
KUKA Aktiengesellschaft



KUKA flexFELLOW operation II

Example: Contract manufacturing



Customer advantages

- Firmly calculable output
- Reduction in secondary tasks/breaks
- Released worker capacity
- Elimination of waiting times



KUKA flexFELLOW operation III

Example: Inserting plugs

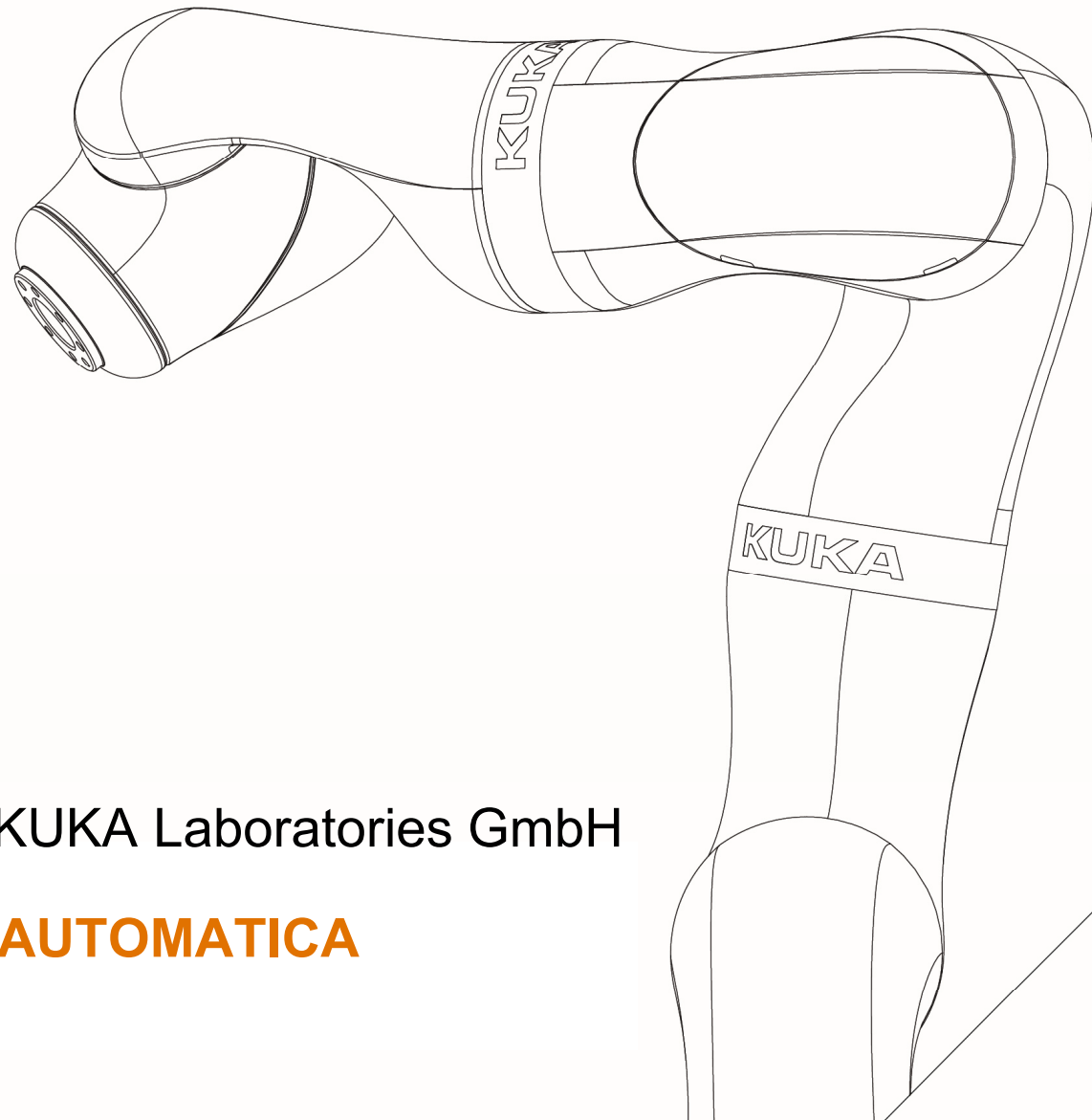


Customer advantages

- Avoidance of non-ergonomic work
- Fast material provision
- Reliable insertion of plugs in every position
- Permanent setpoint/actual value comparison for process optimization and quality assurance



KUKA



Christian Tarragona
Head of Software of KUKA Laboratories GmbH

Capital Market Day AUTOMATICA

June 03, 2014



Growth through technology

LBR iiwa¹ – creating a new robotic world

[+] COWORKER

Enabled by

[+] ASSISTANT



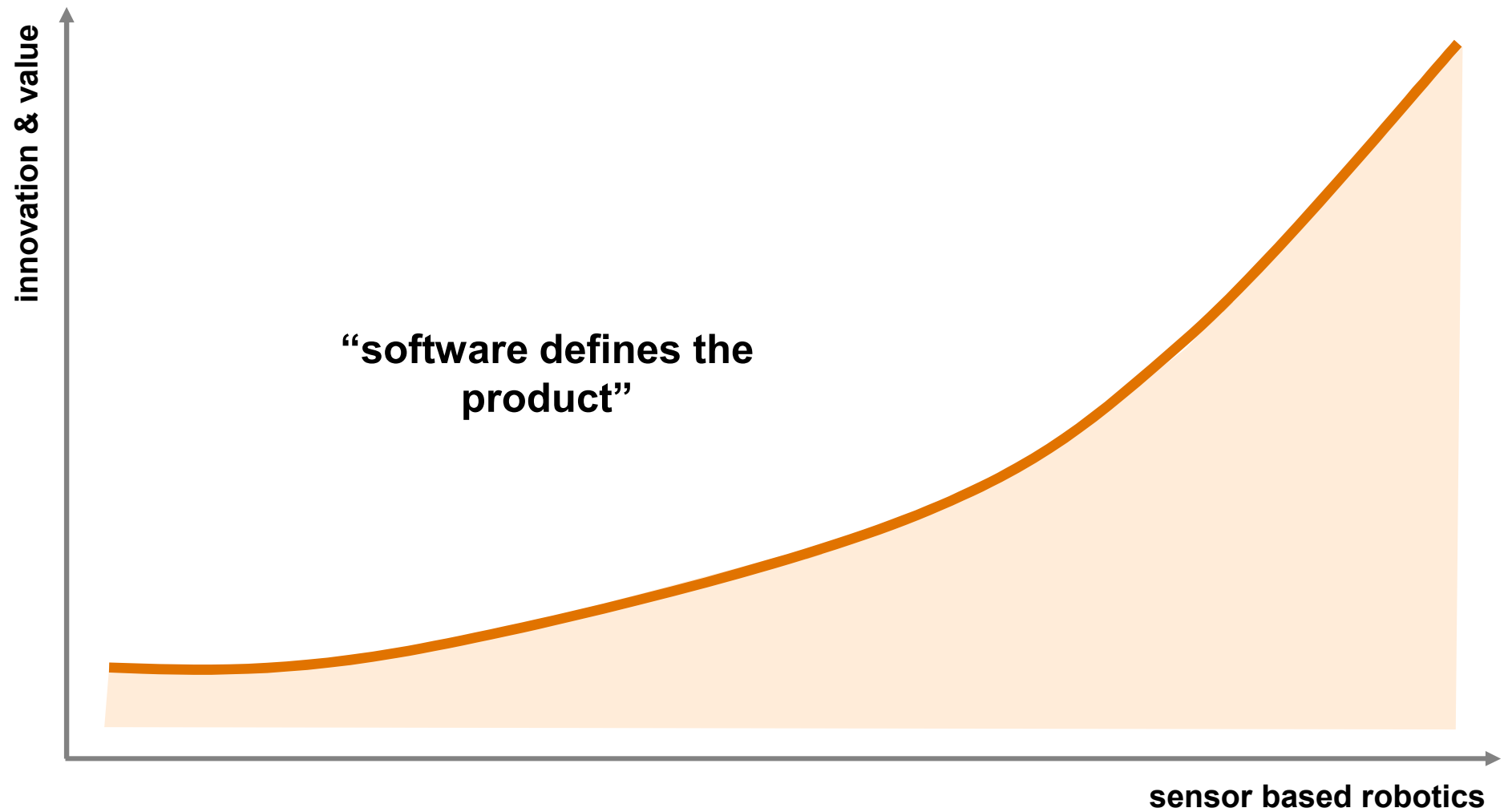
[+] COMPANION

1) LBR iiwa – Leichtbauroboter intelligent industrial work assistant
KUKA Aktiengesellschaft



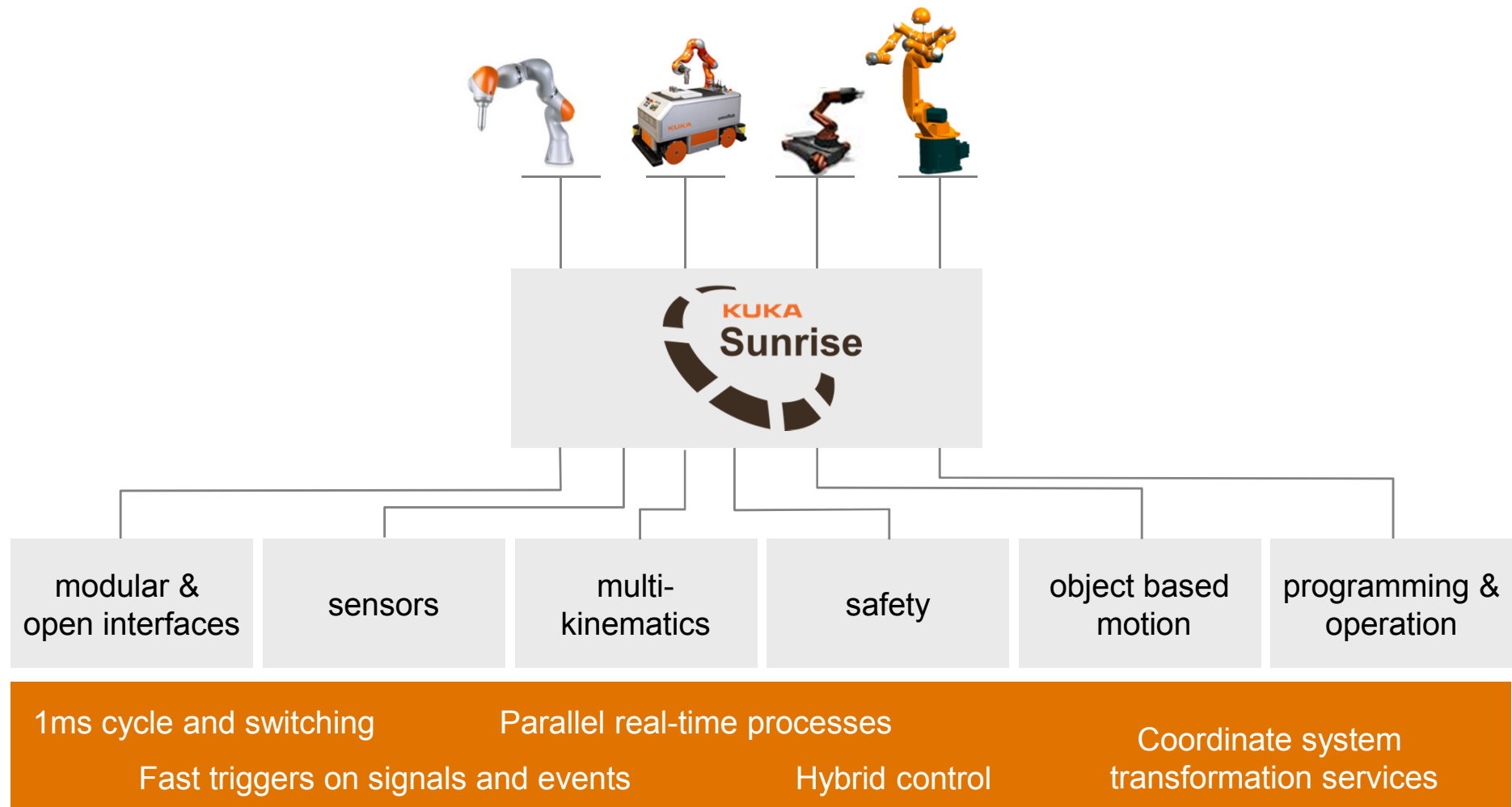
Growth through technology

Software – driver of innovation



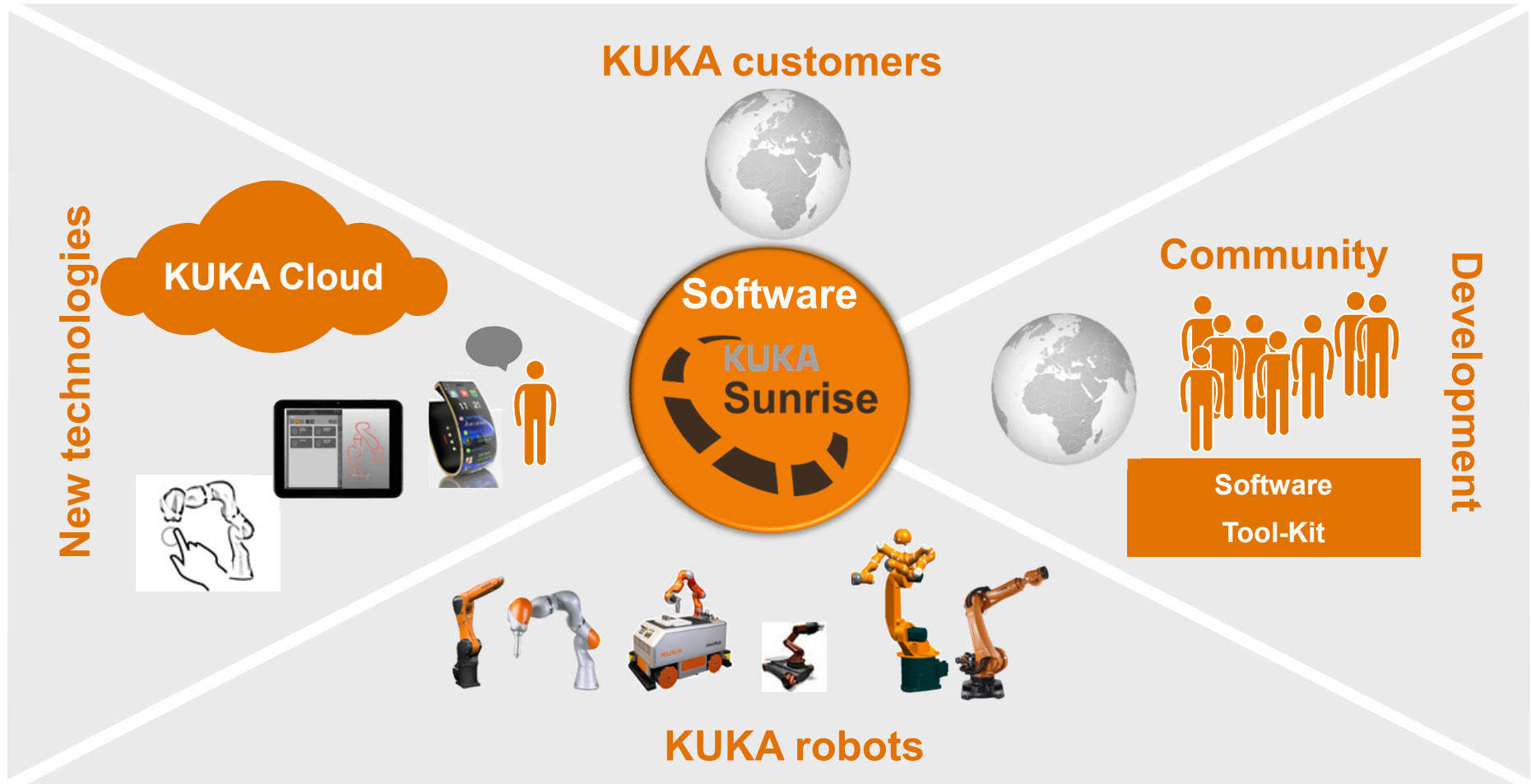
Sunrise control systems

Enables safe and sensor-based multi-kinematics



Future development

Sunrise develops new markets for KUKA



Growth through technology

Sunrise – using mainstream technology

[+] Operating



[+] Programming

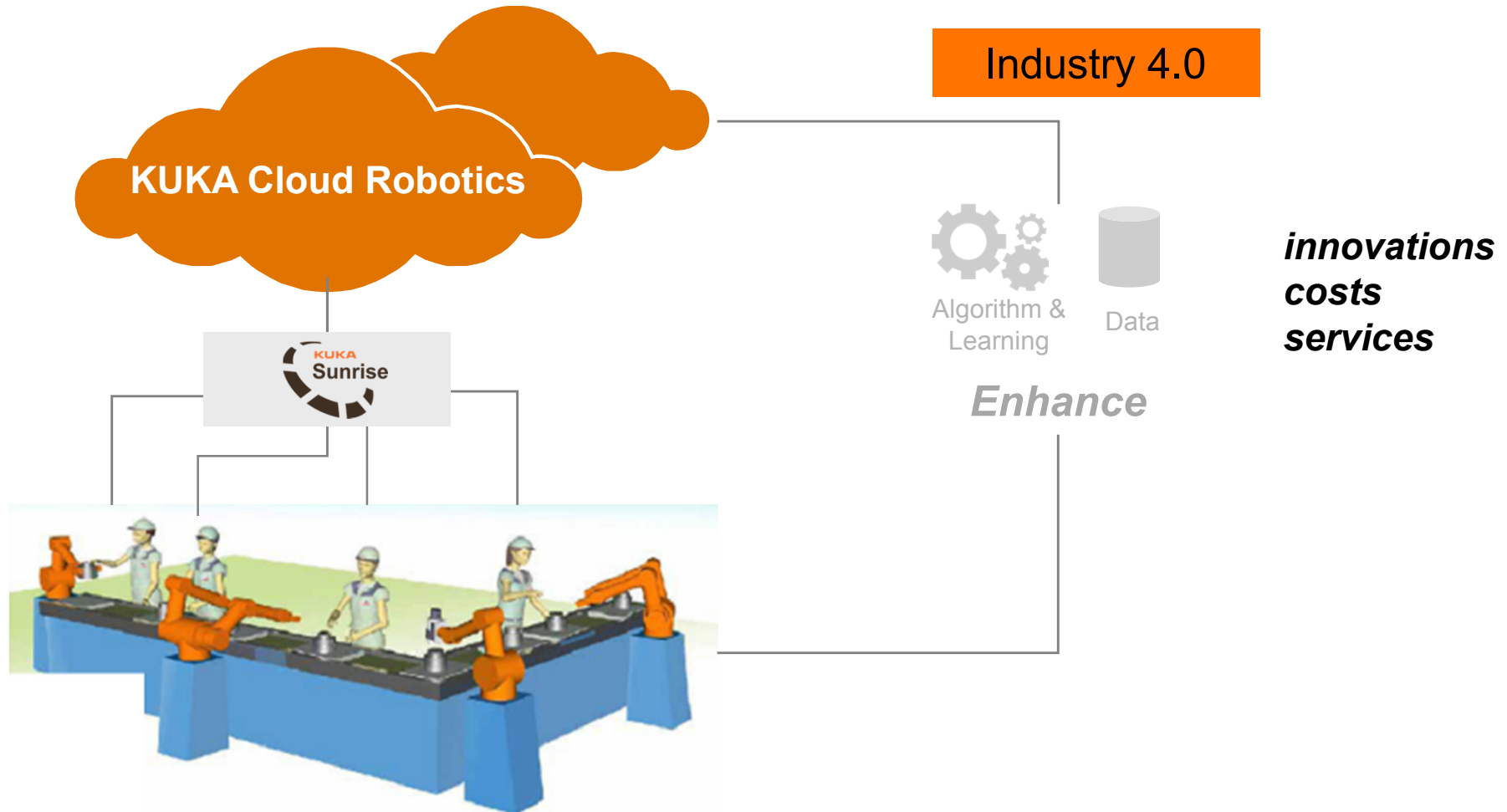


[+] Hardware



Growth through technology

Sunrise – towards to the 4th Robotic Revolution



sensor-based, multi-kinematics, mobile, human robot collaboration



Disclaimer

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